SHRI SHIVAJI EDUCATION SOCIETY AMRAVATI'S

SHRI SHIVAJI COLLEGE OF ARTS, COMMERCE AND SCIENCE, AKOLA

NEAR SHIVAJI PARK, AKOLA – 444003

(NAAC Reaccredited with A++ Grade, CGPA- 3.58)

UGC Status of College with Potential for Excellence, Lead College Status by Parent

University, DST FIST Support

Website: www.shivajiakola.ac.in

Criterion- 3

3.3.2.1

Number of Research Papers in the Journals notified on the UGC website during the year (2023)

The information provided in this document is true and as per the official record of Shri Shivaji College of Arts, Commerce and Science, Akola.

Shri Shivaji Education Society, Amravati's

SHRI SHIVAJI COLLEGE OF ARTS, COMMERCE AND SCIENCE, AKOLA

NAAC Re-Accredited A** Grade with CGPA 3.58

UGC Status 'College with Potential for Excellence', DST-FIST level- 0 Support

Lead College Status by S.G.B.A.U. Amravati

Near Shivaji Park, Akola - 444 001 (Maharashtra)

Phone & Fax : 0724-2410438/2411039

Website : shivajiakola.ac.in E-mail : principal@shivajiakola.ac.in

Late Dr. Panjabrao alias Bhausaheb Deshmukh, Founder President | Shri. Harshvardhan P. Deshmukh, President | Dr. Rameshwar M. Bhise, Principal

No. SSCAKL/

Date : 1-7-2024

Declaration

This is to declare that the information, reports, true copies and numerical data etc. furnished in this file as supporting documents is verified by IQAC and found correct.

Dr. A. S. Raut
IQAC Co-ordinator

Dr. A. S. Raut
IQAC CO-ordinator
Shri Shivaji College of Arts,
Commerce & Science AKOLA
A++ Grade CGPA.3.58 by NAAC

Dr. R. M. Bhise
Principal

PRINCIPAL
Shri Shivaji College of Arts,
Commerce and Science
Akola

Shri Shivaji College of Arts, Com. & Science Akola. A++ Grade CGPA.3.58 by NAAC

DOI: 10.5958/0976-2469.2023.00031.3

LIBRARY HERALD
Vol 61 No 4
December 2023

Altmetric Analysis of Scholarly Articles Published in DESIDOC Journal of Library and Information Technology

Sagar Khatale*
Ashish Raut**

The present study aims to examine the altmetric presence in scholarly articles and track the academic and societal utilization of research published in the DESIDOC Journal of Library and Information Technology. The population consists of the scholarly articles published in DJLIT and indexed on the Web of Science from the year 2005 to 2020. Web of Science database was used to measure the number of article citations and Altmetric Explorer was used to get the Altmetric Attention Score. Out of the 573 scholarly articles indexed on the Web of Science, 27 (4.71%) articles had an altmetric attention score. The highest number of received citations was 63, and the highest altmetric attention score was 13. The research findings demonstrated that India is the majorcontributor with 85% of the scholarly articles to DJLIT. Twitter (43.39%) followed by Wikipedia (20.75%) are the popular digital media platforms where DJLIT articles were mentioned. Librarians were the most active readers of DJLIT research on Mendeley with 242 readers (25.07%) and the Social Science discipline with 368 highest readers (38.13%) on Mendeley who reads DJLIT Publications.

Keywords: *Altmetric, Scholarly Articles, DESIDOC Journal of Library and Information Technology, DJLIT, Web of Science*

1 INTRODUCTION

Traditional citation metrics do not provide a clear understanding of the impact of research in the scholarly world, particularly in scientific communication. In recent times a new technique is developed called "Altmetric"

* Librarian, K.J. Somaiya Institute of Dharma Studies, Somaiya Vidyavihar University, Mumbai E-mail: sagar.khatale@somaiya.edu

** Librarian, Shri Shivaji College of Arts, Commerce and Science, Akola E-mail: ashish.satvik@gmail.com

which tracks and measures the scholarly impact as well as the societal impact to evaluate research published in digital forms and formats. The term altmetric, also known as alternative metrics, appeared first in the year 2010 in "Altmetrics: A manifesto" (Priem, Tarborelli, Groth, &Neylon, 2010)[1]. The manifesto did not provide a definition but gave a clear vision of what altmetrics are. Further Priem (2014)[2] defined altmetric as the "study and use of scholarly impact measures based on activity in online tools and environments." Bornmann (2014)[3] stated that "altmetric is a term to describe web-based metrics for the impact of publications and other scholarly material by using data from social media platforms." NISO (2016)[4]defined"altmetric as a broad term that encapsulates the digital collection, creation, and use of multiple forms of assessment that are derived from activity and engagement among diverse stakeholders and scholarly outputs in the research ecosystem." Altmetric works to map the scholarly impact of web-based digital tools and tracks the qualitative data complementary to citation-based, traditional metrics with the help of persistent identifiers.

2 DESIDOC JOURNAL OF LIBRARY AND INFORMATION TECHNOLOGY (DJLIT)

DESIDOC Journal of Library and Information Technology (DJLIT) is an international, open access, peer-reviewed journal which is a bi-monthly publication. It mainly publishes research articles and review papers related to library and Information Science and Information Technology applied to libraries. DJLIT covers broad subject areas like Information systems, Knowledge management, Collection building & management, Information behavior & retrieval, Librarianship/library management, Library & information services, Records management & preservation, etc. Users of DJLIT are librarians, documentation and information professionals, researchers, students etc. DJLIT is indexed in Scopus, Web of Science (Emerging Source Citation Index), UGC-CARE, Dimensions, LISA, LISTA, EBSCO, J-Gate Plus, Proquest, Library Literature and Information Science Index/Full-text, The Informed Librarian Online, Indian Science Abstracts, Indian Citation Index, WorldCat, Google Scholar, etc.[5] The periodical started in 1980 as DESIDOC Bulletin-a four-page newsletter-basically to publish the activities of the DESIDOC. In the late 1980s, a new era of information technology dawned in India. In 1992, the Bulletin was renamed as DESIDOC Bulletin of Information Technology (DBIT). In 2008, DBIT became a primary research journal and was again renamed as DESIDOC Journal of Library and Information Technology (DJLIT). Since then, only primary research work, after peer-evaluation, is accepted for publication.[6]

3 NEED AND SIGNIFICANCE OF THE STUDY:

Traditional metrics like article citation counts and journal impact factor usually take a longer time and reflect only one dimension of the impact of research but altmetric provides immediate information with broader picture of article impact.[7] Scholarly articles published in DJLIT are often practical oriented so scholarly as well as the societal impact of research may be judged more broadly by using altmetric data instead of relying on only traditional metrics. The basic purpose of this research is to examine the altmetric presence in scholarly articles and track the academic and societal utilization of research published in DJLIT.

4 REVIEW OF LITERATURE

Akers (2017)[7] conducted a study to introduce altmetric to the Journal of the Medical Library Association (JMLA) and explained how altmetrics may be better than traditional citations in reflecting the impact of JMLA articles. Erfanmasnesh (2017)[8] conducted a study to examine the altmetric presence in articles published in Scopus-indexed Library and Information Science (LIS) journals. Ezema&Ugwu (2019)[9] studied the research impact of Library and Information Science (LIS) journals using Web of Science (WoS), Scopus and Google Scholar (GS) and then examined whether there is a correlation between their citations and altmetric attention. Rangaswamy&Rajenrda Babu (2019)[10] examined which journals and articles have got the high citations as well as an altmetric attention score in the field of Library and Information Science. The objective of this study was to analyze 5 LIS journals indexed by Google Scholar Metrics 2019. Sankar and Sarangapani (2020)[11] explored the coverage of LIS literature published in 2019 with the primary objective as to know the scholarly communication of LIS Literature on social media and evaluate the altmetric attention score. Tang & Vann (2020)[12] investigated the multidimensional perspective of scholarly articles published in the top-tier Library and Information Science (LIS) journals. The relationships between the impact factors (altmetric attention score, citation count and Mendeley readership) were analyzed, and reader profiles were characterized and studied.

5 OBJECTIVES OF THE STUDY

1. To find out the country-wise count of scholarly articles published in DJLIT and indexed in Web of Science.
2. To find out the top ten highly cited scholarly articles published in DJLIT and indexed in Web of Science.
3. To track altmetric presence in scholarly articles published in DJLIT.
4. To identify mostly used digital media platforms by DJLIT readers for sharing research.

5. To find out the geographical and demographical details of Mendeley readers by professional status and readers by discipline.

6 SCOPE AND LIMITATIONS OF THE STUDY

The scope of the study was limited to the articles published in DESIDOC Journal of Library and Information Technology (DJLIT), which was indexed in the Web of Science (WoS) core collection under the Emerging Sources Citation Index (ESCI).In Web of Science, the search query was run limited to articles published between 2005 to 2020, with a Digital Object Identifier (DOI) and indexed the literature of Library and Information Science under the subject area (Category) namely 'Information Science & Library Science.' All other types of documents that are indexed in the Web of Science like Editorial Material, Review, Early Access, Letter, Correction, Biographical Item, Book Review, Proceedings Paper, News Item, Database Review, Bibliography, Software Review, Retraction, Retracted Publication, Hardware Review, Art Exhibit Review, etc. were excluded from this study.

7 MATERIALS AND METHODS

A quantitative method was adopted for this study. All statistical data of scholarly articles were collected through structured observation by reviewing the Web of Science and Altmetric Explorer databases.

7.1 Data Sources

"Web of Science (WoS) is the world's most trusted publisher-independent global citation database. Guided by the legacy of Dr. Eugene Garfield, inventor of the world's first citation index, the Web of Science is the most powerful research engine, delivering best-in-class publication and citation data for confident discovery, access and assessment".[13]

"Altmetric.com is a London-based digital science company with a vision to track and analyze the online activity around scholarly research outputs"[14]

7.2 Data Collection

Data were collected in two types i.e. primary data and secondary data.

7.2.1 Primary Data

The primary bibliographic data of the scholarly articles published in DESIDOC Journal of Library and Information Technology were retrieved from Web of Science core collection and used Emerging Sources Citation Index (ESCI) as DESIDOC Journal of Library and Information Technology is indexed in ESCI from the year 2005. Accordingly, the time span of this study was from the year 2005 to 2020.To retrieve the primary data, a structured

query was run in Web of Science with the following fields with tags:

- Publication Title (SO): DESIDOC Journal of Library and Information Technology
- DOI (DO): 10.*
- Publication Year (PY): 2005-2020
- Document Type (DT): Article

573 bibliographic records of scholarly articles were retrieved by executing the above query in the advanced search option of Web of Science.(Image 1) The above query was run on 23rd August 2021 and all the data was collected on the same date.

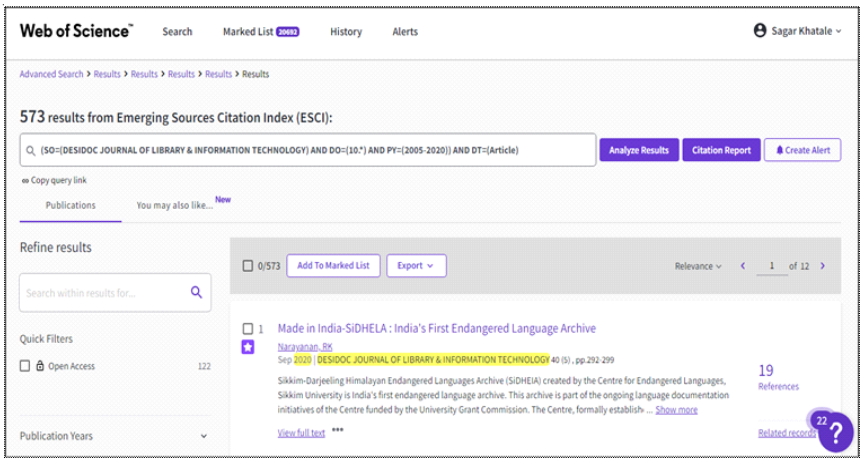


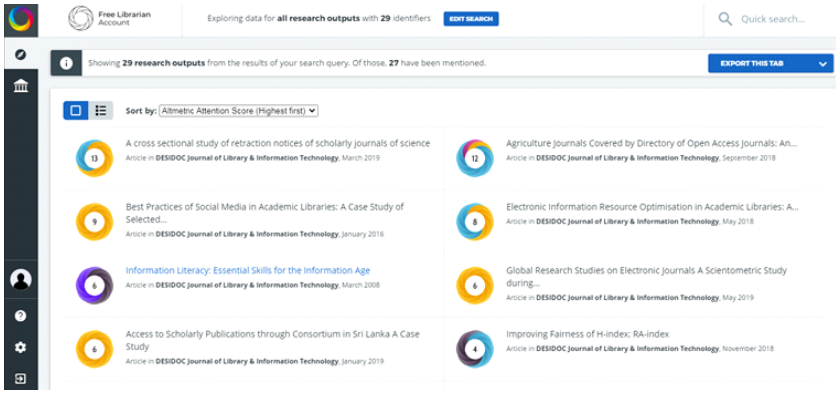
Image 1: Web of Science Search Results

7.2.2 Secondary Data

Altmetric.com provides login based free service of altmetric explorer (Research Output Tab) to librarians as a Free Librarian Account where one can search the research outputs using different scholarly identifiers like Digital Object Identifier, ArXiv ID, etc. Maximum 50 scholarly identifiers are allowed in each search.

The retrieved primary bibliographic data of 573 scholarly articles from Web of Science were checked in the altmetric database using Altmetric Explorer. 12 Search queries of 50 DOI'swere run in altmetric explorer to retrieve the secondary data. Out of 573 scholarly articles from Web of Science, 29 articles are tracked by altmetric.com out of those 27 (4.71%) scholarly articlesreceived at least 01 Altmetric Attention Score. (Image 2) All the details of the 27 articles tracked by altmetric.com were saved in excel file for further analysis.

(*Source*: Altmetric.com)



(Source: Altmetric.com)

Image 2: AltmetricExplorer Search Results

8 DATA ANALYSIS

Data retrieved from Web of Science and Altmetric Explorer is further analyzed to get the results of the research.

Article 1	A cross-sectional study of retraction notices of scholarly journals of science	Mar-2019	39 (2)
Article 2	Agriculture Journals Covered by Directory of Open Access Journals: An Analytical Study	Sep-2018	38 (5)
Article 3	Best Practices of Social Media in Academic Libraries: A Case Study of Selected Engineering College Libraries of Odisha	Sep-2016	36 (5)
Article 4	Electronic Information Resource Optimisation in Academic Libraries: A Comparative Study on Licensing Provision of Commercial Publisher	May-2018	38 (3)
Article 5	Access to Scholarly Publications through Consortium in Sri Lanka A Case Study	Jan-2019	39 (1)
Article 6	Global Research Studies on Electronic Journals A Scientometric Study during 1990 2017	May-2019	39 (3)
Article 7	Information Literacy: Essential Skills for the Information Age	Mar-2008	28 (2)

Article 7	Information Literacy: Essential Skills for the Information Age	Mar-2008	28 (2)
Article 8	Improving Fairness of H-index: RA-index	Nov-2018	38 (6)
Article 9	Finding Facets of Academic Integrity and Plagiarism through the Prism of a Citation Database	Mar-2019	39 (2)
Article 10	Secure Authenticated Key Exchange Protocol for Credential Services	Jul-2009	29 (3)
Article 11	Open Access to Electronic Theses and Dissertations	Jan-2008	28 (1)
Article 12	Retrospective Conversion of Nehru Memorial Museum and Library: Issues and Perspective	May-2008	28 (3)
Article 13	Bibliometrics to Altmetrics: Changing Trends in Assessing Research Impact	Jul-2015	35 (4)
Article 14	Research Contribution of Prof Atul H. Chokshi to Materials Science: A Scientometric Study	2013	33 (5)
Article 15	Open Access and Open J-Gate	Jan-2008	28 (1)
Article 16	Analysis of Open Access Scholarly Journals in Media & Communication	2013	33 (5)
Article 17	Development of Public Libraries through Public-private Partnership in India: Issues and Challenges	2013	33 (1)
Article 18	Building Subject Gateway in a Shifting Digital World	Mar-2009	29 (2)
Article 19	Collection Development in the E-content World: Challenges of Procurement, Access and Preservation	2013	33 (2)
Article 20	Corporate Social Responsibility: Activities in and around Visakhapatnam City	2013	33 (1)
Article 21	Indexing of Indian Journals in SCImago Citation Database: A Decadal Study (2005-2014)	Jan-2017	37 (1)
Article 22	Regulations to Prevent Plagiarism in Higher Education in India A Critical Appraisal	Mar-2019	39 (2)

Article 22	Regulations to Prevent Plagiarism in Higher Education in India A Critical Appraisal	Mar-2019	39 (2)
Article 23	Management of University Research Publication: A Case Study of JUIT Publication Database (JPubDB)	Jul-2016	36 (4)
Article 24	Journal Packing Density across Subject Disciplines among BRICS Countries: A Study	May-2018	38 (3)
Article 25	Availability of Open Access Books in DOAB: An Analytical Study	Mar-2016	36 (2)
Article 26	Tradition and Transition: The Journey of an iSchoolDeep in the Heart of Texas	Jan-2017	37 (1)
Article 27	Development of Online Legal Information System Lawyers Perceptions	Mar-2019	39 (2)

Table 1: Article Numbers with Title

Table 1 shows the list of all 27 articles with titles, published in DJLIT which were tracked by Altmetric.

8.1 Country-Wise count of Scholarly Articles Published in DJLIT

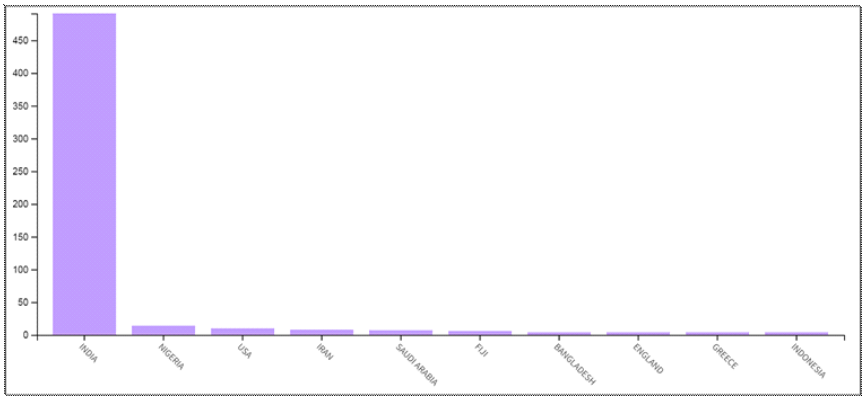


Figure 1: Country-wise count of Scholarly Articles Published in DJLIT

DJLIT has received contributions of scholarly articles from 32 countries of the world.The top10 countries in terms of the highest contribution of scholarly articles were taken for the analysis.From the 573 scholarly articles of DJLIT indexed in Web of Science, 491 (85.69 %) articles were contributed

by India, followed by Nigeria 14 (2.43 %), USA 10 (1.75 %), Iran 8 (1.40 %), Saudi Arabia 7 (1.22 %), etc. Data related to scholarly articles which are published in DJLIT showed that most articles (n=57) had been published in 2017 and 2018 and the least (n=5) in 2005.

8.2 Top Ten Highly Cited Scholarly Articles

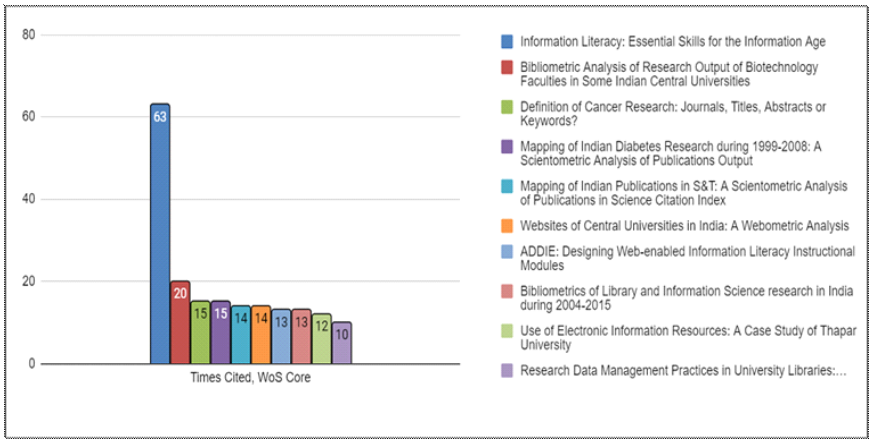


Figure 2: Top Ten Highly Cited Scholarly Articles

Figure 2 shows that the article "Information Literacy: Essential Skills for the Information Age" was the highly cited scholarly article with 63 citations and the only article from top ten highly cited articles that altmetric also tracks with an altmetric attention score of 6.

8.3 Altmetric presence in DJLIT articles:

Article Number	Altmetric Attention Score	Total Mentions																	Number of Mendeley readers
		News	Blog	Policy	Patent	Twitter	Peer review	Weibo	Facebook	Wikipedia	Google+	LinkedIn	Reddit	Pinterest	F1000	Q&A	Video	Syllabi	
Article 1	13	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12
Article 2	12	0	2	0	0	6	0	0	0	0	1	0	0	0	0	0	0	0	13
Article 3	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
Article 4	8	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12
Article 5	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Article 6	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Article 7	6	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	443

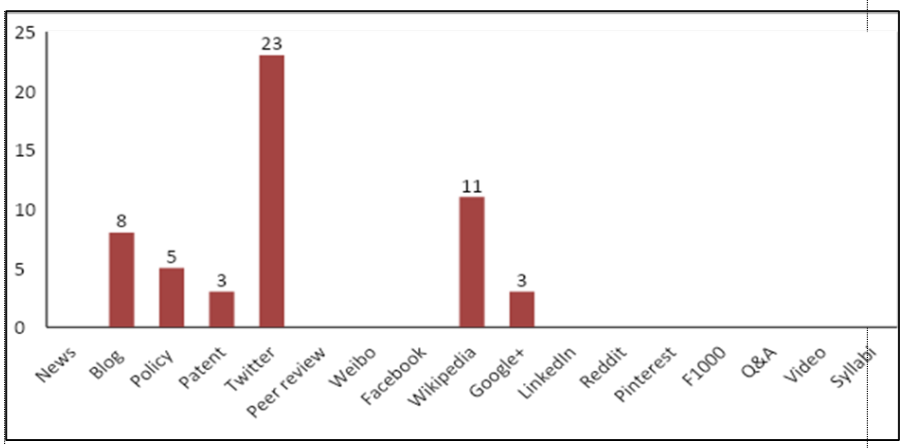
Article 8	4	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	10
Article 9	4	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	17
Article 10	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Article 11	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
Article 12	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4
Article 13	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92
Article 14	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	21
Article 15	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	14
Article 16	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
Article 17	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	21
Article 18	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	8
Article 19	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	32
Article 20	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Article 21	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	36
Article 22	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	22
Article 23	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	25
Article 24	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	8
Article 25	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	19
Article 26	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	15
Article 27	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	16

(*Source*: Altmetric.com)

Table 2: Altmetric presence in DJLIT articles

Table 2 demonstrates the Altmetric presence in DJLIT published research. Out of the total 573 scholarly articles indexed in Web of Science, Altmetric tracked 29 articles (5.06%) from which 27 (4.71%) articles received at least 01 Altmetric Attention Score. Out of 27 articles which altmetric attention score, 10 scholarly articles (37.04%) published in recent two years of data collection i.e. 2019 (n=06) and 2018 (n=04).An article titled 'A cross-sectional study of retraction notices of scholarly journals of science' receivedthe highest Altmetric Attention Score of 13.Article 07 titled 'Information Literacy: Essential Skills for the Information Age' got 443 readers on Mendeley which is highest from all scholarly articles.

8.4 Mostly Used Digital Media Platforms by DJLIT Readers



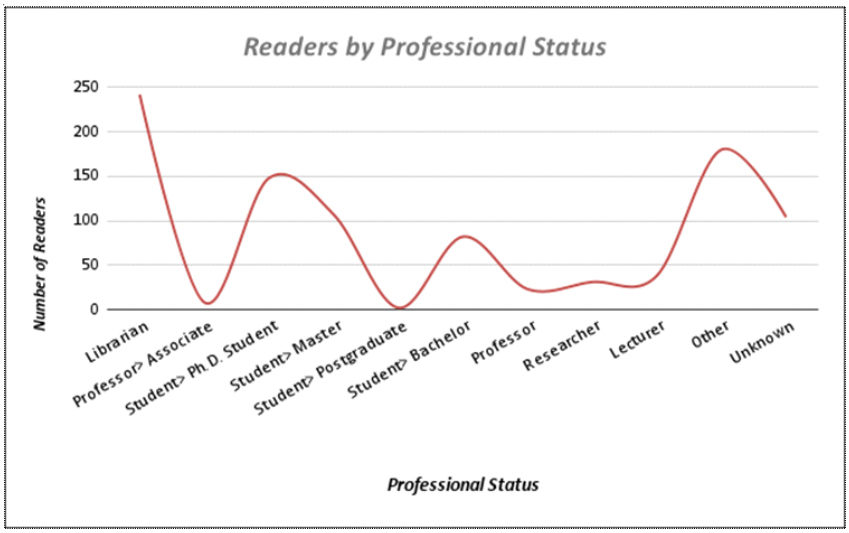
(*Source*: Altmetric.com)

Figure 3: Mostly Used Digital Media Platforms by DJLIT Readers

Figure 3 shows the mostused digital media platforms by DJLIT readers. Altmetric tracked 17 different digital media platforms to get the digital footprints of research published in DJLIT. Out of the total platforms, DJLIT users used Twitter (43.39%) to mention and share research published in DJLIT scholarly articles. The next highest number of mentions was on Wikipedia (20.75%) followed by Blog (15.09%), Policy (09.43%), Patent (05.66%) and Google+ (05.66%).

8.5 Demographic Details of Readers by Professional Status

Mendeley reader count is good evidence of the early impact of scientific output since it appears before citations.[15]



(*Source*: Altmetric.com)

Figure 4: Demographic Details of Readers by Professional Status

Figure 4 and Table 3 demonstrated the DJLIT readers on Mendeley by their professional status.There were mainly 11 categories of readers, including Librarian, Professor, Associate Professor, Lecturer, Researcher, Ph.D., Postgraduate, Master and Bachelor Students; Others and Unknown readers.Librarians were the active readers of DJLIT research on Mendeley with 242 readers (25.07%). The second highest category was the 'other'180 readers (18.65%) indicating that the non-academic community showed good interest in reading DJLIT research.The third highest number of users who reads DJLIT articleswas Ph.D. students with 148 readers (15.34%) followed by 107 Master'sstudents (11.09%).Lecturers (3.94%) were more active readers than Professors (2.38%)and Associate Professors (0.83%).

Article Number	Librarian	Associate Professor	Ph.D. Student	Master Student>	Postgraduate Student>	Bachelor Student>	Professor	Researcher	Lecturer	Other	Unknown	Total
Article 1	5	2	2	--	--	--	1	--	--	--	2	**12**
Article 2	3	--	1	--	--	2	1	--	--	4	2	**13**
Article 3	7	--	--	7	2	--	--	3	--	9	4	**32**
Article 4	3	--	2	1	--	--	--	2	--	2	2	**12**
Article 5	3	--	3		--	--	1	--	--	--	2	**9**

Article 6	3	1	2	1	--		--	2	--	--	4	**13**
Article 7	106	--	54	52	--	65	--	--	27	91	48	**443**
Article 8	1	--	6	1	--	--	--	--	--	--	2	**10**
Article 9	4	--	5	--	--	1	1	--	--	4	2	**17**
Article 10	--	--	--	--	--	--	--	--	--	--	--	**0**
Article 11	9	--	6	4	--	--	3	--	3	4	--	**29**
Article 12	--	--	2	--	--	--	1	--	--	--	1	**4**
Article 13	20	--	17	17	--	--	--	10	--	21	7	**92**
Article 14	5	--	4	3	--	--	1	--	--	3	5	**21**
Article 15	7	--	2	1	--	--	1	--	--	3	--	**14**
Article 16	14	--	3	4	--	5	--	3	--	8	1	**38**
Article 17	2	--	5	5	--	--	2	--	--	5	2	**21**
Article 18	4	--	1	--	--	--	1	2	--	--	--	**8**
Article 19	11	--	9	5	--	2	--	--	--	4	1	**32**
Article 20	--	--	1	1	--	--	1	--	1	--	--	**4**
Article 21	3	--	12	--	--	--	5	7	5	4	--	**36**
Article 22	9	--	3	--	--	--	1	--	--	4	5	**22**
Article 23	7	4	2	--	--	2	--	2	--	5	3	**25**
Article 24	1	1	2	1	--	--	1	--	--	1	1	**8**
Article 25	8	--	1	--	--	1	1	--	--	5	3	**19**
Article 26	3	--	--	3	--	1	1	--	2	3	2	**15**
Article 27	4	--	3	1	--	3	--	--	--	--	5	**16**
Total	**242**	**8**	**148**	**107**	**2**	**82**	**23**	**31**	**38**	**180**	**104**	**965**

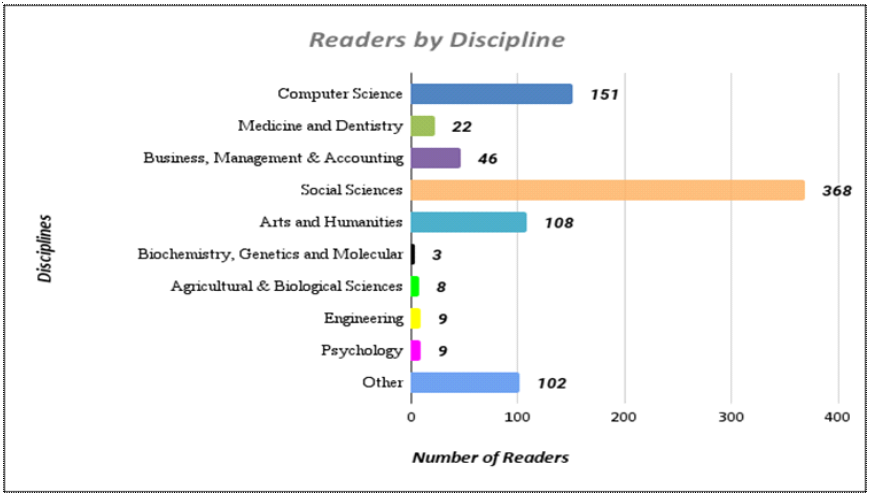
(*Source:* Altmetric.com)

Table 3: Demographic Details of Readers by Professional Status

8.6 Readers by Discipline

Data in Figure 5 shows the discipline-wise readers of DJLIT scholarly articles on Mendeley. The top 10 disciplines were selected for analysis as per

the highest number of readers from 18 different fields. the discipline identified as 'Unknown' in Mendeley was excluded from the analysis. Readers who belong to the Social Sciences discipline were the top readers with 368 readers (38.13%). Out of the total readers, 151 (15.64%) readers were from Computer Science, which stood as the second-highest discipline in terms of readership. The next highest discipline was Arts and Humanities with 108 readers (11.19%) and on the other hand, readers from the 'other' disciplines with 102 readers (10.57%)showed a great interest in reading DJLIT publications.



(*Source*: Altmetric.com)

Figure5: Details of Readers by Discipline

9 FINDINGS

This study investigated the altmetric presence in scholarly articles published in the DESIDOC Journal of Library and Information Technology with the highest digital media mentions. No doubt India has dominated the contribution to the journal as DJLIT is an Indian publication with 85.69 percent share amongst 32 countries who participated and published research inDJLIT. Articles published in the journal have received attention from 08 different digital media sources.27 out of the total 573 publications (with valid DOI) have received at least one attention from digital media platforms.Twitter was the platform providing the most altmetric data for DJLIT publications followed by Wikipedia mentions. Except for Twitter 43.39%,the results showed that the presence of DJLIT scholarly articles on other digital media platforms is not high, as just 15.9% of articleswere shared inBlog, 09.43%were mentioned in the Policy and 5.66% were mentionedin Patent. News, Peer Review, Weibo, Facebook,

LinkedIn, Reddit, Pinterest, F1000, Q&A, Video and Syllabi do not get even one mention for all the 27 articles tracked by Altmetric.

Mendeley is also the major source of altmetric data. This study made a profession-wise and discipline-wise comparison of the Mendeley readership of research outputs published in DJLIT.Mendeley's readership varied according to the user categories for DJLIT Publicationshowever the Librarians were reported as the highest readers. The possible reason for the highest readership by the Librarians is the subject coverage of DJLIT is Library and Information Science.Discipline-wise analysis of readership showed that 18different disciplines (including unknown) read DJLIT scholarly articles with higher readership recorded from Social Sciences, followed by Computer Science.Library and Information Technology is an interdisciplinary subject that comes under the Social Sciencesand is closely related to Computer Science.

10 CONCLUSION

DESIDOC Journal of Library and Information Technology is a well-known journal in the academic fraternity. DJLIT has set a standard to publish research related to new tools and Technologies in the field of Library and Information Science. Journal gives free online open access hence it is one of the highly preferred journalby the LIS Professionals in India. Academicians and researchers use this journal regularly to publish their research and readers to update themselves with current research performed in Library and Information Science.Findings of the research shows thatDJLIT gets very less online attention over the platforms that altmetric measure meaningthe awareness of societal impact amongst DJLIT users is less. It is suggested that the DJLIT should approach altmetric.com and enable journal-level altmetric service to track online attention more effectively and encourage the users to share and mention the research on digital media platforms as well.

Altmetric plays a vital role in measuring academic and social information and knowledge and helps to track the influence of information that is shared via various digital media platforms. Academicians have to understand the role of Altmetric in research communication and must use this new technique in the process of research evaluation.It is the need of time to study and explore the Altmetric technique to measure the research impact not only in the academic community but also in social engagements.

REFERENCES

1. PRIEM (J), TARABORELLI (D), GROTH (P)and NEYLON (C). Altmetrics: A manifesto, 26 October 2010. http://altmetrics.org/manifestoaccessed on 08.08.2022.

2. PRIEM(J).Altmetrics,*In*CRONIN (B) and SUGIMOTO(C R), Eds., Beyond bibliometrics: Harnessing multidimensional indicators of scholarly impact. 2014. MIT Press: Cambridge, MA. Pp. 263–288.
3. BORNMANN (L).Do altmetrics point to the broader impact of research? An overview of benefits and disadvantages of altmetrics. *Journal of Informetrics*, 8,4; 2014; 895–903. DOI: https://doi.org/10.1016/j.joi.2014.09.005
4. National Information Standards Organization (NISO) Outputs of the NISO Alternative Assessment Metrics Project. *NISO RP-25-2016,* 2016.
5. DESIDOC Journal of Library and Information Technology. https://publications.drdo.gov.in/ojs/index.php/djlit/about accessed on 09.08.2022
6. KUMAR (M)and MOORTHY (A). Bibliometric Analysis of DESIDOC Journal of Library and Information Technology from 2001-2010. *DESIDOC Journal of Library & Information Technology*, 31, 3; 2011.https://doi.org/10.14429/djlit.31.3.989
7. AKERS (K G).Introducing altmetrics to the Journal of the Medical Library Association. *Journal of the Medical Library Association,* 105, 3; 2017. https://doi.org/10.5195/jmla.2017.250
8. ERFANMASNESH (M). Highly-alted articles in Library and Information Science. *Webology*, 14, 2; 2017; 66-77. https://www.webology.org/data-cms/articles/20200515031407pma158.pdf
9. EZEMA (I J)and UGWU (C I). Correlating research impact of library and information science journals using citation counts and altmetrics attention. *Information Discovery and Delivery*, 47, 3; 2019; 143–153. https://doi.org/10.1108/IDD-08-2018-0029
10. RANGASWAMY and RAJENDRA (B H). An Altmetric Analysis of top journals in Library and Information Science. In: Angadi, M. & others (Eds.), *Digital Technologies and Transformation in Academic Libraries*, 2019, Vol.2., pp. 352-357. New Delhi: Shree Publishers and Distributors.
11. SANKAR (V)and SARANGAPANI (R). Scholarly Communication of Library and Information Science Literature on SocialMedia: an Altmetrics Analysis, 2020, https://digitalcommons.unl.edu/libphilprac
12. TANG (Y), TSENG (H)and VANN (C). Unwrap citation count, Altmetric Attention Score and Mendeley readership status of highly cited articles in the top-tier LIS journals. *Global Knowledge, Memory and Communication*,69, 8/9; 2020; 653–664.
13. https://clarivate.com/webofsciencegroup/solutions/web-of-science/ accessed on 08.08.2022
14. https://www.altmetric.com/about-us/ accessed on 08.08.2022
15. VYSAKH (C)and RAJENDRA (B H). Who Reads Indian and Chinese LIS Articles on Mendeley? Scoping and Comparing User Categories Through Altmetrics. *Journal of Information Science Theory & Practice (JIStaP)*,9, 4; 2021; 75–83. https://doi.org/10.1633/JISTaP.2021.9.4.6

Journal of Molecular Structure 1281 (2023) 135107

Contents lists available at ScienceDirect

Journal of Molecular Structure

journal homepage: www.elsevier.com/locate/molstr

Synthesis of new heterocyclic N'-(2–hydroxy-3-methoxybenzylidene)-4-oxopiperidine-1-carbohydrazide and its mononuclear metal (II) complexes: Spectroscopic characterization, fluorescence, DFT, thermo-kinetic, and antimicrobial studies

Gajanan Dongare[a], Anand Aswar[b,*]

[a] Department of Chemistry, Shri Shivaji College of Arts, Commerce and Science, Akola, 444001. MS, India
[b] Department of Chemistry, Sant Gadge Baba Amravati University, Amravati, 444602. MS, India

ARTICLE INFO

Article history:
Received 4 November 2022
Revised 17 January 2023
Accepted 5 February 2023
Available online 7 February 2023

Keywords:
Heterocyclic hydrazone
Metal complexes
Spectroscopic characterization
Fluorescence emission
DFT
TGA
Biological activity

ABSTRACT

New hydrazone Schiff base N'–(2–hydroxy-3-methoxybenzylidene)-4-oxopiperidine-1-carbohydrazide (H_2L), synthesized by the condensation reaction of 2–hydroxy-3-methoxybenzaldehyde (HMB) and 4-oxopiperidine-1-carbohydrazide (CPH), form mononuclear complexes, $[Mn(HL)(Cl)(H_2O)_2]$, $[Co(HL)(Cl)(H_2O)_2]$, $[Ni(HL)(Cl)(H_2O)_2]$ and $[Cu(HL)(Cl)\ (H_2O)_2]$. The formation of ligand was confirmed by elemental analysis, melting point, IR, ^1H and ^{13}C NMR, and ESI-Mass spectroscopy, Cu(II) complex was further examined by ESR spectroscopy. Other properties, like, molar conductance, IR, electronic spectra, magnetic susceptibility, DFT, powder X-ray diffractometer, fluorescence and thermal analysis have also been studied. Powder X-ray diffraction patterns inferred that compounds are nanocrystalline nature. Surface morphology further support this observation. All compounds show good absorption properties and in excited state at (λ_{334nm}), the fluorochromes of the ligand and its metal (II) complexes emitted a good fluorescence emission with the resonation of 0.2 nm in (λ_{527-}545 nm) region. The DFT B3LYP/6–311G+(d,p) calculations were carried out for the determination of the optimized structure of ligand (H_2L) and its metal complexes. The frontier MOs energies data indicated good charge transfer (*CT*) from HOMO to LUMO. Thermal study of complexes monitored under nitrogen atmosphere led us to determine the activation parameters of various decomposition steps. On the basis of activation energy evaluated by Coat-Redfern relation, thermal stability order was found to be Ni(II)<Cu(II)<Mn (II)<Co(II). The ligand and complexes have also been screened for their antibacterial and antifungal potency and metal complexes showed higher activity against multi-stranded microorganisms viz. gram -ve bacteria (*Escherichia coli* and *Salmonella. typhi)*, gram + ve bacteria (*Staphylococcus aureus, Bacillus substilis)* and fungal species (*Candida albicans, Aspergillus niger).*

© 2023 Elsevier B.V. All rights reserved.

1. Introduction

Heterocyclic moiety involving hydrazones have gained wide applications, and proven to be a very promising, versatile motif in the medicinal chemistry and drug design. Hydrazone based Schiff bases offer an adaptable series of ligands proficient to tie with different metal ions to give edifices for their various applications. Hydrazone based Schiff bases can be considered to be one of the most researched group of chemical molecules by researchers, the reasons being their versatility, selectivity, sensitivity, stability, and ease of synthesis, just to mention a few, which resulted in their wide applications. It has been reported that the azomethine functional group containing molecules contribute to their bioactivity by interacting and forming intramolecular hydrogen bonding with some responding sites within the cell structure, and thus affects the regular cell processes and signifies their biological significance. Similarly, the lone pair of electrons on the sp^2 hybridized orbital of the azomethine nitrogen is another reason for their chemical reactivity. The compounds of hydrazone Schiff base are not only synthons for the synthesis of new metal complexes but also exhibit interesting coordination mode [1–6]. The chemistry of hydrazones containing piperidine ring and their metal complexes is fascinating due to their importance in pharmacological, clinical, analytical and biological applications such as antimalarial, antibacterial, antifungal, and antiviral activities antioxidant, anti-inflammatory, anticonvulsant, analgesic, antimicrobial, anticancer, antiprotozoal,

* Corresponding author.
E-mail address: aswaranand@gmail.com (A. Aswar).

https://doi.org/10.1016/j.molstruc.2023.135107
0022-2860/© 2023 Elsevier B.V. All rights reserved.

antioxidant, antiparasitic, antiplatelet, cardioprotective, anthelmintic, antidiabetic, antitubercular, trypanocides and anti-HIV activities [7–8]. Their tautomerism, an ability to exist either in enol or keto structural forms gives them the potential to form different types of interesting coordination compounds. The architectural beauty of coordination compounds is due to the interesting ligand systems involving different donor sites say ONO, NNO, NO and NNS. Among the N–O donor ligands, hydrazones possess a special place due to their ease of synthesis, easily tunable electronic properties, denticity and formation of wide variety of complexes with chemical, structural, biological and industrial importance. Further, the remarkable biological activity of aroyl hydrazones and their mode of chelation with transition metal ions present in the living systems have been of significant interest because possessing biological and pharmaceutical properties [9–11]. The ONO triatomic donor ligand systems improve metal complexation, reactivity's, stability, physicochemical property [12–18]. Schiff base ligands like hydrazones are considered privileged ligands because they are easily prepared by a simple one-pot condensation of a carbonyl compound and primary amines in an alcoholic medium. Heterocyclic moiety of hydrazone is an important pharmacophore associated with various interesting types of biological effects which provides an extensive opportunity in exploring this moiety as an antimicrobial agent.

The literatures survey revealed that no attention has been paid to the synthesis of the N'-(2-–hydroxy-3-methoxybenzylidene)–4-oxopiperidine-1-carbohydrazide and its Mn(II), Co(II), Ni(II) and Cu(II) complexes . Furthermore, due to the resistance of antimicrobial agents, there is a continued need for developing heterocyclic compounds with good microbial activity. Hence, it was thought of interest and in view of our continuing interest in a heterocyclic hydrazone, we designed and synthesized new hydrazone Schiff base contains heterocyclic moiety derived from 2-–hydroxy-3-methoxybenzaldehyde (HMB) with 4-oxopiperidine-1-carbohydrazide (H_2L) and its Mn(II), Co(II), Ni(II) and Cu(II) complexes. The compounds were characterized by elemental, molar conductance, IR, electronic spectra, magnetic susceptibility, DFT, SEM, XRD, fluorescence and TG analysis. Also, present a DFT and the evaluation of their biological activity.

2. Experimental

2.1. Materials

All the chemicals used in this study were of analytical reagent grade and acquired from Avra synthesis, S.D. fine chemicals, and Hi-media and used without further purification. Solvents used for the reactions were purified, and dried by conventional methods. The silica granules of size 60–100 mess were used to remove the water contents from all solvents.

2.2. Analysis and physical measurements

The FT-IR spectra of the ligand and its complexes were recorded using an Advance Bruker spectrophotometer. The elemental analysis (C, H, and N) were made using Vario El III Carlo Erba 1108 elemental analyzer. The molar conductance of complexes (10^{-3} M solutions) in DMSO were measured at room temperature using a Elico conductivity meter (180). The complexes were analyzed for their metal and halide content by gravimetric method using standard procedures. The magnetic moments of the complexes were measured at room temperature on a Sherwood scientific magnetic susceptibility balance (MK-1). The NMR spectra (^{1}H, ^{13}C) ligand were carried out on Bruker model 400 MHz using *TMS* as an internal standard (d ppm) and DMSO-–d_6 as the solvent. The mass spectrum of the ligand was done on water micro-mass spectrophotometer (Q-T range 4000–20,000 a.m.u.). The micro graphical image of ligand and their metal complexes was captured by using a JEOL-6390LV SEM at high resolution (10μm-100 μm) under the magnification (X250 - X 3000) by accelerating the voltage of 10kv. The electronic spectra were recorded on a double beam Shimadzu UV–visible spectrophotometer (1800) in the range of 200-1100 nm. The ESR spectrum of Cu(II) complex was performed on JES - FA200 in X band (Std. freq.=8.75–9 to 65 GHz in LNT) at 77–78k. The optimization of molecular structure was done out using Gaussian 09 with B3LYP and Gauss View 6.0 was used for creation of a input file for the calculation of graphical interface (3D) to evaluate the data, and generate MEP. Fluorescence spectra were recorded on a Hitachi-F-7000 spectrophotometer having a scan speed of 240 nm/min. The light source 150 W xenon lamp was used with an electrical power supply at 700 V. The monochromatic stigmatic concave diffraction with power was utilized by grating at 900 lines/mm and F 2.2 for high resolution 1.00 nm, and 1 nm wavelength accuracy. The brazed wavelength was operated at excitation 300 nm and emission 400 nm, and may expandable ~900 nm accelerated drive speed-60,000 nm/min. The simultaneous TG-DTG curves were recorded on Perkin-Elmer (TGA-4000) thermal analyzer in the temperature range 40 - 800 °C with the heating rate of 20 °C per min in N_2 atmosphere. X-ray diffractograms (pattern) were recorded on a Rigaku-Miniflex (600). The melting point was determined on digital melting point apparatus.

2.3. Synthesis of (2–hydroxy-3-methoxybenzylidene)–4-oxopiperidine-1-carbohydride (H_2L)

An equimolar mixture of 4-oxo-1-carbopiperidone hydrazide (0.314 g, 2 mmol) and 3-methoxy salicylaldehyde (0.304 g, 2 mmol) dissolved in 25 mL dry ethyl alcohol and mixture was refluxed for 4 h with a catalytic amount con.H_2SO_4 (2drops). The reaction progress was monitored by TLC. The bright yellow solid obtained was separated out by vacuum filtration, washed with dry ethanol, and finally recrystallized from DMSO. The purity of ligand was checked by TLC utilizing silica gel and shown in Scheme 1. The structure of ligand was confirmed by M.p., CHN analysis, FT-IR, NMR (^{1}H and ^{13}C), and ESI-Mass spectroscopy. Color: Yellow. Yield: 0.464 g, (75.2%), M.p.:160–162 °C.

Elemental analysis of [$C_{14}H_{17}N_3O_4$] (%): Calcd.; C, 57.72; H, 5.88; N, 14.42 and found; C, 57.94; H, 5.40; N,14.85.

FT-IR ($\bar{\nu}$, cm^{-1}): 3390 (OH, broad, Ph-OH), 3268(N–H, amide), 1678(C = O, amide), 1618(C = N azomethine), 1451(C–O, -OCH_3), 1304(C–O, phenolic), 962 (N–N, azomethine).

UV/Vis (DMSO, λ_{max}, nm, ε): 331(1.67), 290(1.15), 250(2.25).

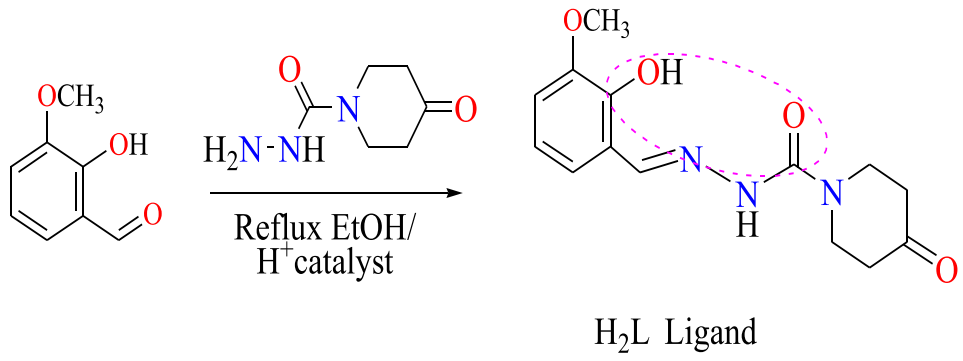
^{1H}NMR (DMSO-–d^6,500 MHz, δ ppm): 10.898(s,1H, OH, Phenolic.), 9.511 (s,1H,-C*H*=N- azomethine), 8.99 (s,1H,N*H*,amide), 6.934(d, J = 9.4 Hz, 1H,aryl-H), 7.122 (dd, J = 9.4 Hz, 1H,aryl-H), 7.303 (d, J = 9.05 Hz, 1H,aryl-H),3.839 (s, 3H, -OCH_3), and 3.358, 2.516(s, J = 4.21 Hz, 4H), 2.513,2.506 (s, J = 3.5 Hz, 4H) in the heterocyclic ring.

^{13C}NMR (DMSO–d_6, 500 MHz, δ ppm): 148.38 (C1,Ar-C, phenolic), 115.15 (C2, Ar-C), 121.92 (C3, Ar-C), 119.16 (C4, Ar-C,), 118.22 (C5, Ar-C), 147.85 (C6, Ar-C, methoxy), 162.66 (C7, C = O, amide), 55.16 (C11, -OCH_3), 147.85 (C17, HC=N, azomethine), 158.1 (C22, >NHC=O, amide), and 39.45 (C24), 39.23 (C25), 39.40 (C26), 39.56 (C28), 185.54 (C33, C = O, heterocyclic ring).

HRMS (ESI-*m/z*) calcd. for [$C_{14}H_{17}N_3O_4$], 291.30; Found $[M]^{+1}$ = 292.12.

2.4. Synthesis of Mn(II), Co(II), Ni(II), and Cu(II) complexes

Metal complexes of Mn(II), Co(II), Ni(II), and Cu(II) were synthesized by following general method. A hot ethanolic solution



Scheme 1. Synthesis of hydrazone ligand (H_2L).

Table 1
Analytical data of ligand (H_2L) and its metal (II) complexes.

Compounds	Molecular Formula	Mol.Wt. gm/mol	Elemental analysis found, (calcd.) %				
			C	H	N	Cl	Metal
Ligand [H_2L]	$C_{14}H_{17}N_3O_4$	291.30	58.00 (57.72)	5.98 (5.88)	14.60 (14.42)	–	–-
[Mn(HL)$(H_2O)_2$Cl]	$MnC_{14}H_{20}N_3O_6Cl$	416.71	40.82 (40.34)	4.70 (4.83)	10.20 (10.08)	8.60 (8.50)	13.25 (13.18)
[Co(HL)$(H_2O)_2$Cl]	$CoC_{14}H_{20}N_3O_6Cl$	420.71	40.10 (39.99)	4.99 (4.79)	10.02 (9.98)	8.90 (8.42)	14.25 (14.00)
[Ni(HL)$(H_2O)_2$Cl]	$NiC_{14}H_{20}N_3O_6Cl$	420.47	40.00 (39.99)	4.95 (4.70)	10.00 (9.99)	8.75 (8.43)	14.00 (13.95)
[Cu(HL)$(H_2O)_2$Cl]	$CuC_{14}H_{20}N_3O_6Cl$	425.32	40.00 (39.53)	4.90 (4.73)	10.00 (9.87)	8.60 (8.33)	15.07 (14.94)

of metal salt (2.0 mmol, 20 mL) [$MnCl_2{\cdot}2H_2O$, $CoCl_2{\cdot}6H_2O$, $NiCl_2.H_2O$, $CuCl_2{\cdot}2H_2O$] was added dropwise in to a hot solution of hydrazone ligand (H_2L) (2.0 mmol, 20 mL) in DMSO. The pH of the reaction mixture was maintained at ~7–8 by the addition of alcoholic ammonia (2 ml). Further, the reaction mixture was refluxed in an oil bath for ca. 4 h. The precipitate separated out during refluxing was filtered and washed with the warm ethanol and diethyl ether, and then dried in a vacuum using anhydrous $CaCl_2$ in a desiccator [19]. The elemental data, mol. formula, mol. Wt. and molar conductance values of metal complexes are summarised in **[**Table 1**]**.

3. Results and discussion

3.1. Synthesis

The equimolar amounts of 2–hydroxy-3-methoxybenzaldehyde and 4-oxo-1-carbopiperidone hydrazide react in ethanol in the presence of H^+ catalyst yields a 2–hydroxy-3-methoxybenzylidene-4-oxopiperidine-1-carbohydrazide ligand (***H_2L***) (Scheme 1). The homogeneity of the ligand was regularly checked by TLC. The reaction of the ligand with metal salts in 1:1 molar ratio in dry ethanol-DMSO affords metal complexes, [Mn(HL)$(H_2O)_2$Cl] (**1**), [Co(HL)$(H_2O)_2$Cl] (**2**) [Ni(HL)$(H_2O)_2$Cl] (**3**) and [Cu(HL)$(H_2O)_2$Cl] (**4**). The ligand behaves as monobasic tridentate coordinating through '*ONO*' donor sequence. All these metal complexes have been obtained as colored solid, stable on prolonged exposure to air and insoluble in most common organic solvents except in DMF and DMSO. The analytical data are well agreeing with the proposed components of ligand (H_2L) and its metal (II) complexes. The analytical data of the complexes along with their molar conductance values are given in Table 1. The molar conductivity of metal complexes in DMSO ($10^{-}3$ M) has low value 6.14–26.15 Sm^2mol^{-1} in DMSO indicating non electrolytic nature.

3.2. Characterization of heterocyclic hydrazone ligand (H_2L)

The ^{1H}NMRspectrum of hydrazone ligand showed low field singlet distinctly for phenolic–O*H*, azomethine proton (-*H*C=N-), and amide proton (>*N*–-H) at high frequency resonance region at δ 10.898, 9.511 and 8.99 ppm respectively (Fig. 1). Further, another singlet was observed at δ 3.893 ppm due to the methoxy proton suggesting identical protons environment around the carbon C11. The heterocyclic ring system shows the two up-field doublets in the low frequency regions at δ 3.358 ppm corresponding to four protons of the two -C*H*$_2$- group (α-position) and another two-doublet at δ 2.513 ppm appeared of four protons in another two -C*H*$_2$- group (β-position). The three non-equivalent aryl protons exhibit three doublets in the expected region of 6.934, 7.122, 7.303 ppm with well resolution. The ^{13C}NMR spectrum of the hydrazone ligand exhibits four signals at δ 39.45, 39.23, 39.40 and 39.56 ppm respectively due to the four carbons of the heterocyclic ring. The signal observed at δ 185.54 ppm assigned for the saturated carbonyl carbon of the heterocyclic ring which appeared at low intensity whereas another signal appeared at δ158.1 ppm is assigned for amide carbonyl carbon. The azomethine carbon (-H*C*=N-) signal appeared at δ 147.85 ppm. The separate signals appeared at δ 55.16 is due to methoxy carbon, and other aromatic carbons appeared well within the region of δ148.38–118.22 ppm (**Fig.S1**).

The HR-Mass spectrum of the ligand shows M^+ = 333.34 *m/z* of its molecular ion peak, considered as to its molecular mass. Some stable fragmented molecular ion species are 260.10 *m/z* ($C_{13}H_{14}N_3O_3^+$) at 100% intensity regarded as a base peak whereas other fragmented species 206.12 *m/z* and 164.10 *m/z* indicating ($C_{11}H_{16}N_3O^+$) and ($C_{10}H_{14}NO^+$) molecular ions, respectively. The HR-mass spectrum displayed a molecular ion peak M^{+1} at 292.12 is assigned to its molecular mass. The significant stable fragmented molecular ions obtained as *m/z* ($C_{13}H_{14}N_3O_3^+$) 260.17 of 100% intensity are corresponding to a base peak. The other fragmented species assigned, *m/z* with their intensities are as; ($C_{13}H_{14}N_3O_2^+$) 244 of 48.12%, ($C_7H_{10}N_3O_2^+$)168 of 32.50%, ($C_6H_9N_2O_2^+$), 141 of 24.99%, ($C_5H_8NO^+$) 98 of 22.15% (**Fig.S2**).

3.3. IR spectral analysis of hydrazone ligand (H_2L) and its metal (II) complexes

The FTIR spectra of the ligand and its metal complexes were closely compared and the modifications in frequency vibrations due to the interaction of the metal ion with the ligand were

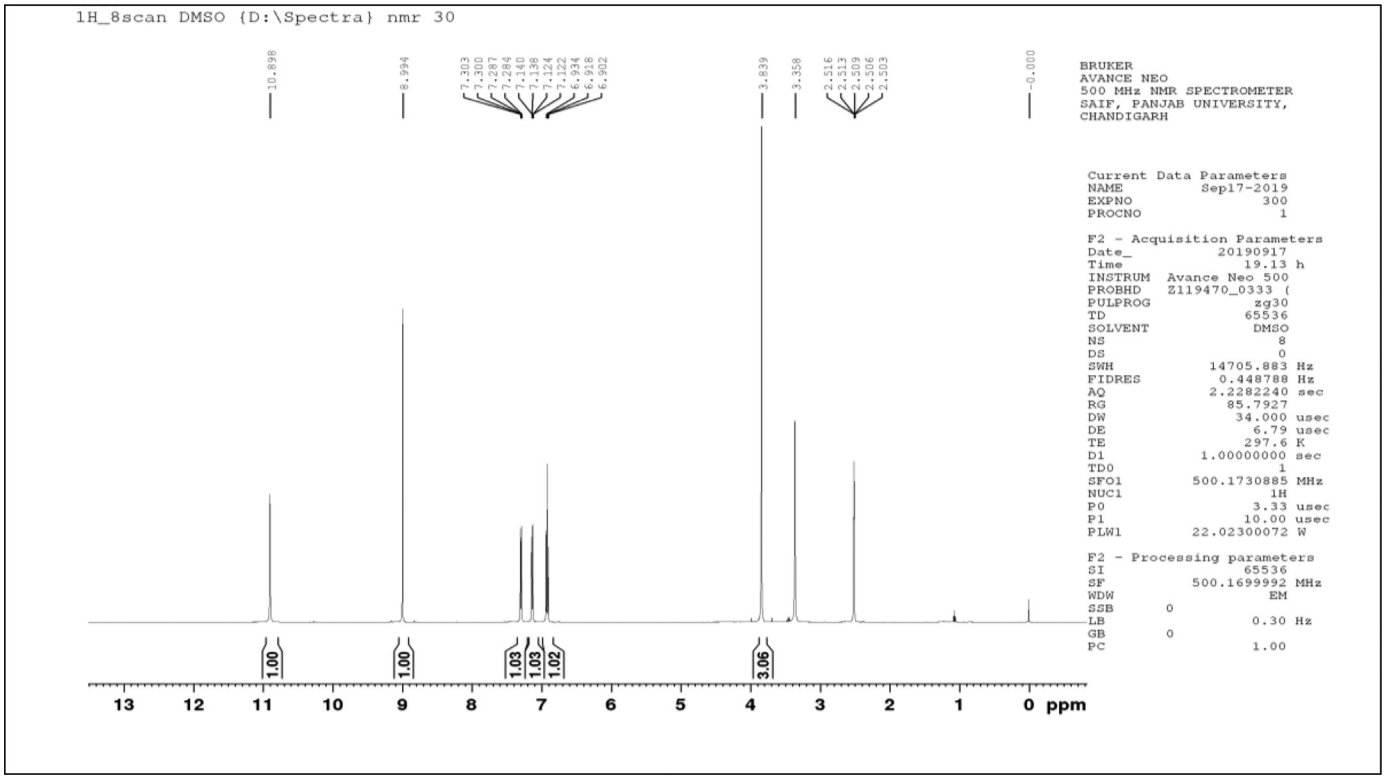


Fig. 1. ^{1H}NMR spectrum of hydrazone ligand (H_2L).

recorded. The FT-IR spectra of hydrazone ligand (H_2L) and its metal complexes are presented in (Fig. 2**)** as well as simulated spectra **(Fig.S5 a-b),** and their selected band frequencies are given in [Table 2] The ligand spectrum shows a broad band at 3390 cm^{-1} is due to phenolic ν_{O-H} group. The absence of this band in the spectra of complexes indicates the formation of coordination bond between the metal ion and phenolic oxygen *via* deprotonation. This is further confirmed by the increase in absorption frequency of ν (C–O) about 31 to 77 cm^{-1} from 1304 cm^{-1} in all the complexes indicating the participation of oxygen atom of phenolic 'OH' in

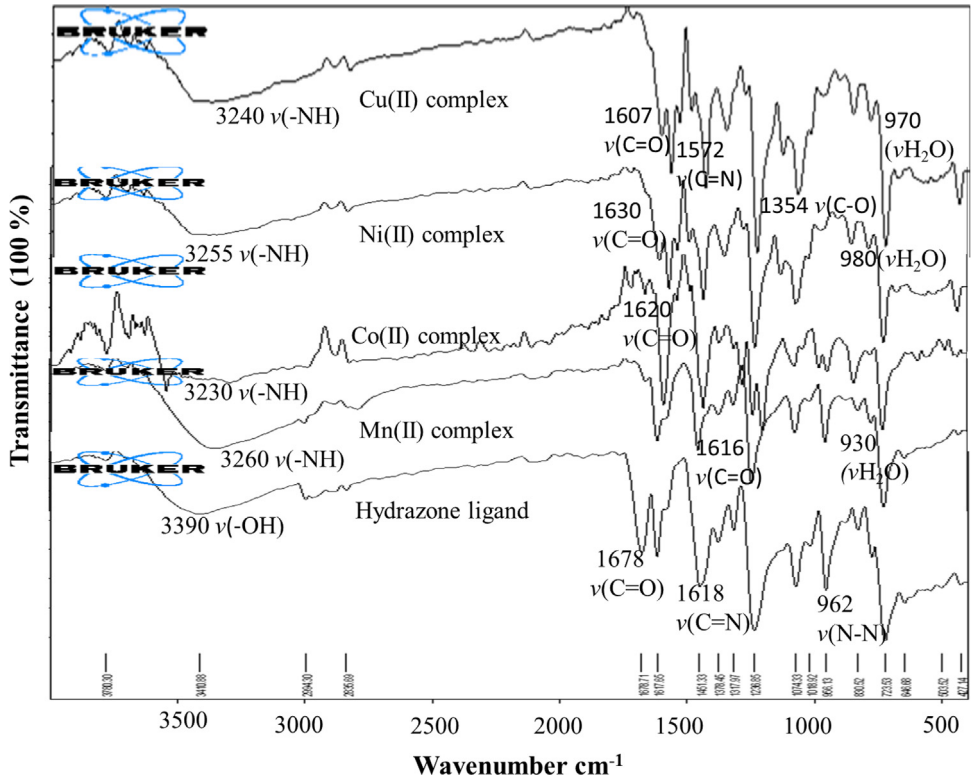


Fig. 2. FT-IR spectra of hydrazone ligand (H_2L) and its metal(II) complexes.

Table 2
Important FT-IR spectral data of ligand (H_2L) and its metal (II) complexes (cm^{-1}).

Compound	ν_{OH}	ν_{N-H}	$\nu_{C=O}$ amide	$\nu_{C=N}$ azomethine	ν_{C-O} Phenolic	ν_{N-N}	ν_{H2O} coord.	ν_{M-O}	ν_{M-N}
Hydrazone ligand	3390	3268	1678	1618	1304	962	–	–	–
$[Mn(HL)Cl(H_2O)_2]$	–	3260	1616	1605	1377	970	930	564	436
$[Co(L)Cl(H_2O)_2]$	–	3230	1620	1600	1350	975	908	591	450
$[Ni(HL)Cl(H_2O)_2]$	–	3255	1630	1614	1381	980	891	593	460
$[Cu(HL)Cl(H_2O)_2]$	–	3240	1607	1572	1354	970	890	540	439

coordination. The IR spectrum of ligand shows intense band at 1618 cm^{-1} due to azomethine $\nu_{HC==N}$ stretching frequency. This band has been shifted to the low-frequency region by 46–4 cm^{-1} in the spectra of all complexes and supported the coordination of azomethine nitrogen to metal center, this has been further strengthened by the shift of ν (N–N) band from 962 cm^{-1} in free ligand to 970–980 cm^{-1} in complexes [20,21]. The ligand shows band at 3268 cm^{-1} due to amide ν_{N-H} stretching frequency [>*N*–H of >CONH] and which appeared almost at about same position in the case of Mn(II), Co(II), Ni(II) and Cu(II) complexes, thus indicating its non-involvement in coordination and confirming the presence of ligand in its ketonic form in these complexes. Further, the shift of amide carbonyl ν (C = O) to a lower frequency side by an extent of 71–48 cm^{-1} in all these complexes supported the coordination of the oxygen atom of the amide carbonyl ν(C = O) with the metal ions as such without undergoing enolization [22,23]. The coordination of the metal ions with ligand was further confirmed by the appearance of new weak intensity, non-ligand bands in the region 540–564 cm^{-1} and 436–460 cm^{-1} in the IR spectra of the complexes are assigned to frequencies of ν(M-O) and ν(M-N) stretching vibration respectively. The IR spectra of complexes displayed the low frequencies stretching bands in the region of 891–930 cm^{-1} indicating the presence of coordinated water molecules attached to the metal center. On the basis of the IR spectral data, it is confirmed that the Schiff base ligand is coordinated in tridentate manner through the oxygen atom of the carbonyl group and the nitrogen atom of the azomethine group and phenolic-OH after deprotonation.

3.4. Magnetic moment, and UV–Visible spectroscopic studies

The electronic absorption spectrum of hydrazone ligand (H_2L) was recorded in DMSO (conc.=2 × 10^{-4}) in the UV region λ(210–432)nm and shown in Fig. (3**a**). The spectral bands observed at λ=331, 290 and 250 nm were due to the (>C = O) group, N-atom of >NH amide, (-N = C--H) in azomethine, and O-atom in phenolic-OH. The transition was due to the excitation by absorption of σ, π, and its lone pair electrons of these chromophores. The absorption band was appearing in the region of λ 405-432 nm in the azomethine –N = C--H of ($\pi \rightarrow \pi^*$) transition shifted at a higher wavelength refereed to red shift absorption. The hypsochromic shift (blue shift) also occurred due to the hydrogen bonding because of the significant impact of $n \rightarrow \pi^*$ at a shorter wavelength of 210-243 nm. The other allowed transition of $\pi \rightarrow \pi^*$ which exhibited bands in λ 210-250 nm in the substituted aromatic ring of the title ligand.

In order to obtain information concerning the stereochemistry of the metal ion, the electronic absorption spectra and magnetic moment of complexes were recorded and date are given in [Table 3] and spectra shown as (**3b**). The electronic spectrum of Mn(II) complex exhibits three weak absorption bands at 918, 755 and 328 nm which correspond to $^6A_{1g} \rightarrow {}^4E_g(^4D)$, $^6A_{1g} \rightarrow {}^4E_g$ (G) and $^6A_{1g} \rightarrow {}^4E_g$, transitions, respectively and clearly indicates the octahedral geometry of Mn (II) complex. The observed magnetic moment value 5.94 B.M. may be taken as an additional evidence for octahedral geometry. The various ligand field parameters have been calculated by known relations and values are found to be (Dq=1127 cm^{-1}, B = 700 cm^{-1}, β=0.81 and ν_2/ν_1= 1.18 and suggesting the presence of covalency in the M-L bond. The electronic spectrum of Co(II) complex displayed three absorption bands at 1085, 765, and 409 nm due to $^4T_{1g}, \rightarrow {}^4T_{2g}$, $^4T_{1g} \rightarrow {}^4A_{2g}$ and $^4T_{1g} \rightarrow {}^4T_{1g}$(P), transitions, respectively towards characteristic of high spin octahedral Co(II) complexes. The room temperature magnetic moment value was found to be 4.62 B.M. assignable of the presence of three unpaired electrons, indicating a quartet ground state, which was orbital triply degenerate and would cause an angular mo-

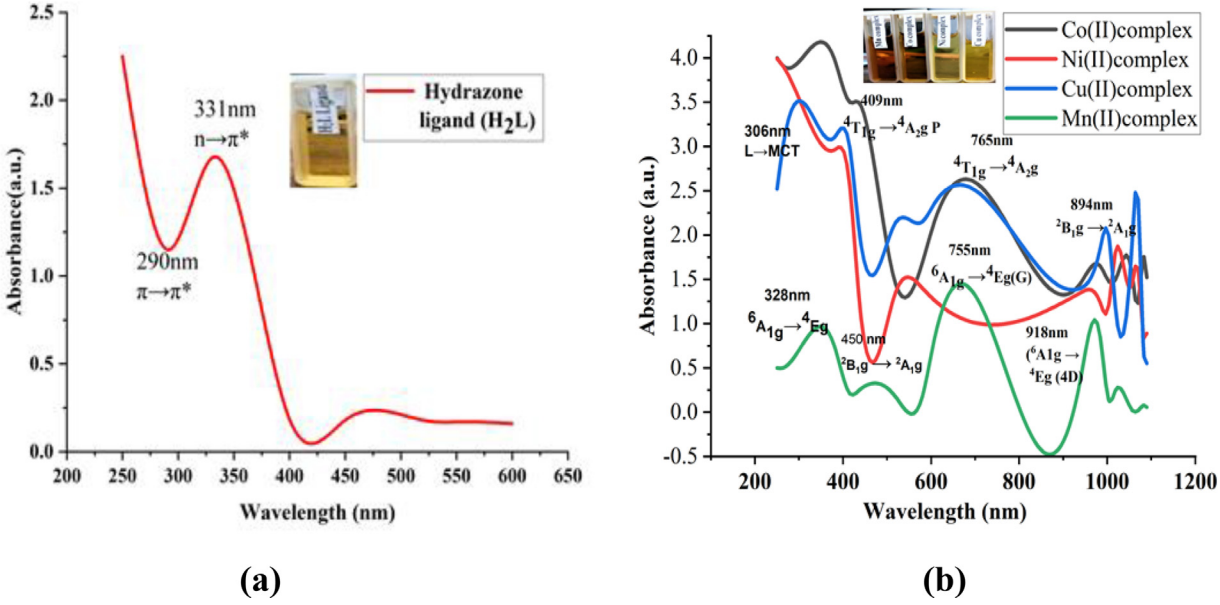


Fig. 3. (**a**) Electronic absorbance of hydrazone ligand (H_2L) and (**b**) Metal(II) complexes in DMSO (2 × 10^{-}4 mol dm^{-3}).

Table 3
Molar conductance, magnetic, electronic absorbance data of metal (II) complexes

Compounds	Molar cond.(Sm^2mol^{-1})	μ_{eff} (B.M.)	Absorption maxima (nm) cm^{-1}		Spectral transitions	Ligand Field Parameters				
			(λ_{nm})	(ν cm^{-1})		Dq (cm^{-1})	B (cm^{-1})	B_0 (cm^{-1})	β=B/B_0	ν_2/ν_1
$[Mn(HL)Cl(H_2O)_2]$	20.00	5.83	918	10,893	$^6A_{1g}\rightarrow{}^4E_g$ (^4D)	1089	737	860	0.86	1.22
			755	13,245	$^6A_{1g}\rightarrow{}^4E_g$ (G)					
			328	30,488	$^6A_{1g}\rightarrow{}^4E_g$					
$[Co(HL)Cl(H_2O)_2]$	18.40	4.62	1085	9217	$^4T_{1g}\rightarrow{}^4T_{2g}$	1152	658	971	0.68	1.42
			765	13,072	$^4T_{1g}\rightarrow{}^4A_2g$					
			409	24,450	$^4T_{1g}\rightarrow{}^4T_{1g}$(P)					
$[Ni(HL)Cl(H_2O)_2]$	15.50	2.79	1088	9191	$^3A_{2g}\rightarrow{}^3T_{2g}$	919	693	1030	0.67	1.24
			874	11,441	$^3A_{2g}\rightarrow{}^3T_{1g}$(F)					
			450	26,526	$^3A_{2g}\rightarrow{}^3T_{1g}$(P)					
$[Cu(HL)Cl(H_2O)_2]$	4.60	1.72	894	11,164	$^2B_1g\rightarrow{}^2A_1g$	––	–	––	––	–
			551	18,148	$^2B_1g\rightarrow{}^2Eg$					
			306	32,680	LMCT					

Table 4
The fluorescence emission data of hydrazone ligand (H_2L) and its metal(II) complexes excited at 334 nm.

Compounds	Wavelength (nm)	Fluorescence intensity I_F (a.u.)
Ligand (H_2L)	527	908.80
$[Mn(L)(H_2O)_2Cl]$	552	231.30
$[Co(HL)(H_2O)_2Cl]$	535	210.60
$[Ni(HL)(H_2O)_2Cl]$	545	196.90
$[Cu(HL)(H_2O)_2Cl]$	543	119.00

ment contribution to magnetic moment expected for the octahedral geometry of Co(II) complex. The different ligand field parameters have been evaluated from the spin allowed transitions and values are found to be Dq =1152 cm^{-1}, B = 658 cm^{-1}, β=0.68, and ν_2/ν_1 =1.42. The observed lower B value than free ion (971 cm^{-1}) indicated presence of covalency in the M-L bond. The Ni(II) complex exhibits three bands at 1088,874,450 nm which may be assigned to the $^3A_{2g}\rightarrow{}^3T_{2g}$, $^3A_{2g}\rightarrow{}^3T_{1g}$(F) and $^3A_{2g}\rightarrow{}^3T_{1g}$ (P) transitions, respectively in an octahedral environment around Ni(II) ion. The observed magnetic moment for Ni(II) complex is 2.89 B.M. which well within the expected for Ni(II) octahedral complexes . The observed ν_2/ν_1 ratio (1.60) is also expected for an octahedral Ni(II) complexes. The calculated B value (B = 704 cm^{-1}) for the Ni(II) complex is lower than the free Ni(II) ion value (1011cm^{-1}) due to the presence of orbital overlap and delocalization of d-orbitals. Further, β value for complex found is less than one indicating a considerable amount of covalent character in the metal–ligand bond. The Cu(II) complex showed a broad absorption band around 894 nm due to $2B_{1g}\rightarrow2A_{1g}$, transition, characteristic for a distorted octahedral geometry around the Cu(II) ion. Other two bands observed at 551, and 306 nm are assigned to $^2B_1g\rightarrow{}^2Eg$ transition and ligand to metal charge transfer (LMCT) in $\pi\rightarrow\pi^*$ and $n\rightarrow\pi^*$ state, respectively. The observed magnetic moment for Cu(II) is 1.72 B.M., which suggests the distorted octahedral geometry around Cu(II) ion [24,25].

3.5. The fluorescence emission analysis

The emission spectra of the solid hydrazone ligand (H_2L) and its Mn(II), Co(II), Ni(II), and Cu(II) complexes were recorded (the excitation and emission slit widths were 1.0 nm) in the range of (λ = 210–810) nm at room temperature and spectra are presented in (Fig. 4) as (**a**) and (**b**), and the results obtained are summarised in [Table 4]**.** The emission band measured at a rate of 240 nm/min showing excellent sensitivity at S/N 800. All the compounds exhibit excitation at $\lambda_{excitation}$334 nm, and emission intensity was measured in the solid state. The hydrazone (H_2L) ligand showed a good fluorescence intensity at 527 nm (I_F =908.80 a.u). The Mn(II), Co(II), Ni(II) and Cu(II) complexes also exhibit quick response for emission and fluorescence intensity was found to be I_F=231.30, 210.60, 196.90 and 119.00 a.u. at λ = 552, 535, 545, and 543 nm, respectively. The wavelength at which non-radiative emission was apprised in the free ligand and its complexes are as H_2L > Mn(II)> Co(II)> Ni(II) [211–213]. The emitted intensity of the hydrazone ligand and its $[Mn(HL)(Cl)(H_2O)_2]$, $[Co(HL)(Cl)(H_2O)_2]$, $[Ni(HL)(Cl)(H_2O)_2]$, and $[Cu(HL)(Cl)(H_2O)_2]$ complexes was due to the photoinduced electron transfer (PET), the combined inhibition effects of static interaction by charge transfer (*CT*) from metal ion to fluorophore groups, and active fluorochromes group viz. azomethine (-C*H*=N-) and (*C* = *O*) groups present in heterocyclic ring [26–28]. The photoemission data revealed that the ligand and its metal (II) complexes are good fluorescent candidates may be used for photochemical applications, and heavy metal ions detection in biological sciences.

3.6. ESR tensor components, and bonding parameters of Cu(II)complex

In order to obtain structural information of the Cu(II) complex from the hyperfine graphs, which elucidates the nature of the Cu-ligand bond and environment around central metal ion. The X-band spectrum (anisotropic) of Cu(II) complex is depicted in (Fig. 5) and its tensor components are given in [Table 5]. The well-defined ESR spectrum shows two peaks, $g_{||}$ are located at 2972.64 G, 2644.3 G, and another two peaks of $g_\perp$ located at 3310 G, 3339 G. The tensor components ($g_{||}$ and $g_\perp$) for complex were found to be $g_{||}$ 2.384 and $g_\perp$ 2.075 which indicate that the complex is axially symmetric. In the present study the observed measurements for Cu(II) complex is $g_{||} > g_\perp >$ ge (2.0023), suggests that copper site has a dx^2-dy^2 ground state characteristic of octahedral geometry [29]. The geometric parameter (G) is measure of extent of exchange interactions and calculated value (G = 4.27 cm^{-1}) for complex is found to be greater than 4, suggests the exchange interaction between the copper centres is negligible. The hyperfine splitting constant (HSC) also inferred that, the tensor components $A_{||}$ =287cm^{-1} and $A_{\perp}$=257cm^{-1} confirmed that electron interacted with only one copper nucleus in the distorted octahedral structure. The coordination environment of Cu^{2+} ion shows a distorted octahedral geometry an axial elongation with ligands, due to Jahn–Teller distortion. The axial bonds with the longer bond lengths which coordinated to Cu^{2+} ion.

The tensor components ($A_{||} > A_\perp$) suggested an axial symmetry with of Cu-O bond, and Cu-N bond in a distorted octahedral geometry. An inverse relation of the $A_{||}$ and $g_{||}$ was indicating the

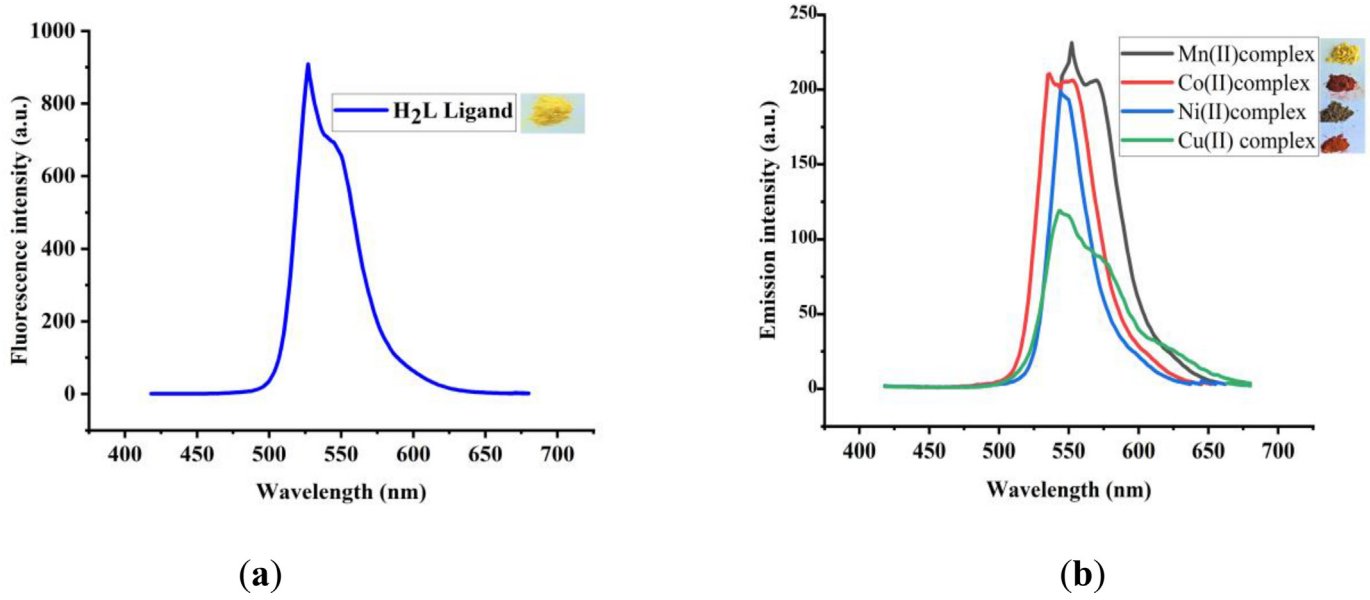


Fig. 4. Comparative fluorescence emission spectra of ligand (**a**) and (**b**) metal complexes.

Table 5
Calculation of ESR tensors and bonding parameters of Cu(II) complex.

ESR Tensors				Hyperfine splitting constant (HSC) (10^4), cm^{-1}		$A_{av.}$	$f = g_{\parallel}/A_{\parallel}$	Bonding parameter (covalency)		Orbital Reduction (overlapping)	
g	$g_{\parallel}$	$g_{\perp}$	G	$A_{\parallel}$	$A_{\perp}$	272	81.82	α^2	β^2	$K^2_{\parallel}$	$K^2_{\perp}$
2.0036	2.3485	2.075	4.27	287	257			0.44	3.02	1.19	0.95

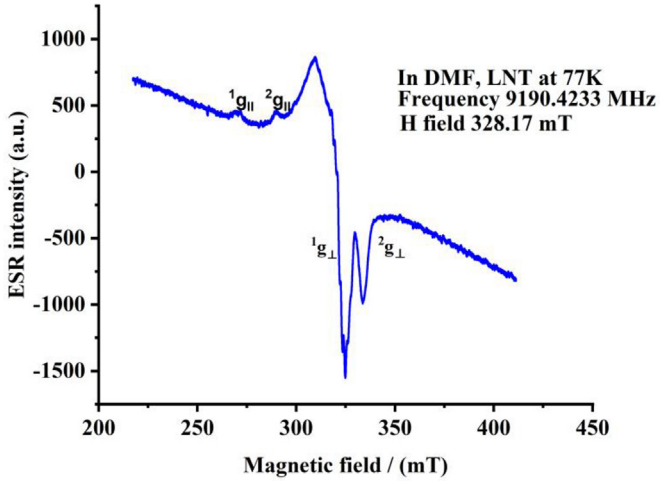


Fig. 5. ESR spectrum of Cu(II) complex.

increases in covalency of the metal−ligand bond the greater the delocalization of the electron density. As a result of this, the interaction between the electron, and nuclear spin increases with the increasing A‖ value compared while the decreasing trend of g‖ value. The values of the functioning ratio (f) =g‖/A‖ was evaluated (81.82) which clearly indicated ligand effects on the metal's unpaired electron density, and its coordination environment. Another important parameter of molecular orbital coefficients α^2= (covalency in σ bonding), and β^2 = (covalency in π bonding) were informed that (β^2=3.02)>(α^2 =1.19) that covalency in π bonding was found stronger than covalency in σ bonding. Additional confirmation of an axial distortion in the octahedral structure was validated from the evaluation of the orbital reduction parameter ($K^2_{\perp}$= 0.95) < ($K^2_{||}$=1.0) in Cu(II) complex and optimized molecular structure [30,31].

3.7. Molecular geometry optimization

The structures of hydrazone Schiff base ligand (H_2L) and its complexes [Mn(HL)(Cl)(H_2O)$_2$], [Co(HL)(Cl)(H_2O)$_2$], [Ni(HL)(Cl)(H_2O)$_2$] and [Cu(HL)(Cl)(H_2O)$_2$] were optimized by DFT and are presented along with their atom numbering in (Fig. 6) as (**a)** and (**b-e**), and the selected atomic distances, and bond angles are tabulated in [Table 6-7]. Gaussian-*09* program with a B3LYP basis sets has been used to study the molecular structure, energies, DFT calculations, and surface analysis. The quantum chemical literature inferred that the functional B3LYP basis set to yield the good results in bond lengths (Å), and bond angles (°) of connected atoms. The structural parameters of hydrazone ligand (H_2L) for selected atoms, and groups of the optimized molecule reveals that phenyl ring and a heterocyclic ring of piperidine are present in a planar form. The shorter bond length was observed for C17=N19 [1.2613(Å)] in azomethine group of free hydrazone ligand, and this information indicates a partial electron delocalization within the H18–C17–N19 fragment, while the longer bond length C18-N10 was observed from1.3440–1.4426(Å) in metal complexes. It was assigned the movement of nitrogen lone-pair electrons toward the metal's vacant orbitals which resulting the weakened C17=N19 bond [32]. The C–C bond distance was calculated of the phenyl ring of C3–C2, C4–C3, C5–C4, C6–C5 bond found well within the expected range of bond distances (1.3724–1.3935 Å), and bond angles (119.0973°–120.5788°) with sp^2 hybridised carbon atom which corresponding to delocalization of π-electrons. The heterocyclic ring of C33–C26 bond length was found 1.5162 Å, and consisting the bond angle 111.0840° of C33–C26–C24 in sp^3

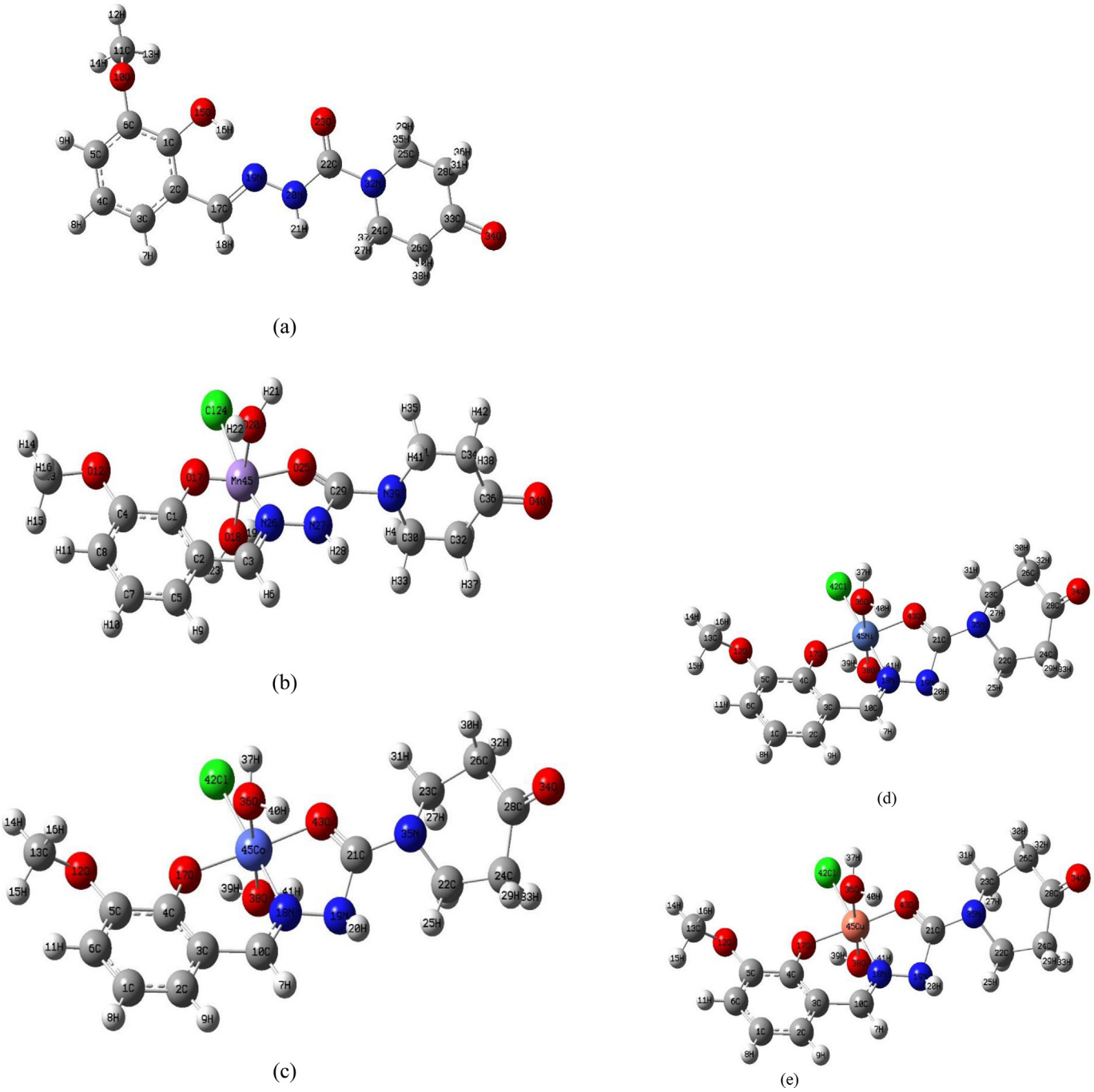


Fig. 6. Optimized molecular structure of (a) ligand, (b) Mn(II), (c) Co(II),(d) Ni(II), (e) Cu(II) complexes.

hybridized carbon atom indicating the presence of localized σ bond. The two chromophores i.e. C = O shows the nearly equal, and shorter bond length of 1.2174° (chain) and 1.2095° (heterocyclic). The shorter bond length of (H16–O15) appears (0.9792 Å) in the phenolic atoms due to the more electronegative 'O' atom bonded with the smaller H atom.

The optimized molecular structures of $[Mn(HL)(Cl)(H_2O)_2]$, $[Co(HL)(Cl)(H_2O)_2]$, $[Ni(HL)(Cl)(H_2O)_2]$ and $[Cu(HL)(Cl)(H_2O)_2]$ complexes suggested that each central metal(II) ion is bonded by six donor sites with an arrangement of the octahedral sphere. The short bond length (1.8582–1.8594) Å of the metal–O bond of deprotonated phenolic group than the metal–O bond from carbonyl group adjusted to *trans* at an angle of ~ 95° The larger bond length of M45–O36 atoms and M45–O38 atoms as well as corresponding the bond angle of O36-M45-O38 appearing at (179.774–180.101°) clearly indicating water molecules axially coordinated with the metal center at *trans* position in all metal complexes. The atomic arrangement involved two oxygen at an angle of ~ 97° informed its *trans* positions. The azomethine-N and chlorine atoms as fifth and sixth donor atom to form planar within the coordination sphere. The interatomic distances of metal–Cl (42) was calculated (2.1721–2.1861) Å inferred *trans*-directing group of azomethine nitrogen donor atom. The bond angle within the chelate cycle differs slightly from the expected values of 90°

Table 6
Selected geometrical parameters of hydrazone ligand (H_2L).

Bond connectivity	Bond lengths(Å)	Bond connectivity	Bond angles (°)
C(2)-C(1)	1.3941	–	–
C(3)-C(2)	1.3935	C(3)-C(2)-C(1)	120.2285
C(4)-C(3)	1.3724	C(4)-C(3)-C(2)	120.5788
C(5)-C(4)	1.3882	C(5)-C(4)-C(3)	119.0973
C(6)-C(5)	1.3737	C(6)-C(5)-C(4)	121.2068
O(10)-C(6)	1.3775	O(10)-C(6)-C(5)	118.1922
C(11)-C(10)	1.4548	C(11)-C(10)-C(6)	118.5076
H(16)-O(15)	0.9792	H(16)-O(15)-C(1)	113.3859
C(17)-C(2)	1.4633	C(17)-C(2)-C(1)	121.0470
C(17)-N(19)	1.2613	H(18)-C(17)-N(19) C(2)	121.1456
C(20)-N(19)	0.9960	C(20)-N(19)-C(17)	119.6748
C(22)-N(20)	1.3794	C(22)-N(20)-N(19)	119.6748
O(23)-C(22)	1.2174	O(23)-C(22)-N(20)	121.9978
H(31)-C(28)	1.0835386	H(31)-C(28)-C(25)	111.3342
C(33)-C(26)	1.5162580	C(33)-C(26)-C(24)	111.0840
O(34)-C(33)	1.2095837	O(34)-C(33)-C(26)	122.6657
H(38)-C(26)	1.0851092	H(38)-C(26)-C(24)	109.2693

Table 7
Selected geometrical parameters of metal (II) complexes.

Parameters	Mn (II) complex	Co(II) complex	Ni(II) complex	Cu(II) complex
Bond connectivity	Bond length (Å)			
M(45)-N(18)	1.8322	1.8420	1.8440	1.8426
M(45)-O(43)	1.8584	1.8594	1.8474	1.8582
M(45)-O(17)	1.8299	1.8319	1.8224	1.8339
M(45)-O(36)	1.8419	1.8319	1.8299	1.8389
M(45)-O(38)	1.8414	1.8412	1.8399	1.8487
M(45)-Cl(42)	2.1721	2.1701	2.1814	2.1861
C(10)- N(18)	1.4221	1.4420	1.3440	1.4426
Bond connectivity	Bond angles (°)			
N(18)-M(45)-O(43)	84.711	84.751	84.779	84.799
N(18)-M(45)-O(17)	97.142	97.122	97.164	97.124
N(18)-M(45)-O(36)	93.142	92.152	92.167	93.142
N(18)-M(45)-O(38)	88.209	88.123	88.150	88.130
N(18)-M(45)-O(42)	177.001	176.925	176.925	176.401
O(17)-M(45)-O(43)	179.990	179.860	179.890	179.423
O(36)-M(45)-O(43)	89.952	89.452	89.452	89.439
O(43)-M(45)-O(38)	90.221	90.152	90.152	90.159
O(43)-M(45)-Cl(42)	95.949	95.982	95.982	95.999
O(17)-M(45)-Cl(42)	95.182	95.182	95.182	95.189
O(17)-M(45)-Cl(38)	89.190	89.152	89.152	89.142
O(36)-M(45)-O(38)	180.101	179.899	179.899	179.774
O(36)-M(45)-Cl(42)	90.691	90.590	90.590	90.452
O(38)-M(45)-Cl(42)	90.887	90.691	90.691	90.571

and 180° indicating the octahedral geometry. The experimental and theoretical study show comparable values and validated for the octahedral geometry of metal complexes [33–34].

3.8. Frontier molecular orbitals (FMOs)

Frontier molecular orbitals (FMOs) calculation was performed for an optimized structure of the compounds by using the B3LYP method with 6–311G+(d,p) for the charge transfer reactions. The frontier molecular orbital (FMOs) of hydrazone ligand (H_2L) and Mn(II) complex are displayed in Fig. 7(**a-d**) as the representative case. The significant quantum chemical data of FMOs of ligand (H_2L) and Mn(II) complex viz., E(HOMO), E(LUMO), energy band gap (ΔE), properties are presented in [Table 8]. The energies of FMOs are good evidence for charge transfer (*CT*) from HOMO to LUMO. The molecules containing a small HOMO-LUMO energy gap are normally correlated with high chemical reactivity, and low kinetic stability. The energies of the ligand (H_2L) for

Table 8
Calculated energies (eV), band gaps (ΔE), properties of Frontier MOs of hydrazone ligand (H_2L) and Mn(II) complex.

Compounds	Orbitals	Energies			Chemical properties				
		Hartrees	Convertionof energy (eV)	Energy band gap (ΔE)	Chemical potential (μ)	Global hardness (η)	Softness (S)	Electrophilicity index (ω)	Nucleophilicity index (N)
Hydrazone ligand (H_2L)	HUMO	−0.21924	−5.965	4.258	−2.1295	4.2598	0.2347	0.5322	4.72
	LUMO	−0.0627	−1.706						
Mn(II) complex	HOMO	−0.1858	−5.055	3.461	−3.324	1.7305	0.5778	3.1924	3.81
	LUMO	−0.05858	−1.5940						

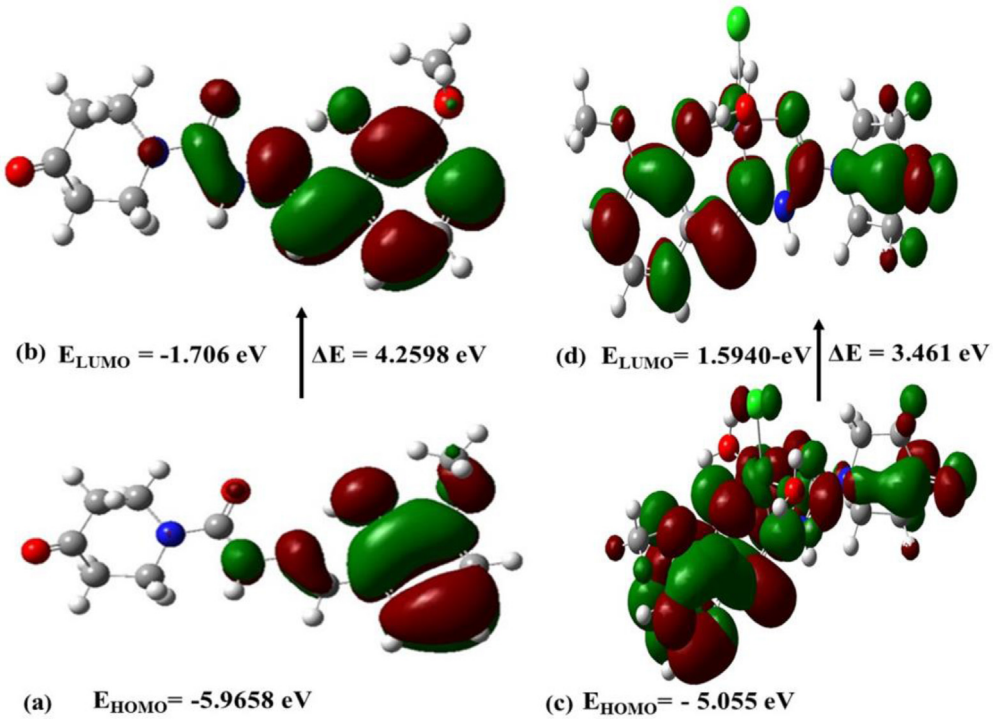


Fig. 7. Frontier molecular orbitals (a) HOMO, (b) LUMO of ligand (H_2L), and (c) HOMO and (d) LUMO of Mn(II) Complex.

HOMO consist of (−0.21924 Hartree = −5.9658 eV) due to the π-orbital in the triatomic moiety while LUMO was the π^*-orbital consist of (−0.0627 Hartree = −1.706 eV) [35] and degeneracies of Boltzmann population ratios of 6.982e+100 at 298.15 K. The very small energy gap (4.2598 eV) was observed for the ligand molecule and hence, the most probability of electron transition in ($\pi \rightarrow \pi^*$) from HOMO to LUMO. HOMO density is located at phenolic-O, azomethine-N, and carbonyl-O referred as a functional region of hydrazone ligand. The highly delocalized HOMO is specifying promptly shifted of the electrons, and hence resulting in intermolecular charge transfer (*ICT*). Furthermore, the HOMO localizes on triatomic (ONO) orbital contains the loan pairs of electrons at O-15, N-19, and O-22 indicating the presence of favorable atomic centers within hydrazone molecule for possible nucleophilic attacks. The according to the frontier orbital theory, nucleophilic attacks occur by the electron flow of a HOMO nucleophile into the LUMO of the electrophile. In the metal complexes, HOMO density is located on the metal ion, azomethine-N atom, carbonyl-O, and chlorine atom whereas LUMO region have been substantiated the charge distribution in the complete molecule. As a result of this, charge transfers occur from the electron-donor groups to electron-acceptor groups through coordination. In addition to this, the computations study of ligand and its metal complexes FMO energy (eV) shows in the order of $[Co(HL)(Cl)(H_2O)_2]$(1.7892) < $[Ni(HL)(Cl)(H_2O)_2]$ (1.9920) < $[Cu(HL)(Cl)H_2O)_2]$(−2.0101) < $[Mn(HL)(Cl)(H_2O)_2]$(3.461) < $[H_2L]$ligand (4.258) [36]. The calculated values of large stabilization occurred of the LUMO are due to the greater electron-accepting ability of the acceptor group, and causes transfers of the electron density from the triatomic active the electron-donor of azomethine-N and phenyl-O and carbonyl-O to its electron-acceptor region.

In addition to these, calculated molecular properties such as the chemical potential (μ), global hardness (η), and softness (S) are presented [37]. These molecular parameters also co-relate to each other, where

$$(\mu) = -\chi,$$

$$\text{Chemical potential}(\mu) = \frac{\text{E (HOMO)+E (LUMO)}}{2} \quad (1)$$

$$\text{Global hardness}(\eta) = \frac{\text{E (LUMO)} - \text{E (HOMO)}}{2} \quad (2)$$

The inverse relation of the global hardness (η) with the softness (S) are found as

$$\text{Softness } (S) = \frac{1}{\eta} \quad (3)$$

$$\text{Electrophilicity index } (\omega) = \frac{\mu^2}{2\eta} \quad (4)$$

$$\text{Nucleophilicity index } (N) = \text{E}(\text{HOMO}_{\text{nu}}) - \text{E}\left(\text{HOMO}_{\text{ligand}}\right) \quad (5)$$

The significant chemical properties reactivity's of molecular for ligand were calculated viz., chemical potential (μ) = –2.1295 gives stability, and global hardness (η) = 4.2598, and softness (S)= 0.2347 supported the confirmation of electron transfer. Similarly, the evaluated chemical potential (μ) of Mn(II) complex was = –3.324 which suggest a more stability of compound. Another factors of global hardness (η) = 1.7305, and softness (S)=0.5778 informed of electron transfer from HOMO to LUMO region. The evaluated nucleophilicity index are comparatively more than the electrophilicity index in ligand (N = 4.72 eV > ω= 0.5322) and in Mn(II) complex (N = 3.81 eV > ω= 3.1924) useful key indicators for in vitro biological activities. [38–39].

3.9. Molecular electrostatic potential surface analysis (MEP)

Molecular electrical potential map helped in understanding distribution of charges in ligand and also known as electrostatic potential energy maps of molecular electrical potential surfaces. This is an important tool for the study of efficient ionic binding receptors for electrophilic and nucleophilic attack in chemical reactions, hydrogen bonding interactions, and the total charge distribution in the molecule. The analysis of the electrostatic potential map from B3LYP/6–311G+(d, p) are presented in (Fig. 8) as (**a**) ligand, and (**b**) Mn(II) complex as the representative case. The different values of

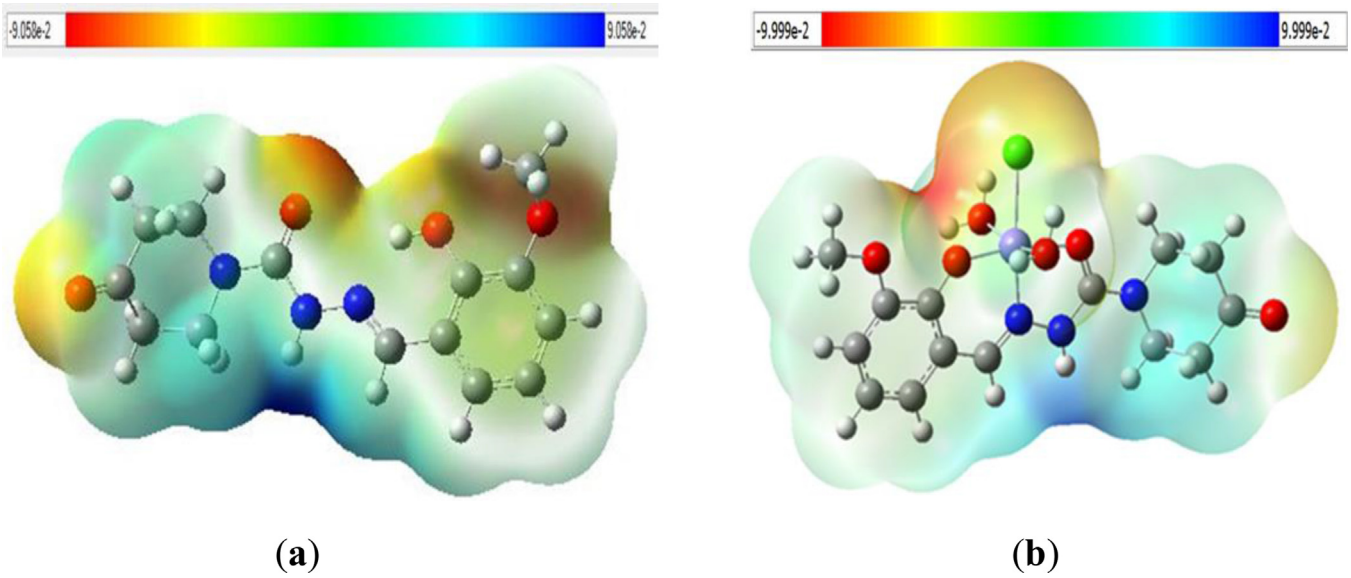


Fig. 8. Molecular electrostatic potential surface of (a) Ligand, and (b) Mn(II) complex.

the electrostatic potential are displayed by the various colors with the increase in order of yellow <green <red < blue in ligand, and these color intensities decreasing in metal complexes except the blue which are indicating a low nucleophilic or electrophilic attack after the complex formation. In ligand, the negative electrostatic potential appears at a maximum due to the presence of phenolic group, hydrazone group (>C = N − *N*<), and carbonyl group indicating a possible site for electrophilic attack. The reduction in the polarity in metal (II) complex shows a very low electrostatic potential in the structure, and followed the similar trend in the structure of Mn(II) complex.

The hydrazone ligand reveals that the electrostatic negative region belongs to the two-carbonyl oxygen (O22, O34) represented in the molecule with a magnitude in the range of −134 to 210 kJ/mol. Other the reduced magnitude of the negative electrostatic potential on the oxygen of the methoxy group (O10) was calculated and found to be in the range of −22 to 74 kJ/mol. The nitrogen atoms of the azomethine (N19), and amide N(20) displayed the negative electrostatic potential indicating an important magnitude in the range of (−50 to −85 kJ/mol). Similarly, the magnitude for the hydrogen attached to sp^2 and sp^3 carbon was in the range of ∼32 to125kJ/mol. In the heterocyclic ring, nitrogen (N32) shows a negative electrostatic potential, due to the acidic N–C of a magnitude of 92 kJ/mol [40–42].

3.10. Powder X-ray diffraction pattern

Though the newly synthesized complexes were soluble in some polar organic solvents like DMSO and DMF, crystals that are suitable for single crystal studies are not obtained. Hence powder-XRD pattern of the ligand and metal complexes have been studied in order to test the degree of crystallinity of the complexes. The powder X-ray diffraction spectra of ligand and its metal (II) complexes were scanned and shown in **Fig.3S** as (**a-e**). The unit cell and crystal lattice parameter data of compounds are summarized in [**Tables S1-S5**]. The calculated glancing angle (2Θ) and interplanar distances were compared with theoretical, and both values are comparable equal. The miller indices h, k, l which was also supported by intercepts of the faces along the crystallographic axes in unit cell dimensions. The values of unit cell parameters of hydrazone ligand areas: crystal system orthorhombic, a = 7.1200Å, b = 21.8820Å, c = 13.1561Å; and interaxial angle (α=γ=β=90) deg. The interplanar spacing from the peak position=3.343,065Å, V = 2047 Å^3 with the space group=*P*, Z = 8. The metal complex of [Mn(HL)Cl(H_2O)$_2$]: system = cubic, a = 9.4110Å, b = 9.4110Å, c = 9.4110Å, and (α=β=γ=90 deg)., V = 822.056 Å^3. Z = 1, space group = P, and interplanar spacing from the peak position=4.0828Å. [Ni(HL)Cl(H_2O)$_2$] complex: crystal system=orthorhombic, a = 7.9270Å, b = 6.1590Å, c = 22.4700Å (a≠b≠c) and α=β=γ=90 deg., V = 1086.993Å^3, Z = 2 with interplanar spacing from peak position = 3.40,008Å. The average particle size was calculated from Scherrer's equation L= [Kλ/β(2Θ)cosΘ] using (K = 0.9) constant in all cases. [CuHL)Cl(H_2O)$_2$] complex: crystal system=Ortho-rhombic, a = 8.0914 Å, b = 10.2920 Å, c = 12.8843 8843Å and α =β =γ =90 deg., volume (V) = Å^3, Z= with interplanar spacing from peak position=3.29,500Å. Upon the calculation of full width at half maximum (FWHM), the average crystallite particle size from Scherrer's equation L= [Kλ/β(2Θ)cosΘ] using (K = 0.9) constant in all cases of hydrazone ligand (H_2L), Mn(II), Ni(II), and Cu(II) complexes were found to be 18.94, 28.88, 16.98 and 25.07 nm respectively, which confirmed their nanocrystalline nature [43,44].

3.11. Scanning electron microscopic study

SEM study provides information about the comparative surface morphology and topography of ligand and metal complexes. The SEM micrographs of hydrazone ligand (H_2L) and its Co(II) complex are given in Fig. 9 as **(a)** and **(b))** as representative one**.** The ligand was magnified at X600 showed well-defined crystal free from any shadow, and appeared as scattered rod's like with sharp edges. The ligand exhibits with variable lateral dimensions as glass-smooth surface looks whereas Co(II) complex showed as small crystal of broken rods. The different characteristic shapes and size of the particles of hydrazone Schiff base and metal complexes give evidence of the metal complexation [45–46].

3.12. Thermogravimetric analysis

Thermogravimetric analysis is an important tool to evaluate the thermal stability of complexes in terms of mass loss with respect to the linear variation of temperature. The thermal behavior of the hydrazone ligand (H_2L) and its metal complexes were studied in detail under N_2 atmosphere in the temperature range of

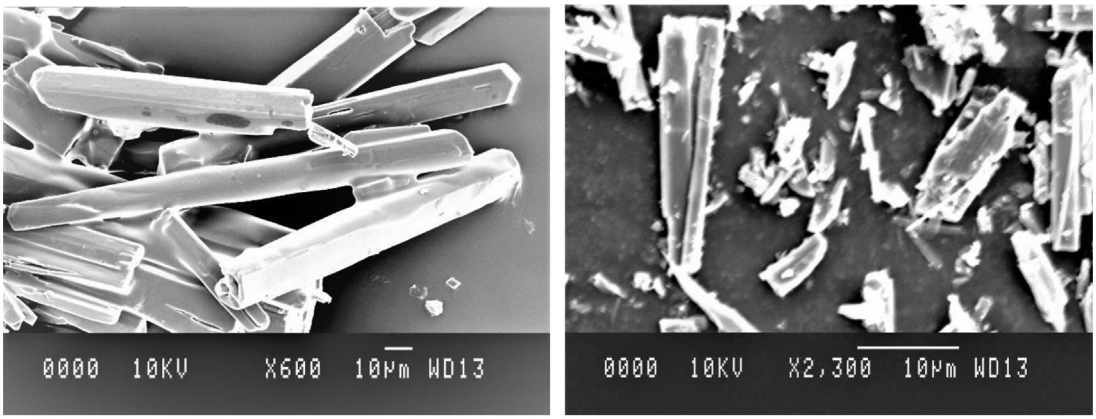


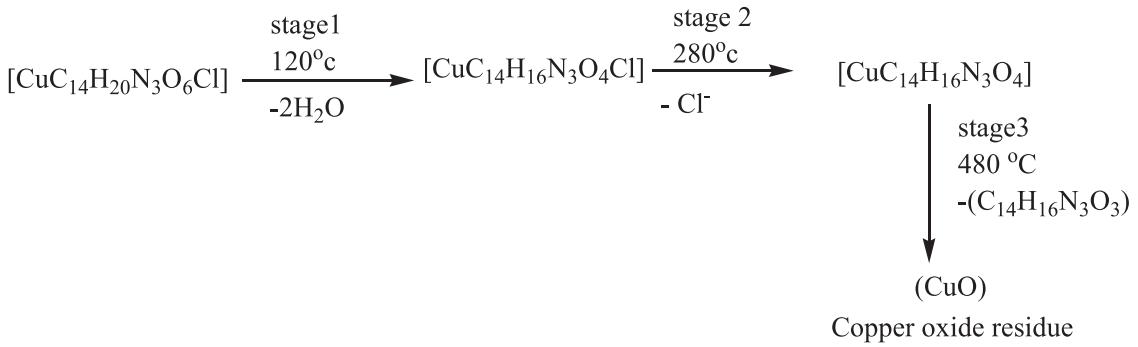
Fig. 9. SEM of (**a**) ligand (H_2L), and (**b**) Co(II) complex.

40–800 °C with a linear heating rate of 20 °C/min. The thermograms of hydrazone ligand (H_2L) and its Co(II) complex are presented as representative cases in Fig. 10(**a & b**), while thermograms of Mn(II),Ni(II),Cu(II) complexes are shown in **Fig. S4** (**c-e**). The thermogram of ligand shows a single step of decomposition with a (broad DTG_{max}) peak at ~370 °C with maximum mass loss of 88.31% (theor. 92.15 %) assignable to the fragmented loss of organic species ($-H_{17}N_3O_4$). Further, in continued heating up to 700 °C, formed the carbon residues of 11.69% (theor. 7.88%) as end product of reaction. The thermograms of Mn(II), Co(II), Ni(II), Cu(II) complexes in the range 45 °C to 800 °C indicated three steps decompositions.

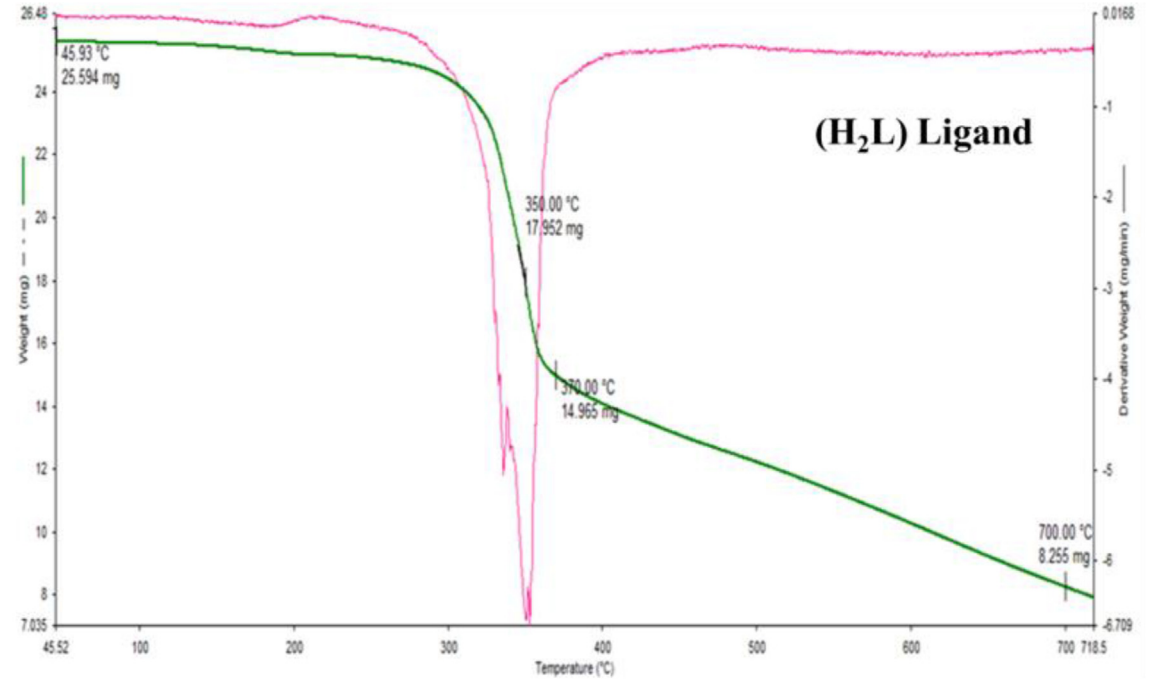
The thermograms of Mn(II), Co(II), Ni(II) and Cu(II) complexes showed decomposition in three steps and thermal decompostion of Cu(II) shown in (Scheme 2) as a representative case. The proposed stepwise thermal degradation pattern of all the complexes with respect to temperature and formation of respective metal oxides are depicted in Table 9. In all complexes the first step of decomposing involving TG-DTG plateau in the temperature range of ~110–120 °C with broad DTG_{max} peak corresponding to a loss of two coordinated water molecules per mole of complex. In continued further heating, the second decomposition step in between 200–280 °c (DTG_{max}) shows a loss of one mole of chloride ions. The third degradation step observed in the range ~340–490 °c involves a mass loss of organic ligand moiety and finally, TG curve attain a horizontal level indicates the formation the stable metal oxide as residue [47–49]. A small peak appears in the thermograms was may be due to some endothermic reactions that occur simultaneously such as breaking, rearrangement of the covalent bonds, oxidative degradation, during the decomposition reaction. The vibration IR frequency data 930–908 cm^{-1} and TG 110–120 °C both indicate the presence of coordinated water molecules in the complexes, and the presence of chloride ions was confirmed by the Volhard estimation.

3.13. Kinetic studies of metal (II) complexes (Coats-Redfern relation)

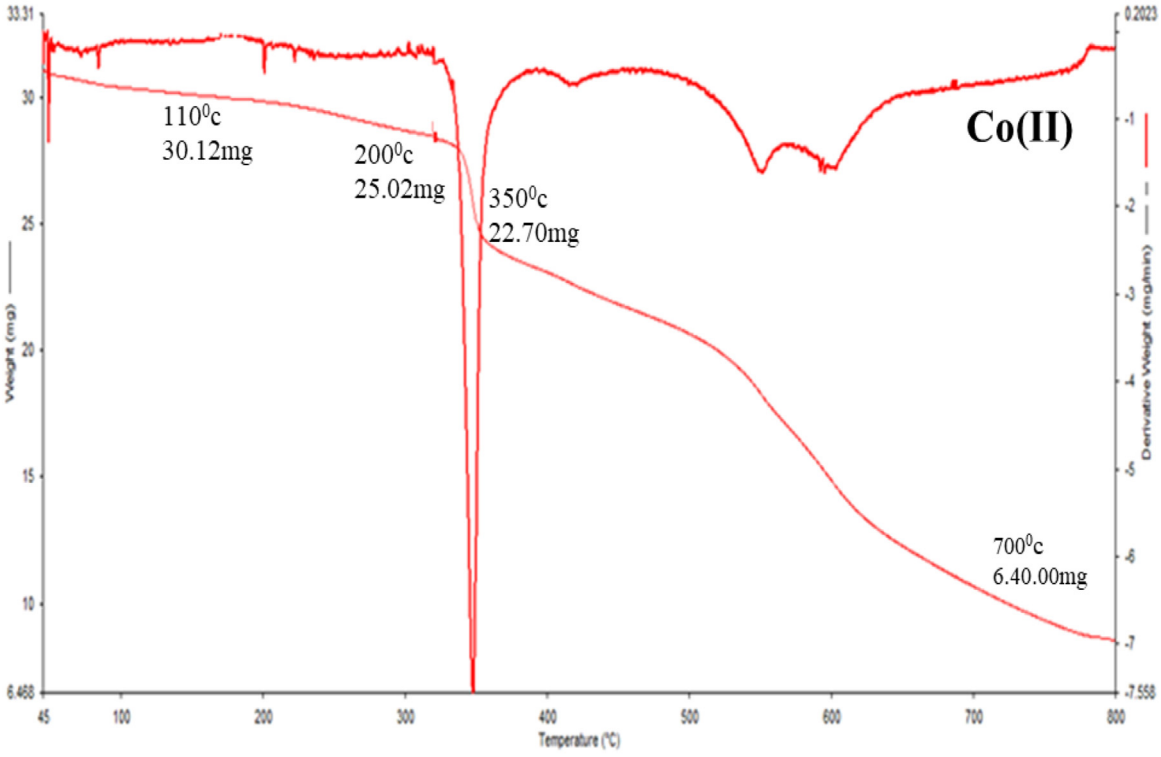
The kinetic and thermodynamic energy parameters associated with various decomposition steps in the thermal process are very important for the evaluation of the nature of complexes and also a quick technique for assigning the stability of the material substances. In the present investigation significant kinetic parameters such as activation energy (Ea*), entropy (ΔS*), activation enthalpy (ΔH*), and free energy change (ΔG*) have been evaluated from the thermal decomposition by using Coats-Redfern relation and values are listed in [Table 10]. The increasing order of the activation energy (Ea*) from 9.6 to 293 kJ/mol with declining the values of entropy from −9.5 to −15.3 (J/mol/k), this confirms their more thermal stability with more ordered structure due to the more degree of structural 'complexity'. The negative values of entropy (ΔS) for the degradation process indicates more ordered activated complex than the reactants. The high value of the energy of activation of the complexes reveals the high stability of such complexes due to presence of covalency in metal-ligand bond character. It was proved in the first, second, and third steps of thermal decomposition, the lowering frequency factor (Z) are due to the decreasing trends of the entropy, and the non-spontaneous thermal decomposition reaction. When compared parameters of $E_a < \Delta G \cong \Delta H$ which informed that more thermal stability possessed by the compounds. The free energy +ΔG values (10.3 to 299 KJ/mol)



Scheme 2. Schematic representation of thermal decomposition of Cu(II) complex.



(a)



(b)

Fig. 10. Thermogravimetric curve of (a) H_2L Ligand and (b) Co(II) complex.

Table 9
Thermogravimetric data of ligand (H_2L) and its metal (II) complexes.

Compounds	Stages	Temp.range (°C)	DTG_{mx} (°C)	% Mass loss		Decomposition Assignments
				Exptl.	Calcd.	
Ligand (H_2L)	I	45–370	370	88.311	92.15	Loss of $H_{17}N_3O_4$ species
	II	375–700	–	11.69	7.88	Carbon residue
$[Mn(HL)Cl(H_2O)_2]$	I	45–110	110	9.20	8.65	Loss of two coordinated H_2O molecules
	II	110–230	130	10.81	8.51	Loss of one coordinated Cl ion
	III	230–600	340	63.12	62.23	Loss of organic moieties ($C_{14}H_{16}N_3O_3$
	IV	600–808	—	16.87	20.61	Metallic oxide residue of MnO
$[Co(HL)Cl(H_2O)_2]$	I	45–160	110	9.93	8.55	Loss of two coordinated H_2O molecules
	II	160–310	200	9.50	9.22	Loss of one coordinated Cl ion
	III	310–540	350	58.72	60.22	Loss of organic moieties ($C_{14}H_{16}N_3O_3$)
	IV	540–800	—	22.05	21.45	Metallic oxide residue of (CoO)
$[Ni(HL)Cl(H_2O)_2]$	I	45–120	120	9.90	8.56	Loss of two coordinated H_2O molecules
	II	120–250	240	10.80	9.23	Loss of one coordinated Cl ion
	III	250–490	400	60.61	60.80	Loss of organic moieties ($C_{14}H_{16}N_3O_3$)
	IV	490–800	–	19.00	21.40	Metallic oxide residue of NiO
$[Cu(HL)Cl(H_2O)_2]$	I	45–120	120	8.37	8.46	Loss of two coordinated H_2O molecules
	II	120–250	280	10.62	9.11	Loss of one coordinated Cl ion
	III	320–490	490	57.40	60.10	Loss of organic moieties ($C_{14}H_{16}N_3O_3$)
	IV	490–650	—	23.61	22.32	Metallic oxide residue of CuO

Table 10
The kinetic parameters for thermal decomposition of (H_2L) ligand and its complexes (Coat-Redfern method).

Compounds	Decomp.temp.(°C)	(Ea) (kJ mol^{-1})	Z (s^{-1})	ΔS ($Jmol^{-1}k^{-1}$)	ΔH (kJ mol^{-1})	ΔG (kJ mol^{-1})
Ligand (H_2L)	350	221.93	1.362×10^1	−14.6	216.6	225.8
$[Mn(HL)Cl(H_2O)_2]$	150	57.82	1.218×10^3	−9.8	55.2	58.3
	230	19.97	12.06×10^2	−11.2	16.9	21.2
$[Co(HL)Cl(H_2O)_2]$	180	59.62	1.224×10^3	−9.8	57.0	60.1
	250	55.44	1.212×10^2	−12.8	51.7	57.5
	347	152.71	0.1236×10^4	−13.9	148.4	155.6
$[Ni(HL)Cl(H_2O)_2]$	100	57.80	1.206×10^3	−9.8	55.2	58.3
	250	23.81	1.230×10^3	−11.2	20.7	24.9
	450	293.16	0.1230×10^4	−13.9	287	299.1
$[Cu(HL)Cl(H_2O)_2]$	120	48.31	1.218×10^3	−14.7	144.1	152.5
	350	105.30	1.230×10^3	−11.5	204.5	214.1
	490	209.72	1.239×10^3	−15.3	274.2	287.2

was investigated, it reveals that the decomposition steps are non-spontaneous processes [50,51]. On the basis of third-step of decomposition the thermo-kinetic data inferred the stability order is found to be increased as Mn (II)<Ni(II)<Co(II)<Cu(II).

3.14. Evaluation of antibacterial and antifungal activities

In recent years, the heterocyclic compounds of hydrazone and its metal complexes have gained considerable importance, especially in the repository, slow-release and long-acting drugs. A number of heterocyclic organic compounds and their metal complexes have been tested for their efficacy as antibacterial and antifungal drugs. Considering this enormous biological importance associated with hydrazone (H_2L) ligand system involving piperidine ring, inspired us to undertake synthesis and study their biological potency.

The in vitro antimicrobial activity of the ligand and its Mn(II), Co(II) Ni(II) and Cu(II) complexes were tested against the gram – ve bacterial strains of *Escherichia coli* (NCBI-0157), *Salmonella typhi* (NICM-2257); gram +ve bacterial strains *of Staphylococcus aureus* (NDCM-2257), *Bacillus substilis* (NICM-2477), and fungal species of *Candida albicans* (MTCC-1637), *Aspergillus niger* (NCIM-1005) at a conc.1.0 mg/mL using the disk diffusion method (DDM). The activity in zone of inhibition (mm) was compared with the standard drug ofloxacin, azithromycin, fluconazole and given in Table 11 and presented graphically in (Fig. 11). The ligand and its metal complexes showed different results against different bacterial strains. The newly synthesized metal complexes exhibited good results than the free ligand. This activity found to be enhanced on coordination with metal ions. This enhancement in the antimicrobial activity of the complexes over free ligand can be explained on the basis of *Tweedy's* chelation theory [52]. The chelation reduces the polarity of the metal ion mainly because of partial sharing of its positive charge with donor groups, electron delocalization over the entire ring, the effect of metals ion charges, and the geometry of the complex. Lipophilic character played an important role in the resulting liposolubility of metal (II) complex which facilitated its

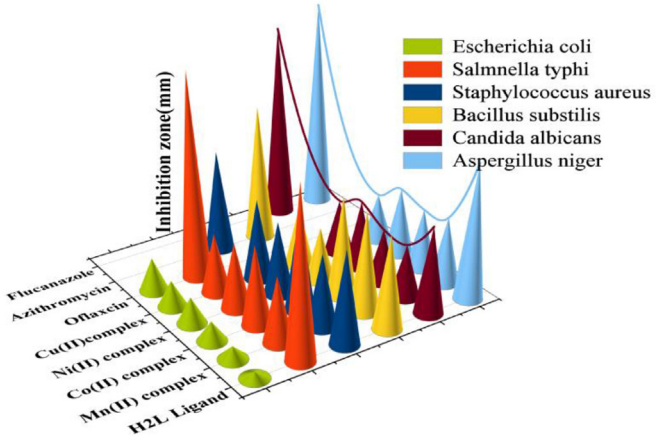


Fig. 11. Inhibition zone growth of microorganisms of tested compounds of ligand (H_2L) and its metal (II) complexes.

Table 11
Antimicrobial assay of ligand (H_2L) and its metal (II) complexes compared with std. drugs.

Compounds and standard drugs	Bacteria (Gram –ve)		Bacteria (Gram +ve)		Fungal species	
	Escherichia. coli (NCBI-0157)	*Salmonella. typhi* (NICM-2257)	*Staphylococcus aureus* (NDCM-2257)	*Bacillus substillis* (NICM-2477)	*Candida albicans* (MTCC-1637)	*Aspergillus niger* (NCIM-1005)
Ligand (H_2L)	18	25	14	14	13	20
$[Mn(HL)(H_2O)_2Cl]$	20	10	11	15	08	10
$[Co(HL)(H_2O)_2Cl]$	15	12	15	15	08	09
$[Ni(HL)(H_2O)_2Cl]$	12	10	11	08	10	10
$[Cu(HL)(H_2O)_2Cl]$	12	09	12	09	08	07
Ofloxacin*	30	30	–	–	–	–
Azithromycin*	–	–	15	20	–	–
Fluconazole*	–	–	–	–	28	30
DMSO –ve control	–	–	–	–	–	–

penetration through the lipid layer into bacterial cell walls [53]. Such enhanced intake rate of molecules, and displayed the prominent antimicrobial potency.

The experimental results showed that the complexes Mn(II) Co(II), Ni(II), Cu(II) are more active against bacterial microorganisms than the free ligand (H_2L). The ligand and its metal complexes show moderate performance against fungal species *C. albicans and A. niger and* fluconazole as standard drug because such organisms have been achieved resistance to antibiotics may through biochemical and morphological modification [54–56]. The enhancement in the antimicrobial activity may be rationalized on the basis presence of heterocyclic moiety, comprises of carbonyl group, one piperidinic ring, one azomethine (-CH=N-), ($-OCH_3$), -Cl groups. Moreover, in metal complex, the positive charge on the metal ion is partially shared with the hetero donor atoms present in the ligand and there may be π electrons delocalization over the whole chelating system. The experimental antimicrobial activity of ligand and metal complexes also validated from the theoretical study data of nucleophilicity index (N) than electrophilicity index (ω). The zone of inhibition data of the metal complexes was indicated a good biological activity as compared with free (H_2L) ligand, and may be used as a future potential antimicrobial candidate in biological science.

4. Conclusions

A comprehensive explication of synthesis, structural, electronic and biological characteristics of the new hydrazone Schiff base, N'-(2–hydroxy-3-methoxybenzyl-idene)–4-oxopiperidine-1-carbohydrazide and its Mn(II) Co(II), Ni(II), Cu(II) complexes are accomplished through this examination. The outcomes of the elemental investigation were in acceptable concurrence with theoretically determined data and affirm synthesis of complexes. The stoichiometry of the metal to ligand ratio in all complexes was observed to be 1:1. The IR, electronic absorption, and magnetic moment data confirmed that the binding of the H_2L ligand through donor (*ONO)* denticity with the metal ion and designated the octahedral structure to all complexes. The ESR tensor parameters of the Cu(II) complex indicating the presence of axial distortion in structure. The X-ray diffraction parameters viz., glancing angle (2Θ), interplanar distances, and the full width at half maximum (FWHM) indicating the hydrazone ligand (H_2L), Mn(II), Ni(II) complexes which confirmed their nano crystalline nature. Interpretations of thermal and structural data depicted that all prepared metal complexes are thermally stable and prepared successfully. The fluorescence intensity data (I_F) in excited state of emission informed concrete evidences of good fluorescent components, and may use in photochemical applications. The DFT geometrical parameters of hydrazone ligand indicating the triatomic moiety, and Mn(II), Co(II), NI(II),and Cu(II) complexes suggest the octahedral geometry. The smaller energy gap in HOMO and LUMO are more responsible for charge transfer interaction in the heterocyclic hydrazone ligand and its metal complex results in the more bioactivity. Each MEP plot of ligand and Mn(II) complex are good tools which displayed the its color scaling in the molecule as the nucleophilic reactions and electrophilic sites. The enhanced activity of metal-complexes in inhibiting the growth of specific microorganisms will be made them an effective for antibacterial and antifungal drugs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Gajanan Dongare: Conceptualization, Methodology, Investigation, Writing – original draft, Formal analysis, Data curation, Investigation. **Anand Aswar:** Methodology, Validation, Supervision, Project administration, Resources, Validation, Writing – review & editing, Investigation.

Data availability

Data will be made available on request.

Acknowledgements

The authors are thankful to authorities of Sant Gadge Baba Amravati University, Amravati for providing of the laboratory facilities (Bruker-IR instrument and Perkin Elmer-TG analyser). Authors are also thankful to SAIF, Chandigarh for the analysis of elemental, NMR (^1H,^{13}C), Mass spectra, as well as analysis of SEM. Author also thankful to SAIF-IIT, Mumbai for recording ESR spectrum and Principal, Shri Shivaji Science College, Amravati (M.S.) for the recording UV–Visible, and XRD spectra respectively.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.molstruc.2023.135107.

References

[1] P.L. Higgs, A.J. Ruiz-Sanchez, M. Dalmina, B.R. Horrocks, A. G.Leach, D.A. Fulton, Enhancing the kinetics of hydrazone exchange processes: an experimental and computational study, Org. Biomo. Chem. 17 (2019) 3218–3224, doi:10.1039/c9ob00058e.
[2] M. Pellei, V. Gandin, C. Cimarelli, W. Quaglia, N. Mosca, L. Bagnarelli, C. Marzano, C. Santini, Syntheses and biological Studies of nitroimidazole conjugated heteroscorpionate ligands and related Cu(I) and Cu(II) complexes, J. Inorg. Chem 187 (2018) 33–40, doi:10.1016/j.jinorgbio. 2018.07.008.

[3] S. Thota, D.A. Rodrigues, P.S.M. Pinheiro, L.M. Lima, C.A.M. Fraga, E.J. Barreiro, N-Acylhydrazones Drugs. Bioorg. Med. Chem. Lett. 28 (2018) 2797–2806, doi:10.1016/j.bmcl.2018.07.015.
[4] D. Osmaniye, S. Levent, A.B. Karaduman, S. Ilgın, Y. Zkay, Z.A. Kaplancikli, Synthesis of new benzothiazole acylhydrazones as anticancer agents, Molecules 23 (2018) 1–14, doi:10.3390/molecules23051054.
[5] Q.Y. Mo, J.G. Deng, Y. Liu, G.D. Huang, Z.W. Li, P. Yu, Y. Gou, F. Yang, Mixed-ligand Cu(II) hydrazone complexes designed to enhance anticancer activity, Eur. J. of Med. Chem. 156 (2018) 368–380, doi:10.1016/j.ejmech.2018.07.022.
[6] G.L. Backes, D.M. Neumann, B.S. Jursic, Synthesis and antifungal activity of substituted salicylaldehyde hydrazones, hydrazides and sulfohydrazides, Bioorg. Med. Chem. 22 (2014) 4629–4636, doi:10.1016/j.bmc.2014.07.022.
[7] P. Goel, O.A. Naim, M.J. Nawaz, F. Iqbal, M. Alam, M. Iqbal, Recent advancement of piperidine moiety in treatment of cancer-a review, Eur. J. Med. Chem. 157 (2018) 480–502, doi:10.1016/j.ejmech.2018.08.017.
[8] N. Karaman, Y. Sicak, T. Taskın-Tok, M. Ozturk, A.K. Iyidogan, M. Dikmen, K. Kocyigit, B. Kocyigit-Kaymakcioglu, E.E. Oruc-Emre, New piperidine-hydrazone derivatives: synthesis, biological evaluations and molecular docking studies as AChE and BChE inhibitors, Eur. J. Med. Chem. 124 (2016) 29270–29283, doi:10.1016/j.ejmech.2016.08.037.
[9] N.M. El-Barasi, M.M. Miloud, M.M. El-ajaily, R.K. Sarangi, A.K. Das, D. Mahal, P.K. Parhi, L. Pintilie, S.R. Barik, M.N. Amin Bitu, M. Kudrat-E-Zahan, Z. Tabassum, S.I. Al-Resayes, M. Azam, Synthesis, structural investigations and antimicrobial studies of hydrazone based ternary complexes with Cr(III), Fe(III) and La(III) Ions, J. Saudi Chem. Soc. 24 (2020) 492–503, doi:10.1016/j.jscs.2020.04.005.
[10] E. Raczuk, B. Dmochowska, J. Samaszko-Fiertek, J. Madaj, Different schiff bases—structure, importance and classification, Molecules 27 (2022) 2–24, doi:10.3390/molecules27030787.
[11] P.C. Sharma, D. Sharma, A. Sharma, N. Saini, R. Goyal, M. Ola, R. Chawla, V.K. Thakur, Hydrazone comprising compounds as promising anti-infective agents: chemistry and structure-property relationship, Mater. Today Chem. 18 (2020) 1–21, doi:10.1016/j.mtchem.2020.100349.
[12] D. Iacopetta, J. Ceramella, A. Catalano, C. Saturnino, M.G. Bonomo, C. Franchini, M.S. Sinicropi, Schiff bases: interesting scaffolds with promising antitumoral properties, Appl. Sci. 11 (2021) 1–20, doi:10.3390/app11041877.
[13] A.A. El-asmy, W.M.A. El-maaty, M.M. Mostafa, Spectrochimica acta part A : molecular and biomolecular spectroscopy synthesis and spectroscopic studies of 2, 5-hexanedione bis (isonicotinylhydrazone) and its first raw transition metal complexes, Spectro. Acta part A: Mol. Bio. Spectr. 75 (2010) 1516–1522, doi:10.1016/j.saa.2010.02.009.
[14] S. Wu, X. Liang, F. Luo, H. Liu, L. Shen, X. Yang, Y. Huang, H. Xu, N. Wu, Q. Zhang, C. Redshaw, Synthesis, crystal structure and bioactivity of phenazine-1-carboxylic acylhydrazone derivatives, Molecules 26 (2021) 1–12, doi:10.3390/molecules26175320.
[15] P. Kumar, B. Narasimhan, P. Yogeeswari, D. Sriram, Synthesis and antitubercular activities of substituted benzoic acid N′-(substituted benzylidene/furan-2-Ylmethylene)-N-(Pyridine-3-Carbonyl)-hydrazides, Euro. J. Med. Chem. 45 (2010) 6085–6089, doi:10.1016/j.ejmech.2010.08.030.
[16] J.M.D. Filho, S.M. Pinheiro, Stereoselective, solvent free, highly efficient synthesis of aldo- and keto-: n-acylhydrazones applying grindstone chemistry, Green Chem. 19 (2017) 2212–2224, doi:10.1039/c7gc00730b.
[17] W. Al Zoubi, K. Prisla, F. Muhammad, N. Siti, N. Nisa, G.K. Young, Recent advances in hybrid organic-inorganic materials with spatial architecture for state-of-the-art applications, Prog. Mater. Sci. 112 (2020) 100663, doi:10.1016/j.pmatsci.2020.100663.
[18] W. Al Zoubi, Putri, A.K. Rosy, G.K. Young, Understanding the metal ion-ligand responsible in the plasma-assisted electrochemical reactions for optimizing chemical stability, J. Mol. Liquids 321 (2020) 114756, doi:10.1016/j.molliq.2020.114756.
[19] A.S. Aswar, G.M. Dongare, Synthesis, Spectral characterization, thermo-kinetic and biological studies of some complexes derived from tridentate hydrazone schiff base, J. Saudi Chem. Soc. 25 (2021) 1–18, doi:10.1016/j.jscs.2021.101325.
[20] N.H. Al-Shaalan, Synthesis, characterization and biological activities of Cu(II), Co(II), Mn(II), Fe(II), and UO 2(VI) complexes with a new schiff base hydrazone: o-hydroxyacetophenone-7-chloro-4-quinoline hydrazone, Molecules 16 (2011) 8629–8645, doi:10.3390/molecules16108629.
[21] M.L. Dianu, A. Kriza, N. Stanica, A.M. Musuc, Transition metal M(II) complexes with isonicotinic acid 2-(9-Anthrylmethylene)-hydrazide, J. Serbian Chem. Soc. 75 (2010) 1515–1531, doi:10.2298/JSC091113121D.
[22] R. Fouad, I.A. Shaaban, T.E. Ali, M.A. Assiri, S.S. Shenouda, Co(II), Ni(II), Cu(II) and Cd(II)-Thiocarbonohydrazone complexes: spectroscopic, DFT, thermal, and electrical conductivity studies, RSC Adv. 11 (2021) 37726–37743, doi:10.1039/d1ra06902k.
[23] Y. Bai, H. Gao, Z.Y. Qi, D.B. Dang, Synthesis, crystal structure, and luminescent properties of a helical complex [(CuL) 2.5(H 2O) 0.375] (H 2L = benzil Bis[(5-*bromo oxidobenzylidene*) *hydrazone*]), Synth. React. Inorg. Metal-Org. Nano-Metal Chem. 42 (2012) 53–58, doi:10.1080/15533174.2011.609228.
[24] S. Abou El-Enein, F.A. El-Saied, S.M. Emam, M.A. Ell-Salamony, First row transition metal complexes of salicylidene and 2- hydroxy-1-naphthylidene-Ncyanoacetohydrazone, Spectro.Acta - Part A: Mol. Biomol. Spectr. 71 (2008) 421–429, doi:10.1016/j.saa.2007.12.031.
[25] P. Jyothi, S. Koppu, V. Sumalatha, B. Ushaiah, C.G. Kumari, Synthesis, characterisation, cytotoxicity, DNA binding and antimicrobial studies of binary and ternary metal complexes of Co (II), Inorg. Chem. Commu. 110 (2019) 1–6, doi:10.1016/j.inoche.2019.107590.
[26] B. Shao, M. Baroncini, H. Qian, L. Bussotti, M. Donato, A. Credi, I. Aprahamian, Solution and solid-state emission toggling of a photochromic hydrazone, J. Am. Chem. Soc. 140 (2018) 12323–12327, doi:10.1021/jacs.8b07108.
[27] B.X. Wu, H.Y. Chang, Y.S. Liao, M.Y. Yeh, Synthesis, photochemical isomerization and photophysical properties of hydrazide-hydrazone derivatives, New J. Chem. 45 (3) (2021) 1651–1657, doi:10.1039/d0nj05172a.
[28] T. Aysha, S. Lunak, A. Lycka, R. Hrdina, Synthesis, absorption and fluorescence of hydrazone colorants based on pyrrolinone esters, Dyes Pigments 91 (2011) 170–176, doi:10.1016/j.dyepig.2011.03.013.
[29] A.P. Mishra, R.K. Mishra, S.P. Shrivastava, Structural and antimicrobial studies of coordination compounds of VO(II), Co(II), Ni(II) and Cu(II) with some Schiff bases involving 2-amino-4-chlorophenol, J. Serb. Chem. Soc. 74 (2009) 523–535, doi:10.2298/JSC0905523M.
[30] R.C. Maurya, J.M. Mir, P.K. Vishwakarma, Conjoint experimental–theoretical evaluation of pyrone-salicylic acid hydrazide copper(II) schiff base complexes: their synthesis, sod and electrochemical fronts, J. Chin. Adv. Mat. Soc. 6 (2018) 55–80, doi:10.1080/22243682.2017.1407669.
[31] R.N. Patel, Magnetic, epr and SOD studies of some CuII/CuII, CuII/NiII and Cu(II)/Zn(II) imidazolate bridged complexes, Spectrochimica Acta Part A 59 (2003) 713–721, doi:10.1016/S1386-1425(02)00217-2.
[32] S. Saouli, I. Selatnia, B. Zouchoune, A. Sid, S.M. Zendaoui, C. Bensouici, E.E. Bendeif, Synthesis, Spectroscopic characterization, crystal structure, DFT studies and biological activities of new hydrazone derivative: 1-(2,5-bis((E)-4isopropylbenzylidene) cyclopentylidene)-2-(2,4-Dinitrophenyl) hydrazine, J. Mol. Struct. 1213 (2020) 128203, doi:10.1016/j.molstruc.2020.128203.
[33] M. Toy, H. Tanak, H. Şenoz, Experimental and DFT computational studies of novel 3-(p-cyanophenyl)-5-(o,m,p-Nitrophenyl)-5-phenylformazans, J. Mol. Struct. 1213 (2020) 2–11, doi:10.1016/j.molstruc.2020.128178.
[34] R.C. Maurya, B.A. Malik, J.M. Mir, P.K. Vishwakarma, D.K. Rajak, N. Jain, Nickel(II) complexes of ONS donor schiff base ligands: synthesis, combined DFT-experimental characterization, redox, thermal, and in vitro biological investigation, J. Coord. Chem. 68 (2015) 2902–2922, doi:10.1080/00958972.2015.1064526.
[35] S.A. Rupa, R. Moni, A.M. Patwary, M. Mahmud, A. Haque, J. Uddin, S.M.T. Abedin, Biological activity, DFT, and molecular docking studies, Molecules 27 (2022) 1–20, doi:10.3390/molecules27051656.
[36] J.H. Jiang, Y.H. Lei, X. Li, Y. Pi, H. Zhu, Q.G. Li, C.H. Li, New cobalt(II) schiff base complex: synthesis, characterization, DFT calculation and antimicrobial activity, Inorg. Chem. Commun. 127 (2021) 108350, doi:10.1016/j.inoche.2020.108350.
[37] L.R. Domingo, M. Rios-Gutierrez, P. Perez, Applications of the conceptual density functional theory indices to organic chemistry reactivity, Molecules 21 (2016) 1–22, doi:10.3390/molecules21060748.
[38] M.V. Putz, Koopmans analysis of chemical hardness with spectral-like resolution, Science World J. 348415 (2013) 1–14, doi:10.1155/2013/348415.
[39] P. Jaramillo, L.R. Domingo, E. Chamorro, P.A. Perez, Further exploration of a nucleophilicity index based on the gas-phase ionization potentials, J. Mol. Struct., Theochem 865 (2008) 68–72, doi:10.1016/j.theochem.2008.06.022.
[40] R. Shukla, P. Bandopadhyay, M. Sathe, D. Chopra, Quantitative investigation on the intermolecular interactions present in 8-(4-Ethoxyphenyl)-1,3-dimethyl-3,7-dihydro-1H-purine-2,6-dione with insight from interaction energies, energy framework, electrostatic potential map and fingerprint analysis, J. Chem. Sci. 132 (2020) 1–7, doi:10.1007/s12039-019-1726-2.
[41] S. Lakshminarayanan, V. Jeyasingh, K. Murugesan, N. Selvapalam, G. Dass, Molecular electrostatic potential (mep) surface analysis of chemo sensors: an extra supporting hand for strength, selectivity and non-traditional interactions, J. Photochem. Photobio. 6 (2021) 1–3, doi:10.1016/j.jpap.2021.100022.
[42] M. Roy, D. Biswal, N.R. Pramanik, M.G.B. Drew, S. Paul, P. Kachhap, C. Haldar, S. Chakrabarti, Structural elucidation, DFT calculations and catalytic activity of dioxomolybdenum(VI) complexes with N–N donor ligand: role of halogen Atom coordinated to the molybdenum centre, Polyhedron 200 (2021) 1–13, doi:10.1016/j.poly.2021.115144.
[43] T.M. Seck, A. Sy, D. Lo, P.A. Gaye, M.L. Sall, O. Diouf, M. Diaw, M. Gaye, Synthesis, spectroscopic studies and X-ray diffraction of heptacoordinated Mn(II) and Co(II) complexes with ligands derived from carbonohydrazide, Open J. Inorg. Chem. 09 (2019) 35–52, doi:10.4236/ojic.2019.94004.
[44] M. Rafiq, M. Khalid, M.N. Tahir, M.U. Ahmad, M.U. Khan, M.M. Naseer, A.A.C. Braga, S. Muhammad, Z. Shafiq, Synthesis, XRD, spectral (IR, UV–Vis, NMR) characterization and quantum chemical exploration of benzoimidazole-based hydrazones: a synergistic experimental-computational analysis, Appl. Org. Chem. 33 (2019) 1–17, doi:10.1002/aoc.5182.
[45] M.I. Khan, A. Khan, I. Hussain, M.A. Khan, S. Gul, M. Iqbal, F. Khuda, Spectral, XRD, SEM and biological properties of new mononuclear schiff base transition metal complexes, Inorg. Chem. Commun. 35 (2013) 104–109, doi:10.1016/j.inoche.2013.06.014.
[46] M. Shakir, S. Hanif, M.A. Sherwani, O. Mohammad, S.I. Al-Resayes, Pharmacologically significant complexes of Mn(II), Co(II), Ni(II), Cu(II) and Zn(II) of novel schiff base ligand, (E)-N-(furan-2-yl methylene) quinolin-8-amine: synthesis, spectral, XRD, SEM, antimicrobial, antioxidant and in vitro cytotoxic studies, J. Mol. Struct. 1092 (2015) 143–159, doi:10.1016/j.molstruc.2015.03.012.
[47] B. S.Kusmariya, A.P. Mishra, Co(II), Ni(II), Cu(II) and Zn(II) complexes of tridentate ONO donor schiff base ligand: synthesis, characterization, thermal, non-isothermal kinetics and DFT calculations, J. Mol. Struct. 1130 (2017) 727–738, doi:10.1016/j.molstruc.2016.11.009.
[48] M.A. Ayoub, E.H. Abd-Elnasser, M.A.-A Ahmed, M.G. Rizk, Synthesis, physicochemical, thermal, fluorescence and catalytic activity studies of novel

Mn(II), Co(II), Ni(II) and Cu(II) complexes with tridentate (ONS) schiff base ligand, Euro. J. Chem. 8 (2017) 85–95, doi:10.5155/eurjchem.8.1.85-95.1513.

[49] G. Swiderski, R. Swisłocka, R. Lyszczek, S. Wojtulewski, M. Samsonowicz, W. Lewandowski, Thermal, spectroscopic, X-ray and theoretical studies of metal complexes (sodium, manganese, copper, nickel, cobalt and zinc) with pyrimidine-5-Ccarboxylic and pyrimidine-2-carboxylic acids, J. Thermal Anal. Calor. 138 (2019) 2813–2837, doi:10.1007/s10973-019-08594-x.

[50] S.M. Abdallah, G.G. Mohamed, M.A. Zayed, M.S.A. El-Ela, Spectroscopic study of molecular structures of novel schiff base derived from O-phthaldehyde and 2-aminophenol and its coordination compounds together with their biological activity, Spectro. Acta - Part A: Mol. Biomol. Spectr. 73 (2009) 833–840, doi:10.1016/j.saa.2009.04.005.

[51] B.K. Singh, U.K. Jetley, R.K. Sharma, B.S. Garg, Synthesis, characterization and biological activity of complexes of 2-hydroxy-3,5-dimethylacetophenoneoxime (HDMAOX) with copper(II), cobalt(II), nickel(II) and palladium(II), Spectro, Acta Part A 68 (2007) 63–73, doi:10.1016/j.saa.2006.11.001.

[52] V.K. Srivastava, Synthesis, characterization, and biological studies of some biometal complexes, Future J. Pharma. Sci. 7 (2021), doi:10.1186/s43094-021-00191-w.

[53] E. MacKova, K. Hruskova, P. Bendova, A. Vavrova, H. Jansova, P. Haskova, P. Kovarikova, K. Vavrova, T. Simunek, Methyl and ethyl ketone analogs of salicylaldehyde isonicotinoyl hydrazone: novel iron chelators with selective antiproliferative action, Chem. Biol. Interact. 197 (2012) 69–79, doi:10.1016/j.cbi.2012.03.010.

[54] R.N. Patel, S.P. Rawat, M. Choudhary, V.P. Sondhiya, D.K. Patel, K.K. Shukla, D.K. Patel, Y. Singh, R. Pandey, Synthesis, structure and biological activities of mixed ligand copper(II) and nickel(II) complexes of N′-(1E)-[(5-bromo-2-hydroxyphenyl)methylidene] benzoylhydrazone, Inorg. Chimica Acta 392 (2012) 283–291, doi:10.1016/j.ica.2012.03.040.

[55] S. Sharma, F. Athar, M.R. Maurya, F. Naqvi, A. Azam, Novel bidentate complexes of Cu(II) derived from 5-nitrofuran-2- carboxaldehyde thiosemicarbazones with antiamoebic activity against E. histolytica, Euro. J. Med. Chem. 40 (2005) 557–562, doi:10.1016/j.ejmech.2005.01.003.

[56] G. Sridhar, B.I. Mohammed, D. Easwaramoorthy, R.S. Kutti, S. B.Kumar, C.S. Manohar, Synthesis, characterization and antimicrobial activities of copper, nickel, cobalt, chromium complexes derived from (Z)-4-fluoro-N-(2,7-dimethylhept-6-enylidene) benzenamine, J. Braz. Chem. Soc. 28 (2017) 756–767, doi:10.21577/0103-5053.20160224.

Indian J. Applied & Pure Bio. Vol. 38(3), 1199-1215 (2023). **ISSN: 0970-2091**
A Web of Science Journal

Role of Phenolic compounds in plant defense mechanism: An updated review

Pratiksha Salunke and *Dipak Koche

Department of Botany,
Shri Shivaji College of Arts, Commerce, and Science, Akola-444003 (India)
*Corresponding author: kochedeepak77@gmail.com

Abstract

Being immovable, plants have to face all types of abiotic and biotic stress conditions. In response to various stress conditions, different plants accumulate different phenolic compounds. The phenolic compounds accumulated to counter various stresses depend on the type of stress conditions. In general, light stress induce the synthesis of phenolics and flavonoids; temperature extremes inducethe accumulation of osmoprotectant compounds which eventually stimulate the synthesis of antioxidants such as flavonoids, tannins, and phenolics in plants. In nearly all types of stress conditions plants increase the production of reactive oxygen species (ROS) and also to counter this, the plant produces phenolic acids, polyphenols, flavonoids, anthocyanins, and other compounds with similar properties to counter ROS such as (H_2O_2). In case of biological stresses, the plants accumulate phenolics at the infection site to restrict microbes' growth. Sometimes, they also induce the synthesis and accumulation of Salicylic acid (SA) and H_2O_2 at the site of infection. It's important for plants as they develop systemic acquired resistance (SAR). The synthesis and accumulation of phenolic compounds were also recorded immediately after post-infection; indicating their crucial role in plant defense mechanisms against various types of stresses. The present review focuses on current updates on the role of phenolics and their physiological functions as a response to stress conditions and their probable applications in stress counter.

Key words : Abiotic and biotic stress, Phenolic compounds, Plant defense.

Every time, when plants are exposed to any abiotic or biotic stress conditions, these stresses negatively impacted the plant's growth, development, and yield[12,13]. During the course of evolutions,plants have developed a variety ofbiochemical or metabolic pathways

to respond to different abiotic and biotic stress conditions,especially through induced biosynthesis of secondary metabolites. These metabolic pathways are important and integral parts of plant growth, survival, development, reproduction, and defense.

During stress conditions, plants divert more energy towardthe synthesis of secondary metabolites resulting accumulation of various secondary metabolites in plants[23,35,132]. These secondary metabolites are essential toregulate the plant's defense mechanism and other developmental processes. Among various plant metabolites, phenolic compounds constitute a special class of natural secondary metabolites synthesized through various pathways likepentose phosphate, shikimate, and phenylpropanoid pathway[16,29,51]. The plants use these pathways to produce either monomeric phenolic compounds (flavonoids, phenolic acids, and phenylpropanoids) or polymeric phenolic compounds (tannins, lignins, lignans, melanins, etc.). Phenolic compounds show high structural as well as functional diversity. In terms of their occurrence, some phenolic compounds are widely found frequently in many plant species while others are only observed in a fewplant species[67]. Nearly all known phenolic compounds are reported to have a defensive function against abiotic and biotic stress conditions[36,67].

Most common abiotic stress includes extreme environmental conditions such as high or low light conditions and temperature, ultraviolet (UV) radiation, deficiency of nutrients, drought or flood-like conditions, etc. while the biotic stress includes infection by microbial pathogens, attack by herbivorous organisms, nematodes, larvae, etc.

The capability to synthesize specific phenolic compounds in response to particular abiotic or biotic stress is developed by plants through adaptive evolutionary phenomena over a period of time. To respondto different environmental challenges, plants have developed a variety of arrays to synthesize various phenolics to defend against the stresses[27]. Flavonoids and isoflavones accumulate heavily in plants exposed to very low temperatures, nutrient deficiency, UV- B radiations, pathogenic attack, and herbivorous activities[87,109,114]. Phenolics were also known to accumulate in plants as a response to metallic stress in the soil[82,86] and microbial infection[15,70,127,133]. Fig. 1. is the schematic representation of various types of abiotic stress conditions, which stimulates the biosynthesis of phenolic compounds and later increased accumulation of phenolic compounds helps to counter the abiotic stress conditions.

This article is a compiled presentation of various research work related to the synthesis and accumulation of various phenolic compounds by plants exposed to various kinds of stresses and their role in plant defense mechanisms as understood so far.

Fundamentals of Phenolic compounds :

Phenolic compounds are a diverse group of plant chemicals having phenol moiety in their structure. These compounds are basically classified into two categories as simple phenolics and polyphenolics (Fig. 2) which are groups of structurally and functionally allied phenol-containing compounds. They are abundant in plants and found in all parts of

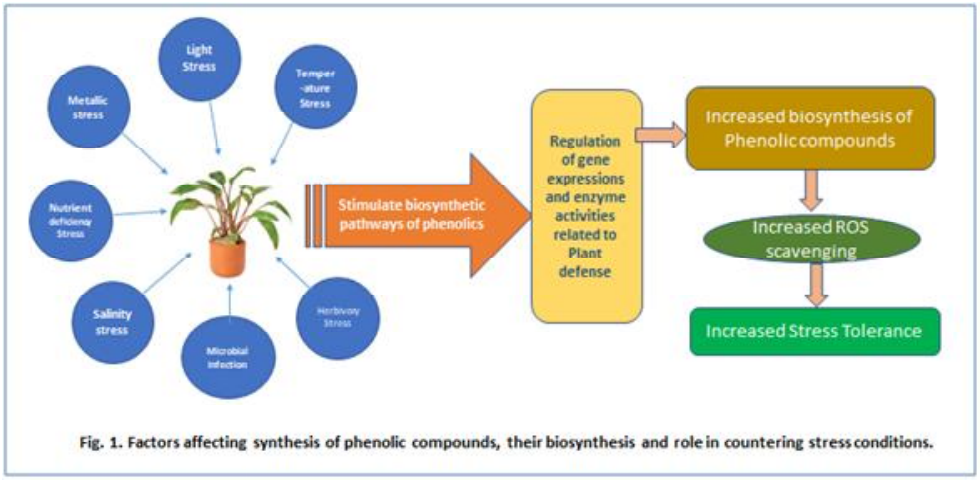


Fig. 1. Factors affecting synthesis of phenolic compounds, their biosynthesis and role in countering stress conditions.

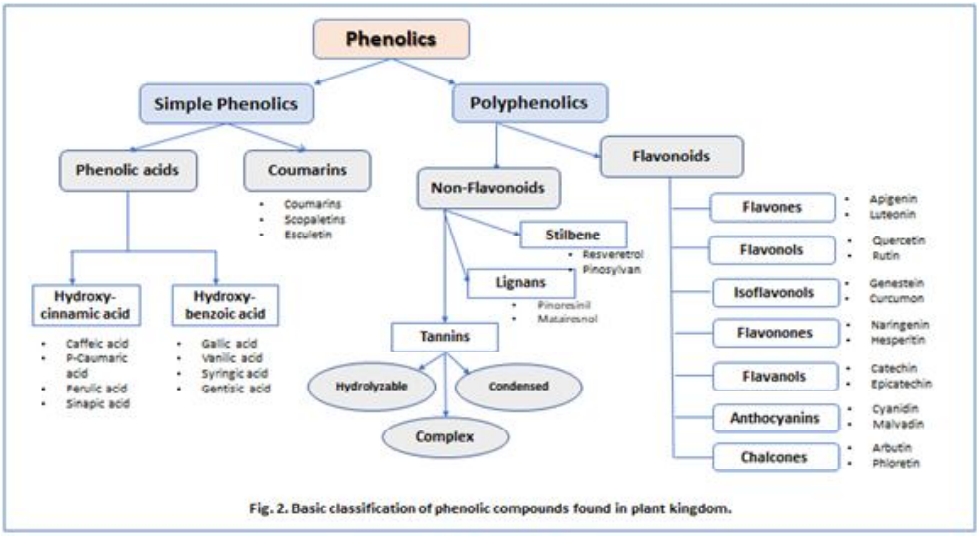


Fig. 2. Basic classification of phenolic compounds found in plant kingdom.

plants. These compounds display a wide variety of biological activities. The most important biological properties of phenolics include antioxidant, antimicrobial, anti-inflammatory etc.[29,77].

Role of plant phenolics in countering light stress :

Phenolic compounds in plants play an important role in growth control and have antioxidant, structural, attractant, signaling, and protective functions. Plants synthesize and accumulate phenolic acids and flavonoids in the vacuoles of mesophyll and epidermal cells in response to light stress conditions[124]. Falcone *et al.*[37] noted that after exposure to UV-B radiation the genes P1, B, and PL1 increaseexpression in maize which inducesthe

synthesis of transcription regulators that regulates the activity of protein ZmFLS1 for converting the dihydro-flavanols, dihydro-quercetin, and dihydro-kaempferol to flavonols, quercetin, and kaempferol respectively. Radyukina *et al.,*[103] observed the accumulation of flavonoids and anthocyanins in plants exposed to ultraviolet light and salinity stress. Their report suggested that flavonoids protect plants from UV-B radiation and anthocyanins protect them from salinity stress. Manukyan[83] reporteda high accumulation of total phenol in *Melissa officinalis*, *Nepeta cataria,* and *Salvia officinalis* after exposure to low UV-B radiation. In *Salvia miltiorrhiza*, Ma *et al.*[80] observed that UV radiation increases the concentration of rosmarinic acid and lithospermic acid. They suggested that methyl jasmonate induces biosynthesis of enzymes tyrosine aminotransferase, cinnamic acid 4-hydroxylase, 4-hydroxyphenylpyruvate reductase, and phenylalanine ammonia-lyase (PAL) that are responsible forthe biosynthesis of rosmarinic acid and lithospermic acid. Ghasemzadeh *et al.*[43] reported accumulation of specific phenolic compounds in sweet basil leaves was dependent on the intensity of UV-B radiation. They suggesteda direct correlation between synthesized phenolic compounds'reactive oxygen species (ROS) generation due to UV light damage. They observed that some phenolic acids like cinnamic acid, gallic acid, quercetin, ferulic acid, catechin, rutin, luteolin, and kaempferol are precursors for biosynthesis of different flavonoids through phenylpropanoid metabolism that utilizes PAL and chalcone synthase enzymes. when it is exposed to low UV-B light Csepregi *et al.*[34] reportedan increased accumulation of flavonols, quercetin, and kaempferol derivatives in leaves of *Arabidopsis thaliana*. Leon-Chan *et al.*[73] observed that the low temperature and UV-B radiation causes the degradation of chlorophyll and accumulation of carotenoids, chlorogenic acid, flavonoids apigenin-7-O-glucoside, and luteolin-7-O-glucoside in leaves of bell pepper. They specifically observed that UV-B radiation increases flavonoid concentration in leaves whereas the combination of low temperature and UV-B radiation increases chlorogenic acid in leaves. They also noted that the luteolin-7-O-glucoside is involved in quenching of the reactive oxygen species (ROS) produced due to low temperature and UV-B radiation stress. Lobiuc *et al.*[78] suggested that the phytochemical content of the basil green cultivar was high in red light whereas of the basil red cultivar was high in blue light when exposed to different proportions of blue and red light. In a comparative study, they observed an increased accumulation of rosmarinic acid, caffeic acid, and anthocyanin when exposed to blue light and white light. Similar reports were made by Taulavuori *et al.,*[125], Stagnari *et al.,*[122], and Nadeem *et al.,*[91]. Teerarat[126] reported an accumulation of phenolic compounds, especially chlorogenic acid and other flavonoids in leaves of *Coffea arabica* after exposure to UV light.

Role of plant phenolics in countering temperature stress and drought stress :

Extreme temperature conditions usually inhibit plant metabolism and stimulate the production of reactive oxygen species (ROS) which damage the cells[10,48]. To combat this damaging stress plants accumulate osmoprotective compounds such as soluble sugars, proline, glycine betaine antioxidant

enzymes, and other defensive substances which provide protection from oxidative damage[17,116]. The phenolics, terpenes, and alkaloids also accumulateduring temperature stress to develop stress resistance ability in plants[52,96]. During temperature stress activity of the enzyme phenylalanine ammonia-lyase (PAL) increases which results in the accumulation of phenolic compounds in plant cells. Rivero *et al.,*[108] suggested that during heat and cold stress, there is a remarkable accumulation of soluble phenolics in watermelon and tomato. Kasuga *et al.,*[60] indicated that cold-induced phenols accumulation in plant cells decreases the freezing point, maintains water potential, and protects cellsfrom disruption. Weidner *et al.*,[130] reported increased content of tannins and soluble phenols in the roots of grapevine after cold treatment. Amarowicz *et al.*[5] demonstrated that during cold stress there is increased accumulation of gallic acid, ferulic acid, and caffeic acid in plants. Isshiki *et al.*[55] observed an accumulation of farinose flavonoids in the aerial part of fairy primrosewhen it was exposed to freezing cold stress. Rana and Bhushan[105] suggested that biosynthesis and accumulation of phenolic compounds in plants provide tolerance against cold stress. In the same line, Commisso *et al.*[32] provided evidence that phenolic compounds protect the cytoskeleton of microfilaments from reactive oxygen species. Chalker-Scott and Fuchigami[28] reported that cellular injury and stress tolerance capacity in plants is increased by the accumulation of phenolic compounds like suberin or lignin.

When the plant is exposed to drought stress it usually produces reactive oxygen species (ROS) (hydrogen peroxide H_2O_2, singlet oxygen O, superoxide anion O_{2-}, and hydroxyl radical OH) which may cause protein degradation, membrane damage, lipid peroxidation, deoxyribose nucleic acid (DNA) damage andcell mortality[117,136]. To prevent this damage, plants have a special system of detoxification which is regulated either by enzymes (superoxide dismutase (SOD), ascorbate peroxidase (APX), catalase (CAT), peroxidase (POD)) or by antioxidant molecules (phenols, vitamin C, carotenoids, tocopherol, and glutathione)[12]. Kumar *et al.*[67] suggested that the overproduction of reactive oxygen species (ROS) during stress is balanced through the production of phenolic compounds and flavonoids using the phenylpropanoid pathway[67]. Akula and Ravishankar[1] observed an accumulation of flavonoids in the leaves of willow plantsduring drought stress. A similar observation was made by Nakabayashi *et al.,*[92] in leaves of *Arabidopsisthaliana*in response to drought conditions. An increase in phenylalanine ammonia-lyase (PAL) activity indicates the beginning of the plant's antioxidant defense mechanism and is regulated by the feedback inhibition process through the increase in the accumulation of its own product cinnamic acid[22]. It regulates the activity of the enzyme and in turn, specific phenolic compounds are synthesized in response to biotic or abiotic stress. Chalcone synthase is an enzyme that shows high activity during drought stress. It is a key enzyme in the flavonoid synthesis pathway that acts on the CoA-ester of cinnamic acid to form chalcone. The chalcone is converted to flavanone by the chalcone flavanone isomerase (CHI) enzyme through isomerization which is a precursor for the synthesis of numerous flavonoid compounds[67]. Hura *et al.,*[54] reported the accumulation of ferulic acid and high

activity of PAL enzyme in leaves of maize under water stress conditions. Phimchan *et al.*[101] also reported high PAL activity and ferulic acid accumulation in fruits of capsicum during drought stress. Nakabayashi *et al.*[92] observed the high activity of another enzyme chalcone synthase (CHS) in response to drought stress in *Arabidopsis*. Some workers have observeda high accumulation of phenolic compounds in vegetables, fruits, and cereals under drought stress[42,121]. Sarker and Oba[112] observed a high accumulation of flavonoids in the leaves of *Amaranthustricolor* during drought stress. Brunetti *et al.*[24] suggested that *Moringa oleifera*can serve in water deficit conditions by accumulating flavonoids in leaves. Moayedinezhad *et al.,*[90] indicated that drought stress had a marked influence on the content of various phenolic compounds such as total phenolic content, total as well as individual polyamines, and organic acids in grapevine cultivars. Severe heat stress increases the accumulation of phenolic acids *i.e.*, p-coumaric, syringic, and vanillic acids, and decreasesferulic acid, whereas severe drought had a higher impact on ferulic acid and the total sum of phenolic acids in durum wheat[69]. Park *et al.,*[99] also identified drought-responsive phenolic compounds in *Ligularia fischeri*and studied their biosynthesis and regulation.

Role of plant phenolics in countering salinity stress :

Usually, salinity stress induces the production of reactive oxygen species (ROS) in plants resultingin oxidative stress. To counter this oxidative damage plants produce antioxidative metabolites such as polyphenols, flavonoids, anthocyanins, pro-anthocyanidins, phenolic acids, and phenolic terpenes which quench the singlet oxygen, neutralize or absorb free radicals and decompose peroxides[96]. Yang *et al.,*[134] suggested the accumulation of specific phenolic compounds in plants during salinity stress. Parida *et al.,*[98] earlier reported that there was a significant increase in polyphenols content in plants of *Aegiceras corniculatum* after 250 mM NaCl treatment. Ksouri *et al.,*[66] suggested that there was a significant increase in polyphenols in jerboa plants after treatment with 100 mM and 400 mM NaCl. Hanen *et al.,*[45] suggested that the phenol content in a leaf of the plant *Cynara cardunculus* increases in response to 50 mM NaCl treatment. Lim *et al.,*[76] suggested that the accumulation of phenolic compounds in response to salinity stress in *Fagopyrum esculentum* is due to the increased content of compounds such as vitexin, iso-orientin, rutin, and orientin. Similar reports were presented by Petridis *et al.*,[100] and Borgognone *et al.,*[21].

Another mechanism acquired by plants to resist salinity stress is through salicylic acid which is an endogenous growth regulator and signaling molecule. It is a phenolic phytohormone that controls stress by decreasing H_2O_2 levels and reducing oxidative damage in plants[72]. It enhances growth, development, and productivity in plants during stress conditions[104]. Many research studies have suggested the function of salicylic acid in increasing salinity tolerance in plants. Jini and Joseph[58] and Khan *et al.,*[62] suggested that salicylic acid strengthens the salinity tolerance in plants such as *Medicago sativa, Vicia faba, Brassica juncea,* and *Vigna radiata.* Jayakannan *et al.,*[57] observed that exogenous salicylic treatment increased

water content and growth of shoots in Arabidopsis plants growing under saline conditions. Various studies of mutant plants have suggested the function of salicylic acid in providing salinity tolerance to plants[11,26,47,89]. Various studies on the exogenous application of salicylic acid to salinity-stressed plants have also confirmed that salicylic acid alleviates the toxic effect of salt and increases the resistance of plants against salinity[9,12,61,97]. Hanifah and Purvestri[46] reported that there is an increase in the accumulation of Phenolic compounds, total flavonoid, and antioxidant activity with the increase of saline concentration.Kiana *et al.* (2021) reported the vigorous antioxidant activity and robust accumulation of phenolic compounds in the leaves of *Triticum vulgare* and *Aegilops cylindrica*.

Role of plant phenolics in countering heavy metal stress :

The plants take up heavy metals through their roots which get accumulated inside the cell wall by the apoplastic system. These heavy metals may cause harm to plants by hindering biochemical metabolisms such as cell division,cell elongation, photosynthesis, nitrogen metabolism, respiration, mineral nutrient utilization, and water transportation[31,123]. It was noted that heavy metals inactivate essential enzymes by binding to their active sites, it alsoinducesthe biosynthesis of reactive oxygen species, and exchange metal ions from biomolecules[115]. Under heavy metal stress conditions, plants synthesize phenols and flavonoids to scavenge the harmful reactive oxygen species (ROS) which donates their electron to peroxidase enzymes to detoxify hydrogen peroxide produced by heavy metals[111]. Under cadmium stress, maize accumulates phenolic compounds in roots[118]. Ali *et al.,*[4] observed high activity of enzymes responsible for the biosynthesis of phenols and flavonoids in roots of Panax ginseng exposed to copper sulfate. Kovacik *et al.,*[65] reported that when *Matricaria chamomilla*was exposed to nickel,the activity of the polyphenol oxidase enzyme decreased and there was an increase in total phenolics content. There was a remarkable increase in the activity of phenylalanine ammonia-lyase (PAL) and shikimate dehydrogenase enzymes with an accumulation of chlorogenic acid, protocatechuic acid, and caffeic acid. Marquez-Garcia *et al.,*[84] observed that when*Erica andevalensis* are exposed to cadmium, the concentration of rutin, cinnamic acid derivatives, and epigallocatechin increases. They suggested that increased cadmium exposure decreases the concentration of phenolic compounds in plants to reduce the deleterious effect of produced phenoxyl radicals. Malcovska *et al.,*[81] suggested the production of phenolic compounds increases in plant cells when plants are under heavy metal stress as phenols are reactive oxygen species (ROS) scavengers and metal chelators. Kisa *et al.,*[63] observed that when Zey maize plants are exposed to cadmium and lead, the phenolic compounds (chlorogenic acid and rutin) increased in leaves whereas there was a decrease of caffeic acid and ferulic acid. Later in 2019, Kisa *et al.,*[64] reported the changes in phenolics compounds in tomatoes in relation to heavy metal stress. Janczak-Pieniążek*et al.,*[56] studied the pattern and correlated the metal stress with an accumulation of phenolic compounds in winter wheat varieties.

Role of plant phenolics in countering microbial pathogens :

Plant growth and development are directly influenced by a variety of abiotic and biotic stresses.The plants mechanize their defense in two stages, first there is a rapid accumulation of phenols at the infection site that slowdowns the growth of invading pathogens. In the second step,it biosynthesizes specific stress-related substances (simple phenols, phenolic phytoalexins, hydroxycinnamic acids, etc.). These compounds restrict the pathogen from invasion. The sequence of plant defense mechanisms includes the accumulation of phenolic compounds, necrosis, host cell death, modification of cell wall through phenolic compounds deposition or development of some kind of barriers, and at last synthesis of specific toxic compounds to eradicate the pathogens[95]. Pattern recognition receptors (PRRs) are the proteins present in the cell membrane of plants. They recognize conserved pathogen-associated molecular patterns (PAMPs) of microorganisms and givea signal to synthesize specific phenolic compounds, through a defense mechanism known as PAMPs-induced immunity[20,50,94,102,138].

In some cases, plants induce multi-component defense response after a pathogen attack which includes the reprogramming of genetic resources, expression of a large number of defense-related genes, and encoding of enzymes that catalyze the biosynthesis of defense metabolites (phytoalexins). The process is regulated by transcriptional factors responsible for the accumulation of specific phytoalexins in plants. Salicylic acid also plays a crucial role in resisting pathogen attacks in plants. During pathogenic infection, there is a remarkable accumulation of pathogenesis-related (PR) protein at the location distant from the infection site and to regulate systemic acquired resistance (SAR) in plants salicylic acid and H_2O_2 play a vital role[14,59].

Some plants possess innate immunity against pathogenic bacterial species. They have developed metabolic mechanisms to resist pathogenic bacteria through the accumulation of phenolic compounds. Postel and Kemmerling[102] reported that plants recognize bacterial pathogens through pathogen-associated molecular patterns (PAMPs). In walnut plantsinfected by *Xanthomonas arboricola* bacteria, Mikulic Petkovsek *et al.,*[88] observed an accumulation of hydroxycinnamic acid, gallic acid, quercetins and catechin. Cho and Lee[30] identifiedan accumulation of sakuranetin in rice plants infected by *Xanthomonas oryzae* and *Burkholderiaglumae*. Wang *et al.,*[129] suggested that polyphenols inhibit bacterial species such as *Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Salmonella cholera-esuis, Bacillus subtilis, Serratia marcescens,* and *Pseudomonas aeruginosa*.

Earlier studies suggested that phenolic compounds eliminate fungal pathogens by altering the permeability of cell membrane, the integrity of the cell wall, the formation of free radicals andsuppression of enzymes activity, damage of DNA, and suppression the expression of virulence genes[6,39,93,102]. Gallego-Giraldo *et al.,*[41] reported the suppression of lignin biosynthesis genes (HCT) leads to the accumulation of salicylic acid which in turn increases the transcription level of some pathogenesis-related (PR) genes to improve the immunity of plants. Widodo *et al.,*[131] suggested that

coumarins inhibit the growth of fungi by altering the thickness of the mitochondrial matrix, inducing apoptosis. Al-Barwani and Eltayeb[3] observed the antifungal activity of psoralen and furanocoumarin against fungi *Alternaria brassicicola, Sclerotinia sclerotiorum* and *Cercospora carotae*. Some other similar reports includes that of Al-Amiery *et. al*.,[2], Serpa *et al.*[116] and Zuzarte *et al.,*[139]. Belofsky *et. al*.,[18] suggested that the isoflavone sedonan A isolated from plant *Dalea formosa* prevents from infection caused by *Candida albicans* and *Candida glabrata* by inhibiting the activity of intracellular transcription targets and efflux pumps. Sherwood and Bonello[119] suggested that lignin has potent antifungal activity against the fungi *Diplodia pinea* under in vitro conditions. Anttila *et al.,*[7] suggested that the tannin extract isolated from the cone and bark of conifer plants has a toxic effect on four soft rot fungi, three white rot fungi, and eight brown rot fungi. Rashed *et al.,*[106] observed the toxic effect of *Ammivisnaga* seed extract against the fungi *Rhizoctonia solani* was due to the presence of coumarins. In sugarcane, Marques *et. al*.,[85] observed the accumulation of phenolic compounds at the infected site during the early stage that might be helpful to prevent the penetration and spread of *Sporisorium scitamineum* fungi in other parts of the plant.

Kumar and Pandey[68] suggested that phenolic compounds suppress viral infection in plants by inhibiting viral replication through simultaneous damageof protein,and nucleic acids and inhibition of viral enzyme activities. Hu *et al.*[53] observed the antiviral activity of different phenolic compounds isolated from *Arundina graminifolia* against the tobacco mosaic virus. Zhao *et al.,*[137] suggested that the two flavonoids (fistula flavonoid B and C) isolated from the bark and stem of the plant *Cassia fistula* has antiviral activity against the tobacco mosaic virus. Shokoohinia *et al.*[120] suggested that coumarins inhibit viral replication in cells by inhibiting enzymes such as protease, integrase and reverse transcriptase. Li *et al.,*[75] identified the phenolic compound gramniphenol which exhibited antiviral activity against the tobacco mosaic virus. Later in 2016, Liu *et al*. reportedthe antiviral potential of two coumarins isolated from leaves of *Nicotiana tabacum* against tobacco mosaic virus. Zakaryan *et al.,*[135] suggested that flavonoids suppress viral infection by distracting of viral RNA translation, inhibiting viral DNA replication, inhibiting viral protein synthesis, inhibiting transcription factors responsible for viral enzymes and genome synthesis, and interfering with viral structural protein.

Role of plant phenolics in countering insects, nematodes, and herbivorous organisms :

Plants have to face various pathogenic attacks in the natural environment. To resist these pathogens plants have adjusted their physiological metabolism and developed metabolic pathways which synthesize a wide range of phenolic compounds. These phenolic compounds are used either to attract or repel different organisms as per plants' benefit. Through their toxicant effect and inhibition, they protect plants from various insects, nematodes, and herbivorous animals which feed on them[19]. Feeny[38] suggested that tannins have an inhibitory effect on the growth of

Opheropthera brumata larvae. Levin[74] suggested that the phenolic quinone hypericin secreted by glands on leaves, sepals, or petals of *Hypericum* spp. is toxic to insects and mammals. He also suggested that the presence of gossypol in the leaves and flowers of plants can inhibit grazing by mammals and infection by tobacco budworms or bollworms. Hedin *et al.,*[49] suggested that some flavonoids present in cotton plants are feeding inhibitors for the boll weevil, Anthonomus grandis. Luczynski *et al.,*[79] suggested that the concentration of catechol increases in the leaves of strawberries when infected by spotted spider mites. Byers[25] suggested that the bark beetle *Scolytus multistriatus* does not consume *Carya ovata* due to the presence of the phenolic compound juglone which is not palatable to them Accumulation of anthocyanins provides red, blue, or purple color to leaves, and flowers or fruits which protects the plant from the herbivorous animals and insect pathogens. These pigments developed in leaves are either not palatable for animals to eat or are not visible to animals due to a lack of red visualization receptors. Usually, insect pathogens are found to avoid red leaves and are noted to colonize mostly on green leaves. Because red leaves have better chemical defense, coupled with the worst nutritional value,whichinduces adverse effects in insects. Hence autumn colors of leaves is an adaptive mechanism of plants to reduce pathogen attacks[8,44,71]. Further, Rehman *et al.,*[107] suggested that catechol, a phenolic compound binds to the digestive system of mites and inactivates digestive enzymes mites. Furstenberg-Hagg *et al.*[40] opined that most wheat cultivars arevery rich in phenolic content,therefore, not consumed by cereal aphids *Rhopalosiphum padi*.

Plants constantly interact with the environment, and climate change has already impacted their diversity, growth, and survival. In order to minimize the impact of various climate change-related stresses, plants produce diverse defense secondary metabolites, mainly phenolic compounds. Phenolic compounds regulate crucial steps in plant metabolism to provide resistance against various biotic and abiotic stresses. To protect against UV radiation plants synthesize phenolic acids and flavonoids to scavenge the reactive oxygen species (ROS) generated. During temperature stress activity of the phenylalanine ammonia-lyase(PAL) enzyme increases which results in the accumulation of phenols in plant tissues. The accumulation of phenols during drought stress is regulated by the activity of either phenylalanine ammonia-lyase (PAL) or chalcone synthase (CS). Phenylalanine ammonia-lyase (PAL) acts as a precursor for the biosynthesis of various phenolic compounds. Chalcone (CS) synthase helps to accumulate numerous flavonoid compounds in plants during water deficiency. During salinity stress plants accumulate polyphenols, flavonoids, anthocyanins, phenolic acids, and terpenes to resist oxidative stress. Plants also accumulate salicylic acid during salinity stress to decrease the level of H_2O_2 and reduce oxidative damage. Plants synthesize phenols and flavonoids to scavenge the reactive oxygen species (ROS) produced during heavy metal stress. Plants accumulate phenolic compounds at the infection site to inhibitthe growth and penetration of microbial pathogens in other tissues and organs. It recognizes microbial pathogens and induces a defense response at the genetic level to biosynthesize defense metabolites. Plants also accumulate salicylic

acid and H_2O_2 at the infection site to regulate systemic acquired resistance (SAR). Phenolic compounds also play a vital role as inhibitors or toxicants for nematodes, insects, and herbivores.

Future prospective :

The biosynthesis of phenolic compounds in plants during abiotic and biotic stress increases the adaptation of plants in extreme environmental conditions. Therefore, it is necessary to understand the molecular mechanism regulating biosynthesis and accumulation of specific phenolic compounds during particular stress conditions. There should be molecular and genetic level studies on the regulation of transcription factors responsible for the biosynthesis of specific phenolic compounds during each type of stress. A line of progressive study on interactive biology between phenolic compounds and salicylic acid is possible to understand the crosstalk between them while respondingto salinity stress, oxidative damage, and microbial pathogen attack. This will help to develop effective strategies to develop crop varieties that could overcome stress conditions.

Reference :

1. Akula, R. and G. A. Ravishankar, (2011). *Plant Signaling and Behavior 6*(11): 1720-1731.
2. Al-Amiery, A. A., A. A. Kadhum, and A. B. Mohamad, (2012). *Molecules*. *17*(5): 5713-5723.
3. Al-Barwani, F. M. and E. A. Eltayeb, (2004). *Biochemical Systematics and Ecology*. *32:* 1097-1108.
4. Ali, M. B., N. Singh, A.M. Shohael, E. J. Hahn, and K. Y. Paek, (2006). *Plant Science 171*(1): 147-154.
5. Amarowicz, R., S. Weidner, I. Wójtowicz, M. Karmac, A. Kosinska and A. Rybarczyk (2010). *Functional Plant Science and Biotechnology 4:* 90-96.
6. Ansari, M. A., Z. Fatima and S. Hameed, (2014). *Journal of Pathogens 24:* 895193.
7. Anttila, A-K., A.M. Pirttila, H. Häggman, A. Harju, M. Venalainen, A. Haapala, *et al.* (2013). *Holzforschung. 67(7):* 825-832.
8. Archetti, M., T. F. Doring, S. B. Hagen, N. M. Hughes, S. R. Leather and D. W. Lee, (2009). *Trends in Ecology and Evolution 24:* 166-173.
9. Ardebili, N.O., S. Saadatmand, V. Niknam and R. A. Khavari-Nejad, (2014). *Acta Physiologiae Plantarum 36(12):* 3199-3205.
10. Asada, K. (2006). *Plant Physiology 141(2):* 391-396.
11. Asensi-Fabado, M. and S. Munne-Bosch (2011). *Journal of Plant Growth Regulation 30:* 456-466.
12. Ashraf, M. A., M. Riaz, M. S. Arif, R. Rasheed, M. Iqbal, I. Hussain and M. S. Mubarik (2019). The role of non-enzymatic antioxidants in improving abiotic stress tolerance in plants. In: *Plant Tolerance to Environmental Stress*: Role of Phyto-protectants. Boca Raton: CRC Press; 2019. pp. 129-144.
13. Ashraf, M., N. A. Akram, R. N. Arteca, and M.R. Foolad (2010). *Critical Reviews in Plant Sciences 29:* 162-190.
14. Badere, R. S., D. K. Koche, S. E. Powar, and A.D. Choudhary, (2007). *Journal of Plant Biology 34:* 139-145.
15. Bais, H.P., T.S. Walker, F.R. Stermitz,

R.A. Hufbauer, and J.M. Vivanco (2002). *Plant Physiology 128*(4): 1173-1179.
16. Balasundram, N., K. Sundram, and S. Samman, (2006). *Food Chemistry 99*(1): 191-203.
17. Balla, K., S. Bencze, T. Janda, and O. Veisz (2009). *Acta Agronomica Hungarica 57*(4)*:* 437-444.
18. Belofsky, G., M. Kolaczkowski, E. Adams, J. Schreiber, V. Eisenberg, and C.M. Coleman, *et al*. (2013). *Journal of Natural Products 76*(5): 915-925.
19. Bhattacharya, A., P. Sood and V. Citovsky (2010). *Molecular Plant Pathology 11:* 705-719.
20. Bittel, P. and S. Robatzek (2007). *Current Opinion in Plant Biology 10:* 335- 341.
21. Borgognone, D., M. Cardarelli, E. Rea, L. Lucini, and G. Colla, (2014). *Journal of the Science of Food and Agriculture 94:* 1231-1237.
22. Boudet, A. (2007). *Phytochemistry 68*(22-24): 2722-2735.
23. Broun, P. (2005). *Current Opinion in Plant Biology 8*(3): 272-279.
24. Brunetti, C., F. Loreto, F. Ferrini, A. Gori, L. Guidi, D. Remorini, M. Centritto, A. Fini and M. Tattini (2018). *Tree Physiology 38*(11): 1640-1165.
25. Byers, J. A. (1995). *Chemical Ecology of Insects*. *2:* 154-213.
26. Cao, Y., Z. W. Zhang, L. W. Xue, J. B. Du, J. Shang, F. Xu, S. Yuan and H.H. Lin (2009). *Zeitschrift für Naturforschung***.** *C64:* 231-238.
27. Caputi, L., M. Malnoy, V. Goremykin, S. Nikiforova, and S. Martens, (2012). *The Plant Journal 69*(6): 1030-1042.
28. Chalker-Scott, L. and L. H. Fuchigami, (2018). The role of phenolic compounds in plant stress responses. In: Low-Temperature Stress Physiology in Crops. Boca Raton: CRC Press; pp. 67-80.
29. Cheynier, V., G. Comte, K. M. Davies, V. Lattanzio, and S. Martens, (2013). *Plant Physiology and Biochemistry 72:* 1-20.
30. Cho, M. and S. Lee (2015). *International Journal of Molecular Sciences 16*(12): 29120-29133.
31. Ciriakova, A. (2009). *Oecologia Montana 18*(1-2): 23-26.
32. Commisso, M., K. Toffali, P. Strazzer, M. Stocchero, S. Ceoldo, B. Baldan, M. Levi, and F. Guzzo, (2016). *Frontiers in Plant Science 7:* 1439.
33. Conejero, G., M. Noirot, P. Talamond, and J. L. Verdeil, (2014). *Frontiers in Plant Science*. *5:* 39.
34. Csepregi, K., A. Coffey, N. Cunningham, E. Prinsen, E. Hideg, and M. A. Jansen, (2017). *Environmental and Experimental Botany 140:* 19-25.
35. Do Nascimento, N. C. and A. G. Fett-Neto (2010). Plant secondary metabolism and challenges in modifying its operation: An overview. In: Fett-Neto A, editor. *Plant Secondary Metabolism Engineering. Methods in Molecular Biology (Methods and Protocols)*. Vol. *643:* Totowa, NJ: Humana Press; 2010. pp. 1-13.
36. Esmaeili, S., M. Sharifi, F. Ghanati, B.M. Soltani, E. Samari, and M. Saghariyan, (2023). *Scientific Reports 13:* 4158. https://doi.org/10.1038/s41598-023-30954-9.
37. Falcone Ferreyra, M. L., S. Rius, J. Emiliani, L. Pourcel, A. Feller, K. Morohashi, P. Casati, and E. Grotewold, (2010). *The Plant Journal 62*(1): 77-91.
38. Feeny, P. (1970). *Ecology 51:* 565-581.

DOI: 10.2307/1934037.

39. Fernandes, K.R.P., P.S. Bittercourt, A.D.L. Souza, A. Q. L. Souza, F.M.A. Silva and E. S. Lima, (2019). *Acta Amaz. 49*(1): 48-53.
40. Fürstenberg-Hagg, J., M. Zagrobelny and S. Bak, (2013). *International Journal of Molecular Sciences. 14:* 10242-10297. DOI: 10.3390/ijms140510242 .
41. Gallego-Giraldo, L., Y. Jikumaru, Y. Kamiya, Y. Tang, and R. A. Dixon, (2011). *The New Phytologist 190:* 627-639.
42. Gharibi, S., B. E. S. Tabatabaei, G. Saeidi, and S. A. H. Goli. (2016). *Applied Biochemistry and Biotechnology 178*(4): 796-809.
43. Ghasemzadeh, A., H. Z. Jaafar, and A. Rahmat, (2010). *Molecules 15*(6): 4324-4333.
44. Gould, K. S. (2004). *Journal of Biomedicine and Biotechnology 5:* 314-320.
45. Hanen, F., R. Ksouri, W. Megdiche, N. Trabelsi, M. Boulaaba, and C. Abdelly, (2008). Effect of salinity on growth, leaf phenolic content and antioxidant scavenging activity in Cynara cardunculus L. In: Abdelli C, Öztürk M, Ashraf M, Grignon YC, editors. 2008 Biosaline Agriculture and High Salinity Tolerance. Basel: Birkhauser Verlag; pp. 335-343.
46. Hanifah, N. and Y. A. Purwestri, (2021). The effect of NaCl salinity stress to phenolic compound, total flavonoid and antioxidant activity of Pegagan (*Centella asiatica* (L.) Urban) Leaves. *BIO Web of Conferences* 41, 06004. https://doi.org/10.1051/bioconf/20214106004.
47. Hao, L., Y. Zhao, D. Jin, L. Zhang, X. Bi, H. Chen, Q. Xu, C. Ma, and G. Li, (2012). *Plant and Soil 354:* 81-95.
48. Hasanuzzaman, M., K. Nahar, M. Alam, R. Roychowdhury, and M. Fujita, (2013). *International Journal of Molecular Sciences 14*(5): 9643-9684.
49. Hedin P A, J N Jenkins, A C Thompson, J C McCarty, D H Smith, W L Parrott, *et al*. (1988). *Journal of Agricultural and Food Chemistry. 36:* 1055-1061.
50. Heil, M. (2008). *The New Phytologist 178:* 41-61.
51. Heleno, S. A., A. Martins, M. J. Queiroz, and I.C. Ferreira (2015). *Food Chemistry 173:* 501-513.
52. Hoque T S, A A M Sohag, D J. Burritt and M A. Hossain (2020). Salicylic acid-mediated salt stress tolerance in plants. In *Plant Phenolics in Sustainable Agriculture*. Singapore: Springer; 2020. pp. 1-38.
53. Hu, Q-F., B. Zhou, J-M. Huang, X-M. Gao, L-D. Shu, and G-Y. Yang, (2013). *Journal of Natural Products 76*(2): 292-296.
54. Hura, T., K. Hura and S. Grzesiak (2008). *Journal of Agronomy and Crop Science 194*(2): 104-112.
55. Isshiki, R., I. Galis, and S. Tanakamaru, (2014). *Journal of Integrative Plant Biology 56*(2): 181-188.
56. Janczak-Pieniązek, M., J. Cichonski, P. Michalik, and G. Chrzanowski, (2023). *Molecules 28*(1): 241. doi: 10.3390/molecules28010241.
57. Jayakannan, M., J. Bose, O. Babourina, Z. Rengel and S. Shabala (2013). *Journal of Experimental Botany 64*(8): 2255-2268.
58. Jini, D. and B. Joseph, (2017). *Rice Science 24:* 97-108.
59. Kamle, M., R. Borah, H. Bora, A. K. Jaiswal, R.K. Singh and P. Kumar (2020). Systemic Acquired Resistance (SAR)

and Induced Systemic Resistance (ISR): Role and mechanisms of action against phytopathogens. In : Hesham A L, Upadhyay R, Sharma G, Manoharachary C. and Gupta V. (Eds) Fungal Biotechnology and Bioengineering. Fungal Biology, Springer, doi.org/10.1007/978-3-030-41870-0 20.

60. Kasuga, J., Y. Hashidoko, A. Nishioka, M. Yoshiba, K. Arakawa and S. Fujikawa (2008). *Plant, Cell and Environment*. *31*(9): 1335-1348.
61. Khan, M.I.R., M. Asgher, and N. A. Khan (2014). *Plant Physiology and Biochemistry 80:* 67-74.
62. Khan, M.I.R., M. Fatma, T.S. Per, N. A. Anjum and N.A. Khan, (2015). *Frontiers in Plant Science 6:* 462.
63. Kısa, D., M. Elmastaş, L. Oztürk and O. Kayır, (2016). *Applied Biological Chemistry 59*(6): 813-820.
64. Kisa, D., O. Kayir, N. Saglam, S. Sahin, L. Ozturk, and M. Elmastas, (2019). *Bartın University International Journal of Natural and Applied Sciences 2*(1): 35-43.
65. Kovacik, J., B. Klejdus, M. Backor, and M. Repcak (2007). *Plant Science 172*(2): 393-399.
66. Ksouri, R., W. Megdiche, and A. Debez, (2007). *Plant Physiology and Biochemistry 45:* 244-249.
67. Kumar, S., M. M. Abedin, A. K. Singh, and S. Das, (2020). Role of phenolic compounds in plant-defensive mechanisms. In: Plant Phenolics in Sustainable Agriculture. Singapore: Springer; 2020. pp. 517-532. DOI: 10.1007/978-981-15-4890-1_22.
68. Kumar, S. and A. K. Pandey, (2013). *Scientific World Journal 16:* 2750.
69. Laddomada, B., A. Blanco, G. Mita, L. D'Amico, R.P. Singh, K. Ammar, J. Crossa and C. Guzmán, (2021). *Foods 10:* 2142. https://doi.org/10.3390/ foods10092142.
70. Lanoue, A., V. Burlat, U. Schurr and U.S. Röse, (2010). *Plant Signaling and Behavior 5*(8): 1037-1038.
71. Lee, D. W., and K. S. Gould, (2002). *American Scientist 90:* 524-531.
72. Lee, N. Y., M. J. Lee, Y. K. Kim, J. Park, H. K. Park, J. S. Choi, J-N. Hyun, K. J. Kim, K. H. Park, J. K. Ko, and J. G. Kim (2010). *Journal of Korean Society for Applied Biological Chemistry 53:* 685-690.
73. Leon-Chan, R.G., M. Lopez-Meyer, T. Osuna-Enciso, J. A. Sanudo-Barajas, J.B. Heredia and J. Leon-Felix (2017). *Environmental and Experimental Botany*. *139:* 143-151.
74. Levin, D. A. (1971). Plant phenolics: An ecological perspective. The American Naturalist. *105*(942): 157-181.
75. Li, L., W-X. Xu, C-B. Liu, C-M. Zhang, W. Zhao, S-Z Shang, *et al*. (2015). *Asian Journal of Chemistry 27:* 3525-3526.
76. Lim, J. H., K. J. Park, B. K. Kim, J. W. Jeong, and H. J. Kim, (2012). *Food Chemistry 135:* 1065-1070.
77. Lin, D., M. Xiao, J. Zhao, Z. Li, B. Xing, X. Li, M. King, L. Li, Q. Zhang, Y. Liu, H. Chen, W. Qin, H. Wu, and S. Chen, (2016). *Molecules., 21:* 1374-1393.
78. Lobiuc, A., V. Vasilache, O Pintilie, T. Stoleru, M. Burducea, M. Oroian and M.M. *L. Microgreens*. *Molecules 22*(12): 2111.
79. Luczynski A, MB. Isman and DA. Raworth (1990). *Journal of Economic Entomology 83:* 557-563. DOI: 10.1093/ jee/83.2.557.

80. Ma P, J Liu, C. Zhang and Z. Liang (2013). *Applied Biochemistry and Biotechnology 170*(6): 1253-1262.
81. Malcovska, S. M., Z. Ducaiova, I. Maslanakova, and M. Backor, (2014). *Water, Air, and Soil Pollution 225*(8): 2056
82. Mandal, S. M., D. Chakraborty, and S. Dey, (2010). *Plant Signaling and Behavior 5*(4): 359-368.
83. Manukyan, A. (2013). *Photochemistry and Photobiology 89*(2): 406-414.
84. Marquez-Garcia, B., M. Fernandez-Recamales, and F. Cordoba, (2012). *Environmental and Experimental Botany 75*(1): 159-166.
85. Marques, J.P. R., J.W. Hoy, B. Appezzatoda-Gloria, A. F. G Viveros, M. L. C. Vieira, and N. Baisakh, (2018). *Frontiers in Plant Science 9:* 698.
86. Michalak, A. (2006). *Polish Journal of Environmental Studies 15*(4): 523-530.
87. Mierziak, J., K. Kostyn and A. Kulma (2014). *Molecules 19*(10): 16240-16265.
88. Mikulic-Petkovsek, M., A. Slatnar, R. Veberic, F. Stampar, and A. Solar, (2011). *Physiological and Molecular Plant Pathology 76*(3-4): 159-165.
89. Miura, K., A. Sato, M. Ohta and J. Furukawa (2011). *Planta 234:*1191-1199.
90. Moayedinezhad A, B Mohammadparast, G H Salekdeh, E. Mohseni fard and MA. Nejatian (2020). *Journal of Plant Process and Function 8*(34): 19-26.
91. Nadeem, M., B. H. Abbasi, M. Younas, W Ahmad, A. Zahir and C. Hano, (2019). *Journal of Photochemistry and Photobiology B*: *Biology*. *190:* 172-178.
92. Nakabayashi, R., K. Yonekura Sakakibara, K. Urano, M Suzuki, Y Yamada, T Nishizawa, F Matsuda, M Kojima, H Sakakibara, K Shinozaki, A J Michael, T Tohge M. Yamazaki and K. Saito (2014). *The Plant Journal 77*(3): 367-379.
93. Negritto, M. C., C. Valdez, J Sharma, C. Rosenberg and C R. Selassie (2017). *ACS Omega 2*(12): 8568-8579.
94. Nicaise, V., M. Roux and C. Zipfel (2009). *Plant Physiology 150:* 1638-1647.
95. Nicholson, R. L. and R. Hammerschmidt, (1992). *Annual Review of Phytopathology 30:* 369-389.
96. Oh, M.M., E.E. Carey and C.B. Rajashekar (2009). *Plant Physiology and Biochemistry 47*(7): 578-583.
97. Palma F, M López-Gómez, N A. Tejera and C. Lluch (2013). *Plant Science 208:* 75-82.
98. Parida, A. K., A. B. Das, Y. Sanada, and P. Mohanty (2004). *Aegiceras corniculatum*. *Aquatic Botany 80 :* 77-87.
99. Park, Y. J., D.Y. Kwon, S.Y. Koo, T. Q. Truong, S-C. Hong, J. Choi, J. Moon, and S.M. Kim, (2023). *Frontiers in Plant Science 14:* 1140509. doi: 10.3389/fpls. 2023.1140509.
100. Petridis, A., I. Therios, G. Samouris, and C. Tananaki, (2012). *Environmental and Experimental Botany 79:* 37-43.
101. Phimchan, P., S. Chanthai, P. W. Bosland, and S. Techawongstien, (2014). *Journal of Agricultural and Food Chemistry 62*(29): 7057-7062.
102. Postel, S. and B. Kemmerling (2009). *Seminars in Cell and Developmental Biology*, *20*(9): 1025-1031.
103. Radyukina, N. L., V.I. Toaima, and N.R. Zaripova, (2012). *Russian Journal of Plant Physiology 59*(1): 71-78.
104. Rajeshwari, V. and V. Bhuvaneshwari, (2017). *International Journal of Plant Biology and Research 5:*1067.

105. Rana, S. and S. Bhushan (2016). *Journal of Food Science and Technology*. *53*(4): 1727-1738.
106. Rashed, Y. M., D. G. Aseel, and E. E. Hafez (2018). *Phytopathologia Mediterranea. 57*(1): 73-88.
107. Rehman, F., F. A. Khan, and S M A. Badruddin (2012). Role of phenolics in plant defense against insect herbivory. In: Chemistry of Phytopotentials: Health, Energy and Environmental Perspectives. Berlin/Heidelberg: Springer; 2012. pp. 309-313
108. Rivero, R. M., Ruiz, J M, P C Garcia, L R Lopez-Lefebre, E. Sánchez and L. Romero (2001). *Plant Science 160*(2): 315-321.
109. Rodríguez-Calzada, T., M. Qian, A. Strid, S. Neugart, M. Schreiner, I. Torres-Pacheco and R. Guevara-Gonzalez (2019). *Plant Physiology and Biochemistry 134:* 94-102. DOI: 10.1016/j. plaphy.2018.06.025.
110. Sakamoto, A. and N. Murata (2000). *Journal of Experimental Botany 51*(342): 81-88.
111. Sakihama, Y. and H. Yamasaki, (2002). *Biologia Plantarum 45*(2): 249-254.
112. Sarker, U. and S. Oba (2018). *BMC Plant Biology 18*(1)*:* 258.
113. Sarker, U. and S. Oba, (2020). *Frontiers in Plant Science 11:* 559876.
114. Schulz, E., T. Tohge, E Zuther, A R Fernie, and D. K. Hincha (2016). *Scientific Reports 6*(1): 1. DOI: 10.1038/srep34027.
115. Schutzendubel, A. and A. Polle, (2002). *Journal of Experimental Botany 53:* 1351-1365.
116. Serpa, R., E. J. Franca, L. Furlaneto-Maia, C.G. Andrade, A. Diniz and M. C. Furlaneto (2012). *Journal of Medical Microbiology 61:* 1704-1708.
117. Shao, H.B., L.Y. Chu, Z. H. Lu and C.M. Kang (2008). *International Journal of Biological Sciences 4*(1): 8.
118. Shemet, S. A. and V.S. Fedenko, (2005). *Fiziologiia i biokhimiia kul'turnykh rastenii 37*(6): 505.
119. Sherwood, P. and P. Bonello, (2013). *Tree Physiology 33*(8): 845-854.
120. Shokoohinia, Y., S.E. Sajjadi, S. Gholamzadeh, A. Fattahi and M. Behbahani (2014). *Pharmaceutical Biology 52*(12): 1543-1549.
121. Siracusa, L., F. Gresta, E. Sperlinga, and G. Ruberto, (2017). *Journal of Food Composition and Analysis 62:* 1-7.
122. Stagnari, F., C Di, Mattia, A. Galieni, V. Santarelli, , D'Egidio, G. Pagnani and M. Pisante, (2018). *Industrial Crops and Products 122:* 277-289.
123. Sytar, O., A. Kumar, D. Latowski, P. Kuczynska, K. Strzałka and M.N.V. Prasad (2013). *Acta Physiologiae Plantarum 35*(4): 985-999.
124. Szymanska, R., I. Slesak, A. Orzechowska and J. Kruk, (2017). *Environmental and Experimental Botany, 139*: 165-177.
125. Taulavuori, K., A. Pyysalo, E. Taulavuori, and R. Julkunen-Tiitto, (2018). *Environmental and Experimental Botany*. *150:* 183-187. DOI: 10.1016/j.envexpbot.2018. 03.016.
126. Teerarat, Duangsodsri (2021). Phenolic compounds in the response of Coffea arabica L. to abiotic stresses. Agricultural sciences. Université Montpellier, 2020.
127. Tuladhar, P., S. Sasidharan and P. Saudagar (2021). Role of phenols and polyphenols in defense response to biotic and abiotic stresses. Biocontrol Agents and Secondary Metabolites, 419-441.
128. Upadhyay, A., S. Mooyottu, H. Yin, M. Nair,

V. Bhattaram, and K. Venkitanarayanan, (2015). *Medicine 2:* 186-211.

129. Wang, L., R. Sun, Q. Zhang, Q. Luo, S. Zeng, and X. Li, (2018). An update on polyphenol disposition via coupled metabolic pathways. In: Expert Opinion on Drug Metabolism and Toxicology. London: Ashley Publications; 2018. pp. 1-15.
130. Weidner, S., M. Karolak, M. Karamac, A. Kosinska, and R. Amarowicz, (2009). *Acta Societatis Botanicorum Poloniae 78*(2): 97-103.
131. Widodo, G. P., E. Y. Sukandar, and I. K. Adynyana (2012). *ITB Journal of Science 44A:* 145-151.
132. Wink, M. (1999). Biochemistry of Plant Secondary Metabolism. UK/Sheffield, Boca Raton: Sheffield Academic Press/ CRC Press.
133. Wurst, S., R. Wagenaar, A. Biere, and W. H. Van der Putten, (2010). *Plant and Soil*. *329*(1) : 117-126.
134. Yang, L., K. Wen, X Ruan, Y. Zhao, F. Wei and Q. Wang (2018). *Molecules 23:* 276.
135. Zakaryan, H., E. Arabyan, A. Oo, and K. Zandi (2017). *Archives of Virology 162*(9): 2539-2551.
136. Zhang, J. and M. B. Kirkham, (1994). *Plant and Cell Physiology 35*(5): 785-791.
137. Zhao, W., X.Y. Zeng, T Zhang, L. Wang, G. Y. Yang, and Y. K. Chen, (2013). *Phytochemistry Letters. 6:* 179-182.
138. Zipfel, C. (2008). *Current Opinion in Immunology 20:* 10-16.
139. Zuzarte, M., L. Vale-Silva, M.J. Goncalves, C. Cavaleiro, S. Vaz and J. Canhoto (2012). *European Journal of Clinical Microbiologyand Infectious Diseases*. *31*(7): 1359-1366.

Clinical Interventions and Clinical Trials
2023 Volume 1, Issue 1
DOI: 10.59657/cict.brs.23.002

BioRes Scientia
Value your Research

Research Article

Open Access

Synthesis, Characterization and Antimicrobial Activity of Copper Oxide Nanoparticles Using Sol-Gel Method

Jagannath S. Godse[1], Kishore Puri[2], Santosh B. Gaikwad[3], Sanjay B. Ubale[1]*, Savita A. Kate[4] and Rajendra P. Pawar[4]*

[1]*Department of Chemistry, Deogiri College, Aurangabad, India.*
[2]*Department of Chemistry, Shri Shivaji College of Arts, Commerce and Science, Akola, India.*
[3]*Department of Chemistry, L P G Arts and Science College, Shirpur (Jain), Washim, India.*
[4]*Department of Chemistry, Shi Chhatrapati College, Aurangabad, India.*
Corresponding Author: Sanjay B. Ubale & Rajendra P. Pawar.

Abstract

This study investigates a novel way for producing copper oxide (CuO) nanoparticles using the sol-gel process and citric acid as a surfactant. In this technique, water is used as a potent solvent. Because of its low cost, ease of preparation, and commercial practicality, the synthetic approach is environmentally beneficial. X-ray diffraction (XRD), Field Emission Scanning Electron Microscopy (FE-SEM), Energy-Dispersive X-ray spectroscopy (EDX), Fourier Transform Infra-Red spectroscopy (FTIR), and Ultra-Violet visible spectroscopy (UV-Vis) were used to examine the antimicrobial activity of bacterial, fungal, as well as Pneumonia activity. Copper oxide NPs synthesized demonstrates highly scattered characterization and application findings. The green method is a practical, eco-friendly, simple, and valuable method for producing copper oxide nanoparticles.

Keywords: Copper oxide; sol-gel method; nanomaterial; antimicrobial; antifungal

Introduction

The unique properties of nanomaterials, as well as their high surface-to-volume ratio, have made them a viable and new tool in many scientific disciplines. This flexible material has numerous applications, including antimicrobial activities, photovoltaics, sensors, storage devices, medicine administration, photocatalytic training, and so on. Copper oxide nanoparticles most used because they are cheap, common, have low toxicity, and are easy to manufacture. Because of their high catalytic activity and durability, photo-catalysts constructed of single metal oxides are becoming increasingly popular [1-2].

A multitude of procedures can be used to create single metal oxide nanoparticles. Solid-state synthesis, the hydrothermal method, the electrochemical approach, the sol-gel technique, co-precipitation, microwave-assisted synthesis, the thermal decomposition method, and others are examples[3-4]. We choose the sol-gel process due to worries about overheating and hazardous solvents in other procedures. The sol-gel method is the most environmentally friendly and cutting-edge of these techniques because it does not require high pressure or high temperature, is inexpensive, and allows for easy monitoring of the crystalline size and structure of the nanomaterial through pH modification of the medium while preparing a large amount of sample. This paper describes a simple sol-gel method for producing copper oxide (CuO) nanoparticles with citric acid as a suitable surfactant. Synthesized Copper oxide nanoparticles were screened for biological activity of antibacterial, antifungal, and antimalarial activity which showed better to excellent results.

Experimental

Characterization

Copper chloride, citric acid, hydrochloric acid, and ammonium hydroxide were purchased from SD-Fine Chemical Company and used without further purification. The X-ray diffraction (XRD) pattern was recorded by the Rigaku X-ray Diffractometer with a Cu

© 2023 Rajendra P. Pawar & Sanjay B. Ubale, et al.

K-α radiation source (λ=1.5406 A°) operated at 40 kV. Field emission scanning electron microscopy (FE-SEM) images were obtained on JEOL 6390LA, Japanand the energy dispersive spectrometry (EDS) analysis was studied by JEOL/JEM 2100, Japan, with an acceleration voltage of 200 kV. Fourier transform infrared (FT-IR) spectra were recorded on Shimadzu IR spectrophotometer. Ultraviolet visible (UV-Vis) spectra were recorded on Thermo Scientific UV-Vis's spectrophotometer.

Synthesis of CuMn2O4 nanoparticles

Synthesis of Copper oxide (CuO) nanoparticles was carried out by the sol-gel method. Initially, 0.25 M of copper chloride were dissolved in 100 ml of distilled water. 0.1 N hydrochloric acid improves the solubility of copper chloride in water. Both the solutions were mixed with constant stirring. After mixingthe solutions, 1 gm of the citric acid solution was added as a surfactant. The pH of the above solution was adjusted at 8-8.5 (basic) using 3 to 3.5 ml NH_4OH solution. Precipitation was formed, which stirred with constant stirring for an hour at room temperature. The mixture was filtered using Whatman filter paper No. 42 and washed with deionized water 2-3 times. The obtained product was dried in an oven at 100°C for 2 hours. Finally, the dried material was calcinated for 3 hours at 500°C in the furnace. The black-colored precipitate was obtained as a final product and was stored for further study **(Figure 1).**



Figure 1: Flow Chart for Synthesis Method of CuO NPs

Result and Discussion

UV-Visible Analysis of CuO oxide Nanoparticle

The UV-Visible diffused reflectance spectra of nanostructured equimolar concentration of copper oxide NPs are shown in Figure. It has a wide range of absorption at 260 to 300 nm [5]. This proves that equimolar concentrations of copper oxide NPs result in lower reflectance. These findings suggest that synthesized copper oxide NPs metal to shift the absorption of the resulting nanoparticles from the infrared to the visible. This indicates that transition metal oxides that have been optically active. The copper oxide NPs effect on the band gaps of CuO semiconductors is the more immediate cause of the change in reflectance. The increased photogeneration rate of charge-transfer between Cu^{2+} electrons valence band greatly improves the photo reactivity, catalytic activity of copper oxide NPs **(Figure 2)**.

© 2023 Rajendra P. Pawar & Sanjay B. Ubale, et al.

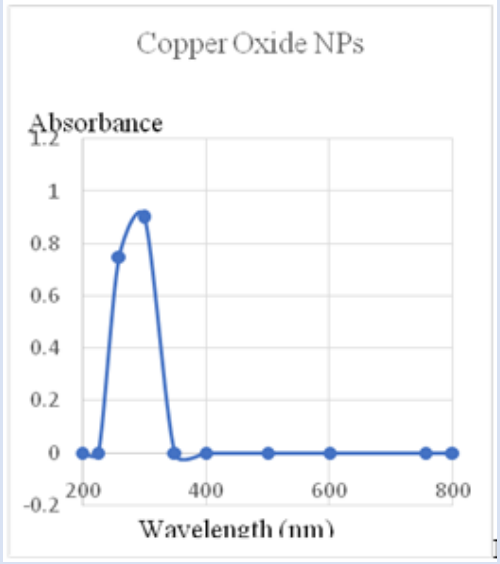


Figure 2: Uv-Vis's data of CuO NPs

FTIR analysis of CuO oxide nanomaterial

Fourier transform infrared spectrometer confirms the formation of metal oxide bonds in the CuO nanoparticles as shown in Figure 2. Investigation of nanomaterial is observed at the wavelength range from 397 cm^{-1} to 3980 cm^{-1}. The low-frequency vibrations of the M-O bond appear below 1000 cm^{-1}. In Figure 1the firm peaks at position 403.12cm^{-1} and 462.92 cm^{-1} represent Cu–O stretching of CuO stretching vibrational modes, respectively and the band that appeared in the range of 800–1300 cm^{-1} is recognized as the stretching vibration of –OH (**Figure 3**). These results as approximately match with another study [6-7].

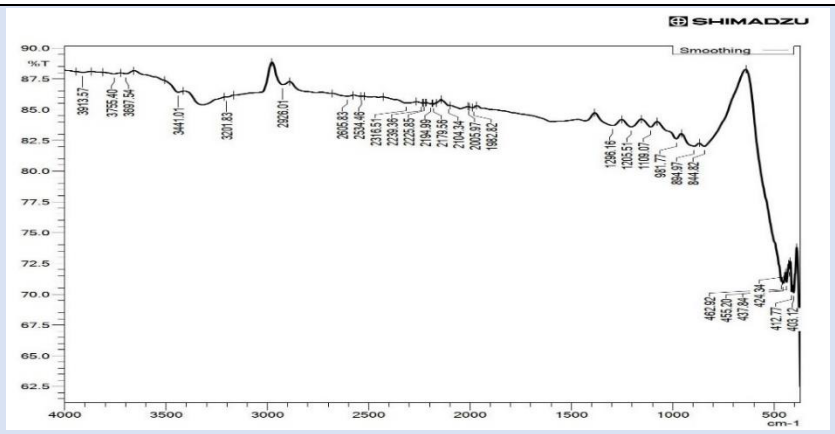


Figure 3: FTIR data of CuO NPs

XRD characterization of CuMn2O4 oxide nanomaterial

The X-ray diffraction technique investigated the chemical, structural, and spectroscopic properties of CuO nanomaterial. All X-ray diffraction peaks were indexed according to the standard data for CuO as shown in Figure 2. The significant peaks are obtained for 2θ at 32.5°,35.49°, 38.71°, 47.42°, 56.29°, 61.59°, 66.32°68.11°and 75.17°, corresponding to the planes (110), (111), (111), (220), (020), (113), (022) (220) and (004) respectively (**Figure 4**). In addition, the Fd-3m space group and Monoclinic Crystal system of CuO nanomaterial are recognized in the X-ray diffraction pattern and correctly matched with the standard JCPDs card no. 05-0661[8-9]. The average crystallite size (D) of CuO nanomaterial was calculated by using the Scherer formula [5, 10].

$$D = \frac{K\lambda}{\beta Cos\theta} \qquad (1)$$

Where, K is a shape factor, D is the size of the nanomaterial, λ is the incident X-ray beam's wave length, θ is Bragg's diffraction angle, and β is the Full width half maximum. The average particle size of the investigating nanomaterial was 15.5 nm.

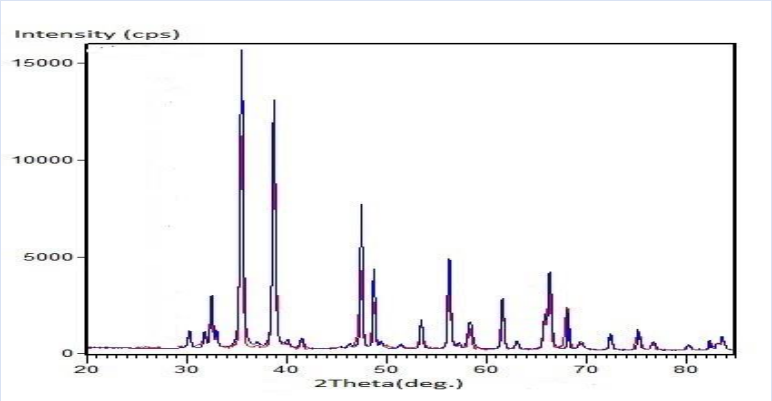


Figure 4: XRD data of CuO NPs

SEM and EDX studies of CuO oxide nanomaterial

The morphology and complete structures of CuO nanomaterial were contributed by scanning electron microscope (SEM) and energy-dispersive X-ray (EDX) spectroscopy. SEM images of CuO nanomaterial synthesized by sol-gel method from chloride precursors strengthening the precursors at 500°C are shown in as shown in (Figure 6 and Figure 7). Scanning electron microscope (SEM) instrument in the range of scale taken between 500 nm and 1µm.

The elemental compositional investigation of CuO nanomaterial is shown in as shown in (Figure 8 and Table 1). The presence of Cu and O and the Cu/O ratio were determined by EDX investigation, which matches perfectly with CuO. This confirms the availability of copper and oxygen with a weight percentage of 94 %, 6 %, and atomic percentages of 79.9% and 20.1% respectively.

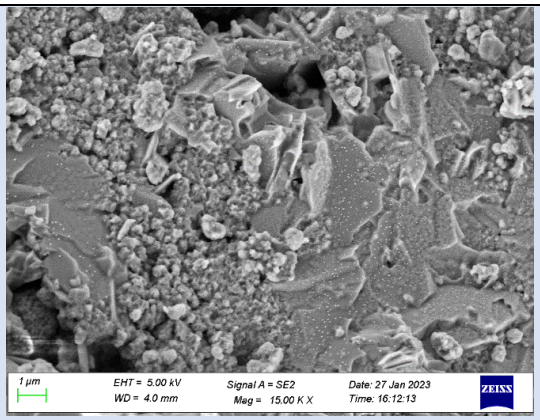


Figure 5: FESEM data of CuO NPs

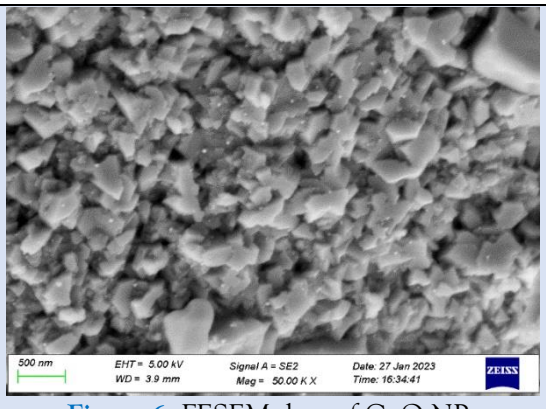


Figure 6: FESEM data of CuO NPs

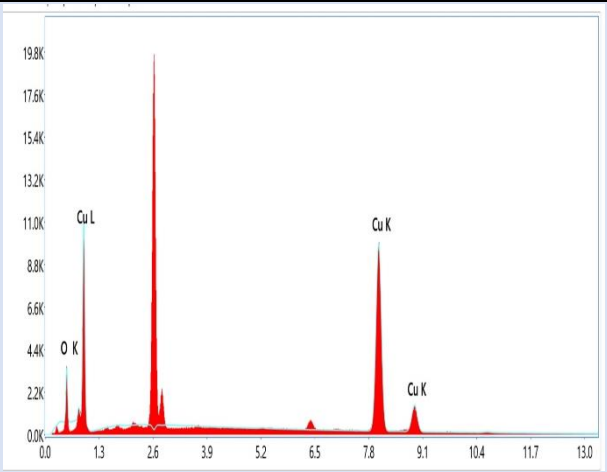


Figure 7: EDX data of CuO NPs

Table 1: EDX data of CuO NPs

Element	Line Type	Wt.%	Atomic %
O	K series	6	20.1
Cu	K series	94	79.9
Total:		100	100

In recent years, nanomaterial has a broader range of applications and uses in various fields. Some researchers have studied the use of nanomaterials for catalytic activity for oxidation [11], photo-catalytic activity [12], a high-performance electrode for supercapacitors [13], solid oxide fuel cells [14]and catalytic ozonation membrane reactor [15]. These example sconfirm that CuO oxide nanomaterial is environmentally supportive for living organisms and extremely useful in different fields.

Biological Activity

Synthesized copper oxide nanoparticles were tested for their antimicrobial efficacy against four different bacteria. - S. *aureus* (MTCC 96), *E. coli* (MTCC 443), *P. aeruginosa* (MTCC 1688), S. *pyogenus* (MTCC442), and three fungi-C. *Albicans* (MTCC 227), A. *clavatus* (MTCC1323)and A. *niger* (MTCC282)using broth dilution method[16-17]. Gentamycin, Ampicillin chloramphenicol, ciprofloxacin and norfloxacin were used as the standards for antibacterial activity, whereas griseofulvin and nystatin were used as the standards for antifungal activity. Minimum Inhibitory Concentration (MIC) values were used to describe the outcomes. The MIC of a drug is the smallest concentration of the sample that clearly stunts the growth of the microbe. Minimum Inhibitory Concentration (MIC) values were used to describe the outcomes. The MIC of a drug is the smallest concentration of the sample that clearly stunts the growth of the microbe[18-19].

The efficiency of synthesized copper oxide nanoparticles to act as antimalarial hits was studied in-*vitro* against *Plasmodium falciparum* in 96-well microtitre plate according to the different reported method [20-21].chloroquine was used as the standard, and the results were reported in terms of IC50 values. All the screening was performed at Microcare Laboratory, Surat, Gujarat, India.

Antibacterial activity

Antibacterial activity was tested on the synthesized copper oxide nanoparticles compounds[22-23]. The broth dilution technique was used to demonstrate antibacterial activity against *E. coli* (MTCC443), P. *aeruginosa* (MTCC1688), *S. aureus* (MTCC96), S. *pyogenus* (MTCC442) bacterial strains using *Gentamycin, Ampicillin, chloramphenicol, ciprofloxacin* and *norfloxacin* as the standard drugs. Copper oxide nanoparticles showing a strong and excellent antibacterial activity against *S. aureus*. The standard *chloramphenicol* (50µg/mL) other had weaker antibacterial activity against *E. coli*, P. *aeruginosa* and S. *pyogenus* as compared to the standard chloramphenicol show in (Table1). copper oxide nanoparticles showing a weak antibacterial activity against *E. coli*, P. *aeruginosa*, *S. aureus* and S. *pyogenus* the standard *Gentamycin, Ampicillin, ciprofloxacin* and *norfloxacin* show in **(Table 2)**.

Table 2: Antibacterial activity data of CuO NPs

Antibacterial Activity Table					
Minimum Inhibition Concentration (Microgram /ML)					
SR.	Code	E. Coli	P. Aeruginosa	S. Aureus	S. Pyogenus
NO	NO	MTCC 443	MTCC 1688	MTCC 96	MTCC 442
1	**Sample CuO NPs**	**250**	**50**	**100**	**100**
2	*Gentamycin	0.05	1	0.25	0.5
3	*Ampicillin	30	-	40	25
4	*Chloramphenicol	50	50	50	50
5	*Ciprofloxacin	25	25	50	50
6	*Norfloxacin	10	10	10	10

Antifungal Activity

Antifungal Activity was studied against *C. albicans* (MTCC227), *A. niger* (MTCC282), *A. clavatus* (MTCC1323) fungal strains. The results of antifungal activity reveal that the copper oxide nanoparticles synthesized compounds showed lower antifungal activity as compared to the standard *Nystatin* and *Greseofulvin*. The compounds were less active against the *C. albicans*, *A. niger* and *A. clavatus* fungal strains in comparison with both the standards **(Table 3)**.

Table 3: Antifungal activity data of CuO NPs

Antifungal Activity Table				
Minimum Inhibition Concentration (Microgram /ML)				
SR.	Code	C. Albicans	A. Niger	A. Clavatus
NO	NO	MTCC 227	MTCC 282	MTCC 1323
1	**Sample CuO NPs**	**>1000**	**500**	**500**
2	*Nystatin	100	100	100
3	*Greseofulvin	500	100	100
***Standard Drug**				

Antimalarial Activity

Copper oxide nanoparticles synthesized compounds showed the antimalarial activity was carried against Plasmodium falciparum. The compound copper oxide nanoparticles showed less antimalarial activity. The results of antimalarial activity revealed that copper oxide nano particles compounds were moderately active but less potent than the standard chloroquine, which is show in (Table 4).

Table 4: Antimalarial activity data of CuO NPs

Antimalarial Activity (Plasmodium Falciparum)		
Minimum Inhibition Concentration (Microgram /ML)		
SR.	Code	Mean IC50 Values a
NO	NO	MTCC 227
1	**Sample CuO NPs**	**0.88**µg /ml
2	*Chloroquine IC50	0.020 µg /ml
***Standard Drug, a: mean values in representative assay.**		

Conclusions

In summary, we report the synthesis, characterization, antibacterial, antifungal and antimalarial activity of copper oxide nano particles antibacterial activity against *E. coli* as they had lower MIC values in comparison with the standard ampicillin. Copper oxide nanoparticles compounds the compounds were less active against the *C. albicans*, *A. niger* and *A. clavatus* fungal strains in comparison with both the standards. The compounds exhibited moderate antimalarial activity but less than the standard chloroquine. Antibacterial and antimalarial entities are thus revealed by the current studies, highlighting their potential future significance in medicinal chemistry. A CuO oxide nanomaterial was successfully prepared using a sol-gel, an environmentally supportive method. In the

© 2023 Rajendra P. Pawar & Sanjay B. Ubale, et al.

synthesis of CuO nanomaterial, copper chloride with using citric acid as a surfactant. This method is eco-friendly, cheap, easy handling, non-hazardous, and harmless aqueous solvent systems.

Declarations

Funding

This research received no external funding.

Acknowledgments

This research has no acknowledgment.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Ananda Murthy, H. Abebe, B. CH, P. Shantaveerayya, K. (2018). A review on green synthesis and applications of Cu and CuO nanoparticles. *Material Science Research India*. 15 (3):279-295.
2. Ren, G. Hu, D. Cheng, E. W. Vargas-Reus, M. A. Reip. et.al. (2009). Characterization of copper oxide nanoparticles for antimicrobial applications. *International journal of antimicrobial agents*. 33(6):587-590.
3. Singh, J. Kaur, G. Rawat, M. (2016). A brief review on synthesis and characterization of copper oxide nanoparticles and its applications. *J. Bio electron. Nano technol*.
4. Dörner, L. Cancellieri, C. Rheingans, B. Walter, M. Kägi, et.al. (2019). Cost-effective sol-gel synthesis of porous CuO nanoparticle aggregates with tunable specific surface area. *Scientific reports*. 9(1):1-13.
5. Sahooli, M. Sabbaghi, S. Saboori, R. (2012). Synthesis and characterization of mono sized CuO nanoparticles. *Materials Letters*. 81:169-172.
6. Sahai, A. Goswami, N. Kaushik, S. Tripathi, S. (2016). Cu/Cu2O/CuO nanoparticles: Novel synthesis by exploding wire technique and extensive characterization. *Applied Surface Science*. 390:974-983.
7. Nabila, M. I. Kannabiran, K. Biosynthesis, (2018). characterization and antibacterial activity of copper oxide nanoparticles (CuO NPs) from actinomycetes. *Bio catalysis and agricultural biotechnology*. 15:56-62.
8. Mohammed, W. M. Mubark, T. H. Al-Haddad, R. M. (2018). Effect of CuO nanoparticles on antimicrobial activity prepared by sol-gel method. Int. J. Appl. Eng. Res. Dev. 13:10559-10562.
9. Dhineshbabu, N. Rajendran, V. Nithyavathy, N. Vetumperumal, R. (2016). Study of structural and optical properties of cupric oxide nanoparticles. *Applied Nanoscience* 6:933-939.
10. Manimaran, R. Palaniradja, K. Alagumurthi, N. Sendhilnathan, S. Hussain, J. (2014). Preparation and characterization of copper oxide nanofluid for heat transfer applications. *Applied Nanoscience*. 4:163-167.
11. Zedan, A. F. Mohamed, A. T. El-Shall, M. S. AlQaradawi, S. Y. AlJaber, A. S. (2019). Tailoring the reducibility and catalytic activity of CuO nanoparticles for low temperature CO oxidation. *RSC advances*. 8(35):19499-19511.
12. Siddique, S. Waseem, M. Naseem, T. Bibi, A. (2021). Hafeez, et.al. S. Photo-Catalytic and Anti-microbial Activities of r GO/CuO Nanocomposite. *Journal of Inorganic and Organometallic Polymers and Materials*. 31:1359-1372.
13. Zhan, Y. Bai, J. Guo, F. Zhou, H. Shu, R. Yu, Y. Qian, L. (2021). Facile synthesis of biomass-derived porous carbons incorporated with CuO nanoparticles as promising electrode materials for high-performance supercapacitor applications. *Journal of Alloys and Compounds*. 885:161014.
14. Beigzadeh, M. Pourfayaz, F. Ahmadi, M. H. (2020). Modeling and improvement of solid oxide fuel cell-single effect absorption chiller hybrid system by using nanofluids as heat transporters. *Applied Thermal Engineering*. 166:114707.
15. Coelho, L. L. Scaratti, G. Hissanaga, A. M. Oechsler, B. F. José, et.al. (2021). Modeling and fouling control in a hybrid membrane process using CuO-catalytic membrane coupled to ozone. *Journal of Environmental Chemical Engineering*. 9(5):106138.
16. Padil, V. V. T. Černík, M. (2013). Green synthesis of copper oxide nanoparticles using gum karaya as a biotemplate and their antibacterial application. *International journal of nanomedicine*. 889-898.
17. Ahamed, M. Alhadlaq, H. A. Khan, M. M. Karuppiah, P. Al-Dhabi, N. A. Synthesis, (2014). characterization, and antimicrobial activity of copper oxide nanoparticles. *Journal of Nanomaterials*. 17-17.
18. Fouda, A. Hassan, S. E.-D. Eid, A. M. Awad, M. A. Althumayri, et.al. (2022). Endophytic bacterial strain, Brevibacillus brevis-mediated green synthesis of copper oxide nanoparticles, characterization,

© 2023 Rajendra P. Pawar & Sanjay B. Ubale, et al.

antifungal, in vitro cytotoxicity, and larvicidal activity. *Green Processing and Synthesis*. 11(1):931-950.

19. Chaerun, S. K. Prabowo, B. A. Winarko, R. (2022). Bio nano technology the formation of copper nanoparticles assisted by biological agents and their applications as antimicrobial and antiviral agents. *Environmental Nanotechnology, Monitoring & Management*. 18:100703.
20. Hang, X. Peng, H. Song, H. Qi, Z. Miao, X. Xu, W. (2015). Antiviral activity of cuprous oxide nanoparticles against Hepatitis C Virus in vitro. *Journal of virological methods*. 222:150-157.
21. Jayaseelan, C. Abdulhaq, A. Ragavendran, C. Mohan, S. (2022). Phytoconstituents Assisted Biofabrication of Copper Oxide Nanoparticles and Their Antiplasmodial, and Antilarval Efficacy: A Novel Approach for the Control of Parasites. Molecules 27(23):8269.
22. Meghana, S. Kabra, P. Chakraborty, S. Padmavathy, N. (2015). Understanding the pathway of antibacterial activity of copper oxide nanoparticles. *RSC advances*. 5(16):12293-12299.
23. Khatami, M. Heli, H. Mohammadzadeh Jahani, P. Azizi, H. Lima Nobre, M. A. (2017). Copper/copper oxide nanoparticles synthesis using Stachys lavandulifolia and its antibacterial activity. *Iet Nanobiotechnology*.11(6)709-713.

Cite this article: Rajendra P. Pawar, Kishore Puri, Santosh B. Gaikwad, Sanjay B. Ubale, Savita A. (2023). Synthesis, Characterization and Antimicrobial Activity of Copper Oxide Nanoparticles Using Sol-Gel Method, *Clinical Interventions and Clinical Trials*, BRS Publishers. 1(1); DOI: 10.59657/cict.brs.23.002

Copyright: © 2023 Rajendra P. Pawar and Sanjay B. Ubale, this is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Article History: **Received:** April 10, 2023 | **Accepted:** April 28, 2023 | **Published:** May 05, 2023

Inspira-Journal of Commerce, Economics & Computer Science (JCECS)
ISSN : 2395-7069, Impact Factor: 6.751, Volume 10, No. 02, April-June, 2024, pp. 35-38

CROP INSURANCE: CONCEPT AND PRACTICES

Ms. S. M. Shegokar*

ABSTRACT

Agricultural infrastructure, including irrigation systems, storage facilities, and transportation networks, can be spoiled or destroyed during natural disasters. In addition, there are substantial data gaps or inadequate data regarding the influence of natural hazards and disasters on agriculture in developing countries. Government and development assistance to the agriculture sector remains relatively small compared to the economic impact and agriculture sector needs. Investing more in disaster risk reduction is essential for resilient livelihoods of farmers and food production systems of the country. In summary, natural disasters and hazards pointedly affect agriculture, emphasizing the significance of disaster preparedness of governments, farmers and related agencies, risk reduction, and sustainable practices to safeguard food security and livelihoods of the farmers.

***KEYWORDS**: Agricultural Infrastructure, Transportation Network, Natural Disasters, Risk Reduction.*

Introduction

Agriculture is affected by natural disasters, hazards and risks beyond control, it is necessary to take precautionary measures to control agriculture produce damage faced by farmers. Natural hazards and disasters have significant impacts on agriculture resulting various impacts on the livelihoods of the farmers. As per the Food and Agriculture Organisation research, the agriculture sector absorbs approximately 22% of the economic impact caused by natural hazards and disasters in developing countries. Disasters such as floods, droughts, or storms can destroy crops and agriculture produce, leading to food scarcity and economic losses. Disrupted ecosystems and stressed crops or crops become more vulnerable to diseases and pests.

Given the high impact on agriculture underscores the need for enhanced disaster risk reduction and resilience building within the agricultural sectors. There are some key risk management tools that can be employed at various levels of farming such as Agricultural Diversification, Agricultural (crop) Insurance, Weather Index-Based Insurance, Warehouse Receipts System, Social Protection, Commodity Exchanges and Futures Markets, Agricultural Finance and Microfinance. Out this risk mitigation tools crop insurances are found the crucial for the farmers for agricultural-related issues. A crop insurance schemes assists in the stabilization of agriculture income and reduces the adverse impacts on the lives of the farmers.

Importance of Study at International and National Level

United States, China, Brazil, Argentina and India are the top agricultural producing countries in the world. These nations play a crucial role in global agriculture and contribute significantly to food production. In these country, government and private agencies have been providing different crop insurance products and scheme for disaster risk reduction and resilience building within the agricultural sectors. All these five top agrarian countries providing multi-peril insurance scheme for the insuring the farmland, agricultural produce and the farmers.

---

* Assistant Professor, Shri Shivaji College of Arts, Commerce and Science, Akola, Maharashtra, India.

In the United States, the Federal Crop Insurance Program (FCIP) offers a comprehensive safety net for farmers, providing coverage against various risks including price fluctuation. China's agricultural insurance system has been providing Multi-Peril Crop Insurance (MPCI), emphasizing premium subsidies and voluntary participation of farmers. Brazil's Government Premium Subsidies Program for Agricultural Insurance (PSR) focus on premium subsidies, risk mitigation, and support for farmers. PSR of Brazil's government play a dynamic role in ensuring the resilience of agricultural sector. Argentina's crop insurance landscape involves both private cooperatives and government-backed initiatives for its agricultural sector. In India, considering that majority of the farmers' livelihood is dependent on the quality and quantity of the yield they produce, crop insurance also aids in fighting poverty. In India, there are four major crop insurance policies naming PMFBY, RWBCIS, UPIS and CPIS.

Crop insurance plays an essential role in safeguarding the interests of farmers and ensuring the sustainability of agriculture. So here is need to study the crop insurance concepts and practices.

Objectives of the Study

- To review evolution of crop insurance concepts in India.
- To review crop insurance schemes in practices in India.

Evolution of Crop Insurance Concepts in India

The development of crop insurance in India has been a dynamic journey, adapting to changing needs of agriculture and challenges facing in implementation of crop insurance policies. In the year of 1915, Mr. J.S. Chakravarthi of the state of Mysore proposed a scheme for rain insurance to protect farmers against drought. The scheme was grounded on an area approach and intended to provide relief to farmers affected by insufficient rainfall in this region. Other states like Madras now Channai, Dewas, and Baroda also made attempts to introduce crop insurance relief from the loss by the natural disasters but achieved partial success. In 1947, crop insurance increased more attention for the implementation to protect the farmland and farmers against disasters and risk. The government of India decided to introduce a crop insurance bill in the year 1965 for crop protection.

The first official crop insurance program of Indian government was introduced in 1972-73 by the General Insurance Department of Life Insurance Corporation. Later, the General Insurance Corporation of India (GIC) experimented insurance scheme with an "Individual Approach". This scheme continued until 1978-79 and covered only 3,110 farmers. Prof. V.M. Dandekar suggested an approach called the "Homogeneous Area approach". Based on this approach, the GIC introduced the Pilot Crop Insurance Scheme (PCIS) in 1979. This scheme covered crops such as cereals, millets, oilseeds, potato, gram, and barley. Premiums decided from 5% to 10% of the sum insured. The scheme implemented till 1984-85, involving 13 states and covering 6.27 million farmers. Introduced on April 1, 1985, the Comprehensive Crop Insurance Scheme (CCIS) actively involved state governments. CCIS followed the Homogeneous Area Approach and linked to short-term crop credit. Over the years, CCIS covered 7.63 crore farmers across 12.76 crore hectares of farmland with a sum insured of ₹ 24,949 crores and collected a premium of ₹403.56 crores. However, the CCIS was discontinued after Kharif 1999 and substituted by the National Agriculture Insurance Scheme (NAIS). Introducing NAIS, it was a significant step taken by the government toward comprehensive coverage. It was covered multiple crops against various risks. Farm Income Insurance Scheme (FIIS) (2003-04) introduced aiming at income stabilization of the farmers. Weather-Based Crop Insurance Scheme (WBCIS) introduced for Kharif crops. The scheme was linked pay-outs to weather parameters such as rainfall, temperature, humid. Modified National Agriculture Insurance Scheme (MNAIS) focused on Rabi crops.The scheme improved coverage and risk assessment in comparison of NAIS.

Review the Existing Crop Insurance Schemes in India

Pradhan Mantri Fasal Bima Yojana (PMFBY) implemented from Kharif 2016. This scheme combined yield index-based and restructured WBCIS. PMFBY are having salient features such as covers food crops, oilseeds, and horticultural crops, compulsory for loanee and voluntary for non-loanee farmers (now becomes voluntary to all farmers from 2020), covers various risks, including drought, flood, hailstorm, pests, diseases, and more., upfront premium subsidy by the government, individual farm-level assessment for localized and post-harvest losses, actuarial premium rate based on risk, extensive use of technology for efficient implementation, indemnity level i.e. 70%, government acts as the reinsurer for extreme claims.

The Restructured Weather Based Crop Insurance Scheme (RWBCIS) employed from 2016 pointing to ease the suffering of insured farmers against the likelihood of financial loss due to projected crop loss resulting from hostile weather conditions. The objectives of this scheme is to provides financial protection to farmers by compensating them for deemed crop losses caused by adverse weather conditions. It uses weather parameters as proxies for crop yields in determining compensation. RWBCIS covers the food crops such as cereals, millets, and pulses, oilseeds, commercial and horticultural crops The scheme addresses major weather hazards that lead to adverse weather incidents and resulted crop loss. It covers temperature, high temperature (heat), low temperature; rainfall, deficit rainfall, excess rainfall, unseasonal rainfall, rainy days, dry spells, hailstorm and cloud-burst; relative humidity, wind speed or a combination of these weather incidents. The government provides a subsidy equal to the difference between the actuarial premium and the premium paid by the farmer for crop insurance. RWBCIS uses weather triggers to determine the extent of deemed crop losses. Compensation is provided to farmers based on the actual weather conditions experienced during the crop season. Pay-out of the compensation structures are developed based on the weather parameters. The scheme covers both tenant farmers and sharecroppers. All farmers working in a notified area mentioned in the policy gazetted resolution and growing a notified variety of crops are eligible.

The Coconut Palm Insurance Scheme (CPIS) is implemented for the coconut palm by the Coconut Development Board, under the Ministry of Agriculture and Farmers Welfare, Government of India. Its primary objective is to provide insurance coverage for coconut palms against various risks and perils. The CPIS presented at aiming to insure coconut palms against natural disasters and hazards, pests and diseases, climatic risks, other perils resulted in coconut produce loss. The scheme is applicable to healthy nut-bearing coconut palms. All varieties of coconutare eligible for insurance coverage. The CPIS covers coconut palms in the age group from 4 years to 60 years. The scheme provides coverage against the following perils leading to death or loss of palm such as storm, hailstorm, cyclone, typhoon, tornado, heavy rains, flood and inundation, pest and diseases causing irreparable damage, accidental fire including forest fire and bush fire, earthquake, landslide, and tsunami, severe drought and total loss due to it. The scheme aims to provide timely relief to farmers who suffer income loss due to sudden palm death.

The Unified Package Insurance Scheme (UPIS) contributes to the overall well-being of farmers and the stability of the agriculture sector. The UPIS aims to provide financial protection to farming community in India. The UPIS ensures food security, crop diversification, enhanced growth and competitiveness of the agriculture sector, protection for farmers from financial risks. The UPIS covers seven sections first one is crop insurance which mandatory section. Second one is personal accident insurance; it provides coverage in case of accidental death or disablement at farming. Third one is life insurance, it protects the farmer and family members up to 70 years. Fourth one is building and contents insurance-fire &allied perils, it covers dwelling and its contents against fire-related risks. Fifth one is agriculture pump set insurance insures agricultural pump sets. Sixth one is student safety insurance, it ensures safety for school/college-going children of farmers. Seventh one is agricultural tractor insurance covers tractors owned by farmers. The UPIS is implemented in 45 selected districts on a pilot basis since kharif 2016 season. The UPIS Scheme covers both seasons in a full year, except for crop insurance which separately issues for kharif and rabi seasons and is renewable annually. The scheme covers the lonee farmers through banks/financial institutions, while non-loanee farmers covers through banks and/or insurance intermediaries. The UPIS provides to the insurance all needs of farmers involved in agriculture activities covering seven types of protections. It provides yield-based crop insurance based on land ownership and sown crops. In addition, it offers protection in case of accidental death or disablement, accidental insurance for school/college-going children, and life insurance for the farmer and family members. The government provides a subsidy equivalent to the difference between actuarial premium and the premium paid by the farmer for crop insurance.

Conclusion

Crop insurance scheme has been founding the risk mitigation tool for covering the natural disasters and hazards at top five agrarians' countries. Therefore, various crop insurance schemes have introduced and implemented for resilience to the crop loss due to agriculture risks. In India, prior the independence, government had been taking initiatives for introducing crop insurance for coping with the natural disasters and hazards due to dependence of farmers on the farming activities for their livelihoods. In current situation, government successfully implemented the four schemes for protecting the crops as well as the farmers.

References

1. Jeyabala singh, Paul &A, Nisha. (2020). Crop insurance in India: evolution, issues and way forward. Journal of critical reviews. 7. 2851-2869.
2. Ghosh S. & Mamun A. (2012). The economics of crop insurance: are view of the empirical literature. Ijfans international journal of food and nutritional sciences, Vol. 11, Iss 10. 2753-2760.
3. Arora, A. &Birwal, D. (2017). Natural calamities, crop losses and coping strategies: an economic analysis from Odisha. Indian journal of agricultural economics, 72, (3), 11 https://isaeindia.org/wp-content/uploads/2020/11/12-Article-Anchal-Arora.pdf
4. Bhattacharya, S. (2015). Crop insurance in india: a brief overview. The MA journal, 50, 102-107. https://www.semanticscholar.org/author/Saheli-Bhattacharya/1916772928
5. Jain, R. & Parshad, M. (2012). Report of the working group on risk management in agriculture for the eleventh five-year plan (2007-2012) https://pmfby.gov.in/compendium/General/2007%20-THE%20WORKING%20GROUP%20ON%20Risk%20Management%20Agriculture.pdf
6. Kodidala, S. P. (2017). CAG report summary agriculture crop insurance schemes. PRS legislative research, institute for policy research studies, Gandharva Mahavidyalaya.
7. www.prsindia.org
8. LARDIS. (2015). Crop insurance Report 2015 https://loksabhadocs.nic.in/Refinput/ New_Reference_Notes/English/CROP_INSU
9. RANCE_IN_INDIA_2015.pdf
10. Ministry of Finance. (2023, Jan. 31). India's foodgrains production touched a
11. record 315.7 million tonnes in 2021-22. (Press release) https://pib.gov.in/ PressReleasePage.aspx?PRID=1894899
12. Economic Survey 2019-20
13. Report of AIC Ltd. 2021
14. Government resolution of govt. of Maharashtra related to crop insurance Report on review implementation of crop insurance of department of agriculture & cooperation, Ministry of Agriculture, GOI(2014)
15. https://www.fao.org/3/i4434e/i4434e.pdf
16. https://www.pmfby.gov.in
17. https://coconutboard.gov.in/
18. https://www.vikaspedia.com
19. https://irdai.gov.in/
20. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1601904.

❑❑❑

Check for updates

Received: 5 December 2023 | Revised: 30 January 2024 | Accepted: 2 February 2024

DOI: 10.1002/aoc.7405

FULL PAPER

Applied Organometallic Chemistry WILEY

Solvothermal single-pot synthesis of Pd-Fe_3O_4@GO catalyst: Enhanced catalytic performance in Sonogashira coupling reactions

Mahesh A. Pawar[1] | **Akhil V. Nakhate**[2] | **Samidha S. Kadu**[1] | **Pradip V. Tekade**[2]

[1]Shri Shivaji College of Arts, Commerce and Science, Akola, India

[2]Bajaj College of Science, Wardha, India

Correspondence
Akhil V. Nakhate, Bajaj College of Science, Wardha 442001, India.
Email: akhiln30@gmail.com

In this study, we present a new approach to synthesizing a magnetically separable Pd-Fe_3O_4@GO catalyst using a simple single-pot method. The catalyst was employed in Sonogashira coupling reactions, demonstrating excellent results. The catalyst was studied using a various characterization method, including X-ray photoelectron spectroscopy (XPS), scanning electron microscope–energy-dispersive X-ray spectroscopy (SEM-EDS) mapping, TEM, X-ray diffraction (XRD), FTIR, and inductively coupled plasma mass spectrometry (ICP-MS). Pd-Fe_3O_4@GO exhibited superior catalytic activity compared with its conventional counterparts in phenylacetylene-iodobenzene coupling reactions under copper co-catalyzed-free and ligand-free conditions, with a higher turnover frequency (TOF) of 118.3 h^{-1}. Optimized conditions yielded high yields for various substrates, including inactive aryl chloride and bromide substrates, emphasizing its versatility. Also, a reaction mechanism was proposed and a kinetic model was developed. The catalyst's green chemistry potential was highlighted because of its high efficiency, purity of products, recoverability, and ease of preparation. Moreover, Pd-Fe_3O_4@GO demonstrated impressive stability through multiple recycling rounds without loss of functionality, making it a promising tool for sustainable chemical processes.

KEYWORDS

graphene oxide, magnetic separable catalyst, palladium, Sonogashira coupling reactions

1 | INTRODUCTION

Catalysis plays a crucial role in the production of pharmaceuticals, agrochemicals, and essential molecules through diverse chemical transformations.[1–6] The use of catalysts to facilitate coupling reactions holds tremendous potential for advancing sustainable organic syntheses, thereby overcoming significant drawbacks linked to conventional approaches. Catalysts contribute to heightened selectivity, significantly accelerated reaction rates, and a reduction in by-product generation. Various catalytic methods have been developed to address diverse coupling reactions.[7] Cross-coupling reactions, particularly in the synthesis of medicinal, natural, and agricultural products, have garnered considerable attention.

The Sonogashira coupling process stands out as a highly effective synthetic technique for establishing carbon–carbon bonds.[8,9] Palladium metal salts have typically been utilized as catalysts in Sonogashira coupling procedures involving aryl halides and alkynes, in combination with co-catalytic like copper, toxic phosphine, N-based ligands, and significant volumes of solvents. Although the presence of Cu(I) salt improves the reaction by generating Cu acetylide, it has the disadvantage of

 © 2024 John Wiley & Sons Ltd.

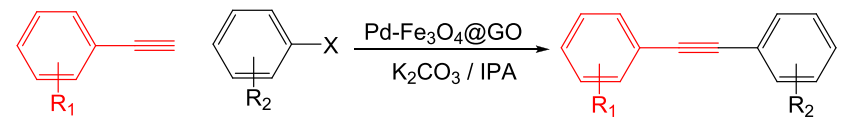
forming an unwanted alkyne homocoupled product alongside the intended product by Glaser-type oxidative dimerization, which reduces the efficiency of the cross-coupling reaction.[10,11]

Noble metals have lately gained attraction because of their applications in catalysis, biomedicine, solar energy conversion, photocatalysis, gas sensors, fuel cells, and drug delivery.[12–15] Metal nanoparticles (NPs) have attracted the interest of researchers because of their high catalytic activity and huge surface area, allowing effective interaction between the reactant and the catalyst surface. However, metal NPs have two fundamental drawbacks, that is, rapid agglomerate during chemical transformation due to their high surface energy, and their tiny size making their separation from the reaction mixture extremely challenging.[16] However, immobilizing NPs on a structurally suitable support can solve these problems.[17]

Throughout the last decade, researchers have explored NPs anchored on various materials as catalysts, including activated carbon nanotubes, metal oxides, graphene, graphene oxide (GO), polymers, zeolite, alumina, magnetic materials, and metal–organic frameworks. A variety of nanocatalysts for carbon–carbon bond formation have been discovered, with Pd NP-supported catalysts showing exceptional catalytic activity.[18] Graphene, along with its equivalents, has recently piqued the interest of scientists globally because of its two-dimensional structure, large surface area, great tensile strength, outstanding thermal conductivity, tremendous dispersibility, and other exceptional features.[19,20] It finds various applications in the fields of sensors, the biomedical sector, storage and conversion, and catalytic support.[21,22] Because of the oxygen functionality on the surface, GO gets readily dispersed in water as well as different organic solvents, making it easier to handle. Metal anchoring is also conceivable, resulting in increased catalytic activity. Chemically produced graphenes like GO and reduced graphene oxide (rGO) are promising candidates for catalytic support due to their inertness, wide surface area, accessibility, and stability.[23] Various investigations on catalysis with GO as support have been reported including Pd/graphene (Pd/G),[24] Ag-Pd@rGO,[25] Pd-Co/G,[26] Pd@g-C_3N_4-Fe-GO,[27] (Pd@APGO),[28] Pd/PRGO,[29] and Pd/Cu@GO.[30]

However, the use of traditional catalyst isolation techniques, such as centrifugation or filtering, is required, limiting the economic viability of nanocatalysts. Consequently, magnetically separable catalysts, known for their exceptional stability, present an attractive alternative, especially when compared with commercial palladium catalysts used in coupling reactions. These catalysts can be easily separated from the reaction media by utilizing a magnet.[31] Various magnetically separable heterogeneous catalysts have been reported for Sonogashira reactions as well as other coupling reactions, such as Nano-Fe_3O_4@CA-Pd,[32] Pd-GO-Fe_3O_4-Cellulose,[33] Pd-$CuFe_2O_4$@SiO_2,[31] Pd–Fe_3O_4 heterodimeric nanocrystal catalyst,[34] γ-Fe_2O_3@SiO_2–$(CH_2)_3$–PDTC–Pd,[35] Pd NPs on magnetic nanoparticle starch substrate (MNPSS),[36] CPS-MNPs-NNN-Pd,[37] MNP-CD-Pd,[38] Palladium anchored PEI grafted Fe_3O_4/SiO_2/P (GMA-co-EGDMA) NP nanocatalyst,[39] Pd-Fe_3O_4, a rose-shaped nanocatalyst,[40] bis-salophen palladium complex immobilized on Fe_3O_4@SiO_2,[41] Pd@GO/Fe_3O_4/PAA/DCA catalyst,[42] palladium supported magnetically separable moisture- and air-stable catalyst,[43] Pd NPs immobilized on metal NPs with dendritic "click" PEGylated ligands ("Click" PEGylated γ-Fe_2O_3–Pd),[44] and palladium supported on guanidine-terminated magnetic dendrimer (G3-Gu-Pd).[45] Notably, Pd/Fe_3O_4@SiO_2/Schiff base,[46,47] Cu/Fe_3O_4@SiO_2/Schiff base,[48] and Ni(II) EDTA-Fe_3O_4@SiO_2/Schiff base[49] have been developed as magnetically separable catalysts for constructing C-N bonds. The Sonogashira coupling as well as other coupling processes like C-N bond formation and heck reactions was carried out with the aforementioned catalysts, resulting in satisfactory yields of the desired products. It overcomes catalyst separation using a simple magnet. However, it has been observed that Pd catalyst synthesis involves multistep synthesis use of excessive non-green solvents, a long reaction time, and expensive ligands and reagents.

To address these challenges, the current study introduces a single-pot synthesis method for ligand-free Pd NPs supported on Fe_3O_4@GO a heterogeneous catalyst that is magnetically separable, reusable, effective, and environmentally friendly. This catalyst has been successfully employed in the Sonogashira cross-coupling reaction (Scheme 1). The kinetics of the reaction were studied systematically and validated against experimental data.



R_1 - H, $-C_2H_5$

R_2 - H, -F, $-CF_3$, -OMe, -Me, $-NO_2$, -Cl, -Br

X- I, Br[a] & Cl[b]

SCHEME 1 Sonogashira cross-coupling reaction.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2 | EXPERIMENTAL

The Electronic Supporting Information (ESI) contains information about the chemicals, testing technique, compounds, and characterizations.

2.1 | Synthesis of GO

The modified Hummer's method was used to synthesize GO from natural graphite powder, synthesis process mentioned in supporting information.[50]

2.2 | Preparation of Pd-Fe_3O_4@GO

In a typical synthesis, previously synthesized GO (0.3 g) was disseminated for 60 min under sonication in a beaker of 100 mL containing 50 mL of ethylene glycol. Simultaneously, $FeCl_3{\cdot}6H_2O$ (5 mmol) in 50 mL of ethylene glycol was sonicated for 3 min. Both solutions were then agitated for 1 h at room temperature. The well-dispersed GO solution was combined with the $FeCl_3{\cdot}6H_2O$ solution, and the reaction mass was sonicated and agitated for an hour. Then, a $PdCl_2$ solution was prepared by dissolving 15 mg in a small amount of saline water. The palladium solution was gradually introduced into the previously described solution while continuously stirring. While stirring, 7 g of sodium acetate was added to the solution. The entire suspension was then transferred in an autoclave with internal Teflon-coated stainless-steel lining and heated for 24 h in a hot air oven at 180°C. Following solvothermal synthesis, the autoclave was allowed to cool to ambient temperature. The Pd-Fe_3O_4@GO nanomaterial was rinsed many times with distilled water and IPA before being centrifuged for 25 min at 6000 rpm. The produced Pd-Fe_3O_4@GO nanocatalyst was vacuum-dried for 24 h at 60°C. The palladium concentration of Pd-Fe_3O_4@GO was determined by inductively coupled plasma mass spectrometry (ICP-MS) and was found to be 1.92% wt. Pd.

2.3 | General procedure for Sonogashira cross-coupling reaction using Pd-Fe_3O_4@GO catalyst

A mixture of aryl halide (1 mmol), alkyne (1.1 mmol), K_2CO_3 (1.5 mmol), isopropyl alcohol (IPA) (5 mL), and 9 mg of the catalyst (1.92 wt.% Pd) was placed in a 20 mL sealed glass tube. The reaction mixture was vigorously stirred for 3 h at 90°C. The progress of the reaction was checked by TLC. Once the reaction was completed, the catalyst was separated using an external magnet, and the reaction mixture was washed successively with water-ethyl acetate, followed by brine. The mixture was then dehydrated using anhydrous Na_2SO_4. The resulting residue was purified through column chromatography to obtain the desired product.

3 | RESULT AND DISCUSSION

The prepared materials were characterized by scanning electron microscope (SEM), energy dispersive X-ray (EDX)-mapping, TEM, X-ray photoelectron spectroscopy (XPS), FTIR, single crystal X-ray diffraction (XRD), and XRD.

3.1 | SEM

The surface morphology of the synthesized Pd-Fe_3O_4@GO was examined using SEM at various magnifications (Figure 1). The structure of Pd-Fe_3O_4@GO was found to be uneven, displaying some Pd-Fe_3O_4 NPs agglomerated on the surface along with some semi-spherical-shaped particles. Furthermore, the SEM results for the Pd-Fe_3O_4@GO catalyst are consistent with the EDX and elemental mapping data. The chemical composition of Pd-Fe_3O_4@GO, as well as the dispersion of palladium and iron atoms on the GO surface, were determined using energy-dispersive X-ray spectroscopy (EDS) and mapping analysis. The SEM revealed that only palladium (yellow), iron (orange), oxygen (red), and carbon (green), were evenly dispersed across the surface of GO, confirming the excellent purity of Pd-Fe_3O_4@GO NPs.

3.2 | HR-TEM

The morphology and metal distribution of Pd-Fe_3O_4@GO were investigated using high-resolution transmission electron microscopy (HR-TEM), as shown in Figure 2a–d. Figure 2a,b displays a typical TEM image of the GO sheet, illustrating the structure and arrangement of Pd-Fe_3O_4 NPs on the surface of the GO sheet. In the cross-sectional view of the HR-TEM image of Pd-Fe_3O_4@GO, the intersecting crystal fringes indicate the coexistence of Pd and Fe_3O_4 as a mixture, rather than individual metal entities (Figure 2a). The combination of palladium NPs with iron oxide NPs has a synergistic impact in the form of palladium NP stability and dispersion, reducing agglomeration during the reaction and therefore increasing catalytic activity. From the particle size distribution, it was observed that the size of particles falls within the

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

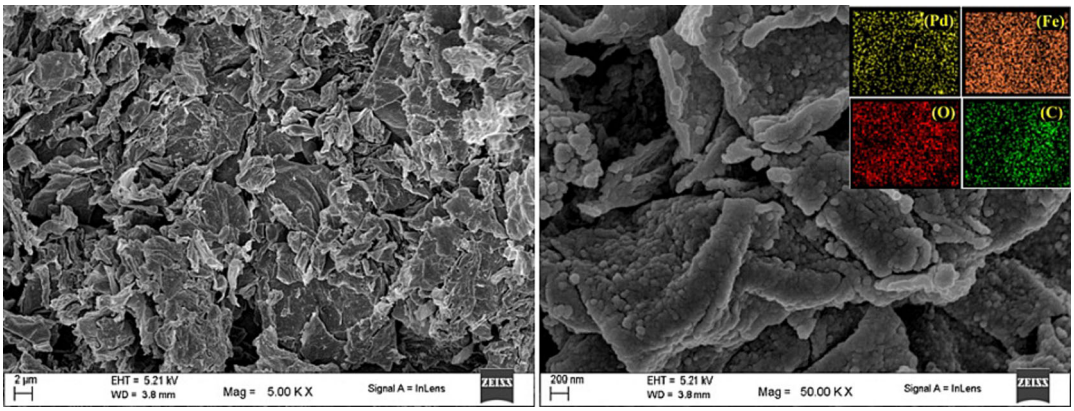


FIGURE 1 SEM image and elemental mapping of Pd-Fe_3O_4@GO.

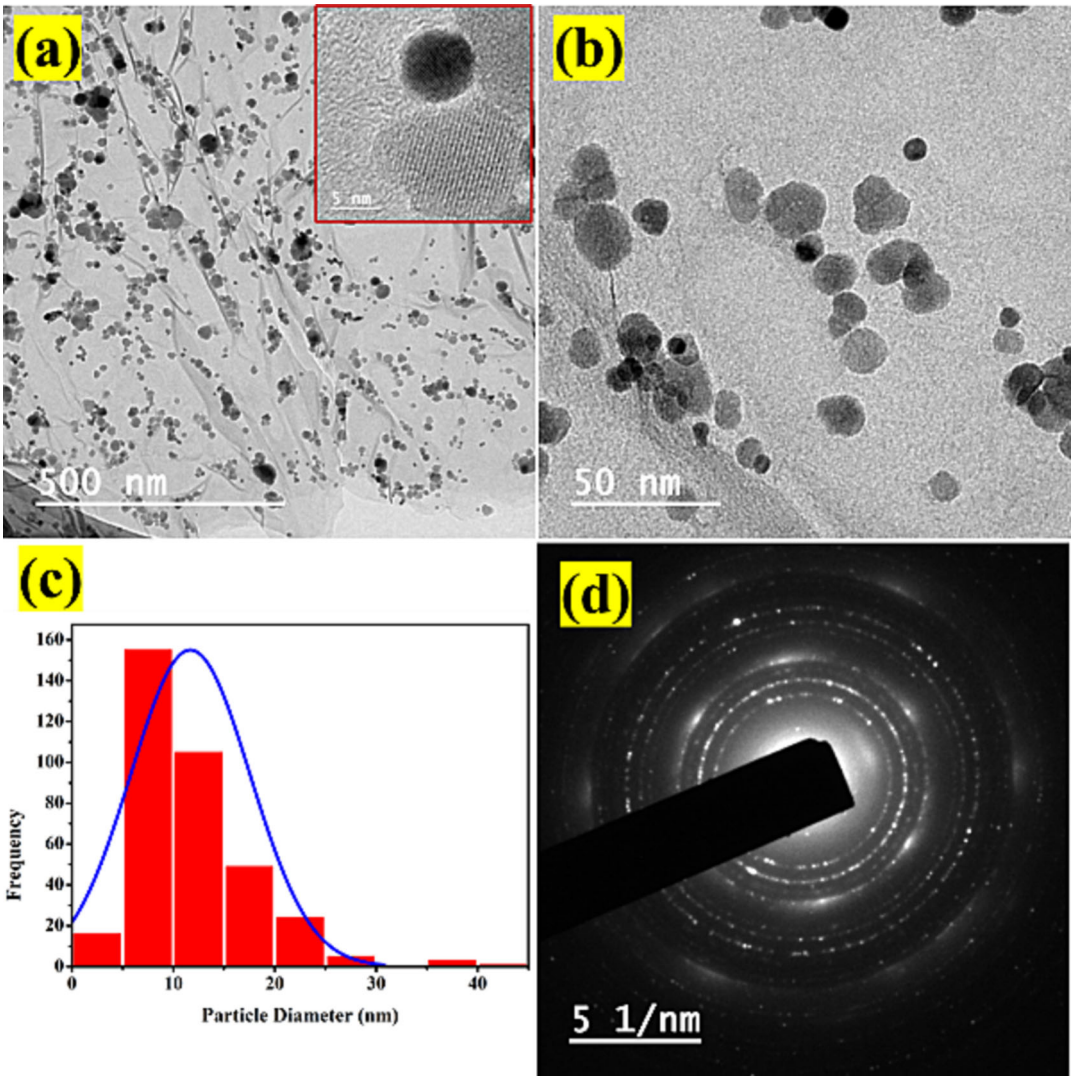


FIGURE 2 TEM image of (a, b) Pd-Fe_3O_4@GO low and high magnifications (c) particle size distribution (d) selected area electron diffraction (SAED) pattern.

range of 5–20 nm. Palladium exhibits a smaller particle size, while Fe_3O_4 has a larger size (Figures 2c and S1). The selected area electron diffraction (SAED) patterns confirm their crystallinity (Figure 2d). According to TEM analysis, Pd-Fe_3O_4 NPs are distributed on the GO surface, with a higher percentage of Fe than Pd.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

3.3 | XPS

Pd-Fe_3O_4@GO was subjected to XPS studies to explore the chemical states of Pd3d, Fe2p, O1s, and C1s on the catalyst's surface (Figure 3). The Pd3d high-resolution XPS splitting pattern revealed two doublet peaks of Pd $3d_{5/2}$ and Pd $3d_{3/2}$ spin-orbit components at 335.5 and 340.8 eV, which are related to metallic Pd, whereas the other doublet peaks at 337.9 and 343.3 eV are connected with Pd's + 2-oxidation state. The Pd3d high-resolution XPS splitting pattern showed two doublet peaks of Pd $3d_{3/2}$ and Pd $3d_{5/2}$ spin-orbit components at 340.8 and 335.5 eV are attributed to metallic Pd, whereas the additional doublet peaks at 343.3 and 337.9 eV are associated with the Pd + 2-oxidation.[16] The existence of Pd in metallic form in the catalyst could be due to the solvothermal process's reduction of Pd ions by ethylene glycol and sodium acetate, as well as the occurrence of PdO from the oxidation of bare metal Pd atoms under atmospheric circumstances. Peaks in the Fe2p high-resolution XPS had binding energies of 710.9 and 724.3 eV are associated with $Fe2p_{3/2}$ and Fe $2p_{1/2}$, showing the development of composite oxides of Fe(III) and Fe(II). Three peaks at 284.5 eV in the C1s high-resolution XPS relate to GO carbon, which corresponds to the non-oxygenated ring C=C: the C atom in the C-O bond at 285.6 eV, and carbonyl C (C=O) at 288.3 eV. In addition, an O1s signal was found at 530.2 eV, showing that the oxygen groups on GO were effectively incorporated. Furthermore, the O1s XPS spectrum showed peaks at 530.2, 531.4, and 532.9 eV, which are ascribed to O-C=O, C=O, and C-OH moieties, respectively.[51] The nanoscale interactions among palladium, iron oxide, and GO resulted in electronic modifications in the catalyst. These modifications optimized the binding energies of reactants and intermediates, enhancing the catalyst's catalytic activity in promoting Sonogashira coupling reactions.

3.4 | XRD

Further insight into the structural properties of GO, Fe_3O_4, and Pd-Fe_3O_4@GO was gained through XRD characterization, as depicted in Figure 4a–c. In the XRD pattern of GO, a prominent peak at 2θ 10.7 arises from its (001) planes, confirming the complete oxidation of graphite to GO due to the successful incorporation of epoxy and hydroxyl groups into the graphite sheets (Figure 4a).[50] Moving to the XRD pattern of Fe_3O_4 (Figure 4b), significant peaks at 2θ values of 30.2 (220), 35.8 (311), 43.3 (400), 53.8 (422), 57.1 (511), and 62.7 (440) are observed.[52] These peaks correspond to the face-centered cubic (FCC) structure of Fe_3O_4, consistent with the reference pattern from JCPDS 75-0033. In the XRD pattern of Pd-Fe_3O_4@GO, distinct peaks at 2θ = 40.1 and 47.1 are observed, corresponding to the 111 and 200 planes of the FCC structure of Pd (Figure 2c).[52] The SAED image of Pd-Fe_3O_4@GO aligns with the XRD

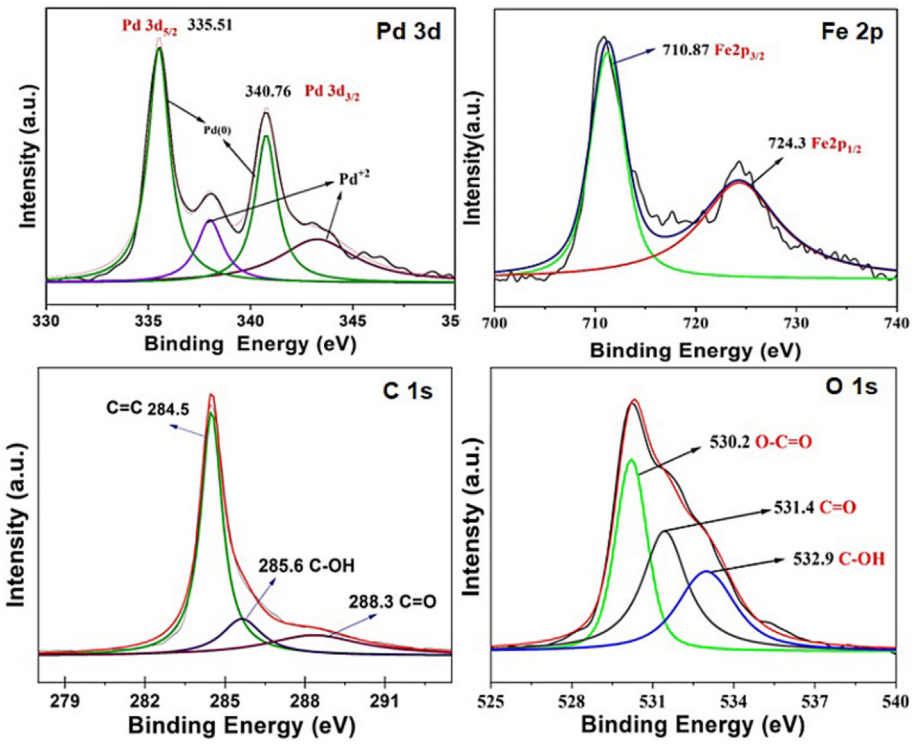


FIGURE 3 XPS of Pd-Fe_3O_4@GO, Pd3d, Fe2p, C1s, and O1s.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

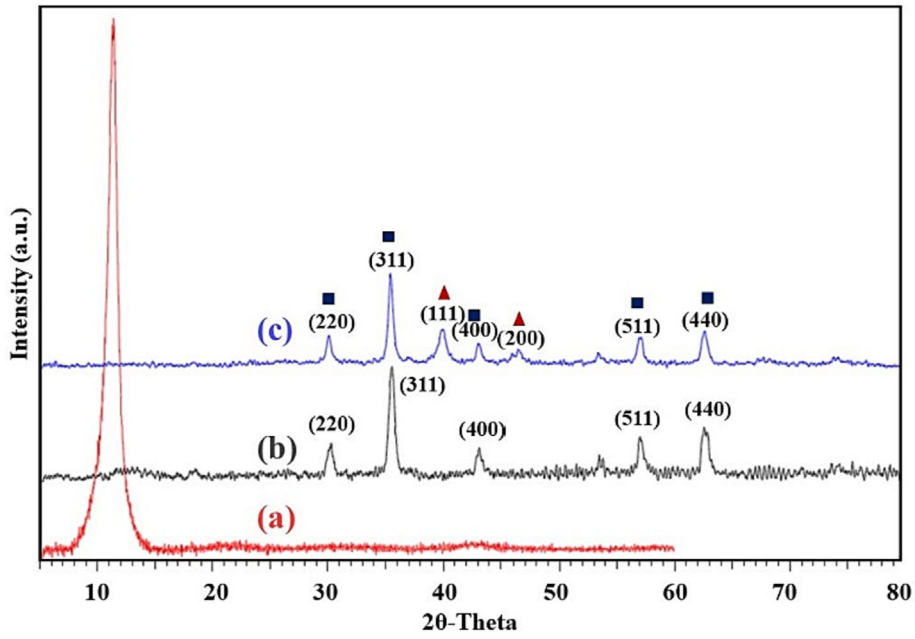


FIGURE 4 XRD of (a) graphene oxide (GO) (b) Fe_3O_4 (c) Pd-Fe_3O_4@GO.

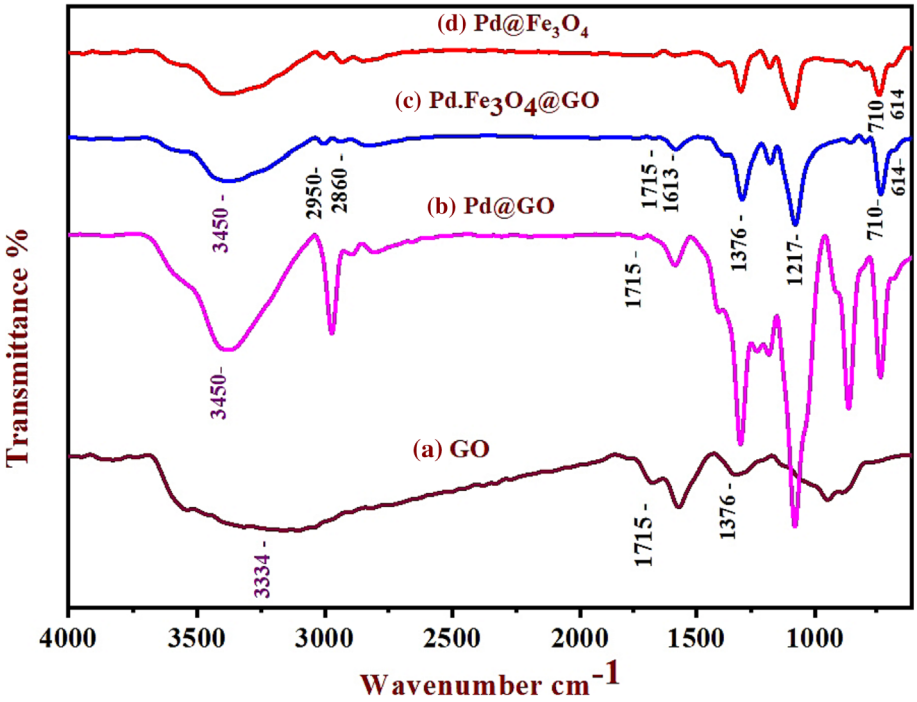


FIGURE 5 FTIR of (a) graphene oxide (GO) (b) Pd@GO (c) Pd-GO@Fe_3O_4 (d) Pd@Fe_3O_4.

results, confirming the face-centered crystalline structure of Pd and Fe_3O_4. The XRD pattern of Pd-Fe_3O_4@GO further validates the presence of Fe_3O_4 with an FCC structure, as evidenced by peaks at the same 2θ positions as those of pure Fe_3O_4. This confirmation indicates the successful incorporation of Pd and GO into the Fe_3O_4 structure without inducing a phase transformation, resulting in the formation of a composite material with the desired crystal structure.

3.5 | FTIR

Figure 5a–d illustrates the infrared (IR) spectra of diverse materials, namely, GO, Pd@GO, Pd-Fe_3O_4@GO, and Pd-@Fe_3O_4. In the spectra of GO, Pd@GO, and Pd-Fe_3O_4@GO, a noticeable peak at 1715 cm^{-1} and broad absorption band ranging from 3100 to 3700 cm^{-1}, attributed to the stretching vibration of the O-H functional group.[50] Comparative analysis of the spectra of GO,

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Pd@GO, and Pd-Fe_3O_4@GO reveals a noteworthy reduction in the intensity of the stretching vibration peak of the -C=O (carbonyl) functional group in Pd@GO and Pd-Fe_3O_4@GO. This decline may be attributed to the interaction between the carbonyl group and Pd and $PdFe_3O_4$ NPs. Furthermore, Figure 5a–c exhibits distinct bands at 1376, 1092, 1613, and 1217 cm^{-1} corresponding to the stretching frequencies of various functional groups, namely, C-O-C, -C-OH, C=C (aromatic), and epoxy C-O functionality.[51] Additionally, absorption bands at 2950 and 2860 cm^{-1} are assigned to the symmetric and asymmetric stretching vibrations of -CH_2 groups. In the spectrum of Figure 5c, corresponding to Pd-Fe_3O_4@GO, and Figure 5d, representing Pd@Fe_3O_4, two prominent peaks cantered at 710 and 614 cm^{-1} are observed. These peaks are indicative of the Fe-O stretching vibration of Fe_3O_4 NPs, suggesting the successful adsorption of Pd-Fe_3O_4 on GO.

3.6 | Refining reaction conditions for optimal performance

In order to determine the best reaction conditions, we selected iodobenzene and phenylacetylene as the model substrates and conducted a series of reactions under different conditions, as presented in Table 1. The model reaction began at room temperature using phenylacetylene (1.1 mmol) and iodobenzene (1 mmol) as coupling partners. We employed 6 mg of Pd-Fe_3O_4@GO as a catalyst, IPA as a solvent, and Et_3N as the base. Initially, the reaction progressed slowly, and as it continued, the temperature of the reaction rose. Fortunately, the desired product was obtained in 5 h with an impressive yield of 85%. This finding prompted us to focus on optimizing reaction parameters, including the catalyst, catalyst loading, base, and temperature. Our initial investigation involved testing various catalysts, namely, Pd@Fe_3O_4, Pd@GO, Pd/C (commercial catalyst), and Pd-Fe_3O_4@GO (Table 1 entries 1–4). We utilized iodobenzene and phenylacetylene as coupling partners, with K_2CO_3 as the base and IPA as the solvent, at 90°C. Additionally, we tested the same conditions without a catalyst and did not get any product formation (Table 1 entry 5). Pd-Fe_3O_4@GO emerged as the superior catalyst, providing 85% conversion and producing excellent products (Table 1 entry 4). Consequently, Pd-Fe_3O_4@GO was selected for further study. Following catalyst screening, we explored various bases, including NaOH, pyridine, Et_3N, and K_2CO_3, to achieve a high yield in the desired

TABLE 1 Optimizing the experimental conditions for the coupling of phenylacetylene and iodobenzene.[a]

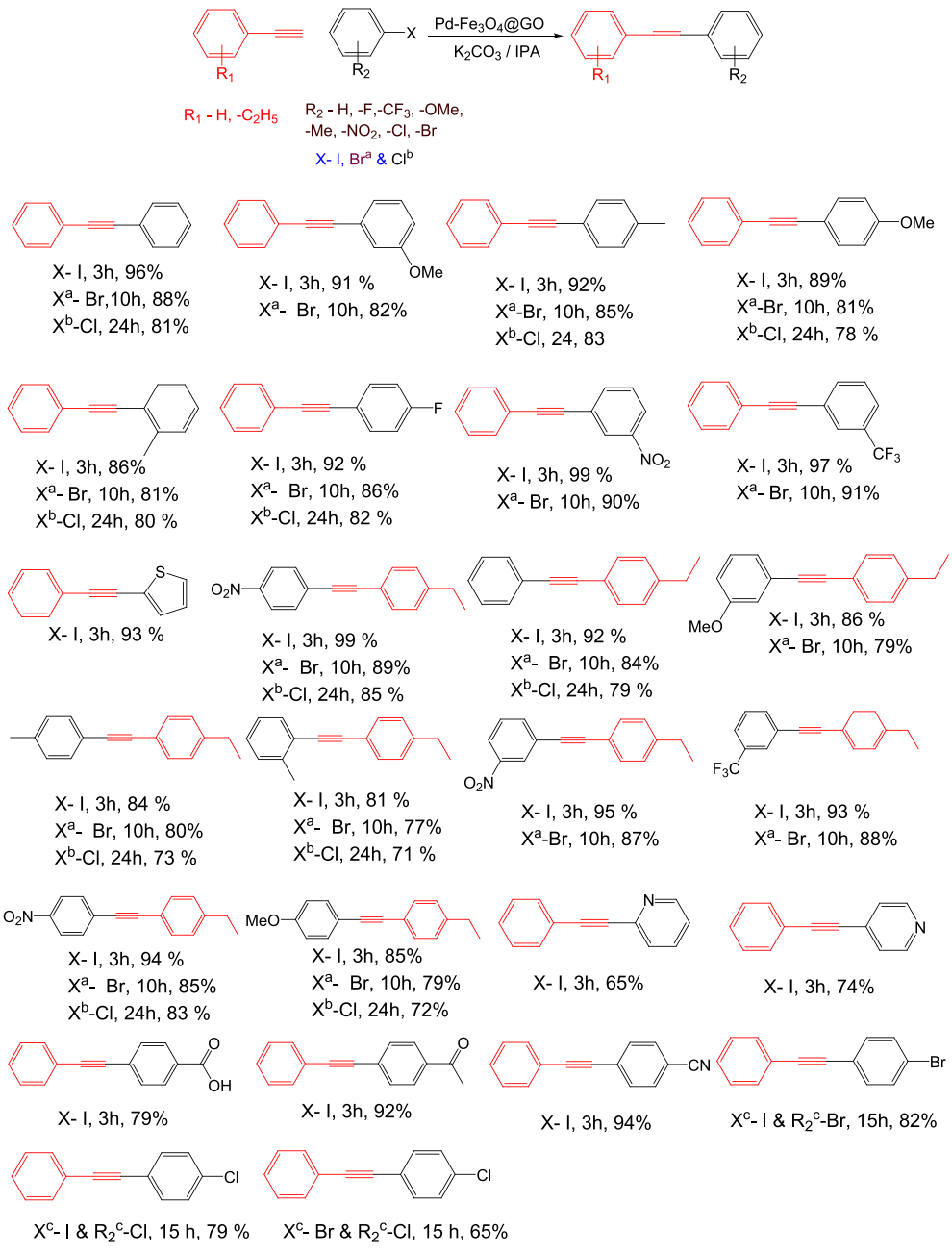
Entry	Catalyst	Solvent	Base	Catalyst loading	Temperature (°C)	Yield %
1	Pd@Fe_3O_4	IPA	K_2CO_3	6 mg	90	34
2	Pd@GO	IPA	K_2CO_3	6 mg	90	55
3	Pd/C (commercial)	IPA	K_2CO_3	6 mg	90	68
4	Pd-Fe_3O_4@GO	IPA	K_2CO_3	6 mg	90	85
5	-	IPA	K_2CO_3	6 mg	90	0
6	Pd-Fe_3O_4@GO	IPA	NaOH	6 mg	90	23
7	Pd-Fe_3O_4@GO	IPA	Pyridine	6 mg	90	45
8	Pd-Fe_3O_4@GO	IPA	Et_3N	6 mg	90	59
9	Pd-Fe_3O_4@GO	DCM	K_2CO_3	6 mg	90	65
10	Pd-Fe_3O_4@GO	DMF	K_2CO_3	6 mg	90	73
11	Pd-Fe_3O_4@GO	Toluene	K_2CO_3	6 mg	90	23
12	Pd-Fe_3O_4@GO	Acetonitrile	K_2CO_3	6 mg	90	55
13	Pd-Fe_3O_4@GO	IPA	K_2CO_3	3 mg	90	65
14	Pd-Fe_3O_4@GO	IPA	K_2CO_3	6 mg	90	85
15	Pd-Fe_3O_4@GO	IPA	K_2CO_3	9 mg	90	96
16	Pd-Fe_3O_4@GO	IPA	K_2CO_3	12 mg	90	97
17	Pd-Fe_3O_4@GO	IPA	K_2CO_3	9 mg	70	33
18	Pd-Fe_3O_4@GO	IPA	K_2CO_3	9 mg	80	65
19	Pd-Fe_3O_4@GO	IPA	K_2CO_3	9 mg	100	97

Abbreviations: GO, graphene oxide; IPA, isopropyl alcohol.

[a]All reactions were conducted using 1 mmol of aryl halide, 1.1 mmol of alkyne, 1.5 mmol of the base, and 5 mL of solvent.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

product (Table 1 entries 6–8). Among these, K_2CO_3 exhibited outstanding results, as depicted in Table 1 entry 4. The superiority of K_2CO_3 can be attributed to factors such as its suitable basicity, solubility, and stability under the given reaction conditions. K_2CO_3 efficiently deprotonated specific alkyne, enhancing the interaction between the catalyst and reactants, leading to higher yields. After base screening, we tested various solvents such as toluene, acetonitrile (CH_3CN), dichloromethane (DCM), and N,N-dimethylformamide (DMF) for the model reaction, comparing them to IPA. However, alternative solvents did not result in a higher yield (Table 1 entries 9–12), so IPA was chosen for further research (Table 1 entry 4). IPA, recognized as a polar protic solvent, shows an intermediate coordinating polarity in relation to other solvents like DMF, DCM, CH_3CN, and toluene. This intermediate coordinating polarity of IPA proves to be advantageous in Sonogashira coupling reactions by facilitating a balanced interplay between the formation and desorption of palladium intermediates without excessively stabilizing them.[53,54] This equilibrium prevents the undue stabilization of palladium intermediates, leading to exceptional conversion selectivity towards the desired product. Following the solvent screening, we explored the catalyst loading, as shown in Table 1 entries 13–16, revealing that the quantity of palladium is a critical parameter influencing catalyst activity during coupling processes. The reaction yield increased from 65% to 96%



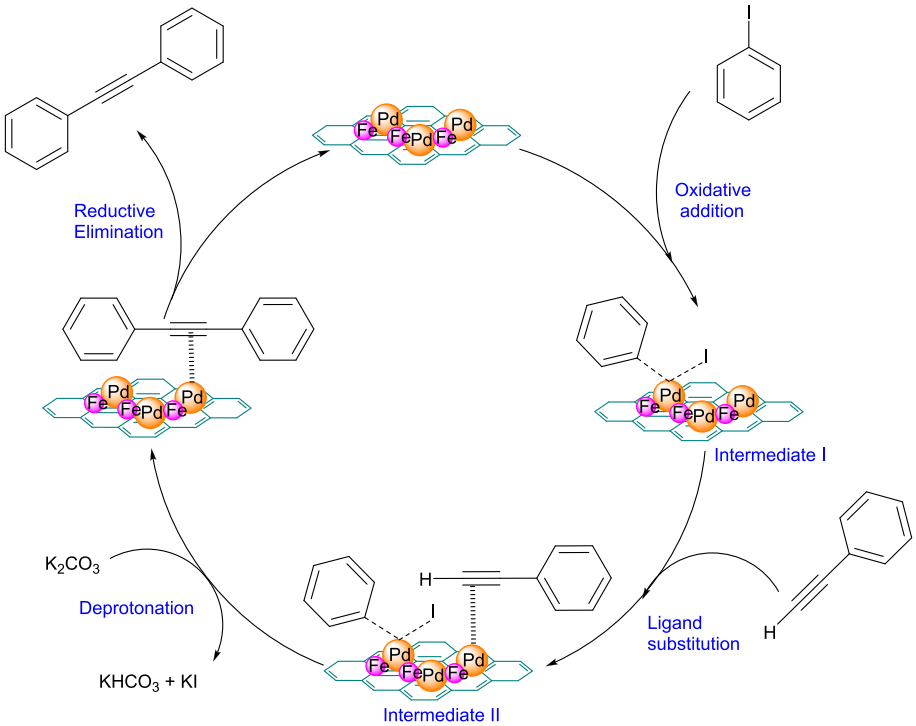
SCHEME 2 Sonogashira coupling, reaction condition: aryl halide (1 mmol), substituted phenylacetylene (1.1 mmol), K_2CO_3 (1.5 mmol), Pd-Fe_3O_4@GO (9 mg), solvent isopropyl alcohol (IPA) (5 mL), temperature (90°C), (110°C)[a], (130°C)[b] and (2 mmol phenylacetylene, 110°C)[c].

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

when the quantity of Pd-Fe_3O_4@GO was increased from 3 to 12 mg. Notably, increasing the catalyst concentration to 12 mg had no impact on performance. Thus, 9 mg of Pd-Fe_3O_4@GO in an IPA solvent at 90°C was confirmed as the optimal condition for the coupling reaction (Table 1 entry 14). Finally, we conducted the reaction at various temperatures such as 70, 80, 90, and 100°C to identify the ideal reaction temperature (Table 1 entry 16–19). The reaction successfully progressed at 90°C within 3 h, yielding 96%. The yield remained stable above 90°C; however, below this temperature, the product yield significantly declined.

3.7 | Substrate scope

The catalytic efficiency of Pd-Fe_3O_4@GO was investigated across a diverse range of functionalized phenylacetylene compounds with aryl halide substrates, as outlined in Scheme 2. Notably, iodobenzene exhibited strong interaction with phenylacetylene over Pd-Fe_3O_4@GO, leading to an impressive 96% conversion of the desired product within 3 h. This desired product, substituted diphenylethyne, was consistently generated in exceptionally high yields. This was achieved through the Sonogashira coupling reaction involving iodobenzene and electron-withdrawing substituents like -NO_2, -F, -COOH, -$COCH_3$, CN, and -CF_3 at the o, p, and m positions. Furthermore, aryl iodides featuring electron-releasing substitutions such as -CH_3 and -OCH_3 at the p- and o-positions, when combined with phenylacetylene, yielded the anticipated products with consistently high to exceptional yields. It was noted that iodobenzene with electron-withdrawing groups displayed superior yields compared with those with electron-donating groups. In addition to iodobenzene, other compounds including bromobenzene, chlorobenzene, substituted bromobenzene, substituted chlorobenzene, and heterocyclic derivatives such as 2-iodothiophene, 4-iodopyridine, and 2-iodopyridine when reacted with phenylacetylene, all resulted in a high yield of the desired product. Moreover, 1-ethyl-4-ethynylbenzene, when subjected to reactions with substituted iodobenzene, bromobenzene, and chlorobenzene, demonstrated a favorable yield of the desired products. We conducted screening tests using 1-Bromo-4-iodobenzene, 1-Chloro-4-iodobenzene, and 1-Bromo-4-chlorobenzene to understand the competitive preferences for breakage of C-I, C-Br, and C-Cl bonds. In the screening of 1-Bromo-4-iodobenzene with phenylacetylene, we observed that the C-I bond broke preferentially, leading to the formation of 1-bromo-4-(phenylethynyl)benzene as the major product, along with the small quantity of bisphenyl product, 1,4-bis (phenylethynyl)benzene, with a less than 15% conversion. Then, we conducted screenings on 1-Chloro-4-iodobenzene and 1-Bromo-4-chlorobenzene, revealing a preference for C-I and C-Br bond cleavage, respectively. The results showed the predominant formation of 1-chloro-4-(phenylethynyl)benzene in both reactions, with no bis-product formation. From the above experiments, it was observed that the C-I bond



SCHEME 3 Sonogashira coupling reaction mechanism.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

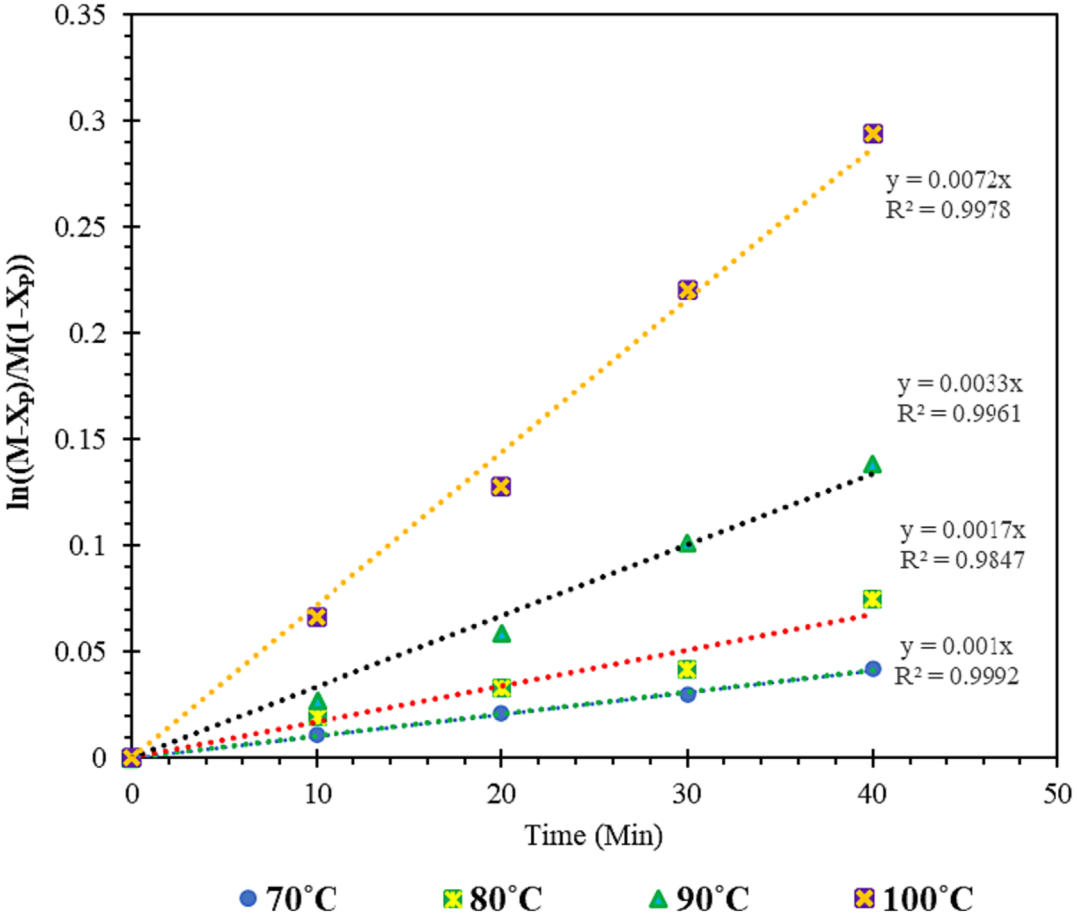


FIGURE 6 Plot of [ln ((M − X_P)/M(1 − X_P))] versus time at different temperatures.

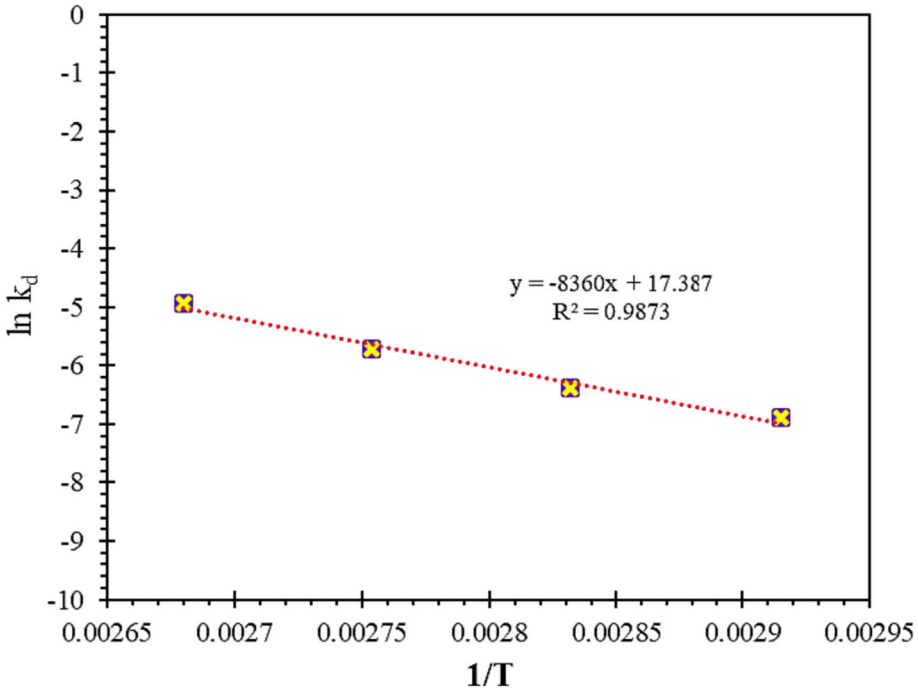


FIGURE 7 Arrhenius plot lnkp versus 1/T.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

easily breaks down compared with C-Br and C-Cl. This indicates a cascade reaction in which weaker bonds, such as C-I, break down preferentially before stronger bonds like C-Br and C-Cl. This comprehensive study showcases the versatility of Pd-Fe_3O_4@GO in facilitating these reactions, providing valuable insights into the reactivity of various substrates and their yields in the presence of different aryl halides.

3.8 | Reaction mechanism and kinetic modeling

The mechanism of Sonogashira cross-coupling reactions is well-documented in the literature.[55,56] Scheme 3 illustrates the potential reaction mechanism involved in the Sonogashira coupling between phenylacetylene and iodobenzene. In heterogeneous catalyst adsorption, surface reaction and desorption pathways follow. The deprotonation mechanisms involve the initial oxidative addition of iodobenzene to Pd(0), resulting in the formation of a benzene-catalyst-iodide complex (intermediate 1). Subsequently, phenylacetylene coordinates with palladium, leading to the formation of intermediate 2. At this stage, deprotonation of phenylacetylene occurs via the base K_2CO_3, resulting in a Pd complex with the two organic groups in a cis disposition. Finally, the coupled product 1,2-diphenylethyne is expelled through reductive elimination. This depicted mechanism serves as the foundation for formulating a mathematical model. Building upon the Langmuir–Hinshelwood–Hougen–Watson (LHHW) type of mechanism, a model was developed to describe the reaction kinetics, revealing a second-order reaction. The kinetic model derivation is given in the supplementary information. To assess the validity of the model, a plot of $\ln(M - X_P)/M(1 - X_P)$ against time was generated at various temperatures, demonstrating a linear correlation (Figure 6) and confirming the model's appropriateness. Subsequently, an Arrhenius plot, employing the slopes obtained from the aforementioned linear relationships, was constructed to determine the apparent activation energy, yielding a value of 16.61 kcal/mol (Figure 7). This outcome suggests that the reaction is under kinetic control.

3.9 | Comparison of Pd-Fe_3O_4@GO with other reported catalysts systems

The catalytic efficiency of the Pd-Fe_3O_4@GO catalyst has been systematically evaluated through a comparative analysis with previously reported catalysts, as outlined in Table 2. Noteworthy among these are the Fe_3O_4/GO-

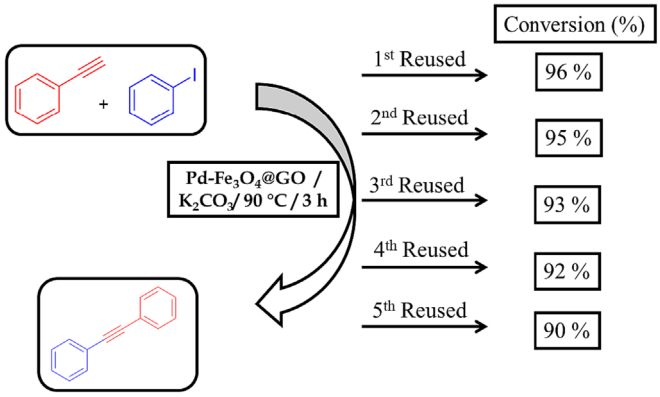


FIGURE 8 Reusability of Pd-Fe_3O_4@GO catalyst.

TABLE 2 Comparison of Pd-Fe_3O_4@GO system and other reported catalysts systems.

Sr. no	Catalyst[a]	Base/solvent/catalyst	Temp. (°C)	Time (h)	Yield[b] (%)	Ref.
1	Fe_3O_4/GO-Cellulose-Pd	K_2CO_3/DMAC:Gly/0.024 g	120	8	91	33
2	Pd@Fe_3O_4 NPs	Piperidine/DMF/0.024 g	110	24	83	34
3	CS/MMT/Pd	CH_3COOK/DMSO + ethylene glycol/0.026 g	110	5	94	57
4	CPS-MNPs-NNN-Pd	K_2CO_3/H2O DMF/ (0.020 mmol Pd), PPh_3, CuI	90	7	91	37
5	Pd-Co/G	Et_3N/THF-H_2O/ (0.020 mmol Pd), PPh_3, CuI	80	12	98	26
6	G3-Gu-Pd	K_2CO_3/H_2O/0.012 g	100	8	85	45
7	MNPs–PdNPs	Et_3N/THF/0.012 g	65	24	85	44
8	Pd/$CuFe_2O_4$	K_2CO_3/DMSO/4 mol%	120	12	78	58
9	Pd-Fe_3O_4@GO	K_2CO_3/IPA/0.009 g	90	3	96	This Work

Abbreviations: GO, graphene oxide; IPA, isopropyl alcohol; NPs, nanoparticles.
[a]All reactions were carried out with phenylacetylene and iodobenzene.
[b]Yield refers to isolated pure products.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Cellulose-Pd,[25] CS/MMT/Pd,[40] G3-Gu-Pd,[37] and MNPs–PdNPs[36] catalysts, which exhibited higher yields. However, these catalysts are associated with the use of harsh reaction conditions, prolonged reaction times, and higher catalytic loadings. On the other hand, the catalysts $Pd/CuFe_2O_4$[41] and $Pd@Fe_3O_4$ NPs[26] demonstrated lower yields, attributed to their reliance on harsh reaction conditions and extended reaction times. Catalysts like CPS-MNPs-NNN-Pd[29] and Pd-Co/G[18] have shown improved yields in Sonogashira coupling reactions. However, these catalysts utilize copper as a co-catalyst, toxic phosphine ligands, and also higher catalytic loadings. However, the $Pd\text{-}Fe_3O_4$@GO catalyst offers several advantages over these methods: (i) it functions under mild reaction conditions, devoid of ligands and additional co-catalysts; (ii) it proves cost-effective; and (iii) the catalyst exhibits recyclability without apparent leaching. The preparation of the catalyst via the solvothermal process presents further benefits: (i) It allows for a single-pot synthesis of the catalyst rather than a multi-step catalyst synthesis. (ii) Utilizes simple ethylene glycol as both solvent and reducing agent, replacing the need for toxic chemicals. (iii) Solvothermal conditions provide precise control over temperature and pressure, enhancing control over particle size, morphology, and crystallinity. (iv) Elevated temperature and pressure enable unique catalyst properties

TABLE 3 Reusability of catalyst data.

Reusability run	Catalyst loading (mg)	Recovered catalyst (mg)	Top-up catalyst (mg)	Top-up (%)
1st reused	9	8.4	0.6	7
2nd reused	9	8.3	0.7	8
3rd reused	9	8.6	0.4	4
4th reused	9	8.5	0.5	6
5th reused	9	8.3	0.7	8

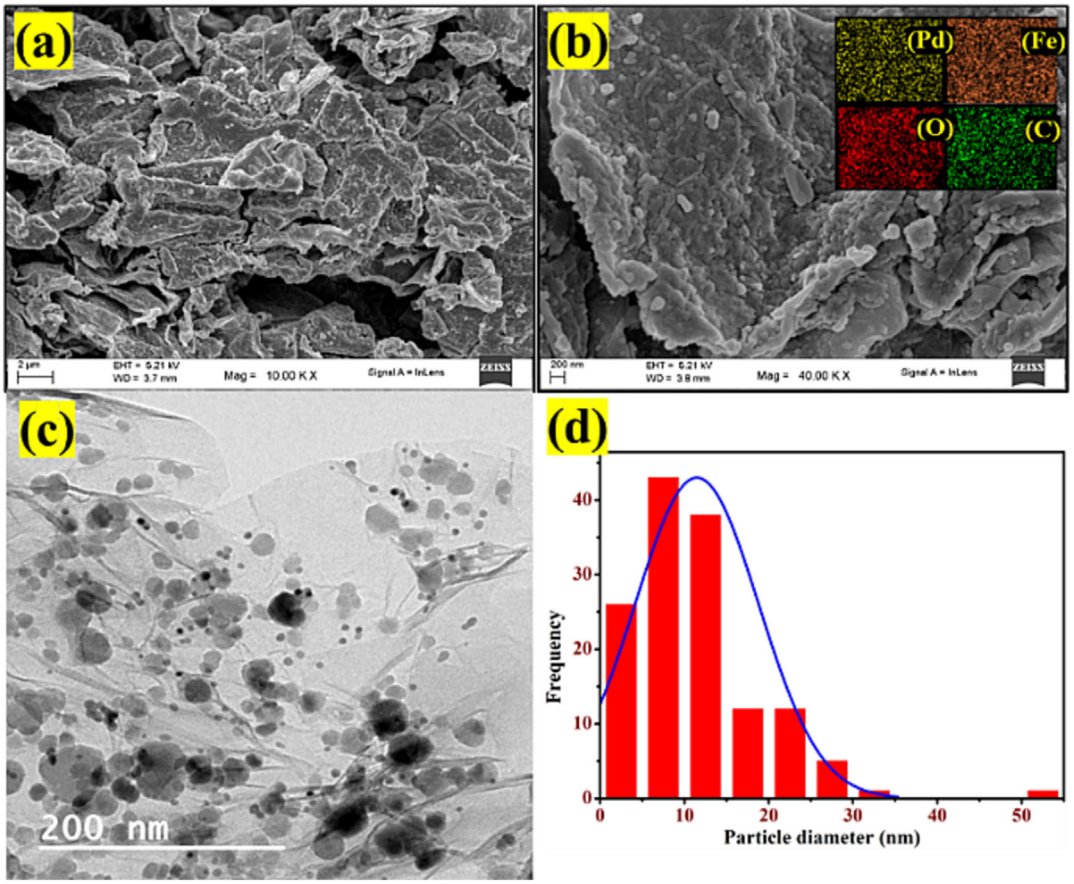


FIGURE 9 Reused $Pd\text{-}Fe_3O_4$@GO catalyst (a, b) SEM image and mapping (c) TEM (d) particle size distribution.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

that may not be achievable with other methods. (v) While controlled nucleation and growth lead to well-defined structures and improved catalytic activity.

3.10 | Reusability of catalyst

Five tests were conducted to assess the recyclability of the Pd-Fe_3O_4@GO catalyst, as illustrated in Figure 8. The catalyst was recovered by a magnet, washed with water, dried, and then refluxed in 5 mL of IPA for 4 h. Subsequently, it underwent another wash with IPA before being vacuum-dried for 5 h at 50°C. Despite a slight decrease in conversion, indicating changes in the catalyst's selectivity, activity, and reusability, it remained effective. The reduction in the quantity of the catalyst obtained after separation and drying (approximately 4%–8%) was compensated by the addition of virgin catalyst (Table 3). The catalyst's activity remained practically consistent in all experiments. Moreover, when the reused catalyst was utilized without additional supplementation, but the volume of the reaction mass was decreased to maintain the same catalyst loading, comparable rates and conversions were achieved. Consequently, the catalyst exhibited robustness, sustained activity, and reusability.

3.11 | Hot filtration test

To further assess the catalyst's reusability, a hot filtration test was conducted using iodobenzene and phenylacetylene as model substrates under optimized reaction conditions. Stirring was halted after 1 h, and the reaction mixture was filtered to separate the catalyst. The

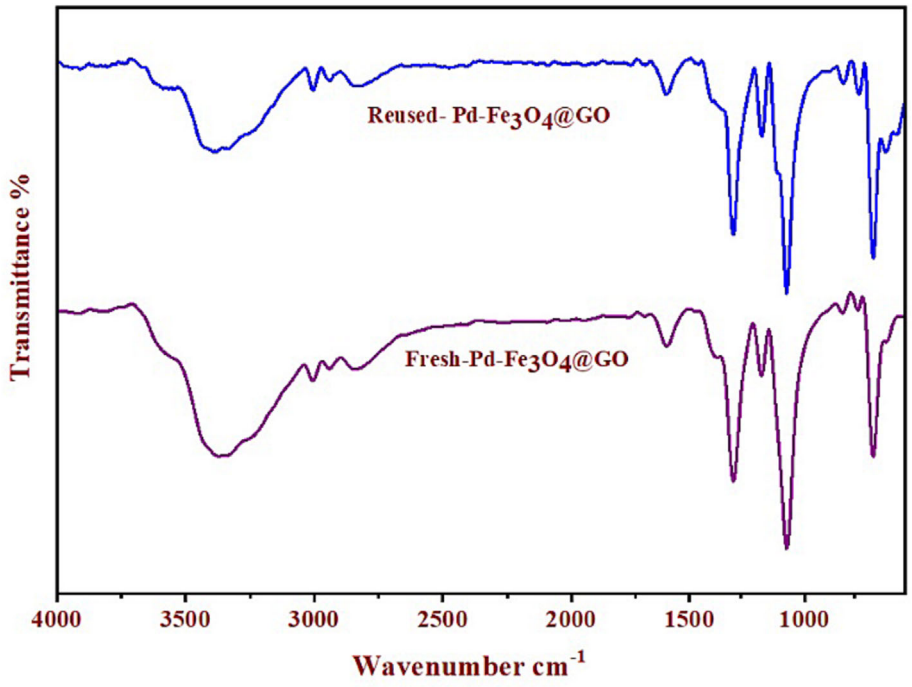


FIGURE 10 FTIR of Fresh and Reused Pd-Fe_3O_4@GO catalyst.

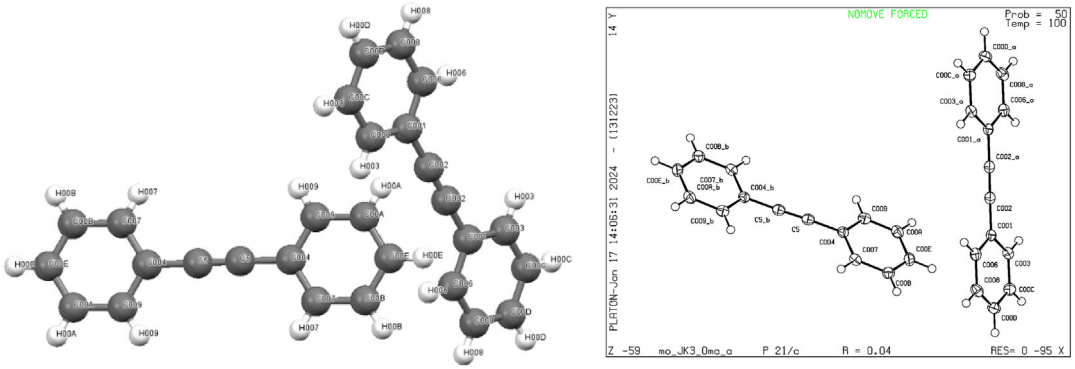


FIGURE 11 Single crystal XRD structure of 1,2-diphenylethyne (mo_JK3_0ma_a).

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

percentage of product formation was analyzed using GC (61%). The clear filtrate was continuously stirred for the next 2 h at 90°C, revealing no change in conversion. This lack of alteration confirmed the absence of catalyst leaching into the reaction mass filtrate, demonstrating the retention of active Pd sites. Furthermore, ICP-MS measurements of the reaction mass indicated that palladium leaching was below the detection limit. This comprehensive analysis validates the catalyst's stability and suitability for repeated use.

3.12 | Reused catalyst characterization

The fifth reused catalyst was thoroughly characterized using SEM, EDS, TEM, and IR. From the SEM images, we observed that the morphology of the reused catalyst closely resembles that of the fresh catalyst, with Pd-Fe_3O_4 NPs agglomerated on the surface. The majority of the particles exhibit a spherical or semi-spherical shape with a smooth surface. EDS mapping revealed that the concentrations of Pd and Fe are the same as those in the fresh catalyst (Figure 9a,b). TEM analysis showed that the Pd-Fe_3O_4 particles are distributed on GO, along with some agglomeration of larger particles. The particle size distribution indicated a slight increase in size, ranging from 2 to 30 nm in diameter (Figures 9c,d and S2). The IR spectra of both the synthesized catalyst and the catalyst recovered from the reaction mass after five runs were analyzed. No significant changes in functional groups were observed (Figure 10).

3.13 | Single crystal XRD parameters of 1,2-diphenylethyne (mo_JK3_0ma_a)

Examine the crystal structure analysis of 1,2-diphenylethyne, including insights into bond lengths, angles, and packing arrangement (Figures 11 and S3). Table S1 provides a summary of the crystallographic data and refinement parameters.

4 | CONCLUSION

The main findings of this study can be summed up as follows:

Single-pot synthesis of Pd-Fe_3O_4@GO: In this study, we successfully synthesized a magnetically separable catalyst using the single-pot solvothermal method for the first time, showcasing its efficacy in Sonogashira coupling reactions.

Advanced catalyst characterization: The catalyst was comprehensively characterized using sophisticated techniques, ensuring a thorough understanding of its properties and structure.

Outstanding performance in Sonogashira coupling: Among the reported palladium-based catalysts, Pd-Fe_3O_4@GO demonstrated exceptional performance in the Sonogashira coupling process (iodobenzene [1 mmol], phenylacetylene [1.1 mmol], K_2CO_3 [1.5 mmol], Pd-Fe_3O_4@GO [9 mg]) at 90°C in IPA solvent with high turnover frequency (TOF, 118.3 h^{-1})1.

Sustained activity and stability: Remarkably, even after the fifth cycle, Pd-Fe_3O_4@GO maintained outstanding conversion rates in the Sonogashira coupling reaction. This enduring activity and stability can be attributed to the redox behavior of Fe_3O_4 and the GO support, enhancing electron transfer between the metal and the support.

Efficient conversion without co-catalysts: The catalyst achieved remarkable conversion rates to the desired product without requiring co-catalysts like copper or any other expensive ligands. Additionally, it exhibited excellent conversion rates for inactive substituted aryl chlorides and bromides.

Reaction mechanism and kinetic modeling: A reaction mechanism was suggested, and a kinetic equation was formulated for the Sonogashira reaction, which is under kinetic control. It adheres to a second-order kinetic equation, with an apparent activation energy of 16.61 kcal/mol.

Versatile applications in industrial processes: Pd-Fe_3O_4@GO demonstrates significant potential as a catalyst in a wide array of industrial manufacturing processes. Its versatility positions it as a valuable asset in diverse industrial applications.

AUTHOR CONTRIBUTIONS

Mahesh A. Pawar: Data curation; formal analysis; writing original draft. **Akhil V. Nakhate**: Supervision; correcting draft; writing original draft. **Samidha S. Kadu**: Supervision; correcting draft; final writing. **Pradip V. Tekade**: Supervision; writing original draft.

ACKNOWLEDGMENTS

SSK and MAP gratefully acknowledge the support provided by Shri Shivaji College of Arts, Commerce, and Science in Akola, while AVN and PVT gratefully acknowledge the support provided by Bajaj College of Science, Wardha.

CONFLICT OF INTEREST STATEMENT

The authors declare no competing financial interest.

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of the study are available within the article and its supplementary material. Raw data that supports the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

[1] M. Khoobi, A. Foroumadi, S. Emami, M. Safavi, G. Dehghan, B. H. Alizadeh, A. Ramazani, S. K. Ardestani, A. Shafiee, *Chem. Biol. Drug Des.* **2011**, *78*, 580. https://doi.org/10.1111/j.1747-0285.2011.01175.x

[2] A. Ramazani, A. Reza Kazemizadeh, *Curr. Org. Chem.* **2011**, *15*, 3986. https://doi.org/10.2174/138527211798072412

[3] I. Yavari, A. Ramazani, *Synth. Commun.* **1997**, *27*, 1449. https://doi.org/10.1080/00397919708006076

[4] M. Khoobi, S. Emami, G. Dehghan, A. Foroumadi, A. Ramazani, A. Shafiee, *Arch. Pharm. (Weinheim).* **2011**, *344*, 588. https://doi.org/10.1002/ardp.201000271

[5] F. Kalantari, S. Rezayati, A. Ramazani, M. Poor Heravi, *Appl. Organomet. Chem.* **2023**, *37*. https://doi.org/10.1002/aoc.7064

[6] H. Aghahosseini, A. Ramazani, N. S. Jalayer, Z. Ranjdoost, A. Souldozi, K. Ślepokura, T. Lis, *Org. Lett.* **2019**, *21*, 22. https://doi.org/10.1021/acs.orglett.8b03388

[7] M. Dodangeh, A. Ramazani, M.-T. Maghsoodlou, A. Zarei, S. Rezayati, *Curr. Org. Chem.* **2020**, *24*, 1582. https://doi.org/10.2174/1385272824999200616114037

[8] J. Rayadurgam, S. Sana, M. Sasikumar, Q. Gu, *Org. Chem. Front.* **2021**, *8*, 384. https://doi.org/10.1039/D0QO01146K

[9] P. Devendar, R.-Y. Qu, W.-M. Kang, B. He, G.-F. Yang, *J. Agric. Food Chem.* **2018**, *66*, 8914. https://doi.org/10.1021/acs.jafc.8b03792

[10] K. Karami, S. Abedanzadeh, P. Hervés, *RSC Adv.* **2016**, *6*, 93660. https://doi.org/10.1039/C6RA17914B

[11] Y. Liang, Y.-X. Xie, J.-H. Li, *J. Org. Chem.* **2006**, *71*, 379. https://doi.org/10.1021/jo051882t

[12] G. Li, Z. Tang, *Nanoscale.* **2014**, *6*, 3995. https://doi.org/10.1039/C3NR06787D

[13] M. Azharuddin, G. H. Zhu, D. Das, E. Ozgur, L. Uzun, A. P. F. Turner, H. K. Patra, *Chem. Commun.* **2019**, *55*, 6964. https://doi.org/10.1039/C9CC01741K

[14] S. Yang, X. Luo, *Nanoscale.* **2014**, *6*, 4438. https://doi.org/10.1039/C3NR06858G

[15] S. F. Motevalizadeh, M. Alipour, F. Ashori, A. Samzadeh-Kermani, H. Hamadi, M. R. Ganjali, H. Aghahosseini, A. Ramazani, M. Khoobi, E. Gholibegloo, *Appl. Organomet. Chem.* **2018**, *32*. https://doi.org/10.1002/aoc.4123

[16] A. V. Nakhate, G. D. Yadav, *ChemistrySelect* **2016**, *1*, 3954. https://doi.org/10.1002/slct.201600819

[17] C. Gao, F. Lyu, Y. Yin, *Chem. Rev.* **2021**, *121*, 834. https://doi.org/10.1021/acs.chemrev.0c00237

[18] M. Aksoy, H. Kilic, B. Nişancı, Ö. Metin, *Inorg. Chem. Front.* **2021**, *8*, 499. https://doi.org/10.1039/D0QI01283A

[19] A. Chouhan, H. P. Mungse, O. P. Khatri, *Adv. Colloid Interface Sci.* **2020**, *283*, 102215. https://doi.org/10.1016/j.cis.2020.102215

[20] M. Terrones, A. R. Botello-Méndez, J. Campos-Delgado, F. López-Urías, Y. I. Vega-Cantú, F. J. Rodríguez-Macías, A. L. Elías, E. Muñoz-Sandoval, A. G. Cano-Márquez, J.-C. Charlier, *Nano Today* **2010**, *5*, 351. https://doi.org/10.1016/j.nantod.2010.06.010

[21] A. T. Lawal, *Biosens. Bioelectron.* **2019**, *141*, 111384. https://doi.org/10.1016/j.bios.2019.111384

[22] J. Martínez-Laguna, A. Caballero, P. J. Pérez, *Adv. Synth. Catal.* **2021**, *363*, 1740. https://doi.org/10.1002/adsc.202001325

[23] X. Fan, G. Zhang, F. Zhang, *Chem. Soc. Rev.* **2015**, *44*, 3023. https://doi.org/10.1039/C5CS00094G

[24] K. H. Lee, S.-W. Han, K.-Y. Kwon, J. B. Park, *J. Colloid Interface Sci.* **2013**, *403*, 127. https://doi.org/10.1016/j.jcis.2013.04.006

[25] M. Chen, Z. Zhang, L. Li, Y. Liu, W. Wang, J. Gao, *RSC Adv.* **2014**, *4*, 30914. https://doi.org/10.1039/C4RA05186F

[26] Y.-S. Feng, X.-Y. Lin, J. Hao, H.-J. Xu, *Tetrahedron.* **2014**, *70*, 5249. https://doi.org/10.1016/j.tet.2014.05.083

[27] S. Sadjadi, M. Malmir, M. M. Heravi, F. Ghoreyshi Kahangi, *Inorganica Chim. Acta.* **2019**, *488*, 62. https://doi.org/10.1016/j.ica.2018.12.048

[28] V. B. Saptal, M. V. Saptal, R. S. Mane, T. Sasaki, B. M. Bhanage, *ACS Omega.* **2019**, *4*, 643. https://doi.org/10.1021/acsomega.8b03023

[29] S. Moussa, A. R. Siamaki, B. F. Gupton, M. S. El-Shall, *ACS Catal.* **2012**, *2*, 145. https://doi.org/10.1021/cs200497e

[30] S. Sultana, S. D. Mech, F. L. Hussain, P. Pahari, G. Borah, P. K. Gogoi, *RSC Adv.* **2020**, *10*, 23108. https://doi.org/10.1039/D0RA01189D

[31] M. Gholinejad, J. Ahmadi, *Chempluschem.* **2015**, *80*, 973. https://doi.org/10.1002/cplu.201500015

[32] E. Ghonchepour, M. R. Islami, A. M. Tikdari, *J. Organomet. Chem.* **2019**, *883*, 1. https://doi.org/10.1016/j.jorganchem.2019.01.008

[33] M. Niakan, M. Masteri-Farahani, H. Shekaari, S. Karimi, *Carbohydr. Polym.* **2021**, *251*, 117109. https://doi.org/10.1016/j.carbpol.2020.117109

[34] J. Chung, J. Kim, Y. Jang, S. Byun, T. Hyeon, B. M. Kim, *Tetrahedron Lett.* **2013**, *54*, 5192. https://doi.org/10.1016/j.tetlet.2013.07.057

[35] Z. Tashrifi, S. Bahadorikhalili, H. Lijan, S. Ansari, H. Hamedifar, M. Mahdavi, *New J. Chem.* **2019**, *43*, 8930. https://doi.org/10.1039/C9NJ01562K

[36] M. Tukhani, F. Panahi, A. Khalafi-Nezhad, *ACS Sustain. Chem. Eng.* **2018**, *6*, 1456. https://doi.org/10.1021/acssuschemeng.7b03923

[37] F. Dehghani Firuzabadi, Z. Asadi, F. Panahi, *RSC Adv.* **2016**, *6*, 101061. https://doi.org/10.1039/C6RA22535G

[38] H. Salemi, B. Kaboudin, F. Kazemi, T. Yokomatsu, *RSC Adv.* **2016**, *6*, 52656. https://doi.org/10.1039/C6RA04575H

[39] W. Li, X. Jia, B. Zhang, L. Tian, X. Li, H. Zhang, Q. Zhang, *New J. Chem.* **2015**, *39*, 2925. https://doi.org/10.1039/C4NJ02117G

[40] H. Woo, K. Lee, J. C. Park, K. H. Park, *Solid State Sci.* **2016**, *53*, 78. https://doi.org/10.1016/j.solidstatesciences.2016.01.010

[41] A. R. Sardarian, M. Kazemnejadi, M. Esmaeilpour, *Dalt. Trans.* **2019**, *48*, 3132. https://doi.org/10.1039/C9DT00060G

[42] M. Daraie, M. M. Heravi, S. S. Kazemi, *J. Coord. Chem.* **2019**, *72*, 2279. https://doi.org/10.1080/00958972.2019.1640360

[43] P. Li, L. Wang, L. Zhang, G.-W. Wang, *Adv. Synth. Catal.* **2012**, *354*, 1307. https://doi.org/10.1002/adsc.201100725

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

[44] D. Wang, C. Deraedt, L. Salmon, C. Labrugère, L. Etienne, J. Ruiz, D. Astruc, *Chem. - A Eur. J.* **2015**, *21*, 1508. https://doi.org/10.1002/chem.201404590
[45] E. Niknam, A. Moaddeli, A. Khalafi-Nezhad, *J. Organomet. Chem.* **2020**, *923*, 121369. https://doi.org/10.1016/j.jorganchem.2020.121369
[46] A. R. Sardarian, M. Zangiabadi, I. D. Inaloo, *RSC Adv.* **2016**, *6*, 92057. https://doi.org/10.1039/C6RA17268G
[47] I. D. Inaloo, S. Majnooni, *European J. Org. Chem.* **2019**, *2019*, 6359. https://doi.org/10.1002/ejoc.201901140
[48] A. R. Sardarian, I. Dindarloo Inaloo, M. Zangiabadi, *New J. Chem.* **2019**, *43*, 8557. https://doi.org/10.1039/C9NJ00028C
[49] I. Dindarloo Inaloo, S. Majnooni, H. Eslahi, M. Esmaeilpour, *Mol. Catal.* **2020**, *492*, 110915. https://doi.org/10.1016/j.mcat.2020.110915
[50] A. V. Nakhate, G. D. Yadav, *ACS Sustain. Chem. Eng.* **2016**, *4*, 1963. https://doi.org/10.1021/acssuschemeng.5b01205
[51] A. V. Nakhate, G. D. Yadav, *ChemistrySelect.* **2017**, *2*, 7150. https://doi.org/10.1002/slct.201700556
[52] M. Kim, H. Kang, K. H. Park, *Catal. Commun.* **2015**, *72*, 150. https://doi.org/10.1016/j.catcom.2015.09.032
[53] J. Sherwood, J. H. Clark, I. J. S. Fairlamb, J. M. Slattery, *Green Chem.* **2019**, *21*, 2164. https://doi.org/10.1039/C9GC00617F
[54] C. Reichardt, T. Welton, *Solvents and Solvent Effects in Organic Chemistry*, Wiley **2010**.
[55] M. García-Melchor, M. C. Pacheco, C. Nájera, A. Lledós, G. Ujaque, *ACS Catal.* **2012**, *2*, 135. https://doi.org/10.1021/cs200526x
[56] P. Veerakumar, P. Thanasekaran, K.-L. Lu, K.-C. Lin, S. Rajagopal, *ACS Sustain. Chem. Eng.* **2017**, *5*, 8475. https://doi.org/10.1021/acssuschemeng.7b00922
[57] M. Zeng, X. Yuan, S. Zuo, C. Qi, *RSC Adv.* **2015**, *5*, 37995. https://doi.org/10.1039/C5RA01902H
[58] B. Lakshminarayana, J. Chakraborty, G. Satyanarayana, C. Subrahmanyam, *RSC Adv.* **2018**, *8*, 21030. https://doi.org/10.1039/C8RA03697G

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: M. A. Pawar, A. V. Nakhate, S. S. Kadu, P. V. Tekade, *Appl Organomet Chem* **2024**, e7405. https://doi.org/10.1002/aoc.7405

10990739, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/aoc.7405 by Institute Of Chemical Technology, Mumbai, Wiley Online Library on [26/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Indian Journal of Heterocyclic Chemistry
Vol. 33 - Number XX (xxx-xxx 2023) 1-5
https://connectjournals.com/01951.2023.33.X
https://doi.org/10.59467/IJHC.2023.33.x

ISSN (Print) : 0971-1627
ISSN (Online) : 2456-4311

Synthesis and Antimicrobial Evaluation of 3-Carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino-1,3,4-thiadiazolidines

Dipali S. Mankar[1]*, Mamata T. Sangole[1] and Sham H. Mankar[2]

[1]Department of Chemistry, Shri Shivaji College of Arts, Commerce and Science, Akola, Maharashtra, India
[2]Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering and Research, Pune, Maharashtra, India

ABSTRACT A new series of 3-carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino-1,3,4-thiadiazolidines was synthesized by the interaction of 1-carbonyl-(pyrid-4-yl)-4-hepta-*O*-benzoyl-β-D-lactosyl-3-thiosemicarbazide with aryl isocyanodichlorides. The required 1-carbonyl-(pyrid-4-yl)-4-hepta-*O*-benzoyl-β-D-lactosyl-3-thiosemicarbazide was synthesized by the interaction of 1-hepta-*O*-benzoyl-β-D-lactosyl isothiocyanates and isoniazid. These compounds were screened for their antibacterial and antifungal activity against some pathogenic organisms to get potent bioactive molecule.

KEYWORDS 1-hepta-*O*-benzoyl-β-D-lactosyl isothiocyanate, Thiosemicarbazide, Thiadiazolidines, Antimicrobial activity.

How to cite this article: Mankar, D.S., Sangole, M.T. and Mankar, S.H. Synthesis and Antimicrobial Evaluation of 3-Carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino-1,3,4-thiadiazolidines, *Indian J. Heterocycl. Chem.*, **2023**, *33*, 1–5. *https://doi.org/10.59467/IJHC.2023.33.X*

INTRODUCTION

Carbohydrates mediate a variety of important, medicinally relevant biological processes, playing a key role in numerous diseases.[1] The ability to understand their functions is of paramount importance for the development of new drugs and therapeutics to treat human diseases.

Heterocyclic compounds[2] play a vital role among organic compounds with biological activities that are used as medicines in human and veterinary drugs or as insecticides and pesticides in agricultural applications. Chemical rings, available in various medicines, may have pharmacological characteristics or may provide a platform for the pharmacophoric sets, which will work to gather with the receptors. Thiadiazoles belong to the group of nitrogen–sulfur-containing heterocycles with wide application as structural parts of biologically active molecules and as useful intermediates in medicinal chemistry. Since the past few years, substituted 1,3,4-thiadiazole derivatives have received important consideration and have been increasingly investigated due to their large spectrum of pharmacological characteristics. It is assumed that 1,3,4-thiadiazole derivatives show different biological activities due to the occurrence of =N-C-S- moiety. Other authors assume that the biological activities of 1,3,4-thiadiazole derivatives are due to strong aromaticity of the ring, which also gives great *in vivo* stability to this five-membered ring system and low toxicity for higher vertebrates, including humans.

1,3,4-Thiadiazoles are significant heterocyclic compounds with a wide range of applications in medicinal, agricultural, and materials chemistry.[3] Their derivatives bearing an amino or imino group display a broad spectrum of pharmaceutical and biological properties[4] including antimicrobial,[5] antitubercular,[6] anticancer,[7] anti-inflammatory/analgesic,[8] antidepressant,[9] and antioxidant activities.[10] In view of these observations, we report herein synthesis and antimicrobial evaluation of some new 3-carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino-1,3,4-thiadiazolidines.

*Corresponding author: Email: dipalimhaisne@rediffmail.com

Published & Hosted by :
Journal Homepage :
www.connectjournals.com/ijhc
www.connectjournals.com

©2023 Connect Journals

RESULTS AND DISCUSSION

The synthetic routes for the preparation of new thiosemicarbazide **(3)** and thiadiazolidines **(5a-g)** are shown in **Scheme 1**. In the first step, 1-carbonyl-(pyrid-4-yl)-4-hepta-*O*-benzoyl-β-D-lactosyl-3-thiosemicarbazide **(3)** was prepared by reacting hepta-*O*-benzoyl-β-D-lactosyl isothiocyanate **(1)** with isoniazid **(2)** in acetone as a solvent. In the second step, 3-carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino-1,3,4-thiadiazolidines **(5a-g)** was prepared by interaction of 1-carbonyl-(pyrid-4-yl)-4- hepta-*O*-benzoyl-β-D-lactosyl-3-thiosemicarbazide **(3)** with various aryl isocyanodichlorides **(4a-g)** using acetone as a solvent. The products were found to be optically active. The chemical structures of the title compounds were deduced by infrared (IR),[13,14] ^{1}H NMR,[15] mass spectra,[16] and elemental analysis [**Table 1**].

EXPERIMENTAL SECTION

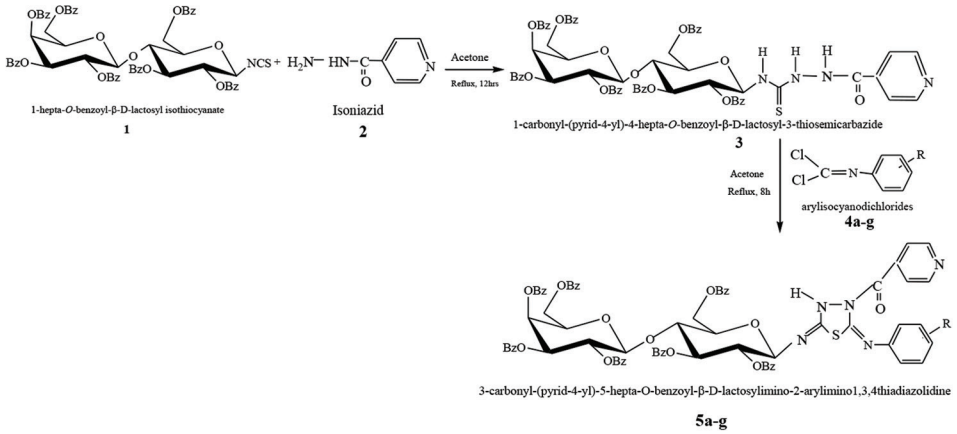
Chemicals, reagents, and solvent were obtained from chemical sources and purified by either distillation or crystallization before use. Thin-layer chromatography (TLC), performed on E. Merck pre-coated silica gel plates, was used to test the compound purity. Melting points were determined in open capillary tubes on Mac digital melting point apparatus and are uncorrected. IR spectra were recorded in solid phases KBr pellets on Shimadzu IRAffinity-1 Fourier-transform infrared spectroscopy spectrometer. ^{1}H NMR spectra were recorded in $CHCl_3$ on Bruker of NMR spectrometer 500 MHz. The mass of the synthesized compounds was also obtained from CIF, SPPU, Pune, using mass spectrometer (Bruker Compass). Equiptronics Digital Polarimeter EQ-801 at 31°C in $CHCl_3$ was used to determine optical rotations $[\alpha]_D^{31}$.

Synthesis of 1-carbonyl-(pyrid-4-yl)-4-hepta-O-benzoyl-β-D-lactosyl-3-thiosemicarbazide (3)

Lactosyl isothiocyanate (0.009 M, 10 g) and isoniazid (0.009 M, 1.23 g) were mixed together in acetone solution (60 mL). The reaction mixture was shaken for some time to form clear solution and refluxed for 12 h. This reaction was monitored by TLC. After completion of reaction, reaction mixture was brought to the room temperature and solvent was distilled off to obtain a sticky residue. This residue was triturated by means of petroleum ether (60–80°C) to afford a pale-yellow solid product **(3)**.

3) Yield-11.1 g, m.p. 107–109°, $[\alpha]^{D3}1$ = +37 (c, 0.1 in chloroform)

IR (KBr, cm^{-1}): υ3495 (N-H stretch), 3070 (Aromatic C-H stretch), 2970 (Aliphatic C-H stretch), 1720 (C=O



(Bz =COC_6H_5, **4a/5a**: R = phenyl; **4b/5b**: R = *o*-tolyl; **4c/5c**: R = *m*-tolyl; **4d/5d**: R = *p*-tolyl; **4e/5e**: R = *o*-Cl-phenyl; **4f/5f**: R = *m*-Cl-phenyl; **4g/5g**: R = *p*-Cl-phenyl)

Scheme 1: Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino1,3,4-thiadiazolidines (5a-g)

Table 1: Physical and analytical data of compounds (5a-g)

Products	Yield (%)	M.P. (°C)	$[\alpha]_D^{31}$ (c, in$CHCl_3$)	Elemental analysis (%) found (required)	
				N	S
5a	96.30	143–145	+154.50	5.17 (5.19)	2.38 (2.37)
5b	75.91	132–133	−300	5.12 (5.14)	2.36 (2.35)
5c	75.09	124–125	+262	5.13 (5.14)	2.37 (2.35)
5d	81.75	142–143	+229	5.13 (5.14)	2.39 (2.35)
5e	92.80	121–123	+145.40	5.04 (5.06)	2.33 (2.31)
5f	87.05	136–137	+71.40	5.03 (5.06)	2.34 (2.31)
5g	81.29	121–122	−88.23	5.03 (5.06)	2.32 (2.31)

stretch), 1265 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose unit), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.75 (1H, *s*, NH), δ 8.02–7.20 (39 H, *m*, aromatic protons), δ6.15 (1H, *s*, NH), δ 5.75–3.73 (14 H, *m*, lactosyl ring protons), δ1.94 (1H, *s*, NH). Mass (m/z): (M^+) 1248, (M+1) 1249 (100%), 1053, 949, 579. Found: C: 65. 25; H: 4.37; N: 4.36; S: 2.48, $C_{68}H_{56}O_{18}N_4S$: Required C: 65.38; H: 4.49; N: 4.49; S: 2.56%.

5a) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-phenylimino-1,3,4-thiadiazolidines

The 1-carbonyl-(pyrid-4-yl)-4-hepta-*O*-benzoyl-β-D-lactosyl-3-thiosemicarbazide (0.001 M, 1.25 g) **(3)** was mixed with phenyl isocyanodichloride (0.001 M, 0.174 g) **(4a)** in acetone (30 mL). This reaction mixture was refluxed for 3. This reaction was monitored by TLC. After completion of reaction, the reaction mixture was brought to room temperature and solvent was distilled off to give a sticky residue. The sticky residue was triturated several times with petroleum ether (60–80°C) and the product was obtained as yellow solid **(5a)**.

IR (KBr, cm^{-1}): υ3425 (N-H stretch), 3062 (Aromatic C-H stretch), 2970 (Aliphatic C-H stretch), 1728 (C=O stretch), 1597 (C=N stretch), 1265 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.02–7.21 (44H, *m*, aromatic protons), 5.75 (1H, *s*, NH), δ 5.75–3.74 (14H, *m,* lactosyl ring protons). Mass (*m/z*): (M^+) 1349, 1249 (100%), 1053, 579. Found: C: 66.71; H: 4.35; N: 5.17; S: 2.38, $C_{75}H_{59}O_{18}N_5S$: Required: C: 66.72; H: 4.37; N: 5.19; S: 2.37%.

Similar method was used to prepare remaining compounds **(5b-g)**. The physical characterization data of thus obtained compounds are summarized in **Table 1: (5a-g).**

5b) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-o-tolyl imino-1,3,4-thiadiazolidines

IR (KBr, cm^{-1}): υ3433 (N-H stretch), 3062 (Aromatic C-H stretch), 2970 (Aliphatic C-H stretch), 1720 (C=O stretch), 1604 (C=N stretch), 1257 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.06–7.18 (43H, *m*, aromatic protons), δ 5.77–3.74 (14H, *m*, lactosyl ring protons) δ 5.77 (1H, *s*, NH), δ 2.56 (3H, *s*, CH_3). Mass (m/z): M^+ 1363, 1053, 579 (100%). Found: C: 66.89; H: 4.45; N: 5.12; S: 2.36, $C_{76}H_{61}O_{18}N_5S$: Required: C:66.91; H:4.48; N:5.14; S:2.35.

5c) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-m-tolyl imino-1,3,4-thiadiazolidines

IR (KBr,cm^{-1}): υ3433 (N-H stretch), 3070 (Aromatic C-H stretch), 2970 (Aliphatic C-H stretch), 1728 (C=O stretch), 1604 (C=N stretch), 1265 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.02–7.18 (43H, *m*, aromatic protons), δ 5.62 (1H, *s*, NH), δ5.77–3.88 (14H, *m*, lactosyl ring protons) δ 2.16 (3H, *s*, CH_3). Mass (m/z): (M+) 1363, 1215 (100%), 1053, 949, 579. Found: C: 66.88; H: 4.46; N: 5.13; S: 2.37, $C_{76}H_{61}O_{18}N_5S$: Required: C: 66.91; H: 4.48; N:5.14; S:2.35%.

5d) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-p-tolyl imino-1,3,4-thiadiazolidines

IR(KBr,cm^{-1}): υ3425 (N-H stretch), 3070 (Aromatic C-H stretch), 2970 (Aliphatic C-H stretch), 1720 (C=O stretch), 1604 (C=N stretch), 1265 (C-O stretch), 1172 (C-N stretch), 1095, 1064 &1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$,ppm): δ 8.00-7.12 (43H,*m*, aromatic protons), δ 6.81 (1H,*s*,NH), δ5.90-3.88 (14H,*m*, lactosyl ring protons) δ 2.34 (3H,*s*,CH_3).Mass (m/z): (M+)1363, 1053, 949, 579 (100%). Found: C: 66.89; H:4.44; N:5.13; S:2.36, $C_{76}H_{61}O_{18}N_5S$: Required: C:66.91; H:4.48; N:5.14; S:2.35%.

5e) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-o-chloro phenylimino-1,3,4-thiadiazolidines

IR (KBr, cm^{-1}): υ3433 (N-H stretch), 3062 (Aromatic C-H stretch), 2978 (Aliphatic C-H stretch), 1728 (C=O stretch), 1604 (C=N stretch), 1265 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.02–7.21 (43H,*m*, aromatic protons), δ 7.20 (1H, *s*, NH), δ 5.77–3.89 (14H, *m*, lactosyl ring protons). Mass (m/z): (M+) 1383, 1053, 949, 579 (100%). Found: C: 65.01; H: 4.17; N: 5.04; S: 2.33% $C_{75}H_{58}O_{18}N_5SCl$: Required: C: 65.05; H: 4.19; N: 5.06; S: 2.31%.

5f) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-m-chloro phenyl imino-1,3,4-thiadiazolidines

IR (KBr, cm^{-1}): υ3417 (N-H stretch), 3062 (Aromatic C-H stretch), 2970 (Aliphatic C-H stretch), 1720 (C=O stretch), 1597 (C=N stretch), 1257 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.02–7.26 (43H, *m*, aromatic protons), δ 5.74 (1H, *s*, NH), δ 5.39–3.72 (14H, *m*, lactosyl ring protons). Mass (m/z): M^+1383, (M+2) 1385, 1053, 579 (100%). Found: C: 65.04; H: 4.17; N: 5.03; S: 2.33%. $C_{75}H_{58}O_{18}N_5SCl$: Required: C: 65.05; H: 4.19; N: 5.06; S: 2.31.

5g) Synthesis of 3-carbonyl-(pyrid-4-yl)-5-hepta-O-benzoyl-β-D-lactosylimino-2-p-chloro phenylimino-1,3,4-thiadiazolidines

IR (KBr, cm^{-1}): υ3425 (N-H stretch), 3070 (Aromatic C-H stretch), 2962 (Aliphatic C-H stretch), 1720 (C=O stretch), 1604 (C=N stretch), 1265 (C-O stretch), 1172 (C-N stretch), 1095, 1064 and 1026 (characteristics of lactose), 709 (C-S stretch). ^{1}H NMR ($CDCl_3$, ppm): δ 8.02–7.19 (43H, *m*, aromatic protons), δ 6.04 (1H, *s*, NH), δ5.77–3.72 (14H, *m*, lactosyl ring protons). Mass (m/z): (M+) 1383, (M+2)

1385, 1053, 949, 579 (100%). Found: C: 65.02; H: 4.16; N: 5.03; S: 2.32 $C_{75}H_{58}O_{18}N_5SCl$: Required: C: 65.05; H: 4.19; N: 5.06; S: 2.31.

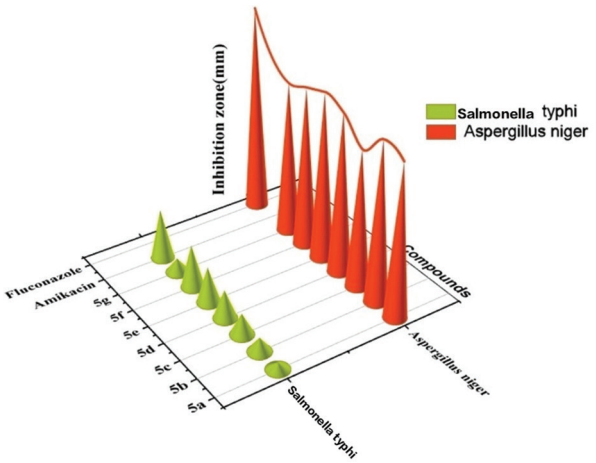
Antimicrobial Activity

All the synthesized compounds were evaluated for their minimum inhibitory activity against bacteria (*Salmonella typhi*) and fungal strain (*Aspergillus Niger*) using cup plate agar diffusion method[17-19] by measuring the inhibition zone in mm. The compounds were taken at a concentration of 1 mg/mL using dimethyl sulfoxide as a solvent. The minimum inhibition concentration of all the synthesized compounds was obtained. Similarly, study was also conducted for the reference standard amikacin for antibacterial activity and fluconazole for antifungal activity. The zone of incubation observed around the cup after incubation was measured. The results are presented in **Table 2.** The results of this preliminary screening study are also shown in the graphical method. From the data, it is clear that novel compounds 5a, 5b, 5d, 5e, 5f possess good activity, while compounds 5c possess moderate activity against bacteria (*S. typhi)* and fungi (*A. Niger*).

Table 2: Antimicrobial activities of newly synthesized 3-carbonyl-(pyrid-4-yl)-5-hepta-*O*-benzoyl-β-D-lactosylimino-2-arylimino-1,3,4-thiadiazolidines (5a-g)

Compound	Antibacterial	Antifungal
	Salmonella typhi	*Aspergillus niger*
5a	21	21
5b	19	22
5c	15	19
5d	18	22
5e	22	23
5f	20	22
5g	19	21
Amikacin	26	-
Fluconazole	-	28

**Zone of inhibition measured in mm, (15 or less) resistance, (16–20 mm) moderate and (more than 20 mm) sensitive



CONCLUSION

Novel compounds were prepared with good yields through a facile synthetic pathway, and their chemical structures were characterized by detecting their physicochemical properties and analyzing their IR, ^{1}H NMR and mass spectra. These compounds also were screened for their antimicrobial activity against bacteria (*S. typhi*) and fungi (*A. niger*) using a solution of amikacin and fluconazole as a positive control, respectively. Some of these compounds possess a high response against bacteria as well as fungi. Therefore, these novel compounds can be considered as an encouraging wide spectrum antibacterial agent and antifungal agent.

ACKNOWLEDGMENT

Authors are grateful to CIF, SPPU, Pune, for providing the spectral data and also to Dr. A. L. Kulat Principal, Shri Shivaji College of Art's Commerce and science Akola, for encouragement and providing necessary facilities.

REFERENCES

[1] Fernandez-Tejada, F., Canada, F.J. and Jimenez-Barbero, J. Recent developments in synthetic carbohydrate-based diagnostics, vaccines, and therapeutics, *Chem. Eur. J*., **2015,** *21*, 10616–10628.

[2] Serban, G., Stanasel, O., Serban, E. and Bota, S. 2-Amino-1,3,4-thiadiazole as a potential scaffold for promising antimicrobial agents, *Drug Des. Devel. Ther*., **2018,** *12*, 1545–1566.

[3] Huang, Z., Zhang, Q., Zhao, Q., Yu, W. and Chang. ???, J. *Am. Chem. Soc. Org. Lett*., **2022**, ???, ???.

[4] (a) Supuran, C.T., Briganti, F., Tilli, S., Chegwidden, W.R. and Scozzafava, A. Carbonic anhydrase inhibitors: Sulfonamides as antitumor agents?, *Bioorg. Med. Chem*., **2001,** *9*, 703−704. (b) Serban, G., Stanasel, O., Serban, E. and Bota, S. 2-Amino-1,3,4-thiadiazole as a potential scaffold for promising antimicrobial agents, *Drug Des. Devl. Ther*., **2018,** *12*, 1545−1566.

[5] (a) Chandrakantha, B., Isloor, A.M., Shetty, P., Fun, H.K. and Hegde, G. Synthesis and biological evaluation of novel substituted 1,3,4-thiadiazole and 2,6-di aryl substituted imidazo [2,1-b] [1,3,4] thiadiazole derivatives, *Eur. J. Med. Chem*., **2014,** *71*, 316−323. (b) Farghaly, T.A., Abdallah, M.A., Masaret, G.S. and Muhammad, Z.A. New and efficient approach for synthesis of novel bioactive [1,3,4] thiadiazoles incorporated with 1,3-thiazole moiety, *Eur. J. Med. Chem*., **2015**, *97*, 320−333. (c) Kumar, G.S., Poornachandra, Y., Reddy, K.R., Kumar, C.G. and Narsaiah, B. Synthesis of novel triazolothione, thiadiazole, triazole-functionalized furo/thieno[2,3-b] pyridine derivatives and their antimicrobial activity, *Synth. Commun*., **2017,** *47*, 1864−1873.

[6] (a) Alegaon, S.G., Alagawadi, K.R., Sonkusare, P.V., Chaudhary, S.M., Dadwe, D.H. and Shah, A.S. Novel imidazo[2,1-b][1,3,4]thiadiazole carrying rhodanine-3-acetic acid as potential antitubercular agents, *Bioorg. Med. Chem. Lett*., **2012,** *22*, 1917−1921. (b) Patel, H.M., Noolvi, M.N., Sethi, N.S., Gadad, A.K. and

Cameotra, S.S. Synthesis and antitubercular evaluation of imidazo[2,1-b][1,3,4]thiadiazole derivatives, *Arabian J. Chem*., **2017,** *10*, S996−S1002.

[7] (a) Andreani, A., Burnelli, S., Granaiola, M., Leoni, A., Locatelli, A., Morigi, R., Rambaldi, M., Varoli, L., Calonghi, N., Cappadone, C., Voltattorni, M., Zini, M., Stefanelli, C., Masotti, L. and Shoemaker, R.H. Antitumor activity of bis-indole derivatives (1), *J. Med. Chem*., **2008,** *51*, 7508−7513. (b) Noolvi, M.N., Patel, H.M., Singh, N., Gadad, A.K., Cameotra, S.S. and Badiger, A. Synthesis and *in vitro* antitumor activity of substituted quinazoline and quinoxaline derivatives: Search for anticancer agent, *Eur. J. Med. Chem*., **2011,** *46*, 4411−4418. (c) Yang, X.H., Xiang, L., Li, X., Zhao, T.T., Zhang, H., Zhou, W.P., Wang, X.M., Gong, H.B., Zhu, H.L. Synthesis, biological evaluation, and molecular docking studies of 1,3,4-thiadiazol-2-amide derivatives as novel anticancer agents, *Bioorg. Med. Chem*., **2012,** *20*, 2789−2795. (d) Li, Y.J., Qin, Y.J., Makawana, J.A., Wang, Y.T., Zhang, Y.Q., Zhang, Y.L., Yang, M.R., Jiang, A.Q. and Zhu, H.L. Synthesis, biological evaluation and molecular modeling of 1,3,4-thiadiazol-2-amide derivatives as novel antitubulin agents, *Bioorg. Med. Chem*., **2014,** *22*, 4312−4322. (e) Dawood, K.M. and Gomha, S.M. Synthesis and anti-cancer activity of 1, 3, 4-thiadiazole and 1, 3-thiazole derivatives having 1, 3, 4-oxadiazole moiety, *J. Heterocyclic Chem*., **2015,** *52*, 1400−1405. (f) Gomha, S.M., Abdulla, M.M. and Abou-Seri, S.M. Identification of novel aminothiazole and aminothiadiazole conjugated cyanopyridines as selective CHK1 inhibitors, *Eur. J. Med. Chem*., **2015,** *92*, 459−470.

[8] (a) Gadad, A.K., Palkar, M.B., Anand, K., Noolvi, M.N., Boreddy, T.S. and Wagwade, J. Synthesis and biological evaluation of 2-trifluoromethyl/sulfonamido-5,6-diaryl substituted imidazo[2,1-b]-1,3,4-thiadiazoles: A novel class of cyclooxygenase-2 inhibitors, *Bioorg. Med. Chem*., **2008**, *16*, 276−283. (b) Gilani, S.J., Khan, S.A. and Siddiqui, N. Synthesis and pharmacological evaluation of condensed heterocyclic 6-substituted 1,2,4-triazolo-[3,4-b]-1,3,4-thiadiazole and 1,3,4-oxadiazole derivatives of isoniazid, *Bioorg. Med. Chem. Lett*., **2010,** *20*, 4762−4765.

[9] Jubie, S., Ramesh, P.N., Dhanabal, P., Kalirajan, R., Murugananthan, N. and Antony, A.S. Synthesis, antidepressant and antimicrobial activities of some novel stearic acid analogues, *Eur. J. Med. Chem*., **2012,** *54*, 931−935.

[10] (a) Al-Omair, M.A., Sayed, A.R. and Youssef, M.M. Synthesis of novel triazoles, tetrazine, thiadiazoles and their biological activities, *Molecules*, **2015**, *20*, 2591−2610. (b) Badrey, M.G., Gomha, S.M., Arafa, W.A.A. and Abdulla, M.M. An approach to polysubstituted triazipines, thiadiazoles and thiazoles based on benzopyran moiety through the utility of versatile hydrazonoyl halides as *in vitro* monoamine oxidase inhibitors, *J. Heterocyclic Chem*., **2017**, *54*, 1215−1227.

[11] Tale, P.V. and Deshmukh, S.P. Synthesis of 2-phenylimino-3-aryl-4-S-benzyl-6-hepta-O-acetyl- β -Dlacosylimino-2,3-dihydro-1,3,5-thiadiazine hydrochlorides, *Indian J. Chem*., **2006**, *45B*, 558–560.

[12] Yadgire, A.V., Barate, D.L. and Deshmukh, S.P. Dithiazolidines: Synthesis and anti-microbial activity of some novel n-maltosides, *Rasayan J. Chem*., **2011**, *4*, 780–783.

[13] Silverstein, R.M. and Webster, F.X. S*pectrometric Identification of Organic Compounds*, 6th ed. John Wiley and Sons, Inc., New York, **2011**.

[14] Dyer, J.R. *Applications of Absorption Spectroscopy of Organic Compounds, PHI Learning Private Limited*, New Delhi, **2010.**

[15] Williams, D.H. and Fleming, L. *Spectroscopic Methods in Organic Chemistry*. 6th ed. United States: Tata McGraw-Hill Education, **2011.**

[16] Budzikiewicz, H., Djerassiand, C. and Williams, H. *Structural Elucidation of Natural products by mass Spectrometry*, Vol. 2. Holden-Day 207, San Francisco, **1964.**

[17] Kawangh, F. *Analytical Microbiology*, Academic Press, NewYork, **1963.**

[18] British Pharmacopeia-II. *Biological Assay and Tests*, The Stationary Office Ltd., London, **1998**, pA205.

[19] Kumar, V.M.M.J., Jayadevaiah, K.V., Nagaraj, T.S., Jayachandran, E., Bharathi, D.R. Sreenivasa, G.M., Synthesis, characterization and antimicrobial activity of new N-substituted-3-chloro-2-azetidinones, *Arch. Pharm. Sci. Res*., **2009,** *1*, 31–29.

Received: 31 Jan 2023; Accepted: 24 May 2023

Author Queries???
AQ1: Kindly check and confirm the heading level
AQ2: Kindly cite references 11 and 12 in the text part
AQ3: Kindly provide article title
AQ4: Kindly provide volume number and page number

ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/371249190

Powder Microscopy, Fluorescence, Qualitative Phytochemistry, and GC-MS analysis of a Neglected Ethnomedicinal Weed -Ruellia brittoniana Leonard

Article · May 2023

DOI: 10.36348/sjls.2023.v08i05.004

CITATIONS
0

READS
162

2 authors, including:



Dipak Koche
Shri Shivaji College of Arts, Commerce and Science
51 PUBLICATIONS **443** CITATIONS

SEE PROFILE

All content following this page was uploaded by Dipak Koche on 02 June 2023.

The user has requested enhancement of the downloaded file.

OPEN ACCESS

Haya: The Saudi Journal of Life Sciences
Abbreviated Key Title: Haya Saudi J Life Sci
ISSN 2415-623X (Print) | ISSN 2415-6221 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Powder Microscopy, Fluorescence, Qualitative Phytochemistry, and GC- MS analysis of a Neglected Ethnomedicinal Weed - *Ruellia brittoniana* Leonard

Tripty Jagtap, Dipak Koche[1*]

[1]Department of Botany, Shri Shivaji College of Arts, Commerce and Science, Akola (MS) India 444003

DOI: 10.36348/sjls.2023.v08i05.004 | **Received:** 15.04.2023 | **Accepted:** 22.05.2023 | **Published:** 31.05.2023

***Corresponding author:** Dipak Koche
Department of Botany, Shri Shivaji College of Arts, Commerce and Science, Akola (MS) India 444003

Abstract

Ruellia brittoniana is a common wild ethnomedicinal plant belonging to the Acanthaceae family. The plant was claimed ethnically wound-healing properties, use as an antidote against snake bites and to cure bone fractures. However, these claims are not been validated. The present study deals with powder microscopy, fluorescence, and qualitative phytochemical analysis of the leaves, stem, and root of this plant. The powdered microscopy showed the presence of both types of trichomes and spiral elements. The Fluorescence analysis under visible and ultra-violet light for leaves, stems and root powder treated with various chemical reagents revealed different patterns of fluorescence effect. The qualitative phytochemical study showed that the plant is rich in phytochemicals and possesses significant levels of Glycosides, alkaloids, flavonoids, terpenoids, steroids, and saponins. The availability of these groups of Phyto- components indicates that the plant could prove an alternative remedy to cure asthma, fever, bronchitis, high blood pressure, eczema, and diabetes. Further, the GC-MS analysis revealed the 10 phytochemical compounds have significant medicinal potential. The major objective of this study is to endorse this plant as a step toward commercial drug developments after confirming and standardizing its microscopic features and fluorescence behavior to identify adulteration in market-available crude drug powder and screening for possible drug molecules.

Keywords: *Ruellia brittoniana*, powder microscopy, fluorescence, phytochemistry, GC-MS.

Copyright © 2023 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

Since civilization, humans are using plants and plant products for their various needs including routine healthcare. As plants possess healing properties, they are being used as traditional medicinal plants across the globe, especially by different tribes. Now, it's a known fact that the properties of medicinal plants are due to their active secondary metabolites. The actual herbal era started after isolating active compounds like digitoxin, quinine, cocaine, and codeine from different medicinal plants (Wachtel-Galor *et al*, 2011).

The genus *Ruellia brittoniana* Leonard belongs to the family Acanthaceae (Acanthus family). It is native to Mexico (Mexican petunia), The Caribbean, and South America. Later in the early 20th Century it was introduced in various European and Asian countries and become invasive. It is an evergreen perennial plant (Elgindi *et al*, 2015). The plant growing in its actual habitat and its morphological details are given in fig. 1A, B & C. The present study is focused on powder microscopy, fluorescence, and qualitative phytochemical analysis of the plant *Ruellia brittoniana* and GC-MS analysis of its ethanolic leaf extract.



Figure 1: A) Photographs from the natural habitat of *Ruellia brittoniana* B) & C) Photographs showing flowers and pods of *Ruellia brittoniana* respectively

MATERIAL AND METHODS

The plant was collected from various places in the Western Vidarbha region and identified using the flora of Marathwada (Naik, 1998) and the flora of Maharashtra (Singh and Karthikeyan, 2000). The collected plants after identification, were dried under shade for about 7- 10 days and then ground into fine powdered with the help of a blender.

Powder Microscopy

The powdered material of leaves, stem, and root of *Ruellia brittoniana* was soaked in 20% Nitric acid overnight. The sample is washed with distilled water the following day. Slides are prepared by staining the soaked spice powders with safranin and observed under the microscope, and the images were captured (Carl Zeiss Binocular Research Microscope, PRIMOSTAR). The powdered microscopy was done as per Kokate *et al*, (2004); (API, 2007), and Hole *et al*, (2008).

Fluorescence Analysis

The coarsely powdered samples of leaves, stem & root (1 g each) were treated separately with different reagents (5ml each) such as acids and alkaline solutions along with other solvents inside clean test tubes and shaken well and allowed to stand overnight. The individual solutions were observed under visible light and UV light for their characteristic color and compared with a standard color chart (Shirsat and Suradkar, 2017; Jasutkar *et al*, 2018) and all the observations were taken as per Aeri *et al*, (2020).

Qualitative Phytochemical Analysis

For qualitative phytochemical analysis, standard protocols were followed (Harborne, 1998; Krishnaiah *et al*, 2009; Koche *et al*, 2010). The reagents and chemicals used were of SD Fine and QualiChem make.

GC- MS analysis

The GC-MS analysis of these extracts was availed from SAIF, CDRI, Lucknow that performed with GC Clarus 500 Perkin Elmer system and GC interfaced to an MS equipped with an Elite-1 fused silica capillary column (30 mm × 0.25 mm 1D × 1 µm of the capillary column, composed of 100% Dimethylpolysiloxane). For GC-MS detection, an electron ionization system with ionizing energy of 70 eV was used. Helium gas (99.99%) was used as the carrier gas at a constant flow rate of 1 ml/min and an injection volume of 2 µl was employed (Split ratio of 10:1); Injector temperature 250°C; ion-source temperature 280°C.

The oven temperature was programmed from 110°C (isothermal for 2 minutes) with an increase of 10°C/minute to 200°C, then 5°C/minute to 280°C, ending with 9 minutes isothermal at 280°C. Mass spectra were taken at 70 eV, a scanning interval of 0.5 seconds, and fragments from 45 to 450 kDa. The total GC running time was 36 minutes. The plant extract was dissolved in ethanol and filtered with a polymeric solid phase extraction column and analysed in GC-MS for different components. The relative percentage amount of each component was calculated by comparing its average peak area to the total areas, software adopted to handle mass spectra, and chromatograms were a turbo mass. Interpretation of the mass spectrum of GC-MS was done using the database of the National Institute of Standards and Technology (NIST).

RESULT AND DISCUSSION

The detailed observations on powder microscopy, fluorescent analysis, qualitative phytochemical analysis, and GC-MS analysis of methanolic extracts of *Ruellia brittoniana* are presented in the following paragraphs.

Powder Microscopy

Leaves: The powder is fine and moss green in color without any taste or odor. It showed the presence of epidermal cells with stomata, unicellular as well as multicellular trichomes, thick fiber walls, parenchymatous cells, and chlorophyll tissues. The powder also showed the presence of many square and prismatic crystals of calcium oxalate shown in Fig. 2 A, C, D and E.

Stem: The powder of the stem is yellowish-green in color without any odor or taste. It showed the presence of multicellular uniseriate trichomes, a group of parenchymatous cells, conducting elements, tissue fibers and vascular tissues with vessels of fibers, fragmented fibers, fragments of vessel elements bearing spiral pitted thickening shown in Fig. 2 A, E, G, and H.

Root: The powder of root is fine and greyish brown or rusty brown in color without any taste or odor. It showed spiral vessel elements, vascular tissues, fragmented fibers, parenchymatous cells, epidermal cells, irregular brown cork cells, aseptate fibers with tapering ends, and broken aggregated calcium oxalate crystals. Root hairs, mesocarp cells, etc. shown in fig. 2. A, B, F, and G.

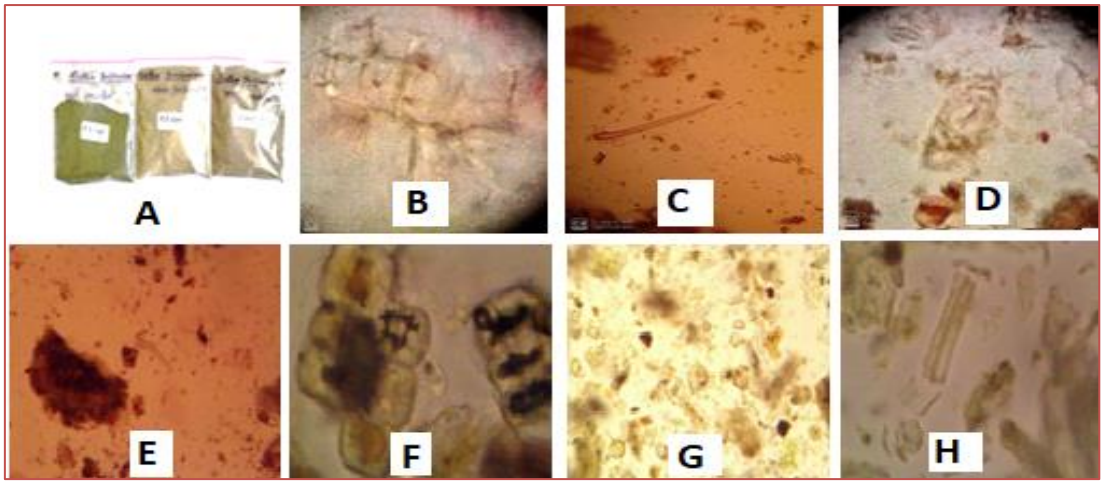


Figure 2: Images of powder microscopy

A) Power of leaf, stem & root of *Ruellia brittoniana* B) Epidermal cells C) Unicellular trichome D) Stomata E) Multicellular trichome F) Vascular tissue G) Calcium oxalate crystals H) Conducting elements.

Fluorescence Analysis

The powdered material of shade-dried leaves, stem, and root of *Ruellia brittoniana* was analyzed for its physical properties, especially its coloration; untreated as control and after the addition of various routine laboratory chemicals under visible light as well as UV light. The results showed that there is a drastic color change when the reaction mixture was exposed to both visible light and UV light. It is an important criterion to decide the authenticity of the market available crude powdered drugs of traditional medicinal plants. The fluorescence characters of leaf, stem, and root powders of *R. brittoniana* are noted in Table 1, Table 2, and Table 3. It was noted that with the same reagent, the powder sample showed different coloration in visible and UV- light. Also with different reagents, different colorations were seen (Fig. 3. A, B, C, D, E, F). This might be the marker test for the authenticity of the crude powder drug of the plant.

Table 1: Fluorescence Analysis of *R. brittoniana* Leaf Powder

Sr. No.	Chemicals	Visible light	UV light
1.	H_2SO4	Black	Black
2.	50% H_2SO4	Black	Black
3.	HNO_3	Yellow	Moss Green
4.	50% HNO_3	Orange Yellow	Blackish Green
5.	1N HCL	Greyish Brown	Grey
6.	Acetic Acid	Blackish Green	Pinkish
7.	1N NaOH	Brown	Dark brown
8.	1N NaOH+ Methanol	Green	Pinkish
9.	50% KOH	Brown	Blackish
10.	Ammonia	Yellowish	Rusty Green
11	Chloroform	Leafy Green	Pink tinge

Table 2: Fluorescence Analysis of *R. brittoniana* Stem Powder

Sr. No	Chemicals	Visible light	UV light
1.	H_2SO4	Black	Black
2.	50% H_2SO4	Black	Black
3.	HNO_3	Yellow	Moss Green
4.	50% HNO_3	Light Green	Moss Green
5.	1N HCL	Brownish	Pinkish tinge
6.	Acetic Acid	Greyish Yellow	Colourless
7.	1N NaOH	Orange Brown	Brown
8.	1N NaOH+ Methanol	Yellowish Brown	Brownish Green
9.	50% KOH	Orange Brown	Blackish Green
10.	Ammonia	Brownish	Moss Green
11	Chloroform	Colourless	Pinkish

Table 3: Fluorescence Analysis of *R. brittoniana* Root Powder

Sr. No	Chemicals	Visible light	UV light
1.	H_2SO4	Black	Black
2.	50% H_2SO4	Black	Black
3.	HNO_3	Yellow	Moss Green
4.	50% HNO_3	Light Green	Moss Green
5.	1N HCL	Light Brownish	Greyish Pink
6.	Acetic Acid	Brownish	Pinkish
7.	1N NaOH	Orange Brown	Brownish Green
8.	1N NaOH+ Methanol	Orange Brown	Moss Green
9.	50% KOH	Orange Brown	Blackish Brown
10.	Ammonia	Brown	Black
11	Chloroform	Colourless	Colourless

There are few reports on powder microscopy of some medicinal plants like that *Ocimum gratissimum* (Gupta *et al,* 2011); *Hilleria latifolia* (Amponsah *et al,* 2014); *Vitex negundo* (Bharathi *et al,* 2017) and *Colebrookea oppositifolia* (Shirsat and Suradkar, 2017) indicating the importance of work to authenticate the market available crude drug. Our work is an addition to the standardization of powdered drug material.

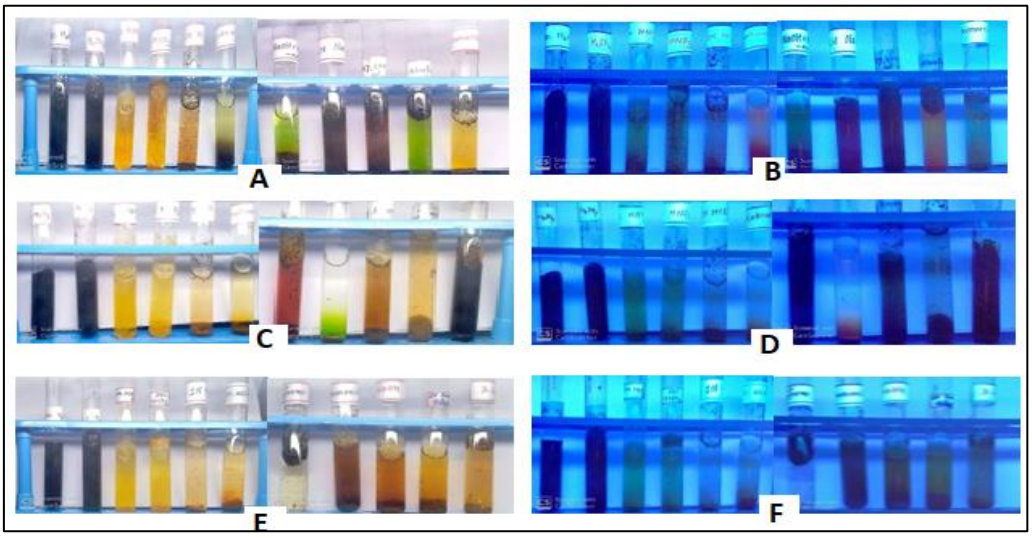


Figure 3: Images showing fluorescence colors

A) & B) Leaf of *R. brittoniana* fluorescence at visible and UV light respectively,
C) & D) Stem of *R. brittoniana* fluorescence at visible and UV light respectively,
E) & F) Root of *R. brittoniana* fluorescence at visible and UV light respectively.

Qualitative Phytochemical Analysis

The qualitative phytochemical analysis of *Ruellia brittoniana* leaf, stem, and root extract showed that it is rich in phytoconstituents. The qualitative tests were done in three solvents i.e., methanol, acetone, and petroleum ether. Methanol was observed to be more useful the for extraction of phytochemicals than the rest of the solvents. The methanol extract showed the presence of alkaloids, glycosides, carbohydrates, flavonoids, phenolics, tannins, terpenes, steroids, reducing sugar, and saponins. (Table-4). In Acetone extract carbohydrates, terpenes, steroids, and, reducing sugar were absent. While petroleum ether extract showed positive tests for alkaloids, carbohydrates, terpenes, steroids, reducing sugar saponins, and flavonoids, phenolics, were absent (Table-4). Further, the qualitative tests for most of the phytochemicals are found positive in roots powder followed by leaf powder and stem powder respectively. The tests for alkaloids, glycosides, saponins, reducing sugar and carbohydrates are positive in all powder samples. Phenolics, flavonoids, steroids, and terpenes are found absent in acetone and petroleum ether extracts of leaves, stem, and root powder of *R. brittoniana*. The results of the qualitative analysis of powder material are presented in table-4 and Fig. 4 A, B & C.

Phytochemicals are the biologically active compounds having medicinal properties. The qualitative phytochemistry of plants indicates the basic bioactive compounds present in that plants. Earlier, several workers had presented the phytochemical analysis of different medicinal plants. Gupta *et al,* (2013) revealed a qualitative phytochemical analysis of four different

medicinal plants. Angidew *et al*, (2022) reported a phytochemical analysis of some medicinal plants from Ethiopia. Ashwathi Shrinivasan & Angayarkanni (2023) reported qualitative phytochemicals from 17 different therapeutically important plants from diverse habitats. Qualitative phytochemical analysis of any plant gives an insight into the phytoconstituents present in that plant and possible medicinal properties possessed by the plant. It is an essential step in the phytochemical analysis of any given plant.



Figure 4: Qualitative phytochemical tests of *R. brittoniana* powder material
A. in methanolic extract, B. in acetone extract & C. in petroleum ether extract

Table 4: Qualitative Phytochemical Analysis of *Ruellia brittoniana* Leaf, stem, and root extract

Plant species	**Solvents or Extracts**	**Test for phytoconstituents**										
		Alkaloids	Glycosides	Phenolics	Flavonoids	Tannins	Terpenes	Steroids	Saponins	Red. Sugar	Carbohydrates	Proteins
Ruellia brittoniana Leaf	Me	+	+	+	+	+	+	+	+	+	+	-
	Ac	+	+	+	+	+	-	-	+	+	+	+
	PE	+	+	-	-	-	+	+	+	+	+	+
Ruellia brittonia na Stem	Me	+	+	+	+	+	+	+	+	+	+	-
	Ac	+	+	+	+	-	-	-	+	+	+	-
	PE	+	+	-	-	-	-	-	+	+	+	-
Ruellia brittonia na Root	Me	+	+	+	+	+	+	+	+	+	+	-
	Ac	+	+	+	+	+	+	+	+	+	+	-
	PE	+	+	-	-	-	-	-	+	+	+	-

NOTE: Me= Methanol extract; Ac= Acetone extract; PE = Petroleum ether extract

GC- MS analysis

The major compounds identified include- 3,7,11,15-tetramethyl-2-hexadecen-1-ol (28.75%) as the major component followed by α-sitosterol (15.35%), 9,12-octadecodienoic acid (10.27%), 1,1,3-triethoxy Propane, (8.21%), phytol (8.15%), α-amyrin (6.15%), squalene (5.75%), γ-tocopherol (3.85%), 9,12,15-octadecatrienal (2.39%), 1,2-benzene dicarboxylic acid di-heptyl ester (1.75%). Kartika et al., (2016) presented a similar GC- MS analysis in *Ruellia patula* from the South of India. Konappa *et al*, (2020) reported the GC- MS analysis of *Ammomum* species

with various phytochemicals. A similar report of GC MS analysis of Hibiscus asper was made by Olivia *et al*, (2021). This indicates that to identify the active compounds in plants, GC- MS plays a vital role. Our report is similar and made a significant contribution in identifying phytochemical compounds from *R. brittoniana*. This also helps to know the putative therapeutic potential of the identified phytochemicals and thereby the their source plant.

Table 5: GC- MS analysis of methanol extract of *R. brittoniana* leaves

Sr. No.	RT	Peak Area	MW	Molecular Formula	Compound identified
1	2.87	8.25	176	$C_9H_{20}O_3$	1,1-3 tri ethoxy propane
2	11.70	28.75	296	$C_{20}H_{40}O$	3,7,11,15- tetra-methoxy- 2hexadecen-l-ol
3	13.17	1.75	362	$C_{22}H_{34}O_4$	1-2 benzine-dicarboxylic acid di-heptyl ester
4	15.03	8.15	296	$C_{20}H_{40}O$	Phytol
5	15.84	2.45	262	$C_{18}H_{30}O$	9,12,15-Octadecatrienal
6	24.84	5.75	410	$C_{30}H_{50}$	Squalene
7	28.01	3.85	416	$C_{28}H_{48}O_2$	γ-tocopherol
8	31.45	10.45	370	$C_{25}H_{38}O_2$	9,12-Octadecodienoic acid
9	32.65	15.35	414	$C_{29}H_{50}O$	α-Sitosterol
10	33.56	6.15	426	$C_{30}H_{50}O$	α-Amyrin

CONCLUSION

The structure of *Ruellia brittoniana* powder is fine without any smell or odor. It has a unique color and microscopic characters with both simple and glandular trichomes, stomata, chlorophyll tissue, parenchymatous cells, calcium oxalate crystals, vascular elements, and epidermal cells. The fluorescent analysis of powder was unique and could be used as a marker to note the adulteration in market-available crude drug powder. The present study reveals that the plant *Ruellia brittoniana* is rich in phytochemical constituents especially alkaloids, glycosides, saponins, and carbohydrates, reducing sugar in all three solvents i.e., methanol, acetone, and petroleum ether. Except for petroleum ether; phenolics, flavonoids, terpenes, and tannins are found in the rest of the two extracts and proteins are absent in almost all the extracts. The availability of these groups of phyto-components indicates that the plant could prove an alternative remedy to cure asthma, fever, bronchitis, high blood pressure, eczema, and diabetes. The GC MS analysis helped to identify 10 phyto-compounds which are known to have antioxidant, anticancer, anti-inflammatory, anti-coronary, and anti-hepatic properties. Further, the pharmacological investigation is essential to confirm the medicinal potential of plant powder and its identified phyto -components.

ACKNOWLEDGMENT

The authors are grateful to SARATHI, Govt. of Maharashtra for financial support and Principal Shri Shivaji College of Arts, Commerce and Science for providing all the instrumental facilities through CIC.

REFERENCES

- Aeri, V., Anantha Nayarana, D. B., & Singh, D. (2020). Microscopic identifying features of barks and leaves. In, *Powdered Crude Drug Microscopy of Leaves and Barks* (Eds. Aeri et al). Elsevier Publication.
- Agidew, M. G. (2022). Phytochemical analysis of some selected traditional medicinal plants in Ethiopia. Bulletin of National Research Center, 46, 87 (2022).
- Amponsah, I. K., Mnsah, A. Y., Otto, A., & Jato, J. (2014). Pharmacognostic standardisation of *Hilleria latifolia* (Lam.) H. Walt. (Phytolaccaceae). *Asian Pacific Journal of Tropical Biomedicine*, *4*(12), 941-946.
- API **(**2007). Microscopic methods of examining crude vegetable drugs, formulations, Edition1, Part 2, Vol 1. *Ministry of Health and Family Welfare*, New Delhi, 136.
- Ashwathi Shrinivasan, C, V., & Angayarkanni, D. T. (2023). Qualitative Phytochemical Analysis of Medicinal Plants Selected from Temperate, Tropical and Hill Regions. *International Journal of Pharmaceutical and Bio-Medical Science*, *3*(1), 11–17.
- Bharathi, V., Meghashree, B. M., Shantha, T. R., Rama Rao, V., Siddhamalayya, N., & Bhat, S. (2017). Phytochemical analysis and powder microscopy of flowers of Vitex negundo L. Verbenaceae. *World Journal of Pharmacy and Pharmaceutical Science*, *6*(4), 1852-1862.
- Elgindi, E. R., Haggag, E. G., & Mohamed, S. E. (2015). Phytochemical and biological studies of *Ruellia brittoniana*. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *6*(2), 926-933.
- Gupta, M., Thakur, S., Sharma, A., & Gupta, S. (2013). Qualitative and Quantitative analysis of phytochemicals and pharmacological value of some dye yielding medicinal plants. *Oriental Journal of Chemistry*, *29*(2), 475-481.

- Harborne, J. B. (1998). Phytochemical Methods: A guide to modern techniques of plant analysis. Edition: 3, Springer. Germany.
- Hole, A. D., Dhanorkar, Y. M., Gurav, A. M., Dhar, B. P., & Lavekar, G. S. (2008). Powder microscopy and phytochemical studies of ayurvedic single drug - apamarga (*Achyranthus aspera* linn.). *Journal of Drug Research in Ayurvedic Sciences*, XXIX (3-4), 61-72.
- Jasutkar, J. M., Shirsat, R. P., & Koche, D. K. (2018). Pharmacognostic Study, Chemical Analysis and Antioxidant Potential of *Leucas indica* L. (R. Br.). *Journal of Herbal Drugs, 9* (1), 1- 5.
- Karthika, C., Yogeshwari, G., Muruganantham, K., & Manivannan, S. (2016). Phytochemical analysis of *Ruellia patula* using Gas Chromatography-Mass Spectrometry. *Asian J. Pharmaceutical and Clinical Research, 9*(2), 211- 213.
- Koche, D. K., Shirsat, R. P., Imran, S., & Bhadange, D. G. (2010). Phytochemical screening of eight folk medicinal plants from Akola District (MS) India. *International Journal Pharma and Bioscience, 1*(4), 256-261.
- Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2004). *Practical Pharmacognosy*, 2nd edition. Vallabh Prakashan, New Delhi 466-470.
- Konappa, N., Udayashankar, A. C., & Krishnamurthy, S. (2020). GC–MS analysis of phytoconstituents from *Amomum nilgiricum* and molecular docking interactions of bioactive serverogenin acetate with target proteins. *Scientific Reports, 10*, 16438 (2020).
- Krishanaiah, D., Devi, T., Bano, A. & Sarbatly, R. (2009). Studies on phytochemical constituents of six Malaysian medicinal plants. *African Journal of Medicinal Plant Research, 3*(2), 67-72.
- Naik, V. N. (1998). Flora of Marathwada, Amrut Prakashan, Aurangabad (MS).
- Olivia, N. U., Goodness, U. C. & Obinna, O.M. (2021). Phytochemical profiling and GC-MS analysis of aqueous methanol fraction of *Hibiscus asper* leaves. *Future Journal of Pharmaceutical Science, 7*, 59 (2021).
- Shirsat, R. P., & Suradkar, S. S (2017). Macroscopic, phytochemical and fluorescent analysis of Colebrookeaoppositifolia smith. *International Journal of Applied Research. Special Issue*, 288-89.
- Singh, N. P., & Karthikeyan, S. (Eds.). 2000. *Flora of Maharashtra State.* Vol. 1. Botanical Survey of India, Calcutta.
- Wachtel-Galor, S., & Benzie, I. F. F. (2011). *Herbal Medicine: An Introduction to Its History, Usage, Regulation, Current Trends, and Research Needs*. In: Benzie IFF, Wachtel-Galor S, editors. Herbal Medicine: Biomolecular and Clinical Aspects. 2nd ed. Boca Raton (FL): CRC Press/Taylor & Francis; 2011. Chapter 1. PMID: 22593939.

View publication stats

ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/371033080

Current Scenario of Wild Edible Plants (WEPs), their Importance, Possible Threats, and Conservation: A Mini Review

Article *in* Journal of Agriculture and Ecology Research International · May 2023

DOI: 10.9734/jaeri/2023/v24i5538

CITATIONS
0

READS
196

5 authors, including:



R. Shirsat
Shri Dr R. G. Rathod Arts and Science college Murtizapur Dist-Akola
23 PUBLICATIONS **356** CITATIONS
SEE PROFILE



Dipak Koche
Shri Shivaji College of Arts, Commerce and Science
51 PUBLICATIONS **443** CITATIONS
SEE PROFILE

All content following this page was uploaded by Dipak Koche on 02 June 2023.

The user has requested enhancement of the downloaded file.



Journal of Agriculture and Ecology Research International

Volume 24, Issue 5, Page 18-27, 2023; Article no.JAERI.100019
ISSN: 2394-1073

Current Scenario of Wild Edible Plants (WEPs), their Importance, Possible Threats, and Conservation: A Mini Review

Rupali Shirsat [a], Tripty Jagtap [b], Ashwini Sirsat [b], Shubham Rathod [b] and Dipak Koche [b*]

[a] Department of Botany, Shri Dr. R. G. Rathod College of Arts and Science, Murtizapur, District- Akola, M.S.-444107, India.
[b] Department of Botany, Shri Shivaji College of Arts, Commerce and Science, Akola, District- Akola, M.S.-444003, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author DK conceptualize the review, RS prepare a primary manuscript. Authors AS, TJ and SR improvise the manuscript section-wise and all authors finalized the review. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2023/v24i5538

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/100019

Mini-review Article

Received: 11/03/2023
Accepted: 15/05/2023
Published: 24/05/2023

ABSTRACT

The knowledge of Wild Edible Plants (WEPs) is as old as human civilization and still, they are playing a supplementary role in global food security. WEPs are an integral part of their traditional food systems and have nutritional and cultural values in their routine livelihood. WEPs are increasingly considered a potential source of a naturally healthy diet. But in many cases, the available WEPs resources are under threat of various kinds like overexploitation, overgrazing, forest fires, agricultural encroachment, etc.; the changing climate also negatively impacts on WEPs. Therefore, there is an urgent need for the conservation of the diversity of WEPs and their

**Corresponding author: E-mail: kochedeepak77@gmail.com;*

sustainable management. The present mini-review is an attempt to present the current scenario of WEPs, their importance, and a potential source of nutrients for future food security, ethnic knowledge associated with them, threats encountered by WEPs, and their possible sustainable management scheme.

Keywords: Traditional food system; food security; sustainable management; ethnic knowledge.

1. INTRODUCTION

Since early civilization, humans use to consume wild edible plants (WEPs) which later became an integral part of their routine food. During their early evolutionary period, humans use to obtain their food by gathering eatable items from plants or plant parts (like roots, stems, leaves, flowers, seeds, etc.) and hunting animals. When the humans started settling by making huts and shades, they also started the domestication of some plants and animals [1]. Still, such types of traditions could be observed in different tribal communities across the globe [2].

It is now a clear fact that all the cultivated crop plants of today's era were ones known as wild edible plants (WEPs). After thousands of years of regular practice of cultivation by humans following the strategy of selecting more favorable traits of plants, some of them have reached the status of domesticated crop plants. With the emergence of domesticated crops, another term 'weed' comes into the picture. Weeds are the undesired plants growing along with crop plants. It was noted that most of the weed species are found to be the relatives of domesticated crop plants.

As per literature, the term "Wild", commonly indicates those species that grow spontaneously in self-sustaining populations outside cultivated areas, along the field margins, hedges, grasslands, and forest woodlands [3]. However, the distinction between "wild" and "domesticated" or "cultivated" is not so clear, and many WFPs fall somewhere in between these extremes depending on the degree of human intervention [4]. There are several plant species that are not domesticated to that extent but play prominent roles as good sources of food and nutrition by various local as well as tribal communities globally. There are a few examples that farmers use to grow a few wild species to meet their food and nutrition needs [5,6]. Under the WEPs, various communities across the globe consume leaves, flowers, fruits, nuts, legumes, pods, fruiting bodies of mushrooms, and other non-timber forest products [7].

The knowledge of WEPs is as old as human civilization and still, they are playing a supplementary role in global food security. But in many cases, the available WEPs resources are under threat of various kinds like overexploitation, overgrazing, forest fires, agricultural encroachment etc. Recent studies suggest that there are more than 7000 wild edible plant species that are being used for their multiple uses as food, nutrition, medicine, or environmental cause [8] and about 11% of them are under the threatened category of IUCN.

In this review, the authors tried to explain the term wild edible plants (WEPs) considering all possible dimensions [9] and elaborate on their importance to human beings and will also focus on the possible threats.

2. MATERIALS AND METHODS

For the present work, all the work related to wild edible plants (WEPs), their food values and nutrition, traditional knowledge associated with WEPs, and probable threats to the existing biodiversity of WEPs was collected from different online and offline journals included in various reputed databases like Scopus, WOS, Springer, Elsevier, etc. Later, the collected resource material was analyzed and interpreted critically and thematically presented in this mini-review. The related articles published in different databases were selected on the basis of their titles, abstracts, and text focusing on the reasons to include the reference in the present article and later screened by reading the full text and removing the references or part of it which do not meet the criteria of inclusion.

3. RESULTS AND DISCUSSION

3.1 The Importance of WEPs as a Source of Food and Nutrition

Since ancient days, wild edible plants (WEPs) continue to play a vital role as the principal provider of food and nutrition to sizable human populations particularly under the scarcity and

unavailability of main food crops. Further, many tribals and poor villagers residing in the vicinity of the forest depend on WEPs for their food, nutrition, and medicine [8–13].

The studies on various indigenous communities confirm the fact that wild edible plants (WEPs) are an integral part of their traditional food systems and have nutritional and cultural values in their routine livelihood [14]. Indigenous community peoples about 5% of the global population, are deeply connected to their land. Today these indigenous peoples are considered the sole custodians of rich and diverse traditional knowledge about how to use different plants, traditional food systems, and local biodiversity within the ecosystem range [15].

Indigenous communities also have a better ecological understanding of local environments and thus they could use the available food resources as per their requirement [16]. However, it was noted that the caloric contribution of WEPs is a little low compared to conventional staple foods [17]. But, these wild species contribute to diet diversification in many geographical regions which usually have different types of monotonous food systems, unique to that region [18-19].

The foods obtained from wild edible plants and plant parts usually contain a significant amount of mineral nutrients (Calcium, copper, iron, manganese, potash, sulfur, zinc, etc.) and different vitamins [17] required to support proper growth and development. These wild edible plants are otherwise neglected biological resources as the work in this field is comparatively less, but available reports indicate that these contain a significant amount of nutrients compared to available regional commercial crops [20,21]. If the nutritional potential of wild edible plants is properly assessed and managed, could be introduced as one of the main-stream foods; it might be a step towards food and nutrition security with nutrient adequacy. WEPs are increasingly considered a potential source of natural health products, therefore it is necessary to foster biochemical research on them and document their nutritional properties and main bioactive products [22,23].

If managed properly, Wild edible plants (WEPs) could also boost to empower the local market in turn local communities as it will reduce the distance between the producers and consumers. Further, it will also reduce the complete reliance of the local market on the global market. Some major pieces of evidence indicate that the local trade and markets where the local minor crops, traditional varieties, and wild edible plants are traded, have the potential to empower communities and increase livelihoods in rural areas, particularly of women and youth [24-26].

The current global crisis of the Covid-19 pandemic reveals the importance of local markets and locally available wild edible plants as most of the global food systems and supply chains were affected adversely due to pandemic lockdowns [27-29]. Several workers reported that such a situation opens up opportunities for a new type of food system that supports the local traditional market [30,31]. If such situations create food shortages, peoples turn towards traditional foods and wild edible plants as an important available source of minerals and vitamins, and herbal ingredients [7-8,32,33].

3.2 Traditional Knowledge Associated with WEPs

If we knew and understand the nutritional importance of WEPs and the traditional knowledge associated with them, it might be useful that assist in the prioritization process. The availability of nutrient content and health-promoting properties of WEPs could help in developing local guidelines in different geographical patches. The collection of nutritional data from earlier references is daunting work [34]. The documentation and protection of traditional knowledge related to consumption and recipe preparation of WFPs are available largely to the local users, i.e., rural, indigenous, and forest-dependent communities, including local farmers and elder peoples. The national floras, herbaria, and ethnological studies of local ethnic groups also provide additional botanical, culinary, nutritional, and cultural information needed for research requirements to fill this knowledge gap.

Biological knowledge of individual species is also frequently lacking but particularly essential for conservation. One of the most recent and comprehensive attempts to fill the evidence gap in food composition data is provided by the GEF-supported Biodiversity for Food and Nutrition Project (BFN). Led by Brazil, Kenya, Sri Lanka, and Turkey, and implemented by Biodiversity International with support from the UN Environment Programme (UNEP) and the Food and Agriculture Organization of the United

Nations (FAO), the project has generated food composition data for 185 plant species, many of them wild, particularly in Brazil and Turkey [34,35]. Considering the significance and role of WEPs, they are considered as food for the future [36].

In a case study of Central India, authors have demonstrated that WEPs supplements significantly higher quantities of nutrients in the core zone compared to other zones. These are currently underutilized especially in buffer and transition zones and complement the local staple foods and partially supplement the essential macro- and micro-nutrients [7]. However, most of these WEPs have the potential to fulfill dietary needs and ensure balanced nutrition. Peduruhewa et. al. explained the potential of underutilized WEPs to cope with malnutrition and food insecurity, which are burning issues that need immediate attention [36]. About 71 wild edible plants (WEPs) belonging to 57 genera and 27 families from the semi-arid zone of Punjab, Pakistan were reported by Waheed et al. [35]. They further stated that most of these WEPs are also being used as ethnomedicinal plants for long and as seasonal wild vegetables that have high amounts of nutrition.

3.3 Threats to Wild Edible Plants (WEPs)

The researchers in recent past indicate that Wild edible plants (WEPs) are an integral part of local biodiversity and play a vital role in food security at the local level. Despite its importance, it was found that the diversity of WEPs is declining rapidly. To combat this issue, in 2019, the Food and Agricultural Organization (FAO) constituted “The State of World Biodiversity for Food and Agriculture (SOWBFA), an independent body to take care of and assess the diversity of food and agriculture [37].

According to the reports of FAO [37] and Royal Botanical Garden [38] changes in land use and management like conversion of forest-covered land area to agriculture, for industry and infrastructure development, habitat destruction due to grazing, forest fires, and overharvesting of forest products are some of the major causes of depletion in plant diversity including WEPs. These reasons account for about 62% of threats to WEPs which are growing beyond the range of protected forests [7]. Some workers also reported a decline in the abundance and diversity of WEPs from different areas [39,40]. Many WEPs found to grow in agricultural lands as weeds, in hedges, as wild trees in agroforestry systems, and in some small forest patches [17]. The change in agricultural practices, including intensification, use of more pesticides, and removal of existing flora can negatively impact the existence of these biological resources [41,42].

The SOWBFA used the Sampled Red List Index for Plants prepared by the International Union for Conservation on Nature (IUCN) [41]. Under this project, a total of 822 WEPs species were considered across 7 different classes of which 73% are currently at low risk of extinction but some classes are highly threatened in the wild. However, the IUCN Red List Index for Plants includes global conservation assessments for only one-third (31%) of known WFPs. Furthermore, International Center for Tropical Agriculture (CIAT) as part of a larger study to identify conservation gaps for useful plants, an assessment of the comprehensiveness of conservation of 1587 WFP taxa was carried that showed only 3.3% of WFPs are sufficiently conserved ex-situ, while 89.1% require urgent off-site conservation measures [42]. Of the WFP taxa analyzed 42.1% are sufficiently conserved, 46.7% deserve medium priority and 11.1% require stepping up conservation measures [42]. Rapidly increasing temperatures and habitat destruction can alter the species’ geographic distribution, driving them across the artificially designated boundaries of many protected areas in pursuit of favorable growing conditions.

3.4 Priorities and Integrated Approach for Conservation of WEPs

The conservation and sustainable management strategies of WFPs must include close collaboration with indigenous and local communities and tribes who are the main users and custodians of WEPs local diversity. It must have participatory research approaches that integrate traditional and scientific knowledge about WEPs; it will be most appropriate to maximize benefits for those communities or community peoples who are involved in the process. Before starting such work, the local community people should be made aware and they should agree on every aspect of the research process including methodology, analysis, and purpose of research or data collection [43].

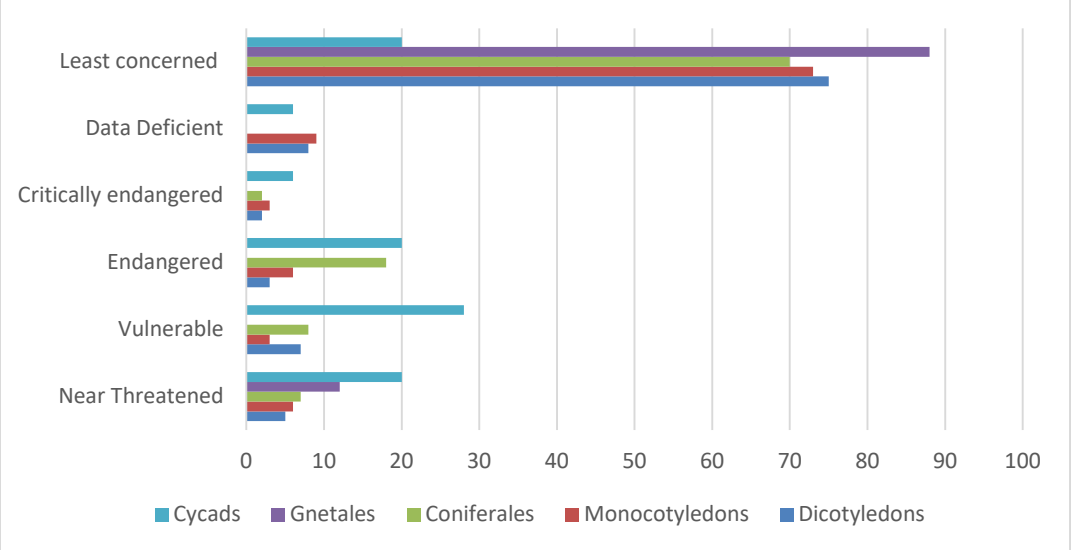


Fig. 1. Major plant groups and their IUCN status (2019)
(Note: All values are in percentage. Adopted from FAO (2019))

There are several reports on declining of WEPs from their habitats, local markets, and even from regular diets of different local communities. Therefore, their conservation and sustainable management for future food security is one of the very difficult tasks for the entire human community. For the sustainable management of WEPs, Borelli [35] proposed a highly appreciable scheme. It includes the challenges in environmental conditions, information, and infrastructure, and the practices to be conducted for sustainable management of WEPs. Reportedly there are over 20,000 species of WEPs across the globe; some of which are enlisted in the form of their respective references in Table 1 as per the literature available [51]. Currently, we are utilizing less than 10% of these WEPs, others are declining due to mere negligence and less awareness of these species worldwide. For future food security, and to maintain the ecological balance these species must have to conserved. It is very urgent to conserve the diversity of WEPs using both in-situ and ex-situ conservation methods. For maximum utilization, we need to develop a specific knowledge system for WEPs and provide the required infrastructure and support (Fig. 2) to strengthen the developing system for the conservation and management of WEPs across the globe.

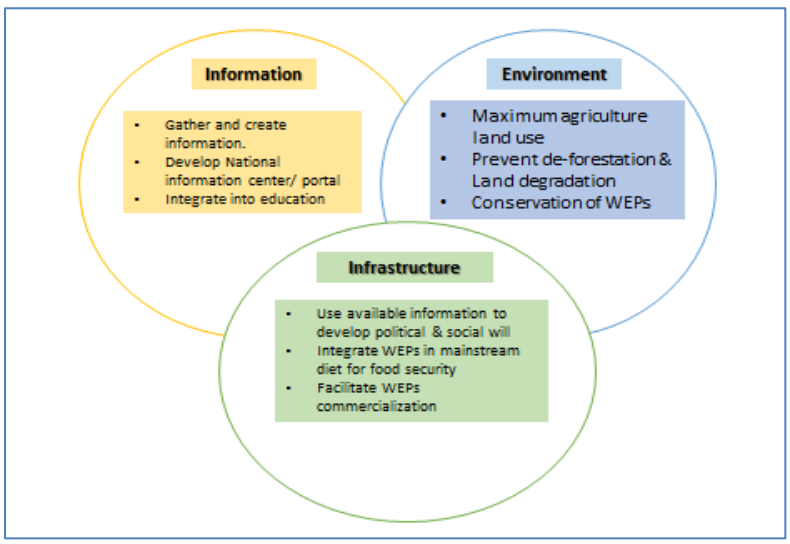


Fig. 2. Integrated approach to conserving WEPs

Table 1. Literature available on wild edible plants (WEPs) from different countries

Sr. No.	Country	Work done by
1	African countries (South Africa, Ethiopia, Kenya, Tanzania, Zambia)	[44,45,46,47,48,49,50,52]
2	America (USA)	[5,80]
3	China	[56,57,58,59,60]
4	European Countries	[61,62,63,64,65]
5	Asian Countries excluding China (India, Pakistan, Bhutan, Nepal, Srilanka, Thailand, etc.)	[53,54,55,66,67,68,69,70,71,72,73,74,75, 76,77,78,79]
6	Australia	[81,82]

4. CONCLUSION

At the local level, Wild edible plants (WFPs) contribute significantly to the diets and livelihoods of millions of people worldwide. Several workers reported the importance of WEPs at the local level, but their national scenario and conservation assessment are not recorded, and thus it fails to convey the full utility of WEPs in food security and as a bioresource. As we do not explore the WEPs fully, their role in mankind is not fully appreciated and they remain neglected. There are limited cases that clearly demonstrate that the contribution of WFPs to food security, nutrition, and livelihoods is significant. Now it becomes a challenge to apply useful strategies for the conservation and sustainable management of WEPs. Further, we are unaware of how the changing climate impacts the WEPs now and in the future. For sustainable management of WEPs, we have to follow the integrated conservation approach. For the same, apart from their nutritional potential, medicinal values, and pharmacological importance must have to be considered to bridge the knowledge gap while strategic planning WEP's sustainable management. Further, it is essential to involve local communities in the conservation process of WEPs so that they could cooperate and will get the maximum benefit out of it.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sowunmi MA. The beginnings of agriculture in West Africa: botanical evidence. Curr Anthropol. 1985;26(1):127-9.
2. Johnson A, Behrens CA. Nutritional criteria in Machiguenga food production decisions: A linear- programming analysis. Hum Ecol. 1982;10(2):167-89.
3. Heywood VH. Use and potential of wild plants in farm households; FAO farm system management series. Rome, Italy: Food and Agriculture Organization. 2010;1999. Bharucha Z, Pretty J. The roles and values of wild foods in agricultural systems. Philos Trans R Soc Lond B Biol Sci. 2010;365(1554):2913-26.
4. Bharucha Z, Pretty J. The role and importance of wild foods in agricultural systems. Phil Trans R Soc B. 2010;365 (1554):2913-26.
5. Casas A, Otero-Arnaiz A, Pérez-Negrón E, Valiente-Banuet A. In situ management and domestication of plants in Mesoamerica. Ann Bot. 2007;100(5): 1101-15.
6. Cruz-Garcia GS. Management and motivations to manage "wild" food plants. A case study in a mestizo village in the amazon deforestation frontier. Front Ecol Evol. 2017;5:127.
7. Mishra A, Swamy SL, Thakur TK, Bhat R, Bijalwan A, Kumar A. Use of wild edible plants: can they meet the dietary and nutritional needs of indigenous communities in central India. Foods. 2021; 10(7):1453.
8. Ulian T, Diazgranados M, Pironon S, Padulosi S, Liu U, Davies L, et al. Unlocking plant resources to support food security and promote sustainable agriculture. Plants People Planet. 2020; 2(5):421-45.
9. Asprilla-Perea J, Díaz-Puente JM. Importance of wild foods to household food security in tropical forest areas. Food Sec. 2019;11(1):15-22.
10. Broegaard RB, Rasmussen LV, Dawson N, Mertz O, Vongvisouk T, Grogan K. Wild food collection and nutrition under commercial agriculture expansion in

agriculture-forest landscapes. For Policy Econ. 2017;84:92-101.
11. Ickowitz A, Powell B, Rowland D, Jones A, Sunderland T. Agricultural intensification, dietary diversity, and markets in the global food security narrative. Glob Food Sec. 2019;20:9-16.
12. Ojelel S, Mucunguzi P, Katuura E, Kakudidi EK, Namaganda M, Kalema J. Wild edible plants used by communities in and around selected forest reserves of Teso-Karamoja Region, Uganda. J Ethnobiol Ethnomed. 2019;15(1):3.
13. Rowland D, Ickowitz A, Powell B, Nasi R, Sunderland T. Forest foods and healthy diets: Quantifying the contributions. Environ Conserv. 2017;44(2):102-14.
14. Kuhnlein HV, Erasmus B, Spigelski D. Indigenous peoples' food systems: the many dimensions of culture, diversity and environment for nutrition and health. Rome, Italy: food and agriculture organization of the United Nations; 2009.
15. Kuhnlein HV. Holding on to agrobiodiversity: human nutrition and health of indigenous peoples. In: Hunter D, Guarino L, Spillane C, McKeown PC, editors. Routledge handbook of agricultural biodiversity. London, UK: Routledge. 2017;692.
16. Angelsen A. Policies for reduced deforestation and their impact on agricultural production. Proc Natl Acad Sci U S A. 2010;107(46):19639-44.
17. Powell B, Thilsted SH, Ickowitz A, Termote C, Sunderland T, Herforth A. Improving diets with wild and cultivated biodiversity from across the landscape. Food Sec. 2015;7(3):535-54. .
18. Aryal KP, Poudel S, Chaudhary RP, Chettri N, Chaudhary P, Ning W et al. Diversity and use of wild and non-cultivated edible plants in the western Himalayas. J Ethnobiol Ethnomed. 2018;14(1):10.
19. Smith E, Ahmed S, Dupuis V, Running Crane M, Eggers M, Pierre M et al. Contribution of wild foods to diet, food security, and cultural values amidst climate change. J Agric Food Syst Community Dev. 2019;9;Suppl 2:1-24.
20. Fernández-Ruiz V, Morales P, Ruiz-Rodríguez BM, Isasa ET. Nutrients and bioactive compounds in wild fruits through different continents. In: Wild plants, mushrooms and nuts. Chichester, UK: John Wiley & Sons, Ltd. 2016; 263-314.
21. Hunter D, Borelli T, Beltrame DMO, Oliveira CNS, Coradin L, Wasike VW, et al. The potential of neglected and underutilized species for improving diets and nutrition. Planta. 2019;250(3):709-29.
22. Alwafa RA, Mudalal S, Mauriello G. *Origanum syriacum* L. (Za'atar), from raw to go: A review. Plants (Basel). 2021;10(5):1001.
23. Sibiya NP, Kayitesi E, Moteetee AN. Proximate analyses and amino acid composition of selected wild indigenous fruits of Southern Africa. Plants (Basel). 2021;10(4):721.
24. Kinnunen P, Guillaume JHA, Taka M, D'Odorico P, Siebert S, Puma MJ et al. Local food crop production can fulfill the demand for less than one-third of the population. Nat Food. 2020;1:229-37.
25. Padulosi S, Mal B, King O, Gotor E. Minor millets as a central element for sustainably enhanced incomes, empowerment, and nutrition in rural India. Sustainability. 2015;7(7):8904-33.
26. Shackleton S, Paumgarten F, Kassa H, Husselman M, Zida M. Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African Non-Timber Forest Products (NTFPs). Int For Rev. 2011;13(2):136-51.
27. Béné C. Resilience of local food systems and links to food security—A review of some important concepts in the context of COVID-19 and other shocks. Food Secur. 2020;12(4):805-22.
28. Fernandes N. Economic effects of coronavirus outbreak (COVID-19) on the world economy. SSRN Electron J; 2020.
29. Torero M. Without food, there can be no exit from the pandemic. Nature. 2020;580(7805):588-9.
30. Cappelli A, Cini E. Will the COVID-19 pandemic make us reconsider the relevance of short food supply chains and local productions? Trends Food Sci Technol. 2020;99:566-7.
31. Vandebroek I, Pieroni A, Stepp JR, Hanazaki N, Ladio A, Alves RRN, et al. Reshaping the future of ethnobiology research after the COVID-19 pandemic. Nat Plants. 2020;6(7):723-30..
32. Kitessa GB, Tokuma UG. Edible woody plants diversity and potential contribution to food security in Ethiopia. Int J Ecotoxicol Ecobiol. 2022;7(3):37-48.
33. Waheed M, Haq SM, Arshad F, Bussmann RW, Pieroni A, Mahmoud EA et al.

Traditional wild food plants gathered by ethnic groups living in semi-arid region of Punjab, Pakistan. Biology. 2023;12(2):269.
34. Gee E, Borelli T, Beltrame DMO, Oliveira CNS, Coradin L, Wasike V, et al. The ABC of mainstreaming biodiversity for food and nutrition. Concepts, theory and practice. In: Hunter D, Borelli T, Gee E, editors. Biodiversity food and nutrition. A new agenda for sustainable food systems. Abingdon, UK: Routledge; 2020.
35. Borrelli P, Robinson DA, Panagos P, Lugato E, Yang JE, Alewell C et al. Land use and climate change impacts on global soil erosion by water (2015-2070). Proc Natl Acad Sci U S A. 2020;117(36): 21994-2001.
36. Peduruhewa PS, Jayathunge KGLR, Liyanage R. Potential of Underutilized Wild Edible Plants as the Food for the Future – a review. J Food Sec. 2021;9(4):136-47.
37. FAO. The state of the World's biodiversity for food and agriculture. Rome, Italy: Food and Agriculture Organization; 2019.
38. Royal Botanic Gardens, Kew. State of the World's plants. London, UK: Royal Botanic Gardens, Kew; 2016.
39. Díaz S, Settele J, Eduardo B, Ngo HT, Guèze M, Agard J, et al. The global assessment report on biodiversity and ecosystem services. Summary for policymakers. Bonn, Germany: IPBES; 2019.
40. Masson-Delmotte V, Zhai P, Pörtner H-O, Roberts D, Skea J, Calvo E, et al. Climate change and land [IPCC report]. Geneva, Switzerland: IPCC; 2019.
41. Kew. Plants under pressure—A global assessment. London, UK: Royal Botanic Gardens, Kew, UK and Natural History Museum; 2016.
42. Khoury CK, Amariles D, Soto JS, Diaz MV, Sotelo S, Sosa CC, et al. Comprehensiveness of conservation of useful wild plants: an operational indicator for biodiversity and sustainable development targets. Ecol Indic. 2019; 98:420-9.
43. SCBD. Report of the AHTEG on indicators for the Strategic Plan for biodiversity 2011-2020. Montreal: Secretariat of the Convention on Biological Diversity; 2011.
44. Boedecker J, Termote C, Assogbadjo AE, Van Damme P, Lachat C. Dietary contribution of Wild Edible Plants to women's diets in the buffer zone around the Lama forest, Benin-an underutilized potential. Food Sec. 2014;6(6):833-49.
45. Shackleton C, Shackleton S. The importance of non-timber forest products in rural livelihood security and as safety nets: A review of evidence from South Africa. S Afr J Chem. 2004;100:658-64.
46. Ogoye-Ndegwa C. Traditional gathering of wild vegetables among the luo of Western Kenya-a nutritional anthropology project1. Ecol Food Nutr. 2003;42(1):69-89.
47. Shumsky SA, Hickey GM, Pelletier B, Johns T. Understanding the contribution of wild edible plants to rural social-ecological resilience in semi-arid Kenya. Ecol Soc. 2014;19(4).
48. Mulenga BP, Richardson RB, Tembo G. Non-timber forest products and rural poverty alleviation in Zambia. Zambia: Indaba Agricultural Policy Research Institute; 2012.
49. Maundu P. Utilization and conservation status of wild food plants in Kenya. In: The biodiversity of African plants. Springer. 1996; 678-83.
50. Keller GB, Mndiga H, Maass BL. Diversity and genetic erosion of traditional vegetables in Tanzania from the farmer's point of view. Plant Genet Resour. 2005; 3(3):400-13.
51. Tinsae Bahru ZA, Sebsebe D. Wild edible plants: sustainable use and management by in and the buffer area of awash national park, Ethiopia. Ethiopian J Sci. 2013;3:93-108.
52. Tahir M, Abrahim A, Beyene T, Dinsa G, Guluma T, Alemneh Y et al. The traditional use of wild edible plants in pastoral and agro-pastoral communities of Mieso District, eastern Ethiopia. Trop Med Health. 2023;51(1):10.
53. Ugyen J, Gurung T. Assessment of yam (*Dioscorea spp.*) diversity at community level in Nangkor gewog under Zhemgang dzongkhag. J Bhutan Stud. 2015;33.
54. Chhoeda Yangchen U. Wild vegetable diversity and their contribution to household income at Patshaling gewog, Tsirang. Bhutan J Nat Resour Dev. 2017;4(1):30-8.
55. FAO, editor. Non-wood forest products of Bhutan Bangkok, Thailand RAP publication; 1996.
56. Ju Y, Zhuo J, Liu B, Long C. Eating from the wild: diversity of wild edible plants used by Tibetans in Shangri-la region, Yunnan,

China. J Ethnobiol Ethnomed. 2013;9 (1):28.
57. Kang Y, Łuczaj Ł, Kang J, Zhang S. Wild food plants and wild edible fungi in two valleys of the Qinling Mountains (Shaanxi, central China). J Ethnobiol Ethnomed. 2013;9(1):26.
58. Baranov AI. Wild vegetables of the Chinese in Manchuria. Econ Bot. 1967;21(2):140-55.
59. Cheng Z, Lu X, Lin F, Naeem A, Long C. Ethnobotanical study on wild edible plants used by Dulong people in northwestern Yunnan, China. J Ethnobiol Ethnomed. 2022;18(1):3.
60. Sachula G, Zhang, Zhang YY, Zhao H, Khasbagan. *et al*. Wild edible plants collected and consumed by the locals in Daqinggou, Inner Mongolia, China. J Ethnobiol Ethnomed. 2020;16(1):60.
61. Radina K, editor. Booklet. Common useful wild plants in Central Europe. Promoting traditional collection and use of wild plants to reduce social and economic disparities in Central Europe. Budapest, Hungary: TRAFFIC and WWF Verlagsgesellschaft; 2013.
62. Pardo De Santayana M, Pieroni A, Puri RK. Ethnobotany in the new Europe: people, health, and wild plant resources. New York: Berghahn Books; 2010.
63. Tardío J, Pascual H, Morales R. Wild food plants traditionally used in the province of Madrid, Central Spain. Econ Bot. 2005;59(2):122-36.
64. Benítez G, Molero-Mesa J, González-Tejero MR. Wild edible plants of Andalusia: Traditional uses and potential of eating wild in a highly diverse region. Plants (Basel). 2023;12(6):12-8.
65. Łuczaj Ł, Pieroni A, Tardío J, Pardo-de-Santayana M, Sõukand R, Svanberg I et al. Wild food plant use in 21st century Europe: the disappearance of old traditions and the search for new cuisines involving wild edibles. Acta Soc Bot Pol. 2012;81(4):359-70.
66. Barua U, Hore D, Sarma R. Wild edible plants of Majuli island and Darrang districts of Assam. Indian J Trad Knowl. 2007;6(1):191-4.
67. Yesodharan Y, Sujana KA. Wild edible plants traditionally used by the tribes in the Parambikulam wildlife sanctuary, Kerala, India. Nat Prod Radiance. 2007;6(1):7.
68. Tiwari J, Ballabha R, Tiwari P. Some promising wild edible plants of Srinagar and its adjacent area in Alaknanda valley of Garhwal Himalaya, India. J Am Sci. 2010;6(4):167-74.
69. Sundriyal M, Sundriyal RC, Sharma E. Dietary use of wild plant resources in the Sikkim Himalaya, India. Econ Bot. 2004;58(4):626-38.
70. Arora RK, Pandey A. Indian Council of Agricultural Research. National Bureau of Plant Genetic Resources: wild edible plants of India: diversity, conservation, and use. New Delhi: Indian Council of Agricultural Research. National Bureau of Plant Genetic Resources; 1996.
71. Ray A, Ray R, Sreevidya EA. How many wild edible plants do we eat—their diversity, use, and implications for sustainable food system: an exploratory analysis in India. Front Sustain Food Syst. 2020;4:56.
72. Abbasi AM, Khan MA, Shah MH, Shah MM, Pervez A, Ahmad M. Ethnobotanical appraisal and cultural values of medicinally important wild edible vegetables of Lesser Himalayas-Pakistan. J Ethnobiol Ethnomed. 2013;9(1):66.
73. Shaheen S, Ahmad M, Haroon N. Status of edible wild plants in Pakistan: Case studies. In: Edible Wild Plants: An alternative approach to food security. Springer. 2017;65-125.
74. Gajurel PR, Singh B, Kashung S, Adhikary P, Nopi S, Barman R et al. Foods from the wild: a review on the diversity and use pattern of wild edible plants of Arunachal Himalaya for sustainable management. Plant Sci. Today. 2023;10(1):80-9.
75. Talang H, Yanthan A, Rathi RS, Pradheep K, Longkumer S, Imsong B et al. Nutritional evaluation of some potential wild edible plantsof North Eastern region of India. Front Nutr. 2023;10: 1052086.
76. Aryal K, Berg Å, Ogle BM. Uncultivated plants and livelihood support: A case study from the Chepang people of Nepal. Ethnobot Res Appl. 2009;7:409-22.
77. Nirmala J, Siwakoti M, Kehlenbeck K. Developing a Domestication Priority Setting Approach for Wild Vegetable to improve food security in Makanwar District, Central Nepal. Stuttgart-Hohenheim Tropentag. 2013;3.
78. Bhattarai S, Chaudhary RP, Taylor RS. Wild edible plants used by the people of Manang district, Central Nepal. Ecol Food Nutr. 2009;48(1):1-20.

79. Panyadee P, Wangpakapattanawong P, Inta A, Balslev H. Very high food plant diversity among ethnic groups in Northern Thailand. Diversity. 2023;15(1):120.
80. Available:https://www.kuhl.com/borninthemountains/edible-plants-on-the-trails-in-usa.
81. Canning AD. Rediscovering wild food to diversify production across Australia's agricultural landscapes. Front Sustain Food Syst. 2022;6:865580.
82. Fyfe S, Smyth HE, Schirra HJ, Rychlik M, Sultanbawa Y. The framework for responsible research with Australian native plant foods: A food chemist's perspective. Front Nutr. 2021;8: 738627.

© 2023 Shirsat et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/100019

View publication stats

Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Machine Learning for Fraud Detection: Comparative Analysis of Algorithms and Performance Evaluation

Dr. Swapnil G. Deshpande[1], Gopal P. Gawali[2], Ram B Ghayalkar[3], Dr. Santosh Madhusing Chavan[4], Jaykumar H. Meshram[5], Dr. Diwakar Ramanuj Tripathi[6]

[1]Assistant Professor, S.S. Maniar College of Computer and Management, India, swapnildeshpande33@gmail.com
[2]Head, Department of Computer Science, R.A.Arts, Shri M.K.Commerce and Shri S.R.Rathi Science College, India, gawali.gopal@rediffmail.com
[3]Assistant Professor, Sri R. L. T. College of Science, Akola, India, rambg29@gmail.com
[4]Assistant Professor, Shri Shivaji Art's Commerce and Science College, Akola, India, santoshchavan9881@gmail.com
[5]Research Scholar, smt Narsamma Arts commerce and Science College, Amravati, India, jaykumarmeshram1996@gmail.com
[6]HOD/Assistant Professor, PGTD Computer Science, S.S. Maniar College of Computer and Management, India, drtcomptech@live.com

One type of fraud involves using another customer's credit card account to secure or get loans. By creating credit card exchanges with the knowledge of those that have been fraudulent, the Credit Card fraud detection project recognizes the fraudulent notion of the new exchange. Such unethical actions can have an impact on a large number of people worldwide due to the data fraud and financial shortage. The financial sector is more at risk from crime, which is arriving at recommendations. Data extraction appeared to have been anticipated to be a crucial task in the recognition of online instalment fraud because the effectiveness of fraud detection in credit card purchases is significantly influenced by the informational collection estimating methodology, the choice of variable, and the detection procedures used. This distribution assesses the performance of Backing Vector Machine, Guileless Bayes, Strategic Relapse, and K-Closest Neighbour on highly distorted data on credit card fraud. These techniques must be carried out with precision, awareness, accuracy, and explicitness. The overall results demonstrate that strategic relapse outperforms other algorithms.

Keywords: Machine Learning, Fraud Detection, Comparative Analysis, Performance Evaluation, Algorithms, Credit Card fraud.

1. Introduction

Theft of credit cards is a growing, serious problem that costs banks and card issuer cooperatives a tremendous amount of money. Banking institutions combine a variety of security measures in an effort to prevent account abuse. As security measures get significantly more complex, fraudsters become more skilled; for instance, they gradually alter their tactics. Therefore, improving fraud detection and counteraction techniques It is crucial to use security modules that aim to prevent fraud. Fraud detection has evolved into a crucial step toward reducing the negative impact on the provision of services, prices, and the reputation of the organization of fraudulent trades. With the aim of maintaining excellent administration, there are numerous methods for spotting fraud. great assistance performance while reducing to a minimum the number of passings. Fraud is expensive, and before the data is discovered, fraud detection can cost a fortune. The structure is incredibly exact and doesn't emphasize many unfounded warnings. Genuine proactive handling, according to Edge and Falcone Pre-decisional, significantly reduces the amount of time available for PC processing and the precise decision made in light of new exchanges. The proactive techniques also increase the likelihood of early fraud warnings.

A framework for detecting fraud should be as quick as possible. Frameworks for detecting fraud are developed using historical exchange data to select new ones. This preparation method is typically compared to. Processing time can be reduced by reducing the number of previous exchanges handled by avoiding a time period with less complicated techniques.

Any attempt to use the cardholder's information without their knowledge or consent is considered credit card fraud and is considered illegal behaviour. Credit cards can be used in two different ways: online fraud, which can be discovered through mobile devices, the internet, and online purchasing, and offline fraud, which can identify a card that has been stolen by using the perpetrator's personal details. Credit card fraud is one of the vindictive acts that happen in a web-based commerce. Unauthorized use of a credit or charge card to make instalment payments is referred to as credit card fraud frequently. In essence, these are the fictitious sources of assets that are employed in various exchanges. With the growth of online commerce, credit card use and acceptance for online purchases as well as other payments have increased. Customers are increasingly relying on the well-known credit card instalment plan today to pay their payments and conduct beneficial online purchasing. Credit card fraud is growing daily in tandem with their increased use, causing a global catastrophe as a single fraud can result in a significant number of catastrophes. Fraud is happening at an alarming pace as a result of innovations on the increase and the ensuing significant financial loss. A person's credit or charge card may really be confiscated, or credit card details, like the cardholder's name, card number, expiration date, GOT code, etc., may have been compromised. are directly taken from an actual credit card. From the many datasets, fraud detection predicts if something is fraudulent or not. The deluge of information is recognized by several fraud detection systems, which then study fraud schemes. To distinguish these workouts, numerous machine learning models have been developed. There are a number of reasons why machine learning algorithms can't resolve the problem completely.

2. Literature Review

Sonal Mehndiratta and others In this study, various techniques for detecting credit card fraud are examined and held to particular standards. Here, predictive analysis techniques can be applied to acquire verified data in order to spot fraud. Here, a variety of techniques are used, including Counterfeit Brain Organization, Stowed away Markov Model, Hereditary Calculation, Innocent Bayes, and KNN classifier. In this study, credit card fraud detection is mostly accomplished using the two steps of highlight extraction and grouping, and a half-breed strategy is chosen to be used in the future.

Zarrabi and co. The developer suggests Profound Auto encoder, which performs as the best extraction of the finer points of the credit card fraud exchange's highlights. The author used softmax devices in this case to address class mark concerns. Here, an AutoEncoder is used to map the data into a highly layered space for the purpose of sorting a specific type of fraud. Deep learning is one of the greatest methods for identifying credit card fraud, it may be mentioned. Understanding the distinctive way that information is distributed among the various organizational kinds becomes challenging. Organizations used Profound Auto encoder to extract the greatest informational components with a high degree of precision and little variation.

Al-Khatib, Adnan M. The separation of honest transactions from dishonest transactions frequently has the downside of making fraud detection more difficult. Fraud detection includes observing the dishonest behavior of customers and clients in order to identify, separate, or get away from annoying behavior. In today's world, using credit cards is commonplace. The engineer is also investigating a few issues related to credit card fraud detection. Brain Organizations, Hereditary Algorithms (GAs), Rule acceptance, Master frameworks, Case-based thinking (CBR), Inductive rationale programming (ILP), Relapse, Man-made consciousness, and other cutting-edge fraud detection techniques have all been used by the research laborer to identify shady transactions. Comparative focus on information mining techniques are used to spot dishonest inclusion and obtain a low fake problem rate. This study demonstrates the use of several computational procedures to obtain bigger expense reserve funds.

To create a three layer backpropagation ANN, RaghavendraPatidar et al. used a dataset with hereditary algorithms (GA) for the identification of credit card fraud. In this analysis, the organization design, location, number of secret layers, and number of hubs inside each layer were managed by hereditary algorithms.

The research of the outcomes of a few classifier-examining procedures when applied to the informative collection on credit card fraud, when classes are imbalanced, was done by Dilip Singh Sisodia et al. 28 essential parts were found in the information using head part analysis (PCA) for real data with the factors time, amount, and class. From the three datasets we used, we were able to access 10,000, 15,000, and 20,000 times. The researchers looked into five over-testing procedures and four under-inspecting strategies independently. Few expensive delicate and gathering classifiers are used.

Guanjun Liu and others. Here, the author used two different types of erratic woodlands to instruct how to conduct honest and dishonest transactions in order to examine each separately

for the purpose of a classifier and perform on the identification of credit card fraud. The data used to examine the performance of those 2 types of irregular wood models is in partnership with a web-based commercial organization in China. To identify duplicitous B2C datasets used by the authors in this paper. The use of an arbitrary Woodland classifier, which improved results only on small datasets and cannot handle imbalanced datasets, is inefficient because fraud datasets are typically uneven.

A. Roy et al. suggested a sophisticated learning method for identifying fraud swaps. Exchanges of 80 million have been reported as fraudulent. To achieve outstanding performance, they made use of cloud-based climate. A dep learning technique with adjusting boundary for shady trades identification has been completed by the scientists, helping to build the financial foundation for the enforcement of legal procedures.

A cutting-edge procedure that includes installment of solicitations or invoices was proposed by Dastgir Pojee and colleagues. The "No Money" cell phone program is the name of this tactic, which is primarily used by merchants who may enable customer installment services. The NFC-Enabled Retail location (PoS) Machines Approach is not necessary in the current situation; only phones are needed. This architecture was designed to limit the clients' need to bring their cards and to provide a straightforward approach for making payments. Due to the growth in the number of NFC-enabled cell phones, the program No Cash, which has a few highlights, is utilized, which enhances the customer's buying experience. Clients of the application can make references to the historical context of the cost, and exorbitant charges will be reduced.

3. Experimental Methodology

The techniques and methods utilized to analyze the dataset that was used to develop the model, as well as the four machine learning review procedures—Backing Vector Machine, Credulous Bayes, K-Closest Neighbor, and Calculated Relapse—are explained in this section. Data collection, management, evaluation, classifier calculation, and evaluation—division of the data into train set and test set—were among the numerous stages of the trial.

After receiving the separated data, the classifier's framework is formed, and the test is then assessed using disarray lattice estimation rates.

3.1 Dataset

Out of the Kaggle Machine Learning stage, the dataset appears [24]. The 3075 interactions in this dataset are presented as 12 exchange items in a CSV record. The key nuances and foundational information cannot be introduced because of privacy concerns. The components include the daily average of exchange, exchange amount, whether it has dropped or not, whether it is an unknown exchange or not, if it is high-risk, and the half-year normal equilibrium in the dataset. The "is fraudulent" highlight, which has priority Y for illegal activity (fraud) and N for legal activity (not fraud), may be the mark for the Boolean evaluation.

3.2 Logistic Regression:

The computed relapse computation makes use of the sigmoid and strategic relapse capabilities

to perform paired grouping in light of the various dataset components. The following is a presentation of the sigmoid capability:

$$y^i = \frac{1}{1 + e^{-(Z)}} \qquad (1)$$

To find a paired order likelihood, the Sigmoid capability is used. In this instance, z represents the log-chances of the model, and y is the likelihood of the output.

$$z = b + m_1x_1 + m_2x_2 + m_3x_3 + \ldots\ldots\ldots\ldots m_{\cap}x_{th} \qquad (2)$$

Where m stands for the weighted traits and predisposition, x stands for the highlighted qualities, and b is the direct relapse capture. The sigmoid capacity predicts the likelihood of a given outcome.

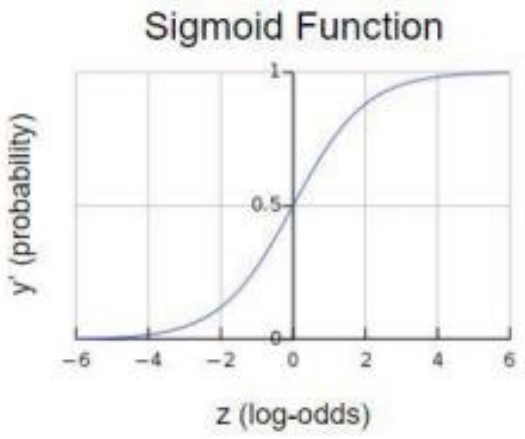


Figure 1: graph of the logistic regression's sigmoid function

Any number greater than this edge is seen as 1, and any value less than this edge is obviously regarded as 0. There is a maximum of 0.5. Strategic relapse is used to characterize paired events as either 1 or 0.

3.3 K-Nearest Neighbor (KNN):

The K-closest neighbour computation is an order calculation that predicts the properties of various educational highlights based on its relative position. Based on estimations of comparability such the Manhattan distance and Euclidean distance, it is categorized. It is expected that the pertinent preparation set data that is closest to the test point in Euclidean space would have the same cryptic property as the test point. Using the Euclidean distance metric, the KNN classifier is employed in this review. The distance between the two-point vectors of Euclidean (EC's) geometry (x1) is not fixed by:

$$EC = \sqrt{\sum (X_1 - X_2)^2} \qquad k = 1,2,\ldots\ldots,n \qquad (3)$$

Manhattan distance measure is a measurement where the distance between two focuses (xi, yi) and (xn, yn) is the outright contrast of their Cartesian direction.

$$M = (x_i - x_n) + (y_i - y_n) \quad (4)$$

3.4 Naïve Bayes:

Trustworthy Bayes classifiers rely on the Bayes hypothesis, which selects the most notable likelihood-based option. Bayesian likelihood measurements are based on known probabilities and values.

The calculation is a directed machine learning calculation, and

$$P(A|B) = \frac{p(B|A).\,p(A)}{P(B)} \quad (5)$$

The Bayes hypothesis provides a method for calculating the likelihood of a result (A) given specified circumstances (B), or the back-probability P (A|B).

With almost no knowledge of compelling circumstances, the hypothesis calculates the later likelihood by relating it to the past likelihood of the result using the likelihood proportion P (B|A) = P (B).

The guileless bayes hypothesis is predicated on the knowledge that each element effects the outcome independently and is thus gullible. A technique for identifying fraudulent credit card exchange is the guileless bayes classifier.

3.5 Support Vector Machine

Examples of directed learning techniques that can be applied to grouping and relapsing issues include support vector machines. A helper vector machine will choose the most precise data grouping technique.

A distinct hyper-plane legally classifies a help machine (SVM) as a biased classifier. As a result, the calculation that categorizes fresh models delivers an optimum hyper-plane given the marked preparation. A plane that lies on one side or the other in each class of a two-dimensional space is divided into two portions by a line known as a hyperplane.

Information concentrations on one side of the hyper-planes are said to be non-fraudulent, whilst information concentrations on the other side are said to be fraudulent. In the figure above, both hyper-plane successfully segregate the data that fraudsters are interested in, but the better hyper-plane will achieve a comparable degree of accuracy when it is necessary to group unrelated data.

This decides on the ideal hyper-plane based on the line distance as depicted in picture 2. Support vector machines split the class at the points on either side that are closest to them. Help vectors relate to the edge at this distance and the edge point.

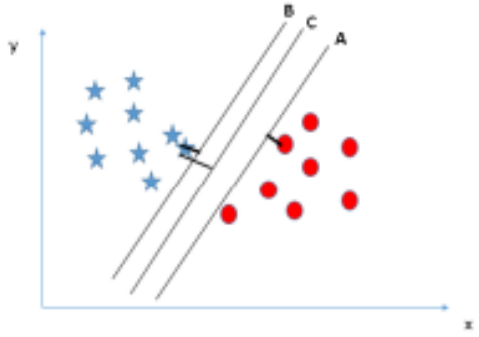


Figure 2: Static Vector Machine

4. Evaluation and Result

We concentrated on two different methods to assess these machine learning models:

(1) Classification accuracy, as determined by condition 6, is the proportion of accurate predictions to all information examined. However, if each class has an equal amount of assessments, this is quite effective.

$$\text{Accuracy} = \frac{\text{number of correct prediction}}{\text{total number of predicted made}} \qquad (6)$$

(2) Confusion Matrix: This produces a network as a consequence and illustrates how well the model performed overall. Genuine Positive Proportion (TPR), Genuine Negative Proportion (TNR), Bogus Positive Proportion (FPR), and Misleading Negative Proportion (FNR) rates metrics independently are the four primary estimations that are utilized to evaluate the tests.

P and n are the unmistakable benefits of the positive and negative class cases that are being decided because the amounts described by obvious positive, bogus positive, genuine negative, and misleading negative analyses are genuine positive, genuine negative, misleading positive, and bogus positive, respectively.

Genuine positive classes are those that are both supposed to be and actually are positive, whereas genuine negative classes are those that are both expected to be and actually are negatively. Classes that should be negative but are positive instead are known as false positives, while classes that should be certain but are assumed to be negative are known as misleading positives.

In terms of exactness, responsiveness (review), particularity, and accuracy, the efficacy of the assist vector machine, credulous bayes, k-nearest neighbor, and calculated relapse classifier is assessed.

Table 1: Confusion Matrix Table

Actual no of sample	Predicted No	Predicted Yes
Actual No	True Negative	False Positive
Actual Yes	False Negative	True Positive

Equation 7 states that exactness is defined as the ratio of the number of genuine occurrences of the positive and negative to the number of many expected examples.

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \qquad (7)$$

Awareness, also called examine, is the proportion of accurate positive forecasts to the total of inaccurate negative and accurate positive forecasts. The review evaluates the program's success by counting the number of really good outcomes that were noted. According to equation 8.

$$\text{Sensitivity (recall)} = \frac{\text{TP}}{\text{TP} + \text{FN}} \qquad (8)$$

What jumps out is the ratio of actual negative to the total of actual negative and fictional positive.

$$\text{Specificity} = \frac{\text{TN}}{\text{TN} + \text{FP}} \qquad (9)$$

Accuracy is defined as the ratio of the total number of real positive results to the total number of real positive results and fake positive results. It is possible to say that being the fraction of the nature of positive input data can be said. Equation 10 is where you should be looking to find the equation for accuracy.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \qquad (10)$$

In the course of this investigation, four distinct calculation frameworks are developed. These frameworks are dependent on the following: strategic relapse, svm, guileless bayes, and kclosest neighbor. While 80% of that analogous example is put toward planning and evaluating the strategy, the remaining 20% is set aside for testing and learning from mistakes. The concepts of particularity, precision, exactness, and responsiveness are brought into play when evaluating the performance of the classifiers.

Table 2: Table of comparisons for the four different classifiers

Metrics	Classifiers (%)			
	Support Vector Machine	K-nearest Neighbour	Naïve Bayes	Logistic Regression
Accuracy	86.42%	85.82%	84.88%	88.163%
Sensitivity	86.65%	98.25%	1%	200%
Specificity	86.42%	89.28%	200%	89.83%
Precision	94.2%	98.25%	200%	82.53%

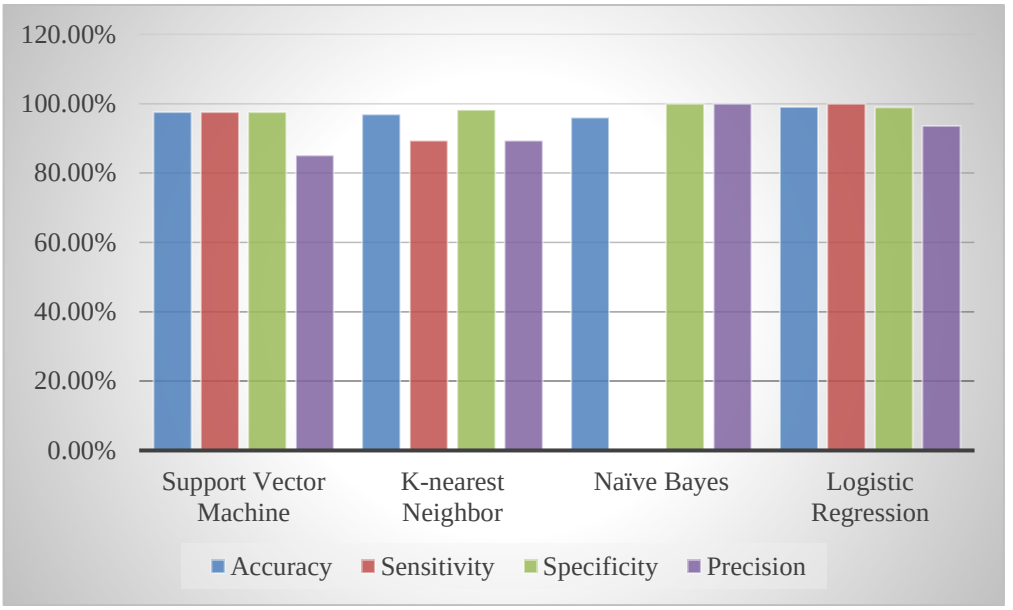


Figure 3: Graph showing the differences between the four classifiers

The efficiency of each of the four models for data designation is compared and contrasted in Table 2, which can be found above. This data assignment demonstrated the effectiveness that is better founded in reality. The method of calculated relapse had the highest degree of accuracy in terms of results across all of the evaluation measurements that were used.

5. Conclusion

In the past ten years, the strategies for detecting fraudulent use of credit cards have come into prominence thanks to the development of factual models, machine learning algorithms, and information mining technologies. The comparative examination of machine learning algorithms for the detection of fraud provides crucial experiences into the performance and viability of the algorithms. The investigation demonstrates that different algorithms exhibit varying degrees of exactness, responsiveness, explicitness, and accuracy when it comes to spotting fraudulent activities. The Help Vector Machine demonstrates a high level of exactness and explicitness, but the K-closest Neighbour algorithm achieves a respectable harmony between preciseness and responsiveness. Calculated Relapse performs astonishingly well across all measurements, while Gullible Bayes is successful in explicitness but has lesser awareness. These discoveries highlight how important it is to evaluate fraud detection systems while taking a variety of measurements into consideration. The article discusses the significance of machine learning in the detection of fraud and draws attention to the importance of selecting the appropriate computation in consideration of specific requirements. In order to increase the accuracy and productivity of fraud detection systems, further research in this area can concentrate on honing algorithms, looking into different techniques, and compiling new information sources.

References

1. Adnan M. Al-Khatib "Electronic Payment Fraud Detection Techniques", World of Computer Science and Information Technology Journal (WCSIT) ISSN: 2221-0741 Vol. 2, No. 4, 137-141, 2012.
2. Bahnsen, A. C., Stojanovic, A., Aouada, D., & Ottersten, B. (2014). Improving credit card fraud detection with calibrated probabilities. In Proceedings of the 2014 SIAM International Conference on Data Mining (pp. 677-685).
3. Data Analytics vs Data Science: Two Separate, but Interconnected Disciplines, Data Scientist Insights, 28-Apr-2018.
4. J. Steele and J. Gonzalez, Credit card fraud and ID theft statistics, CreditCards.com.
5. K. Ratna Sree Valli, P. Jyothi, G.Varun Sai, R. Rohith Sai Subash (2020), "Credit card fraud detection using Machine learning algorithms, Quest Journals Journal of Research in Humanities and Social Science Volumn 8, Issue 2 (2020) pp: 04-11 ISSN(Online): 2321-9467
6. Khyati Chaudhary, Jyoti Yadav, Bhawna Mallick, "A review of Fraud Detection Techniques: Credit Card", International Journal of Computer Application, Volume 45- No.1 2012.
7. Maes, S., Tuyls, K., Vanschoenwinkel, B. and Manderick, B., (2002). Credit card fraud detection using Bayesian and neural networks. Proceeding International NAISO Congress on Neuro Fuzzy Technologies.
8. Ogwueleka, F. N., (2011). Data Mining Application in Credit Card Fraud Detection System, Journal of Engineering Science and Technology, Vol. 6, No. 3, pp. 311 – 322
9. Patil, S., Somavanshi, H., Gaikwad, J., Deshmane, A., and Badgujar, R., (2015). Credit Card Fraud Detection Using Decision Tree Induction Algorithm, International Journal of Computer Science and Mobile Computing (IJCSMC), Vol.4, Issue 4, pp. 92-95, ISSN: 2320-088X
10. R. Harrow, Is Your Credit Card Less Secure Than Ever Before? Forbes, 20-Apr-2018.
11. RamaKalyani, K. and UmaDevi, D., (2012). Fraud Detection of Credit Card Payment System by Genetic Algorithm, International Journal of Scientific & Engineering Research, Vol. 3, Issue 7, pp. 1 – 6, ISSN 2229-5518
12. Seeja, K. R., and Zareapoor, M., (2014). FraudMiner: A Novel Credit Card Fraud Detection Model Based on Frequent Itemset Mining, The Scientific World Journal, Hindawi Publishing Corporation, Volume 2014, Article ID 252797, pp. 1 – 10.
13. Singh, G., Gupta, R., Rastogi, A., Chandel, M. D. S., and Riyaz, A., (2012). A Machine Learning Approach for Detection of Fraud based on SVM, International Journal of Scientific Engineering and Technology, Volume No.1, Issue No.3, pp. 194-198, ISSN: 2277-1581
14. Sonal Mehndiratta and K. Gupta (2018), "Credit Card Fraud Detection Techniques: A Review, :IJCSMC, Vol 8, Issue 8, August 2019.
15. Zarrabi, H. Kazemi, "Using deep networks for fraud detection in the credit card transactions, "IEEE 4th International Conference In Knowledge-Based Engineering and Innovation (KBEI), pp. 0630-0633, 2017

Analysis of Nutritional Components, Crude Fibre and Phytochemical Constituents of Varieties of Different Millets from the Vidarbha Region.

Ashwini A. Balode [#1], Ravi L. Dabhade [*2], Aakash M. Harkut[#3]

Department of Biochemistry, Shri Shivaji College of Arts, Commerce and Science, Akola, Maharashtra, India 444003.
Sant Gadge Baba Amravati University, Amravati

Abstract- Millets are considered as rich source of energy, carbohydrate and protein as compared to other cereals and have more calcium, iron, zinc, fibre and vitamins content. The presence of high fibre and secondary metabolites in millets help in the prevention of many diseases. Different types of varieties of millets were analyzed for their nutritional properties, fibre content, antioxidant property and phytochemicals. The samples of different varieties of millets were collected from Vidarbha region of Maharashtra. The results showed that highest crude fibre contents are in PKV Kalyani 12.6% in variety of Sorghum followed Finger, Little and Foxtail millet. The study revealed that phytochemicals such as Carbohydrates, Glycosides, Phenols are present in all varieties of millets. Regarding nutritional properties, proteins concentration is highest in CSV45 variety of sorghum whereas Carbohydrates are highest in Dopoli-3 variety of Finger millet and Crude fats are highest in Phule Nachni having 8.2% variety of finger millet. The antioxidant potential estimated by total phenolic content across the millet varieties ranged from 130 µg/ml to 235 µg/ml.

Keywords- Millet, Phytochemicals, Nutritional properties, health benefits, fibres.

I. INTRODUCTION

Millets are regarded as some of the earliest cereals, having been cultivated thousands of years ago at the advent of human civilization. They are valued for their resilience in diverse climatic conditions and their nutritional benefits. Millets are known for being gluten-free and rich in nutrients such as protein, fibre, vitamins, and minerals. These grains play an important role in the diets of many communities around the world, particularly in regions where they are native or have been traditionally cultivated. Additionally, millets are gaining popularity as health-conscious consumers seek out alternative grains with nutritional benefits. It is well known that these millets are good source of fibers (soluble-insoluble). Some popular types of millets include pearl millet, foxtail millet, finger millet, and sorghum.

India is the top most producers of millets followed by Nigeria for the year 2000 and 2009. In India, eight millets species (Sorghum, Pearl millet, Finger millet, Foxtail millet, Kodo millet, Proso millet, Barnyard millet and Little millet) are commonly cultivated under rain fed conditions.

Sorghum (Sorghum bicolour) is a warm season crop, intolerant of low temperatures but fairly resistant to serious pests and diseases. Its remarkable ability to thrive in diverse climatic conditions and various soil types solidifies its position as a vital staple food for millions of people worldwide [1]. Sorghum, when compared to other cereals, offers similar nutritional value in terms of its composition, including protein, fat, carbohydrates, and non-starch polysaccharides. Furthermore, non-nutrient compounds like carotenoids and polyphenols contribute to the grain's numerous health benefits, including anti-oxidative, anti-inflammatory, and anti-cancer effects. Sorghum also exhibits free radical scavenging properties and boasts high antioxidant activity [2].

Finger millet is nutrient-rich, and the nutritional value can be increased through processing. Vital nutrients like carbohydrates, dietary fiber, essential amino acids, and minerals are present in sufficient amounts in finger millet. The grains are a good option for those with celiac disease because they are free of gluten and are simple to digest [3].

Foxtail millet, like most millets, is also a good source of crude fiber, helps in the digestive process and helps to induce bowl movement, thus producing a laxative effect that is beneficial for a healthy digestive system [4]. All these nutritional properties have made foxtail millet an important ingredient for preparing noodles, nourishing gruel or soup, brewing alcoholic beverages, cereal porridges and pancakes in China [5].

The decline in the cultivation of diverse millet species/varieties despite their rich diversity and adaptability can be attributed to several factors such as the lack of awareness of nutritional benefits, inconveniences in food preparations, lack of processing technologies and a lack of institutional support compared to crops like rice and wheat. This lack of support leads to a shrinking of the millet-growing region. However, despite these challenges, many communities in dry and rain-fed regions still recognize the nutritional and cultural importance of millets. Phenolic compounds found in millets encompass a diverse range of chemical substances such as phenolic acids, flavonoids, and condensed tannins. These compounds are known for their antioxidant properties and have been linked to various health benefits, including reducing the risk of chronic diseases such as cardiovascular diseases, cancer, and diabetes. Millets, is a good source of crude fiber, helps in the digestive process and helps to induce bowl movement, thus producing a laxative effect that is beneficial for a healthy digestive system. Incorporating millets into the diet can provide a rich source of these beneficial compounds, offering both nutritional and health advantages. The present study was undertaken to analyze the nutrient composition, fibre content and antioxidant potential of local varieties of different millets. The research also explored the diverse phytochemicals present in these millets.

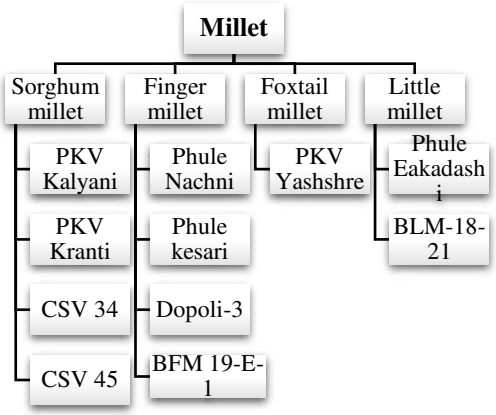


Fig 1: Different varieties of millets used in the study.

II. MATERIALS AND METHOD

A. *Preliminary Phytochemical Screening*

The samples were collected from PDKV Akola and Buldhana, Maharashtra, India and subjected for removal of stones and cleaned for further analysis. Cleaned millet samples were grounded into fine powder and an ethanolic extract was prepared for the phytochemical analysis by using Soxhlet apparatus. Further analysis was carried out using following standard procedures:

1. Test for Carbohydrates: Molisch's test
2. Test for Phenols: Phenol test
3. Test for Tannins: Alkali reagent test
4. Test for Flavonoid: NaOH test
5. Test for Glycosides: Molisch's test

B. *Determination Of Percentage Crude Fibre Content*

To find out the crude fibre contents in the millets sample, acid and subsequent alkali treatment followed by drying and ashing takes place. Which involve the standard biochemical protocol.

Calculations:

$$\%\ \text{crude fiber in ground sample} = \frac{\text{Loss in weight on ignition (W2 - W1)} - \text{(W3 - W1)}}{\text{Weight of the sample(Ws)}} \times 100$$

Where,

pre-weighed crucible (W1)

Weight of crucible with dried residue (W2)

Weight of crucible with ashed residue (W3)

C. *Determination Of Carbohydrates Concentration*

Determination of carbohydrates contents was carried out by the standard procedure of Anthrone reagent. Absorbance of standard was measured using the UV-Visible spectrophotometer at 630nm. Standard graph was drawn by plotting the concentration on x-axis verses absorbance on y-axis. Using standard graph and formulae, the concentration of carbohydrates in millet samples was determined. D-glucose used as a standard having concentration 10(µg/ml).

Calculations:

$$\text{Amount of carbohydrate present in 100mg of the sample} = \frac{\text{mg of glucose}}{\text{Volume of test sample}} \times 100$$

D. *Determination Of Percent Crude Fat Content*

The dried sample was placed in a porous thimble. The Soxhlet apparatus was assembled. The flask was filled with petroleum ether and heated until the solvent reached its boiling point. As the solvent vapor rose, it condensed and dripped into the sample chamber. The solvent permeated the sample, dissolving the fat. The condensed solvent then drained back into the flask. This extraction process was repeated multiple times, typically over 4 hours.

For fat recovery and analysis, the solvent containing the dissolved fat was collected from the flask in the beaker (pre weight beaker, W_1). The solvent was evaporated to recover the fat. The fat residue with beaker was weighed(W_2), and the percentage crude fat content was calculated by the following formula.

Calculations:

$$\text{Percentage of crude fat of the given sample} = \frac{W2 - W1}{Weight\ of\ sample} \times 100$$

E. *Determination Of Protein Concentration*

The protein contents was determined according to Lowry method [6]. Results were referred to the standard curve of BSA (Bovin Serum Albumin) having concentration of 500 (µg/ml).

F. *Total Phenolic Contents*

The total phenolic content of millets was determined spectrophotometrically using Folin-Ciocalteu's reagent. The extract (100 µl ;1 mg/ml) was mixed with 100 µl of Folin-Ciocalteu's phenol reagent and kept for 5 min. A volume of 1.00 ml of a 7% Na_2CO_3 solution was added to the reaction mixture followed by addition of 1.30 ml of deionized (DI) water. The mixture was kept in the dark at ambient temperature for 90 min and thereafter the absorbance measured at 750 nm. A calibration graph was prepared using Gallic acid as the standard and the total phenolic content in the extract was expressed as milligrams of Gallic acid equivalents in one gram of extract [7].

III. RESULT AND DISCUSSION

The result obtained from phytochemical screening of each variety of millets is tabulated as follows in table 1

TABLE 1

PRESENCE AND ABSENCE OF PHYTOCHEMICALS

Sr. No.	Test	Sorghum millet				Finger millet				Foxtail millet	Little millet	
		PKV Kalyani	PKV Kranti	CSV 34	CSV 45	Phule Nachani	Phule Kasari	BFM-19-E-1	Dapoli-3	PDKV Yashshree	Phule Eakadashi	BLM 18-21
1	Carbohydrates	+	+	+	+	++	++	+	+++	++	++	+
2	Phenols	+	+	++	++	+++	+++	++	+++	++	+	++
3	Tannins	+	+	+	+	+	-	-	+	++	+	++
4	Flavonoid	+	+	++	++	-	-	-	-	+	++	+
5	Glycoside	+	+	+	+	++	++	+	++	++	+	++

(+) = Presence 0f Phytoconstituents

(-) = Absence of Phytoconstituents

CSV 45 and CSV 34 showed higher contents of carbohydrates than the other varieties of Sorghum millet.

P. Nachani and P. Kasari showed higher contents of phenol than the other varieties of Finger millet. Foxtail and little millet showed mixed results of presence of phytoconstituents. Flavonoids are abundant phenolic group present in Sorghum, Foxtail and little millet varieties and Phenols are abundant in Finger millet varieties.

TABLE 2

DETAILED OVERVIEW OF CRUDE FIBRE CONTENT AND NUTRITIONAL COMPOSITION PRESENT IN THE MILLET SAMPLES:

Tests	Sorghum Millet				Finger millet				Foxtail millet	Little millet	
	PKV Kalyani	PKV Kranti	CSV 34	CSV 45	Phule Nachani	Phule Kasari	BFM-19-E-1	Dapoli-3	PDKV Yashshree	Phule Eakadashi	BLM-18-21
Crude fibre (%)	12.6	7.9	12.5	4.1	4.4	7.5	6.4	4.9	5	5.2	5.9
Carbohydrates (µg/ml)	15.3	16.8	18.6	17.8	16.5	20	17.25	25.5	16.2	17.75	19.2
Proteins (µg/ml)	283.3	366.6	400	341.6	300	200	308.3	208.3	325	283.3	241.6
Crude Fat (%)	4.3	3.9	4.6	3.8	8.2	7.6	6.3	3.2	4.5	5.9	5.5

A. *Crude Fiber Content*

Crude fibre content was high in PKV Kalyani 12.6% variety of sorghum Similarly P. Kasari 7.5% variety of finger millet was high in fibre content. PDKV Yashshree, the variety of foxtail millet was found to be 5% and the BLM-18-21, variety of little millet was found to be 5.9%.

The crude fibre contents are varied from 4.1% to 12.6% percent with varying varieties of millets.

Those results are near to those found by Joshi and Katoch (1990), Kamath and Belavady (1980) who reported that the crude fibre contents in finger millet 3.6%, 3.7% and 3.6% [8].

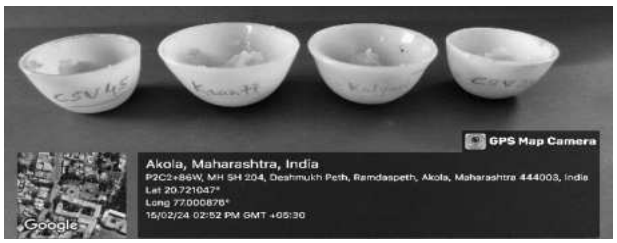


Fig: Millet residue before ashing.



Fig: Millet residue after ashing.

B. *Protein Contents*

The crude protein content among sorghum varieties, CSV 34 exhibited the highest protein content at 400 (µg/ml). In finger millet varieties, BFM-19-E-1 had the highest protein content at 308.3 (µg/ml). Among foxtail millet varieties, PDKV Yashshree contained 325 (µg/ml) of protein. Phule Eakadashi had a protein content of 283.3 (µg/ml), followed by BLM-18-21 at 241.66 (µg/ml) among little millet varieties.



Fig.: Standard tubes of Proteins.

C. *Carbohydrate Contents*

Among sorghum varieties, CSV34 exhibited the highest carbohydrate content at 18.62µg/ml. For finger millet varieties, Dapoli-3 had the highest carbohydrate concentration at 25.50µg/ml. Foxtail millet variety PDKV Yashshree registered 16.25µg/ml, while little millet variety BLM-18-21 recorded 19.5µg/ml, followed by Phule Eakadashi at 17.75µg/ml.

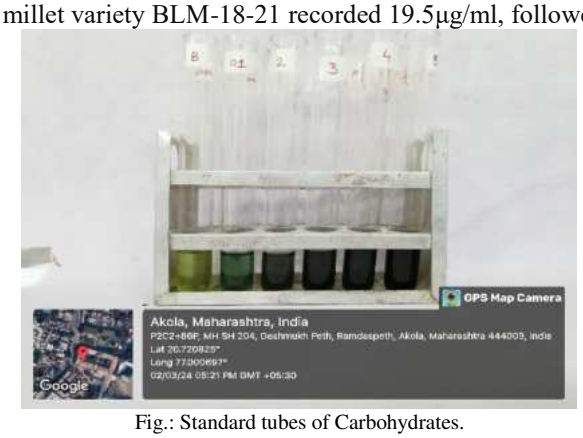


Fig.: Standard tubes of Carbohydrates.

D. *Crude Fats Content*

It was observed that Finger and Little millet exhibited higher crude fat contents compared to sorghum and foxtail millet. Among the sorghum varieties, CSV 34 displayed the highest crude fat content at 4.6%. Similarly, in finger millet, Phule Nachani had the highest crude fat content at 8.2%. Foxtail millet variety PDKV Yashshree exhibited 4.5% crude fat content. Little millet variety, Phule Eakadashi showed the highest content at 5.9%, followed by BLM-18-21 at 5.5%.

The results obtained were in between the results of the Zhang, A., Liu (et al., 2015) which were ranged from 3.38% to 6.49%, and the average was 4.51% [9].

E. *The Total Phenolic Content*

TPC is quantified in terms of Gallic acid equivalents per milliliter (µg/ml) of extract. Among the different millet varieties, little millets exhibited the highest total phenolic content, followed by sorghum, Finger, and Foxtail millet varieties. Specifically, Phule Eakadashi, a variety of little millet, demonstrated 235 µg/ml of TPC, with BLM-18-21 following closely at 195 µg/ml. In the sorghum millet category, CSV 34 displayed the highest TPC content at 195 µg/ml, trailed by CSV 45 at 180 µg/ml, PKV Kranti at 165 µg/ml, and PKV Kalyani at 140 µg/ml. Among Finger millet varieties, Dapoli-3 exhibited the highest TPC content at 190 µg/ml, followed by Phule Kasari at 175 µg/ml, Phule Nachani at 155 µg/ml, and BFM-19-E-1 at 145 µg/ml. PDKV Yashshree, a type of Foxtail millet, displayed the lowest phenolic activity at 130 µg/ml.

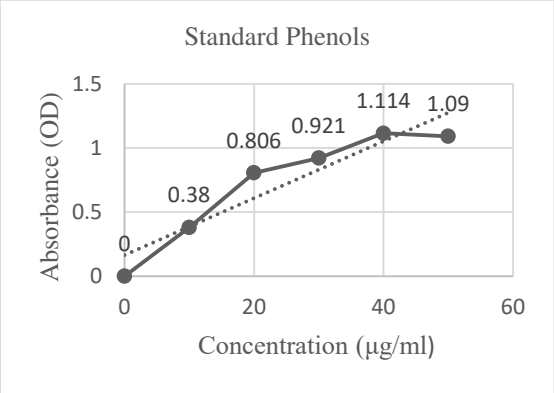


Fig.: Concentration vs Absorbance graph of Standard total phenols.

IV. CONCLUSIONS

The study showed that the different varieties of same millets contain variations in crude fibre. It was found that the high fibre content in millets due to its incomplete or slow fermentation by microflora in the colon can promote normal laxation which prevents constipation. High fibre content in daily diet can thus reduce the risk of celiac diseases.

The study threw light on presence of secondary metabolites such as glycosides, phenols, flavonoids, tannins in different varieties of sorghum, finger, Foxtail and Little millets. The study can conclude that millets are good for the dietary management of cardiovascular diseases and oxidative stress due to the presence of flavonoid and phenolic compounds.

The study emphasized on the nutritional composition and health benefits of locally available millets in Vidarbha region. Millets are staple food source that is not only providing major nutrients like protein, carbohydrate, fat etc. but also provide ample of vitamins and minerals. Our study explored the presence of phytochemicals with high antioxidant activity in BLM-18-21 variety of little millet. The study also impacted on developing specific agenda for these crops which must be recognized as an important food to introduce the millets as a nutritious food, fulfil the nutritional need of global population and to find ways to consume the millets nutritionally, effectively and to reduce the problems of malnutrition and other health problems like obesity, diabetes, cardiovascular disease, skin problems, cancer, celiac disease etc.

This study highlighted millets as “food medicine” embracing millets as a regular part of our diet that can lead to enhanced overall well-being and a healthier lifestyle. With their versatility and numerous health advantages, millets undoubtedly deserve a prominent place in our daily food choices.

ACKNOWLEDGEMENT

I express my heartfelt appreciation to Dr. Darasingh R. Rathod, Assistant Professor, Department of Agricultural Botany, and Dr. S. B. Thawari, Millet Breeder, Sorghum Research Center, Dr. PDKV, Akola, for their timely assistance and provision of sorghum millet varieties.

I am sincerely grateful to Dr. D. G. Kanwade, Millet Breeder, Agriculture Research Station (ARS), Dr. PDKV, Buldhana, for supplying the latest varieties of Finger, Foxtail, and Little Millet varieties.

References

I. Mbulwe, L., & Ajayi, O. C. (2020). Case Study–Sorghum Improvement in Zambia: Promotion of Sorghum Open Pollinated Varieties (SOPVs). *European Journal of Agriculture and Food Sciences*, *2*(5), 6, 2020.

II. Chhikara, N., Abdulahi, B., Munezero, C., Kaur, R., Singh, G., & Panghal, A. Exploring the nutritional and phytochemical potential of sorghum in food processing for food security. *Nutrition & Food Science*, *49*(2), 318-332, 2019.

III. Muthamilarasan, M., Dhaka, A., Yadav, R., & Prasad, M. Exploration of millet models for developing nutrient rich graminaceous crops. *Plant Science*, *242*, 89-97, 2016.

IV. Sharma, N., & Niranjan, K. Foxtail millet: Properties, processing, health benefits, and uses. *Food reviews international*, *34*(4), 329-363, 2018.

V. Krishna, K. R. *Agroecosystems: soils, climate, crops, nutrient dynamics and productivity*. CRC Press, 2013.

VI. Lowry, O. H., Rosebrough, N. J., Farr, A. L., & Randall, R. J. Protein measurement with the Folin phenol reagent. *J biol Chem*, *193*(1), 265-275, 1951.

VII. Wickramaratne, M. N., Punchihewa, J. C., & Wickramaratne, D. B. M. In-vitro alpha amylase inhibitory activity of the leaf extracts of Adenanthera pavonina. *BMC complementary and alternative medicine*, *16*, 1-5, 2016.

VIII. Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: a review. *Journal of food science and technology*, *51*, 1021-1040, 2014.

IX. Zhang, A., Liu, X., Wang, G., Wang, H., Liu, J., Zhao, W., & Zhang, Y. Crude fat content and fatty acid profile and their correlations in foxtail millet. *Cereal chemistry*, *92*(5), 455-459, 2015.

16. Exploring the Acid Neutralizing Capacity and Nanoparticle Synthesis Potential of *Polygonum Barbatum* Leaves

Ashwini A. Balode
Department of Biochemistry, Shri Shivaji College of Arts, Commerce and Science, Akola.
Ravi L. Dabhade
Department of Biochemistry, Shri Shivaji College of Arts, Commerce and Science, Akola.
Dr. Tushar G. Deshmukh
Department of Zoology, Shri Shivaji College of Arts, Commerce and Science, Akola.
Abhishek Gawande
Department of Biochemistry, Shri Shivaji College of Arts, Commerce and Science, Akola.

Abstract

Polygonum barbatum Linn, a robust annual herb with an upright stem, belongs to the Polygonaceae family and is commonly found across the warmer regions of India. The leaf extract of *Polygonum barbatum* has been traditionally utilized in Chinese medicine to treat ulcers, while the root extract serves as both an astringent and a carminative agent. Acid neutralizing capacity of plant was assessed by back titration and pH meter method. **Objective:** Present study was undertaken to investigate the acid neutralizing capacity (ANC) and silver nanoparticles synthesis potential of alcoholic extract of leaves of *Polygonum barbatum*. The fresh leaves of herb *Polygonum barbatum* were air-dried to remove moisture before extraction, then mechanically powdered to increase surface area. 25 g of the powdered plant material was extracted with 95% ethanol. 10 ml aqueous solution of plant leaves was mixed with 90 ml of 1 mM aqueous silver nitrate ($AgNO_3$) solution and incubated in darkness at room temperature for 24 hours. Silver nanoparticles thus formed were extracted using centrifugation and were analyzed by UV-Vis spectra. Acid neutralizing capacity of plant was assessed by back titration and pH meter method. The UV-Vis spectrum of AgNPs synthesized from *Polygonum barbatum* leaf extract exhibited characteristic absorbance peaks at 446 nm with 1 mM AgNO3. Acid neutralizing capacity of plant leaf was found to be 239.5 and 52.4 for 100 mg/ml and 500 mg/ml concentration of plant leaves respectively.

Keywords: Acid Neutralizing Capacity (ANC), Polygonum barbatum, antacid AHM

Introduction

Over the past decade, there has been a notable surge in interest and acceptance of herbal medicine for therapeutic purposes worldwide. This can be attributed to various factors, including a growing awareness of the potential toxicity and side effects associated with some allopathic medicines. In recent years, there has been a resurgence of interest in traditional healing practices, and scientific research is beginning to validate the efficacy of certain herbal remedies. The use of herbal medicine has deep historical roots, with many cultures relying on plant-based remedies for centuries. Herbal medicine is often perceived as a more natural and holistic approach to healing. These are often considered to have fewer side effects compared to some synthetic drugs. Advances in scientific research and technology provide opportunities to explore new compounds and therapeutic approaches. Researchers are continually investigating natural compounds, innovative drug delivery systems, and targeted therapies to improve the safety profile of pain and inflammation medications.

A peptic ulcer is an irregular lining in the stomach or the first segment of the small intestine called as duodenum (de Sousa Falcão H et al, 2008). When it affects your stomach, it's called a gastric ulcer. The pathophysiology of peptic ulcers emphasizes the role of an imbalance between mucosal defense mechanisms and aggressive factors, particularly gastric acid and pepsin. The mucosal lining of the stomach and duodenum has natural defense mechanisms to protect against the corrosive effects of gastric acid and digestive enzymes. Mucus secretion, bicarbonate production and the integrity of the mucosal barrier are all crucial components of these defense mechanisms (Baggio C. H et al 2002). Gastric acid, produced by the stomach lining, plays a central role in digestion. The activation of the vagus-vagal refluxes by stimulation of pressure, receptors in the gastric mucosa is believed to increase gastric acid secretion. (Kumar V 2012). However, an excessive production of gastric acid can contribute to the erosion of the protective mucosal barrier. This increased acid secretion, if not properly regulated, can contribute to the development or exacerbation of peptic ulcers. Complications of peptic ulcers, such as bleeding, perforation, or obstruction, can lead to increased mortality risk. Understanding the complex interplay between mucosal defense mechanisms and aggressive factors is crucial for developing effective strategies to prevent and treat peptic ulcers. Some antacid products may neutralize more acid in the stomach than others. People usually prefer antacids which are commercially available to alleviate the symptoms. It was observed that some of the common

remedies used for relief in acidity such as ginger showed little to no acid fighting capacity. (Divya J.O Et al, 2021) The Antacid's Neutralizing Capacity ANC is a measure of an antacid's ability to neutralize acid within a specific pH range, typically between 3.5 to 4 (Hoogerwerf et al., 2001). This property is essential in assessing the effectiveness of antacids in alleviating conditions associated with excess stomach acid. Phytoconstituents like flavonoids i.e., quercetin, catechin seems to play a very important role in promoting mucus secretion for prevention and treatment of peptic ulcer (Middleton E et al., 2013). These natural compounds, found in various plant-based foods, have been studied for their role in peptic ulcer pathology.

Polygonum barbatum Linn described as a stout, annual herb with an erect stem is distributed in the hotter regions of India, particularly in wet places. The seeds are used to relieve griping pain in colic and, the roots are utilized as an astringent and cooling remedy. In China, a decoction of the leaves and stalk is reported to be used as a stimulating wash for ulcers. In China, decoction of the leaves and stalk are said to be used as a stimulating wash for ulcer Ngwuluka, N. C. et al, 2009). The traditional uses of *Polygonum barbatum* Linn involve its application in addressing gastrointestinal issues, such as colic, and as a remedy for conditions like ulcers. In indigenous system of medicine, it has been used as potential anticancer agent against oral cancer. *P. barbatum* has also been reported to have antimicrobial activity, suggesting it to be a source of potential antibiotic agents. However, it's important to note that traditional uses do not necessarily imply scientific validation, and further research is often needed to establish the safety and efficacy of such traditional remedies.

Nanotechnology, which involves manipulating and utilizing materials at the nanoscale, has garnered attention due to the unique properties of nanoparticles, such as their high surface area-to-volume ratio and diverse magnetic, mechanical, optical, and chemical properties. They have remarkable prospects in emerging fields such as food, biomedicine, agriculture, and genetics. Nobel metal NPs, such as copper, silver, platinum, gold, zinc, magnesium and titanium have received a lot of recognition for their multifunctional abilities in biomedical applications (Ahmed et al., 2015). Nanoparticle synthesis has been achieved using chemical and physical techniques; however, these methods are not beneficial to the environment. As nanoparticles includes plant extract, animal proteins agro waste, pigments, bacteria fungi, and small viruses, which are difficult to handle with conventional methods green synthesis of nanoparticles is recommended. Plant-derived bioactive secondary metabolites play a significant role in the

synthesis of metal nanoparticles. These secondary metabolites, serve as stabilizing and capping agents, enabling the reduction of metal ions and the synthesis of nanoparticles with beneficial properties.

The present study aimed to evaluate the antiulcer activity of the ethanolic extract of *Polygonum barbatum* using in-vitro methods, specifically focusing on acid neutralizing capacity which would validate the traditional claim that *Polygonum barbatum* possesses anti-ulcer properties. Further, the research intended to synthesize AgNPs through bio-reduction of Ag+ ions using the aqueous leaf extract of *Polygonum barbatum* and to assess the enhanced antibacterial activities against human pathogenic bacterial strains.

Materials and Methods

1. Preparation of Ethanolic extract

The leaves of *Polygonum barbatum* were collected along the beds of the Shahanur river, Nandkhed near Akola. The leaves of the plant were used for the extraction process. The plant leaves were air-dried, indicating the removal of moisture content before extraction. The dried leaves were mechanically powdered, likely to increase the surface area for efficient extraction. The powdered plant material (25 g) was extracted using 95% ethanol.

2. Phytochemical screening

Ethanolic extract of *Polygonum barbatum* leaves was used for phytochemical screening. The Ethanolic extract was subjected to preliminary phytochemical screening by means of standard chemical tests to detect presence of different phytoconstituents like alkaloids, glysosides, flavanoids, tannins, saponins, phenols, terpenoids etc

3. Acid neutralizing capacity

The acid neutralizing capacity of the Ethanolic extract of *Polygonum barbatum* were assessed using two methods.

a. Back Titration method Singhal et al. (2022): Standard antacid AHMH was prepared at a concentration of 500 mg/ml. To 5 ml of each extract individually, water was added and mixed well to make up the total volume to 70 ml. 30 ml of 1N HCl (hydrochloric acid) was added into both the standard and test preparations. The solutions were stirred for 15 minutes. 2-3 drops of phenolphthalein solution were added to each solution. The excess HCl was immediately titrated with 0.5N Sodium hydroxide solution drop wise until a pink colour is appeared (Singhal et al., 2022)

The moles of acid neutralized is calculated

by,

Moles of acid neutralized = (vol. of HCl × Normality of HCl) - (vol. Of NaOH × Normality of NaOH)

$$\text{ANC Per gram of antacid} = \frac{\text{Moles of HCl neutralized}}{\text{Grams of Antacid / Extract}}$$

b. pH Meter Method: 60 ml of 0.1M HCl solution was prepared and poured into a beaker. The pH of the 0.1M HCl solution was measured using a pH meter, and the reading was recorded. Three tablets from each brand were powdered using a mortar and pestle. The powdered tablets were then carefully transferred into the beaker containing the 0.1M HCl solution. The mixture of 0.1M HCl and the powdered antacid tablets was stirred for 10 minutes. The final pH of the mixture was measured using a pH meter. Ethanolic extract of *Polygonum barbatum* (500 mg) was transferred into a separate beaker. The 0.1M HCl solution was added to the beaker containing the test extract. The mixture of 0.1M HCl and the test extract was stirred for 10 minutes and the final pH of the mixture was measured. (Alalor, C., et al)

4. Biosynthesis of Silver nanoparticles

10 ml of *Polygonum barbatum* aqueous solution was added to 90 ml of 1 mM aqueous silver nitrate ($AgNO_3$) solution. The reaction mixture was incubated at room temperature in dark conditions for 24 hours. After incubation, the solution containing silver nanoparticles was centrifuged at 10000 rpm for 20 minutes. The silver nanoparticles obtained after centrifugation were separated. The UV-Vis spectral analysis for silver nanoparticles was performed.

Results and Discussion

1. Synthesis of Nanoparticles

Being most simple and sensitive technique, spectroscopy is used for monitoring formation and primary characterization of silver nanoparticles. When silver nanoparticles are illuminated with light, particularly in the visible spectrum, the incident photons can induce resonant oscillations of the nanoparticle's conduction band electrons. The frequency of these oscillations corresponds to the wavelength of light that is most strongly absorbed by the nanoparticles. In the case of silver nanoparticles, this often falls within the visible range, resulting in a characteristic peak in the absorption spectrum.

UV-Vis spectrum of colloidal solutions of AgNPs synthesized from *Polygonum barbatum* leaf extract showed the characteristic absorbance peaks at 446 nm at 1 mM AgNO3.

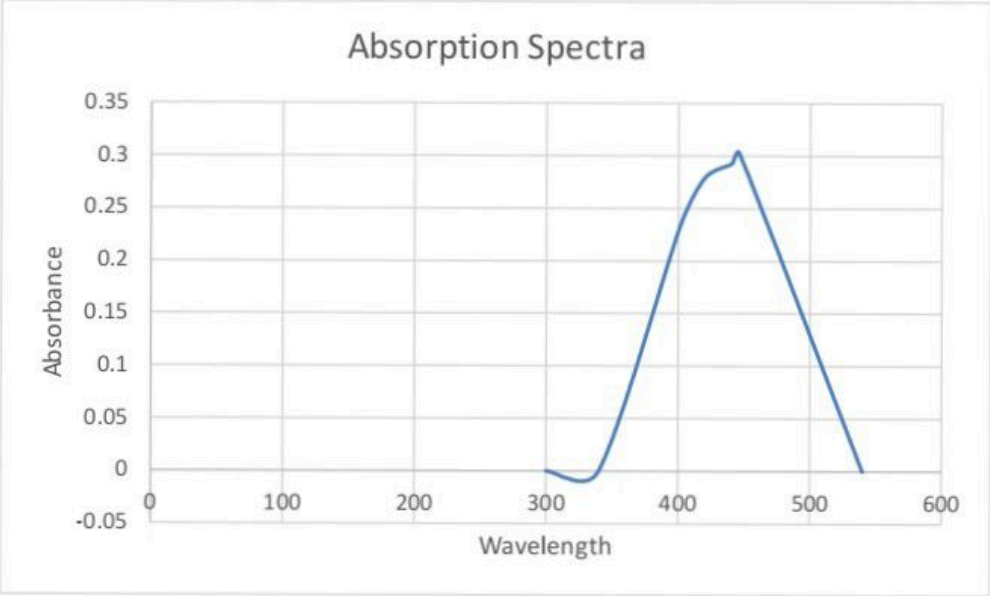


Fig. 1 - Absorption spectra of AgNPs

2. Phytochemical Screening

Being free from any harmful chemicals, Plants are good sources for formation of nanoparticles. It also contains natural capping agents which stabilizes nanoparticles. Phytochemicals present in plant significantly control the Size and morphology of AgNPs. Therefore, it is necessary to identify the exact phytochemicals participating in the production AgNPs. Table 1 Shows the result of phytochemical screening.

Table 1

Sr. No.	Metabolites	Name of test	+/-
1	Alkaloids	Wagner's test	+
2	Glycoside	Molisch's test	+
3	Saponins	Foam Test	+
4	Phenol	Ferric Chloride test	+
5	Tannins	Sodium Hydroxide Test	+
6	Sterols	Libermann-Burchard test	+
7	Triterpenoids	Chloroform test	+

3. Acid Neutralizing Capacity (ANC)

Back titration method was used to analyze the acid neutralizing capacity of the *Polygonum barbatum*. In this method the antacid is first mixed with excess of hydrochloric acid

which is then titrated with standard sodium hydroxide. Being main constituent of gastric juice, excess of HCl was added to the sample. At the endpoint of the titration, base completely neutralise the acid and the ability of the antacid to neutralize the base (Acid neutralizing capacity).

Table 2

Concentration (mg/ml)	Volume of NaOH consumed (ml)	ANC per gram of antacid
EEPB – 100 mg	12.1	239.5
EEPB – 500 mg	7.6	52.4
AHMH – 500 mg	16.1	43.9

Conclusion

Acid neutralizing capacity of AHMH (aluminum hydroxide + magnesium hydroxide) at concentration of 500 mg/ml was found to be 43.9 whereas that of plant extract was found to be 52.4. It indicates that plant has considerable potential to neutralize acid and therefore can be used as a source of lowering the acidity of the stomach and reducing the risk of ulcer formation.

Acknowledgement

The authors are grateful to the Principal, Shri Shivaji College of Arts, Commerce and Science, Akola for providing resources and facilities available in the college.

References

1. Kumar V., Bhat Z.A., Kumar D., Khan N. A., Chashoo I.A., Ara I. Gastroprotective effect of leaf extracts of Basella alba var. alba against experimental gastric ulcers in rats. Braz. J. Pharmacogn., 2012, 22(3): 657-662.
2. Middleton E, Kandaswami C, Theoharides TC. The effects of plant flavonoids on mammalian cells: implications for inflammation, heart disease, and cancer. Pharmacol Rev, 2000 52: 673-751
3. Hoogerwerf, W. A., P. J. Pasricha. “Agents used for control of gastric acidity and treatment of peptic ulcers and gastroesophageal reflux disease.” The pharmacological basis of therapeutics (2001): 1005-1019.
4. N. C. Ngwuluka, K. Lawal, P. O. Olorunfemi and N. A. Ochekpe “post-market in vitro bioequivalence study of six brands of ciprofloxacin tablets/caplets in Jos, Nigeria.” Scientific research and essay 4.4 (2009): 298-305.

5. Ahmed, S., Ikram, S., 'Silver nanoparticles: one pot green synthesis using Terminalia arjuna extract for biological application', Int. J. Pharm. Sci. Res., 2015, 6, (1), pp. 14–30 11.
6. Dr. Keshamma E, Mittal P., Dr. Kumar A., Kumar A., Maurya V.K., Singhal T., Varma A. K., Giri S., Kumar R. "Investigation of In-Vitro Anti-Oxidant & Anti-Ulcer Activity of Angiogenesis Latifolia Roxb (Dhava)." NeuroQuantology 20.11 (2022): 5680-5
7. Alalor C.A, Avbunudiogba J.A., Builders F.P., Okpara L.O. "Evaluation of the acid-neutralizing capacity of Some Commercially Available Brands of Antacid Tablets in Nigeria." East Afr Med J 2.1 (2019): 12-6
8. Divya J.O, Faseela Mohammed Rasheed., Evaluation of the Effectiveness of Acid-Neutralizing Property of Traditional Antacids commonly used in India., Journal of Scientific Research, Volume 65, Issue 4, (2021)
9. De Sousa Falcão H, Leite JA, Barbosa-Filho JM, de Athayde-Filho PF, de Oliveira Chaves MC, Moura MD, Ferreira AL, de Almeida AB, Souza-Brito AR, de Fátima Formiga Melo Diniz M, Batista LM (2008). Gastric duodenal antiulcer activityof alkaloids. Molecules 13(12):3198-3223.
10. Baggio C. H.,Freitas C. F., Lia Rieck L., Maria Consuelo Andrade Marques; Gastroprotective effects of a crude extract of Baccharis illinita DC in rats; Pharmacological Research 47 (2003) 93–98

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(9): 774-777
© 2022 TPI
www.thepharmajournal.com
Received: 12-06-2022
Accepted: 22-08-2022

Gajanan W Belsare
Department of Chemistry, Shri Shivaji College of Arts, Commerce and Science, Akola, Maharashtra, India

Corresponding Author:
Gajanan W Belsare
Department of Chemistry, Shri Shivaji College of Arts, Commerce and Science, Akola, Maharashtra, India

Sensitization of Pyrogallol red with Cetylpyridinium bromide for the spectrophotometric determination of Pb^{2+}

Gajanan W Belsare

Abstract
The sensitization of Pyrogallol Red (PGR), a member of triphenylmethane dye in presence of Cetylpyridinium bromide (CPB), a cationic surfactant has been studied. Addition of Pb^{2+} solution in the modified reagent (PGR + CPB) formed intense coloured complexes with the shift in λ max and increase in molar absorptivity and sensitivity. The change in the properties of Pyrogallol Red (PGR + CPB) utilized for the Microdetermination of Lead.

Keywords: Sensitization, pyrogallol red, cetylpyridenium bromide, molar absorptivity etc.

1. Introduction
Water, soil and food products are contaminated by different sources, like mining steel industry, crop enhancers automobiles etc. These heavy metals show toxic effect on different human organs. The literature on lead toxicity is far too vast to review in this paper. Instead, this section summarizes the international scientific consensus, based on comprehensive evaluations of the literature conducted by international organizations and national governments. Lead paint is a primary source of lead exposure and the major source of lead toxicity in children. The U.S. Department of Housing and Urban Development currently estimates that 38 million homes in the United States contain lead paint. Of those, 24 million are considered to contain significant lead-based paint hazards, including deteriorating paint and/or contaminated dust or soil outside the home. As lead paint deteriorates and airborne lead settles, it contaminates dust and soil. Exposure to soil that contains particulate lead has been shown to be significantly hazardous for children, who are more commonly exposed by ingestion of house dust or soil than by paint chips. Blood lead levels are more closely related to indoor dust exposure than to outdoor soil exposure. Lead exposure can also occur during remodeling of a home built prior to 1978, when lead-based paints were still in commerce. Many workers carried out the determination of lead in many samples [1]. The analytical and complex ion chemistry of Lead have not kept place with growing interest because the heavy metal ions have less tendency to form complexes with normally strong coordinating agents. This may be due to their large size of its cation. With the development of chelatometry in this context very few reagents have been introduced for the determination of Lead. Spectrophotometric determination of Pb(II), Bi(III) and Fe(III) in complexes with 1,2-diaminocyclohexane -N, N, Ni, Ni-tetraacetic acid has been carried out by Jan Krzek *et al*. [1] B. Jankiewicz carried out the determination of lead in soil sample [2]. A detail spectrophotometric determination of lead with o-hydroxy-thiobenzmorpholide has been carried out by I. Badea *et al*. [3] Spectrophotometric determination of lead with 1-(2-pyridylazo)-2-naphthol and non-ionic surfactants has been carried out by Escriche JM *et al*. [4] A detail Spectrophotometric determination of lead in foods with dibromop-methyl-bromosulfonazo has been carried out by Escriche. The synthesis and purification of a new chromogenic reagent dibromo-pmethyl-bromosulfonazo (DBMBSA) has been synthesized by Guozhen Fang for the spectrophotometric determination of lead in food stuff [5]. A sensitive spectrophotometric method for the determination of lead in aqueous solutions has been developed and applied for a range of concentration of 0-60 µg/ml of lead using the complex Lead (II) Using 3-Methyl-1, 2-Cyclopentanodione Dithiosemicarbazone [6], Thus it becomes important to sensitize these reagents by some process. The present work primarily been undertaken to explore the utility of cationic surfactant such as Cetylpyridinium bromide (CPB) in the sensitization of Pyrogallol Red (PGR) for the determination of lead.

In this context new and sensitive method is proposed which will helpful to determine percentage toxicity of lead in micrograms. The proposed method will be applicable to control water, air pollution causes because of these toxic metals in future.

2. Material and Methods

2.1 Instrumentation and Reagent solutions

All the spectral measurements have been carried out on Chemline model CL 133 microcontroller based spectrophotometer with glass cuvettes of light paths 10mm. distilled water has been used as a reference solution. Chemline model CL 180 pH meters with combine electrode has been used for the adjustment of pH. The scale has been standardizing every day before making the pH measurement with buffer solutions of pH 4.0, 7.0 & 9.0. The pH of the each solution has been adjusted with HCl and NaOH solution of suitable concentration.

The Pyrogallol Red and Cetylpyridinium bromide were used in this work were of analytical grade purity and supplied by Sigma-Aldrich chemical company, USA. The Lead acetate of analytical grade purity was supplied by Merk chemical company. The solution of both the reagents have been prepared by using distilled water using ethanol. The stock solution of all reagents have been prepared in the concentration 1.0×10^{-2}M. The HCl and NaOH used was supplied by SD fine chemical laboratories.

2.2 General Procedure

All experiments are carried out at room temperature 30± 2 ^{o}C. The CPB solution was first added to the PGR solution and kept for equilibration for half an hour. The metal solution was then added in the dye-surfactant solution and kept for half an hour for complete equilibration. This order of mixing of solution was maintained throughout the investigation.

3. Result and Discussion

It has been considered necessary to have prior information on the nature of interaction between PGR and CPB before evaluating the PGR as sensitive reagent for the estimation of Lead in the presence of CPB. Therefore, absorption spectra of PGR in absence and presence of CPB, composition of dye-surfactant complex, absorption spectra of lead in absence and presence of CPB, effect of pH, composition of the chelates in absence and presence of CPB, have been studied.

3.1.1 Absorption spectra of PGR in the absence and presence of CPB

The color of PGR has been found to be different at different pH values. The addition of CPB brings about a slight change in color of PGR at the same pH value. The absorption spectra of PGR, has been therefore, studied at different pH values (3.0 to 10.0) in the absence and presence of CPB. The wavelength of maximum absorbance of PGR in the absence and presence of CPB are summarized in table 1.

Absorption spectra of alkaline PGR solution at pH 8.0 show a characteristics maximum at 580 nm in presence of CPB with the increase in the absorbance value. This may be due to the formation of dye-detergent complex.

Table 1: Wavelengths of maximum absorbance of PGR in the presence and absence of CPB.

PGR		PGR + CPB	
pH	**Λmax (nm)**	**pH**	**Λmax (nm)**
1.0-3.0	480	1.0-3.0	480
4.0-4.5	520	4.0-4.5	520
5.0-12.0	560	5.0-12.0	600

3.1.2 Composition of PGR-CPB Complex

The effect of varying CPB concentration on the absorbance of PGR has been studied in basic medium at pH 8.0, at λ_{max}, 440 nm where the maximum discoloration takes place. The absorbance of different concentrations of PGR is plotted against the variable concentration CPB. It has been observed that the two times higher concentration of CPB required for complete decolorization of PGR. Thus, the ratio of PGR: CPB will be 1:2 the modified reagent species thus formed, May therefore, be written as [PGR $(CPB)_2$].

3.1.3 Absorption Spectra of Lead-PGR Chelates in Presence and Absence of CDMEAB

A series of solutions were prepared keeping the ratio of Pb^{2+}: PGR:CPB as 1:1:5 and 4:1:5. A number of sets were prepared for each ratio and pH was adjusted to 3.0 to 10.0. The absorption Spectra were recorded in the entire visible region from 400 nm to 700 nm. Absorbance maxima of PGR and its complexes with Lead in the absence and presence of CPB have been summarized at different pH values in table 2.

Table 2: Absorbance Maxima (nm) of PGR and its chelates in the absence and presence of CPB at different pH. Absorption Spectra of Pb-PGR Chelates in Absence and Presence of CPB

System/pH	4.0	5.0	6.0	7.0
PGR	520	560	560	560
PGR + CPB	520	600	600	600
PGR + Pb^{2+}	520	520	620	620
PGR + CPB + Pb^{2+}	540	540	660	660

The absorption spectra of PGR shows peak at 440 nm in the presence of CPB in the pH range 3.0 to 5.0 but shows peak at 580 nm in the pH 8.0 to 10.0. In the pH range 3.0 to 7.0, in absence and presence of CPB, the wavelength maxima of PGR shows small no change in λ_{max} and absorbance values; indicating poor complexation. But, change in λ_{max} and increase in the absorbance value in pH range 8.0 to 10.0 show complex formation in absence and presence of CPB. By comparing the absorption spectra and the absorbance values of the reagent and complex in presence of CPB, it has been observed that the maximum complexation takes place at pH 8.0. Thus bath chromic shift of 140 nm in absence and 20nm

in the presence of CPB have been observed for Lead. The absorption spectra of lead chelate in absence and presence of CPB at pH 8.0 has been recorded in Fig 3

3.2 Effect of pH

Effect of pH on λ_{max} and on the absorbance, of the Lead complexes of PGR in the absence and presence of tenfold excess of CPB have been studied. It is found that the $\lambda_{max\ of}$ the complexes remain constant in the pH range 8.0 10.0 indicating pH range of stability of complex formation in presence and absence of CPB.

3.3 Composition of Chelates

The composition of the chelates has been studied by the Mole ratio method. solutions of Lead and PGR have been taken in two equimolar concentrations of $2.0x10^{-5}$ M and, $4.0x10^{-5}$ M; Five times excess of CPB has been then added for studying the composition in the presence of surfactant.

The stoichiometric composition between the Pb^{2+} and PGR in the presence and absence of CPB has been found to be 1:2. It has been observed that PGR reagent at pH 8.0 exists as [PGR $(CPB)_2$] and therefore, the composition of complexes in the presence of CPB may be written as $Pb^{2+}[PGR(CPB)_2]_2$ for lead.

$$Pb^{2+} + 2\ [PGR\ (CPB)_2] \rightleftharpoons Pb^{2+}[PGR(CPB)_2]_2$$

3.4 Analytical Applications of lead chelates with PGR in absence and in presence of CPB

3.4.1 Order of Addition of Reactants

The sequence of addition of reactants must be followed strictly. In all the experiments, CPB was first added to PGR solution. This solution was kept for at least 30 minutes for equilibration. To this solution of modified PGR, Pb^{2+} solution was then added which again kept for 30 minutes for complete formation of the ternary complex.

3.4.2 Rate of Color Formation and Stability of Color at Room Temperature

The color formation does not depend on reaction time and is almost instantaneous. However, the mixtures were kept for 30 minutes for equilibration. The temperature was found to have no effect on color intensity of ternary complexes from 20 ºC to 60 ºC.

3.4.3 Beer's Law and Effective Photometric Ranges

The linearity between the absorbance of the chelates and concentration of metal ion has been tested by taking the different volumes of metal ion solution (1.0 x 10^{-3} M in absence in presence of CPB). The final concentration of PGR taken was 2.0 x 10^{-5} M, of CPB was 1.0 x 10^{-4} M. Total volume was kept constant at 25ml at pH 8.0. The absorbance values were measured in the absence of CPB at 580 nm. However, in the presence of CPB, all the spectral measurement was made at 600 nm. The range of Beer's law is given in table 3 in absence and presence of CPB. The effective range for photometric determination was also calculated from this data by Ringbom (23) plot of log of metal ion concentration versus percentage transmittance. Thus, the range as derived by the slope of the curve is selected to be range for the effective photometric determination as given in table 3.

Table 4: Photometric Determination of Lead with PGR in the Absence and Presence of CPB. Photometric Determination of Pb-PGR Cheletes in presence and absence of CPB

PGR Cheletes	pH of Study	Wavelength of Study(nm)	Beers Law Range (ppm)	Effective Photometric range (ppm)	Molar Absorptivity	Sensitivity (µg/cm^2)
PGR + Pb^{2+}	6.5	600	0.517-3.619	1.551-2.585	3600	1.40
PGR + CPB + Pb^{2+}	6.5	660	0.517-4.136	1.034-3.619	5400	1.03

4. Conclusion

The spectrophotometeric determination of lead with Pyrogallol Red in the presence and absence of Cetylpyridinium Bromide has been studied. Following are the merits of modified method. The sensitization of PGR by the addition of CPB is clear from the fact that the formation of stable ternary complex with Lead occurs at pH range 6.0-7.0 with bath chromic shift in the λmax of Pb-PGR complexes in the presence of CPB. This change λmax and high absorbance value is attributed due to the formation of ternary complex system in the presence of CPB compared to the binary system in the absence of CPB. Due to the shifted λmax towards higher wavelength (From 620 nm to 660 nm) a large difference in the absorbance between the reagents blank (PGR + CPB) and its ternary complex results in enhancement of the sensitivities and molar absorptivities again indicate the great sensitivity of colour reaction. Further, the modified method requires smaller molar concentration of PGR over the metal ion concentration for full colour development and is instantaneous in the presence of CPB, again indicates the stability of the colour reaction. The modified reagent i.e. [PGR (CPB)2] has also been found to be extremely useful in the Complexometric titration of the Lead. This modified reagent act as sensitive metallochrome indicator giving a very sharp colour change at the end of complex metric titration. The increase in the sensitivity and absorptivity facilitate the determination of lead in the given photometric range.

5. Acknowledgments

Authors are thankful to Dr. A. L. Kulat, Principal, Shri Shivaji College of Arts, Commerce and Science, Akola for providing necessary facilities

6. References

1. Jan Krzek, Anna Apola, Mariusz Stolarczyk, Weodzimierz Rzeszueko. Medyczna Str. 30-688 KrakÛw, Poland; c2000.
2. Jankiewicz B, Ptaszyński B, Wieczorek M. Żwirki 36, 90-924 Łódź,Poland; c2000.
3. Badea, Luminita Vladescu, Cornelia Cercasov; c2001.
4. Escriche JM, Estelles ML, Cabeza AS; c2004.
5. Guozhen Fang, Shuangming Meng, Guizhi Zhang, Jiaomai Pan. Yanbei; Normal Institute, Datong 037000.
6. Guozhen Fang, Yongwen Liu, Shuangming Meng, Yong Guo; Talanta. 2002;57:1155-1160.
7. Anil Zade B, Pawan Kalbande P, Mayuri Umekar S, Gajanan Belsare W. E-Journal of Chemistry. 2012;9(4):2394-2406.

8. Belsare GW, Zade AB, Kalbande PP, Belsare PU. Der Pharma Chemica. 2012;4(3):1226-1238.
9. Upase AB, Zade AB, Kalbende PP. E-J Chem. 2011;8(3):1132-1141.
10. Upase AB, Zade AB, Kalbende PP, Belsare GW. J Indian Chem. Soc. 89.

IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

"Employing MEGA-X Software for DNA Barcoding to Evaluate Evolutionary Relations in the Fabaceae Family"

Nikhil B. Choukhande[1], P.P. Umale[2]

[1]**Research Scholer**, Department of Botany, Shri Shivaji College of Arts, Commerce & Science Akola.

[2] **Former Professor and Head**, Department of Botany, Shri Shivaji College of Arts, Commerce & Science Akola.

Abstract- DNA barcode is a short section of specific genes or genome. Over the last decade, three plant DNA barcode markers *rbc*L, *mat*K, and ITS2 have been developed and used to address basic questions in systematics, ecology, conservation, monitoring biodiversity, including taxonomic discovery and assessing priority areas for environmental protection. Therefore, in the present study we have constructed a phylogeny tree or cladistics for family Fabaceae with the help of DNA sequences by using *rbc*L (ribulose-bisphosphate carboxylase gene) as a DNA barcode marker with the help of **Mega-X** Software (Neighbour Joining Method). The DNA barcode *rbc*L provides the best discrimination power at species-level. Considering the overall performance of *rbc*L barcode, we suggest that the *rbc*L region is a suitable barcode (genetic marker) for Fabaceae family.

Keywords – DNA barcoding, Fabaceae, MEGA-X, Phylogeny, *rbc*L.

INTRODUCTION

Phylogeny is the study of relationships among different groups of organisms and their evolutionary development. Phylogeny attempts to trace the evolutionary history of all life on the planet. It is based on the phylogenetic hypothesis that all living organisms share a common ancestry. The relationships among organisms are depicted in what is known as a phylogenetic tree. Relationships are determined by shared characteristics, as indicated through the comparison of genetic, morphological and anatomical similarities (Brooks *et al.,*1991).

There are several types of data and ways that can be used to build phylogenetic trees: Traditionally, phylogenetic trees were built from morphological characters. Now a days, we are using mostly molecular data like DNA sequences and protein sequences (Patwardhan *et al.* 2014).

DNA barcoding is a molecular technique used to identify species using DNA code-based similarity in combination with morphological characters, which minimizes errors from conventional identification (Liu *et al*., 2017; Hebert *et al*. 2004) defined the DNA barcode as a short sequence used as a standard tool to identify the species to which an organism belongs. Its purpose is to provide a simple and automatic method to correctly identify species, with little or no recourse to taxonomic expertise. In recent years in operational terms DNA barcode was defined in a very well manner and it was explained as a genetic method for better taxonomical research (Goldstein *et al*.,2019).

The Fabaceae family is chosen for this analysis because it is one of the largest families of flowering plants with 750 genera and approximately 18,000 species (Wojciechowski *et al.*, 2004), and can serve as a model for such an approach. Fabaceae is the third largest family of flowering plant, which further subdivided into three widely accepted sub-families: the Caesalpiniodeae, the Mimosoideae and the Papilioniodeae. The high-quality protein source from the legumes can be substituted to dietary animal protein (Anderson *et al*., 1999). Wide range of secondary metabolites from leguminous plants have been utilized as nutraceuticals and various by-products have also been developed for industrial application including biofuels (Lewis *et al.*, 2005). Moreover, legumes were playing an important role in sustainable agriculture: managing soil fertility via symbiotic nitrogen fixation and used to grown as a rotation crop with cereal and vegetable (Arianoutsou and Thanos 1996; Velazquez *et al.* 2010). It is widely distributed on every continent and in a wide variety of habitats, and many species are agriculturally and economically important.

Now, it has been accepted facts that DNA barcodes could be used successfully for phylogenetic studies in specific plant group. With this view, the present work was planned to explore new possibilities to reconsider phylogenetics of some wild members of Fabaceae from Amravati Division, Maharashtra, India.

MATERIALS AND METHODS -

Collection of plants from study area - It was collected from different natural habitats from Washim and Akola districts of Vidarbha region (MS) India. The collected plant species were identified taxonomically by using flora of Vidarbha (Naik, 1998) and flora of Maharashtra (Karthikeyan and Singh, 2001).
In present work following plants were undertaken.

List of plants

1) *Indigofera cordifolia* Heyen Ex. Roth.
2) *Psoralea corylifolia* L.
3) *Acacia catechu* (L.f.)Willd.
4) *Tephrosia purpurea* (L.)Pers.

DNA barcoding of selected plant species:

DNA Barcoding was performed by "Rajiv Gandhi Centre for Biotechnology" (RGCB), Thycaud Post, Poojappura, Thiruvananthapuram - 695 014, Kerala, India

DNA Barcoding using universal primers of RBCL

I Protocols

DNA isolation using NucleoSpin® Plant II Kit (Macherey-Nagel)

About 100 mg of the tissue/mycelium is homogenized using liquid nitrogen and the powdered tissue is transferred to a microcentrifuge tube. Four hundred microlitres of buffer PL1 is added and vortexed for 1 minute. Ten microlitres of RNase A solution is added and inverted to mix. The homogenate is incubated at 65^{o}C for 10 minutes. The lysate is transferred to a Nucleospin filter and centrifuged at 11000 x g for 2 minutes. The flow through liquid is collected and the filter is discarded. Four hundred and fifty microlitres of buffer PC is added and mixed well. The solution is transferred to a Nucleospin Plant II column, centrifuged for 1 minute and the flow through liquid is discarded. Four hundred microlitre buffer PW1 is added to the column, centrifuged at 11000 x g for 1 minute and flow though liquid is discarded. Then 700 µl PW2 is added, centrifuged at 11000 x g and flow through liquid is discarded. Finally, 200 µl of PW2 is added and centrifuged at 11000 x g for 2 minutes to dry the silica membrane. The column is transferred to a new 1.7 ml tube and 50 µl of buffer PE is added and incubated at 65^{o}C for 5 minutes. The column is then centrifuged at 11000 x g for 1 minute to elute the DNA. The eluted DNA was stored at 4^{o}C.

Agarose Gel Electrophoresis for DNA Quality check

The quality of the DNA isolated was checked using agarose gel electrophoresis. 1µl of 6X gel-loading buffer (0.25% bromophenol blue, 30% sucrose in TE buffer pH-8.0) was added to 5µl of DNA. The samples were loaded to 0.8% agarose gel prepared in 0.5X TBE (Tris-Borate-EDTA) buffer containing 0.5

µg/ml ethidium bromide. Electrophoresis was performed with 0.5X TBE as electrophoresis buffer at 75 V until bromophenol dye front has migrated to the bottom of the gel. The gels were visualized in a UV transilluminator (Genei) and the image was captured under UV light using Gel documentation system (Bio-Rad).

PCR Analysis

Contents	Volume
2X Master Mix	5µL
D/W	4µL
Forward Primer	0.25µL
Reverse Primer	0.25µL
DNA	1µL

Primers used

Target	Primer Name	Direction	Sequence (5' → 3')
RBCL	RBCL-AF	Forward	ATGTCACCACAAACAGAGACTAAAGC
	RBCL-724R	Reverse	TCGCATGTACCTGCAGTAGC

The PCR amplification was carried out in a PCR thermal cycler (GeneAmp PCR System 9700, Applied Biosystems).

PCR amplification profile

RBCL

98 ºC - 30 sec
98 ºC - 5 sec
58 ºC - 10 sec } 40 cycles
72 ºC - 15 sec
72 ºC - 60 sec
4 ºC - ∞

Agarose Gel electrophoresis of PCR products

The PCR products were checked in 1.2% agarose gels prepared in 0.5X TBE buffer containing 0.5 µg/ml ethidium bromide. 1 µl of 6X loading dye was mixed with 4 µl of PCR products and was loaded and electrophoresis was performed at 75V power supply with 0.5X TBE as electrophoresis buffer for about 1-2 hours, until the bromophenol blue front had migrated to almost the bottom of the gel. The molecular standard used was 2-log DNA ladder (NEB). The gels were visualized in a UV transilluminator (Genei) and the image was captured under UV light using Gel documentation system (Bio-Rad).

ExoSAP-IT Treatment

ExoSAP-IT (GE Healthcare) consists of two hydrolytic enzymes, Exonuclease I and Shrimp Alkaline Phosphatase (SAP), in a specially formulated buffer for the removal of unwanted primers and dNTPs from a PCR product mixture with no interference in downstream applications. Five micro litres of PCR product is

mixed with 0.5µl of ExoSAP-IT and incubated at 37ºC for 15 minutes followed by enzyme inactivation at 85ºC for 5 minutes.

Sequencing using BigDye Terminator v3.1

Sequencing reaction was done in a PCR thermal cycler (GeneAmp PCR System 9700, Applied Biosystems) using the BigDye Terminator v3.1 Cycle sequencing Kit (Applied Biosystems, USA) following manufactures protocol.

The Sequencing PCR mix consisted of the following components:

D/W	6.6µL
5X Sequencing Buffer	1.9µL
Forward Primer	0.3µL
Reverse Primer	0.3µL
Sequencing Mix	0.2µL
Exosap treated PCR product	1µL

SequencingPCR amplification profile

96ºC - 2min
96ºC - 30sec
50ºC - 40sec } 30 cycles
60 ºC - 4min
4 ºC - ∞

Post Sequencing PCR Clean up

D/W	5 µl
3M Sodium Acetate	1 µl
EDTA	0.1 µl
100% Ethanol	44 µl

1. Mix D/W, 125mM EDTA, 3M sodium acetate pH 4.6 and ethanol were prepared and were properly mixed.
2. 50 µl of mix was added to each well in the sequencing plate containing sequencing PCR product.
3. Vortex by Mix mate vortex and incubated at room temperature for 30 minutes
4. Spun at 3700 rpm for 30 minutes
5. Decanted the supernatant and added 50 µl of 70% ethanol to each well
6. Spun at 3700 rpm for 20 minutes.
7. Decanted the supernatant and repeated 70% ethanol wash
8. Decanted the supernatant and air dried the pellet.
   The cleaned-up air dried product was sequenced in ABI 3500 DNA Analyzer (Applied Biosystems).

Sequence Analysis

The sequence quality was checked using Sequence Scanner Software v1 (Applied Biosystems). Sequence alignment and required editing of the obtained sequences were carried out using Geneious Pro v5.1 (Drummond *et al.*, 2010).

Lastly, **FASTA Forward** and **FASTA reverse** DNA sequences were obtained from RGCB in the form of **AB1 format**.

Phylogenetic analysis -

In order to assess phylogenetic relationship, phylogenetic trees were reconstructed in **MEGA -X** software, after appropriate model selection in the same software for each barcode, of all the studied species of Fabaceae family. The barcode marker i.e. *rbc*L were compared on the basis of the nodal bootstrap support in neighbor-joining (NJ) as well as in maximum-likelihood (ML) statistical methods (Tang *et al*., 2015; Xu *et al*., 2015; Zhang *et al*., 2015).

OBSERVATIONS

I - *Indigofera cordifolia Roth.*

Forward Sequences

>SR2837-A-RBCLF_E07.ab1
TTATAAATTGACTTATTATACTCCTGAGTATCAAACCAAAGATACTGATATCTTGGCAGCAT
TCCGAGTAACTCCTCAACCTGGAGTTCCTCCTGAAGAAGCAGGTGCCGCGGTAGCTGCTGA
ATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTGATCGTTACA
AAGGACGATGCTACCACATCGAGCCCGTTGCTGGAGAAGACAATCAATATATTGCTTATGT
AGCTTATCCTTTATACCTTTTTGAAGAAGGGTCTGTTACTAACATGTTTACTTCCATTGTAGG
TAATGTATTTGGATTCAAGGCCCTGCGCGCTCTACGTCTGGAGGATTTGCGAATCCCTATAT
CTTATATTAAAACTTTCCAAGGTCCTCCTCATGGTATCCAGGTTGAAAGAGATAAATTGAAC
AAGTATGGTCGTCCCCTATTGGGATGTACTATTAAACCTAAATTGGGATTATCTGCTATAAA
TTACAGTAGATCGGTTTAGGAATGTCTACGCGGGGGACTTGATTTTACCAAAGATGATGAA
AATG

Reverse Sequences

>SR2837-A-RBCLR_E08.ab1
TGCTTTAAAATTGCTTCGGCACAAAATAAGAAACGGTCTCTCCAACGCATAAATGGTTGGGA
ATTCACATTTTCATCATCTTTGGTAAAATCAAGTCCCCCGCGTAGACATTCATAAACCGCTCT
ACCGTAATTCTTAGCAGATAATCCCAATTTAGGTTTAATAGTACATCCCAATAGGGGACGAC
CATACTTGTTCAATTTATCTCTCTCAACCTGGATACCATGAGGAGGACCTTGGAAAGTTTTAA
TATAAGATATAGGGATTCGCAAATCCTCCAGACGTAGAGCGCGCAGGGCCTTGAATCCAAA
TACATTACCTACAATGGAAGTAAACATGTTAGTAACAGACCCTTCTTCAAAAAGGTCTAAAG
GATAAGCTACATAAGCAATATATTGATTGTCTTCTCCAGCAACGGGCTCGATGTGGTAGCAT
CGTCCTTTGTAACGATCAAGACTGGTAAGCCCATCGGTCCACACAGTTGTCCATGTACCAGT
AGAAGATTCAGCAGCTACCGCGGCACCTGCTTCTTCAGGAGGAACTCCAGGTTGAGGAGTT
ACTCGGAATGCTGCCAAGATATCAGTATCTTTGGTTTGATACTCAGGAGTATAATAAGTCAA
TTTATAATCTTTAACACCAG

Indigofera coralifolia

>**Consensus Sequences (By using Bio edit software)**

ACTTATTATACTCCTGAGTATCAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCT
GGAGTTCCTCCTGAAGAAGCAGGTGCCGCGGTAGCTGCTGAATCTTCTACTGGTACATGGACAACTGTGT
GGACCGATGGGCTTACCAGTCTTGATCGTTACAAAGGACGATGCTACCACATCGAGCCCGTTGCTGGAGA
AGACAATCAATATATTGCTTATGTAGCTTATCCTTTAKACCTTTTTGAAGAAGGGTCTGTTACTAACATGTTT
ACTTCCATTGTAGGTAATGTATTTGGATTCAAGGCCCTGCGCGCTCTACGTCTGGAGGATTTGCGAATCCCT
ATATCTTATATTAAAACTTTCCAAGGTCCTCCTCATGGTATCCAGGTTGARAGAGATAAATTGAACAAGTAT
GGTCGTCCCCTATTGGGATGTACTATTAAACCTAAATTGGGATTATCTGCTAAGAATTACGGTAGAGCGGTT
TATGAATGTCTACGCGGGGGACTTGATTTTACCAAAGATGATGAAAATGTGAATTCCCAACCATTTATGCGT
TGGAGAGACCGTTTCTTATTTTGTG

II - *Psoralea corylifolia L.*

Forward Sequences

>SR2837-B-RBCLF_F07.ab1
ATTATAAATTGACTTATTATACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCAT
TCCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGTGCTGCGGTAGCCGCCGAA
TCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTGATCGTTACAAA
GGACGATGCTACCACCTTGAACCTGTTGCTGGGGAAGAAAATCAATATATTGCTTATGTAGC
TTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTCGGTAAT
GTATTTGGGTTCAAGGCCCTGCGCGCTCTACGTCTGGAGGATTTGCGAATCCCTACTGCTTAT
ATTAAAACTTTCCAAGGTCCGCCTCATGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTA
TGGTCGTCCCCTATTAGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTATGG
TAGAGCAGTTTATGAATGTCTTCGTGGGGGACTTGATTTTACCAAAGATGATGAAAATGTGA
ATTCCCAACCATTTATGCGTTGGAGAGACCGTTTCTTATTTTGTGCCGAAGCTCTGTTTAAAG
CACAGGCTGAAACAGGTGAAATCAAAGGGCATA

Reverse Sequences

>SR2837-B-RBCLR_F08.ab1
AGCCTGTGCTTTAAAAAGAGCTTCGGCACAAAATAAGAAACGGTCTCTCCAACGCATAAA
TGGTTGGGAATTCACATTTTCATCATCTTTGGTAAAATCAAGTCCCCCACGAAGACATTCA
TAAACTGCTCTACCATAATTCTTAGCGGATAACCCCAATTTAGGTTTAATAGTACATCCTA
ATAGGGGACGACCATACTTGTTCAATTTATCTCTCTCAACTTGGATGCCATGAGGCGGACC
TTGGAAAGTTTTAATATAAGCAGTAGGGATTCGCAAATCCTCCAGACGTAGAGCGCGCAG
GGCCTTGAACCCAAATACATTACCGACAATGGAAGTAAACATGTTAGTAACAGAACCTTC
TTCAAAAAGGTCTAAGGGATAAGCTACATAAGCAATATATTGATTTTCTTCCCCAGCAAC
AGGTTCAAGGTGGTAGCATCGTCCTTTGTAACGATCAAGACTGGTAAGCCCATCGGTCCA
CACAGTTGTCCATGTACCAGTAGAAGATTCGGCGGCTACCGCAGCACCTGCTTCTTCAGG
CGGAACTCCAGGTTGAGGAGTTACTCGGAATGCTGCCAAGATATCAGTATCTTTGGTTTCA
TAGTCAGGAGTATAATAAGTCAATTTATAATCTTTAACACCAGCTTTGAACCCAACACTA

Psoralea corylifolia

>Consensus Sequences (By using Bio edit software)

ACTCCTGACTATGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCC
GCCTGAAGAAGCAGGTGCTGCGGTAGCCGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGAT
GGGCTTACCAGTCTTGATCGTTACAAAGGACGATGCTACCACCTTGAACCTGTTGCTGGGGAAGAAAATC
AATATATTGCTTATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCAT
TGTCGGTAATGTATTTGGGTTCAAGGCCCTGCGCGCTCTACGTCTGGAGGATTTGCGAATCCCTACTGCTT
ATATTAAAACTTTCCAAGGTCCGCCTCATGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGT
CCCCTATTAGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTATGGTAGAGCAGTTTATGAAT
GTCTTCGTGGGGGGACTTGATTTTACCAAAGATGATGAAAATGTGAATTCCCAACCATTTATGCGTTGGAGA
GACCGTTTCTTATTTTGTGC

III - *Acacia catechu* (L.f.) Willd.

Forward Sequences

>SR3027-C-RBCLF_B07.ab1
AGATTATAAATTGACTTATTATACTCCTGACTATGAAACCAAGGATAGTGATATCTTGGCA
GCATTCCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCGGGTGCCGCGGTAGCTG
CTGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTGATCG
TTACAAAGGACGATGCTACCACATCGAGCCCGTTGCTGGAGAAGAAAGTCAATTTATTGCT
TATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTCGAT
TGTGGGTAATGTATTTGGGTTCAAGGCCCTGCGCGCTCTACGTCTGGAAGATTTGCGAATC
CCTCCTTCTTATTCTAAAACTTTCCAAGGTCCGCCTCACGGCATCCAAGTTGAAAGAGATA
AATTGAACAAGTACGGCCGTCCCCTATTGGGATGTACTATTAAACCAAAATTGGGGTTATC
CGCGAAGAATTACGGTAGAGCGGTTTATGAATGTCTCCGTGGTGGACTTGATTTTACCAAA
GATGATGAGAATGTGAATTCCCAACCATTTATGCGTTGGAGAGACCGTTTCTTATTTTGTGC
CGAAGCAATTTATAAAGCACAGGCCGAAACAGGTGAGA

Reverse Sequence

>SR3027-C-RBCLR_B08.ab1
TGTTTCGGCCTGTGCTTTATAAATTGCTTCGGCACAAAATAAGAAACGGTCTCTCCAACGCAT
AAATGGTTGGGAATTCACATTCTCATCATCTTTGGTAAAATCAAGTCCACCACGGAGACATT
CATAAACCGCTCTACCGTAATTCTTCGCGGATAACCCCAATTTTGGTTTAATAGTACATCCCA
ATAGGGGACGGCCGTACTTGTTCAATTTATCTCTTTCAACTTGGATGCCGTGAGGCGGACCTT
GGAAAGTTTTAGAATAAGAAGGAGGGATTCGCAAATCTTCCAGACGTAGAGCGCGCAGGGC
CTTGAACCCAAATACATTACCCACAATCGAAGTAAACATGTTAGTAACAGAACCTTCTTCAA
AAAGGTCTAAGGGATAAGCTACATAAGCAATAAATTGACTTTCTTCTCCAGCAACGGGCTCG
ATGTGGTAGCATCGTCCTTTGTAACGATCAAGACTGGTAAGCCCATCGGTCCACACAGTTGT
CCATGTACCAGTAGAAGATTCAGCAGCTACCGCGGCACCCGCTTCTTCAGGCGGAACTCCAG
GTTGAGGAGTTACTCGGAATGCTGCCAAGATATCACTATCCTTGGTTTCATAGTCAGGAGTAT
AATAAGTCAATTTATAATCTTTAACACCAGCTTTGAATCCAA

Acacia catechu

>Consensus Sequences (By using Bio edit software)

CTGACTATGAAACCAAGGATAGTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCGCCT
GAAGAAGCGGGTGCCGCGGTAGCTGCTGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGC
TTACCAGTCTTGATCGTTACAAGAKGACGATGCTACCACATCGAGCCCGTTGCTGGAGAAGAAAGTCAAT
TTATTGCTTATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTCGATTGT
GGGTAATGTATTTGGGTTCAAGGCCCTGCGCGCTCTACGTCTGGAAGATTTGCGAATCCCTCCTTCTTATTC
TAAAACTTTCCAAGGTCCGCCTCACGGCATCCAAGTTGAAAGAGATAAATTGAACAAGTACGGCCGTCCC
CTATTGGGATGTACTATTAAACCAAAATTGGGGTTATCCGCGAAGAATTACGGTAGAGCGGTTTATGAATGT
CTCCGTGGTGGACTTGATTTTACCAAAGATGATGAGAATGTGAATTCCCAACCATTTATGCGTTGGAGAGA
CCGTTTCTTATTTTGTGC

IV - *Tephrosia purpurea* (L.) Pers.

Forward Sequences

>SR3027-D-RBCLF_A07.ab1
GGTGTTAAGATTATAAATTGAATTATTATACTCCTGACTATGAAACCAAAGATACTGATATC
TTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGTGCTGCAGT
AGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCTTACCAGTCTTG
ATCGTTACAAAGGACGATGCTACCACATCGAACCCGTTGCTGGAGAAGAAAATCAATATAT
TGCTTATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAATATGTTTACTTCC
ATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTTTGGAGGATTTGCGAAT
CCCCAATTCTTATATTAAAACTTTCCAAGGTCCACCTCATGGTATCCAAGTTGAAAGAGATA
AATTGAACAAGTATGGACGTCCCTTATTGGGATGTACTATTAAACCTAAATTGGGGTTATCC
GCAAAGAATTATGGTAGAGCGGTTTATGAATGTCTACGTGGGGGACTTGATTTTACCAAAGA
TGATGAAAATGTGAATTCCCAACCATTTATGCGATGGAGAGACCGTTTCTTATTTTGTGCAG
AAGCTCTTTTTAAATCACAGGCTGAAACGGGTGAAATCAAAGGGCAA

Reverse Sequences

>SR3027-D-RBCLR_A08.ab1
CGTTTCAGCCTGTGATTTAAAAAGAGCTTCTGCACAAAATAAGAAACGGTCTCTCCATCGCA
TAAATGGTTGGGAATTCACATTTTCATCATCTTTGGTAAAATCAAGTCCCCCACGTAGACAT
TCATAAACCGCTCTACCATAATTCTTTGCGGATAACCCCAATTTAGGTTTAATAGTACATCCC
AATAAGGGACGTCCATACTTGTTCAATTTATCTCTTTCAACTTGGATACCATGAGGTGGACC
TTGGAAAGTTTTAATATAAGAATTGGGGATTCGCAAATCCTCCAAACGTAGAGCACGCAGG
GCTTTGAACCCAAATACATTACCTACAATGGAAGTAAACATATTAGTAACAGAACCTTCTTC
AAAAAGGTCTAAGGGATAAGCTACATAAGCAATATATTGATTTTCTTCTCCAGCAACGGGTT
CGATGTGGTAGCATCGTCCTTTGTAACGATCAAGACTGGTAAGCCCATCGGTCCACACAGTT
GTCCATGTACCAGTAGAAGATTCGGCAGCTACTGCAGCACCTGCTTCTTCAGGCGGAACTCC
AGGTTGAGGAGTTACTCGGAATGCTGCCAAGATATCAGTATCTTTGGTTTCATAGTCAGGAG
TATAATAATTCAATTTATAATCTTTAACACCAGCCTTGAACCCACC

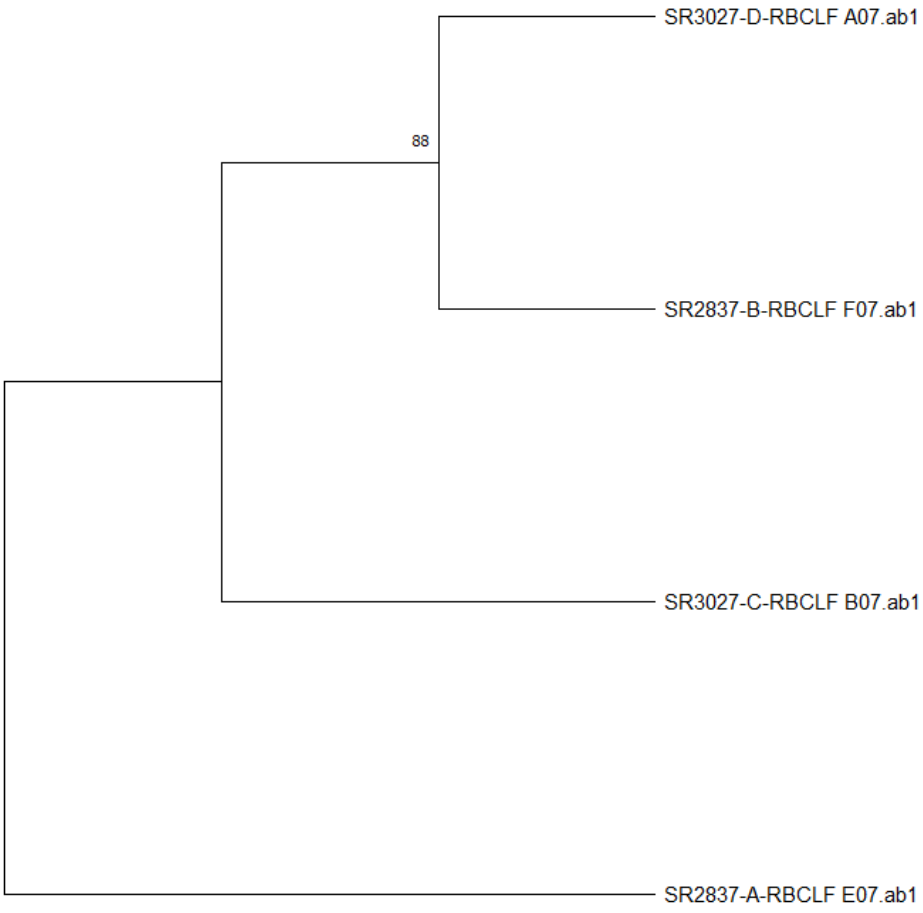
> *Tephrosia purpurea*

>Consensus Sequences (By using Bio edit software)

TGACTATGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCGCCTG
AAGAAGCAGGTGCTGCAGTAGCTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGGCT
TACCAGTCTTGATCGTTACAAAGGACGATGCTACCACATCGAACCCGTTGCTGGAGAAGAAAATCAATATA
TTGCTTATGTAGCTTATCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAATATGTTTACTTCCATTGTAGG
TAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTTTGGAGGATTTGCGAATCCCCAATTCTTATATTAA
AACTTTCCAAGGTCCACCTCATGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGACGTYYCTTAT
TTTGTGSAGAWGCTMYTWTTAAAYCTAMATTGGGGTTATCCGCAAAGAATTATGGTAGAGCGGTTTATGA
ATGTCTACGTGGGGGACTTGATTTTACCAAAGATGATGAAAATGTGAATTCCCAACCATTTATGCGATGGA
GAGACCGTTTCTTATTTTGTGCA

RESULT-

Following phylogenetic tree was constructed by using **MEGA-X** software using DNA barcoding sequences.



Where,
SR2837-A-RBCLF_E07.ab1 Indigofera cordyfolia
SR2837-B-RBCLF_F07.ab1 Psoralea corylifolia
SR3027-C-RBCLF_B07.ab1 Acacia catechu
SR3027-D-RBCLF_A07.ab1 Tephrosia purpurea

Evolutionary relationships of taxa-

The evolutionary history was inferred using the Neighbor-Joining method (Saitou *et al*.,1987). The optimal tree is shown. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (500 replicates) are shown next to the branches (Felsenstein,1985). The evolutionary distances were computed using the Maximum Composite Likelihood method (Tamura *et al*.,2004) and are in the units of the number of base substitutions per site. This analysis involved 4 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All ambiguous positions were removed for each sequence pair (pairwise deletion option). There was a total of 669 positions in the final dataset. Evolutionary analyses were conducted in **MEGA X (**Kumar *et al.*,2018).

DISCUSSION

While studying the evolutionary tree of taxa, it was found that, out of four plant species, *Indigofera cordyfolia* was evolved earlier and *Psoralea corylifolia* and *Tephrosia purpurea* were sister group and *Acacia catechu* was the outgroup of sister group with Bootstrap value 88.

In other word, we called it as a ***Indigofera cordyfolia*** was evolved earlier, after that ***Acacia catechu*** was evolved and ***Psoralea corylifolia*** and ***Tephrosia purpurea*** was evolved together.

CONCLUSION

From above study, it was concluded that, the DNA Barcoding is the best technique to construct phylogeny of plants with the help of **MEGA -X** software.

REFERENCES

- Anderson JW, Smith BM, Washnock CS. 1999. Cardiovascular and renal benefits of dry bean and soybean intake. Am. J. Clin. Nutr. 70: 464s-474s.
- Arianoutsou M, Thanos CA. 1996. Legumes in the fire-prone Mediterranean regions: An example from Greece. Int. J. Wildland Fire 6: 77-82.
- BigDye Terminator v3.1 Cycle sequencing Kit – User Manual, Applied Biosystems.
- Brooks, D. R., McLennan, D. A., & McLennan, D. A. (1991). *Phylogeny, ecology, and behavior: a research program in comparative biology*. University of Chicago press.
- Drummond, A. Kearse, M., Moir, R., Wilson, A., Stones-Havas, S., Cheung, M., Sturrock, S., ... & (2010). Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics*, *28*(12), 1647-1649.
- ExoSAP-IT – User Guide, GE Healthcare
- Felsenstein J. (**1985**). Confidence limits on phylogenies: An approach using the bootstrap. *Evolution* **39**:783-791.
- Goldstein, P. Z., & DeSalle, R. (2019). Review and interpretation of trends in DNA barcoding. Frontiers in Ecology and Evolution, 7, 302.
- Hebert, P.D.N.; Penton, E.H.; Burns, J.M.; Janzen, D.H.; Hallwachs, W. (2004) Ten species in one: DNA barcoding reveals cryptic species in the neotropical skipper butterfly Astraptes fulgerator. Proc. Natl. Acad. Sci. USA 2004, 101, 14812–14817.
- Kumar S., Stecher G., Li M., Knyaz C., and Tamura K. (**2018**). MEGA X: Molecular Evolutionary Genetics Analysis across computing platforms. *Molecular Biology and Evolution* **35**:1547-1549.
- Lewis G, Schrire B, Mackinder B, Lock M. 2005. Legumes of the world. Royal Botanic Gardens, Kew, United Kingdom. pp.577.
- Liu ZF, Ci XQ, Li L. 2017. DNA barcoding evaluation and implications for phylogenetic relationships in Lauraceae from China. PloS ONE. 12(4): 1-20.
- Naik, V. N. (1998). Flora of Marathwada, Amrut Prakashan, Aurangabad (MS) India.

- Patwardhan, A., Ray, S., & Roy, A. (2014). Molecular markers in phylogenetic studies-a review. *Journal of Phylogenetics & Evolutionary Biology*, *2014*.
- Saitou N. and Nei M. (**1987**). The neighbor-joining method: A new method for reconstructing phylogenetic trees. *Molecular Biology and Evolution* **4**:406-425.
- Singh, N. P., & Karthikeyan, S. (2001). Flora of Maharashtra. *Vol. II. Series*, *2*, 31.
- Tamura K., Nei M., and Kumar S. (**2004**). Prospects for inferring very large phylogenies by using the neighbor-joining method. *Proceedings of the National Academy of Sciences* (*USA*) **101**:11030-11035.
- Tang GD, Zhang GQ, Hong WJ, Liu ZJ, Zhuang XY. (2015). Phylogenetic analysis of Malaxideae (Orchidaceae: Epidendroideae): two new species based on the combined nrDNA ITS and chloroplast matK sequences. Journal of Guangxi Plant Science 35:447–463 DOI 10.11931/guihaia.gxzw201506015.
- Velazquez E, Silva LR, Alvaro P. 2010. Legumes: a healthy and ecological source of flavonoids. Curr. Nutr. Food Sci. 6: 109-144.
- Wojciechowski, M. F., Lavin, M., & Sanderson, M. J. (2004). A phylogeny of legumes (Leguminosae) based on analysis of the plastid matK gene resolves many well-supported subclades within the family. *American journal of botany*, *91*(11), 1846-1862.
- Xu S, Li D, Li J, Xiang X, Jin W, Huang W, Jin X, Huang L. 2015. Evaluation of the DNA barcodes in Dendrobium (Orchidaceae) from mainland Asia. PLOS ONE 10:e0115168 DOI 10.1371/journal.pone.0115168.
- Zhang J, Chen M, Dong X, Lin R, Fan J, Chen Z. 2015. Evaluation of four commonly used DNA barcoding loci for Chinese medicinal plants of the family Schisandraceae. PLOS ONE 10:e0125574 DOI 10.1371/journal.pone.0125574.

Opportunities in Research for Generative Artificial Intelligence (GenAI), Challenges and Future Direction: A Study

J. D. Chavan[1], C. R. Mankar[2], Dr. V. M. Patil[3]

[1] Student, [2] Research Scholar, [3] Research Guide
[1,2,3] Department of Computer Science, Shri Shivaji college, Akola

---

Abstract: The use of Generative Artificial Intelligence as a tool is growing tremendously, as GenAI helps users to generate results and apply them in various areas like research, new images, etc. GenAI has received attendance from users working in different areas like artists, researchers, and academicians where they found a tool that gives them the desired result to achieve their goal, during their work they came across a point where they found no way to go ahead. Here GenAI helped by guiding them to complete the work. The objective of AIGC is to expedite the generation of high-quality content by streamlining and simplifying the process of content creation. AIGC is accomplished by taking human instructions and deriving intent information from them, then using that information to generate content based on its expertise. The paper organization includes the introduction to GenAI, history, types of GenAI, its application and challenges, revie of literatures and future direction.

Keywords: GenAI, GAN, VAE, Machine Learning, Deep Learning.

I. Introduction:

The GenAI is not new for all but the term was available publicly in 2022 as a chatbot called ChatGPT. The working ChatGPT is based on the learning AI model which uses a provided dataset from which the designed algorithm works, understands, classifies, and then from the appropriate learning gives the result. The GenAI is modelled such that it adopts the feature of self-learning from the dataset, also nowadays various deep learning models like VAEs, and GANs are seen to be used. GenAI gives creativity, innovation, and the ability to solve problems with new content.

- **What is GenAI:** AIGC is accomplished by taking human instructions, deriving meaning from them, and using that aimed information to create content depending on its knowledge and understanding. Large-scale models have grown in significance in AIGC in recent years because they enable superior intent extraction and thus, better generation outcomes. The distribution that the model can learn becomes more extensive and true to reality as data and model sizes increase, resulting in the creation of higher-quality and more realistic content. This survey offers a thorough analysis of the development of generative models over time, as well as an overview of their fundamental elements and current developments in AIGC from unimodal to multimodal interaction. We provide the generation tasks and related text and image models from the standpoint of unimodality.

II. History of AI and Generative:

Generative AI, also known as generative modelling, is a branch of artificial intelligence (AI) focused on creating models capable of generating new data that is similar to a given dataset. This field has a rich history spanning several decades, with significant advancements made in recent years due to developments in deep learning and neural networks. Below is a detailed overview of the history of generative AI:

The 2010s witnessed significant breakthroughs in generative AI, largely driven by advancements in deep learning. Variational autoencoders (VAEs), introduced by Kingma and Welling in 2013, provided a probabilistic framework for learning latent data representations.

Generative adversarial networks (GANs), proposed by Ian Goodfellow et al. in 2014, introduced a novel approach to generative modelling based on adversarial training.

GANs consist of two neural networks, a generator and a discriminator, trained simultaneously in a minimax game framework, where the generator learns to generate realistic data while the discriminator learns to distinguish between real and generated data. GANs have demonstrated remarkable success in generating high-quality images, audio, text, and other types of data, leading to widespread applications in art generation, image synthesis, and data augmentation

Transformer models, introduced by Vaswani et al. in 2017, revolutionized natural language processing (NLP) by enabling efficient parallelization and capturing long-range dependencies in text. Large language models such as Open Ai's GPT (Generative Pre-trained Transformer) series have pushed the boundaries of generative AI by training on vast amounts of text data and achieving human-level performance on various NLP tasks, including text generation, summarization, and translation.

III. Different types and subtypes:

The various GenAI Tools are classified into unimodal and multimodal respectively.

Unimodal models are those models which are implemented for single mode, they can be used to for generating images, variational autoencoders (VAEs), GANs are its examples.

Multimodal models are those which are capable of processing and generating functionality, such as generating an image from text which describes the image, example Leonardo AI. According to the different implementation of GenAI are classified as below.

Type	Subtypes
Probabilistic Models	- Markov Models – Hidden Markov Models – Bayesian Networks – Markov Random Fields
Deep Learning Models	- Autoencoders – Generative Adversarial Networks (GANs) – Autoregressive Models
	- Transformers
Neural Network	- Recurrent Neural Networks (RNNs) – Convolutional Neural Networks (CNNs) – Attention Mechanisms
Application-Specific	- Text Generation Models – Image Generation Models – Music Generation Models
Models	- Video Generation Models

Table 1. Types of GenAI

IV. Application and uses:

With the widespread of GenAI, it is being used in various areas like Deep Learning Models, Neural Networks, Arts, Music, Video Making,

Application	Uses	Challenges
Art Generation	- Creating paintings, sculptures, etc.	- Ensuring originality and creativity
	- Generating digital artwork	- Maintaining consistency in style and quality
Image Synthesis	- Generating realistic images	- Avoiding artefacts and distortions in generated images
	- Data augmentation for training	- Ensuring diversity and relevance of generated images
Natural Language Generation	- Text completion	- Maintaining coherence and context in the generated text
	- Content summarization	- Addressing biases and stereotypes in language generation
Music Composition	- Creating melodies, harmonies, etc.	- Capturing musical structure and emotion in compositions
	- Generating background music	- Ensuring uniqueness and variety in generated music
Video Generation	- Creating animations, simulations	- Handling temporal coherence and motion in videos
	- Generating synthetic data	- Managing computational complexity for high-resolution videos

Table 2. Applications and uses GenAI

V. Literature reviewed:

.

[1]. The paper provides a detailed overview and key concepts through his survey, also including various techniques and applications of GenAI, exploring the history and development of GenAI, and milestones such as GANs, AIGC, and VAEs used today. provides language models, learning and developmental models like Chat GPT. The survey gives various applications of AIGC in different domains from image generation using text, also generating text and music compositions for the users, emphasizing addressing issues while using GenAI technology. the author has also provided a classification of the GenAI on the various parameters and differentiating them based on unimodal model and multimodal model.

[2]. The paper introduces a novel framework for generating generative models based on adversarial learning: GANs. GANs are a combination of two neural networks, a generator and a discriminator, trained in the minimax game framework at the same time. The generator learns to generate realistic data samples, while the discriminator learns to distinguish between actual and generated samples. Since then, GANs have become a cornerstone of generative AI research and have led to many uses in image synthesis as well as text creation.

[3]. This influential paper introduces Variational Autoencoders (VAEs), a powerful generative model that combines ideas from variational inference and neural networks. VAEs will learn a probabilistic latent representation of the input data and will be able to generate new samples by sampling the learned distribution. The paper shows how the VAE framework has been developed in detail and demonstrates its ability to produce accurate images and texts.

[4]. The Transformer architecture, a novel neural network architecture based on fully autonomous mechanisms of attention, is presented in this paper. In the various tasks of natural language processing, including machine translation, text understanding and word comprehension, the Transformer model achieves state-of-the-art performance. The paper's introduction of self-attention mechanisms revolutionized the field of sequence modelling and paved the way for large-scale pre-trained language models such as BERT and GPT.

[5]. Progressive growing of GANsProgressive growing of GANs, a technique for training GANs that gradually increases the resolution of images generated during training, is presented in this paper. By introducing a progressive training process and a multiscale architecture, progressive GANs address challenges such as mode failure and training instability. The approach will lead to significant improvements in the quality, stability and variation of the images produced.

[6]. This paper introduces StyleGAN, an innovative architecture for GANs that enables fine-grained control over the style and appearance of generated images. StyleGAN achieves state-of-the-art results in image synthesis tasks, allowing various visual attributes such as facial expressions, hairstyles and backgrounds to be manipulated. The paper's contributions to the generation and manipulation of images have an important impact on generative AI.

[7]. The current research in this paper provides valuable insight into the ability and uniqueness of AI chatbots, including ChatGPT, to produce scientific content in the humanities. However, these chatbots are often challenged by factual accuracy and uniqueness in complex areas such as humanities research, despite their impressive ability to generate languages. To understand the capabilities and limitations of AI chatbots, as well as to inform them about their proper integration into scholarly workflows, it is necessary to continue research in this area.

[8]. By exploring the enduring presence and social impacts of generative AI, this paper contributes to an active discussion on it. The importance of responsible development and deployment of generative AI, balancing innovation with ethical considerations, is underlined through the synthesis of existing research findings. To navigate the complex landscape of generative AI, and to ensure its benefit in society, it is necessary to continue interinstitutional research and dialogue.

[9] The paper by Takefuji is contributing to a growing body of literature on the application of generative AI for healthcare fraud detection and payment analysis. By leveraging advanced AI techniques, such as deep learning and data mining, Takefuji's approach offers a promising solution for identifying Medicare improper payments with high accuracy and efficiency. To advance the development of AI-driven solutions for fighting health fraud and protecting the integrity of government insurance schemes such as Social Security, continued research in this area is necessary.

[10]. The potential impact of generative AI on education, in particular from the point of view of management teachers, is explored in this paper. Lim et al. present a paradoxical perspective, questioning whether generative AI will lead to the downfall (Ragnarök) or transformation (reformation) of education. They take into account factors such as curriculum development, student engagement and the role of teachers in a technologically driven future to analyse the impact of generative AI on education.

[11]. The article addresses, in particular, ChatGPT and its potential threat to academic integrity, and concerns about the development of generative artificial intelligence. The paper examines the ethics of applying generative AI to academic contexts, such as detecting plagiarism and content generation. Eke addresses the challenges of the widespread use of digital intelligent tools in education and proposes strategies to safeguard intellectual integrity as technology progresses.

[12]. Walkowiak investigates the task interdependencies between generative AI systems and human workers, particularly in economic contexts. This paper examines how intelligent artificial intelligence can supplement and enhance human labour, resulting in enhanced productivity and efficiency. To assess the implications for employment rolls, skills requirements and income distribution, Walkowiak raises the potential benefits of integrating generative AI into various economic activities.

[13]. Kang and Yi's research focuses on multimodal approaches for second-language writers, which extend the capability of generative AI beyond text-based applications. The paper discusses how generative artificial intelligence can promote the development of writing skills for L2 learners by producing a variety of media, including text, images and audio. The potential of multimodal generative artificial intelligence for facilitating language learning and promoting creativeness among L2 writers is discussed by Kang and Yi, giving insight into innovative teaching methods.

VI. Challenges:

Some of the key challenges include:

- Quality and Diversity of Generated Output: Ensuring that generated samples are of high quality and diverse remains a significant challenge. Models may produce outputs lacking realism, and exhibit artefacts, or diversity, leading to repetitive or uninteresting results.

- Training Instability: Many generative models, particularly Generative Adversarial Networks (GANs), are prone to training instability. This instability can manifest as mode collapse, where the generator fails to produce diverse outputs, or as oscillations in training dynamics, leading to difficulties in convergence and optimization.

- Mode Collapse: Mode collapse occurs when the generator learns to produce only a subset of the possible outputs, ignoring other modes in the data distribution. This leads to a lack of diversity in generated samples and undermines the model's ability to capture the full complexity of the underlying data distribution.

- Evaluation Metrics: Evaluating the quality of generated samples is challenging, as traditional metrics such as accuracy or loss may need to adequately capture the diversity, realism, or semantic coherence of the generated output. Developing reliable evaluation metrics for generative models remains an active area of research.

- Ethical and Societal Implications: The ability of generative models to create realistic fake content raises ethical concerns, including the potential for misuse, misinformation, and manipulation. Addressing these concerns requires careful consideration of the societal impact of generative AI and the development of appropriate safeguards and regulations.

- Data Bias and Fairness: Generative models trained on biased or incomplete datasets may produce outputs that perpetuate or amplify existing biases present in the data. Ensuring fairness and mitigating bias in generative AI systems is essential for promoting inclusivity and equity.

- Computational Resources: Training deep generative models requires significant computational resources, including high-performance GPUs or TPUs and large-scale datasets. Access to such resources may pose challenges for researchers and organisations with limited computational infrastructure or budget.

- Interpretability and Explainability: Understanding how generative models generate output remains a challenge, particularly for complex deep-learning architectures. Improving the interpretability and explainability of generative AI systems is crucial for building trust and understanding their behaviour in real-world applications.

- Addressing these challenges requires interdisciplinary collaboration across fields such as machine learning, computer vision, natural language processing, and ethics. Continued research and innovation in generative AI will

be essential for overcoming these obstacles and unlocking the full potential of autonomous creativity and generative capabilities.

VII. Future direction:

- Enhanced Realism and Fidelity: Continued efforts will focus on improving the realism, fidelity, and diversity of generated content across various modalities, including images, text, audio, and video. This may involve developing more sophisticated generative models, novel training techniques, and better evaluation metrics to measure the quality of generated output.
- Controllable and Interpretable Generation: Future generative models are expected to offer greater control and interpretability over the generated output. This includes enabling users to specify desired attributes, styles, or characteristics of the generated content and designing models that provide insights into their decision-making process.
- Multimodal Generation: Generative models capable of synthesizing content across multiple modalities (e.g., text-to-image, image-to-text, text-to-audio) will become increasingly important. Multimodal generation opens new possibilities for creative expression and enables more immersive and interactive user experiences.
- Few-Shot and Zero-Shot Learning: Advancements in few-shot and zero-shot learning will enable generative models to generalize to new tasks or domains with limited or no training data. This will reduce the reliance on large annotated datasets and allow for more flexible and adaptable generative systems.
- Adversarial Robustness and Security: Addressing vulnerabilities to adversarial attacks and ensuring the robustness and security of generative models will be critical for real-world deployment. Future research will focus on developing techniques to defend against adversarial manipulation and safeguarding against the malicious use of generative AI.
- Ethical and Societal Implications: As generative AI becomes more pervasive, it will be essential to address ethical and societal implications, including privacy concerns, biases, fairness, and the responsible use of synthetic media. This will require interdisciplinary collaboration and the development of frameworks for ethical guidelines, regulation, and accountability.
- Continual Learning and Lifelong Adaptation: Generative models that can continually learn and adapt over time, incorporating new data and knowledge, will be essential for long-term deployment in dynamic real-world environments. This entails developing algorithms that can efficiently update and refine the model's representations without catastrophic forgetting.
- Human-AI Collaboration and Co-Creation: The future of generative AI may involve closer collaboration between humans and AI systems, enabling co-creation and symbiotic interaction. This includes designing tools and interfaces that facilitate intuitive interaction and creative collaboration between users and generative models.

Overall, the future of generative AI is characterized by ongoing innovation, interdisciplinary collaboration, and a focus on addressing real-world challenges and opportunities. By advancing the capabilities of generative models and ensuring their responsible and ethical use, we can unlock new frontiers in creativity, problem-solving, and human-computer interaction.

VIII. Conclusion:

This paper gives an overview of GenAI for the new researchers, to help them understand the GenAI, how it was introduced, and the challenges and future direction for the new research. This paper includes the history of GenAI, and the articles reviewed provide a overview of it. The researchers are advised to use GenAI tools for their research work as a helping tool instead of using it for writing research articles completely, as new AI generated text are detected by various newly introduce software and the quality of research work goes to low.

References:

1. Cao, Y., Li, S., Liu, Y., Yan, Z., Dai, Y., Yu, P. S., & Sun, L. (2023). A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT. *ArXiv*.

2. Ian Goodfellow, et al., "Generative Adversarial Networks" Advances in Neural Information Processing Systems" 2014

3. Diederik Kingma and Max Welling, "Auto-Encoding Variational Bayes", ICLR 2014

4. Ashish Vaswani et al., "Attention is All You Need", Proceeding 31st international conference on neural information processing system 2017

5. Tero Karras et al., "Progressive Growing of GANs for Improved Quality, Stability, and Variation", 2018

6. Tero Karras et al., "StyliGAN: A Style-Based Generator Architecture for Generative Adversarial Networks", 2019

7. Edisa Lozic, and Benjamin Stular, "Fluent but Not Factual: A Comparative Analysis of ChatGPT and other AI Chatbots Proficiency and Originality in Scientific Writing for Humanities", future Internet,2023

8. Henrik Skaug Saetra, "Generative AI: Here to stay, but for good?",Technoloy in Society,2023

9. Yoashiyasu Takefuji, "Generative AI for analysis and identification of Medicare improper payments by provider type and HCPC code", Exploratory Research in Clinical and Social Pharmacy, 2023

10. Weng Marc Lim, Asanka Gunasekara, Jessica Leigh Pallant, Jason Ian Pallant, Ekaterina Pechenkina, "Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators", The International Journal of Management Education,2023

11. Damian Okaibedi Eke, "ChatGPT and the rise of generative AI: Threat to academic integrity?", Journal of Responsible Technology,2023

12. Emmanuelle Walkowiak, "Task-interdependencies between Generative AI and Workers", Economics Letters, 2023

13. Joohoon Kang, Youngjoo Yi, "Beyond ChatGPT: Multimodal generative AI for L2 writers", Journal of Second Language Writing,2023

Biographies:



Mr. Jagdish D Chavan
PG-Student & AI ML Software Developer,
Department of Computer Science
Shri Shivaji College, Akola



Mr. Chandrakant R. Mankar
Research Scholar,
Department of Computer Science
Shri Shivaji College, Akola



Dr. Prof. Vinod M.Patil
Research Guide,
Department of Computer Science
Shri Shivaji College, Akola

Research on Chemical Intermediates
https://doi.org/10.1007/s11164-023-05169-2

New aroyl heterocyclic (*E*)-*N*′-((2-hydroxynaphthalen-1-yl)methylene)-4-oxopiperidine-1-carbohydrazide and its metal complexes: synthesis, spectroscopic, thermal, DFT, molecular docking and antimicrobial studies

Gajanan Dongare[1] · **Anand Aswar**[2]

Received: 11 September 2023 / Accepted: 16 October 2023
© The Author(s), under exclusive licence to Springer Nature B.V. 2023

Abstract

In order to resist the growth of human pathogenic microorganisms, a new N-heterocyclic ligand of (*E*)-*N*′-((2-hydroxynaphthalen-1-yl)methylene)-4-oxopiperidine-1-carbohydrazide was synthesised from the condensation reaction of 4-oxopiperidine-1-carbohydrazide and 2-hydroxynaphthalene-1-carbaldehyde in ethanol. Reaction of metal salt of $(M(II/III)\cdot Cl_2)\cdot nH_2O$ M = Cr(III), Fe(III), Mn(II), Co(II), Ni(II) and Cu(II) with ligand resulted in the formation the two types of complexes $[M(III)C_{17}H_{19}N_3O_5Cl]$ and $[M(II)C_{17}H_{20}N_3O_5Cl]$ which adopted octahedral geometry. The ligand was thoroughly characterized by elemental analysis, FT-IR, UV–Vis, NMR (^1H, ^{13}C) and HR-mass spectroscopy while the structure of metal complexes was confirmed on the basis of elemental analysis, UV–Vis spectra, molar conductivity, magnetic susceptibility, and TGA-DTA analysis. The ligand behaves as dibasic tridentate, linkages via phenolic-O, azomethine-N, enolic-O atoms in metal (III) complexes and as monobasic tridentate in metal (II) complexes. The decomposition pattern were ascertained by TG analysis, and kinetics accountability from Coats–Redfern relation. The compounds were excited at $\lambda_{ex} = 380$ nm and observed intense emission intensity at $\lambda_{em} = \lambda 527–533$ nm. SEM analysis was performed to observe their surface analysis. The molecular geometry optimization and quantum chemical properties have been retrieved from DFT. ADMET score have been predicted as a drug-likeness prospect from admetSAR. The molecular docking outcomes revealed the good binding score of ligand with Adenylate kinase, Peptide deformylase (bacterial enzymes) and DNA polymerase (fungal enzyme). The in vitro antimicrobial

✉ Anand Aswar
aswaranand@gmail.com

Gajanan Dongare
infogmdongare@gmail.com

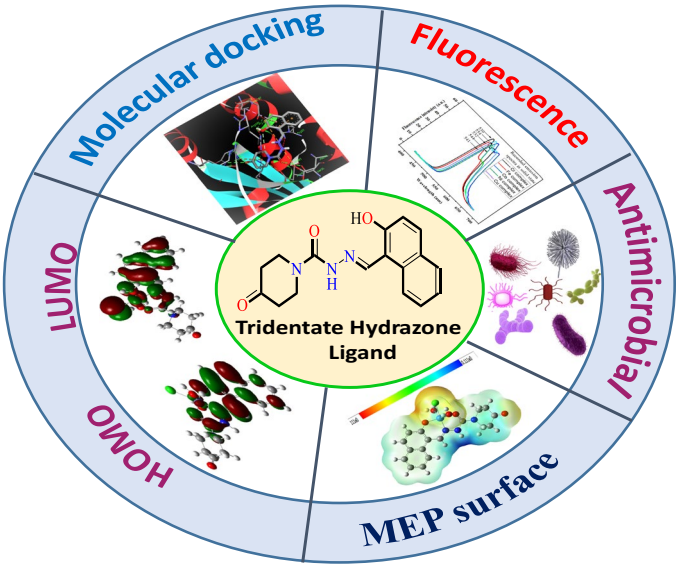
[1] Department of Chemistry, Shri Shivaji College of Arts, Commerce & Science, Akola 444001, MS, India

[2] Department of Chemistry, Sant Gadge Baba Amravati University, Amravati 444602, MS, India

Published online: 09 November 2023

potency of ligand and its metal complexes were carried against the bacterial species (*Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus, Bacillus substilis*), and fungal species (*Candida albicans*, *Aspergillus niger*) and showed their promising activity.

Graphical abstract



Keywords Aroyl hydrazone · Density functional theory · Fluorescence · Molecular docking · Thermo-kinetics · Antimicrobial evaluation

Introduction

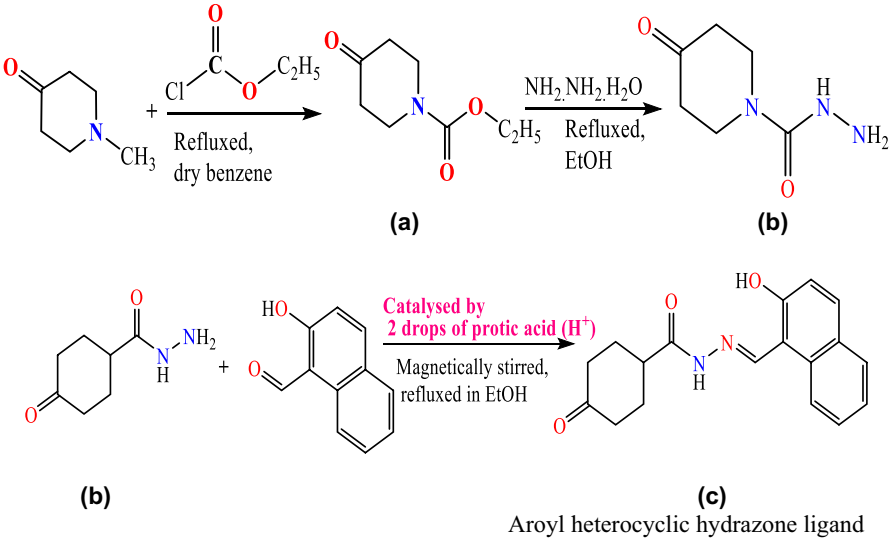
The aroyl tridentate hydrazones are a distinctive class of ligands (triatomic moiety (>C=N–N–C<) possesses flexible donor azomethine (>HC=N–) group that are effective metal ion chelators. They are perfect pioneers in biological, catalytic potential, increasing efficacy and decreasing toxicity. The structural motifs of aroyl hydrazone have been verified by their multifunctional potential in drug-design, favourable catalytic and ultra-trace detection of elements in biological samples [1–3]. In recent years, there is an enhanced interest in the chemistry of hydrazones and their complexes due to their wide range of antidepressant [4], antibacterial, antiviral, antifungal, analgesic, anti-inflammatory, anticonvulsant and antimalarial activities [5, 6]. The core structure of hydrazone ligand contains the nucleophilic imine, amino nitrogen, imine carbon (electrophilic and nucleophilic nature), and intrinsic character of (>C=N–) bond are played the distinctive role in various potential activities [7]. The functional diversity of aroyl hydrazone ligands are responsible for their

pharmacological as well as biological potentials, viz., tuberculosis, antitumoral [4, 8] anticoagulant, antiplatelet [9], and enzymatic inhibitors [10]. The structural tautomerism of hydrazone ligand is also responsible for enhancing their flexibility in donation (ONO) and capable to stable metal complex synthesis. A ligand system having electronegative atoms like nitrogen, oxygen, sulphur and halide atoms also enhances the coordination possibilities [11, 12]. Further, the hydrazone Schiff bases also exhibit numerous biological applications, such as insecticides, herbicides, rodenticides, nematicides and plant growth regulators [13]. Compared with simple hydrazone Schiff bases, aroyl or heteroaroyl Schiff base ligands have additional donor sites which introduces a wider range of properties for these molecules [14]. To the best of our knowledge, there is no such report was found in the literature on synthesis of aroyl hydrazone bearing 4-oxopiperidone moiety and therefore our interest has been grown up to synthesis of importance associated hydrazone ligand and its metal complexes. Such tridentate ligand displayed their better coordinating properties with metal ions showing the pharmacological potential, fluorescence, thermo-kinetic stability. Furthermore, the aroyl hydrazones ligands demonstrated a paramount role in the field of medicinal chemistry as the iron chelators in vivo as well as in vitro for the iron overload treatment. The excellent biological sensitivities of aroyl hydrazones and their mode of chelation with transition metal ions present in living systems have been of significant interest. Additionally, aroyl carbohydrazone are known to have strong chelating properties resulting in the several geometries, e.g. bidentate to multidentate linkages via ONO and N_2O_4, NO donor system. The metal complexes of Mn(II)L, Co(II)L, Ni(II)L, Cu(II)L and Cr(III) L and Fe(III)L have been displayed role in the various diseases belonging to the antioxidant, DNA and cytotoxicity [15]. Therefore, it is envisaged that the 4-oxopiperidone moiety involving in the hydrazide, (*E*)-*N*′-((2-hydroxynaphthalen-1-yl) methylene)-4-oxopiperidine-1-carbohydrazide ligand (H_2L,C) (Scheme 1) and its metal complexes would result in compounds of interesting biological activities. Consequently, in the light of the foregoing details and as a continual of our work on the synthesis of Schiff base complexes, here we report synthesis, spectroscopic characterization, thermal behaviours and the antimicrobial susceptibility of Cr(III) L, Fe(II/III)L Mn(II)L, Co(II)L, Ni(II)L and Cu(II)L complexes with above ligand. DFT calculation has made to confirm the molecular structures and to determine the quantum chemical parameters. Moreover, in silico molecular docking has been used to determine possible binding interaction of the ligand with gram-positive bacteria (*E. coli*) and fungal protein. In addition to above, an in silico-ADMET prediction has also been presented for the development of future potential research, pharmacological applications and drug developments.

Experimental

Materials

The analytical grade reagents of 1-methylpiperidin-4-one (≥98%), 1-Chloroethyl carbonochloridate (≥95%) from, 2-hydroxynaphthalene-1-carbaldehyde (≥98%)



Scheme 1 Synthesis of ethyl 4-oxopiperidine-1-carboxylate (**a**), 4-oxopiperidine-1-carbohydrazide (**b**) and (*E*)-*N*′-((2-hydroxynaphthalen-1-yl)methylene)-4-oxopiperidine-1-carbohydrazide ligand (H_2L, **c**)

were purchased from Fischer Scientific Ltd India, TCI Chemicals Ltd. India, Alpha Aesar (Great Britain) respectively. The metal salts of chromium chloride hexahydrate, manganous chloride tetrahydrate, ferric chloride hexahydrate, cobalt chloride hexahydrate, nickel chloride hexahydrate, copper chloride dihydrate (≥ 95%) and hydrazine monohydrate (≥ 98%) purity were purchased from SD fine Chem (India). The doubly distilled solvent were used for the present works. The pre-coated silica gel (Merck's silica plates 60 F254) of aluminum plates TLC plate was used for completion of reaction and visualized under the UV (255 nm) radiation.

Instrumentation

The elemental analysis of (C, H, N) of ligand and metal complexes were performed on an elemental analyzer (Carlo Erba-1108). The metal contents of the complexes were estimated by gravimetric method by decomposing the organic matter by $HClO_4$: H_2SO_4: HNO_3 (1:1.5:2.5) and later to ignite until they form their respective metal oxide. The molar conductance of complexes was measured in DMSO (10^{-3} M) from the Elico conductivity meter (180). IR spectra were recorded on a Bruker advance FT-IR spectrometer. The magnetic susceptibilities were measured on Sherwood magnetic susceptibility balance (MK-1) of complexes in the solid phase at RT. (^{1}H NMR, ^{13}C NMR) spectra were recorded on the Bruker advance-II Neo NMR spectrophotometer of 500 MHz in DMSO-d_6 solvent and TMS as an internal standard. Mass spectrum was recorded on water micromass (Q-T) spectrophotometer. The UV–visible electronic absorption spectra were recorded on a Shimadzu Spectrophotometer (1800). The ESR spectrum of Cu(II) complex was measured on JES-FA200

in 77 K (− 196 °C) in liquid N_2 atmosphere having an X band at std. freq. of (8.75–9.65 GHz) for precise tensor values. The simultaneous thermogravimetric (TGA-DTA) analysis were carried out on Perkin-Elmer TGA-4000 analyzer in (N_2) atmosphere in the temperature range of 40–750 °C maintaining of a heating rate 20 °C/min (precision of ± 0.8–0.9 °C), digitally uploaded 0.21–22 µg. The powder X-ray diffraction was performed on a Rigaku Miniflex (600) X-ray diffractometer using a target source of CuK_α radiation = 1.5405 Å, scan capacity (10°–80°) pertaining the scan-axis $2\theta/\theta$. The surface morphology of ligand and its complex was captured using a JEOL-6390LV scanning electron microscope. The fluorescence emission spectra were recorded on Fluorescent spectrophotometer (FS) Hitachi F-7000.

Density functional theory calculations

All DFT calculations were retrieved by using Gaussian *09* program with a basis set of functional B3LYP/6–311G++d, p (organic ligand) and LanL2DZ method (metal complex). Gauss View 6.0.16 was utilized for preparative input files towards significant data, and (3D) graphical interface for MEP surface.

ADMET parameters

The ADMET properties, including five parameters such as absorption, distribution, metabolism, excretion, and toxicity were predicted from admetSAR a user-friendly interface tools and bioavailability were predicted by subjecting to computations over Molinspiration cheminformatics tool.

Molecular Docking analysis

The 3D crystallographic structures of *Escherichia coli* protein of peptide deformylase, adenylate kinase and fungal protein of DNA polymerase have been retrieved from the database of RCSB protein data bank (PDB). The preparation of proteins was performed on CHARMM force fields generator. Autodock 4.2.6 was used for molecular docking experiments. Discovery Studio 2.0 (Accelrys, USA) was employed in silico and post docking visualization.

Synthesis of ethyl 4-oxopiperidine-1-carboxylate

To the round flask, 1-methylpiperidin-4-one (2.067 g, 0.02 mol) was added drop wise to a boiling solution of 1-chloroethyl carbonochloridate (2.485 g, 0.02 mol) in 50 ml dry benzene in the course of 50 min with continuous stirring. The reaction mixture was continuously stirred for a ~ 1 h and then refluxed further for 6 h. The progress of reaction was routinely monitored by TLC (70:30 mixtures of n-hexane and ethyl acetate). The benzene was evaporated in rota vapour. The yellow product of ethyl 4-oxopiperidine-1-carboxylate (**a**) was collected with yield: 4.146 ml (85.50%), and boiling point was ~ 138–139 ^{0}C according to reported

literature [16]. The miscibility in common organic solvent, pH recorded ~ 4.6, density 1.4716 /ml at 25 °C and slightly miscible in water (Scheme 1a).

Synthesis of 4-oxopiperidine-1-carbohydrazide (OPCH)

To a hot stirred ethanolic solution (25 mL) of ethyl 4-oxopiperidine-1-carboxylate (a) (3.88 g, 0.020 mol) was add to hydrazine monohydrate solution (1.0302 g, 0.020 mol). The reaction mixture was refluxed for 24 h. The progress reaction was continuously monitored by TLC in (70:30) n-hexane and ethyl ethanoate. The product of 4-oxopiperidine-1-carbohydrazide (Scheme 1b) was isolated filtration by vacuum suction and recrystallized by aprotic solvent DMSO. The solubility was observed in the solvents of ethanol, DMF and DMSO. The off white solid product obtained was dried under vacuum over $CaCl_2$ in desiccator. Yield: (4.143 g), 84.35%. M.P.:78–80 °C. The structure of hydrazide was confirmed by C-H-N-S analyser, FT-IR and NMR (^{1}H and ^{13}C) spectroscopy.

Micro-analytical data of 4-oxopiperidine-1-carbohydrazide

Color: Off white, mol.wt. = 311.34 (g/mol), yield: 0.4935 g (75%). M.P.: 240–242 °C. Elemental Analysis for $C_6H_{11}N_3O_2$ (%): Calc. C, (45.85); H, (7.05); N, (26.73); Found C, (45.90); H, (7.15), N, (26.85). FT-IR (cm^{-1}): 3401 *ν*(–NH pri.), 2976 *ν*(NH sec.), 1696*ν*(C=O keto), 1641 *ν*(C=O amide), 1228 *ν*(C-N aliphatic) (Fig. S1). ^{1}H-NMR (DMSO-d_6, 500 MHz)ppm: $\delta = 2.5$ (s,4H, $J = 3.0$ Hz, α position of the ring,–C(C=O)–CH_2–), δ3.4 (s,4H, $J = 2.9$ Hz, β position of the ring, –NC(=O)–CH_2), δ8 (s, 1H, –NH), δ4 (d, 2H, –NH_2) (Fig. S2). ^{13}C-NMR (DMSO-d_6, 500 MHz, ppm): 39.66(C2), 43.57(C3), 154.75(C4, C=O), C5(43.76), C6 (39.75,C7 (162.75, O=C–NH, Amide) (Fig. S3).

Synthesis of heterocyclic (*E*)-*N*′-((2-hydroxynaphthalen-1-yl) methylene)-4-oxopiperidine-1-carbohydrazide ligand (H_2L)

A hot ethanolic solution in total (20 mL) of precursor 4-oxopiperidine-1-carbohydrazide (b) (0.315 g, 2 mmol) was added slowly to a 20 mL solution of 2-hydroxynaphthalene-1-carbaldehyde (0.344 g, 2 mmol) by magnetically stirring. The reaction mixture was refluxed in acidic condition for ~ 3–4 h with the addition of two drops of conc. H_2SO_4 as a catalyst. [17]. The success of reaction was routinely monitored by TLC. The resulting solution was concentrated to *ca.* 10 mL and then allowed to cool at room temperature where a bright yellow product was obtained (c). The solid product was separated by filtration, washed with warm petroleum ether (boiling range 40–60 °C) (2 × 5 mL) and dried in vacuum over $CaCl_2$ in a desiccator. The ligand (H_2L) was found to be soluble in DMF, and DMSO (Scheme1 **c**).

Micro-analytical data of H_2L Ligand ($C_{17}H_{17}N_3O_3$)

Color: yellow, mol.wt. = 311.34 (g/mol), yield: 0.4935 g (75%). M.P.: 240–242 °C. Elemental analysis: Calc. for: C, 65.58; H, 5.50; N 13.50%. Obs.: C, 65.60; H, 5.59; N, 13.55%. FT-IR: 3347 ν(OH, broad), 3262 ν(N–H), 1670 ν(C=O_{amide}), 1615 ν(C=$N_{azomethine}$), 1230 ν(C–$O_{phenolic}$), 953 ν(N–N) cm^{-1}. UV-Visible: (DMSO, conc. 2×10^{-4} mol dm^{-3}): λ max: 267, 331 and 405 nm. ^{1}H-NMR (DMSO-d^6, 500 MHz, δ ppm): 10.59 (s, 1H, J = 7.90 Hz –OH phenyl), 9.01 (s, 1H, J = 5.30 Hz –(HC=N–) azomethine), 7.95 (d, J = 2.15 Hz aryl, 1H), 7.52 (d, aryl, 1H), 6.80 (t, 1H, aryl), 6.72 (t, aryl, 1H), 6.20 (d, aryl, 2H), and 3.4, 2.5 (s, J = 4.70 Hz, 4H), 2.513, 2.506 (s, J = 3.5 Hz, 4H) of the heterocyclic ring in both α, and β position. ^{13}C-NMR (DMSO-d^6, 500 MHz, δ ppm): 207.78(carbon C=O), 160 (phenyl-C), amide group), 145(azomethine—C), 119 (C11), 131(C12), 118(C13), 126.8 (C14), 127(C15), 128 (C16), 130(C17), 135 (C18). HRMS (ESI-Mass *m/z*): Calc. for [$C_{17}H_{17}N_3O_3$], 311.34; found 312.22.

Synthesis of metal complexes-a general method

An equimolar quantities 1:1 (L:M) of hydrazone ligand (H_2L) (0.623 g, 2.0 mmol) and each metal chloride salts, viz., chromium chloride hexahydrate (0.532 g, 2.0 mmol), manganous chloride tetrahydrate (0.394 g, 2.0 mmol), ferric chloride hexahydrate (0.541 g, 2.0 mmol), cobalt chloride hexahydrate (0.475 g, 2.0 mmol), nickel chloride hexahydrate (0.475 g, 2.0 mmol), copper chloride dihydrate (0.341 g, 2.0 mmol) were dissolved separately in 20.00 mL of warm (DMSO and dry ethanol) solvents. The each reaction mixture was turned to alkaline condition at ~ 8 pH by the addition of 2 ml of ethanol-ammonia in ratio of (7:3). The reaction mixture was refluxed at *ca*. 80 °C with constant stirring for *ca*. 5 h in an oil bath [18]. The colored solid product was cooled at room temperature, filtered, washed several times by the addition of warm ethanol and dried vacuum over $CaCl_2$ in a desiccator. The molar conductivity was found low (4.12–39.20 Sm^2 mol^{-1}) using aprotic/polar solvent of DMSO (10^{-3} M) which indicates the non-electrolyte nature. However, the higher values in some cases may possibly due to the exchange of chloride ion with DMSO. The metal complexes do not melt they undergo decomposition at higher temperature above 300 °C. The physicochemical data of ligand, and metal complexes in terms of molecular formula, elemental analysis, and molar conductance are presented in Table 1.

Micro-analytical data of ($CrC_{17}H_{19}N_3O_5Cl$) complex: Color: Sand stone, Yield (0.99 g, 85%), Mol.Wt = 432.80 (g/mol). Elemental (%): found; C, (47.25); H, (4.50); N (9.85); Cl (8.35); Cr (12.34). Obs.: C (65.60); (H), 5.59; (N), 13.55.Cl (8.19); Cr (12.34). Calcd; C, (47.17); H, (4.42); N (9.70); Cl (8.19); Cr (12.01). $\Lambda_m = 39.20 Sm^2 mol^{-1}$, M.P.: < 300 °C. FT-IR (cm^{-1}): 1573 ν(C=O),1610 ν(C=N) azomethine, 1310 ν(C–O) of phenolic, 1231 ν(C-O)in enolic state, 958 ν(N–N), 850 coordinated ν(H_2O), 520ν(Cr–O), 430ν(Cr–N).

Table 1 Physical and analytical data of ligand (H_2L), and its metal (II/III) complexes

Compounds	M.F. and Mol.Wt. (g/mol)	Color (yield %)	% Found (Calcd.)					Λ_m ($Sm^2\ mol^{-1}$)
			C	H	N	Cl	Metal	
OPCH	$C_6H_{11}N_3O_2$ 157.17	Off white (84)	45.90 (45.85)	7.15 (7.05)	26.85 (26.73)	–	–	–
Hydrazone ligand [H_2L]	$C_{17}H_{17}N_3O_3$ 311.34	Yellow (75)	65.60 (65.58)	5.59 (5.50)	13.55 (13.50)	–	–	–
[Cr(L)$(H_2O)_2$Cl]	$CrC_{17}H_{19}N_3O_5Cl$ 432.80	Sand stone (85)	47.25 (47.17)	4.50 (4.42)	9.85 (9.70)	8.35 (8.19)	12.34 (12.01)	39.20
[Mn(HL)$(H_2O)_2$Cl]	$MnC_{17}H_{20}N_3O_5Cl$ 436.75	Buff yellow (88)	46.80 (46.75)	4.70 (4.61)	9.80 (9.62)	8.34 (8.11)	12.57 12.50	12.35
[Fe(L)$(H_2O)_2$Cl]	$FeC_{17}H_{19}N_3O_5Cl$ 436.64	Desert sand (92)	46.76 (43.60)	4.40 (4.38)	9.60 (9.40)	8.20 (8.11)	12.90 (12.78)	24.80
[Co(HL)$(H_2O)_2$Cl]	$CoC_{17}H_{20}N_3O_5Cl$ 440.74	Timber brown (91)	46.60 (46.32)	4.60 (4.57)	9.64 (9.53)	8.10 (8.04)	13.45 (13.37)	14.40
[Ni(HL)$(H_2O)_2$Cl]	$NiC_{17}H_{20}N_3O_5Cl$ 440.50	Glorious sunset (87)	46.55 (46.35)	4.65 (4.57)	9.60 (9.53)	8.12 (8.04)	13.35 (13.32)	19.90
[Cu(HL)$(H_2O)_2$Cl]	$CuC_{17}H_{20}N_3O_5Cl$ 445.35	Golden brown (89)	45.75 (45.84)	4.58 (4.52)	9.55 (9.43)	8.05 (7.96)	14.30 (14.26)	4.12

($MnC_{17}H_{20}N_3O_5Cl$) complex: Color: Buff yellow, Yield (0.903 g, 88%), Mol. Wt = 436.75 (g/mol). Elemental (%): found; C, (46.80); H, (4.70); N (9.80); Cl (8.34); Cr (12.57). Obs.: C, (46.75); H, (4.61); N, (9.62); Cl (8.11); Mn (12.50). $\Lambda_m = 12.35$ Sm^2mol^{-1}, M.P.: < 300 °C. FT-IR (cm^{-1}): 3245 ν(N–H) amide,1625 ν(C=O), 1612 ν(C=N) azomethine, 1319 ν(C-O) of phen., 973 ν(N–N), 887 coordinated $\nu(H_2O)$, 592 ν(Mn–O), 432 ν(Mn-N).

($FeC_{17}H_{19}N_3O_5Cl$) complex: Color: Desert sand, Yield (1.172 g, 92%), Mol. Wt = 436.64 (g/mol). Elemental (%): found; C, (46.76); H, (4.40); N (9.60); Cl (8.20); Cr (12.90). Obs.: C, (43.60); H, (4.38); N, (9.40); Cl (8.11); Fe (12.78). $\Lambda_m = 24.80$ Sm^2mol^{-1},M.P.: < 300 °C. FT-IR (cm^{-1}): 1609 ν(C=O), 1573 ν(C=N) azomethine, 1314 ν(C-O) of phen, 1239 ν(C-O)in enolic state, 960 ν(N–N), 863 coord. $\nu(H_2O)$, 573 ν(Fe–O) 435 ν(Cr–N).

($CoC_{17}H_{20}N_3O_5Cl$) complex: Color: Timber brown, Yield (0.997 g, 91%), Mol. Wt = 440.74 (g/mol). Elemental (%): found; C, (46.60); H, (4.60); N (9.64); Cl (8.10); Co (13.45). Obs.: C, (46.72); H, (4.53); N, (9.53); Cl (8.04); Mn (13.37). $\Lambda_m = 14.40$ Sm^2mol^{-1}, M.P.: < 300 °C. FT-IR (cm^{-1}): 3252 ν(N–H) amide,1652 ν(C=O), 1592 ν(C=N) azomethine, 1331 ν(C-O) of phen., 968 ν(N–N), 827 coordinated $\nu(H_2O)$, 528 ν(Co–O), 460 ν(Co–N).

($NiC_{17}H_{20}N_3O_5Cl$) complex: Color: Glorious sunset, Yield (0.963 g, 87%), Mol. Wt = 440.74(g/mol). Elemental (%): found; C, (46.55); H, (4.65); N (9.60); Cl (8.12); Co (13.35). Obs.: C, (46.35); H, (4.57); N, (9.53); Cl (8.04); Ni(13.32). $\Lambda_m = 19.90$ Sm^2mol^{-1}, M.P.: < 300 °C. FT-IR (cm^{-1}): 3235 ν(N–H) amide,1610 ν(C=O), 1598 ν(C=N) azomethine, 1340 ν(C-O) of phen., 960 ν(N–N), 941 coordinated $\nu(H_2O)$, 540 ν(Ni–O), 492 ν(Ni–N).

($CuC_{17}H_{20}N_3O_5Cl$) complex: Color: Golden brown, Yield (0.866 g, 89%), Mol. Wt = 445.35 (g/mol). Elemental (%): found; C, (45.75); H, (4.58); N (9.55); Cl (8.05); Cu(14.30). Obs.: C, (45.84); H, (4.52); N, (9.43); Cl (7.96); Cu (14.26). $\Lambda_m = 4.12$ Sm^2mol^{-1}, M.P.: < 300 °C. FT-IR (cm^{-1}): 3254 ν(N–H) amide,1600 ν(C=O), 1597 ν(C=N) azomethine, 1318 ν(C-O) of phen., 965 ν(N–N), 859 coordinated $\nu(H_2O)$, 549 ν(Cu–O), 460 ν(Cu–N).

Results and discussion

Synthesis of heterocyclic hydrazone ligand (H_2L) and complexes

The structural skeleton of newly synthesized (*E*)-*N*′-((2-hydroxynaphthalen-1-yl) methylene)-4-oxopiperidine-1-carbohydrazide (H_2L) (Fig. S8 was thoroughly confirmed from C-H-N-S micro-analyzer and (IR, ^1H, ^{13}C NMR and HR-Mass) spectroscopic tools. The ligand reacted with the corresponding metal salts in DMSO: EtOH and yielded two types of complexes: (I) $[Cr(L)(H_2O)_2Cl]$ (1) and $[Fe(L)(H_2O)_2Cl]$, (II) $[Mn(HL)(H_2O)_2Cl]$ (3), $[Co(HL)(H_2O)_2Cl]$ (4), $[Ni(HL)(H_2O)_2Cl]$ (5) and $[Cu(HL)(H_2O)_2Cl]$ (6). These metal complexes were found non-hygroscopic, colored solid, thermally stable, insoluble in water and common organic solvent except in highly polar solvent like DMF and DMSO. The physico-analytical

data of the metal complexes are in good agreement with the calculated values and well support to the proposed formula as presented in Table 1.

Characterization of heterocyclic hydrazone ligand (H_2L)

The proton-NMR spectrum of ligand exhibits one doublet observed at δ (2.5) ppm due to four H-atoms of the (-CH_2-) group present at both side of α-position in the piperidinic ring. Another doublet appeared at δ(3.4) ppm are due to the (–CH_2–) group of four hydrogen's present at both at β-position in the piperidinic ring. The two separate singlets appeared at δ (10.52, 9.01) ppm due to the phenyl ring (–OH) and azomethine protons (–HC=N–) respectively. The signals due to aromatic protons of the naphthyl ring that appeared in the expected range of δ(6.20–7.95)ppm (Fig. S4). ^{13}C-NMR spectrum of ligand which is shown in (Fig. S5) presented two signals that appeared at δ (39.48, 40.00) ppm due to the (C3, C5; α position) of the carbon atom of the (–CH_2–) group of piperidinic ring, respectively. Another two signals appeared at δ (42.00, 42.36) ppm due to the (C2, C6; β position) of the carbon atoms of (–CH_2–) group of piperidinic ring, respectively. The carbonyl carbon (C–O) (C4) signal appeared at δ (207) in piperidinic ring and another carbon of the amide group (C7) shifted to a higher field δ (154) ppm. Another expected signal appeared at δ(160) due to the phenyl ring (O–H) of C10 position. The azomethine (HC=N–) carbon atom (C8) position signal appeared at δ (145). The signals due to the aromatic carbon of naphthoyl ring have appeared as δ 119 (C11), 131(C12), 118(C13), 126.8 (C14), 127(C15), 128 (C16),130 (C17), 135(C18) ppm. The mass spectrum of the hydrazone (H_2L) ligand with its fragmented species are represented in. The mass spectrum shows a molecular ion peak appeared in [M^{+1}] = 312.22 (Fig. S6) equal to its mol.wt. The molecular ions peaks of fragmented species are observed at 294.11 due to ($C_{17}H_{16}N_3O_2^+$) ion showed 100% intensity and other fragmented masses were found as 168 ($C_7H_{10}N_3O_2^+$), 141 ($C_6H_9N_2O_2^+$), 126 ($C_6H_8NO_2^+$) and 98 ($C_5H_8NO^+$) ion species.

FT-IR Spectroscopy and metal–ligand bonding mode

The FT-IR spectra of ligand (H_2L) and its metal (II/III) complexes are closely correlating, and modifications observed in the vibrational frequency are due to the interaction of metal ions with the ligand molecule. The spectra of ligand and its metal complexes are depicted in Fig. 1), along with simulated spectra presented in Fig. S7(a–e). The important FT-IR spectral bands data are summarized in Table 2. The ligand spectrum showed a medium broad absorption band at 3347 cm^{-1} due to stretching vibrations of the phenolic ν(O–H) group [19]. Further, the disappearance of this band in the spectra of complexes indicated the deprotonation of the phenolic proton, followed by the coordination of the phenolate O-atom to the metal ions and sustained by shifting of ν(C–O) phenolic frequency by 5–35 cm^{-1} from 1305 cm^{-1} indicated the deprotonation and participating in coordination of (C–O–M) bond formation. A sharp band appeared at 1630 cm^{-1} due to the azomethine ν(C=N) group and moved this band to a lower frequency by 57–18 cm^{-1} in the complex

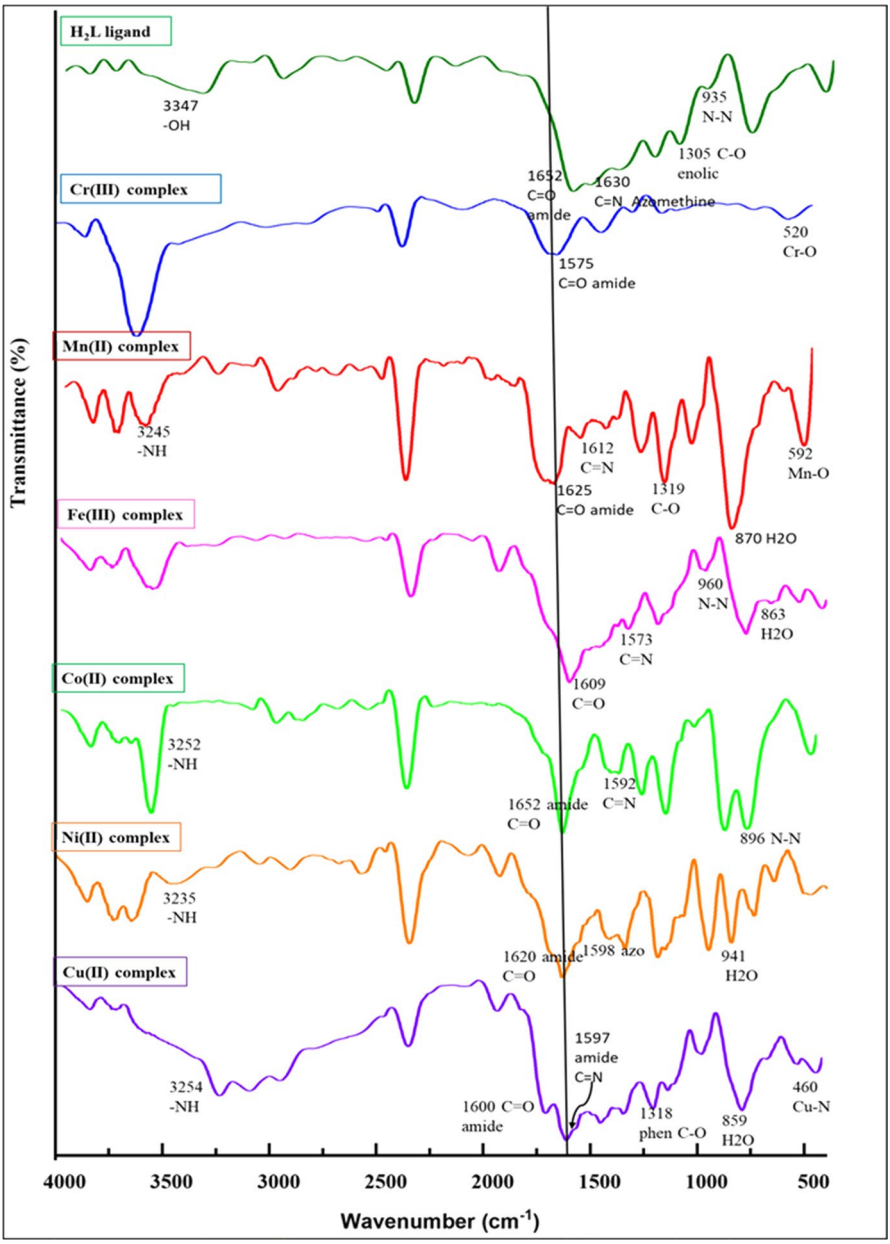


Fig. 1 FT-IR spectra of hydrazone ligand (H_2L), and its metal complexes

spectra which suggested the coordination of the azomethine nitrogen atom to the metal center. The upward shift of ν(N–N) band from 953 cm^{-1} to 958–973 cm^{-1} was found in IR spectra of all complexes [20]. In the spectra of Mn(II), Co(II), Ni(II), and Cu(II) complexes a medium intensity band was observed at ~ 3262 cm^{-1} due to

Table 2 Selected FT-IR spectroscopic data (cm^{-1}) of free hydrazone ligand (H_2L), and its metal (II/III) complexes

Compounds	ν (OH)	ν (N–H) amide	ν (C=O)	ν (C=N) azomethine	ν (C–O)phenolic	ν (C–O)in enolic	ν (N–N)	Coordν (H_2O)	ν (M–O)	ν (M–N)
Ligand (H_2L)	3347	3262	1670	1630	1305	–	953	–	–	–
[Cr(III) complex]	–	–	1573	1610	1310	1231	958	850	520	430
[Mn(II) complex]	–	3245	1625	1612	1319	–	973	887	592	432
[Fe(III) complex]	–	–	1609	1573	1314	1239	960	863	573	435
[Co(II) complex]	–	3252	1652	1592	1331	–	968	827	528	460
[Ni(II) complex]	–	3235	1610	1598	1340	–	960	941	540	492
[Cu(II) complex]	–	3254	1600	1597	1318	–	965	859	589	460

amide (N–H) group which appeared almost as in the case of ligand, thus confirming ligand in its ketonic form in these complexes. Further, the shift of the amide carbonyl (C=O) moiety to lower frequency by 18–97 cm^{-1} in all these complexes confirms the coordination of the amido-O atoms to the metal ions without undergoing enolization. However, the absence of these bands at 3262 and 1670 cm^{-1} due to ν(N–H) and ν(C=O), respectively, in the spectra of Cr(III) and Fe(III) complexes and appearance of a new bands in the range 1231–1239 cm^{-1} due to ν(C–O) (enolate) indicates the destruction of the carbonyl group and coordination of enolic.

Oxygen to these metal ions after deprotonation. The non-ligand bands observed at about 827–950 cm^{-1} in all complexes possibly due to the presence of water molecule was further confirmed by dehydration in thermal study. The appearance of weak intensity of non-ligand band at 592–520 and 492–430 cm^{-1} in the spectra of complexes are characteristics of ν(M–O) and ν(M–N) stretching vibration, respectively [21].

Magnetic susceptibility and UV–Visible spectroscopy

The room temperature magnetic moments and UV–visible absorption spectral data of metal complexes are summarised in Table 3 and spectra are represented in (Fig. S9a–b). The electronic spectrum of ligand displayed an absorption band at shorter (λ_{max} = 267 nm, 331) nm may be significant impact of π–π*, n–π* transition which are the characteristic of (C=O), (C=N) group respectively. The shift of absorption band at to higher wavelength in the spectra of metal complexes indicates the complexation of ligand to the metal ions. The Cr(III) complex displayed three absorption bands at (λ_{max} = 1020, 936 and 500) nm was due to $^4A_{2g} \rightarrow {}^4T_{2g}$, $^4A_{2g} \rightarrow {}^4T_{1g}$(F), and $^4A_{2g} \rightarrow {}^4T_{1g}$(P) transitions, respectively indicating octahedral geometry which was supported by its observed magnetic moment of 3.82 B.M. and its (d^3) configuration [22]. The important ligand field parameters were calculated and values are found to be: Dq = 980 cm^{-1}, B = 680 cm^{-1}, β = 0.74 and v_2/v_1 = 1.09. The low value of B was observed in the metal complex compared to its free metal ion (918 cm^{-1}), which signified the covalent character of the metal-ligand bond. The Mn(II) complex exhibits three weak bands at λ_{max} = 950, 884 and 320 nm was due to $^6A_{1g} \rightarrow {}^4E_g$ (^{4}D)$^6A_{1g} \rightarrow {}^4E_g$ (G) and $^6A_{1g} \rightarrow {}^4E_g$, transitions, respectively, in octahedral complex [23].The observed magnetic moment for the Mn(II) complex is 5.89 B.M. which confirms octahedral geometry having (d^5) configuration. The Fe(III) complex shows three weak absorption bands at 982, 884 and 528 nm assignable to $^6A_{1g} \rightarrow {}^4T_{1g}$(G), $^6A_{1g} \rightarrow {}^4T_{2g}$(D), and $^6A_{1g} \rightarrow {}^4$Eg(D), transitions, respectively, and are consistent with octahedral (O_h) geometry. The observed magnetic moment of this complex was found to be 5.97 B.M., which informs d^5 degeneracy supporting to octahedral field around metal ion [24]. The electronic spectrum of Co(II) complex exhibits three bands at λ_{max} = 1075, 930, and 560 nm due to $^4T_{1g} \rightarrow {}^4T_{2g}$, $^4T_{1g} \rightarrow {}^4A_2$g and $^4T_{1g} \rightarrow {}^4T_{1g}$(P), transitions, respectively for octahedral geometry of Co(II) complex [25]. The observed magnetic moment value 4.30 B.M., for the complex is in accordance with its octahedral geometry. The various ligand field parameters [Dq, B, β and v_2/v_1] have been evaluated from the spin-allowed transitions and their values are

Table 3 Magnetic susceptibility and electronic absorption spectral parameters of metal complexes

Metal complexes	μ_{eff} (B.M)	Absorption maxima (nm)	Band assignments	Ligand field data				
				Dq (cm^{-1})	B (cm^{-1})	B_0 (cm^{-1})	$\beta = B/B_0$	v_2/v_1
[Cr(III) complex]	3.82	1020(v_1) 936(v_2) 500(v_3)	$^4A_{2g} \rightarrow {}^4T_{2g}$ $^4A_{2g} \rightarrow {}^4T_{1g}(F)$ $^4A_{2g} \rightarrow {}^4T_{1g}(P)$	980	680	918	0.74	1.09
[Mn(II) complex]	5.89	950(v_1) 884(v_2) 480(v_3)	$^6A_{1g} \rightarrow {}^4E_g({}^4D)$ $^6A_{1g} \rightarrow {}^4E_g(G)$ $^6A_{1g} \rightarrow {}^4T_2(G)$	1053	687	860	0.80	1.07
[Fe(III) complex]	5.97	982(v_1) 864(v_2) 528(v_3)	$^6A_{1g} \rightarrow {}^4T_{2g}(G)$ $^6A_{1g} \rightarrow {}^4T_{2g}(G)$ $^6A_{1g} \rightarrow {}^4E_g(D)$	–	–	–	–	–
[Co(II) complex]	4.30	1075(v_1) 930(v_2) 780(sh) 560(v_3)	$^4T_{1g} \rightarrow {}^4T_{2g}$ $^4T_{1g} \rightarrow {}^4A_{2g}$ – $^4T_{1g} \rightarrow {}^4A_{2g}(F)$	1163	725	971	0.75	1.16
[Ni(II) complex]	2.92	970 (v_1) 880 (v_2) 729(sh) 460 (v_3)	$^3A_{2g} \rightarrow {}^3T_{2g}(F)$ $^3A_{2g} \rightarrow {}^3T_{1g}(F)$ – $^3A_{2g} \rightarrow {}^3T_{1g}(P)$ $^3A_{2g} \rightarrow {}^3T_{1g}$	1031	762	1030	0.74	1.10
[Cu(II) complex]	1.72	908(v_1) 832(sh) 682(v_2) 565	$^2B_1g \rightarrow {}^2A_1g(v_1)$ – $^2B_1g \rightarrow {}^2B_2g$ (v_2) *Charge transfer(CT)*	–	–	–	–	–

found to be Dq = 1163 cm^{-1} and $B = 725$ cm^{-1}, $\beta = 0.75$ and $v_2/v_1 = 1.16$. The calculated electronic lower value of B for the complex suggests the orbital overlap and delocalization of d-orbitals. The electronic spectrum of Ni(II) complex shows three bands at 970, 880 and 460 nm which are assigned to $^3A_{2g} \rightarrow {}^3T_{2g}$, $^3A_{2g} \rightarrow {}^3T_{1g}(F)$ and $^3A_{2g} \rightarrow {}^3T_{1g}(P)$, transitions, respectively, suggested an octahedral environment around Ni(II) ion [26]. The observed magnetic moment value for the complex is 2.92 B.M., which is well within the expected range (2.83–3.50 B.M.) for the Ni(II) octahedral complexes. The various ligand field parameters have been calculated from the spin-allowed transitions. The ligand field parameter calculated as Dq = 1031 cm^{-1} and $B = 762$ cm^{-1}, $\beta = 0.74$, and $v_2/v_1 = 1.10$ and these values are also in compatible with those reported for Ni(II) octahedral complexes. The electronic spectrum of Cu(II) complex shows broad band around at 908 nm due to $^2B_1g \rightarrow {}^2A_1g$, transition, is characteristic for a elongation due to distortion in Cu(II) of an octahedral field and well supported by ESR spectra [27]. The other bands observed at $\lambda_{max} = 682$ and 565 nm are assigned for $^2B_1g \rightarrow {}^2Eg$ and ligand → metal charge transfer (LMCT) $\pi \rightarrow \pi^*$ transitions, respectively, while observed value of magnetic moment $\mu = 1.72$ B.M. for complex is consistent for single unpaired electron [28].

Evaluation of ESR tensor parameters for copper (II) complex

The well resolved isotropic X band spectrum of Cu(II) complex is shown in Fig. 2 and its expressing significant tensor data are presented in Table S1. The spectrum shows a $g_{||}$ peak at 2933.9 Gand another single peak $g_{\perp}$ peak at 3214.37G. The observed values 2.249 and 2.053 of $g_{||}$ and $g_{\perp}$ components clearly suggest the

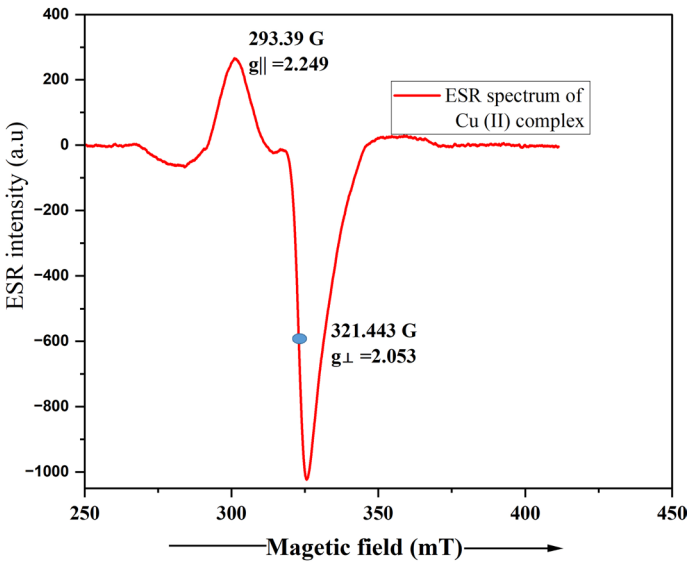


Fig. 2 ESR spectrum of Cu(II) complex

presence of axial symmetry in the complex. The $g_{\parallel} > g_{\perp}$ and with trend g‖> $g_{\perp}$ > ge (2.0023) suggests the presence of one unpaired electron in (dx^2-dy^2) orbital in the ground state of Cu(II) metal ion. The $g_{\parallel}$ value is sensitive towards the covalent nature of the Cu-ligand bond as well as the deviation of 'g' avg.value from free electron values (2.0023) also confirms the presence of covalency in the M-L bond. The 'G' parameter was calculated by Hathway's equation $G = (g_{\parallel} - 2.0023)/(g_{\perp} - 2.002$ 3) which indicates the exchange occurred at the copper center in the structure of the compound. The G value was found to be 5.52 which is greater than four suggesting the negligible interactions between the metal center [29]. The calculated value of component $A_{\parallel}$ (168 cm^{-1}) and $A_{\perp}$ (55.54 cm^{-1}) with ($A_{\parallel} > A_{\perp}$) is in agreement with that electron interacts with only one copper nucleus and the complex has distorted octahedral geometry due to axial elongation. Other supporting parameter $A_{\parallel}$ value was also dependent on the directly coordinated ligand. Due to this effect, the interaction between the electrons with nuclear spin increases with increasing the $A_{\parallel}$ compared with naturally decreased $g_{\parallel}$ value. The values $g_{\parallel}$ and $A_{\parallel}$ of the coefficient value fv = 133 confirmed that ligand influence on the density of metal's unpaired electron and coordination fields. The molecular orbital coefficients α^2 (covalency of in σ-bond) and β^2 (covalency of in π-bond) were found β^2 (2.45) > α^2 (0.35) which indicates that covalency in π-bonding was much stronger than expected covalency in σ-bonding. The orbital reduction parameter found of the component $K^2_{\perp}$ (0.78) > $K^2_{\parallel}$ (0.53) indicates the plane bonding of ligand with metal in the octahedral field [30].

SEM analysis

In the present investigation, we just compared the surface morphology of the hydrazone (H_2L) ligand and its [Fe(L)(H_2O)$_2$Cl] complex are as a representative cases that provides empirical information regarding the molecular aggregation pattern in bulk form. The SEM micrographs of the ligand and its [Fe(L)(H_2O)$_2$Cl] complex are shown in (Fig. 3a, b). The microscopic image of ligand was magnified at 200X, 100 µm, WD13 which clearly indicated that the unit cell with a regular surface area

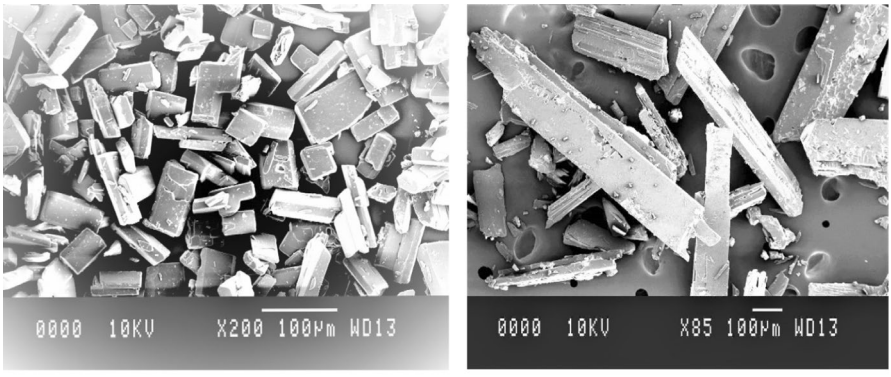


Fig. 3 Scanning electron microscopic EM images of **a** hydrazone ligand (H_2L), and **b** Fe(III) complex

without any shadows possessed the cuboidal in shape. The metal complex magnifies at 85X, 100 µm, WD13 revealed that aggregation appeared in that as broken bricks in a non-uniform irregular shape. The image of surface morphology of two compounds particle were identified differently in shapes and size give evidence for the involvement of metal complexation reaction [31].

X-ray diffraction studies

The nature of ligand (H_2L) and its Cr(III), Mn(II), Fe(III) and Cu(II) complexes were also ascertained by powder X-ray diffraction studies. The XRD pattern compounds are depicted in Fig. S10a–e and data listed in Tables S2–S6. The angle (2θ) and interplanar distance (d) were evaluated by Bragg's equation ($n\lambda = 2d\sin\theta$). The miller indices were found in specified directions along with the lattice plane (*h*, *k*, and *l*). The unit cell parameters for ligand, and its metal complexes are as follows; H_2L ligand: crystal system = rhombohedral, $a = 8.5680$ Å, $b = 6.1020$ Å, $c = 15.9870$ Å and $\alpha = \beta = \gamma = 90°$, V = 835.65 Å^3 [32]. [Cr(L)Cl(H_2O)$_2$] complex: crystal system = orthorhombic, $a = 9.8045$ Å, $b = 7.1020$ Å, $c = 16.701$ Å, and $\alpha = \beta = \gamma = 90°$, V = 1000.55 Å^3; [Mn(HL)Cl(H_2O)$_2$]: Crystal system = orthorhombic, $a = 8.7080$ Å, $b = 7.1312$ Å, $c = 16.2070$ Å and $\alpha = \beta = \gamma$ (90°), V = 1200.221 Å; [Fe(L)Cl(H_2O)$_2$] complex: crystal system = orthorhombic, $a = 18.5680$ Å, $b = 16.1020$ Å, $c = 15.9870$ Å and $\alpha = \beta = \gamma = (90°)$,V = 1600.178 Å^3; [Cu(HL)Cl(H_2O)$_2$] complex: crystal system = monoclinic, $a = 9.9540$ Å, $b = 16.1700$ Å, $c = 17.8373$ Å and $\alpha = \gamma = 90$, $\beta \neq 120°$,V = 2808.992 Å^3. The avg. crystalline size of the H_2L ligand, Cr(III), Mn(II), Fe(III), and Cu(II) complexes were evaluated from Scherer's equation. Upon the full width half maximum intensity (FWHM) calculation, the average crystallite size was 19.98, 33.28, 25.11, 31.46, and 26.28 nm, respectively. All these indicate their nanocrystalline nature [33].

Simultaneous thermal (TGA-DTA) analysis

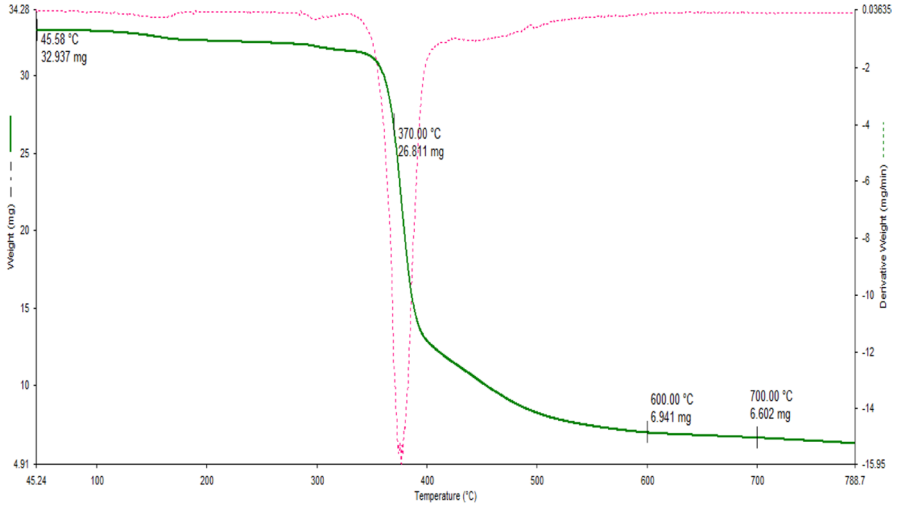
The simultaneous thermogravimetric analysis of complexes consists of the three decomposition steps: temperature scale (40–750 °C), decomposed species in addition to mass loss (%) of ligand and metal complexes are presented in Table 4. The thermograms of hydrazone ligand and its metal complexes are shown in Fig. 4a–g. The thermal reaction data are the good agreements with the proposed formula weight as expected from an analytical and the spectral data. TGA analysis, an important technique, was performed with a thermal rate 20 °C min^{-1} under N_2 atmosphere for the analysis of decomposition pattern, thermal stability, and information regarding about the ligation of different groups associated with metal ions. The ligand (H_2L) shows a single broad (DTG_{max}) peak in the temperature range 365–370 ^{0}C with a maximum mass loss which occurred of 67.27% (theor. 65.55%) due to the complete removal of ligand moiety. Upon continued heating up to 700 ^{0}C, the thermal curve was turned to horizontal state, which signify the formation of stable carbon residue [found: 32.73%, (theor: 34.45%)]. The general thermal decomposition pattern for

Table 4 Stepwise thermal decomposition data of hydrazone ligand and its metal (II/III) complexes

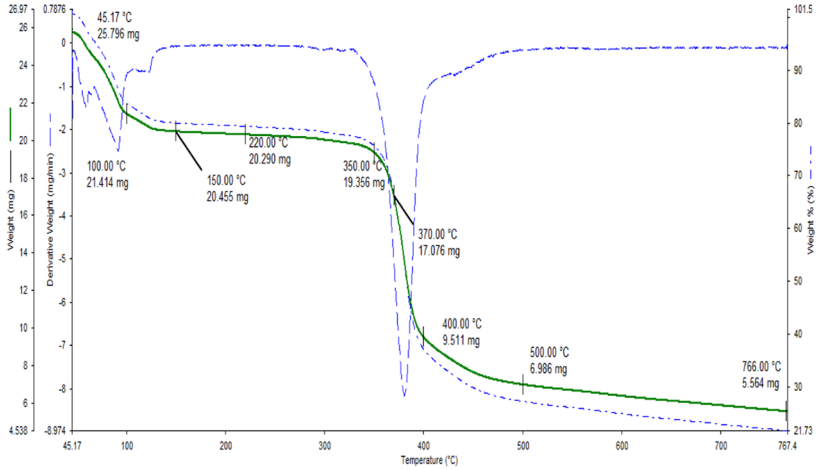
Compounds	Steps	Temp range (°C)	DTG_{max} (°C)	Wt. losses %		Decomposed species
				Expt	Calcd	
Ligand (H_2L)	I	45–370	370	89.50	89.00	Loss of $H_{17}N_3O_3$ species
	II	370–660	–	11.25	11.00	Carbonic residue
$[Cr(L)(H_2O)_2Cl]$	I	45–150	100	08.78	08.31	Elimination of two coord-H_2O molecules
	II	150–360	250	09.10	08.94	Loss of one coord-Cl^- ion
	III	360–500	360	60.12	61.72	Loss of organic moieties ($C_{17}H_{15}N_3O_2$)
	IV	500–700	–	22.00	21.03	metallic oxide residue
$[Mn(HL)(H_2O)_2Cl]$	I	45–150	150	08.50	08.24	Elimination of two coord-H_2O molecules Loss of one coord-Cl^- ion
	II	150–360	260	09.10	08.85	
	III	360–500	500	62.90	63.49	Loss of organic moieties ($C_{17}H_{16}N_3O_2$)
	IV	500–700	–	19.50	19.41	Metallic oxide residue
$[Fe(L)(H_2O)_2Cl]$	I	45–140	140	8.90	08.64	Elimination of two coord-H_2O molecules
	II	140–290	260	9.10	08.86	Loss of one coord-Cl^- ion
	III	290–360	360	61.00	60.72	Loss of organic moieties ($C_{17}H_{15}N_3O_2$)
	IV	360–700	–	22.00	21.77	metallic oxide residue
$[Co(HL)(H_2O)_2Cl]$	I	45–150	150	08.20	08.18	Elimination of two coord-H_2O molecules
	II	150–390	200	08.80	08.77	Loss of one coord-Cl^- ion
	III	390–500	410	63.05	63.01	Loss of organic moieties ($C_{17}H_{16}N_3O_2$)
	IV	500–800	–	20.05	20.03	metallic oxide residue
$[Ni(HL)(H_2O)_2Cl]$	I	45–150	150	08.25	08.18	Elimination of two coord-H_2O molecules
	II	150–380	280	8.87	08.77	Loss of one coord-Cl^- ion
	III	380–600	600	63.25	63.01	Loss of organic moieties ($C_{17}H_{16}N_3O_2$)
	IV	600–709	–	20.07	20.04	metallic oxide residue
$[Cu(HL)(H_2O)_2Cl]$	I	45–110	110	08.92	08.08	Loss of two coord-H_2O molecules
	II	110–245	245	08.70	08.67	Loss of one coord-Cl^- ion
	III	245–345	345	62.30	62.23	Loss of organic moieties ($C_{17}H_{16}N_3O_2$)
	IV	500–703	–	21.08	21.02	Metal oxide residue

$[CoC_{17}H_{20}N_3O_5Cl]$ complex is shown in **Scheme S2**. The following comments were suggested from the simultaneous TG–DTA analysis.

i. Cr(III), Mn(II), Fe(III), Co(II) and Cu(II) complex show thermal decomposition at ca.100–150 °C (broad DTG_{max}) indicated removal of two coordinated water



(a)



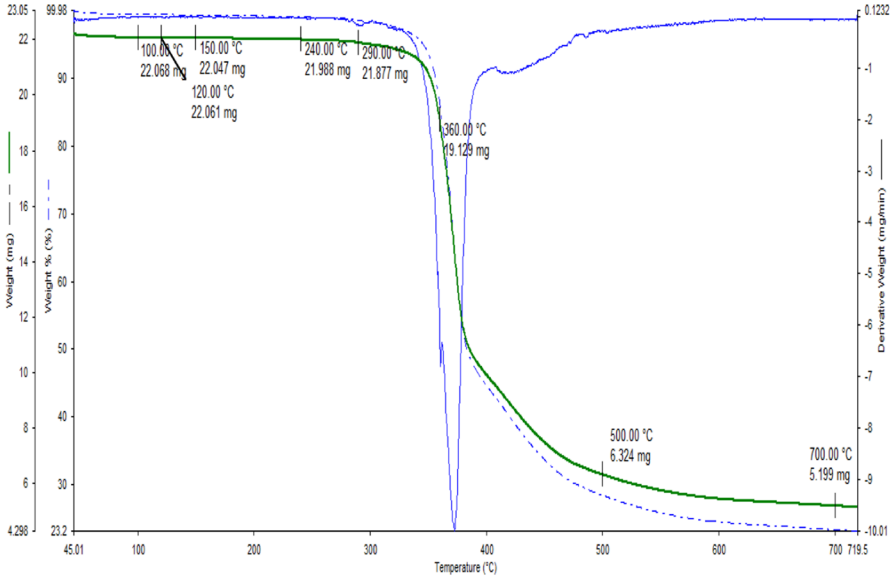
(b)

Fig. 4 TGA—, DTA --- curves of **a** hydrazone ligand, **b** Cr (III), **c** Mn(II), **d**)Fe(III), **e** Co(II), **f** Ni(II), and **g** Cu(II) complexes

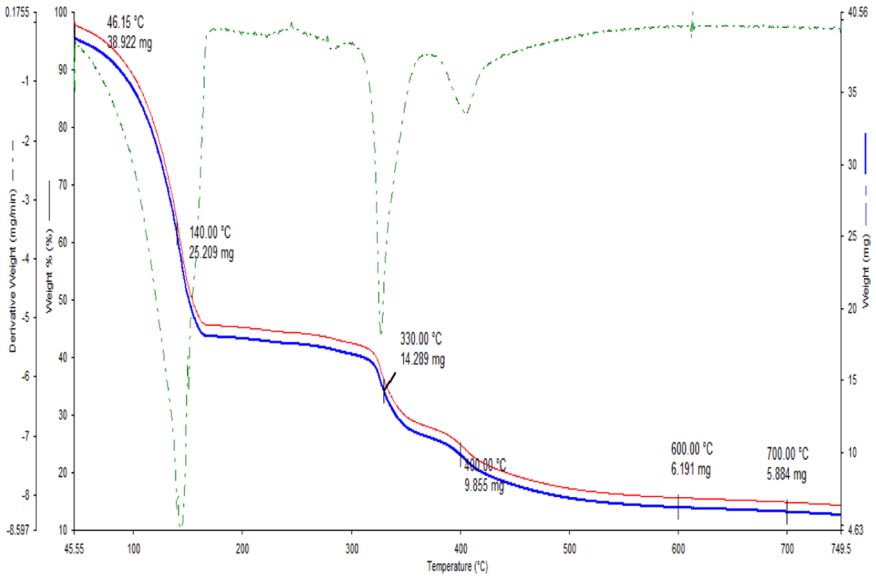
molecules and as expected nearly same loss of mass ~ 8.25–8.90% equivalent to theoretical loss of (~ 8.30–8.64%) [34].

ii. The second step exhibits loss of mass (8.70–9.10%) which coincides with theoretical loss of (8.67–8.94%) in the range of 200–245 °C (DTG_{max}) and these may specify to the loss of chloride ions.

iii. At the end of thermal reaction, the non-coordinated organic moieties mass loss was observed (60.12–63.25%) equivalent to loss of mass (calc.60.72–63.72%)

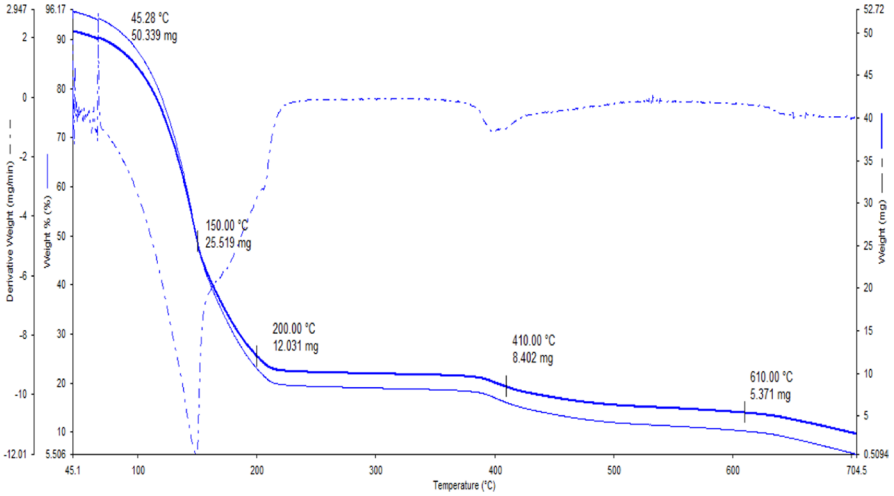


(c)

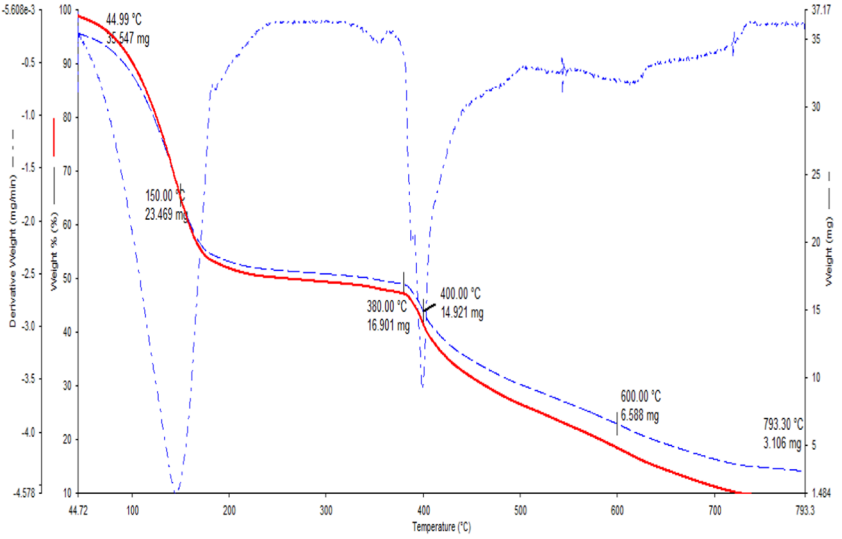


(d)

Fig. 4 (continued)



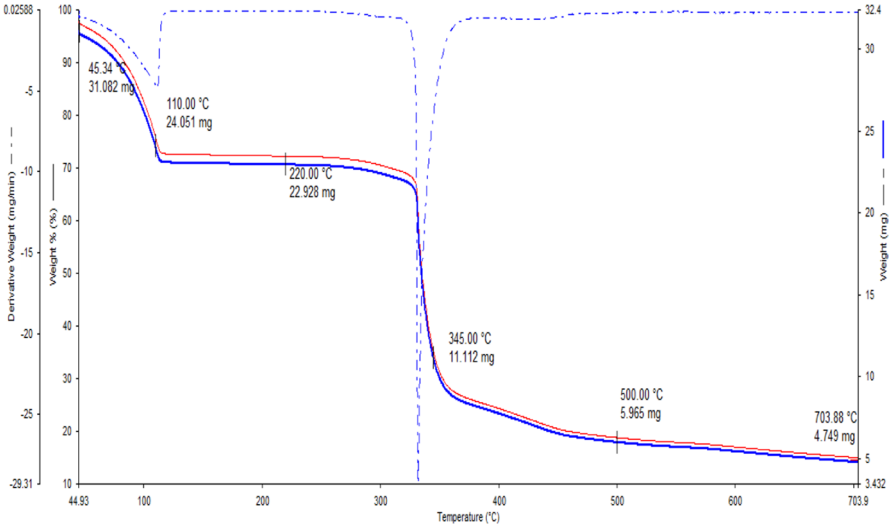
(e)



(f)

Fig. 4 (continued)

when the temperature increased more than 360 oC, the thermal curve became horizontal which possibly notifies the formation of respective stable metal oxide (60.12–63.25%) (Calc. 63.25–63.72%). The presence of water molecule (coordinated) are well supported to IR vibrational frequency data. The thermal stability



(g)

Fig. 4 (continued)

order of metal complexes was found to be in the order of Cu(II) < Fe(III) ≅ Cr (III) < Co(II) ≅ Mn (II) < Ni (II) [35].

Kinetic parameters evaluation-(Coat-Redfern method)

The thermo-kinetic parameters for the non-isothermal degradation of complexes viz., (Ea), (ΔS), (ΔH) and free energy change (ΔG) were evaluated by using the integral method of Coats-Redfern equation [43] and the calculated values are presented in Table 5. From the kinetic data, increasing trends of activation energy (Ea) from (5.15 to 324 kJ/mol) comparing with the decreasing order of entropy (ΔS) was found to be −21.79 to −11.50 $Jmol^{-1}$ k^{-1} [36]. The negative values of (ΔS) in the overall first, second and third steps of decomposition reaction of complexes indicate slow decomposition reactions, the non-spontaneous nature, degree of structural 'complexity' with the low-frequency factor (Z) values and which is further supported by positive values of (ΔG). The activation energy was compared with free energy and heat of the reaction displaying its significance as (Ea) < (ΔG) ≅ (ΔH). The enthalpy parameter (ΔH) and change in the free energy (ΔG) of reaction were found positive term in the range (10.15–521.00) kJ mol^{-1} and (10.22–329.00) kJ mol^{-1}, respectively suggesting that the decomposition of complexes undergo to endothermicity and more stability [37].

Fluorescence emission spectra

The solid state compounds of hydrazone ligand (H_2L) and its metal complexes were excited at room temperature ($\lambda_{ex} = 335$ nm) and recorded

Table 5 Kinetic parameters for decomposition of hydrazone ligand (H_2L), and its metal (II/III) complexes (Coats-Redfern method)

Compounds	Steps	Decomp temp (^{0}C)	(Ea) kJ/mol	(Z) s^{-1}	ΔS (J/mol/k)	ΔH (kJ/mol)	ΔG (kJ/mol)
Ligand (H_2L)	I	370	211.02	1.362×10^{1}	− 14.50	205.80	214.90
Cr(III) complex	I	100	15.84	1.121×10^{1}	− 15.84	12.70	16.90
	II	150	21.79	1.2×10^{3}	− 21.79	18.30	23.50
	III	350	167.01	1.126×10^{3}	− 15.30	161.80	171.40
Mn(II) complex	I	150	111.69	1.106×10^{3}	− 12.11	108.20	113.30
	II	360	309.86	1.230×10^{3}	− 15.30	304.60	314.30
	III	500	175.72	1.121×10^{3}	− 17.30	166.30	179.60
Fe(III) complex	I	140	06.65	1.106×10^{3}	− 12.10	10.15	11.22
	II	330	117.69	1.121×10^{3}	− 15.10	112.70	212.80
	III	400	221.47	1.236×10^{3}	− 16.90	215.90	226.60
Co(II) complex	I	150	05.15	1.224×10^{3}	− 12.30	10.60	10.22
	II	410	112.85	1.236×10^{3}	− 16.00	107.30	117.90
Ni(II) complex	I	150	13.42	1.230×10^{3}	− 12.70	10.00	15.10
	II	380	165.37	1.230×10^{3}	− 15.70	159.90	170.20
	III	600	258.00	1.236×10^{3}	− 18.10	12.17	267.20
Cu(II) complex	I	110	12.02	1.368×10^{3}	− 11.50	10.00	13.20
	II	220	101.08	1.106×10^{3}	− 13.40	97.70	104.30
	III	500	324.84	1.230×10^{3}	− 15.10	521.90	329.00

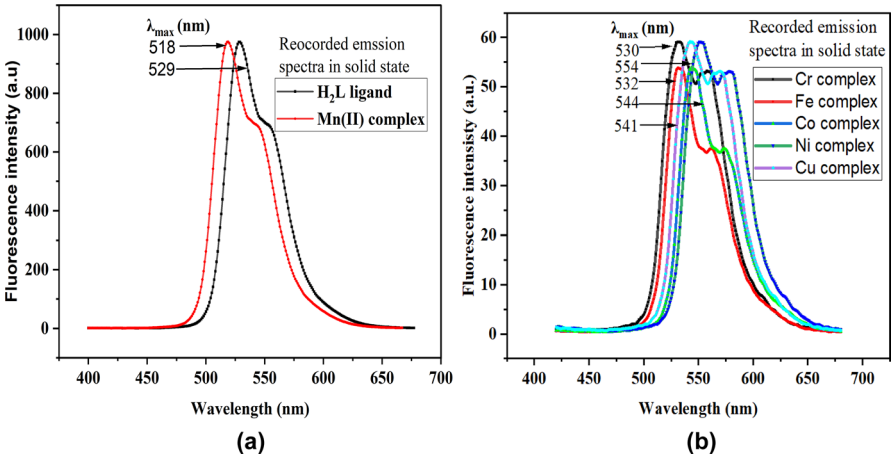


Fig. 5 Emission spectra of **a** hydrazone ligand (H_2L), and Mn (II) complex and **b** its metal (II/III) complexes

Table 6 The fluorescence emission spectral data of ligand, and its metal complexes (solid state)

Compounds	Wavelength (nm)	Emission intensity I_F (a.u.)
Ligand (H_2L)	529	974.60
Mn(II) complex	518	974.20
Cr(III) complex	530	59.11
Fe(III) complex	532	53.58
Co(II) complex	546	59.08
Ni(II) complex	546	54.66
Cu(II) complex	541	59.04

emission spectra (λ_{em} = 480–650)nm through the emission slit widths 1.0 nm, scan rate ~ 240 nm min^{-1}. The fluorescence spectra are depicted in Fig. 5a, b and, data are presented in Table 6. The compounds emitted broad emissions due to the combined effects of inhibition photo-induced electron transfer (PET), magnetic perturbation, redox activity, static interaction of metal ion and causing the hyperchromic to bathochromic shift. [38, 39]. The hydrazone ligand (H_2L), Mn(II) and Cr(III) complexes emitted the radiation in higher intensity (λ_{em} = 518–529)nm whereas other Fe(III), Co(II), Ni(II), and Cu(II) complexes demonstrated lower emission intensity (λ_{em} = 530–546)nm. The free ligand (2-hydroxynaphthalen-1-yl) methylene-4-oxopiperidine-1-carbohydrazide) contains two free (>C=O) chromophores present at two different position characteristics for quenching fluorescence and supported by azomethine group (–HC=N–) which is capable in exchanging the proton of redox reaction as well as extra aryl-π electrons. The emission intensity (I_E) of hydrazone ligand (H_2L) decreases upon complexation with metal ion in the order of; ligand (H_2L) > Mn (II) > Cr (III) > Co(II) > Ni(II) > Cu(II) > Fe (III) complexes. Upon examination of spectral data, the hydrazone and its metal complexes are considered to be a marks of the good fluorescent components, applicable in the photochemical reaction and in detection heavy metal ions in biological samples [40].

Computational study

Optimization of molecular geometry

The DFT calculation have been carried out by using the B3LYP function with 6-311++G (d, p) for hydrazone ligand (H_2L) and LanL2DZ basis set for metal complexes for an account of relativistic effect from Gaussian 09 tool and Gauss view 6.0.16. The optimized structure of ligand (H_2L) and its Cr(III), Mn(II) and Fe(III) complexes with their atoms numbering presented in Fig. 6a–d are as representative cases and others, i.e. Co(II), Ni(II) and Cu(II) complexes are in Fig. S11e–g, and supporting geometrical data are listed in Table 7a–c. The optimized hydrazone ligand consists of two fused aryl rings in a planar and another side of heterocyclic (piperidinic) ring were in the angular strain at C9 atom making an angle of 112.176 (°) of the fragment of C(12)-(C9)-(N16) and similarly at C10

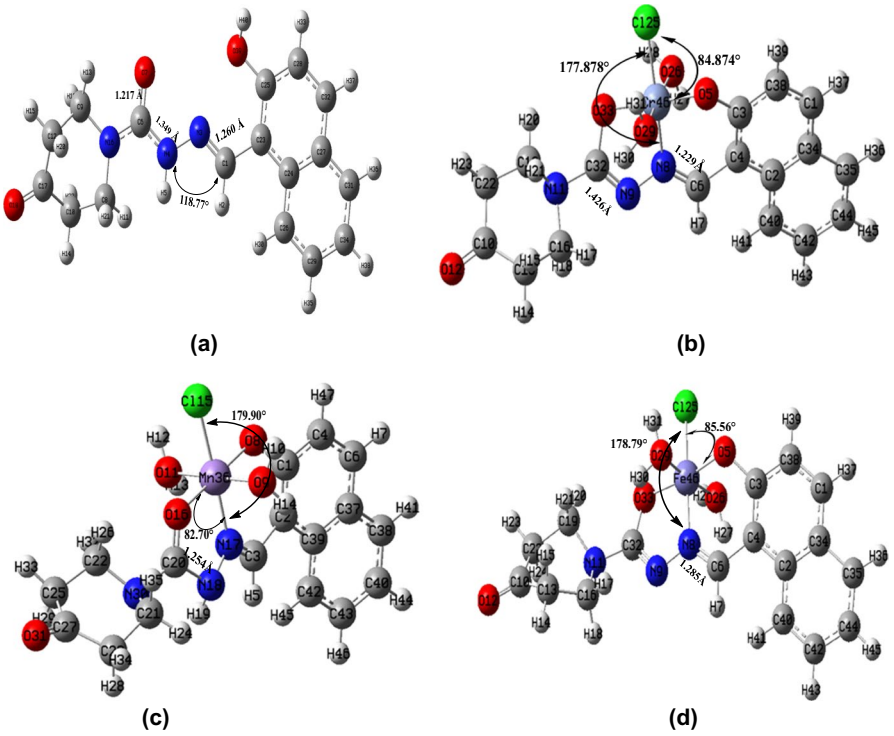


Fig. 6 Optimized molecular structures of **a** hydrazone ligand (H_2L), an octahedral geometry of **b** Cr(III), **c** Mn(II). **d**)Fe(III) complexes

atom making an angle of 111.16 (°) of the fragment of C(17)-(C10)-(C8) with sp^3 (C-atom). The decreased bond lengths of C(12)-C(9) and C17-C10 bonds were found as 1.529 (Å) and 1.5160 (Å), respectively. The bond angle was also decreased and this may be due to the electronegative N(16) hetero atom and O(18) of carbonyl group presence in the ring. The validated torsion angle were found as of C(12)-(C9)-(N10)-(C6) of 55.966 (°) and C (17)-(C10)-(C8)-(C6) of 57.915(°). The atoms of the azomethine group consists of a bond C(1) = N(3) shows the shorter bond length of 1.260 Å which indicates the partial electron delocalization in the fragments of H(2)-C(1) = N(3) with bond angle of 122.032 Å. The phenolic group of atom shows O(39)-H(40) which indicates a short bond length of 0.963 Å with an angle of 113.05(°) of terminal atoms of C(25)-O(39)-H(40) and torsion angle of connected atoms of C(25)-O(39)-H(40)-C(1) was 0.0443(°). The naphthoyl rings displayed torsion angle of C(29)-C(26)-C(24)-C23) and C(32)-C(28)-C(25) = C(23) of two fused aryl ring atoms was found to be 179.93(°) and 0.02514 (°) respectively which indicates the resonance by the delocalization of π-electrons in the ring with sp^2 hybridized carbon atom in the orbitals by extending the above and below the plane of the ring [41, 42]. The metal complexes have coordination number six and revealed slightly distorted octahedral

Table 7 (a) Selected geometrical parameters of (H_2L) ligand, (b) Selected geometrical parameters of Cr(III), and Fe(III) complexes, (c) Selected geometrical parameters of Mn(II), Co(II), Ni(II), and Cu(II) complexes

Bond connectivity	Bond lengths (Å)	Bond connectivity	Bond angles (°)	Bond connectivity	Torsion angle (°)
C(1) = N(3)	1.260	H(2)–C(1) = N(3)	122.034	–	–
N(3)–N(4)	1.387	N(4)–N(3)–C(1)	118.77	N(4)–N(3)–C(1)–H(2)	0.0257
N(4)–C(6)	1.349	N(3)–N(4)–C(6)	116.70	–	–
C(1)–C(23)	1.347	N(3)–C(1)–C(23)	123.52	–	–
C(6)–O(7)	1.217	N(4)–C(6)–O(7)	122.89	N(4)–C(6)–O(7)–N(3)	−1.638
C(6)–N(16)	1.371	N(4)–C(6)–O(16)	114.38	N(3)–N(4)–C(6)–O(16)	178.63
C(12)–(C9)	1.529	C(12)–(C9)–(N16)	112.176	C(12)–(C9)–(N16)–C6	55.966
C(17)–(C10)	1.560	C(17)–(C10)–(C8)	111.166	C(17)–(C10)–(C8)–C6	−57.915
C(17)–O(18)	1.209	O(18)–C(17)–C(10)	122.67	O(18)–C(17)–C(10)–C(8)	−136.49
H(15)–C(12)	1.083	C(15)–C(12)–C(9)	111.45	–	–
O(39)–H(40)	0.963	C(25)–O(39)–H(40)	113.05	C(25)–O(39)–H(40)–C(1)	0.0443
C(23)–C(25)	1.368	C(25)–C(23)–C(1)	115.83	–	–
C(24)–C(27)	1.415	C(23)–C(24)–C(27)	118.65	–	–
C(24)–C(26)	1.413	C(24)–C(26)–C(29)	120.47	C(29)–C(26)–C(24)–C23)	179.93
C(28)–C(32)	1.352	C(32)–C(28)–C(25)	120.040	C(32)–C(28)–C(25)–C23)	0.02514
(b)					
Cr(46)–O(5)	1.855	O(5)–Cr(46)–O(29)	88.829	O(26)–Cr(46)–Cl(25)	87.881
Cr(46)–O(29)	1.887	O(5)–Cr(46)–O(26)	91.242	O(26)–Cr(46)–O(33)	89.048
Cr(46)–O(26)	1.887	O(5)–Cr(46)–Cl(25)	84.874	O(26)–Cr(46)–N(8)	90.226
Cr(46)–Cl(25)	2.219	O(5)–Cr(46)–O(33)	177.640	Cl(25)–Cr(46)–O(33)	97.477
Cr(46)–O(33)	1.866	O(5)–Cr(46)–N(8)	96.130	Cl(25)–Cr(46)–N(8)	177.878
Cr(46)–N(8)	1.914	O(29)–Cr(46)–O(26)	179.132	O(33)–Cr(46)–N(8)	81.526
C(6) = N(8)	1.299	O(26)–Cr(46)–Cl(25)	91.264	O(26)–Cr(46)–N(8)	90.625

Table 7 (continued)

Bond connectivity	Bond lengths (Å)	Bond connectivity	Bond angles (°)	Bond connectivity	Torsion angle (°)
N(9) = C(32)	1.426	O(26)–Cr(46)–O(33)	90.916	O(33)–C(32)–N(9)	117.030
Fe(46)–O(5)	1.850	O(5)–Fe(46)–O(29)	89.721	O(26)–Fe(46)–Cl(25)	88.720
Fe(46)–O(29)	1.889	O(5)–Fe(46)–O(26)	91.310	O(26)–Fe(46)–O(33)	89.152
Fe(46)–O(26)	1.890	O(5)–Fe(46)–Cl(25)	85.567	O(26)– Fe(46)–N(8)	89.887
Fe(46)–Cl(25)	2.224	O(5)–Fe(46)–O(33)	178.532	Cl(25)–Fe(46)–O(33)	96.421
Fe(46)–O(33)	1.870	O(5)–Fe–(46)–N(8)	95.310	Cl(25)–Fe(46)–N(8)	178.789
Fe(46)–N(8)	1.910	O(29)–Fe(46)–O(26)	178.231	O(33)–Fe(46)–N(8)	84.612
C(6) = N(8)	1.285	O(29)–Fe(46)–Cl(26)	91.142	O(26)–Fe(46)–N(8)	89.981
N(9) = C(32)	1.288	O(26)–Fe(46)–O(33)	90.820	O(33)–C(32)–N(9)	119.195
(c)					
Mn(36)–N(17)	1.789	N(17)–Mn(36)–O(16)	82.699	O(16)–Mn(36)–Cl(15)	96.913
Mn(36)–O(16)	1.799	N(17)–Mn(36)–O(8)	97.821	O(16)–Mn(36)–O(9)	89.981
Mn(36)–O–(8)	1.831	N(17)–Mn(36)–O(9)	91.012	O(8)–Mn(36)–(11)	89.182
Mn(36)–O–(9)	1.832	N(17)–Mn(36)–O(11)	88.802	O(8)–Mn(36)–Cl(15)	85.399
Mn(36)–O(11)	1.829	N(17)–Mn(36)–Cl(15)	179.901	O(9)–Mn(36)–O(11)	178.986
Mn(36)–Cl(15)	2.170	O(16)–Mn(36)–O(8)	178.125	O(9)–Mn(36)–Cl(15)	89.799
Co(47)–N(17)	1.841	N(17)–Co(47)–O(16)	82.755	O(16)–Co(47)–Cl(15)	95.106
C(3) = N(17)	1.128	O(16)–Mn(36)–O(9)	89.803	O(11)–Mn(36)–Cl(15)	88.971
Co(47)–O(8)	1.830	N(17)–Co(47)–O(9)	91.053	O(8)–Co(47)–O(11)	90.170
Co(47)–O(9)	1.831	N(17)–Co(47)–O(11)	88.913	O(8)–Co(47)–Cl(15)	85.125
Co(47)–O(11)	1.824	N(17)–Co(47)–Cl(15)	177.991	O(9)–Co(47)–O(11)	179.012
Co(47)–Cl(15)	2.170	O(16)–Co(47)–O(8)	180.152	O(9)–Co(47)–Cl(15)	89.901
Ni(47)–N(17)	1.839	N(17)– Ni(47)–O(16)	82.800	O(16)– Ni(47)–Cl(15)	95.122
Ni (47)–O(16)	1.802	N(17)– Ni(47)–O(8)	97.127	O(16)– Ni(47)–O(9)	91.788

Table 7 (continued)

Bond connectivity	Bond lengths (Å)	Bond connectivity	Bond angles (°)	Bond connectivity	Torsion angle (°)
Ni (47)–O(8)	1.832	N(17)– Ni(47)–O(9)	90.088	O(8)– Ni(47)–O(11)	91.165
Ni(47)–O(9)	1.841	N(17)– Ni(47)–O(11)	89.813	O(8)– Ni(47)–Cl(15)	86.130
Ni(47)–O(11)	1.820	N(17)– Ni(47)–Cl(15)	178.012	O(9)– Ni(47)–O(11)	179.125
Ni(47)–Cl(15)	2.172	O(16)– Ni(47)–O(8)	179.195	O(9)– Ni(47)–Cl(15)	89.813
N(18)–C(20)	1.399	O(16)– Ni(47)–O(11)	89.813	O(16)–C(20)–N(18)	104.231
Cu(47)–N(3)	1.859	N(3)–Cu(47)–O(6)	82.739	O(6)–Cu(47)–Cl(30)	95.996
Cu(47)–O(6)	1.834	N(3)–Cu(47)–O(23)	96.810	O(6)–Cu(47)–O(26)	90.834
Cu(47)–O(23)	1.834	N(3)–Cu(47)–O(26)	92.050	O(23)–Cu(47)–O(24)	89.172
Cu(47)–O(26)	1.830	N(3)–Cu(47)–O(24)	87.926	O(23)–Cu(47)–Cl(30)	84.427
Cu(47)–O(24)	1.830	N(3)–Cu(47)–Cl(30)	176.975	O(26)–Cu(47)–O(24)	179.976
Cu(47)–Cl(30)	2.160	O(6)–Cu(47)–O(23)	179.260	O(26)–Cu(47)–Cl(30)	90.690

(O_h) geometry around the metal ion. The molecular geometry is connected with an ONO donor Schiff base and a monodentate coordination of Cl^- ion to Cr(III) and Fe(III), while Mn(II), Co(II), Ni(II) and Cu(II) center as monomeric species with a basal plane. The four basal positions are occupied by the tridentate, diprotic hydrazone ligand, which furnishes an ONO donor set with interatomic distance (Å) in (Cr/Fe); M(46)-O(5); 1.855–1.850, M(46)-O(33);1.866–1.870, M(46)-N(8);1.914–1.910. The fourth position in the case of Cr(III) and Fe(III) complexes was occupied by a Cl of M(46)-Cl(25); 2.219, 2.224 (Å). The four angles are O(5)-Cr(46)-Cl(25); 84.874, O(5)-Cr(M)-N(8); 96.130, Cl(25)-M(46)-O(33); 97.477, O(33)-M(46)-N(8), 81.526 close to 90 (°) and two angles are O(5)-M(46)-O(33); 177.640 and Cl(25)-M(46)-N(8); 177.878 are close to 180(°) which suggests the presence of the basal plane in the complex. The fifth and sixth coordination positions in the complexes were occupied by two water molecules equatorially as trans to each other with O(29)-M(46)-O(26) 179.132 which suggests an irregular geometry of the studied compounds with a distorted octahedral geometry. The optimized structure of other complexes contains a central metal ion with their atoms numbering represented as Mn(36),Co(47),Ni(47) and Cu(47) were bonded by six donor atoms of the octahedral sphere. The complex exhibits shorter bond length (1.831–1.834) Å for the deprotonated M–O bond of the phenyl-OH group. The triatomic in the range of 1.789–1.831(Å), 1.799–1.834(Å) and 1.830–1.834(Å) indicates a shorter bond of phenolic-O, azomethine-N and carbonyl-O respectively. The atomic arrangement involves two oxygen (*trans* positions), one nitrogen of azomethine (ONO) donor monobasic tridentate Schiff base ligand and chlorine as fourth donor atom to form a planar structure. The fifth and sixth *trans*-coordination sites in the complexes were occupied by H_2O molecules inside the coordination field. The interatomic M-Cl bond distances was found in the range 2.160–2.172 (Å) destine of group to azomethine N-donor atom. The triatomic moieties of the chelate cycle approaches to 89–90 (°) equatorial and the axial bond of the M–O bond of H_2O molecule to the plane by an angle of 178.986–178.976 (°) indicates *trans* directing group. The bond lengths, bond angles within the chelate cycle, equatorial and axial plane approaches to the expected values which confirms the structure of octahedral geometry of metal (II, III) complexes [43, 44].

Frontier MO's: HOMO–LUMO analysis

The frontier molecular orbitals (HOMO–LUMO) of ligand and its metal complexes were analyzed in the ground state to demonstrate the quantum chemical properties evaluated from DFT study. The charge transfer from (HOMO → LUMO) of hydrazone ligand (H_2L) and its metal (II/III) complexes are displayed in Fig. 7a–g. The significant FMO's energies and quantum chemical parameters have been charted in Table 8. The charge transfer was occurred from HOMO → LUMO due the small energy band gap favorable of the polarization to the soft molecules. The analysis of HOMO and LUMO signifies the properties of hardness, softness, chemical stability and reactivity. The implication of the small energy band gap between FMO's of ligand at 5.412 eV clearly

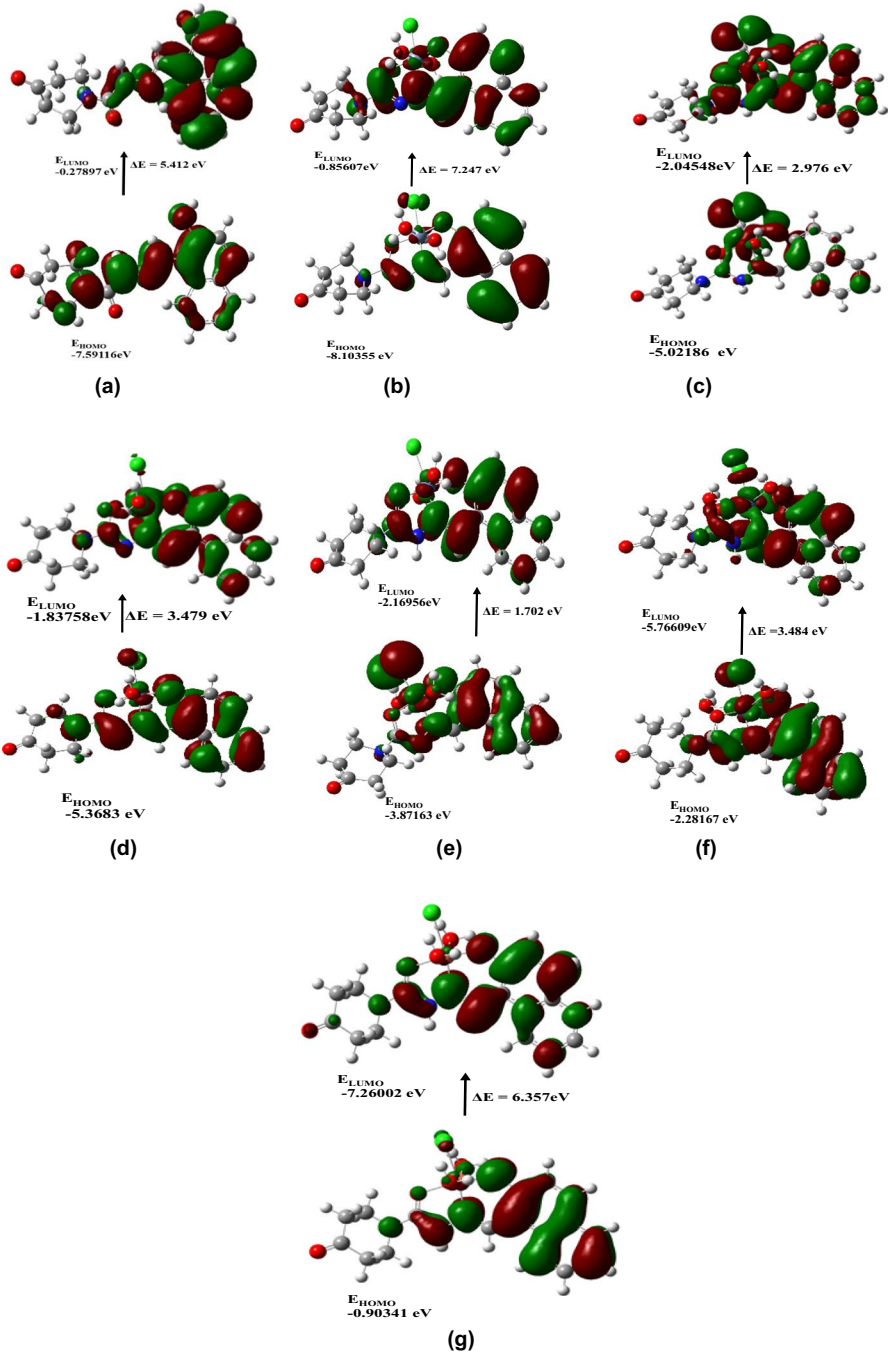


Fig. 7 Plot of frontier MO's HOMO→LUMO **a** Ligand (H_2L), **b** Cr(III), **c** Mn(II), **d** Fe(III), **e** Co(II), **f** Ni(II), and **g** Cu(II) complexes

Table 8 Calculated quantum chemical parameters of hydrazone ligand (H_2L), and its metal complexes

Compounds	FMO's	Energies (eV)	(ΔE)	Quantum chemical parameters								
				(μ)	(η)	(S)	(ω)	(N)	(ΔN_{max})	T. energy (Kcal/mol)	Dipole (debye)	(α)	($\Delta\chi$)
Ligand (H_2L)	E_{HOMO}	−7.5911	5.412	−4.8849	2.7061	0.3695	4.4090	6.346	1.805	−175.19	4.6942	227.86	−8.681
	E_{LUMO}	−2.1788											
Cr(III) complex	E_{HOMO}	−8.1035	7.247	−4.4798	3.6237	0.2759	2.7690	6.859	1.236	−187.01	6.9698	250.97	−8.532
	E_{LUMO}	−0.8560											
Mn(II) complex	E_{HOMO}	−5.0219	2.976	−3.5337	1.4882	0.6720	4.1953	3.777	2.374	−115.89	12.125	237.60	−6.045
	E_{LUMO}	−2.0455											
Fe(III) complex	E_{HOMO}	−5.3168	3.479	−3.5772	1.7396	0.5748	3.6779	4.072	2.056	−122.70	5.2894	240.63	−6.236
	E_{LUMO}	−1.8376											
Co(II) complex	E_{HOMO}	−3.8716	1.702	−3.0206	0.8510	1.1750	5.3605	2.627	3.549	−89.35	9.1312	329.03	−4.956
	E_{LUMO}	−2.1696											
Ni(II) complex	E_{HOMO}	−5.7661	3.484	−4.0239	1.7422	0.5740	4.4912	4.521	2.310	−133.07	8.8182	242.17	−6.907
	E_{LUMO}	−2.2817											
Cu(II) complex	E_{HOMO}	−7.2600	6.357	−4.0817	3.1783	0.3146	2.6210	6.015	1.284	−167.55	8.6190	241.12	−7.712
	E_{LUMO}	−0.9034											

indicates the charge transfer effects at a qualitatively level. The electronic transition ($\pi \rightarrow \pi^*$) occurred from HOMO to LUMO in atoms of phenolic (O-39), carbonyl (O7) and azomethine (N4) group. The metal complexes contain the greater electron density found on 'd' orbital, azomethine-N atom, carbonyl-O atom and Cl^- ion. The FMO's energies indicate the clear evidence in support of charge transfer within metal complex structure. The hydrazone ligand and its metal (II/III) complexes, i.e. energy band gap (ΔE) found decreasing in the order of Cr(III) (7.247) > (Cu (II) (6.357) > (H_2L) ligand (5.412) > Ni(II) (3.484) > Fe(III) (3.479) > Mn (II) (2.976) > Co (II) (1.702) eV which was well supported towards charge transfer within molecule. The other important quantum chemical parameters, i.e. Chemical potential (μ), Global hardness (η), and Softness (S), Electrophilicity index (ω), Nucleophilicity index (N) were calculated [45]. The calculated chemical reactivity's parameters of ligand viz., chemical potential of ligand (μ) = – 4.48849 eV indicating the structural stability and its global hardness (η) = 2.7061, and softness (S) = 0.3695 imply of electron transfer effects. The inverse correlation observed of the global hardness (η) = 1.7305 with the softness (S) = 0.5778 was confirmed the electron transfer from HOMO to LUMO region. This helps in the participating as strong nucleophile which favored to more reactive in the nucleophilic substitution reaction (S_N). The chemical potential of the metal complexes were calculated as (μ) = (–3.0203) to (–4.8849) reflecting their higher stability of molecules. Other factors of global hardness (η) = (0.8510 to 3.6178), compared to softness (S) = (0.2759 to 1.1750) evidence of the complete transfer of electrons occurred from HOMO → LUMO. The calculated nucleophilicity index (N) was more than the electrophilicity index (ω) in ligand (H_2L); ($N = 6.346$ eV > ω = 4.409) and where as in metal complexes of Cr(III); ($N = 6.859 > \omega = 2.769$), Mn(II); ($N = 4.1953 > \omega = 3.777$), Fe(III); ($N = 4.072 > \omega = 3.6779$), Co(II); ($N = 5.3605 > \omega = 2.627$), Ni(II); ($N = 4.521 > \omega = 4.491$), Cu(II); ($N = 6.015 > \omega = 2.621$) as expected. The ($N$) and ($\omega$) are useful key indicators for the concrete information towards in *vitro* anti-microbial potency and well supported by molecular docking [46, 47]. The electrophilic index (ω) was calculated for stabilization purpose after received an additional electron density (ΔN_{max}) from the environment [48, 49].

$$\Delta N_{\max} = -\frac{\mu}{\eta} \tag{6}$$

The overall changes in the total negative energy were calculated (−89.35 to −175.190) kcal mol^{-1} of ligand (H_2L), and its complexes indicate the stabilization of molecular structure at the B3LYP level [59, 60]. The dipole moment of the ligand and metal complexes was evaluated (4.694212.125)D designatory of polarity of molecules in the ground state. The greater the electronegativity difference ($\Delta\chi$) = (−4.956 to −8.681) between two atoms implying the larger the bond's dipole moment and its polarization (α) = (227.89 to 329.031) D. The bonding properties of ligand and its metal complexes show polarity and covalency nature of the molecules were predicted due to the greater electronegativity character ($\boldsymbol{\Delta}\chi$) [50, 51].

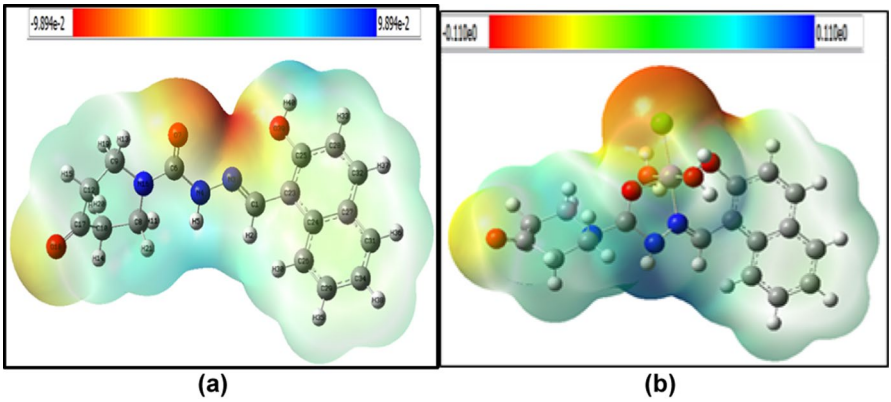


Fig. 8 Molecular electrostatic potential map surface of **a** ligand (H_2L), **b** Mn(II) complex

Molecular electrostatic potential map (MEP)

Molecular electrostatic potential (MEP) map are three-dimensional isocounter surface and are useful descriptor in the understanding of electrophilic and nucleophilic attack to centre and hydrogen bonding interactions on the basis of its electronic charge distribution. The well resolved MEP map were generated from Gaussian *09* of optimized structure of ligand and its Mn(II) complex showed in Fig. 8a, b are as representative cases and other four complexes of Cr(III), Co(II), Ni(II), Cu(II) shown in Fig. S6a–d imaged. The MEP of ligand and its metal complexes correlates the electrophilic and nucleophilic properties which authenticate to negative (red color) and positive (blue) region respectively. The electrostatic potential distinctly increases in the sequence order of yellow < green < red < blue in ligand which informed the exhibiting the nucleophilic active center. In ligand, the –ve electrostatic potential appeared in the maximum region due to the presence of phenyl O(39)-H(40) group, hydrazone group C(1) = N(3)–N(4) and C(6) = O(7) group favorable to electrophilic attack. The MEP of the ligand consists of the negative region of electrostatic belonging to the two–carbonyl-O i.e. (O7, O18), hydrazone group C(1) = N(3)-N(4) and phenolic O(39)-H(40) group showing the magnitude level at − 732.435 kJ/mol. On the other hand, the magnitude for the H-atoms linked to sp^2, sp^3 carbon atom was found in the range of ~ 40 to 150 kJ/mol. The color scale ranges from deep red (− 9.844e−2 a.u.) to deep blue (9.894 e−2 a.u.) in ligand. The deep blue indicates the strong attraction of electrons and red color indicates the repulsion of electrons in ligand, and metal complexes. The region of color in the metal complexes is varied from the ligand after the complex formation. The variation in colored map region of the compounds depends upon the charge distribution, polarity and hydrazone bonding interaction in the complex structures [52, 53].

Absorption, distribution, metabolism, excretion, and toxicity parameters (ADMET)

Experimental

In silico bioactivity prediction of drug-likeness properties was assumed by subjecting them to the calculations from Molinspiration cheminformatics tool. The ADMET properties, including five parameters such as absorption, distribution, metabolism, excretion and toxicity were predicted from a user-friendly interface tools, i.e. admetSAR which is supportive methodology [54]. The pharmacological activity of drugs is defined by the interaction of highly applicable biological targets including enzymes, ion channels and receptors in living things. The bioavailability of the studied compounds were predicted by subjecting them to computations over Molinspiration cheminformatics tool and the results are cited in Table S7. The bioactivity scores of the studied compounds were observed based on six important parameters viz., (i) G-protein coupled receptor ligand (GPCRL), (ii) kinase inhibitor (KI), (iii) ion channel modulation (ICM), (iv) nuclear receptor ligand (NRL), (v) protease inhibition (PI) and (vi) enzyme inhibition (EI). According to earlier researchers, bioactivity scores of 0.0 or higher, then the compounds are promisingly bioactive, while those with scores between 0.50 to 0 have considered moderate activity, and those with a score of −0.50 are inactive [55]. In the present study the compounds exhibit values −0.46 to 0.18 and hence they are expected to show moderate activity. These are predictable to retain such properties as demand for them to behave as possible drugs with some alterations in their molecular structure [56].

Lipinski's rule

In the field of drug design and its development, Lipinski's five (RO5) rule was supported to drugs molecular characteristics. This gives various pharmacokinetic parameters, viz., absorption, distribution, metabolism and excretion (ADME) for predicting the success of an orally administered drug's journey over the body to the site of actions. Some certain molecular characteristics are as follows: (i) The logP (partition coefficient), (ii) Molecular weight (MW) (iii) Number of hydrogen bond acceptors (nON) (iv) Number of Hydrogen bond donors (nOHNH), (iv) Topological polar surface area (TPSA). A drug for an orally active medication should contain logP (≤ 5), hydrogen bond acceptors (≤ 10), hydrogen bond donors (≤ 5) and a molecular weight of (≤ 500), according to RO5 [57]. An orally active medicine should not typically exhibit any rule of violations. Here, the data of the studied compounds based on said parameters are computed and charted in Table S8. Under this rule, milLogP values of ligand (H_2L) (2.63) and its complexes (−5.04 to −5.33) are within the acceptable range for a drug to pass through the bio-membranes and exhibits a good bioavailability. So, the studied compounds can be considered to be oral therapeutic uses of molecules as per RO5.

ADMET Prediction

The theoretical approach has been used for the evaluation in silico ADMET properties. These are pre-indicative whether the studied compounds show toxicity after administration in the body or show any pharmacokinetics. The proceeding for this purpose, the admetSAR methodology was used in the present investigation. The compound was studied on the basis of their molecular structure and the desired compounds were analyzed for the prediction of their pharmacokinetics viz., absorption, distribution, metabolism and elimination (ADMET) as well as their toxicity nature to avoid further potential interactions of drugs with anti-targets causing some side effects. The various absorption as well as excretion models namely (i) aqueous solubility (LogS) (ii) Caco-2 cell permeability, (iii) Blood–Brain Barrier (BBB) penetration, (iv) Human Intestinal Absorption (HIA) and toxicity parameters like (i) carcinogenetic, (ii) LD50 dosage have been used. The predicted ADMET data of the studied ligand (H_2L) and its metal (II, III) complexes are tabulated in Table 9. It was observed that the studied compounds showed absorption and distribution properties indicated by the value of HIA, BBB and Caco2 permeability values which suggests their more auspicious pharmacokinetics. The carcinogenic profile of ligand and its metal (II, III) complexes was also exhibited a non-carcinogenic nature. One of the more applicable information collected from admetSAR is the computed median lethal dose (LD50) in the rat model (acute rat toxicity) which aids in deciding the lethalness of the compounds. Thus, the lower the LD50 value, was more lethal as compared to those with higher LD50 values of the compounds. The LD50 values of studied compounds were mostly more than commonly used as a drug streptomycin (LD50 = 1.841 mol/kg) [58].

Molecular docking

Protein preparation

The three-dimensional crystallographic structures of peptide deformylase, adenylate kinase and DNA polymerase were retrieved from the RCSB protein data bank and used for further processing. Initially, in protein structure modification requires

Table 9 ADMET activity score of hydrazone ligand (H_2L), and its metal complexes

Compounds	BBB	HIA	Caco2	ROCT	Carcinogenicity	LogS	LD50 (mol/kg)
H_2L ligand	0.766	0.974	0.636	Non-inhibitor	Non-carcinogens	− 3.352	2.351
Cr(III) complex	0.578	0.573	0.594	Non-inhibitor	Non-carcinogens	− 3.510	2.635
Fe(III) complex	0.574	0.894	0.596	Non-inhibitor	Non-carcinogens	− 3.518	2.636
Mn(II) complex	0.647	0.510	0.628	Non-inhibitor	Non-carcinogens	− 3.535	2.622
Co(II) complex	0.641	0.921	0.622	Non-inhibitor	Non-carcinogens	− 3.452	2.623
Ni(II) complex	0.641	0.921	0.622	Non-inhibitor	Non-carcinogens	− 3.542	2.623
Cu(II) complex	0.641	0.921	0.622	Non-inhibitor	Non-carcinogens	− 3.542	2.623

various tasks such as insertion of atoms missing in incomplete residues, deletion of alternate confirmations, missing loop region modelling and protonation of titrable residues. The preparation of proteins was performed with the aid of CHARMM force fields generator. For the molecular docking, analysis was performed on the crystal structure of Adenylate kinase (PDB ID-3BE4), peptide deformylase (1LQY) of *Escherichia coli* and fungal enzymes of DNA polymerase (PDB ID-4M8O).

Protein–ligand docking

Discovery studio 2.0 (Accelrys, USA) was employed in silico and post docking visualization. The molecular docking study was completed by a LibDock program of Discovery studio which revealed that the bioactive binding sites of receptor. In LibDock, two protein site features of polar and a polar are available called as hotspots. Further, test compounds were interacted with the polar and a polar sites of receptors. Additionally, the identification to specific interacting residues of the receptor with a bound ligand, a 2D diagram of the docking study was carried out. The molecular docking have been provided the insight of receptor bioactive ligand with specific interactions. Molecular docking structure are presented in Fig. 9a, c, e in 3D view image contains the tube form structure in which hydrogen bond and its bond distance are showed by red color line Fig. 9b, d, f 2D view image contains hydrogen bonding interactions of tridentate hydrazone ligand with enzymes of adenylate kinase, peptide deformylase and DNA polymerase. The molecular docking revealed that the compound have been showed the good binding score with adenylate kinase, peptide deformylase (*E. coli* enzymes) and DNA polymerase (fungal enzyme) as shown in Table 10. Autodock 4.2.6 molecular docking software was operated for the docking analysis in the detection of intramolecular binding of the corresponding linkage of hydrazone ligand with the targeted receptor protein. Before the operation of the docking, the proteins were refined by the removal of water molecules and co-crystallized by adding Kollmann charges and polar hydrogen. The binding affinity of tridentate ligands with the receptors Adenylate kinase and DNA polymerase have signified the dock score of amino acid residues. The greater negative binding energy (-7.42 kcal mol^{-1}) was found in negative terms which displaying the significant binding affinity of ligand with receptor proteins. The binding interactions such as H-bond, van der Wall and hydrophobic interactions distinctly indicate the possible binding ligands with receptor protein [59]. In order to obtain optimum interaction between the protein with the hydrazone ligand, a grid box axis of X, Y and Z with 39, 41 and 41 points was giving rise using Autodock 4.2.6 respectively. The hydrazone ligand have been found pursue in the vicinity of interaction within the active site of the receptor through H-bonding interaction with ASP 167, OSer16, Gly15, Lys18, Ser35, Asp167 residues. The amino acid residue corresponds to binding and holding of the ligand molecule in the active site of Adenylate kinase protein. The molecular docking result indicates that ligand has also Adenylate kinase inhibitory potential. Similarly, the hydrazone ligand when docked with the peptide deformylase showed score with low binding energy (-7.12) kcal mol^{-1} of Gly58, Gly109 which suggested the good inhibitory potential. The molecular docking and its binding data of tested hydrazone ligand showed considerable docking output score of

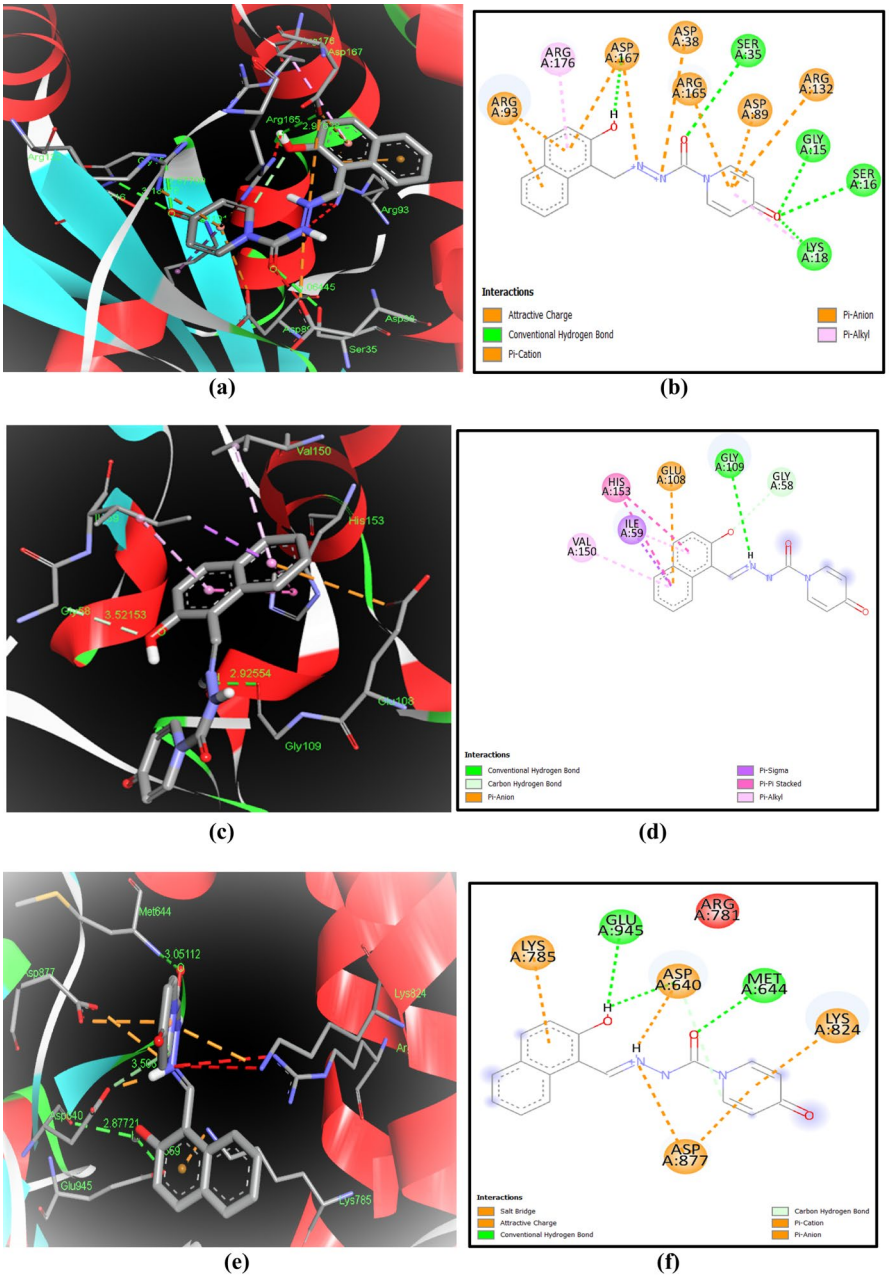


Fig. 9 Molecular docked 3D view image **a**, **c**, **e** in tube form displayed hydrogen bond by red color line and bond distance, and 2D view image of H-bonding interactions of hydrazone ligand (H_2L) with enzymes of **b** adenylate kinase, **d** peptide deformylase, **f** DNA polymerase

Table 10 Molecular docking analysis of bacterial enzyme and fungal enzymes

Compounds	Protein ID	Atom–amino acid residues receptor involved in hydrogen bonding	H-bond distance (Å)	ΔG (kcal/mol)
Adenylate kinase	(3BE4)	O-Ser16	3.18078	−7.42
		O-Gly15	2.87709	
		O-Lys18	2.91191	
		O-Ser35	3.06445	
		H-Asp167	2.97628	
Peptide deformylase	(1LQY)	O-Gly58	3.52153	−7.12
		H-Gly109	2.92554	
DNA polymerase	(4M8O)	H-Glu945	2.55901	−7.20
		H-Asp640	2.87721	
		O-Met644	3.05112	

binding energy (−7.20) kcal mol^{-1}. The 2D docking image well informed the DNA polymerase amino residue has involved in hydrogen bonding of Glu945, Asp640, Met644. The targeted DNA polymerase interacted with ligand through active binding which is capable of damaging the membrane of fungal protein [60, 61].

Antibacterial and antifungal evaluations

The in vitro antibacterial susceptibility of ligand (*E*)-*N*′-((2-hydroxynaphthalen-1-yl)methylene)-4-oxopiperidine-1-carbohydrazide ligand (H_2L) and its metal (II/III) complexes were screened by standard procedure recommended by WHO expert committee on biological standardization; European Committee on antimicrobial susceptibility testing (EUCAST). The disk-diffusion method was employed for the antimicrobial screening against human pathogens of gram-positive bacteria viz., *Staphylococcus aureus* (NDCM-2257), *Bacillus subtilis* (NICM-2477), (gram-negative); *Escherichia coli* (NCBI-0157), *Salmonella typhi* (NICM-2257) and fungi *Candida albicans;* (MTCC-1637) and *Aspergillus niger* (NCIM-1005) at a concentration of 1.0 mg/mL. The microbiological assay was performed in the diagnostic laboratory using fine culture base medium. The mono microbial sensitivity disk was used for the semi-qualitative to evaluate in vitro susceptibility of antimicrobial agents of fast growing human threatening pathogenic species, and several difficult species using an agar disk diffusion techniques. The plates were incubated at temperatures $+35^0$c to $+37^0$c for 24 h. The sensitivity was evaluated by estimating the inhibition zone growth around the loaded disk [62]. The size of the inhibition zone was considered as a basis of resistivity, intermediate or sensitivity and its result were interpreted in (mm). The inhibition activities were presented as a percentage and calculated by the formula ($I = C - TC \times 100$) where I denotes inhibition rate (%); C denotes radial growth of pathogenic microorganism (mm) with solvent DMSO (-ve control); T denotes the radial growth (mm). The commonly useful antibiotic drugs viz., ofloxacin,

Table 11 In vitro antimicrobial result (MICs 1.0 mg/mL) of the tested compounds

Ligand/complexes/ standard drugs	Bacteria (gram negative)		Bacteria (gram positive)		Fungus species	
	Escherichia coli (NCBI-0157)	*Salmonella typhi* (NICM-2257)	*Staphylococcus aureus* (NDCM-2257)	*Bacillus substilis* (NICM-2477)	*Candida albicans* (MTCC-1637)	*Aspergillus niger* (NCIM-1005)
Ligand (H_2L)	18	17	11	10	18	16
Cr(III) complex	21	15	14	12	22	15
Fe(III) complex	20	16	13	12	24	14
Mn(II) complex	24	14	14	13	15	16
Co(II) complex	15	14	11	15	12	30
Ni(II) complex	22	15	10	14	13	20
Cu(II) complex	18	17	14	13	14	21
Ofloxacin*	30	30	–	–	–	–
Azithromycin*	–	–	15	20	–	–
Fluconazole*	–	–	–	–	28	30
DMSO negative control	–	–	–	–	–	–

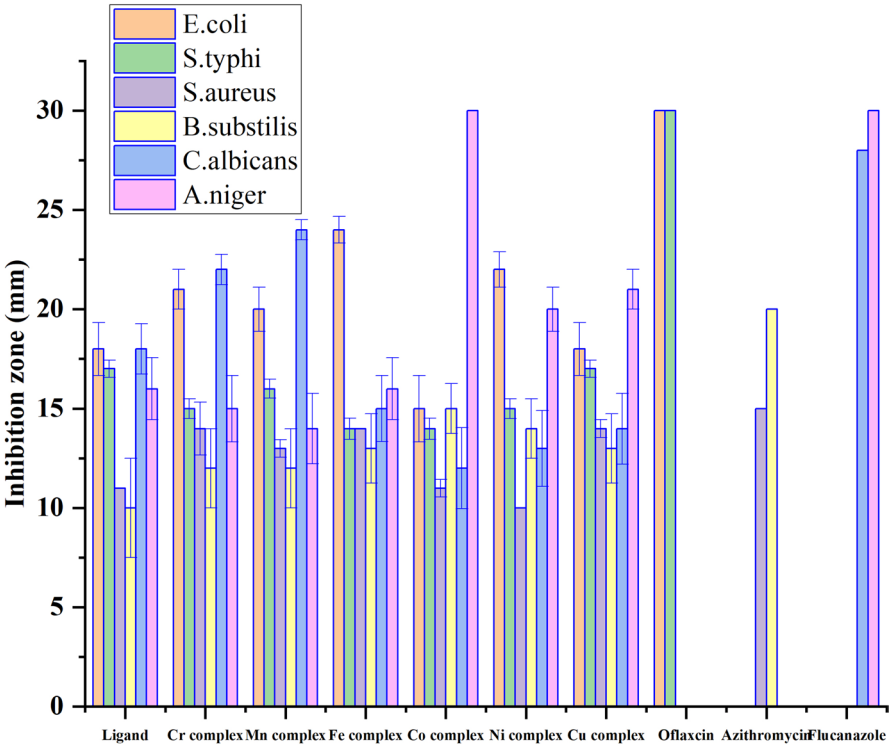


Fig. 10 Inhibition zone growth of microorganism: comparison ligand with metal complexes and standard drugs

azithromycin and fluconazole were used as a (+ ve control) for the comparison of inhibition zone growth [63]. The better activity of compounds was found and this may be due to the presence of an exchangeable proton in (HC=N–) of azomethine group, O-atom in (>C=O) group, delocalized π-electrons of (naphthalene-1-yl) ring, and extra supportive of piperidone moiety. The inhibition zone results are presented in Table 11 and their bar graph (Fig. 10). The results showed that the microbial activity of the ligand also considerably compared to coordinated metal (II/III) complexes. The inhibition zone data indicate gram −ve bacteria, i.e. *E. coli*, and *S. typhi* are more potentially active than gram + ve bacteria, i.e. *S. aureus* and *B. substillis* which is supported by simulation molecular docking analysis. Such group specificity may be due to increase in lipophilicity caused by chelation. The coordination of metal ion with ligand the increases bioactivity, this can be described on the basis of the *Tweedy's chelation theory* (TCT) [64, 65]. On chelation, the polarity of the metal ion is reduced due to the overlap of ligand's orbital and sharing of the positive charge of metal ion with donor atoms. Further, it increases the delocalization of electrons of the chelate ring, the respiration process of cells and blocks the synthesis of proteins which further restricts the growth of organisms. Moreover, the extra benzenoid ring in the structure of

the ligand and its metal complexes reveals the more potential activities against bacterial and fungal growth resistance. Within the fungi, the C. *albicans* is more moderately active than the *A. niger* strain and this may be due to the presence of the *ONO* donor atoms of hydrazone ligand. In azomethine (>C=N) group, an exchangeable proton towards the metal complexes intensify the destroying ability of the human pathogenic microorganisms. The in vitro antimicrobial activities was performed by using a minimum inhibitory concentration (1 mg/ml) of tested with ligand, metal complex and std. drugs. The biological potency of compounds is governed by some factors: (i) The geometrical structure, (ii) ONO donor atoms, (iii) total charge on the metal complex ion, (iv) size of microorganisms, its medium and tolerance factors [66]. The ligand and metal complexes were active against two strains of viz., *E. coli* having an inhibitory zone range of (15–24 mm) than *S. typhi* (14–17 mm) shows a broad spectrum activities in the order of metal complexes of Mn(II) > Ni(II) > Cr(III) > Fe(III) > Cu(II) > H_2L ligand. This may be due to the smaller size (2.0 µm) of *E. coli*, which displayed better sensitivity than the facultative anaerobic S. Typhi size of (5 µm) which has a motile flagella. The compounds in the order of Cr(III) ≈ Mn(II) ≈ Cu(II) > Fe(III) > H_2L ligand showed good antimicrobial activity when treated with B. subtilis and S. aureus inhibitory zone of (10–14 mm) and (10–15 mm) respectively [67]. Moderate activities against *S. auresus* are observed in the complexes of Co(II) > Ni(II). Due to its protective endospores and tolerance in extreme environments, B. subtilis bacteria exhibits less performance than S. aureus. All the compounds treated of *A. niger's* fungal species resulted in good activity of Co(II) > Ni(II) > Cu(II) complexes. All inhibitory zone data reveal that the metal (II/III) complexes show the moderate to good antimicrobial activities than the free ligand. The Co(II) complex is superior among all compounds showing inhibitory zone of 30 mm when compared to std. drug of fluconazole and hence treated good antifungal candidate. The antimicrobial potency result are compatible with targeted *E. coli* protein of peptide deformylase, adenylate kinase, and fungal protein of DNA polymerase with tridentate hydrazone ligand [68, 69].

Conclusions

Herein, we have presented two types of metal complexes in the form of [M(L)$Cl(H_2O)_2$]; [M = Cr(III) and Fe(III)] and [M(HL)$Cl(H_2O)_2$]; [M = Mn(II),Co(II),Ni(II),Cu(II)] with (*E*)-*N*′-((2-hydroxynaphthalen-1-yl)methylene)-4-oxopiperidine-1-carbohydrazide (H_2L) ligand and characterized them by various physicochemical and spectral techniques. The experimental and theoretical studies are quite compatible with each other for the proposed octahedral geometry of metal complexes. The synthetic studies showed the importance of tridentate moiety, *N*-heterocycle in piperidone nucleus present in the ligand. The elemental analysis showed 1:1 ligand-to-metal stoichiometry ratio in addition to the non-electrolytic behavior of metal complexes. All compounds were displayed their superb absorption and fluorescence emission properties. The ESR tensor component features of $A_{\parallel}$ (168 cm^{-1}) > $A_{\perp}$ (55.54 cm^{-1}) in which no metal–metal interaction showed distorted octahedral

geometry of Cu(II) complex. The surface morphology of ligand was distinct from the complex proved by an imaging by SEM analysis. The powder XRD diffraction data inferred showed their nanocrystalline nature. TG analysis of metal complexes indicated the presence of two coordinated-H_2O and one Cl^- ion metal complex. The kinetic parameters of (Ea, Z, ΔS, ΔH, ΔG) indicate a good thermal stability, endothermicity and non-spontaneity due to 'structural order' of metal complexes. The small energy band gap of (HOMO → LUMO) in ligand and metal complexes was sufficient to charge transfer effect. Molecular docking revealed the better binding affinity of the hydrazone ligands with the receptors of Adenylate kinase, DNA polymerase and peptide deformylase. The coordination of ligand with metal ions have enhanced potential antibacterial and antifungal activity against selected pathogenic species. More general, this investigation contributes to structural dynamics in fluorescence, antimicrobial and pharmacological applications.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11164-023-05169-2.

Acknowledgements The authors are greatly acknowledged to the authorities of Sant Gadge Baba Amravati University, Amravati for furnished necessary research facilities viz., Bruker-IR instrument, UV-Vis., and Perkin Elmer-TG analyser. The authors are grateful thanks to SAIF-Punjab University, Chandigarh for elemental, NMR (^1H and ^{13}C), HR-Mass spectra and SEM analysis. The authors are also grateful to the sophisticated analytical Instrumental facility of Indian Institute of Technology (IIT)-Mumbai for recording the ESR spectrum and the Principal, Central instrumentation facility, Shri Shivaji Science College, Amravati (M.S.) for powder X-ray diffraction analysis.

Authors' contribution GD have been written original draft; utilized software along with the conceptualization; performed formal analysis and investigation. AS contributed in methodology; writing—review and editing; resources as well as in supervision of research work.

Funding No funding was received from any agencies for this research work.

Availability of data and materials All the spectral data are provided supplementary information.

Declarations

Conflict of interest The authors declares that they have no conflict of interest.

Ethical approval No animal/ human studies were carried out in the present work.

References

1. S. Kumar, J. Devi, A. Dubey, D. Kumar, D.K. Jindal, S. Asija, A. Sharma, Res. Chem. Intermed. **49**, 939 (2023)
2. A. Erdmann, Y. Menon, C. Gros, V. Masson, Y. Aussagues, F. Ausseil, N. Novosad, P. Schambel, M. Baltas, P.B. Arimondo, Future Med. Chem. **8**, 373 (2016)
3. W. Khalid, A. Badshah, A. UllahKhan, H. Nadeem, S. Ahmed, Chem. Cent. J. **12**, 1 (2018)
4. U. Salgin-Goksen, G. Telli, A. Erikci, E. Dedecengiz, B.C. Tel, F.B. Kaynak, K. Yelekci, G. Ucar, N. Gokhan-Kelekci, J. Med. Chem. **64**, 1989 (2021)
5. M. Gaber, A.M. Khedr, M. Elsharkawy, Appl. Organomet. Chem. **31**, 1 (2017)
6. A. Alka, S. Gautam, R. Kumar, P. Singh, N. Gandhi, P. Jain, Results Chem. **5**, 100849 (2023)

7. T.R.F. de Melo, R.C. Chelucci, M.E.L. Pires, L.A. Dutra, K.P. Barbieri, P.L. Bosquesi, G.H.G. Trossini, M.C. Chung, J.L. dos Santos, Int. J. Mol. Sci. **15**, 5821 (2014)
8. W.B. Júnior, M.S. Alexandre-Moreira, M.A. Alves, A. Perez-Rebolledo, G.L. Parrilha, E.E. Castellano, O.E. Piro, E.J. Barreiro, L.M. Lima, H. Beraldo, Molecules **16**, 6902 (2011)
9. X. Yu, L. Shi, S. Ke, Bioorg. Med. Chem. Lett. **25**, 5772 (2015)
10. O.A. El-Gammal, G.M.A. El-Reash, R.A. Bedier, Appl. Organomet. Chem. **33**, 1 (2019)
11. A.A. Mohamed, F.M. Ahmed, W.A. Zordok, W.H. El-Shwiniy, S.A. Sadeek, H.S. Elshafie, Inorganics **10**, 1 (2022)
12. M.S. El-Attar, F.M. Ahmed, S.A. Sadeek, S.F. Mohamed, W.A. Zordok, W.H. El-Shwiniy, Appl. Organomet. Chem. **36**, 10 (2022)
13. H.S. Seleem, G.A. El-Inany, B.A. El-Shetary, M.A. Mousa, F.I. Hanafy, Chem. Cent. J. **5**, 1 (2011)
14. H.H. Repich, S.I. Orysyk, V.V. Orysyk, Y.L. Zborovskii, A.K. Melnyk, V.V. Trachevskyi, V.I. Pekhnyo, M.V. Vovk, J. Mol. Struct. **1146**, 222 (2017)
15. J. Bureš, H. Jansová, J. Stariat, T. Filipský, P. Mladěnka, T. Šimůnek, R. Kučera, J. Klimeš, Q. Wang, K.J. Franz, P. Kovaříková, J. Pharma Biomed. Anal. **105**, 55 (2015)
16. K.D. Praliev, N.A. Belikova, Zh.I. Isin, D.V. Sokolov, Pharm. Chem. J. **21**, 854 (1987)
17. S.N. Mali, B.R. Thorat, D.R. Gupta, A. Pandey, MDPI Engn. Proc. **11**, 1 (2021)
18. H.S. Seleem, Chem. Cent. J. **5**, 1 (2011)
19. W. Cao, Y. Liu, T. Zhang, J. Jia, Polyhedron **147**, 62 (2018)
20. R. Fouad, I.A. Shaaban, T.E. Ali, M.A. Assiri, S.S. Shenouda, RSC Adv. **11**, 37726 (2021)
21. M. Gaber, S.K. Fathalla, H.A. El-Ghamry, Appl. Organo. Chem. **33**, 1 (2019)
22. P. Jyothi, S. Koppu, V. Sumalatha, B. Ushaiah, C. Gyana Kumari, Inorg. Chem. Commun. **110**, 107590 (2019)
23. M. Gaber, N. El-Wakiel, O.M. Hemeda, J. Mol. Struct. **1180**, 318 (2019)
24. Y. Li, C. Qian, Y. Li, Y. Yang, D. Lin, X. Liu, C. Chen, J. Inorg. Biochem. **218**, 111405 (2021)
25. F.K. Ommenya, E.A. Nyawade, D.M. Andala, J. Kinyua, J. Chem. **2020**, ID1745236 (2020).
26. V.P. Singh, A. Katiyar, J. Coord. Chem. **61**, 3200 (2008)
27. A. Pahonţu, C. Paraschivescu, D.C. Ilieş, D. Poirier, C. Oprean, V.P. Ăunescu, A. Gulea, T. Roşu, O. Bratu, Molecules **21**, 1 (2016)
28. L. Tabrizi, D.Q. Dao, T.A. Vu, RSC Adv. **9**, 3320 (2019)
29. V.P. Singh, A. Katiyar, S. Singh, Biometals **21**, 491 (2008)
30. G.M. Dongare, A.S. Aswar, Euro. J. Chem. **13**, 4 (2022)
31. M. Shakir, S. Hanif, M.A. Sherwani, O. Mohammad, S.I. Al-Resayes, J. Mol. Struct. **1092**, 143 (2015)
32. A.S. Alturiqi, A.N.M.A. Alaghaz, R.A. Ammar, M.E. Zayed, J. Chem. **2018**, 8987 (2018)
33. A.K. Sarangi, B.B. Mahapatra, R.K. Mohapatra, S.K. Sethy, D. Das, L. Pintilie, M. Kudrat-E-Zahan, M. Azam, H. Meher, App. Organomet. Chem. **34**, 1 (2020)
34. O.V. Konnik, M.A. Kiskin, D.S. Balaev, V.F. Shulgin, A.N. Gusev, J. Struct. Chem. **64**, 1361–1368 (2023)
35. L.V. Ababei, A. Kriza, A.M. Musuc, C. Andronescu, E.A. Rogozea, J. Therm. Anal. Calorim. **101**, 987 (2010)
36. S. Shit, J. Chakraborty, B. Samanta, A.M.Z. Slawin, V. Gramlich, S. Mitra, Struct. Chem. **20**, 633 (2009)
37. O.M.I. Adly, Spectrochem. Acta Part A Mol. Biomol. Spectrosc. **79**, 1295 (2011)
38. D. Meng, F. Liu, Y. Li, Z. Yang, G. Li, D. Guo, Luminescence **31**, 507 (2016)
39. Y. Li, Z.Y. Yang, M.F. Wang, J. Fluorine **20**, 891 (2010)
40. N. De Acha, C. Elosúa, J.M. Corres, F.J. Arregui, Sensors **19**, 599 (2019)
41. R. Konakanchi, J. Haribabu, J. Prashanth, V.B. Nishtala, R. Mallela, S. Manchala, D. Gandamalla, R. Karvembu, B.V. Reddy, N.R. Yellu, L.R. Kotha, Appl. Organomet. Chem. **32**, 1 (2018)
42. G. Tamasi, L. Chiasserini, L. Savini, A. Sega, R. Cini, J. Inorg. Biochem. **99**, 1347 (2005)
43. K. Karrouchi, S. Fettach, A. El Hassane, I. Bayach, H. Albalwi, S. Arshad, N.K. Sebbar, H. Tachalait, K. Bougrin, F. My El Abbes, B. Himmi, Polycycl. Arom. Compd. **43**, 2 (2023)
44. M. Bashir, A. A. Dar, and I. Yousuf, ACS Omega **8**, (2023).
45. G.M. Dongare, A.S. Aswar, J. Saudi Chem. Soc. **25**, 101325 (2021)
46. L.R. Domingo, M. Ríos-Gutiérrez, P. Pérez, Molecules **21**, 748 (2016)
47. T.L. Yusuf, S.D. Oladipo, S. Zamisa, H.M. Kumalo, I.A. Lawal, M.M. Lawal, N. Mabuba, ACS Omega **6**, 145 (2021)
48. R.G. Parr, C. Hill, N. Carolina, J. Am. Chem. Soc. **121**, 1922 (1999)

49. G. Badhin, N.V. Likhanova, M.A. Domınguez-Aguilar, R. Martınez-Palou, V. Alberto, J.L. Gazquez, J. Phys. Chem. B **110**, 8928 (2006)
50. F. Soleymani-Bonoti, M.A. Kamyabi, N. Arshadi, Comput. Theor. Chem. **1092**, 47 (2016)
51. J.C. Guo, H.G. Lu, S.D. Li, Comput. Theor. Chem. **1018**, 95 (2013)
52. A. Tabbiche, A. Bouchama, N. Chafai, F. Zaidi, C. Chiter, M. Yahiaoui, A. Abiza, J. Mol. Struct. **1261**, 132865 (2022)
53. N.M. El-Barasi, M.M. Miloud, M.M. El-ajaily, R.K. Mohapatra, A.K. Sarangi, D. Das, A. Mahal, P.K. Parhi, L. Pintilie, S.R. Barik, M.N. AminBitu, M. Kudrat-E-Zahan, Z. Tabassum, S.I. Al-Resayes, M. Azam, J. Saudi Chem. Soc. **24**, 492 (2020)
54. M. Sarkar, A. Nath, A. Kumer, C. Mallik, F. Akter, M. Moniruzzaman, M. Ali, J. Mol. Struct. **1244**, 130953 (2021)
55. F. Cheng, W. Li, Y. Zhou, J. Shen, Z. Wu, G. Liu, P.W. Lee, Y. Tang, J. Chem. Inform. Mod. **52**, 3099 (2012)
56. T. Khan, S. Dixit, R. Ahmad, S. Raza, I. Azad, S. Joshi, A.R. Khan, J. Chem. Bio. **10**, 91 (2017)
57. C.A. Lipinski, F. Lombardo, B.W. Dominy, P.J. Feeney, Adv. Drug Deliv. Rev. **64**, 4 (2012)
58. M. Aarjane, A. Aouidate, S. Slassi, A. Amine, Arab. J. Chem. **13**, 6236 (2020)
59. A.C. Ekennia, E.C. Ibezim, O.C. Okpareke, C.U. Ibeji, C.J.O. Anarado, I. Babahan, B. Coban, B. Abulhasanov, F. Cömert, O.T. Ujam, Appl. Organ. Chem. **33**, 1 (2019)
60. A. Misra, S. Sharma, D. Sharma, S. Dubey, A. Mishra, D. Kishore, J. Dwivedi, J. Chem. Sci. **130**, 31 (2018)
61. F. Marandi, K. Moeini, A. Arkak, Z. Mardani, H. Krautscheid, J. Coord. Chem. **71**, 23 (2018)
62. S. Alyar, Ş Adem, Spectrochem. Acta Part A Mol. Biomol. Spectrosc. **131**, 294 (2014)
63. G.M. Dongare, A.S. Aswar, J. Mol. Struct. **1281**, 135107 (2023)
64. A.A. El-Sherif, M.M. Shoukry, M.M.A. Abd-Elgawad, Spectrochem. Acta Part A Mol. Biomol. Spectrosc. **98**, 307 (2012)
65. R.N. Patel, S.P. Rawat, M. Choudhary, V.P. Sondhiya, D.K. Patel, K.K. Shukla, D.K. Patel, Y. Singh, R. Pandey, Inorg. Chim. Acta **392**, 283 (2012)
66. R.R. Zaky, A.Y. Al-dawood, SILICON **12**, 1259 (2020)
67. Y. Deswal, S. Asija, D. Kumar, D.K. Jindal, G. Chandan, V. Panwar, S. Saroya, N. Kumar, Res. Chem. Intermed. **48**, 703 (2022)
68. A.A. Osowole, A.C. Ekennia, O.O. Olubiyi, M. Olagunju, Res. Chem. Intermed. **43**, 2565 (2017)
69. H. Yakan, T.K. Bakır, M.S. Çavuş, H. Muğlu, Res. Chem. Intermed. **46**, 5417 (2020)

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

ISSN 2319 - 359X

AN INTERNATIONAL MULTIDISCIPLINARY
HALF YEARLY RESEARCH JOURNAL

IDEAL

Volume - XII Issue - II March - August - 2024

ENGLISH PART - VI

Peer Reviewed Referred and
UGC Listed Journal No. 47026

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING
2023 - 7.537
www.sjifactor.com

❖ EDITOR ❖

Assit. Prof. Vinay Shankarrao Hatole
M.Sc (Math's), M.B.A. (Mkt), M.B.A (H.R),
M.Drama (Acting), M.Drama (Prod & Dirt), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan
Aurangabad. (M.S.)

The information and views expressed and the research content published in this journal, the sole responsibility lies entirely with the author(s) and does not reflect the official opinion of the Editorial Board, Advisory Committee and the Editor in Chief of the Journal **"IDEAL"**. Owner, printer & publisher Vinay S. Hatole has printed this journal at Ajanta Computer and Printers, Jaisingpura, University Gate, Aurangabad, also Published the same at Aurangabad.

Printed by

Ajanta Computer, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Published by

Ajanta Prakashan, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Cell No. : 9579260877, 9822620877

E-mail : ajanta2023@gmail.com, www.ajantaprakashan.in

IDEAL - ISSN 2319 - 359X - Impact Factor - 7.537 (www.sjifactor.com)

EDITORIAL BOARD

Mehryar Adibpour
Faculty of Computing London
Metropolitan University,
Holloway Road, London.

Dr. Ashaf Fetoh Eata
College of Art's and Science,
Salmau Bin Adbul Aziz University. KAS

Dr. Altaf Husain Pandi
Dept. of Chemistry University
of Kashmir, Kashmir, India.

Dr. Ramdas S. Wanare
Associate Professor & Head Accounts & Applied Stat,
Vivekanand Art's Sardar Dalip Sing Commerce
& Science College Samarth Nagar, Aurangabad (M.S.)

Dr Harish Kumar
Assistant Professor Department of History,
Mangalayatan University, Extended,
Ncr 33rd Milestone, Mathura - Beswan
Aligarh (U.P.) 202146.

Dr. P. A. Koli
Professor & Head (Retd),
Dept. of Economics, Shivaji University,
Kolhapur - (M.S.) India.

Dr. Rana Pratap Singh
Professor & Dean School for Environment Science,
Dr. Babasaheb Bhimrao Ambedkar University
of Raebareily, Lucknow- India.

Dr. Joyanta Barbora
Head Dept. of Sociology University of
Dibrugarh- India.

Dr. Jagdish R. Baheti
H.O.D., SNJB College of Pharmacy,
Neminagar, Chandwad, Nashik (M.S.) - India.

Prof. P. N. Gajjar
Head, Dept. of Physics,
University of School of Sciences,
Gujarad University, Ahmedabad- India.

Dr. Binoy Musahary
Department of Political Science,
Nalbari College, Nalbari Assam, P. O. Bidyapur.

Dr. Prashant M. Dolia
Dept. of Computer Science and Applications,
Bhavnagar University, India.

Dr. S. Jeyakumar
Assistant Professor, PG & Research Department of
Commerce, P. M. T. College, Melaneelithanallur,
Sankarankovil Tirunelveli, Tamil Nadu.

Dr. P. S. Buvaneswari
Asst. Professor of Commerce,
University of Madras Chepauk, Chennai-05.

Dr. (CA) Subrahmanya Bhat K. M.
Principal, Department of Commerce,
Swami Vivekananda College, Borim Ponda, Goa.

Dr. G. B. Lamb
Associate Professor & Head,
Department of Mathematics
Baliram Patil College, Kinwat, Dist.Nanded. (M.S.)

EDITORIAL BOARD

Dr. Priyanka A. Masatkar
Assistant Professor, Dept. of Botany,
Ghulam Nabi Azad Arts Commerce and
Science College, Barshitakli, Akola, Maharashtra.

Dr. Dhirajkumar S. Kotme
Head, Department of Marathi,
Jaikranti Airts & Com. Sr. College,
Latur. (Maharashtra)

Dr. Manish Ahir
Head Dept. of Microbiology,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Amit Vairale
Head Dept. of Zoology,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Nilima Kankale
Dept. of Zoology,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Vinod Undal
Dept. of Botany,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Siddharth Waghmare
Dept. of Chemistry,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Santosh Suradkar
Head Dept. of Botany,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Sharad Idhole
Head Dept. of Chemistry,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Kailash R. Kale
Dept. of Statistics,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Sanjay Deshmukh
Head Dept. of Geology,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Asst. Prof. Ajit Patil
Head Dept. of Biochemistry,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. S. B. Khobragade
Head Dept. of Mathematics,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Deepika N. Jain
Dept. of Microbiology,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Tejas Patil
Dept. of Geology,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Asst. Prof. Yuvraj Kale
Dept. of Biochemistry,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

EDITORIAL BOARD

Dr. Anant Kute
Dept. of Physics,
Ghulam Nabi Azad Arts Commerce and
Science College, Barshitakli, Akola, Maharashtra.

Astt. Prof. Pramod Tasre
Head Dept. of Statistics,
Jaikranti Airts & Com. Sr. College,
Latur. (Maharashtra)

Asst. Prof. Bhausaheb Gayakwad
Head Dept. of Physics,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Amol Shrirao
Dept. of Chemistry,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

Dr. Bhimrao Jaiwal
Dept. of Biochemistry,
Ghulam Nabi Azad Arts, Commerce &
Science College, Barshitakli, Dist.- Akola. (M.S.)

PUBLISHED BY

Ajanta Prakashan
Aurangabad. (M.S.)

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
1	Morpho Taxonomic Studies of Diversity of Genus Eragrostis Wolf of Family Poaceae of Amravati District, Maharashtra **Dr. Priyanka A. Masatkar**	1-7
2	Rapid study of House Sparrows (Passer Domesticus) From Mahan Dist Akola **Priyanka D. Joshi** **Prof. Nilima Kankale**	8-13
3	MATLAB simulator and Neural Network Classifiers for Iris Detection **Dr. R. D. Chaudhari**	14-20
4	To Study the Different Life Stage of Silkworm Bombyx Mori from Patur Region (Shirla) **Anuradha Datta Karale** **Nilima B. Kankale**	21-29
5	Isolation and Identification of Cellulose Degrading Bacteria from Different Environmental Samples **Miss. Janhavi Surendra Choubey** **Dr. Vijay D. Nanoty**	30-37
6	Study of Spider Diversity at Kapshi Lake, Akola **Kajal N. Wagh** **Prof. Amit Vairale**	38-44
7	Evaluation of Molecular Interaction of 1, 6-Dihydropyrimidine in Acetone and DMSO Solvent **M. M. Mhasal** **P.J. Thakare**	45-53
8	Synthesis, Characterization and Biological Activity of Nitrogen Containing Pyrazolone and its Derivatives **R. N. Gaikwad** **B. N. Chate**	54-60
9	The Poincare Half-Plane Model and Geo Gebra: Powerful Tools for Understanding Hyperbolic Triangles **Rajesh Balkrishna Raut**	61-64

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
10	Biodiversity Informatics Provides Sound Iformation for Better Management - By Using Computing Tools **Ranjan B. Kalbande**	65-68
11	Comprehensive Study on Catla Fish (Catla Catla): Biology, Ecology, and Socioeconomic Significance **Reena P. Dhote**	69-73
12	Diversity of Butterfly from Kapshi Lake, Akola **Roshani P. Ingle** **Prof. Nilima Kankale**	74-80
13	Reflects the Revitalizing and Renewing Effects of the Cranberry and Yogurt Extract Formulation on the Human Skin **Rupali R. Hatolkar** **Dipika V. Muley** **Shraddha Jaiswal** **Mrs. Quddusa Kamil Farooqui**	81-88
14	Synthesis, Spectral Characterization and Antimicrobial Potent Study of Some Novel 7-[(2-Substitutedimino-4-Phenylimino) Amino-1,3, 5-Dithiazino)] Along with Coumarin Nucleus **S. A. Waghmarea** **K. U. Dongareb** **S. B. Sarkatec** **R. N. Ingoled**	89-96
15	Synthesis, Characterization and Biological Evaluation of Chromene -2-Carbonitrile and Their Derivatives **S. G. Badne** **G. W. Belsare**	97-101
16	Acoustic Parameters of 0.001M Aqueous Solution of Hydroxichloroquine at Different Temperatures **S. H. Shrirame** **A. B. Dhote**	102-107

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
17	Studies and Assessment of Water Quality Parameters of Akola District Region (Maharashtra) **S. J. Patil**	108-112
18	Recent Trends in Internet of Things: Issue Challenges and Applications **S. M. Dhakulkar** **A. P. Fulari**	113-119
19	Study the Acoustic Parameters of Li, Na, K ion Salts in Aqueous of Different Concentration at 303K **S. P. Burad** **A. B. Dhote**	120-124
20	GIS Based Morphometric Analysis of Pili Watershed in part of Sapan River, Amravati District, Maharashtra, India **S. R. Warghat** **S. V. Kulkarni** **A. A. Gawande** **Y. K. Mawale** **P. S. Tidke**	125-140
21	A Study of Lineaments or Fracture Zones Regime of Ground Water Potential in Katepurna River Basin, Akola District, Maharashtra, India **Dr. S. S Deshmukh** **Dr. Tejas R. Patil** **Dr. G. D. Gaikwad** **P. P. Pali**	141-146
22	Viscometric Studies of 1-Phenyl-3-[4-(3-Allylimino-1,2,4-Dithiazolo) Aminophenyl]-Prop-2-Ene-1-One At Various Molar Concentrations and At 250c in 70 % Ethanol–Water Mixture **S. S. Padhena** **S. A. Waghmareb**	147-150

1. Morpho Taxonomic Studies of Diversity of Genus Eragrostis Wolf of Family Poaceae of Amravati District, Maharashtra

Dr. Priyanka A. Masatkar
Assistant Professor, Department of Botany Ghulam Nabi Azad Arts Commerce and Science College, Barshitakli, Akola, (Maharashtra)

Abstract

Amravati is one of the 11 districts of vidarbha. It includes 14 talukas. Flora of Amravati district has been already studied by Dhore (2002) reported 84 species of grasses, during last 16 years no survey was conducted of the area. Survey of grasses conducted during 2014-2018 revealed 117 species belonging to 60 genera. Eragrostis Wolf is a largest genus of study area, it has 13 species which belong to subfamily Pooideae. The aim of our investigation is to study morphotaxonomic revision of family poaceae. It focuses on details of macro and micro morphology of some important grasses.

Key words - Amravati, Flora, Survey, morphology.

Introduction

Grasses are most beautiful group of monocotyledonous plants. They occur on every soil, in all kind of situations and under all climatic conditions. As grasses do not like shade, they are not usually abundant within the forest. But in open places they grow very well and some times whole tracts become grasslands.

Grasses are important for entire ecosystem. Tiger is the king of forest ecosystem. If we want to save tiger, we have to save the grasses because tigers are indirectly dependant on grasses for their food. Robinson writes “Grass is king” it rules and governs the world, without it the earth would be a barren waste.

In the early days when the population was much limited and when limited land was under cultivation much of it was covered with plenty of green grasses. So the farmers paid no attention to the grasses. But now population has increased, open land is decreased very much and cattles have increased in number hence farmers have to pay more attentation to grasses. The present destruction of grasses is mainly due to overgrazing, increasing agricultural practices, over use of

herbicides, formation of big dams, road widening, clean agricultural practices and trampling by men and cattles. Grazing needs to be inhibited in certain areas and also reduce the use of herbicides. Tender shoots of Bamboo are used as vegetables and also as pickle by locals. The grains of grasses certainly provide a staple food supply for the human beings Oryza sativa, Triticum aestivum, Zea mays, Avena sativa, Setaria italica, Eleusine coracana, Echinochloa colonum, Sorghum speciesand rice feeds more human beings than any other plant product. Sugarcane is main source of sugar. A high proportion of the most fertile and productive soil were developed under a vegetative covers of grasses. Root, rhizome and other part of grasses are good soil builders and effective soil stabilizers. Most of the birds and animals depend upon grassland habitat for food, shelter and normal completion of their life cycles Gould (1968).

Despite utmost importance of grasses to human beings, the study on grasses continues to be a neglected subject. This is mainly because of the feeling that it is a difficult group for identification, the leaves and branches of grasses are very much similar, Small floral organs, special terminology and variation in the structure of spikelet and inflorescence. "Grasses of Burma, Ceylon, India and Pakistan" studied by Bor (1960) is the main standard reference work on Indian grasses.

Study Area

Amravati district is located in the state of Maharashtra-India. It is at $20^0$55' and 20.93 North latitude $77^0$45' and 77.75 East longitudes. It has an average elevation of 343 meters (1125 feet). Total area of the district is 12210 sq. km. Amravati district has tropical wet and dry climate with hot, dry summer from April to June. The annual average rainfall in the district is 852.1 mm and the temperature has recorded between 18^0C to 46^0C (Falling rain Genomics, inc. 2010).

Apart from this, Amravati is one of the largest district of Maharashtra states. It includes fourteen (14) taluka namely Amravati, Achalpur, Warud, Chandurbazar, Dharni, Morshi, Daryapur, Anjangaon Surji, Chandur Railway, Dhamangaon Railway, Teosa, Nandgaon-Khandeshwar, Bhatkuli, and Chikhaldara. Chikhaldara is the largest talukas of Amravati district and Bhatkuli is the smallest one.

Review of Earlier Work

Though botanical exploration of India has long history, Vidarbha and Marathwada regions remained somewhat neglected. A thorough exploration of Marathwada has been done by

Naik and his students for nearly 30 years. Outcome of this work is "Flora of Marathwada" by Naik (1998) which a wonderful survey and reference flora.

The monumental work of Bor. (1953) on "Grasses of Burma, Ceylon, India and Pakistan"(excluding Bambusiae) published about 50 years ago has changed this scenario and created interest on the study of grasses. This resulted in publication of several books on grasses and the latest addition is "Flora of Tamil Nadu-Grasses" by Altaf and Nair (2009) that deals with 447 species (excluding Bamboos).

Patunkar (1980) studied "Grasses of Marathwada" region has also published a book "Grasses of Marathwada".

Recently, Potdar (2012) has published "Grasses of Maharashtra", the book is an outcome of exploration and detailed studies conducted on documents of grass diversity of Maharashtra for last 20 years. During this period 415 species belonging to 125 genera have been described. There are above 10,000-11,000 species belonging to 700 genera in the world (Clayton and Renvoize, 1989 and Watson and Dallwitz, 1992) in India there are more than 1200 species belonging to 268 genera (Karthikeyan et al., 1989, and Moulk 1997). Kamble and Pradhan (1988) reported 87 species belonging to 49 genera from Akola district. Acharya (1985) reported 100 species belonging to 57 genera from Wardha district. Deore (2010) reported 65 species of grasses from Washim district. Karthikeyan (1993) reported 81 species from Yavatmal district and Diwakar (2000) reported 60 species from Buldhana district.

Floristic surveys of different area of Maharashtra have been compiled and published by Botanical Survey of India such as" Flora of Maharashtra state, Monocotyledon", Sharma et al., (1996), "Flora of Maharashtra state, Dicotyledon"vol. I Singh et al., (2000), vol.II Singh et al., (2001).

Material and Methods

Plan of Work

1. Study of Habitat

In every season the selected areas were explored systematically. Grass covered sites were targeted for study. Grasses were collected from different habitats like irrigated fields, unirrigated fields, open grasslands, forest, bunds of field, bank of rivers, wastelands, rice fields and rocky places.

2. Sample collection and preservation

During excursion specimens of grasses were collected and field number is given to each specimen. Field observations were noted down in field diary. After collection the samples are critically studied in laboratory. Then it is dried properly, poisoned by using 2% Mercury Chloride and mounted using conventional methods. For critical cases BSI (Pune) was consulted to match the specimens.

3. Identification

The identification was confirmed by using floras like flora of British India(Hooker 1872-1897), Flora of Bombay Presidency (Cook 1958), Flora of Marathwada (Naik 1998), Flora of Maharashtra(Almeida,1990), Grasses of Maharashtra (Potdar, Salunkhe and Yadav, 2012) Grasses of Marathawada (Patunkar,1980). Specimens were observed under Sterioscopic binocular microscope.

Artificial keys were provided for genera and species. Population variations are critically studied. Latest nomenclature are given in detail for proper taxonomic level. Each grass specimen description was supported by a note on distribution and herbarium specimen number. Genera and species are arranged alphabetically. Floristic analysis was done to get clear picture of grass biodiversity. Grass species are arranged according to N.L. Bor. All the specimens were deposited in the herbarium of S.S.S.K.R.Innani Mahavidyalaya, Karanja (Lad), Dist-Washim.(M.S.)

4. Observations

Species of Eragrostis and habitat.

Sr. No.	Specimen No.	Name of Species	Habitat
1	PAM 110	Eragrostis aspera (Jacq) Nees.	Unirrigated fields
2	PAM 114	Eragrostis atrovirens (Desf.) Trin.ex Steud.	Cultivated fields
3	PAM 28	Eragrostis cilianensis (All.) Vignolo ex Jaunch.	Open grasslands
4	PAM 82	Eragrostis ciliaris (L.) R.	Wastelands
5	PAM 60	Eragrostis coarctata Stapf.	Sandy soil
6	PAM 81	Eragrostis gangetica (Roxb.) Steud.	Stream banks
7	PAM 30	Eragrostis japonica (Thunb.) Trin.	Cultivated fields
8	PAM 98	Eragrostis multicaulis Steud.	Wastelands
9	PAM 62	Eragrostis nutans (Retz.) Nees ex. Steud.	Wet places
10	PAM 80	Eragrostis pilosa (L.) P.Beauv.	Margin of ponds
11	PAM 31	Eragrostis tef (Zuccagni) Trotter	Waste lands
12	PAM 61	Eragrostis unioloides (Retz.) Nees ex.Steud.	Rice fields
13	PAM 64	Eragrostis viscosa (Retz.) Trin.	Sandy soil

Key for the species of Eragrostis

1a -	Spikelets not breaking up at maturity	E. tef
1b -	Spikelets breaking up at maturity	2
2a -	Spikelets breaking up from above downwards rhachis fragile`	3
2b -	Spikelets breaking up from above upwards rhachis tough	7
3a -	Keels of paleasscabrid or smooth, not ciliate	4
3b -	Keels of paleas more or less ciliate	5
4a -	Panicles lax, open thysiform more than 15 cm wide	E. aspera
4b -	Panicles effuse or contracted not thyrsiform less than 15 cm wide	E. japonica
5a -	Panicles effuse, clums and leaves viscous	E. Viscosa
5b -	Panicles spiciform or compact and dense	6
6a -	Annuals lemmas ciliate on keels	E. ciliaris
6b -	Perennials, lammas not ciliate on keels	E. Coaractata
7a -	Perennials	8
7b -	Annuals	9
8a -	Spikelets 1 to 1.2 mm wide, paleras persistent	E. nutans
8b -	Spikelets 2 to 2.5 cm wide, paleas deciduous	E atrouirens
9a -	Plants glandular	11
9b -	Plants eglandular	10
10a -	Tip of lemma acute or obtuse culme 20-40 cm tall	E. ganetica
10b -	Tips of lemma acute, dwarf plant upto 12 cm tall	E. multicaulis
11a -	Plant glandular spikelets 2-4 mm wide, crowded of loose leaves almost always with raised glands on kells and margines	E. cilianecsis
11b -	Plants devoid of glands	12
12a -	Spikelets 2mm or more wide	E. unioloides
12b	Spikelets narrow, less than 1.5 mm wide	E. Pilosa

Conclusion

Present study is the outcome of exploration tours conducted to document the grass diversity of study area from 2014-2018 and visited different areas of Amravati district in different seasons. During this period over 600 specimens were collected from the study area. During the study 117 species belonging to 60 genera were collected.

Out of 60 genera Eragrostis is the largest genus belonging to sub-family pooideae. The 35 species collected from study area were found to be monotypic. In Amravati district pure patches of Aristada, Ischaemum, Themeda, Andropogon, Heteropogon, Dicanthium, Cynodon and Saccharum were observed.

Though grasses are herbaceous in nature, but are tough in texture so it is easy to prepare herbarium speciman. Some of the beautiful grasses are Thelepogon elegans, Mnesithea granularis, Chrysopogon fulvus, Ischaemum rugosum and Dichanthium species.

Some dominant genera are Apluda, Aristada, Dicanthium, Cynodon, Dinebra, Eragrostis, Ischaemum, Rottboellia, Heteropogon, Ophiuros, Setaria.Some grasses have underground rhizomes i.e. Ischaemum pilosum, Cynodon dactylon, Saccharum spontaneum whichcan not be eradicated hence the productivity of crops decreases. Cynodon is the first class fodder grass present throughout study area. It is palatable and resistant to grazing and trampling because of underground rhizomes. Dactyloctenium aegyptium, Chrysopogon fulvus are other palatable species of grasses. Cymbopogon martini, Vetiveria zizanioides, Saccharum spontaneum and Cynodon dactylon are the medicinal grasses. Hollow internodes of Arundo donax are used formaking pens and musical pipes by locals. The forest areas of Melghat (Chikhaldara and Dharni) are of mixed dry deciduous type with teak as dominant species.

Saccharum spontaneum, Vetiveria zizanioides, Arundo donax present along the sides of rivers and stream which reduce the pressure of flood. The dominant tribes of Melghat are Gond, Korku and Gawali. Gond, and Gawali are the tribal residents of Melghat forest range are the consumers as they feed their livestock mainly by grazing of grasses. Efforts are required to prevent free grazing as once vegetation is lost, it is very difficult to restore.

References

- Acharya, R.M. 1985. Flora of Wardha district. Ph.D. Thesis unpublished, Nagpur University, Nagpur.
- Altaf K. and V.J.Nair, 2009. Flora of Tamil Nadu- Grasses, Botanical Survey of India. Calcutta.Deore A.N. 2010.Floristic Survey of Washim District, Ph.D. Thesis unpublished, Amravati University, Amravati.
- Dhore M.A. 2002.Flora of Amravati District with Special Reference to the Distribution of Tree Species, Amravati University, Amravati.
- Diwakar, P.G. and B.D. Sharma. 2000. Flora of Buldhana District, Maharashtra State. Botanical Survey of India, Calcutta.
- Gould, F.W.1968.Grass systematic.McGraw-Hill.New York.
- Kahalkar, V.I. 2009. Floristic studies on Gondia district of Maharashtra state, Ph.D thesis Nagpur University, Nagpur.
- Kambale, S.Y. and S.G.Pradhan.1988.Flora of Akola District, Maharashtra.Botanical Survey of India, Calcutta.
- Karthikeyan K.S. and Anand Kumar.1993.Flora of Yavatmal District.Botanical Survey of India, Calcutta.
- Naik, V.N.1998. Flora of Marathwada, Vol.I and II.Amrut Prakashan, Aurangabad.
- Patil, B. M.1991. Floristic and palynological investigations in the Monocot flora of Chandrapur and Gadchiroli district, of Vidarbha region, of Maharashtra State. Ph.D thesis, Nagpur University Nagpur.
- Patunkar, B.W.1980. Grasses of Marathwada. Scientific Publisher, Jodhpur.
- Potdar, G.G., Salunkhe C.B., and S.R. Yadav, 2012. Grasses of Maharashtra, Shivaji University, Kolhapur.
- Purekar, P.N. 1885. Grasses of Nagpur District-Taxonomy and Palynology. Ph.D thesis Nagpur University, Nagpur.
- Sharma, B.D. S.Karthikeyan, and N.P. Singh, 1996. Flora of Maharashtra state, Monocotyledones. Botanical Survey of India. Calcutta.
- Yadav, S.R. and M.M. Sardesai, 2002. Flora of Kolhapur District Shivaji University, Kolhapur.

2. Rapid study of House Sparrows (Passer Domesticus) From Mahan Dist Akola

Priyanka D. Joshi
Department of Zoology, Ghulam Nabi Azad College of Arts, Commerce and Science, Barshitakli Dist. Akola.
Prof. Nilima Kankale
Guided by Department of Zoology, Ghulam Nabi Azad College of Arts, Commerce and Science, Barshitakli Dist. Akola.

Abstrct

This study aims to comprehensively document on the sparrows across different area of Mahan. Field surveys were conducted in various habitats, including urban, rural, and forested areas, to assess the presence and abundance of different sparrow species. House sparrow (passer domesticus) belongs to family passeridae. the family Passer contains around 28 species.

Keywords: House Sparrows (Passeridae), Mahan region

1. Introduction

The house sparrow (Passer domesticus) is found in many pieces of the world. It has a place with the family Passeridae and variety passer. The word passer originates from Latin which implies sparrow and this term alludes to speed or easy. Sparrow is generally adorable, little and innocuous social feathered creature. House sparrows are started in the Middle East and get acquainted with most pieces of the world.

Kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Passeriformes

Family: Passeridae

Genus: Passer

Species: domesticus

It is a little feathered creature that has a regular length of 16 cm (6.3 in) and a mass of 24–39.5 g (0.85– 1.39 oz). The house sparrow is emphatically connected with a human area and can live in urban or country settings. The House Sparrow has a verifiable commensal connection with man and has followed his movement of the standard of the earth. Most Passer species are dull-hued flying creatures with short, square tails and squat, conelike mouths, somewhere in the

range of 11 and 18 cm (4.3 and 7.1 in) long. In the Handbook of the Birds of the World, the family Passer contains around 26 species. House sparrows have an inclination to form homes in little gaps in structures, covered rooftops, and even road lights. The genders are dimorphic with the male being intensely designed. Guys and females can be separated particularly - the male has dark throat white cheeks and dark Bib. It has dark cheeks and dims underparts with dark round the eyes. While the female has earthy colored shading with eyes stripe and thick mouth, two wing bars, and a plain throat and bosom. The bill gets darker during the reproducing season and a couple of flying creatures have a totally dark bill. They are short-legged.

Sparrows, small, chirpy birds with a penchant for seeds, are not only a familiar sight in backyards and cityscapes, but also vital components of our ecosystems. India, with its diverse landscapes – from the snow-capped Himalayas to the sun-drenched coasts – provides a haven for a surprising number of these fascinating birds. However, the widespread decline in sparrow populations globally has raised concerns about their conservation status. In India, the decline of sparrows has been particularly noticeable, with various factors such as habitat loss, pesticide use, and changes in urban landscapes contributing to their dwindling numbers.

2. Habitat /Habit

House Sparrows persevere through just in the momentary region of individuals. House Sparrows are firmly connected with individuals and their structures. They are intrigued by structures for perching and haven. They have worn to build their home in cover rooftops, sun conceals, any corner or break, lofts, kitchens, exhaust openings, hanging bins, unused shafts with end tops, garden trees, bushes and so on to give bug food to the youthful.

House Sparrows jump to a limited degree than a stroll on the ground. They are common, taking care of in jam-stuffed rushes and quarreling about pieces or seeds on the ground. House Sparrows can be seen for winged animal feeders; you may likewise observe them swim in roadside puddles or residue washing on open ground, unsettling their otherwise calm disposition and flicking water or residue over themselves. House sparrows are social artists when the winged animals gather in shrubs and assemble. Living in a cozy relationship with people. Guys with bigger measures of dark on the throat tend to command over guys with less dark. At when guys show to an imminent mate, they lighten up their chest, hold their wings incompletely open, fan the tail, and bounce firmly before the female, spinning sideways and here and there bowing all over. Now and then, different guys who spot such a presentation in progress will fly in and start showing also. In herds, guys will in general command over females in fall and winter, yet females stand up for themselves in spring and summer. Typical life expectancy is as long as 12 years.

3. Nesting

House Sparrows home in gaps of structures and different structures, for example, streetlights, service station rooftops, signs, and the overhanging installations that hold traffic lights. They sporadically assemble homes in vines climbing the dividers of structures. House Sparrows are solid contenders for home boxes, as well, now and again uprooting the species the home box was proposed for, for example, bluebirds and Tree Swallows. House Sparrows home in gaps in trees to some degree less regularly. House Sparrow homes are made of coarse dried vegetation, regularly stuffed into the gap until it's about filled. The flying creatures at that point utilize better material, including plumes, string, and paper, for the coating. House Sparrows in some cases fabricate settles close to one another, and these nearby homes can part dividers. House Sparrows routinely reuse their homes. House Sparrows utilize a wide scope of materials for the home structure including fine hair, grass inflorescences, stalks, and underlying foundations of plants, bark, strings, string, and even bits of paper and fleece. Inside home boxes, the home might be essentially a cup of vegetation at the base of the crate or developed with the goal that the home material covers the sides just as the head of the compartment. The most regular tallness while investigating the area of metropolitan sparrow homes was somewhere in the range of three and four meters high. House Sparrows settling in ensured locales, for example, home boxes and gaps in structures will in general beginning reproducing prior and are increasingly fruitful, then those settling among tree limbs.

4. Diversity of House Sparrow

The work on morphology and biology of the house sparrow was initiated around 1900 [1]. Aggressive flocks of sparrows discourage other species of birds from foraging in the same area. Abundance and congregation of house sparrow in a particular area depends on the availability of food sources for both adults and nestlings and essential nest sites around those food sources. Occurrence and abundance of a species in a particular area is determined by biotic factors and different habitat variables such as food sources, habitat covers and relative abundance of other bird species. The following explanatory variables were supposed to affect the abundance of house sparrow Population in a particular area: The food sources are mostly categorized in to three categories.

1. **Leftover food:** This category includes all types of leftover food which are thrown out from the houses and grocery shops and the left over rice grains present in the rice twigs of thatched roof. The left over foods also constituted the rice, wheat, green gram and black gram grains.

2. **Plant buds:** Guava, Citrus, Drum stick trees, and Papayas are the major sources of buds throughout the years. Birds were observed feeding while roosting in the above mentioned trees.
3. **Arthropods:** Arthropods form the major constituent of the nestling diet. There is significant contributions in the field of diversity and conservation of sparrows [2-7]. House Sparrow looking for food in mahan threatened species. the house sparrow population has been declining above 10% in the last three decades in several parts of the world. For this reason the house sparrow has evaluated as Least Concern

5. Importance of House Sparrow

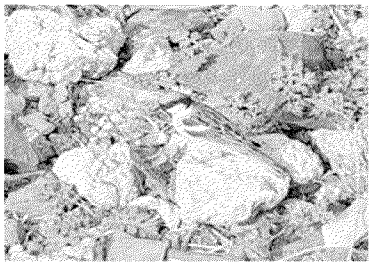
Fossil evidence from a cave in Bethlehem dating back 4, 00,000 years suggests that the house sparrow shared its space with early humans. It simply cannot live without humans and is never found where we are not. Sparrow is a very important member of various urban and natural food chains and food webs and plays a crucial role in ecological balance. The house sparrow is commensal with humans and is considered to be one of the most highly adapted species to urban conditions. Female house sparrow in daytime at Sikar Rajasthan It feeds on grains and also on larva of insects especially mosquitoes which breeds in the water and this mechanism is a natural pest control process It has proven well suited for studies in evolutionary mechanisms, temperature regulation and pest control. It also feeds on larva of mosquitoes which breeds in the water stagnated in the in accessible area of house. The sparrows go in search of larva and feeds on them. This mechanism is a natural pest control process in which human being also favored without any expenses. Sparrow visits many flowers in a day and at the time of visit they carry pollen and. thus is important for pollination.

5.1 Ecological Roles

Each sparrow species exhibits distinct preferences for its habitat. House Sparrows thrive in human settlements, readily utilizing man-made structures for nesting and foraging.

Beyond their charming presence, all these sparrows play crucial ecological roles. They act as seed dispersers, helping in plant regeneration and maintaining the health of various ecosystems. Additionally, they are natural insect predators, keeping insect populations in check and contributing to the ecological balance

Photographs Taken By Different Area of Mahan



House sparrow form field area of Mahan



House sparrow from urban area of Mahan



House sparrow from household area

Conclusion

In conclusion, this study provides valuable insights of sparrows in Mahan. It can be concluded that the sparrow's population is decreasing without specifications of the cause. For sparrow conservation it is the time to take fruitful efforts to conserve the tiny social bird from becoming rare in future. The sparrow act as seed dispersers, helping in plant regeneration and maintaining the health of various ecosystems. Additionally, they are natural insect predators, keeping insect populations in check and contributing to the ecological balance.

References

1. www.ijcrt.org © 2021 IJCRT | Volume 9, Issue 1 January 2021 | ISSN: 2320-2882 IJCRT2101326 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org 2647
2. Ali, S., & Ripley, S. D. (1980). Handbook of the birds of India and Pakistan: Together with those of Bangladesh, Nepal, Bhutan, and Sri Lanka. Oxford University Press.
3. Chakravarthy, A. K., & Sridhar, S. (2013). On the possible role of urbanization in the decline of the House Sparrow Passer domesticus in Bangalore, India. In Avian ecology and conservation in an urbanizing world (pp. 115-128). Springer.

4. Gangoso, L., Agudo, R., Anadón, J. D., de la Riva, M., Suleyman, A. S., Porter, R., & Donázar, J. A. (2013). Reinventing mutualism between humans and wild fauna: insights from vultures as ecosystem services providers. Conservation Letters, 6(3), 172-179.
5. Raman, T. R. S. (2007). Birds of south Asia: The Ripley guide. Smithsonian Institution & Lynx Edicions.
6. Sharma, H. P., & Sathyakumar, S. (2008). Distribution, relative abundance, and conservation status of House Sparrow (Passer domesticus) in Uttarakhand, India. Zoos' Print Journal, 23(12), 5-10
7. Ali, S. The Book of Indian Bird, 1 st edition, Oxford University Press, New Delhi, 1996.
8. Daniels RJR. Can we save the sparrow. Current Science, 2008; 9(5):1527-1528.
9. Hussain A, Dasgupta S, Bargali SH. Case of House Sparrow (Passer domesticus) Population Decline: Role of Semi-Nomadic Pastoralist Community (Van Gujjars) In Their Conservation. International Journal of Conservation Science. 2014; 5(4):493-502.
10. Kamath V, Mathew AO, Lewlyn L, Rodrigues R. Indian sparrows on the brink of extinction: population dynamics combined. International Journal of Renewable Energy and Environmental Engineering. 2014; 02(01):17-22.
11. Kumar A. Status, Distribution, Demography, Threats and Response of House Sparrow (Passer domesticus) to Artificial Nests and Feeds in and around Lucknow, Uttar Pradesh, India. PhD T. Singh R, Kour DN, Ahmed F, Sahi DN. The causes of decline of house sparrow (Passer domesticus) in urban and suburban areas of Jammu Region,. Munis Entomology & Zoology. 2013; 8(2):803-811.
12. Beauregard Erika, François Brischoux, Pierre, Yves Henry, Charline Parenteau, Colette Trouve et al. urbanization cause stress in wild birds during development? Insights from feather corticosterone levels in juvenile house sparrows (Passer domesticus) Ecology and Evolution. 2019; 9(1):640-652
13. Meillere A, Dupoue A, Lourdais O, Angelier F. Traffic noise decreases nestlings' metabolic rates in an urban exploiter. Journa

3. MATLAB simulator and Neural Network Classifiers for Iris Detection

Dr. R. D. Chaudhari
Associate Professor, Shri. R.L.T. College of Science, Akola.

Abstract

Our main aim is to develop a secure biometric recognition system to identify individual person both Irises other than physical or behavioral characteristics. One such method is iris recognition which is one of the most secure and unique features of any person. God has created every individual with an exclusive iris pattern on this earth. The iris recognition technique consists of iris localization, normalization, feature extraction and matching. Their unique feature was extracted and given to the neural network using MATLAB Simulation for detecting the Iris. The match results shows that the individual is identified accurately both the iris of a same Person.

Keywords - Iris recognition, localization, normalization, neural network, person identification, MATLAB

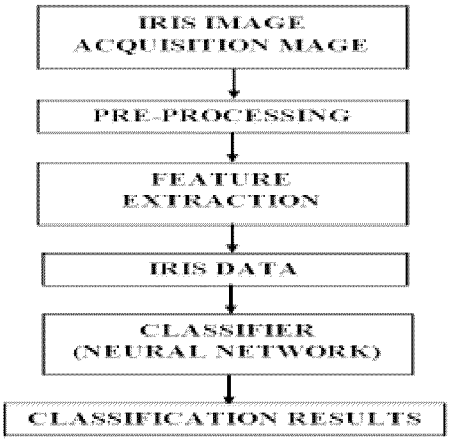
Introduction

Identity verification and identification is becoming increasingly popular. Biometric measures [1] such as recognizing one's fingerprints, face, iris and voice greatly help in person identification authentication, and authorization. Pair of iris recognition has the high potential and non-invasive personal verification. Advances in the field have expanded the options to include biometrics such as iris and retina. Among the large set of options, it has been shown that the iris is the most accurate biometric. The iris is the elastic, pigmented, connective tissue that controls the pupil. Doughman [2] proposed an iris recognition system representing an iris as a mathematical function. Mayank Vatsa proposed a support-vector-machine-based learning algorithm selects locally enhanced regions from each globally enhanced image and combines these good-quality regions to create a single high-quality iris image.[3] proposes algorithms for iris segmentation, quality enhancement, match score fusion, and indexing to improve both the accuracy and the speed of iris recognition Further, Tests on another set of 801 images resulted in false accept and false reject rates of 0.0005% and 0.187% respectively, providing the reliability

and accuracy of the biometric technology[5]. Leila FallahAraghi used Iris Recognition based on covariance of discrete wavelet using Competitive Neural Network (LVQ). A set of Edge of Iris profiles are used to build a covariance matrix by discrete wavelet transform using Neural Network.[4]. Today with the development of Artificial Intelligence algorithm, Iris recognition system may gain speed, hardware simplicity, accuracy and learning ability. The experimental results have shown the effectiveness of the proposed system in comparison with other previous Iris recognition system.

Proposed Work Flow Chart

The complete iris recognition system consists of 4 stages, they are image acquisition, Pre-processing, Feature extraction and Matching. Figure 3.1 shows the flow diagram of Iris recognition system.



Flow Diagram of Iris Recognition Systems

Image Acquisition

This is very first step of the entire process. When a person wishes to be identified by iris recognition system, his/her eye is first photographed. The camera can be positioned between three and a half inches and one meter to capture the image. Today's commercial iris camera typically used infrared light to illuminate iris without causing harm or discomfort to the subject. In the manual procedure, the user needs to adjust the camera to get the iris in focus and needs to be within six to twelve inches of the camera. This process is much more manually intensive and requires proper user training to be successful. We must consider that the occlusion, lighting, number of pixels on the iris are factors that affect the imagequality. Figure 1.2 shows the sample iris images.

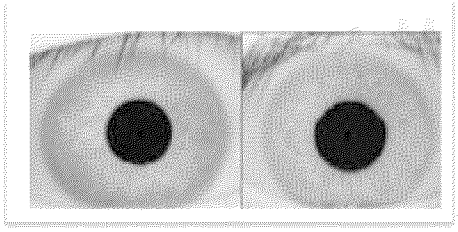


Fig. 1.2 Sample Iris Image

Pre-Processing

The acquired iris image has to be pre- processed to detect the iris, which is an annular portion between the pupil (inner boundary) and the sclera (out boundary). The first step in iris localization is to detect pupil which is the black circular part surrounded by iris tissues. The centre of pupil can be used to detect the outer radius of iris patterns. The important steps involved are :

1. Pupil detection
2. Outer iris localization

The Hough Transform is used for a quick guess of the pupil center and then the Integro-Differential Operator is used to accurately locate pupil and limbus using a smaller search space.

Canny Edge Detection can be used for detecting edges in the entire eye image and Circular Hough Transform for detecting outer boundary of iris by using pupil center and inner boundary of iris. Figure 3.1.2 shows the localized iris image.

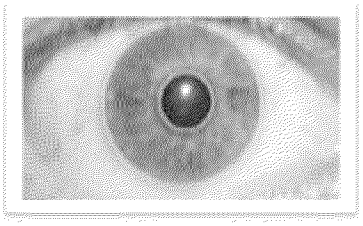


Fig. .1.3 Localized Iris Image.

Normalization

For the purpose of accurate texture analysis, it is necessary to compensate this deformation, since both the inner and outer boundaries of the iris have been detected so it is easy to map the iris ring to a rectangular block of texture of a fixed size. The Cartesian to polar reference transform suggested by Doughman authorizes equivalent rectangular representation of the zone of interest as shown in figure 1.3.

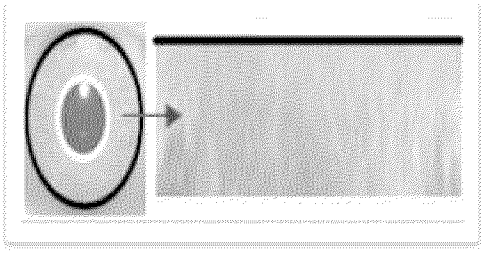


Fig. 1.3 : Iris Rectangular Representation

Pre-processing is a step, which is performed to obtain iris from the eye image. But here we have used standard iris database (i.e. UBIRIS database) so we have extracted features directly using the images.

In order to provide an accurate recognition of an individuals, the most discriminating information present in an iris pattern has been extracted. Only the significant features of the iris have been encoded so that comparison between templates is done. Below figure 1.4 shows the feature extractionstages.

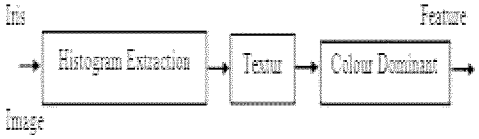


Fig. 1.4: Feature Extraction Stage

Feed forward Network

Feed forward networks consist of a series of layers. The first layer has a connection from the network input. Each subsequent layer has a connection from the previous layer. The final layer produces the network's output.

Feedforward networks can be used for any kind of input to output mapping. A feedforward network with one hidden layer and enough neurons in the hidden layers, can fit any finite input – output mapping problem.

Trainlm is a network training function that updates weight and bias values according to Levenberg – Marquardt optimization as shown in figure 1.5

Trainlm is often the fastest backpropagation algorithm in the toolbox, and is highly recommended as a first – choice supervised algorithm, although it does require extra memory than other algorithms.

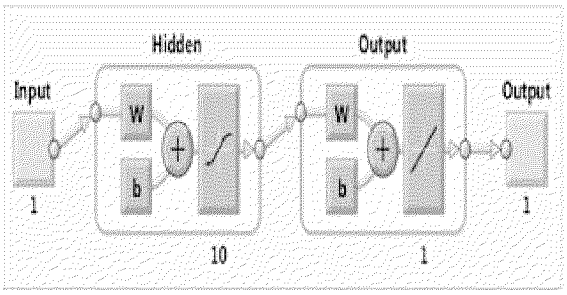


Fig. 1.5 Feedforward Network

Training of Neural Network for Left Iris

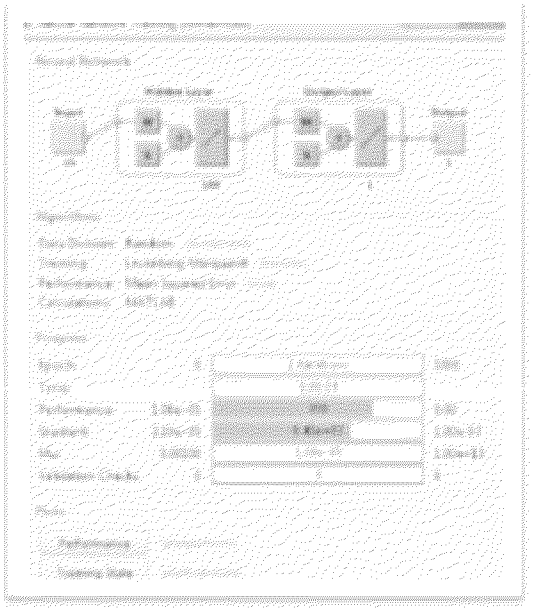


Fig. 1.6 Results of training Network for Right Iris

If the train button is pressed on the menu the neural network training (nntraintool) would be activated from the neural network toolbox. The result of train network is show in fig. 1.6.

In this figure the neural network algorithm would be displayed with 25 input two layers with weight and bias. Hidden layer is 100 and one output layer. According to the present result of training system the epoch is 2 iterations for 100 epochs. Running time is 0.004 hours. The performance is 858 for 1.08e + 05 target. The gradient is 8.41e + 03 for1.00 e – 07 and validationcheck is 0 for 6 must be displayed on to command window. According to the fig. 1.6 the neural network training system has been accomplished and known by the user neural network toolbox is very useful to simulation of this right iris recognition.

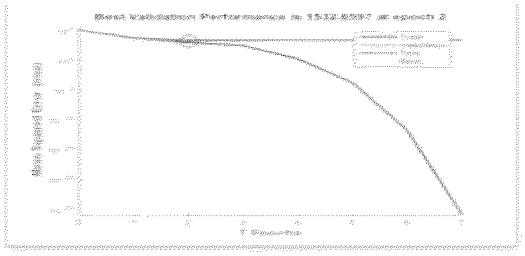


Fig. 1.7 Mean square error of Feedforward NeuralNetwork

The results are found by the algorithm and we can get the number of epochs used and which epoch gives the best result as shown in figure 1.7. As shown in fig. a plot of epoch MSE has been plotted. The epochs get the best validation performance at epoch no. 2. The MSEW is the lowest at this point and hereafter no significant changes take place and no further decrease takes place. Hence this is the best validation performance is 1532.6597 at epoch 2. As shown in fig. 1.8. The training data are shown in the blue colour, validation is shown in blue colour, test data is shown in red colour and zero error is shown from the histogram.

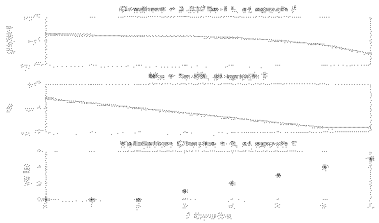


Fig. 1.8Feedforward Neural Network Gradient versus Epoch

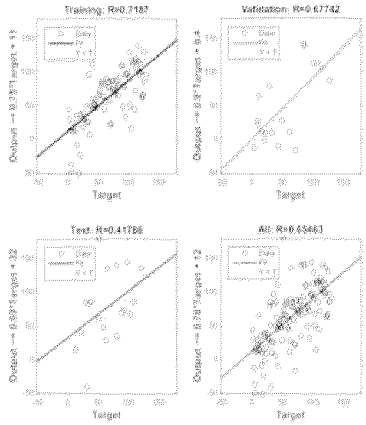


Fig. 1.9 Regression plots for training, testing and validation of ANN

The four plots represent the training, validation, and testing data. The dashed line in each plot represents the perfect result – outputs = targets. The solid line represents the best fit linear regression line between outputs and targets. The R value is an indication of the relationship

between the outputs and targets. If R = 1, this indicates that there is an exact linear relationship between outputs and targets. If R is close to zero, then there is no linear relationship between outputs and targets. For this example, the training data indicates a good fit. The validation and test results also show R values that greater than 0.9. The scatter plot is helpful in showing that certain data points have poor fits. As shown in figure.1.9.

Conclusion

The proposed methodology uses Levenberg – Marquardt feedforward network. Trainlm is often the fastest backpropagation algorithm in the toolbox. According to the fig. 1.6 the neural network training system has beenaccomplished and known by the user neural network toolbox is very useful to simulation of this right iris recognition The results are found by the algorithm and we can get the number of epochs used and which epoch gives the best result as shown in figure 1.7. In this paper gives the training of neural network for detection of right iris from the used database.

References

1. Delac, K., &Grgic.M. "A survey of biometric recognition methods." In 46th international symposium electronics in marine, ELMAR –2004, zadalcroatia. [1] J. Daugman, "New Methods in Iris Recognition" IEEE Trans. Systems, Man, and Cybernetics, Part B, vol. 37, no.5, 2007, pp. 1167-1175.
2. M. Vatsa, R. Singh, A. Noore (2008),"Improving Iris Recognition Performance Using Segmentation, Quality Enhancement, Match Score Fusion, and Indexing," IEEE Transactions on Systems, Man and Cybernetics. Part B. Cybernetics Vol. 38, N° 4,pp. 1021-1035,2008.
3. Leila FallahAraghi, "IRIS Recognition Using Neural Network,"Proceedings of International Multi Conference of engineers and Computer Scientist Vol I, 2010
4. Bhawna chouhan,"Iris Recognition System using canny edge detection for Biometric Identification" International Journal of Engineering Science and Technology (IJEST) Vol. 3 No. 1 Jan 2011.
5. Prof,.S. R. Ganorkar"Person Identification using Iris Recognition" International Journalof Engineering and Technology Vol.3 No.1 February 2011.

4. To Study the Different Life Stage of Silkworm Bombyx Mori from Patur Region (Shirla)

Anuradha Datta Karale
Department of Zoology, Ghulam Nabi Azad Arts, Commerce and Science College, Barshitakli.
Nilima B. Kankale
Department of Zoology, Ghulam Nabi Azad Arts, Commerce and Science College, Barshitakli.

Abstract

Silkworms are crucial in the sericulture industry, providing the silk obtained from their cocoons. Silkworms are the larvae or caterpillars of the domesticated silk moth, known as Bombyx mori. A silkworm has four stages in its life: eggs, caterpillar, pupa, and adult. This takes about 6-8 weeks, depending on the weather. It starts when a female silk moth lays eggs, and they hatch into silkworms. Silkworms eat mulberry leaves. They go through five growing stages, then turn into pupae. In the pupa stage, they make a protective net around themselves using a protein. This net helps them create a cocoon. The silk for the cocoon comes from a thin yarn-like structure made by the silkworm.

Keywords :- Silkworm, Bombyx mori, Sericulture

Introduction

Insects, which make up about 80% of Earth's animal species and 99% of invertebrates, hold great potential for valuable compounds in modern medicine. We share a significant amount of genetic material with all life, even the simplest worms. Among these insects, the Silkworm (Bombyx mori) stands out as a well-known and beneficial lepidopteron insect, particularly valued for producing smooth and luxurious silk fibers. Bombyx mori, it was the first organism in the order lepidoptera for which a draft of the genomic sequence (Xia et al., 2004, Mita et al., 2004) were completed with the haploid nuclear genome of size 530 mb which is broken into 28 chromosomes (Wang et al., 2005).

Sericulture or silk farming is rearing of silkworms for the production of raw silk. Sericulture has become one of the most important cottage industries in number of countries like China, Japan, India, Korea, Brazil, Russia, Italy and France. Today,

China and India are the two main silk producers, together manufacturing more than 60% of the world production each year. Silk is discovered in China about 2700 BC. Silk production

today is a blend of ancient techniques and modern innovations. India is the second largest producer of raw silk after China and the biggest consumer of raw silk and silk fabrics. In India, sericulture is not only a tradition but also a living culture. It is a farm- based, labour intensive and commercially attractive economic activity falling under the cottage and small-scale sector. India is a home to vast variety of silk secreting fauna which also includes an amazing diversity of silk moths to achieve the unique distinction of being a producer of all the five commercially traded varieties of natural silks namely, Mulberry, Tropical Tasar, Oak Tasar, Eri and Muga (Giridhar et al., 2010).

Silk from the Silkworm is proteinaceous in nature and considered as the queen of fibers. The bulk of commercial silk produced in the world is mulberry silk that comes from the domesticated silkworm, Bombyx mori which is a monophagous and voracious eater of the leaves of mulberry plant. Silkworm are lepidopteran insects and their caterpillars spin a cocoon of silk at the end of the larval stage by silk glands. The production of silk depends upon several factors of which the effect of the environmental factors such as biotic andabiotic factors is of vital importance.

Scientific classification

Kingdom Phylum Sub- Phylum	:- :-	Animalia Arthropoda Mandibulata
Class Sub- Class Division Order	:- :-	Insecta Pterygota Endopterygota Lepidoptera
Family Genus Species Binominal Name	:- :-	Bombycidae Bombyx mori *Bombyx mori*

Life cycle

The Mulberry silkworm, Bombyx mori, is a fully domesticated insect with separate sexes, a condition known as dioecious. Internal fertilization occurs following copulation. Its developmental process involves a complex complete metamorphosis, comprising four stages: egg, larva (5 instars), pupa, and adult. The entire life cycle takes around 6-8 weeks. Distribution of life cycle is as follows.

Eggs: - After fertilization, every female moth typically lays around 300 to 400 eggs. These eggs are arranged in clusters on the leaves of a mulberry tree.

Larva :- The larva of silkworm moth is called caterpillar larva. The newly hatched larva is about 4 to 6 mm in length. It has a rough, wrinkled, hairless and yellowish white or greyish worm-like body.

First Instar Larva :- The initial stage of the larva, known as the first instar, typically has a dark brown or black color and is covered with hair-like structures on each body segment. It appears like the ants and hence also called as "ant" or first instar.

Second Instar Larva :- In the second instar stages, the larvae exhibit a light brown body with a shiny milky white head region. They are covered in hair. The mouth is set on the third day of the second instar, and the larvae transition to the third instar on the fourth day.

Third Instar Larva :- When the larva grows and sheds its skin (moult), it enters the third stage, having a new pale yellow or whitish body with a slightly brown head. At this point, it eats entire leaves and small branches of mulberry.

Fourth Instar Larva :- Fourth instar larva: After the third moult the fourth instar resumes and gets the greenish white coloured body with the same-coloured head part. The larvae at this stage feeds on complete leave and small branches of mulberry. The period of fourth instar is 5-6 days. The larvae at this stage feed continuously 24 hours and gains weight 1000 times larger, than before or at first instar stage. The larvae become paint whitish or greenish coloured with spiracles each segment.

Fifth Instar Larva :- after the four moults, silkworm reaches the fifth and final instar and its maximum weight of about 1000 times its own weight at the time of hatching which take place within just a span of 20-25 days. It measures about 6 gms, in weight. In this stage the larvae feeds for 6-8 days and become green yellow in colour and a pair of spiracles present in each segment.

Spinning the silk :- The silk threads are produced by the protein secreted by the silk gland and come out by minute opening to form the cocoon. These spinning larvae make the cocoon around itself.

Pupa :- The thread becomes wrapped around the body of the caterpillar larva forming a complete covering or pupal case called the cocoon. The cocoon- formation takes about 3-4 days.

Imago or Adult :- The mature moth emerges from the cocoon within a span of 2 to 3 weeks, provided it is allowed to complete its life cycle.

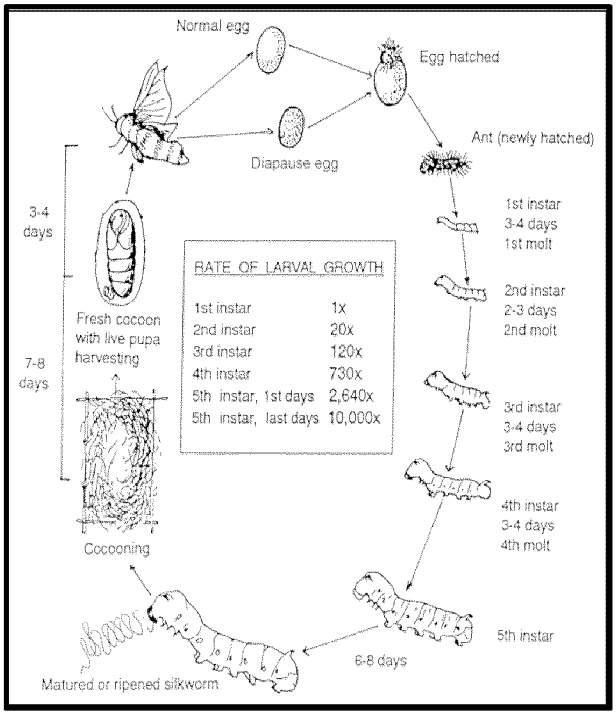


Figure: - Life Cycle of Mulberry silkworm

Material and Methods

Study Area

Akola is the district present in Maharashtra. There are seven district present in Akola, which is: - Akot, Akola, Balapur, Barshitakli, Murtizapur, Patur and Telhara respectively. The present study was carried out in Patur Taluka Village Shirla. Patur is a city and Tehsil in Akola district in the Indian state of Maharashtra. Total number of villages in this Taluka is 90. Distributed in 20.46 North latitudes and 76.94 East

Longitude. Total population of Patur is about 28,531. It belongs to Vidharbha region and Amravati Division. It is located 28 KM towards South from District head quarters Akola. 12 KM from Patur. Shirla Pin code is 444501 and postal head office is Patur. Patur is the Nearest Town to Shirla. Patur is 5 km from Shirla. Road connectivity is there from Patur to Shirla. It is a taluka head quarter. (As of 31 March 2011. Government of Maharashtra). Total population of Patur region in 2024 is about 1,57,631.

Survey and collection of Mulberry Silkworm

With the help of office of the Tehsil sericulture and the permission of local farmers in the tehsil a survey for the active silkworm collection was carried out during the month of 5th of

November 2023 January 2024. During the visit of Shirla from time to time collection of the silkworm is done by actual observation and collection and photographic method.

The method used for the production of mulberry silkworm or mulberry silk the sericulture process follows three primary steps: -

1. Moriculture:- Moriculture refers to the cultivation of mulberry plants, whose leaves are used as silkworm feed. This plant can be grown three different methods.

- Cultivation from seeds
- Root-grafting
- Stem grafting

The stem grafting method is the most commonly used method for mulberry plantation. Here, cuttings.

- Leaf picking: The removal of individual leaves by hand
- Branch Cutting: Removal of the entire branch
- Top shoot harvesting: removal of the mulberry shoot tops.

It is interesting to note that 1 kilogram of mulberry leaves can feed approximately 50 silkworms (from the egg stage to the cocoon stage).

2. Silkworm Rearing :- In sericulture, the silkworm rearing process begins with the laying of eggs by the female silk moth. Typically, 300-500 eggs are obtained from one female silk moth. These eggs are then disinfect with the help of 2% formalin solution. A feeding bed is prepared on a rearing tray by sprinkling chopped mulberry leaves onto it. The hatched larvae are transferred on to this tray via a process known as brushing. In order to maintain humidity, foam strips are soaked in water and place on the tray. The silkworm larvae initially have a good appetite, as they grow, their appetite slowly diminishes until their active stage. At this stage, the silkworm eats enthusiastically until its final feeding stage.Once the silkworms grow up, they look for a good place to make their homes. At this point, their bodies get smaller and see-through. These grown-up silkworms make a protective covering by producing spit from glands on their heads. When this spit touches the air, it turns into silk. Normally, it takes 2-3 days for them to make this covering, but some types of silkworms might take up to 4 days.

3. Silk Reeling:- After the silkworms change into pupae inside the cocoons, the final step of making silk begins. The pupae are killed by boiling the cocoons with steam and dry heat, a process called stifling. After that, the silk threads are taken out from the dead cocoons through a

process called reeling. The cocoons are boiled in water for about 15 minutes, making it easier to separate the silk threads. These threads are twisted into a thread using guides and pulleys. Finally, the silk is boiled again to make it shiny.

Each silk thread has about 50 smaller silk strands. Surprisingly, a single cocoon can give over 900 meters of this silk thread. So, after getting this raw silk from the silkworm, the whole process of sericulture is completed. The natural silk business starts with growing mulberry trees (moriculture) and raising silkworms (sericulture). India is important in this business and produces three types of natural silk: Tasar Silk, Eri, and Muga Silk. Tasar, Eri, and Muga Silks are wild and known as Vanya silks. Eri silk, also called endi or errandi, comes from silkworms that eat Castor plants. The term "eri" comes from the Sanskrit word "eranda," which means castor plant.Tasar silk comes from tasar silkworms, and India is the second-biggest producer. These silkworms eat leaves from trees like Asan, Arjun, and Oak. Muga silk, with its shiny golden color, is made by muga silkworms that feed on Som and Sualu. It's a special silk that makes India proud.

Results and Discussion

The Silkworm (Bombyx mori) life cycle consists of four stages: eggs, larva (caterpillar), pupa (cocoon), and adult moth. After hatching, the silkworm larva feeds on mulberry leaves, spins a silk cocoon during the pupa stage, and transforms into an adult moth. The cycle repeats when the adult lays eggs.The result we got when studying this stages are as follows: -

Stages	**Days/Duration**	**Colour**
Eggs	10-14 days	Pale yellow
Larval stages		
First instar larva	3-4 days	Dark brown & black coloured
Second instar larva	1-3 days	Light brown coloured with skinny milky white head.
Third instar larva	3-4 days	Pale yellow or whitish coloured and slightly brown head.
Fourth instar larva	5-6 days	Greenish white coloured body with slightly brown head.
Fifth instar larva	6-8 days	Greenish yellow colour.
Pupa	10-11 days	At first it shows light colour then converted into dark brown.
Adult(the moth)	3-10 days	Creamy & white coloured moth.

Conclusion

Silkworms are crucial in the sericulture industry, providing the silk obtained from their cocoons. Silkworms are the larvae or caterpillars of the domesticated silk moth, known as Bombyx mori. A silkworm has four stages in its life: eggs, caterpillar, pupa, and adult. This takes about 6-8 weeks, depending on the weather. It starts when a female silk moth lays eggs, and they hatch into silkworms. Silkworms eat mulberry leaves. They go through five growing stages, then turn into pupae. In the pupa stage, they make a protective net around themselves using a protein. This net helps them create a cocoon. The silk for the cocoon comes from a thin yarn-like structure made by the silkworm.

- Growing silkworms can provide jobs for many people and make rural areas better off economically. It's like a tool for creating more money and opportunities in those places.
- Silk farming is a pocket-friendly job for small farmers, giving good returns. Since rich people mostly use silk, it helps money move from the rich to the poor.
- Sericulture provides self-employment opportunities for educated unemployed youth in various sectors. Additionally, several by-products can be produced through sericulture activities.
- People with fewer resources, like those with small plots of land, can consider sericulture as a good job. Raising silkworms on their land can provide enough support for a family of three without needing to hire extra help.
- Silkworms are valuable for genetic and biotechnological research. They produce medicinal products that can be used in medicines. Since all sericulture activities are centered in villages, it helps prevent people from moving from rural to urban areas in search of jobs.
- Sericulture is a women-friendly occupation, playing a crucial role in empowering rural women. In India, 60% of the workforce in sericulture consists of women

References

- Ayandokun, A., Ete, J., Babayemi, I., & Aina-Oduntan, O. (2017). Assessment of two disinfectants in the rearing of Bombyx mori and their effects on larval performance and cocoon yield. African Journal of Agriculture Technology and Environment Vol, 6(1), 45-52.

- Baci, G. M., Cucu, A. A., Moise, A. R., & Dezmirean, D. S. (2021). Applicability of Honey on Silkworms (Bombyx mori) and Quality Improvement of Its Biomaterials. Applied Sciences, 11(10), 4613.
- Banno, Y., Shimada, T., Kajiura, Z., & Sezutsu, H. (2010). The silkworm—an attractive bioresource supplied by Japan. Experimental animals, 59(2), 139- 146.
- Dee Tan, I. Y., & Bautista, M. A. M. (2022). Bacterial Survey in the Guts of Domestic Silkworms, Bombyx mori L. Insects, 13(1), 100.
- Dewangan, S. K. (2017). Employment Generation and Socio-Economic Change through Sericulture in Raigarh District, Chhattisgarh, India. Annals of Natural Sciences, 3(2), 32-42.
- Gupta S.K. and Gaur K.P. (2019). Influence of temperature fecundity, incubation period and fertility of multivoltine mulberry silkworm (Bombyx mori LINN). Eggs.
- Hailu, A. (2016). Assessment of growth and performance of silk worms (Bombyx mori L.) on mulberry leaves at Jimma, South West Ethiopia. Journal of Biology, Agriculture & Healthcare, 6(9).
- Krishnaswami S, Narasimhanna MN, Suryanarayan SK, Kumararaj S (1973) Manual of Sericulture. Vol. 2. Silkworm Rearing. FAO, Rome.
- Pathare, M., Shinde, H. R., & Bagade, A. S. (2021). Economic analysis of silk cocoon production in Maharashtra. Pharma Innovation Journal, 10(11), 534-538.
- Ramya, M. N., & Jagadeesh Kumar, T. S. (2018). The Silkworm, Bombyx mori: A promising model organism to study the longevity-A review. International Journal of Current Microbiology and Applied Sciences (IJCMAS), 7(11), 3433-3442.
- Sarkhel, S., Shrivastava, S., & Pouranik, M. (2017). The effective influence of temperature on the varied characteristic of silkworm: A Review. Asian J. Exp. Sci, 31(2), 31-37.
- Shahd Mehmood. Beneficial importance of insects specifically silkworm (Bombyx mori) as its role in entomological industries.
- Singh, K. P., & Jayasomu, R. S. (2002). Bombyx mori–A Review of its Potential as a Medicinal Insect. Pharmaceutical biology, 40(1), 28-32.

- Soumya, M., Reddy, H., Nageswari, G., & Venkatappa, B. (2017). Silkworm (Bombyx mori) and its constituents: A fascinating insect in science and research. J. Entomol. Zool. Stud, 5, 1701-1705.

- Soumya, M., Reddy, H., Nageswari, G., & Venkatappa, B. (2017). Silkworm (Bombyx mori) and its constituents: A fascinating insect in science and research. J. Entomol. Zool. Stud, 5, 1701-1705.

- Vasantharaj David, V.V. Ramamurthy, 2015, Elements of Economic Entomology, 8th edition, Brillion Publishing, New Delhi.
- Yang, Y., Tang, H., Zhang, Y., Zhu, F., Lü, P., Yao, Q., & Chen, K. (2018). Research progress on the immune mechanism of the silkworm Bombyx mori. Physiological Entomology, 43(3), 159-168.

5. Isolation and Identification of Cellulose Degrading Bacteria from Different Environmental Samples

Miss. Janhavi Surendra Choubey
Shri R. L. T. College of Science, Akola.
Dr. Vijay D. Nanoty
Under the guidance of Principal, Shri R. L. T. College of Science, Akola.

Introduction

One of the delicate protein molecules are enzymes which are necessary for life. Cellulose is the most copious biomass on the planet (Venkata et al., 2013). Plant biomass contains cellulose as the major component of the cell wall as well as algae and oomycetes.

Cellulose accounts for 50% of the dry weight of plant biomass and approximately 50% of the dry weight of secondary sources of biomass such as agricultural wastes.

It is the presiding waste material from agricultural industry in the form of stalks, stems and husk, there has been enormous engrossment in availing cellulose as vitality asset and feed.

Cellulose is a strong fibrous, crystalline polysaccharide, resistant to hydrolysis and is water insoluble it consists of repeating units of D-glucose. Cellulases reasons hydrolysis of the character cellulose fibres to break it into smaller sugars devices and sooner or later generating glucose molecules. It is one of the most versatile organic compounds present on the Earth, it mainly occurs in plants but can be produced by exhausting certain fungal as well as bacterial strains.

According to several research there are only two types of hydrogen bonds in cellulose molecules.

Cellulase enzyme accommodates three classes of soluble extracellular enzymes: 1,4-β-endoglucanase, 1,4-β-exoglucanase, and β-glucosidase (β-D- glucoside glucohydrolase or cellobiase). Endoglucanase is chargeable for random cleavage of β- 1, 4-glycosidic bonds along a cellulose chain.

Exoglucanase is important for cleavage of the nonreducing of a cellulose chain and splitting of the essential fibrils from the crystalline cellulose, and β-1, 4-glucosidase hydrolyses cellobiose and water-soluble cellodextrin to glucose.

Review of Literature

- Verma et al. (2012) conducted a series of examination in which soil samples were obtained (10gm) from Hardoi district, Uttar Pradesh, India. Bacterial colonies were grown over CMC Agar medium. Maximal cellulase production was obtained after 48hrs of incubation at 45oC in medium containing 1.5 % carboxymethyl cellulose (CMC) as substrate. The optimum pH for the isolated enzyme was found to be ranging between 6.5 and 7.5. Their bacteriological studies reported that Bacillus subtilis to be the most frequent cellulolytic bacteria to be found in the agricultural fields.
- Behera et al. (2014) conducted a study that aimed to isolate cellulose degrading bacteria from mangrove soil. According to their results total 15 cellulose degrading bacteria were isolated based on their halo zone formation on Congo red agar medium. The maximum carboxymethylcellulose hydrolysis capacities were ranged from 1.18 to 2.5 cm. A Carboxy-methyl-cellulase test of these fifteen isolates showed that their enzyme activity ranged from 2.471 to 98. 253 U/ml/min. They studied the morphological and biochemical characteristics of the isolates. The isolates that were identified by them were reported as Micrococcus spp., Bacillus spp., Pseudomonas spp., Xanthomonas spp. and Brucella spp.
- Prabhakar et al. (2019) conducted a study which focused on the isolation, identification, and screening of bacteria with high cellulase activity from soil samples. CDB were isolated from soil sample using serial dilution and pour plate method. The isolated bacteria were further identified by the morphological and biochemical tests.

Aims and Objectives

1. To select the site for sample collection.
2. To collect and transport the samples from selected site to the Laboratory.
3. To isolate Cellulose degrading bacteria (CDB) from the given sample.
4. To perform the screening of various CDB's for further work.
5. To study the morphological and biochemical characteristics for identification of selected isolates of CDB.
6. To formulate the medium's composition (carbon source) for the optimum cellulase activity by the isolates.
7. To study the effect of pH and incubation period on the selected CDB isolates.

Materials and Methods

1. Selection of the sites for sample collection

The present study was performed in the Microbiology laboratory at Shri R. L. T. College of Science, Akola.

2. Sample collection and transport from selected site to the Laboratory

The samples were collected from distinct spots during January to April 2023. Soil samples were collected from Vermicompost Shri R. L. T. College of Science Akola, soil from Tilak Park Akola, soil near sugarcane juice shop Durga chowk Akola, Spent Biogas Slurry Shri R. L.T College of Science Akola

The soil samples were collected at different depths. The depths were 10 cm, 9 cm, and 0 cm respectively. About 20 g of soil was collected using a sterile spatula and placed into a sterile bottle.

The Spent Biogas slurry was collected directly from the biogas tank. Pre- sterilized bottles were used for the purpose of collection, and these were brought to lab for isolation of cellulose degrading bacteria. The samples were further stored at 4°C for further use.

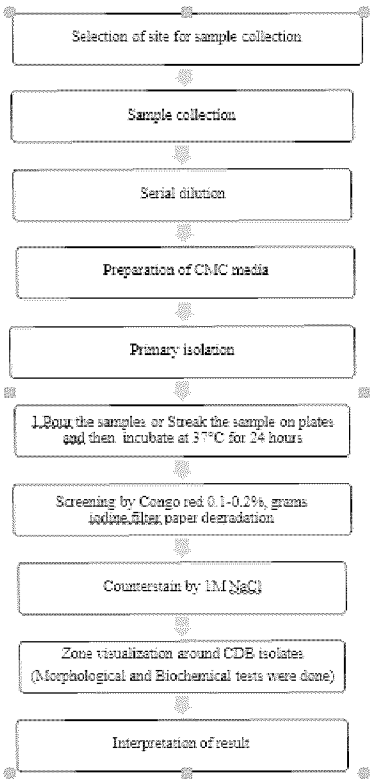
3. Processing of Sample

The samples were diluted using ten-fold dilution, where 1ml of sample is transferred to 9 ml of diluent. After first tube, each tube is dilution of the previous dilution tube. Processed samples were poured in the plate after filtration by sieve.

Preparation of CMC media

Measure all the components. Pour the media in conical flask, seal it with cotton plug and sterilize the media in autoclave for 15-20 minutes at 121°C temperature and 15 lbs pressure. Now pour the media in the sterilized petri plates, let the plates cool down and now inoculate or pour the sample in the plates. For preparation of Nutrient broth there is no need to add agar powder.

Methodology



Results and Discussions

Isolation and screening of cellulolytic bacteria

In the present study, fourteen isolates were isolated and screened from soil and Spent Biogas slurry. The isolates obtained were initially identified They were initially identified to produce cellulose degrading enzymes on CMC agar plates. The isolates were selected on the basis of hollow zones producing around the colonies on the CMC agar plates when flooded with Congo red and grams iodine. Among the total isolates obtained, the isolates CDB4 and CDB8 with high zone of clearance i.e., 14.5 and 16 respectively.

After completion of the isolation total 14 isolates were grown on CMC medium and after screening by Congo red and gram's iodine two isolates where further subjected to subculturing and obtaining the pure culture of the bacteria on the basis of formation of zone of clearance (halazones).

Metal ions were added in order to increase the production of Cellulase enzyme in the medium. Calcium chloride, magnesium sulphate, CaCO3 and FeSO4.

In a set of experiment, we have added CaCO3 as a micronutrient in order to enhance the growth of bacteria.

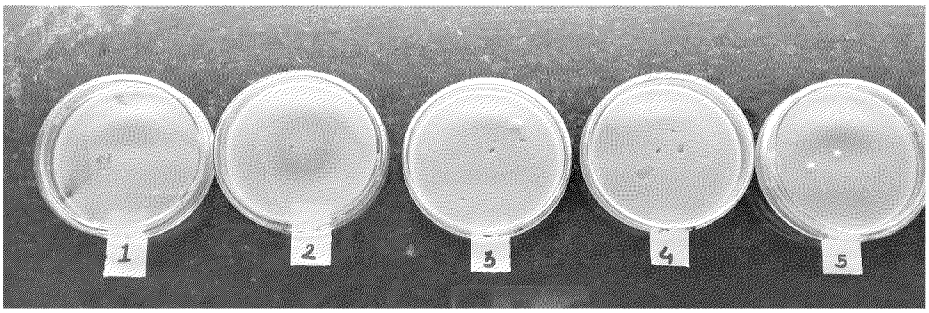


Figure : CMC plates with Calcium carbonate as a nutrient source

The sole source of carbon in the medium i.e., cellulose can be substituted by some other components to visualize the optimum growth of the selected isolates. Microscopic examination of CDB4 isolate was shown gram negative and short rod- shaped bacteria in the same manner colonies of CDB8 was reported to be gram negative and rod-shaped bacteria. According to Muhammad et al. (2012) Bacillus spp. Has shown a remarkable ability of cellulose hydrolysis in terms of Congo red assay by giving a zone, had found various anaerobic hydrolytic and methanogenic bacteria active in cattle dung biogas plants including Syntrophobacte wolinii a propionate degrading bacterium in co-culture with hydrogen utilizing methanogen viz., Mthethanobacterium.

Results indicated that optimum temperature for growth is 37°C, pH 8-9 (indicating alkaline cellulase production in medium) and salt concentration 0.4 % recorded for both the isolates namely CDB4 and CDB8, while the optimum incubation period was 96 hours. Dubey et al. (2014) investigated that optimal pH was 7.0, temperature 26°C for the on the basis of the growth curve.

After the addition of Congo red dye, clear zone of hydrolysis were observed likewise, in another case i.e., of Gram's iodine addition to the CMC plates, zones were observed hence it can be denoted that it is positive for amylase. The highest halozones were similar in case of Congo red and Gram's iodine which was observed for the isolates CDB4 and CDB8.

Sr No.	Biochemical Characteristics	Cdb4	Cdb8
1	Indole		
2	MR		
3	VP	+	+
4	Citrate	+	+
5	Catalase	+	+
6	Oxidase		
7	Motility	+	+
8	Glucose	+ AG	+AG
9	Lactose	+AG	+AG
10	Mannitol	+A	+A

Table 4.3: Biochemical characteristics of isolates.

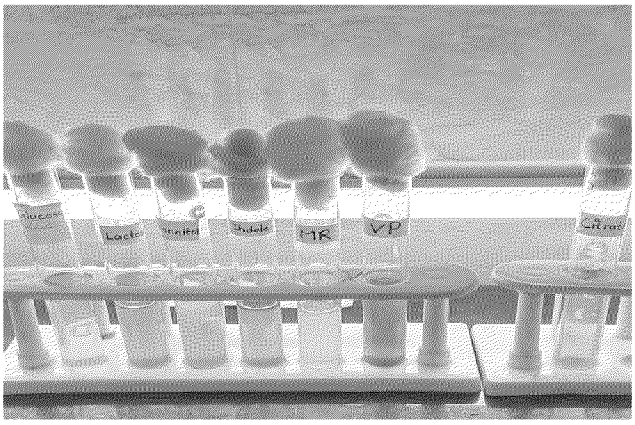


Fig : Biochemical characteristics of isolates.

According to microscopic and biochemical results obtained the CDB4 and CDB8 might be belonging to the Bacillus species.

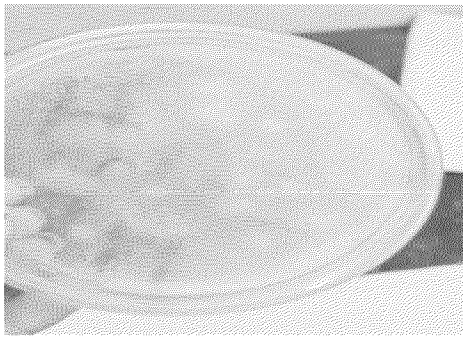


Fig :- Plate after incubation of 96hours.

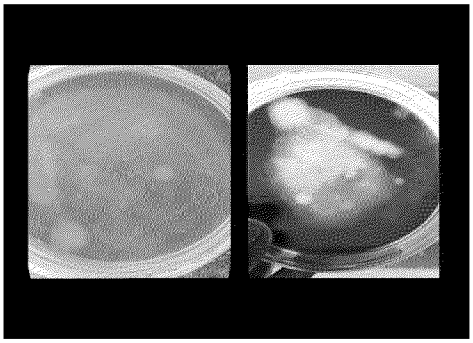


Fig:- After Addition of Congo Red.

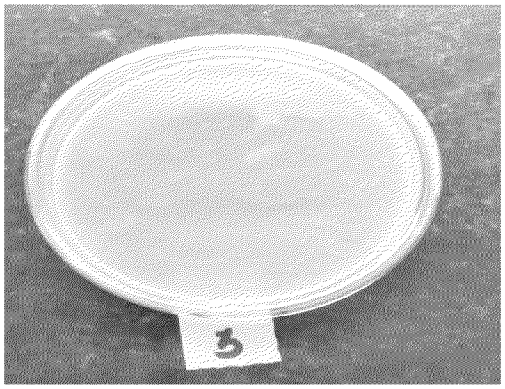


Fig: Pointed colonies on CMC Plates with Calcium carbonate

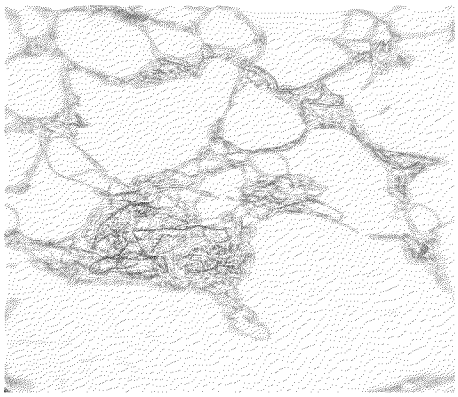


Fig : Showing Morphology of isolate CDB4

Conclusion

From the present study, 14 cellulolytic bacterial isolates were obtained successfully from soil and Spent Biogas slurry. The Gram-negative isolate i.e., CDB4 & CDB8, selected for further studies shown to bear high cellulolytic activities. From the functional tests carried to determine the optimal conditions for cellulolytic activity, the isolate's enzyme activity was found to be high over a range of temperatures i.e., from 37°C to 45°C with the optimum temperature being 37°C. Similarly, enzyme activity was found to be high at the range of pH 7 to pH 9 with an optimum of pH 8, suggesting that the isolate bears alkaline cellulases. The optimum incubation period was of 96 hours which has given highest zone forming isolates. The present study which concludes the isolate to be of Bacillus species gives Indole test negative, Methyl red test negative, Voges-Proskauer test positive, Citrate positive test, Catalase positive and Oxidase negative test, sugar fermentation test's result are as follows glucose acid and gas positive with lactose been acid gas positive with mannitol been showing formation of only acid and no gas.

Application of these two isolates in industries may have several advantages such as high growth rate and ability to secrete proteins extracellularly; these are some features of the Bacillus species. From the present study, it can be concluded that all the two CDB isolates from spent slurry has the capacity to produce cellulase enzyme efficiently in the medium which can probably be helpful for taxonomists and enzymologists, and even some industrialists in their own researches. The use of these CDB's as bio-inoculants can be incorporated to increase soil fertility and to minimize the application of fertilizer. More studies are however needed before industrial application of these isolates.

Future Prospectus

- The isolated organism can be further identified by 16S rRNA sequencing and by PCR amplification of the bacterial DNA.
- Genetic diversity analysis can be performed by Rbac (Universal primer for bacteria) RAPD based markers.
- Research can be done on formulation and optimization of the medium for optimum growth and cellulase production.
- Work can be done for determination of optimal environmental conditions for the isolates.
- Further studies can be progressed in the purification and application of cellulase in different commercial fields. The purified cellulase from the microbial sources can be used in several industries.
- The CDBs can be used for biostoning of denim fabric was also evident, hence there is scope of introducing some more species of bacteria with high efficiency of cellulase production.

References

1. Bai, S., et al. (2012). Cellulase production by Bacillus subtilis isolated from cow dung. Arch Appl Sci Res, 4(1), 269-279.
2. Kuhad, R. C., Gupta, R., & Singh, A. (2011). Microbial cellulases and their industrial applications. Enzyme Research 2011, 1–10.
3. Kuila, A., et al. (2011). Production of ethanol from lignocellulosics: an enzymatic venture. EXCLI journal, 10, 85.
4. Islam, F., & Roy, N. (2018). Screening, purification and characterization of cellulase from cellulase producing bacteria in molasses. BMC research notes, 11(1), 1-6.
5. Karmakar, M., & Ray, R. R. (2011). Current trends in research and application of microbial cellulases. Research Journal of Microbiology, 6(1), 41.

6. Study of Spider Diversity at Kapshi Lake, Akola

Kajal N. Wagh
Department of Zoology, Ghulam Nabi Azad College of Arts, Commerce and Science, Barshitalki, Dist. Akola.
Prof. Amit Vairale
Guided by Department of Zoology, Ghulam Nabi Azad College of Arts, Commerce and Science, Barshitalki, Dist. Akola.

Abstract

The study was conducted at Kapshi Lake Tahasil Barshitakli of Akola District Maharashtra India to study the diversity of Spiders (Class Insecta, phylum Arthopoda). Variety of spiders found in the region shows their relationship in respect of nature and natural habitat. High density of spiders in the lake region as compared to the civilized area is attributed to the high density of varied fauna and flora found in the lake region.

The research shows how the population of spiders responds to change in climate, region and how their morphology changes according to the habitat in which they are dwelling. Spider is one of the important communities in the ecosystem and its study is of as much importance for understanding the ecosystem as a whole.

Keywords: Kapshi, Spider, Population, Diversity.

Introduction

Spiders are one of the most widely recognized groups of Arthropod. Spider populations can be found all over the world and have occupied almost all ecological habitats, except open air and the open sea. They can be traced right from the cold to hot regions of the world. Spiders belong to order Araneae, class Arachnida which are members of phylum Arthropoda. The largest assemblage of animals with jointed legs and hard exoskeleton (A.B.Vairale & G.A.Wagh).

Spiders belonging to the order Araneae, the seventh largest order of the animal kingdom, these are small invertebrate animals distributed throughout the world. Insects constitute the principal portion of the spiders' prey, but certain other arthropods are often consumed. Spiders exhibit stunning morphological diversity and colouration. The exclusive predatory behavior of spiders have a notable impact on the ecosystem (Wise, 1993) and thereby regulate insect populations.

As of November 2023, 51,673 spider species in 136 families have been recorded by taxonomists. Spiders play an important role in regulating insect pests in the agricultural ecosystem. There are currently 1947 spider species in India (Caleb and Sankaran 2023).They are unique among all organisms in their modes of silk production and usage and of reproduction. Spiders from one of the most diverse groups of organisms existing in India but very little documentation has been done on spiders.

Classification

Kingdom - Animalia
Subkingdom - Bilateria
Phylum - Arthropoda
Subphylum - Chelicerata
Class - Arachnida
Order - Araneae

Spiders are predominantly carnivorous invertebrates that feed on a variety of prey, which makes them universal. Their feed mostly consists of insects and other arthropods like collembolans, dipterans, homopterans and also other spiders.

Spiders are abundant and their continued impact on the natural food chain can have numerous effects on insect densities (Foelix, 1996). All spiders produce at least one kind of silk. Orb-weaving spiders are unique in the sense that they can even produce seven different types of silk fibers with unique functional and mechanical properties (Foelix 2011). Spider silk is a one of a kind natural material with a rare combination of high tensile strength and elasticity.Another important and unique characteristics of Spiders is their web which is considered as one of the important feature for the success of spider's ecology.

Spider web is a unique example of high performance natural material design and pattern. In particular, to survive in different environments, spiders have specially optimized and adapted their web architecture by providing housing, protection, and an efficient tool for catching prey. The egg sac of a spider contains eggs in it. In some species the egg sac consists of few silk threads that protects eggs (Huber and Wunderlich 2006) while in some species it has very sophisticated egg sac construction, with a base plate and a cover plate, all of which are coated by numerous layers of silk (Ramirez et al. 2010).

Families

A. Araneidae - These are typically orb weaving spiders, they are distributed all over the world. In general they prefer to live in moist habitats and very rarely found in arid regions. The orb-weaving spider family Araneidae is composed of approximately 3,200 species in 169

genera, making it the third most speciose spider family after Salticidae (jumping spiders) and Linyphiidae (sheet-weavers) (World Spider Catalog, 2023).

Male araneids are much smaller than females and are not commonly seen in the web unlike females. They built spiral wheel shaped webs. Some major genus found in this family are Nephila (Leach), Herennia (Thorell), Argiope.

B. Oxyopidae - The members of the Oxyopidae family have spiny legs through which they are capable of running very fast and jumping on their prey. Hence, they have got the name lynx spiders. Which help them in hunting. Eight eyes that are arranged in a hexagonal shape with a wide clypeus. Spines on the legs are the features of this family. Large number of species are found under this family, some are mentioned here - Oxyopes Latreille, Peucetia Thorell .

C. Salticidae - Spiders of this family can be easily distinguished from other spiders by their four big eyes on the face and four smaller eyes on top of the head. There are more than 5000 species of jumping spiders in the world. These are small to large araneomorph spiders: two tarsal claws: ecribellate: rntelegyne: eight eyes: carapace square fronted with four, forwardly directed eyes of which the anterior median eyes are very large (Coddington, 1991). Some of the species found in this family are Carrhotus viduus, Plexippus paykulli, Plexippus petersi, Stenaelurillus albus, Asemonea Tenuipes, Telamonia dimidiata, Aelurillus sp. Brettus. sp. (World spider Catalog)

D. Lycosidae - Lycosidae or wolf spiders are a clearly delimited and well defined spider family both on somatic and behavioral characteristics. They have a unique eye pattern and a typical egg sac and spider-lings carrying behaviour. 2024). Lycosa, pardosa, Hogna, Hippasa, Arctosa are some of the commonly found genus of this family.

Material and Methods

Study Area and Sampling Site

Kapshi (20 34'43"N) and longitude (7657'18") The Kapshi Lake of Akola is located in Akola tehsil of Akola district in Maharashtra INDIA, it is situated 20 km. away from sub District headquarter Akola. As per 2009 status, Kapshi Lake is the gram panchayat of kapshi Lake village. Kapshi lake 'is the only preliminary study done to list the species and species of spider families, the study is still ongoing. More zoological surveys are planned to study the spider diversity in detail in the near future

The spider creatures were collected from different bits in the Kapashi lake. The spiders were collected from different parts of Kapsh' lake with the help of different methods. This study was conducted during October 2023 to Feb 2024. different methods used for spider collection.

Collection of Spiders - While collecting the spiders we found the majority of them on trees, their foliage and flowers, under the caves of rocks, in the cervices of walls, grass and on the ground. For collection of spiders a number of methods were applied, such as hand collection, sweep netting, beating method, pitfall trap, aerial hand collection, collection by sweep net, Inverted umbrella method, hand-kerchief method.

Result and Discussion

In Barshitakli 127 species of spider belonging to the 12 families were found. In this study I observed that the Araneidae family is the dominant family, in this region I found the 22 species of Araneidae family. I also found other family in this region such as lycosidae, Salticidae, Oxyopidae, Theridiidae and sicariidae. In this region I found 10 species of lycosidae, 16 species of Salticidae, 11 species of Pholcidae, 10 species of Hersiliidae and 12 species of Pisauridae. I rarely found the uloboridae, Theridiidae, Thomisidae, Oxyopidae, Cheracanthiidae, and sicariidae family species in that area. The atmosphere of this region is suitable for the Araneidae family species like cyclosa and Neoscona.

Table 1:- Spider and Their Species.

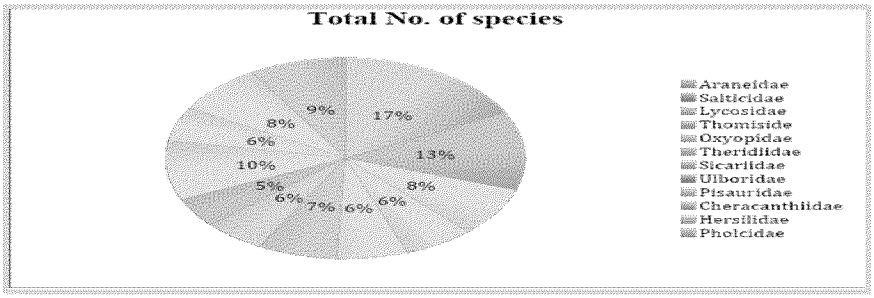
Family	Species
Araneidae	Araneus Argiope keyserlingi Argiope ameula Cyclosa insulana Gasteracantha Argiope keyserlingi (female)
Salticidae	Myrmarachne Menemerus semilimbatus
Lycosidae	Wolf spider
Thomisidae	Xysticus croceus
Oxyopidae	Oxyopes jananus

Table 2:- Count of Spider Species from Different Habitats of Barshitakli

Family	Total No. of species	Percentage of species
Araneidae	22	18%
Salticidae	16	13%
Lycosidae	10	8%
Thomisidae	8	6%
Oxyopidae	8	6%
Theridiidae	9	7%

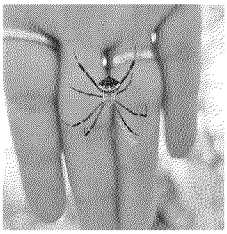
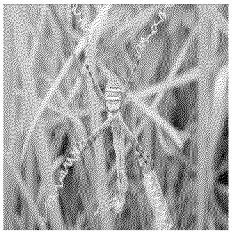
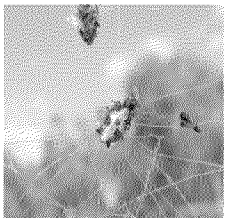
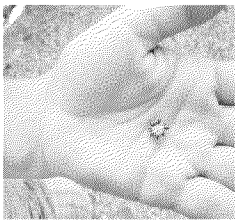
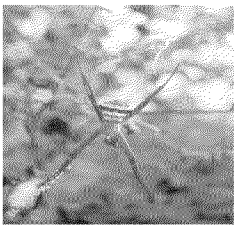
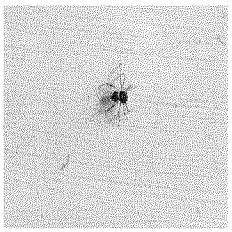
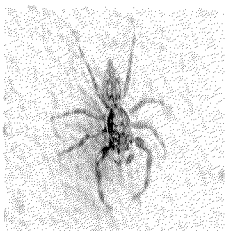
Sicariidae	7	5%
Uloboridae	6	5%
Pisauridae	12	10%
Cheracanthiidae	7	5%
Hersiliidae	10	8%
Pholcidae	11	9%

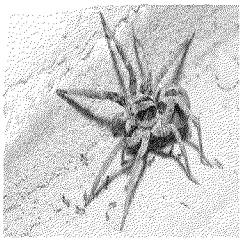
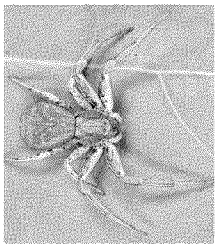
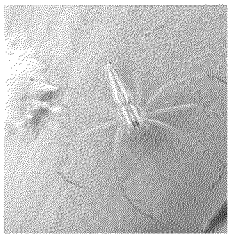
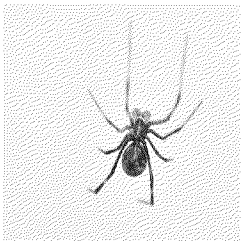
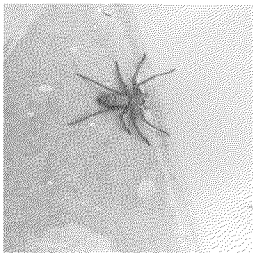
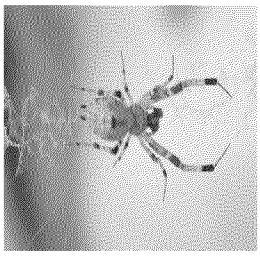
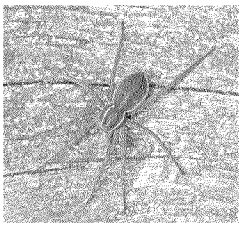
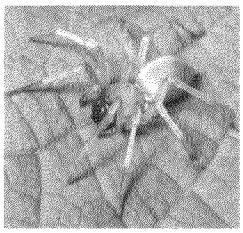
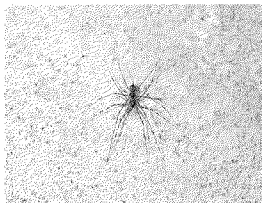
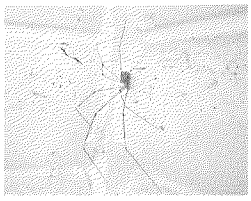
Graph 1:- Chart Showing Distribution Percentage of Spider Family in Study Area.



The above result showed that 18% of Araneidae, 13% of Salticidae, 8% of lycosidae and 6% of Oxopidae families are present. I also observed that the uloboridae. Theridiidae and sicariidae in the same percentage.

Photoplate

 Araneus (Family Araneidae)	 Argiope keyserlingi (Family Araneidae)	 Argiope aemula (Family raneidae)	 Cyclosa insulana (Family Araneidae)
 Gasteracantha (Family Araneidae)	 Argiope keyserlingi (Family Araneidae)	 Myrmarachne (Family Salticidae)	 Menemerus semilimbatus (Family Salticidae)

 Wolf spide (Family Lycosidae)	 Xysticus croceus (Family thomisidae)	 Oxyopes jananus. (Family Oxyopidae)	 Tepidariorum spider (Family Theridiidae)
 Huntsman spider (Family Sicariidae)	 Uloborus plumipes (Family Ulboridae)	 Six-Spotted fishing spider (Family Pisauridae)	 Cheiracanthium (Family Cheracanthiidae)
 Tree Trunk spider (Family Hersiliidae)		 Pholcus phalangioides (Family Pholcidae)	

Conclusion

This study shows the information related to the spider and their species distribution in a particular habitat with response to environment, disturbance and availability of food. The spider such as argiope and Neoscona are the dominant species of spider in the study area kapshi. Various spiders in the kapshilake were found. Most of the spiders found in the Araneidae family and some rarely found were Uloboridae, Theridiidae, Thomiside, Oxyopidae, Cheracanthiidae, and sicariidae family species in that area.

Reference

- Miguel Angel Pinkus Rendo´n1,4, Guillermo Ibarra-Nu´n˜ez2, Victor Parra-Tabla3, Jose Alvaro Garcı´a-Ballinas2 and Yann He´naut2: SPIDER DIVERSITY IN COFFEE

PLANTATIONS WITH DIFFERENT MANAGEMENT IN SOUTHEAST MEXICO 2006. The Journal of Arachnology 34:104–112

- Achal Kumari Pandit. Diversity of common garden and house spider in Tinsukia district Journal of Entomology and Zoology Studies 2019; 7(4): 1432-1439
- Spider diversity and abundance in different habitats of Upper-Northern Rajasthan. International Journal for Environmental Rehabilitation and Conservation ISSN: 0975 — 6272 X (1): 1— 14
- N Priyadarshini1*, R Kumari1, R N Pathak1, A K Pandey2. Biodiversity and Community structure of spiders in Saran, part of Indo-Gangetic Plain, India. Asian Journal of Conservation Biology, December 2015.
- M. Devika, Mohamed Ibrahim N., Julffia Begum A. and Goldin Quadros. Diversity and Feeding Habits of Spiders Across Habitats in Coimbatore District. Indian Journal of Ecology (2022) 49(1): 216-220
- Tanmaya R. Sethy and Janak Ahi. Spider Silk and the Silk of Egg Sacs with its Astonishing Concealed Attributes: A Review. JOURNAL OF NATURAL FIBERS
- U. A. Gajbe. Studies on Some Spiders of The Family Araneidae (Araneae: Arachnida) From Madhya Pradesh, India. zool. Surv. India: 105 (Part 1-2) : 45-60, 2005
- Kandampully Baji Amulya 1,3, Honey Sebastian 2,4 & Ambalaparambil Vasu Sudhikumar 1. A new species of Oxyopes Latreille, 1804 (Araneae: Oxyopidae) from Calicut University Campus, Kerala, India. Serket (2022) vol. 18(3): 299-304.
- B. K. Tikader. Studies on Some Ant-Like Spiders From India (Family: Salticidae).
- Shirbhate Milind V. and Shirbhate Amrita M. Spiders of Katepurna sanctuary from the family Salticidae (Blackwall, 1841). Environment Conservation Jul 20 (18216306 2019.-
- Markus J. Buehler. Imaging and analysis of a threedimensional spider web architecture.
- Amit B Vairale, Gajanan A Wagh. Diversity of spiders in microhabitats of a tropical reserve forest of Amravati, Maharashtra, India. Bioscience Biotechnology Research Communications 14 (1), 446-452, 2021
- Animesh Dey, Susmita Debnath, Biplab Debbarma, PS Chaudhuri. A preliminary study on spider diversity from a house hold garden (artificial mixed plantation) in West Tripura, India. Journal of Research in biology 3 (5), 1009-1017, 2013

7. Evaluation of Molecular Interaction of 1, 6-Dihydropyrimidine in Acetone and DMSO Solvent

M. M. Mhasal
Shri. Shivaji College of Arts, Commerce, Science, Akola.
P.J. Thakare
Shri. Shivaji College of Arts, Commerce, Science, Akola.

Abstract

The main purpose of this study to investigate the impact of binary mixture 1,6 dihydropyrimidine in Acetone and DMSO solvent used to determine the molar refraction and polarizability constant. Molar refractivity (RM) of solution was calculated from density, refractive index data and polarizability (□) was calculated from molar refractivity data.

Keywords: Refractive indices, Molar refraction, Polarizability constant Molecular interaction.

Introduction

One of a unique and important property of liquid is refractive index. Refractometry allows the quantification of concentration changes by means of an associated refractive-index change leading to frequency shifts of optical resonances. The practical application of refractometry, mainly involves the measurement of concentration of one substance dissolved in another. Refractive indices can be measured easily with a high degree of accuracy. The value depends upon the temperature as well as the wavelength of light used. Generally, the D-line of sodium is used for standard measurements. Refractometric measurements directly gave information regarding solute-solvent, solvent-solvent interactions. A.N. Sonar1 and N.S. Pawar have studied the molar refraction and polarizability constant of substituted heterocyclic compounds in different media from refractive indices. Burghate et.al2 have studied the molar refraction and polarizability constant of substituted chalcones in different percentage of acetone-water mixture.

J.D. Pandey et.al3 have studied the refractometric and dielectric studies of binary liquid mixtures at different temperature. J. Padova4 have studied the ion-solvent interaction in mixed solvent using ethanol and acetone medium. The properties of liquid such as viscosity, refractive index and ultrasonic speed of binary mixtures are studied by many workers5. Oswal et al6 have

studied dielectric constants and refractive indices of binary mixtures. Mahajan7 have studied molar refraction and polarizability constant of 2-amino-5-chlorobenzene sulphonic acid in different percentage of dioxane-water mixture. Study of refractive indices in mixed solvents is done by Burghate et al8. Refractometric study on molecular interaction between some bromoalkane and non-polar hydrocarbon is studied by Yadav9. Dadhichi et.al.10 have investigated the measurement of viscosity, refractivity index and metal ligand stability constant of substituted benzofurones in different solvents. The density, viscosity, refractive index and speed of sound in aqueous mixtures of N, N-Dimethylformamide, Dimethyl sulfoxide, N, N-Dimethylacetamide, acetonitrile, ethylene glycol, diethylene glycol, 1,4-Dioxane, tetrahydrofuran, 2-Methoxyethanol and 2- Ethoxyethanol at 298.15K are studied11. Effect of temperature on the partial molar volumes of some bivalent transition metal nitrates and magnesium nitrate in DMF-Water mixtures are studied12. Zhi Zhou have been studied novel fiber optic refractometric method for liquid and gaseous media13. A. M. Kshirsagar et.al. have been studied effect of dioxane on N-(4-hydroxy-6- methyl-1,3,5-triazin-2-yl)-N'-phenylthiocarbamide at 250C in 60% dioxane-water system at various concentrations14.W. B. Shirsath have studied Physiochemical Properties of Binary Mixture of Methanol and Dimethyl sulfoxide (DMSO) and Methanol and Dimethylformamide (DMF)15.Yasmine Chabouni and Fauzia Amireche have been studied physicochemical properties of binary mixtures of glycerol with butanol isomers in the temperature range 293.15–318.15 k and ambient pressure16. D.S.Hedaoo, M. M. Kalaskar and M. P. Wadekar studied Refractometric study of substituted 2,3-dihydroquinazolin-4(1H)-ones in different binary mixture17.A.S. Chandami, P.P.Choudhari and M.P.Wadekar studied molecular interactions in the solution18.Insight into the the solute - solvent interactions by physicochemical and excess properties in binary systems of the ether and allyl-based functionalized ionic liquid with acetonitrile are studied19. Nimbarte, Gaurav Ramesh investigated refractometric study of substituted dihydropyrimidin 2(1H) one in different solvents20.Manoj R Gaware studies of molar refraction and polarizability constant of 6-(4-chlorophenyl)-1,2,3,4-tetrahydro-2,4- dioxopyrimidine-5-carbonitrile in 60% DMSO in the temperature range 298 to 313 K21.To understand intermolecular interaction, molar refraction and polarizability constant studied by Yaseen SA et.al22. Structural arrangement of an atom in molecule responsible for interactions in solvent medium23.

Experimental

Above all substituted heterocyclic compounds have most important life saving drugs. 1,6-dihydropyrimidine is used as anti-diabetic. It is also used in heart diseases, strokes, kidney diseases, blood circulation problem, and blindness and as antipsychotic. It is effective in liver diseases. The solution of above compound is prepared in DMSO solvent by dissolving an appropriate amount by weight. For density measurement all the weight of solution took on Contech balance (0.001gm). The refractive index of solutions is measured of different concentration (0.625x10-3 to 10x10-3) by Abbe refractometer having accuracy with ± 0.01 unit. The constant temperature of the prism box is maintained by circulating water from thermostat. Refractometer was calibrated by using glass test piece of known refractive index supplied with the instrument.

In the present investigation following ligands are used.

(LA) = 2-Amino [4-(3-nitro phenyl) -6-phenyl-1,6-dihydro] -1,3- pyrimidine,

(LB) = 2-Amino [4,6-diphenyl-1,6-dihydro] -1,3- pyrimidine,

(LC) = 2-Amino [4-(4-hydroxy phenyl) -6-phenyl-1,6-dihydro] -1,3-pyrimidine,

(LD) = 2-Amino [4-(2-hydroxy phenyl) -6-phenyl-1,6-dihydro] -1,3-pyrimidine

The molar refraction of solvent and solution are determined by using Lorentz- Lorentz equation.

The molar refraction of solvent, solvent-water mixtures are determined from-

RDMF-W = X1R1 + X2R2 ……(1) where,

R1 and R2 are molar refractions of solvent and water respectively.

The molar refraction of solutions of ligand in solvent -water mixtures are determined from-

$RMix = (n2-1)\,(n2+2) + [X1M1 + X2M2 + 3M3]\,d\,\}$ …… (2)

where, n is the refractive index of solution, X1 is mole fraction of solvent, X2 is mole fraction of water and X3 is mole fraction of solute, M1, M2 and M3 are molecular weights of solvent, water and solute respectively. 'd' is the density of solution.

The molar refraction of ligand is calculated as –

Rlig = Rmix - RDMF – w …… (3)

The polarizability constant (□) of ligand is calculated from following relation- Rlig = 4/3 □No□ …… (4)

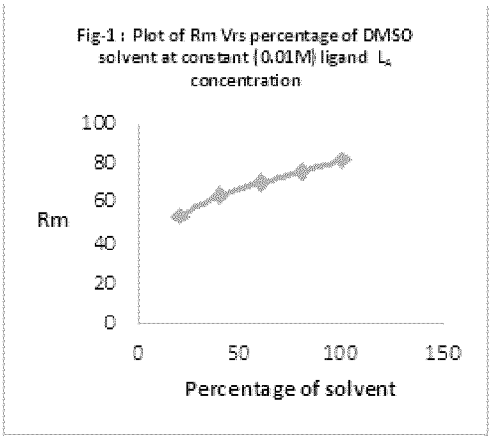
where, No is Avogadro's number.

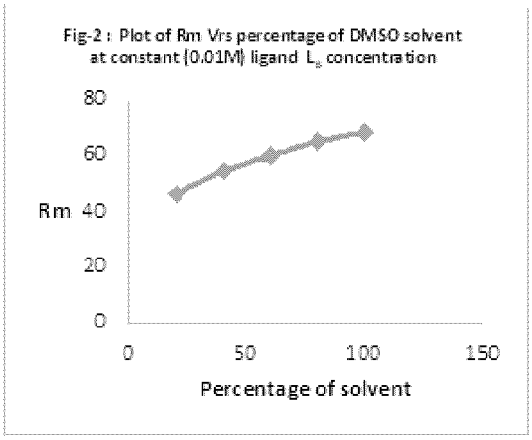
Result and Discussion

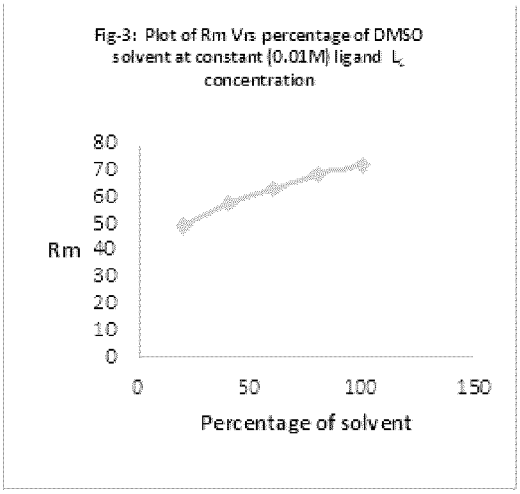
The values of refractive index (n), density (d), molar refraction (Rm) and polarizability constant (α) at 300K

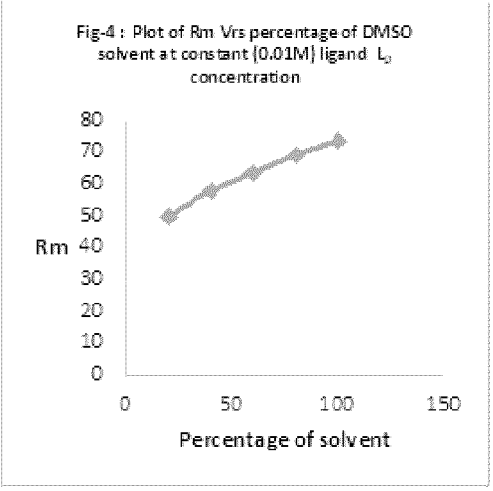
Conc.in %	Constant ligand concentration system (0.01M) with change in DMSO			
	Refractive index (n)	**Density (d) gm/cm^3**	**Rm x10^3 cm^3/mol**	**α x10^{-23} cm^3**
Ligand L_A				
20	1.363	0.9976	53.7781	2.1326
40	1.395	1.0041	64.3623	2.5524
60	1.413	0.9944	70.3808	2.7910
80	1.445	1.0032	76.0290	3.0150
100	1.478	1.0012	82.0658	3.2544
Ligand L_B				
20	1.371	0.9993	46.4766	1.8431
40	1.394	1.0005	54.6358	2.1666
60	1.413	0.9857	60.1607	2.3857
80	1.449	0.9979	65.2527	2.5877
100	1.47	0.9997	68.6089	2.7208
Ligand L_C				
20	1.375	1.0029	49.7148	1.9715
40	1.395	1.0040	58.0503	2.3021
60	1.414	0.9957	63.5075	2.5185
80	1.449	1.0038	69.0285	2.7374
100	1.467	1.0016	72.4822	2.8744
Ligand L_D				
20	1.376	1.0062	49.6688	1.9697
40	1.390	0.9947	57.9369	2.2976
60	1.414	0.9932	63.6663	2.5248
80	1.443	0.9920	69.0440	2.7380
100	1.473	0.9988	73.48268	2.9141

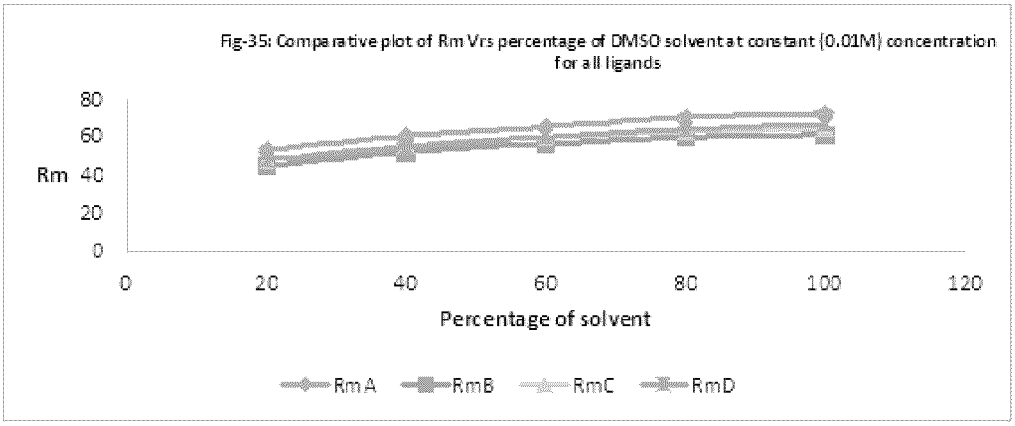
Graphical representation of Molar refraction (Rm) verses changes in DMSO solvent percentage at constant (0.01M) ligand concentration





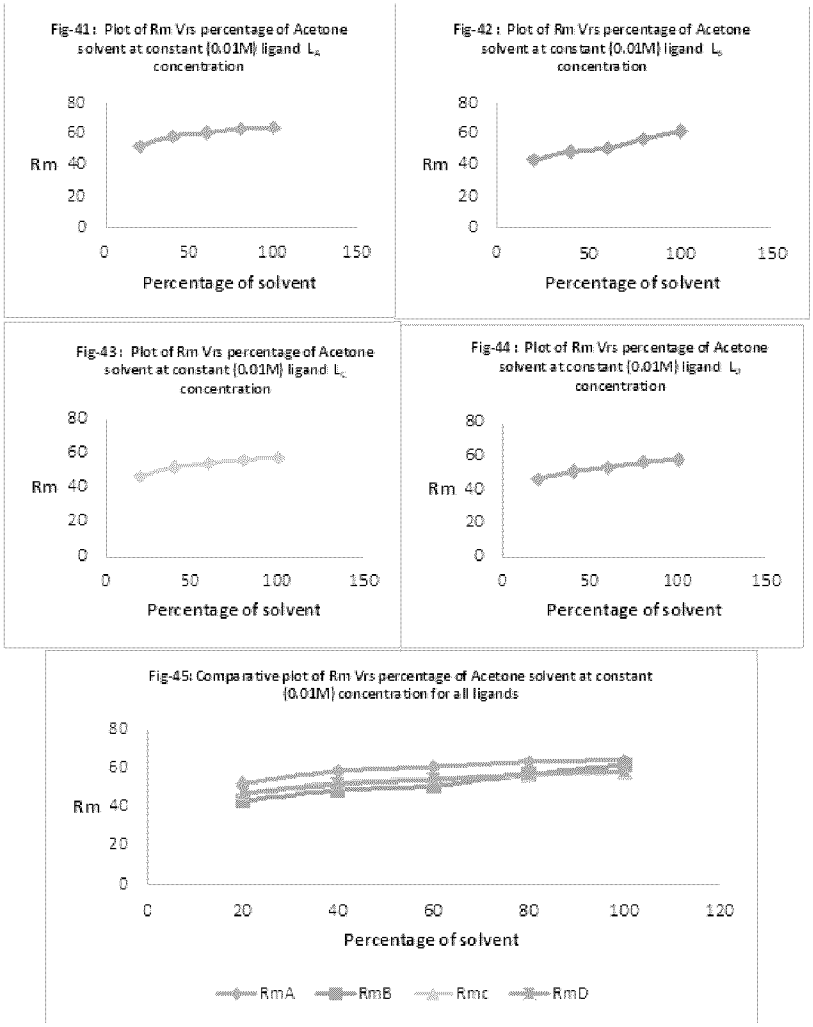






Graphical representation of Molar refraction (Rm) versus change in Acetone solvent percentage at constant (0.01M) ligand concentration

Conc.in %	Constant ligand concentration system (0.01M) with change in Acetone			
	Refractive index (n)	**Density (d) gm/cm^3**	**Rm x10^3 cm^3/mol**	**α x10^{-23} cm^3**
Ligand L_A				
20	1.351	1.0045	51.5776	2.0452
40	1.354	1.0021	58.0016	2.3002
60	1.355	1.0104	60.1695	2.3870
80	1.365	1.0095	62.7370	2.4876
100	1.4	1.1001	63.4008	2.5143
Ligand L_B				
20	1.346	1.0038	42.9098	1.7020
40	1.351	1.0025	48.0155	1.9045
60	1.355	1.0170	50.3987	1.9991
80	1.415	1.0727	56.2931	2.2325
100	1.42	1.0069	61.2389	2.4284
Ligand L_C				
20	1.353	1.0024	46.6540	1.8502
40	1.354	1.0034	52.1190	2.0669
60	1.357	1.0135	54.2340	2.1516
80	1.363	1.0136	56.0443	2.2226
100	1.364	1.0044	57.5689	2.2830
Ligand L_D				
20	1.347	0.9939	46.4519	1.8422
40	1.348	1.0121	51.1423	2.0283
60	1.350	1.0107	53.5564	2.1240
80	1.364	1.0091	56.4311	2.2379
100	1.366	0.9983	58.0446	2.3019



Conclusion

In conclusion, we have demonstrated the values of molar refraction and polarizability constant of 1, 6-dihydropyrimidine with solvent-water mixture. It shows the values of molar refraction and polarizability constant at different concentration of 1,6-dihydropyrimidine in 20%, 40%, 60%, 80% and 100% different solvent water mixture. It was observed form the tables that the molar refraction and polarizability constant of 1,6-dihydropyrimidine decreases in the concentration of 1,6-dihydropyrimidine. From the data it can be predicted that, when the percentage of solvent increases, molar refractivity (true molar volume) continuously increases. At the same time polarizability constant of a substituted aminopyrimidine increases. This may be attributed that with the increase in percentage of solvent it causes decreases in dielectric constant of medium and also considerable dipole association (intermolecular attraction) take place which

can be accompanied by decrease in polarizability. From this study it is clear that when the percentage of solvent increases the solute solvent interactions i.e., interaction of 1,6-dihydropyrimidine and solvent increases which may stabilize the drug activity of higher percentage of solvent.

References

1 A.N. Sonar, N.S. Pawar, Rasayan J. Chem. 2010, 3(2), 250-254.

2 A.S.Burghate, P.B.Agrawal, M. L. Narwade, Asian J. of chem., 2001, 13(4), 1652-1654.

3 J.D. Pandey, Jyotsna Chhabra, N.K. Soni, R.K. Mishtra, Ind. J.of chem., 2006,45 A,653- 656.

4 J. Pandova, Can. J.l of chem.., 1965, 43,458-462.

5 AS Burghate; PB Agrawal; SW Quazi & ML Narwade. Asian J. Chem., 2001, 13(4), 1652.

6 SL Oswal & MV Rathnam. Ind. J. Chem., 1987, 26, 29.

7 DT Mahajan. Ph.D. Thesis in Chemistry Submitted to Amravati University, Amravati,

1. 1997.

8 AS Burghate; PB Agrawal; SW Quazi & ML Narwade. Asian J. Chem., 2001, 13(4), 1652.

9 SS Yadav; Anirudh Yadav; Neetu Kushwaha & Neetu Yadav. Indian J. Chem., 2009,

10 V. S. Jamode, J. C. Dadhichi, D. D. Malkhede, M. L. Narwade, J. Indian Coun. Chemist,

2. (2005), 22(2), 35.

11 T. M. Aminabhavi, B. Gopalakrishna, J. Chem. Eng. Data, (1995), 40(4), 856.

12 M. L. Parmar, D. S. Banyal, Indian J. Chem. Sect A, (2005), 44(8), 1582.

13 Y. N. Kulchin, O. B. Vitrik , A. V. Dyshlyuk, Zhi Zhou, Pacif. Sci. Rev.,(2012),4(1), 23.

14 D. T. Tayade, A. M. Kshirsagar, the Open Phys. Chem. J., (2014), 6, 1.

15 W. B. Shirsath, Journal of Scientific Research (2021), 65, (7),49.

16 Yasmine Chabouni and Fauzia Amireche J. Chem. Eng. Data, (2020), 65, 4, 1679.

17 D. S. Hedaoo, M. M. Kalaskar and M. P. Wadekar, Der Chemica Sinica, (2015), 6(6):7, 14.

18 A. S. Chandami, P. P. Choudhari and M. P. Wadekar, Advances in Applied Science Research, (2016), 7(3):120-126.

19 Dawei Fang,Li Li,jialin Miao,Peizhen Gao,Yuxin Zhang Mei Hong, Journal of the Taiwan Institute of Chemical Engineers (2022),104275.

20 Nimbarte, Gaurav Ramesh, Journal of Advanced Scientific Research, (2021), 12,201-208.

21 Manoj R Gaware, Indian Journal of Science and Technology, (2021), 14(2):113–118.

22 Yaseen SA, Alameen AS, Saif FA, Undre SB, Undre PB. Study of Volumetric and Optical Properties of Cerium Oxide Nano-Fluid. Journal of Physics: Conference Series. 2020; 1644.

23 R Sawale, Kalyankar T, George R, Deosarkar S. Journal of Applied Pharmaceutical Science. (2016), 6(3), 120–124.

8. Synthesis, Characterization and Biological Activity of Nitrogen Containing Pyrazolone and its Derivatives

R. N. Gaikwad
Assistant Professor, Vitthal Rukmini Mahavidyalaya, Sawana, Tq. Mahagaon, Dist. Yavatmal.
B. N. Chate
Associate Professor, Sanjivani Mahavidyalaya, Tq. Chapoli, Dist. Latur.

Abstract

The synthesis of pyrazolone and its derivatives is achieved by a clean, one-pot, multi-component condensation reaction combining ethyl acetoacetate, hydrazine hydrate, aromatic aldehyde in catalytic amount of MSA. This approach has numerous benefits, including a quick reaction time and an easy work-up process. Compounds were identified via mass spectral analysis, NMR, IR, and chemical transformation. The antibacterial activity of the synthesized compounds was assessed against a specific strain of S. aurous and E. coli.

Keywords: aryl aldehyde, ethyl acetoacetate, hydrazine hydrate, MSA, pyrazolone etc.

Introduction

Pyrazolone are a class of organic compounds that feature a five-membered ring containing three carbon atoms and two nitrogen atoms. The molecular formula of pyrazolone is $C_3H_3N_2$. This heterocyclic ring structure imparts unique chemical and pharmacological properties to pyrazolone, making them significant in various fields such as chemistry and medicine. Pyrazolone aromatic nature, stability, and adaptable reactivity are among their essential qualities. They can change chemically in a variety of ways, which makes it possible to create different derivatives with unique characteristics. Pyrazolone have been used extensively in the manufacturing of materials, agrochemicals, and pharmaceuticals. Pyrazolone synthesis is achieved using a variety of techniques, such as condensation and cyclization reactions. These techniques increase the variety of compounds that can be produced by incorporating various functional groups onto the pyrazolone ring. In medicinal chemistry, pyrazolone have been recognized for their biological activities and are frequently used as scaffolds for designing drug candidates. Compounds containing the pyrazolone moiety have been investigated for their anti-inflammatory, antiviral, anticancer, and antifungal properties, among others. Pyrazolone also exhibit interesting coordination chemistry, forming complexes with various metal ions. This property makes them relevant in coordination chemistry and catalysis.

The pyrazolone ring represent a fascinating class of organic compounds with a broad range of applications, from their roles in synthetic chemistry to their significance in drug discovery and materials science. The diverse properties and reactivity of pyrazolone contribute to their continued exploration and utilization in various scientific and industrial fields. Pyrazolone derivatives, which are created with pyrazolone as the primary core, have garnered more and more interest over time. A five-membered heterocyclic organic molecule with two neighboring nitrogen atoms can be found in the center core. The chemical, pharmaceutical, and agrochemical industries are very interested in pyrazolone derivatives[1,2]. Considered an active scaffold with pharmacological importance, pyrazolone and its derivatives exhibit nearly all pharmacological activity. The pyrazolone moiety's pharmacological potential has been demonstrated by the nucleus's presence in pharmacological agents belonging to various therapeutic categories, including rimonabant, difenamizole, an analgesic; fezolamide, an antidepressant; and celecoxib, a potent anti-inflammatory and antipsychotic.[3] Because of their many characteristics and uses, pyrazolones are a class of chemicals that have been studied. These include pyrazol-3-ol and pyrazolin-5-one. Sulfamazone, propyphenazone, and nifenazone[4] are a few of the exploratory small compounds containing pyrazolone that have been considered as potential therapeutic possibilities. Derivatives of pyrazolone are a significant class of heterocyclic chemicals found in numerous medications and synthetic goods. Based on a review of the literature, pyrazolone derivatives exhibit a range of pharmacological actions, including, anti-tubercular[5], anti-fungal,[6,7] anti-bacterial,[8] anti-inflammatory,[9] anti-timor,[10] anti-microbial.[11]

In this study, we have created a sophisticated, effective, simple, and straightforward method for the synthesis of pyrazolone and its derivatives. We do this by employing ethanol as a solvent together with hydrazine hydrate, ethyl acetoacetate, and substituted aryl aldehydes in a catalytic quantity of MSA. In terms of environmentally friendly procedures, the combination of the green technique and the catalyst results in an outstanding product yield. This approach offers many important benefits, including reduced reaction time, solvent-free conditions, atom economy, using a green catalyst, and a more pleasant workup process.

The antibacterial activity of a recently synthesized molecule is the subject of the current antimicrobial study. Using the agar-cup diffusion method, this compound's antibacterial activity was investigated. Both gram positive and gram negative types of bacteria are employed.

1. Gram positive : S.aureus 2. Gram negative : E.coli

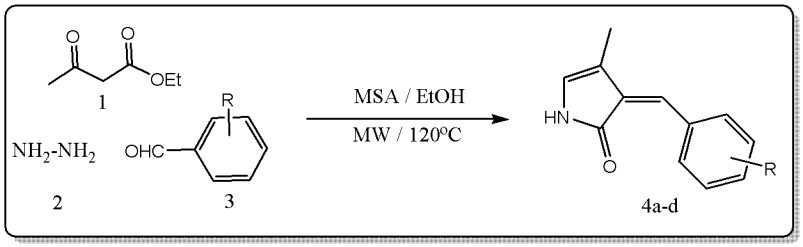
Experimental

General

The digital melting point device (Veego-VMD) was used to record the uncorrected melting point of the produced chemical. A.R. Grade chemicals were used. Every chemical employed was of A.R. Grade, and it wasn't purified further. Microwave irradiation was carried out in a Microwave Oven, Model No. MS2079 DB DB1QILN (2450 MHz, 1050 W) equipped with Erlenmeyer flask. The compound's melting point was measured in an open capillary tube and might not be accurate. Using an FT-IR spectrophotometer made by Perkin-Elimer, IR spectra were recorded. KBR Pellet. Using chloroform as a solvent, the 1H NMR spectra and mass were recorded using a Perkin-Elimer spectrophotometer. The chemical shift value was reported in parts per million (ppm) with respect to TMS, which served as an internal standard. Antimicrobial activity assessed by means of the Kirby-Bauer technique. Hi-media Laboratories Pvt. Ltd. in India produced nutritional agar for the development of all strains of S. aureus and E. coli, which was the medium utilized for the investigation of the newly synthesized compound's antibacterial effectiveness.

General Procedure for the synthesis of Pyrazolone and its Derivatives

The combination of **1** ethyl acetoacetate (0.01mmol), **2** hydrazine hydrate (0.01mmol), and **3** aryl aldehyde (0.01mmol) in catalytic amount of Methane sulphonic acid (MSA) in an Erlenmeyer flask and irradiated until completion of the reaction in microwave oven. The reaction mixture was poured in crushed ice and filtered, washed with ethyl acetate, the product was recognized as 3-methyl-4-arylidene pyrazolone (4a-d). The crude product was collected and recrystallized in ethanol and dried. The entire product was characterized by physical constant and spectroscopic techniques and compared with the standard method.



Scheme 1

Result and Discussion

As indicated in the scheme 1, we reported a direct method for the synthesis of pyrazolone and its derivatives by one pot condensation of aromatic aldehyde, hydrazine hydrate, and ethyl-acetoacetate. The yield was really high. In order to assess the extent and constraints of the

methodology, the reactions were conducted in the absence of a catalyst, and the structures of all newly synthesized pyrazolone derivatives were established using chemical transformation, NMR, IR, and mass analysis.

Table1: Synthesis of pyrazolone & its derivatives catalyzed by MSA under M.W. 120oC/300 W)

Product	Name of compound	% yield	Melting Point in ^{O}C
4a	(Z)-3-benzylidene-4-methyl-1,3-dihydro-2H-pyrrol-2-one	94 %	122^{0}C
4b	(Z)-3-(4-chlorobenzylidene)-4-methyl-1,3-dihydro-2H-pyrrol-2-one	89%	215^{0}C
4c	(Z)-4-methyl-3-(3-nitrobenzylidene)-1,3-dihydro-2H-pyrrol-2-one	87 %	195^{0}C
4d	(Z)-3-(4-hydroxybenzylidene)-4-methyl-1,3-dihydro-2H-pyrrol-2-one	92 %	197 ^{0}C

Table 2. Optimization of catalyst concentration of (4b) under M.W. Irradiation

Entry	Catalyst mol %	Time, min	Yields %
1	No catalyst	9	-
2	1	8	76
3	2	7	89
4	**3**	**3**	**95**
5	4	5	85
6	5	8	70

Initially, the mixture of Ethyl acetoacetate, Hydrazine hydrate and substituted aryl aldehydes, (0.01 mol each) was taken in an 50 mL vessel and subjected to microwave irradiation under neat conditions in the absence of catalyst and solvent, and the reaction was failed to get the product under this condition. The reaction was repeated in the presence of catalyst in the range 1-5 mol %. We have optimized the amount of catalyst for the synthesis of (**4b**, Table 1) under microwave irradiation and excellent yield was obtained in only 3 minutes when 3 mol % catalysts are introduced (**Table 2,** entry 4).

A number of approaches have been put forth and modified for the measuring of antibacterial activity. The cup diffusion method[12-14] was used in the current investigation to screen freshly synthesized compounds for antibacterial activity. There are both gram positive and gram negative bacteria among the species, such as S. aureus and E. coli. Agar medium, subcultures, and nutrient broth were prepared in accordance with normal protocol. Sensitivity plates were seeded with 1× 106 CIU ml-1 bacterial in oculims, and each well (diameter of 8 mm)

was filled with 0.1 ml of 1000µgml-1 test compound solution in chloroform, resulting in a concentration of 100µgml-1 for each test compound. Using an antibiotic zone scale, the zone of inhibition was measured following a 24-hour incubation period at 370C. The compounds' inhibition zone records made it abundantly evident that compounds (15) and (18) were quite effective against S. aureus and E. coli. Table 3 summarizes the test compound's antimicrobial activity and its ability to suppress the growth of different bacterial species.

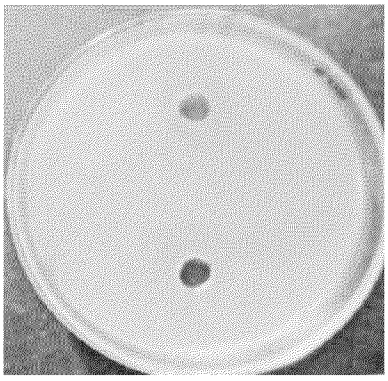
Table 3: Antimicrobial Activity

Compounds	**Inhibition zone recorded in mm**	
Microorganisms	**S. aureus**	**E.Coli**
4a	11mm	14mm
4b	16mm	13mm
4c	13mm	15mm
4d	12mm	17mm

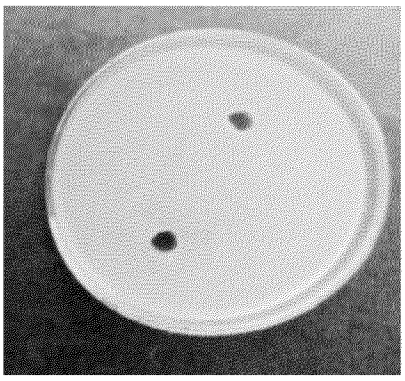
Composition of Nutrient Agar medium:

Peptone : 5.0gm
Yeast extract : 1.5gm
Beef extract : 1.5gm
Sodium chloride : 5.0gm
Agar-agar : 15.0gm
Distilled water : 1000ml
pH : 6.9-7.1

Fig 1: Antimicrobial activity against some selected microorganism.



S.aureus



E.Coli

The quality of media that was employed was bacteriostatic. 28 grams of materials were dissolved in one liter of distilled water to create the nutrient agar medium. It was then autoclaved at 121°C for 20 minutes, 15 pounds at a time. After cooling to roughly 50°C, the medium was added to sterile petriplates and allowed to harden. To obtain grass culture, the test bacterial

organisms were then planted onto the media plates with 24-hour-old, fresh, active nutrient broth cultures. Using standard quality cork boarers, agar medium was scooped out of a petridish to create the typical 8.0mm diameter cups. Operations are performed in an ultra-clean laminar flow system under aseptic conditions. The test chemicals were dissolved in chloroform while maintaining the solution's initial 1000µg/ml concentration. As a control, chloroform solvent was utilized. These plates were placed in an incubator and incubated for 24 hours at 37ºC. Following incubation, test drug inhibitory effect was monitored on the plates by looking for a clean zone surrounding the cups. By comparing the plate to the antibiotic zone scale, the diameter of the zone of inhibition was determined.

Spectroscopic characterization.

4c) (Z)-4-methyl-3-(3-nitrobenzylidene)-1,3-dihydro-2H-pyrrol-2-one

Solid: - Melting point = 195ºC

IR (KBr, Cm^{-1}) : 1354, 1260, 1500, 1607, 670.

^{1}HNMR (400 MHz, DMSO-d6): δ 7.2(1H,s), 1.18 (1 H, s), 6.93 (1 H, s), 8.10-8.12 (4H, m).

4d) (Z)-3-(4-hydroxybenzylidene)-4-methyl-1,3-dihydro-2H-pyrrol-2-one

Solid: - Melting point = 197ºC

IR (KBr, Cm^{-1}) : 1354, 1260, 1500, 1607, 670.

^{1}HNMR (400 MHz, DMSO-d6): δ 7.45(1H, s), 6.89 (1 H, s), 9.81 (1 H, s), 5.0(1H,s), 6.93 (4H, m).

Conclusion

We have been able to offer an effective method for the synthesis of pyrazolone derivatives in the presence of MSA in our current study. All of the recently synthesized compounds' structures were determined via mass spectral analysis, NMR, IR, and chemical transformations.

Condensation-enhanced pyrazolone synthesis and its derivatives provide high yields of pyrazolone in good quality and purity at a low cost. It is discovered that compound 4d has greater potency against E. Coli while compound 4b has greater potency against S. Aureus. This approach has the noteworthy advantages of being catalyst-free and having an easy workup procedure. The synthesis process used to create these molecules is very easy to use, clean, economical, green, and environmentally friendly.

References

1. S. Mert, R. Kashmogullari, Postdoc, 2, 450, 2014.
2. G.Mariappan, B.Saha, Journal of pharmacy research, 3, 2856, 2010.
3. P. Gupta, K.Halve, International journal of pharmaceutical sciences and research, 4, 2291, 2015.
4. Z. Zhao, X. Dai, Eurj.Med.Chem, 186, 1118, 93, 2020.
5. K. Karrouchi, S. Radii, Y. Ramli, Molecule, 23, 45, 2018.
6. M.Radii, V. Bernardo, B. Bechi, D. Castagnoio, Tetrahedron letters, 50, 6572, 2009.
7. P. Mitra, A.Mitra, Indian Chem. Soc., 58, 695, 1981.
8. B.Singh, Indian Chem. Soc., 68, 165, 1991.
9. M. Ruoqun, J. Zhu, J. Liu, L.Chem, X. Shen, H. Jiang, Molecule, 15, 3593, 2010.
10. R. Prajuli, J.Banerjee, H. Khanal, Oriental journal of chem., 31, 540, 2015.
11. M. Nashwa El- Metwaly, G. Marwa, A. Thoraya, M. Abelaua, Biogenetic chemistry and applications, 3, 654, 2018.
12. British Pharmacopici Vol. 2, Her Mejestis Stationary Office, London, 12, (1980) British Pharmacopeia's Pharmaceutical press London, (1953)796.
13. Bary A.I., The antimicrobial susceptibility test, Principle and Practices Illusiea and Febiger, Philadelphia, PA, USA, 180.
14. Cavangh F., Analytical Microbiology Academic Press New York, (1963) 126.

9. The Poincare Half-Plane Model and Geo Gebra: Powerful Tools for Understanding Hyperbolic Triangles

Rajesh Balkrishna Raut
R. D. & S. H. National College and S. W. A. Science College, Linking Road, Bandra.

Abstract

The aim of this paper is to illustrate the construction of geodesics and triangles in the hyperbolic half-plane using GeoGebra software. It further demonstrates the bisection of a geodesic segment and the concurrency of medians for a hyperbolic triangle. Also constructing the incircle for hyperbolic triangle and angle bisectors is explained.

Key Words: Poincaré half-plane model, geodesic, midpoint, incircle

Mathematics Subject Classification: 2000. 51M10

1. Introduction

In the Euclidean plane $\mathbb{R}^2$, the three medians of any triangle are concurrent. Similarly, the three angle bisectors of any triangle are also concurrent. The construction of triangles, the midpoint of its side, and the angle bisector for an angle at its vertex can be accomplished by following certain steps. GeoGebra software, which is freely available to all, facilitates the explanation of these constructions in an easy and effective manner. One can practice the above constructions and further verify the concurrency of medians and angle bisectors by selecting appropriate points for constructing a triangle in the GeoGebra graphic view. GeoGebra software is an excellent tool for teachers to demonstrate these topics and assign enjoyable exercises. It also allows users to create new tools. This paper explains some of the above constructions in the Poincaré half-plane model using GeoGebra.

2. Preliminaries

The hyperbolic plane is set $\mathbb{H}^2 := \{x + iy : x, y \in R \text{ and } y > 0\}$ with distance function $\cosh\big(d(x_1 + i\,y_1, x_2 + iy_2)\big) = 1 + \frac{(x_1-x_2)^2+(y_1-y_2)^2}{2y_1y_2}$. In the Poincaré half-plane model, $z = x + iy \in \mathbb{H}^2$ is identified by the point $(x, y) \in \mathbb{R}^2$. Then a geodesic in $\mathbb{H}^2$ is represented by

either semicircle with centre on x-axis or part of a line parallel to the y-axis, both contained in the upper half-plane $\{(x,y) \in \mathbb{R}^2 : y > 0\}$.

3. Some notations

For $z_1 = x_1 + i\,y_1,\ z_2 = x_2 + iy_2$ the geodesic segment is denoted by $[z_1, z_2]$. The mid-point of $[z_1, z_2]$ is the point $m_{12} \in [z_1, z_2]$ equidistant from z_1 and z_2 with respect to the hyperbolic distance. Further for $z_1, z_2, z_3 \in \mathbb{H}^2$ and not on same geodesic, denote by $[z_1, z_2, z_3]$ the triangle formed by geodesic segments $[z_1, z_2], [z_2, z_3]$ and $[z_3, z_1]$. The angle of this triangle at vertex z_1 is defined as the Euclidean angle between the tangents to circular arcs corresponding to geodesic segments, $[z_1, z_2]$ and $[z_3, z_1]$ at vertex z_1. Further the angle bisector at vertex z_1 is the geodesic segment passing vertex z_1 by making equal angle with geodesic segments, $[z_1, z_2]$ and $[z_3, z_1]$ at vertex z_1.

The procedure in the GeoGebra software to create new tools for constructing geodesic segment and its midpoint are illustrated below. Then using these two new tools, construction of medians, incircle and angle bisectors for hyperbolic triangle are illustrated.

4. Construction of Geodesic segments and triangles in $\mathbb{H}^2$

If $x_1 = x_2$ then the geodesic segment $[z_1, z_2]$ is identified by the vertical line segment joining points $(x_1, y_1), (x_2, y_2)$ and when $x_1 \neq x_2$ it is identified by the circular arc. GeoGebra is interactive software. One way to construct this circular arc with centre $c_{12} = (x_{12}, 0)$ is: select points $(x_1, y_1), (x_2, y_2), (x_{12}, 0)$ using point tool, then use command CircularArc to obtained arc and finally move point c_{12} on the x-axis to obtain required circular arc.

Another way of constructing geodesic segment works in both cases. Following theorem is useful in calculations.

Theorem The circle S in $\mathbb{R}^2$ passing through three points $(x_1, y_1), (x_2, y_2)$ and (x_3, y_3) has equation $\text{determinant}\begin{bmatrix} x^2+y^2 & x & y & 1 \\ x_1^2+y_1^2 & x_1 & y_1 & 1 \\ x_2^2+y_2^2 & x_2 & y_2 & 1 \\ x_3^2+y_3^2 & x_3 & y_3 & 1 \end{bmatrix} = 0.$

Further if (x_{12}, y_{12}) is the centre an r is the radius of circle S, then we have relation

$$\begin{bmatrix} 2x_1 & 2y_1 & 1 \\ 2x_2 & 2y_2 & 1 \\ 2x_3 & 2y_3 & 1 \end{bmatrix} \begin{bmatrix} x_{12} \\ y_{12} \\ c \end{bmatrix} = \begin{bmatrix} -(x_1^2+y_1^2) \\ -(x_2^2+y_2^2) \\ -(x_3^2+y_3^2) \end{bmatrix} \text{ where } r = \sqrt{x_{12}^2 + y_{12}^2 - c^2}.$$

Applying above theorem we get a point $w = \left(0.5(x_1 + x_2), 0.5\sqrt{2(y_1^2 + y_2^2) + (x_1 - x_2)^2}\right)$ on $[z_1, z_2]$. Now GeoGebra Command a: CircumcircularArc(z_1, w, z_2) give required arc where order of points z_1, w, z_2 in command CircumcircularArc is important. One can create new tool 'Geodesic' in GeoGebra by taking output object as a, input objects as z_1 and z_2. Now constructing triangle $[z_1, z_2, z_3]$ (see Figure 1) is easy by using this new tool 'Geodesic'.

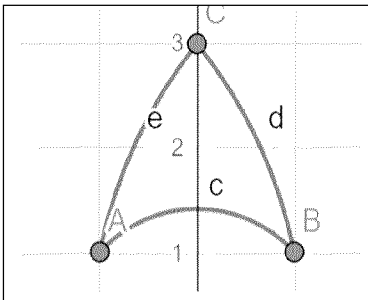


Figure 1 hyperbolic triangle

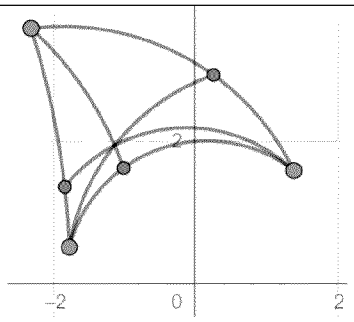


Figure 2 Medians of triangle

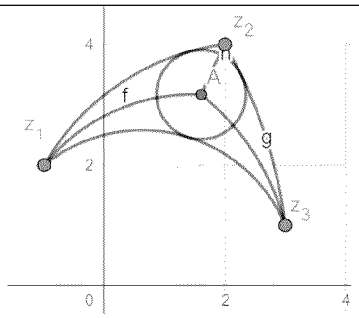


Figure 3 Incircle for triangle

5. Bisecting geodesic segment in $\mathbb{H}^2$

The midpoint of geodesic segment $[z_1, z_2]$ is identified by the point (see 4.4 Lemma in [4]) $m = \left(\frac{x_1y_2 + y_1x_2}{y_1 + y_2}, \sqrt{y_1y_2}\frac{\sqrt{(y_1+y_2)^2 + (x_1 - x_2)^2}}{y_1 + y_2}\right) \in \mathbb{R}^2$. Create new tool 'Hmidpoint' to get point m in GeoGebra. Now using tools 'Hmidpoint' and 'Geodesic' it is easy to get midpoints for sides of triangle $[z_1, z_2, z_3]$ and joining these points to opposite vertices concurrency of medians is verified (see Figure 2).

6. Construction of the incircle and angle bisectors for triangle in $\mathbb{H}^2$

The incircle of a triangle is largest circle contained in it. Every hyperbolic triangle has the incircle, whose centre lies on all three angle bisectors of the triangle. One way to construct the incircle of a hyperbolic triangle is to place one point on each side of the triangle, draw a circle through these three points, and move the points on the sides to adjust the circle's radius and centre, thereby creating the incircle. The other way is by writing equations and solving. The incircle C for triangle $[z_1 = -1 + 2i, z_2 = 2 + 4i, z_3 = 3 + 1i]$ is constructed using steps:

1. 1. Circle C and the geodesic g_1 containing $[z_1, z_2]$ are orthogonal, and C lies inside of g_1. Suppose $p = t + is$ is the centre and r is the radius of C. In this case $x_{12} = (2.5,0)$ is the centre and $r_{12} = 0.5\sqrt{65}$ is the radius for g_1. The Euclidean distance between p, x_{12} give equation $(t-2.5)^2 + s^2 = \left(0.5\sqrt{65} - r\right)^2$. Similarly we get equation from C and the geodesic g_2 containing $[z_2, z_3]$ $(t+5)^2 + s^2 = \left(\sqrt{65} - r\right)^2$.
2. The circle C and geodesic g_3 containing $[z_3, z_1]$ are orthogonal, and C lies outside of g_1. Suppose $p = t + is$ the centre and r is the radius of C. Also $x_{31} = (0.625,0)$ is the centre and $r_{31} = 0.625\sqrt{17}$ is the radius for g_1. The Euclidean distance between p, x_{12} give equation $(t-0.625)^2 + s^2 = \left(0.625\sqrt{17} + r\right)^2$.
3. 3. Solve the three equations obtained in steps 1 and 2 for unknowns t, s, r to get values: $(t, s) = (1.6030192534648684,\ 3.1680011113600326),\ r = 0.7385910230026669$

Now drawing geodesic segments from each vertex of tringle to centre p of incircle C, angle bisectors can be obtained.

Acknowledgement

I thank my Guide Professor A. R. Aithal. Under his guidance I worked on the isoperimetric problem in $\mathbb{H}^2$ for my M.Phil. dissertation.

References

1. Chorwadwala Anisa M. H., "The isoperimetric Problem", Dissertation submitted to the University of Mumbai for the degree of Master of Philosophy in Mathematics in 2003.
2. I. Todhunter, Spherical Trigonometry, Macmillan and Co. Ltd., London (1949).
3. Rajesh Balkrishna Raut, Isoperimetric Problem in $\mathbb{H}2$, Dissertation submitted to the University of Mumbai for the degree of Master of Philosophy in Mathematics in 2005.
4. Riku Klen and Matti Vuorinen Apollonian circles and hyperbolic geometry, Article in The Journal of Analysis · October 2010
5. S. Kesavan, From the Triangle Inequality to the Isoperimetric Inequality, RESONANCE (February 2014).

10. Biodiversity Informatics Provides Sound Iformation for Better Management - By Using Computing Tools

Ranjan B. Kalbande
Department of Botany, Shri. Dr. R. G. Rathod Arts & Science College,
Murtizapur, Dist. Akola, (M.S.) India.

Abstract

Biodiversity provides the assurance of food, countless raw materials such as fiber for clothing, materials for shelter, fertilizer, fuel, medicines and other necessities. The technology of bioinformatics is both versatile and is able to be applied wherever research is being done on genetics, proteins and cells for herbicide-resistant products for crops in agriculture. Biodiversity Informatics is to provide a sound information management infrastructure for biodiversity and Global Change research. In this present research work biodiversity was studied by using computing tools. Biodiversity-Informatics provides sound information for better management by using computing tools

Keywords: Information, Management, Morphology, Biodiversity, Species, Identification etc.

Introduction

The wellbeing and prosperity of earth's ecological balance as well as human society directly depend on the extent and status of biological diversity. In Agriculture, biodiversity provides us with a varied food supply which is needed for balanced human nutrition. A species may be defined as a group of organisms which are able to interbreed freely under natural conditions to produce viable offsprings. Species diversity refers to variety of living species within a geographic area (Glowka, 1994). Genetic diversity refers to the differences in genetic make-up between distinct species as well as the genetic variations within a single species. It encompasses the broad differences between ecosystem types, and the diversity of habitats and ecosystem processes within each ecosystem type. Ecosystem diversity deals with species distribution and community patterns, the role and function of key species, and combines species functions and interactions. Biodiversity informatics is an emerging discipline applying information science, ecology and biodiversity to the understanding and solutions of environmental problems by using computing tools.

Review of Literature

Wattenberg and Breckle (1995) studied tree species diversity of a premontane rain forest in the Cordillera De Tilaran, Costa Rica. The study plot consisted of 25 squares of 20×20 m, located at an altitude of about 1000 m. Dominance and abundance of tree species was critically discussed. Valencia et al., (2004) mapped and studied tree species distributions and local habitat variation in the Amazon. The largest number of species was mid –sized canopy trees with maximum height 10-20m and understrorey treelets with maximum height of 5-10m. Hedge et al., (1998) studied variation in bark thickness in a tropical forest community of Western Ghats in India. They examined the relation between bark thickness and girth in a large sample of trees from evergreen and semi-evergreen rain forest.

Materials and Methods

During study period to acquaint with the forest area, often visits were arranged of the place by taking help of forest guards, foresters, ranger, and collected firsthand information of natural habitat Different sizes of the trees i.e. small, middle and large were also recorded. Photographs of complete tree, flowering twig, bark, fruit and herbarium sheets were taken and samples were preserved. Bioinformatics is more of tools than a discipline. Information technology makes usage of software, hardware and internet based communication systems for the analysis of Biological Data.

Observations and Results

Tree Code	LOCAL NAME	FAMILY	GENERA	BOTANICAL NAME
1	Charoli	Anacardiaceae Lindl.	BUCHANANIA Spreng.	Buchanania Ianzan Spreng. J.
2	Moyen	Anacardiaceae Lindl.	LANNEA A. Rich.	Lannea coromandelica (Houtt.) Merr.
3	Amba	Anacardiaceae Lindl.	MANGIFERA L.	Mangifera indica L. Sp. Pl.
4	Biba	Anacardiaceae Lindl.	SEMECARPUS L.f.	Semecarpus anacardium L. f.
5	Sitaphal	Annonaceae Juss.	ANNONA L.	Annona sqamosa L. Sp. Pl.
6	Dudhi	Apocynaceae Juss.	WRIGHTIA R. Br.	Wrightia tinctoria R. Br. Var rothii (G. Don) Hook.
7	Katesawar	Bombacaceae Kunth	BOMBAX L.	Bombax ceiba L. Sp. Pl.
8	Salai	Burseraceae Kunth	BOSWELLIA Roxb.	Boswellia serrata Roxb. ex. Coleb.
9	Bhosa	Caesalpiniaceae R. Br.	BAUHINIA L.	Bauhinia racemosa Lamk.
10	Kachnar	Caesalpiniaceae R. Br.	BAUHINIA L.	Bauhinia variegata L. Sp. Pl.
11	Amaltas	Caesalpiniaceae R. Br.	CASSIA L.	Cassia fistula L. Sp. Pl.
12	Chinch	Caesalpiniaceae R. Br.	TAMARINDUS L.	Tamarindus indica L. Sp. PI.
13	Dhawada	Combretaceae R. Br.	ANOGEISSUS (DC.) Guill. & Perr.	Anogeissus latifolia (Roxb. ex DC.) Wall.

14	Ain	Combretaceae R. Br.	TERMINALIA L.	Terminalia alata Heyne ex Roth,
15	Arjun	Combretaceae R. Br.	TERMINALIA L.	Terminalia arjuna (Roxb.) Wt. & Arn. Prodr.
16	Behada	Combretaceae R. Br.	TERMINALIA L.	Terminalia bellirica (Gaertn.) Roxb. PI Cor.
17	Tendu	Ebenaceae Gurke	DIOSPYROS L.	Diospyros melanoxylon Roxb. PI. Cor.
18	Aola	Euphorbiaceae Juss.	PHYLLANTHUS L.	Phyllanthus emblica L.s Sp. Pl.
19	Palas	Fabaceae Lindl.	BUTEA Roxb.ex Willd.	Butea monosperma (Lamk.)Taub.
20	Tiwas	Fabaceae Lindl.	DESMODIUM Desv.	Desmodium oojeinensis (Roxb.) Ohashi in Ginkgoana
21	Karanj	Fabaceae Lindl.	PONGAMIA Vent.	Pongamia pinnata (L.) Pierre.
22	Kumbhi	Lecythidaceae - Poit	CAREYA Roxb.	Careya arborea Roxb. PI. Cor.
23	Lendia	Lythraceae J. St. Hil.	LAGERSTROEMIA L.	Lagerstroemia parviflora Roxb. PI. Cor.
24	Rohan	Meliaceae Juss.	SOYMIDA A. Juss.	Soymida febrifuga (Roxb.) A. Juss.
25	Umber	Moraceae Link.	FICUS L.	Ficus racemosa L. Sp. PI.

Table !.

Collection of all the required information available with respect to morphodiversity was done related to the species, specimen samples collections, photographs, plant descriptions, illustrations, height and girth recorded and bark morphology was studied. This study provided a base line information to understand the diversity of the species in the tropical dry deciduous forest

Within widely distributed dry deciduous leafless trees during summer there were a few evergreen trees, the most prominent being Terminalia sp., Madhuca sp., Buchanania sp., Diospyros sp., Lagerstroemia sp., Butea sp. and Ixora sp**.** Out of 456 plant population the highest representation was of Tectona grandis (273); though smaller in number Bridelia airy-shawii P.T.Li, Phyt. Sin. (41) and Wrightia tinctoria R. Br. Var rothii (G. Don) Hook. (40) represented second and third respectively.

Digital bark library of the 40 trees species exhibited diverse surface patterns e.g. smooth, scaly, furrowed, warty and shaggy types.

The computer assisted monitoring of vegetation was done by using World Wide Web to illustrate the out line idea of a new vegetation monitoring methodology through aerial digital satellite maps by using software's to visualize captured data and to zoom it many more times by which wealth of the area was known accurately thereby one could describe relationship in between real world and its computer representation. Mapping of the forest digitally assisted in understanding the complexity of the forest which could not possible even by using any other technical device.

Conclusions

The main intension of using this digital image processing system was to provide current status of forest with its potentially important data for monitoring, planning, conservation and management of the forest.

References

- Blum SD. 2000. An overview of Biodiversity Informatics. From http://research.calacademy.org/research/informatics/sblum/pub/biodivinformatics .html 1-14.
- Brij B. 2008. Bioinformatics: Definition of this New Type of intelligent Technology. From http://www.brightthub.com /science/medical/articles/2282. aspx.
- Hedge V, Chandran MDS, Gadgil M. 1998. Variation in Bark Thickness in a Tropical Forest Community of Western Ghats in India. Functional Ecology 12: 313-318.
- Jain SK. 1998. Some Aspect of Biodiversity and Indian Traditions. Indian Journal of History of Science 33(1):51-62.
- Muthuchelian K, Kannaiyan S, Gopalam A. 2008. Forest Biodiversity. From http://www.vedamsbook.com/no57281.htm 1:1-3.
- Pamayanan: News and Views from Pinoy Environmentalists and Advocates Genetic, Species and Ecosystems Diversity From http://www.bwf.org/bk/ pamayanan/r-genetic.html
- Valencia R, Foster RB, Villa G, Condit R, Svenning JC, Hernandez C, Romoleroux K, Losos E, Magards E, Balslev H. 2004. Tree Species Distributions and Local Habitat Variation in the Amazon: Large Forest Plot in Eastern Ecuador. Journal of Ecology 92: 214-229.
- Wattenberg I, Breckle SW. 1995. Tree Species Diversity of a Premontane Rain Forest in the Cordillera De Tilaran, Costa Rica. Ecotropica 1: 21-30.
- Wilson EO. 2000. A Global Biodiversity Map. Science 29 September 2000. 289, 5488, 2279. ewilson@oeb.harvard.edu.
- Yunus M, Yunus D, Eqbal M. 1990. Systematic Bark Morphology of Some Tropical Trees. Wiley InterScience Botanical Journal of the Linnnean Society 1-2.

11. Comprehensive Study on Catla Fish (Catla Catla): Biology, Ecology, and Socioeconomic Significance

Reena P. Dhote
Ghulam Nabi Azad College of Science Arts and Commerce, Barshitakli, Akola.

Abstract

This paper presents an in-depth analysis of Catla fish (Catla catla), encompassing its taxonomy, morphology, habitat, distribution, biology, ecology, aquaculture practices, economic importance, conservation status, and cultural significance. Drawing from a wide range of scholarly sources and empirical data, this research provides valuable insights into the multifaceted aspects of Catla fish, offering implications for its management, conservation, and sustainable utilization. "Age, Growth and Harvestable size of Catla catla (Ham.) from Lake Pichhola, Udaipur, Rajasthan" is the topic of the current study. The results of this study show that all 20 fish species, belonging to seven families, have been identified in the fish fauna of Lake Pichhola. Of which, Indian Major Carp accounted for 85% of the total landings from the lake, dominating the catch. Furthermore, the percentages of Indian Major carps, Minor carps, and Catfishes were reported to be 8.5%, 6.5%, and 6.3%, respectively.

Introduction

Catla fish (Catla catla), commonly known as Indian carp, is a freshwater species indigenous to the Indian subcontinent. It holds significant socioeconomic importance as a vital source of food and livelihood for millions of people across South Asia. Despite its ecological and cultural significance, comprehensive studies addressing various aspects of Catla fish are limited. This paper aims to fill this gap by providing a comprehensive examination of the biology, ecology, and socioeconomic significance of Catla fish. Researchers and fish fans alike have taken an interest in the Catla catla fish, also referred to as the Indian Carp or Catla [1]. Originating in South Asia, this freshwater fish exhibits a remarkable variety of forms and dimensions, rendering it an intriguing object of study. We will examine the many forms and traits of Catla catla in this piece, illuminating its fascinating diversity and formal importance [2]. Within the family Cyprinidae, which is related to carps, the Catla catla species is distinguished from other fish by its unique appearance. These herbivorous animals are distinguished by their big, flipped mouths, which aid in filter feeding and allow them to efficiently eat plankton and algae [3]. Their sleek, streamlined bodies, marked by a silver hue, reflect their ability to swiftly

navigate through freshwater ecosystems. One of the most intriguing aspects of Catla catla is its diverse range of shapes. The species exhibits variations in body proportions, head size, and fin structure [4]. While some individuals may have elongated bodies with a more pronounced head, others possess a deeper body and a comparatively smaller head. These shape variations not only contribute to the fish's aesthetic appeal but also serve functional purposes, such as adaptation to different aquatic habitats. Catla catla showcases considerable variations in size, allowing for distinct size classifications [5]. On average, these fish can grow up to 1 meter in length and weigh around 40 kilograms. However, larger individuals have been recorded, reaching lengths of up to 2 meters and weighing more than 50 kilograms. Conversely, smaller Catla catla specimens, usually found in ponds and small rivers, measure around 30 centimeters in length [6]. The varying sizes of Catla catla cater to the diverse needs of their habitats and contribute to the overall ecological balance of freshwater ecosystems.

Taxonomy and Morphology

Catla fish belongs to the family Cyprinidae and is classified under the genus Catla. Morphologically, it is characterized by a deep body, a slightly arched head, and a terminal mouth with prominent lips. The body coloration varies from silver to greyish-green, with a conspicuous black spot at the base of the tail fin.

Habitat and Distribution

Catla fish predominantly inhabit freshwater ecosystems, including rivers, lakes, reservoirs, and ponds. They prefer habitats with abundant vegetation and moderate water flow.

Indigenous to the Indian subcontinent, Catla fish are distributed across the river systems of India, Bangladesh, Nepal, and Pakistan. Based on material provided by Dr. E. Woynarovich (Hungary) and Dr. V.R.P. Sinha (FAO Senior Aquaculturist, NACA, Bangkok, Thailand) the Indian carp do not breed naturally in ponds or other confined waters. They are all river spawners, having semifloating, nonadhesive eggs. The eggs have a large perivitelline space, and during swelling they increase their size by about 10 times Swollen, water- hardened eggs are rather delicate, and do not tolerate physical shocks well. This sensitivity to mechanical damage is a very important consideration when Indian carp eggs are to be incubated artificially.

Biology and Life Cycle of Catla (Catla catla)

Catla (Catla catla) is a significant freshwater fish species indigenous to the Indian subcontinent, renowned for its ecological role and socioeconomic importance. This research paper presents a detailed examination of the biology and life cycle of Catla fish, encompassing its morphological characteristics, reproductive biology, growth patterns, and ontogenetic development. Catla fish exhibit distinctive morphological features, including a deep, laterally

compressed body, a slightly arched head, and a terminal mouth with prominent lips. The body coloration ranges from silver to greyish-green, with a conspicuous black spot at the base of the caudal fin. These morphological adaptations are associated with their feeding ecology, habitat preferences, and swimming behavior.

Ecology and Behavior

Catla fish are omnivorous, feeding on a diverse diet comprising plankton, aquatic vegetation, insects, and detritus. They are highly adaptable and exhibit migratory behavior in response to seasonal fluctuations in water levels and temperature. Catla fish play a crucial role in nutrient cycling and trophic dynamics within freshwater ecosystems, serving as both predator and prey to a wide range of species.

Aquaculture Practices

Catla fish farming has gained prominence as a lucrative venture in aquaculture, particularly in South Asia. Aquaculture techniques involve pond culture, cage culture, and integrated farming systems. Key considerations in Catla fish farming include stocking density, nutrition management, water quality maintenance, and disease control. Sustainable aquaculture practices are essential to mitigate environmental impacts and ensure the long-term viability of Catla fish farming.

Economic Significance

Catla fish constitute a significant proportion of freshwater fish production in South Asia, contributing to food security, employment generation, and rural livelihoods. They are highly prized for their high nutritional value, delicious taste, and culinary versatility. The commercial value of Catla fish extends beyond domestic markets, with growing demand in international seafood trade.

Conservation Status Despite their socioeconomic importance, Catla fish face various threats, including habitat degradation, overexploitation, pollution, and invasive species. Conservation efforts are crucial to safeguard Catla fish populations and their habitats. Initiatives focusing on habitat restoration, sustainable fisheries management, and community-based conservation are imperative to ensure the long-term sustainability of Catla fish populations. A multifaceted strategy is required for effective conservation efforts for Catla fish, including policy interventions, community-based conservation programs, pollution control measures, habitat restoration, and sustainable fisheries management. Mitigating anthropogenic impacts and maintaining Catla fish populations require integrated watershed management, protected area creation, enforcement of fishing laws, and promotion of sustainable aquaculture methods.

Discussion

Production Culture based fisheries was a common practice to enhance fish yields, particularly in small water bodies and was widely practiced in Asia and in other developing countries for fish food production (Welcomme and Bartley, 1998; De Silva, 2001) under first level management. It involved regular stocking of suitable species and recaptured at a marketable size. This type of culture was practiced in water bodies such as reservoirs (Phan and De Silva, 2000) and lake (Middendorp et al., 1999) and was considered to have the potential to contribute significantly and increasingly to fish production and food security in developing countries (Lorenzen et al., 1998; Welcomme and Bartley, 1998; Quiros and Mari, 1999). In order to compare the growth and production of stunted and normal (non-stunted) fingerlings of selected major carps, the present study was conducted under second level management. This management enhances the endogenous food production and reduces the utilization of artificial feeds. Only about 15-30% of the nutrients present in supplementary feeds are trapped into harvestable products and the remainings are lost in the surrounding environments (Gross et al., 2000). Therefore, cheaper and efficient means of management practice are essential to increase the fish production through second level management.

Conclusion

In conclusion, Catla fish represent a valuable component of freshwater biodiversity in South Asia, contributing to ecosystem stability, food security, and livelihoods of local communities. However, their conservation status is increasingly threatened by human-induced pressures and environmental degradation. Urgent action is required to address these challenges and implement effective conservation measures to ensure the long-term survival of Catla fish populations and the ecological integrity of their habitats. the biology and life cycle of Catla fish are characterized by a series of interconnected stages, each playing a vital role in the fish's ecological and socioeconomic significance. By elucidating key aspects of Catla fish biology, this research paper contributes to our understanding of their reproductive biology, growth patterns, and ontogenetic development. Future research should focus on addressing knowledge gaps and advancing sustainable management practices for Catla fish populations.

Reference

1. Harikrishnan R, Balasundaram C, Heo MS. Fish health aspects in grouper aquaculture. Aquaculture. 2011; 320(1):1-21. [Crossref] [Google Scholar]
2. Dadar M, Dhama K, Vakharia VN, Hoseinifar SH, Karthik K, Tiwari R, et al. Advances in aquaculture vaccines against fish pathogens: Global status and current trends. Rev Fish Sci Aquac. 2017; 25(3):184-217. [Crossref] [Google Scholar]

3. Gudding R, Van Muiswinkel WB. A history of fish vaccination: Science-based disease prevention in aquaculture. Fish Shellfish Immunol. 2013; 35(6):1683-8. [Crossref] [Google Scholar]
4. Pridgeon JW, Klesius PH. Major bacterial diseases in aquaculture and their vaccine development. Anim Sci Rev. 2012; 7:1-6. [Google Scholar]
5. Aly SM, Albutti A. Antimicrobials use in aquaculture and their public health impact. J Aquac Res Dev. 2014; 5(4):1. [Google Scholar]
6. Balment RJ, Lu W, Weybourne E, Warne JM. Arginine vasotocin a key hormone in fish physiology and behavior: A review with insights from mammalian models. Gen Compar Endocr. 2006; 147(1):9-16. [Cross Ref] [Google Scholar]
7. A study on Age, Growth and Harvestable Size of Catla catla (Ham.) Fish Determination of Fish Age and Growth Measurement (Bhatt A Nakul and Bhanu Kumar Sharma)
8. Ayyappan, S. and J.K. Jena (2003). Grow-out production of carps in India. J. Appl. Aquacult. 13(3/4): 251-282. DOI:10.1300/J028v13n03_04
9. Banerjee, S.M. (1967). Water quality and soil condition of fish ponds in some states of India in relation to fish production. Indian J. Fish., 14: 115-144.
10. Begum, M., M.Y. Hossain, M. A. Wahab and H.M. Kohinoor (2003). Effects of isophosphorus fertilizers on water quality and biological productivity in fish pond. J.Aquacult. Trop., 18(1): 1-12.
11. Bombeo-Tuburan, I. (1988). The effect of stunting on growth, survival, and net production of milkfish (Chanos chanos Forsskaal). Aquaculture, 75(1-2): 97-103. https://doi.org/10.1016/0044-8486(88)90024-5
12. Chakrabarti, N.M. (1998). Biology, Culture and Production of Indian Major Carp: A Review. Narendra Publishing House, Delhi, India, 175 pp. ISBN 13: 9788185375519

12. Diversity of Butterfly from Kapshi Lake, Akola

Roshani P. Ingle
Department of Zoology, Ghulam Nabi Azad College of Arts,
Commerce and Science, Barshitalki, Dist. Akola.
Prof. Nilima Kankale
Guided By Department of Zoology, Ghulam Nabi Azad College of Arts,
Commerce and Science, Barshitalki, Dist. Akola.

Abstract

The present study was evaluating butterflies in the study area like Kapshi lake Region, Maharashtra, India. The results accumulated so far clearly indicate that the overall diversity of Butterflies is richer in the surrounding area of Kapshi Lake, Barshitakli. City lesser in the urbanized area of Barshitakli city. Our Study reflects previous findings that the transformations of forests and natural habitat to urbanization had serve impact not only on single animal population but also on communication as a whole. In particular, species richness and animal biomass are most significantly affected.

Keywords:- Diversity, Kapshi Lake, Butterfly

Introduction

Butterfly fossils date to the Paleocene, about 56 million years ago. Systematic studies on butterfly have been made in different part of world since the turn of 18th century. Heppner 1998 has documented 19238 butterfly species throw out the world. Butterflies makes up a large group of insects known as the order Lepidoptera in phylum Arthropod. There are about 200,000 known species of Lepidoptera of which about 10% are butterflies.

Among the insects' butterflies depends on many host and nectar plants in their lifetime for growth and development. Therefore, host or nectar plants availability and their regeneration status study are essential in understanding the Butterflies population in depth. They help to monitor climate change and environment degradation and are studied as living ecological components of wide importance. They play an important role in the food chain and act as valuable pollinations in the local environment

Butterflies are sensitive s biota, and are several y affected by environmental variations and changes in habital structure.

Classification is done considering butterfly species and families scientifically, but they can also be divided based on their habitual. Although standard classification is listed as

kingdom, phylum, class, order, family, genus and species, there is also in between categories. All butterflies are in the same order, but there is separate.

Families of butterflies, each with its own collection of genera containing one or more species. Some species are pests because in their larval stages they can damage domestic crops or trees; other species are agents of pollination of some plants. Larvae of a few butterflies (eg, harvester) eat harmful insect, and a few are predators of ants, while others live as mutualists in association with ants. Culturally, butterflies are a popular motif in the visual and literary arts. Heppner (1998) has documented 19, 238 butterfly species throughout the world. Over the past century, many researchers have significantly contributed to the field of butterfly ecology within the various ecosystem in India (Bingham, 1905, 1907; Wiliams, 1930; Evan, 1932; Talbot, 1938, Wynter- Blyth, 1947; Kunte, 2000, 2001).

Sharma (2009), Raut and Pendharkar (2010), Kunte et al., (2010), Tewari and Rawat (2013), Sharma and Sharma (2013), and Quraeshi et al., (2014) have reported on the butterfly fauna in a few protected areas of central, northern and north-eastern parts of India.

Classification

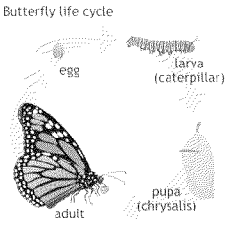
Kingdom	-	Animalia are also metazoa
Phylum	-	Arthropoda
Sub Phylum	-	Hexapoda
Class	-	Insecta
Family	-	Total 126 families
Species	-	12000 to 20000.

Butterflies are the most provoking and striking creatures, among the insect group, they are an often regarded as flagship species. The butterfly diversity is high in the tropics compared the world. Their habitat ranges from Arctic to the great desert of the world. The butterflies are divided into two super families viz. Papilionoidea constitutes 11,100 species and Hesperidia constitutes 3,650 species in the world. Others than their aesthetic value, butterflies have important roles in the functioning of forest ecosystem. Because of their diversity, wide distribution specificity to vegetation type, rapid response to perturbation, taxonomic tractability, statistically significant abundance, and ease of sampling, they have been considered useful organisms to monitor environmental changes.

Life Cycle

The life cycle of butterflies can be discussed in four stages, in detail all butterflies have complete metamorphosis. Winged adults lay eggs on the food plant on which their larvae, known as caterpillars, will feed. The caterpillar grows, sometimes very rapidly, and when fully

developed, pupate in a chrysalis. Every stage has different goals to achieve like caterpillar need to eat a lot and adults need to reproduce. The life cycle of butterfly may depend on the type of butterfly, it might take from a month to a whole year. When metamorphosis is complete, the pupil skin splits, the adult insect climbs our, and after its wings have expanded and dried, it flies off. Some butterflies, especially in the tropics, have several generations in a year, while others have a single generation and a few in cold location may take several years to pass through their entire life cycle.



1. Egg
2. Larva (caterpillar)
3. Pupa (chrysalis)
4. Adults (Imago).

Biodiversity is the total variety of life on the earth. The abundance and diversity of butterflies mainly depend upon various factors such as availability of host and Larval food plants, foliage, humid climate, and various other features etc. As butterflies are mainly dependent on these factors, interruption in any of the above will Directly affect their standing in ecosystem. India is one of the 17 "mega diverse" countries of the world. But deforestation and increased human approach in forest and other Ecosystems have resulted into loss of habitat for most of the local species' diversity (Gupta, 2018). Heppner (1998) reported 19238 species of butterflies in the world. Study by Abreau (1931) reported about 177 species of butterflies in Central Provinces. A total of 92species of butterflies were Reported in Gore Wada International Bio Park situated in central India (Patil and Shende, 2014)

Material and Methods

Study Area and Sampling Site

Kapshi (20 34'43"N) and longitude (7657'18") The Kapshi Lake of Akola is located in Barshitakli Tahshil of Akola District in Maharashtra INDIA; it is situated 20 km away from sub District headquarter Akola. As per 2009 status, Kapshi Lake is the gram panchayat of kapshi Lake village. These Butterflies are recorded from different selected habitats which includes riparian habitats, grassland, dry deciduous forest, mixed forest, mixed forest with tall trees and shrubs. Survey was also carried out for grounds butterflies, Butterflies decaying barks of trees, debris, and crevices of rocks.

Survey Method

The field surveys on butterflies were carried out in the study area three times a week for the period of four months from October 2022 to Feb 2023 Butterflies were accessed in the study area from 8am to 10 am in the morning by random observations during walking through the

three selected sites based on habitats present in the study area. In the field, photographs of the butterflies were taken with the aid of camera for the identification. The Photographs taken in the field were later identified and studied with the help of available keys, reference books, and publications.

Identification the Species of Butterflies

The photographs of butterflies were used for the identification of the species of butterfly and helping of guidance. Color pattern, sizes, and shapes as well as their designs were considered in identification of the species of butterfly with the help entomology expert and relevant available literature as well as photography.

Sampling Techniques

The butterflies were observed and recorded directly in the field and photographs were taken and preserved for further identification. In critical conditions, they were captured by hand net following Tiple (2012) and were identified using suitable keys (Evans1932; Wynter-Blyth 1957; Haribal 1992; Kunte 2000; Kehimkar2008) and released in the same habitat from where they were captured with least disturbance. Appropriate precautions were undertaken to guarantee that the scales present on the wings of the butterflies were minimally affected.

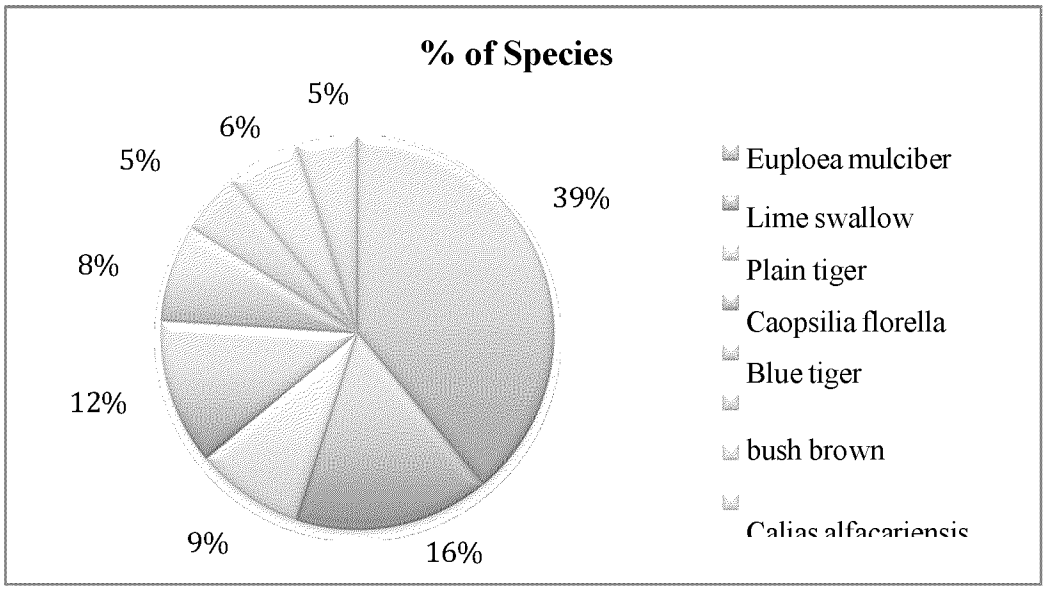
Results and Discussion

A total of 8 Butterflies Species were collected from the study area Among the collected species of butterflies Nymphalidae 4, Pieridae 2, Papilionidae 1, and Hesperidae 1.

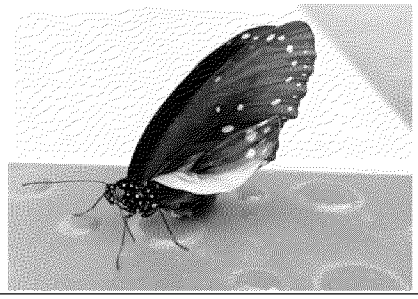
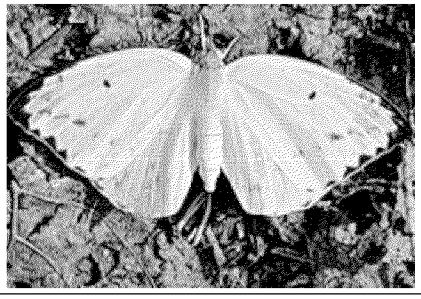
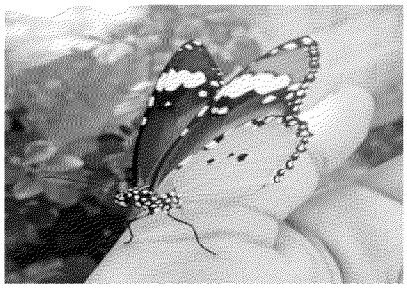
Plain tigers are commonly observed in various picnic spot on various small tress nearby Kapshi Lake, Tq. Barshitakli, Akola district some are observed on near road surrounding Katepurna Dam Region Because of suitable diverse ecosystem this family members found in very large number.

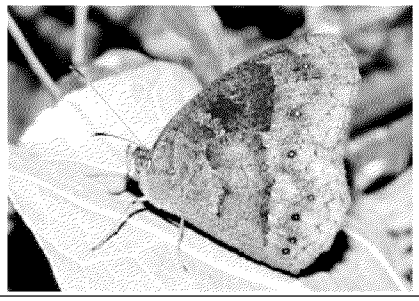
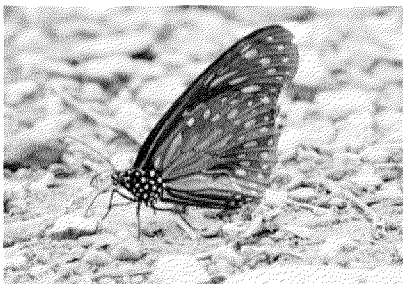
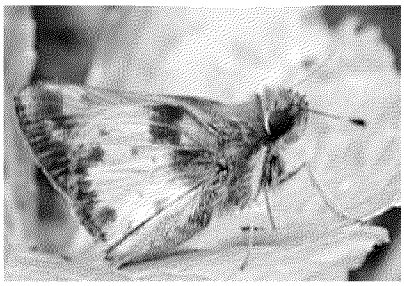
Table - Count of butterflies' species from different habits in Kapshi region.

Sr No	Species	Family	No of collection from natural habitat	% of species
1	Euploea Mulciber (Euploeacore)	Nymphalidae	8	12 %
2	Lime Swallowtail (Papiliodemoleus)	Papilionidae	10	16%
3	Plain Tiger(Danaus chrysippus)	Nymphalidae	25	39 %
4	Catopsilia florella (Catopsilia florella)	Pieridae	6	9%
5	tiger (Tirumal hamata)	Nymphalidae	5	8%
6	Bush brown (Mycalesis perseus)	Nymphalidae	4	6%
7	Calis alfaceriensis (Calis alfacarirnsis)	Pieridae	3	5%
8	Zabulon Blue skipper (Lon Zabulon)	Hesperidae	3	5%



Photoplate

	
Euploea Mulciber (Euploeacore)	Catopsilia florella (Catopsilia florella)
	
Plain Tiger (Danaus chrysippus)	Lime Swallowtail (Papilio demoleus)

	
Bush brown (Mycalesis perseus)	Calis alfaceriensis (Calis alfacarirnsis)
	
Blue tiger (Tirumal hamata)	Zabulon skipper (Lon zabulol)

Plain tigers are commonly observed in various picnic spot on various small tress nearby Dhagadevi Temple and some are observed on near roadside surrounding katepurna Region. Because of suitable diverse ecosystem this family members found in very large number.

Butterflies are food source for birds, spiders, lizards, mice, and other animals. Caterpillars are also eaten by bats, birds, and other animals. If butterfly population diminish, the impact will be felt higher up and can affect the entire ecosystem.

In above results we observed Euploeamulciber (Euploeacore) 8%, Lime swallowtail (Papiliodemoleus) 16%, Plain tiger (Danaus chrysippus) 39%,Catopsiliaflorella (Catopsilia florella) 9%, Blue tiger (Tirumalhamata) 8%, Bush brown (Mycalesis Perseus)6%, Caliasalfacariensis (Caliasalfacariensis) 5%, Zabulon slippers (Lon Zabulon) 5%.

Conclusion

The present study for the first aim at evaluating butterflies in the study area like Kapshi lake Region, Maharashtra, India. The results accumulated so far clearly indicate that the overall diversity of Butterflies is richer in the surrounding area of Murtizapur city lesser in the urbanized area of Murtizapur city. Our Study reflects previous findings that the transformations of forests and natural habitat to urbanization had serve impact not only on single animal population but also on communication as a whole. In particular species richness and animal biomass are most significantly affected.

Reference

- Arora G.S. (1994). Lepidoptera: Butterflies In: fauna of Rajaji National park, fauna of conservation Areas. Zoological Survey of India, Calcutta, 5, pp.245- 300.
- Arora, G.S. (1995). Lepidoptera: Rophalocera. In: fauna of Nanda Devi Biosphere Reserve Ecosystem series, Zoological survey of India, Calcutta, 1, pp. 61-73.
- Patil P. S. (2022). Butterfly species Diversity from Akola district of Maharashtra, India. www.ijert.org
- Basavarajappa S., Gopi Krishna V., and S. Santhosh (2018). Department of Zoology Kuvempu University Shankaraghatta- 577 451, Karnataka, India.
- Bhavana S. Janwe and Dr. Ramdas R. Kamdi (2002). Review of Distributionand Diversity of Butterflies in Maharashtra.
- Paresh Patel, Priya Uttarwar, Dnyaneshwar Kaymakam (2022). Diversity of Butterflies in Wani, District Yavatmal (M.S).
- Jayant S. Walatkar and M.V. Shirbhate (2004). Diversity of Butterflies from
- Amravati University campus, Maharashtra. Journal of Threatened Texa, 3 (1): 1469-1477
- A.1. Raja and Hemant P. Sapkal (2011). Chromosomal diversity in some common butterflies of family Hesperidae, from Akola district of Maharashtra.
- SprihHarsh (2014). Butterfly Diversity of India Institute of forest Management, Bhopal, Madhya Pradesh, India. Hindavi Publication Corporation Journal of Insect, 2024: 1-4.
- Nimbalkar R.K. (2018). Diversity of Butterflies from Ajanta caves area of Aurangabad District (MS) Int. Res. Journal of Science and Engineering 2018;
- species Issue A6: 20-25.
- John Bhutta and Bishnu K Sharma (2020). Diversity of butterfly in South District of Sikkim. Corresponding authors E-mail: fernofsikkim@gamil.com
- Patil P.S. Butterfly Species Diversity from Akola Dist. of Maharashtra, India. Department of Zoology, R.A. Arts, Shri
- M.K.Commerce and Shri S.R.Rathi Science College, Washim. volume 10, issue z repruary 2022 | 100%: 2020-200K

13. Reflects the Revitalizing and Renewing Effects of the Cranberry and Yogurt Extract Formulation on the Human Skin

Rupali R. Hatolkar
Department of Zoology Smt. Maherbanu College of science and Commerce Akola.
Dipika V. Muley
Department of Zoology Smt. Maherbanu College of science and Commerce Akola.
Shraddha Jaiswal
Department of Zoology Smt. Maherbanu College of science and Commerce Akola.
Mrs. Quddusa Kamil Farooqui
Department of Zoology Smt. Maherbanu College of science and Commerce Akola.

Abstract

The present work is focused on Reflects the revitalizing and renewing effects of the cranberry and yogurt extract of a body in order to respond to the current demands of consumers, offering an innovative product within the organic cosmetic market. The experimental conditions and ingredients required to develop a product able to hydrate and moisturize, at the same time, secondly, the developed laboratory-scale process was scaled up to commercial scale, highlighting the differences between the two. Among the product quality tests, microbiological analysis and dry weigh determination were performed to calculate the content of water and volatiles present in the yogurt and whether microbial contamination was present.

Keyword- Cranberry oil, yogurt extract, water.

Introduction

I. Anatomy of the Skin

The skin is the largest organ, and it's one of the most complicated. it contains many specialized cells and structures. The skin's primary function is to serve as a protective barrier. It helps regulate body temperature, gathers sensory information from the surrounding environment, and plays an active role in the immune system to protect the body from disease. The structure of skin having mainly three layers of skin: the epidermis, dermis, and subcutaneous tissue.

1. The epidermis

- The epidermis is the outermost layer of the three layers of skin. There are five layers of the epidermis:
- Stratum basale – This is bottom layer, which is also known as the basal cell layer, has column shaped basal cells that divide and push older cells towards the surface of the skin.
- Stratum spinosum – This layer, which is also known as the squamous cell layer, is the thickest layer of epidermis.
- Stratum granulosum – This layer contains more keratinocytes moving towards the surface.
- Stratum lucidum – This layer exists only on the palms of the hands and soles of the feet.
- Stratum corneum – This is the outermost or top layer of the epidermis. It's made of dead, flat keratinocytes that shed approximately every two weeks.

2. The dermis

- The dermis is the middle layer of the three layers of skin. It's located between the epidermis and the subcutaneous tissue. It contains connective tissue, blood capillaries, oil and sweat glands, nerve ending, and hair follicles.
- The dermis is splits into two parts- the papillary dermis, which is the thin, upper layer, and the reticular dermis, which is the thick, lower layer 5.

3. The hypodermis

- The hypodermis contains the cells known as fibroblasts, adipose tissue, connective tissue, larger nerves and blood vessels, and macrophages, cells which are part of the immune system and help keep your body free of intruders. The thickness of the hypodermis varies in different.

II. Skin Flora

The term skin flora refers to the microorganisms which reside on the skin. Many of them are bacteria of which there are around 1,000 species upon human skin from nineteen phyla. Most are found in the superficial layers of the epidermis and the upper parts of hair follicles.

Skin flora is usually non-pathogenic, and either commensal or mutualistic. The benefits bacteria can offer include preventing transient pathogenic organisms from colonizing the skin

surface, either by 12 competing for nutrients, secreting chemicals against them, or stimulating the skin's immune system.

III. Body Yogurt

Women today are more aware of skincare and the first step in that is realizing that skin isn't just about the face! We've now learned to pay attention to the rest of our bodies – after all, who doesn't love feeling smooth and supple all over?

To this end, there are many specific products targeted for the body. Skincare products for the face are different from those for the rest of the body for the simple reason that the skin is different on the face and the rest of the body. Facial skin is a lot thinner and more sensitive and needs different ingredients for its care.

When it comes to our hands and feet, we have hand creams and foot creams. For the rest of the body, however, there are a plethora of options that can be quite confusing. The latest buzzword in this area seems to be 'body yogurt.' Since body yogurts are absorbed quickly, they are a boon for busy women who don't have too much time to get ready in the morning. The best way to get the benefits of a body yogurt is to apply it all over freshly washed, slightly damp skin. The yogurt is absorbed in under half a minute, and you can quickly get dressed without having to worry about any greasy, slimy feeling that richer creams, oils or lotions.

Material and methods

List of materials used

Sr. no.	Name of the Ingredients	Exporter
1.	Distilled water	Purenso Global, MP
2.	Glycerin	Purenso Global, MP
3.	Soft Xanthan gum	Purenso Global, MP
4.	Fractionated Coconut oil	Purenso Global, MP
5.	Jojoba oil	Purenso Global, MP
6.	Vegetative emulsifying wax	Purenso Global, MP
7.	Optiphen (preservative)	Purenso Global, MP
8.	Vitamin E oil (antioxidant)	Purenso Global, MP
9.	Cranberry oil	Purenso Global, MP
10.	Yogurt extract	Purenso Global, MP

Table – Lists of Material used

List of Equipment –

- Precision balance : Smt. Maherbanu college Akola
- Mechanical stirrer : Smt. Maherbanu college Akola

- pH meter : Smt. Maherbanu college Akola
- beaker : Smt. Maherbanu college Akola
- measuring cylinder : Smt. Maherbanu college Akola

1. Formulation and evaluation of cranberry body yogurt with yogurt extract.
2. To prepared a highly moisturizing body yogurt.
3. To prepared non sticky, non greasy and non oily body yogurt that lives the skin soft and smooth for longer period of time.
4. To provide all properties such as moisturizing, nourishing, hydrating and soothing property in a single product.

Objectives

1. The basic objective of the formulation is to formulate a product that is easily absorbed bt the skin and is suitable for all skin type and also offer moisturizing benefits that last for up to 48 hours.
2. The body yogurt helps hydrate your skin and leaves it in smooth throughout the day.

The cranberry fragrance is reported to enhance health and well being by improving mood, reducing anxiety and stress.

Active and Excipients profile

Active

1. Cranberry oil

Cranberries include an acid that acts as exfoliate, while vitamin A and C with collagen synthesis. Cranberries also protect your skin from free radicals that cause wrinkles and keep it moisturized. Cranberries have been prized for their medicinal, antioxidant, and anti-aging effects for generations. It boosts cell vitality and protects your skin from environmental harm to high levels of antioxidants like vitamin C, B and B-5. Cranberry is one of the winter remedies to preserve your skin.

2. Yogurt extract

Yogurt is obtained by spiking milk with the use of the so-called “good” bacteria. Its composition is also supplemented by calcium, proteins, beneficial-for-your-health vitamins and minerals which along with the generous dose of the “good” bacteria help your cells regenerate faster.

Excipients

1. Purified water

Water is used in the formulation of virtually every type of cosmetic and personal care product. Water is widely used in chemical reactions as a solvent as a solute or catalyst in inorganic reactions, water is a common solvent, dissolving many ionic compounds, as well as other polar compounds such as ammonia.

2. Gycerin

Uses in cosmetics- Glycerin is a well-known humectants that prevents the premature loss of moisture from cosmetics and personal care products so they don't dry out. Glycerin is used in cosmetics and personal care product mainly to improve skin's smoothness and moisture content.

3. Vitamin E Oil

Vitamin E is a fat- soluble antioxidant which may help protect cell membranes from reactive oxygen species. Various ear diseases and infections are treated with eardrops containing tri ethanol amine polypeptides oleate - condensate

4. Fractionated coconut oil

It is ideal for increasing the topical distribution of essential oil. One of its o=primary benefits is that is non-greasy and is easily absorbed into the skin.

5. Xanthan gum

It is a gum obtained by microbial fermentation from the xanthomonas campestris organism.

6. Jojoba oil

It has a variety of healing properties that may make it effective in treating skin conditions like acne, eczema, and paoriasis.

7. Emulsifying wax

It is used in lotions and creams as athickener and emulsifier.

8. Methyl paraben

Parabens are a family of related chemicals that are commonly used as preservatives in products.

Observation

Incorporation of cranberry extract and yogurt extract at different concentration in base formulation

Sr. No.	Ingredient	F3.1 For 100%	F3.2 For 100%
1	Distilled water	75.5	74
2	Glycerin	2	2
3	Xanthan gum	0.5	1.5
4	Fractionated coconut oil	10	10
5	Jojoba oil	2	2
6	Emulsifying wax	5	5
7	Vitamin E oil	1	2
8	Yogurt extract	2	1.5
9	Perfume and preservative	Q.S	Q.S

Incorporation of actives at different concentration in base formulation

Evaluation and Results

Evaluation test

The evaluation of the product was carried out as per Indian standard (IS) for finished products. The various steps carried out for evaluation of cream in order to prove safety and stability of product.

In – Vitro Evaluation

1. Determination of physical parameters
2. Determination of pH
3. Determination of viscosity
4. Determination of spread ability time
5. Microbial examination
6. Stability studies
7. Comparative study between formulated product and marketed products.
8. In – Vivo Evaluation
9. Patch test
10. Photographic evaluation
11. In Vitro studies:

1. Determination of physical parameters

Sr.No.	parameter	F3.1	F3.2
1	Appearance	+++	+++
2	Colour	++	+++
3	Spreadability	+++	+++
4	consistency	++	+++

Determination of physical parameters

Here,

+ Good, ++ Very Good, +++ satisfied

2. Determination of pH

Determination of pH of body yogurt incorporated with cranberry extract and yogurt extract.

Time interval	F3.1	F3.2
1st Day	4.4	4.5
15th Day	4.5	4.5
30th Day	4.6	4.6

Determination of pH. Of body yogurt incorporated with

Cranberry and yogurt extract

3. Determination of spreadability

Sr. No.	Days of Interval	Initial area	Weight	Time
1	Initial Day	6 cm	15 gm	2.1 sec
2	15th Day	6.3 cm	15 gm	2.1 sec
3	30th Day	6.6 cm	15 gm	2.1 sec

Determination of spreadability

Conclusion

Today Women are more aware of skincare and the first step in that is realizing that skin isn't just about the face! There are many specific products targeted for the body. Skincare products for the face are different from those for the rest of the body for the simple reason that the skin is different on the face and the rest of the body. A body yogurt is essentially a moisturizer that is quickly absorbed into the skin. It contains emulsifiers that form an emollient shield around the skin, keeping a sheet of emollient molecules close to the surface for a long time.

Cranberry is a healthy fruit from an evergreen shrub and multiple nutritional benefits. Cranberry seed oil, due to its favorable physicochemical characteristic, good oxidative stability and the pleasant flavor is valued as edible oil.

References

1. Human physiology-volume 2, by Dr. C.C.Chatterjee.
2. Essentials of medical physiology 8th edition, by K Sembulingam Prema Sembulingam.
3. Research paper:- study of the preventive role of cranberry extract on some physiological parameters in male rate induced by sodium fluoride, Shatha Galal Azez

Naseer Marza Hamza Azez & Hamza (2020): Role of cranberry extract January 2020 Vol. 23(I) : Annals of tropical Medicine & Public Health S407

4. Article product Development studies of cranberry seed oil Nanoemulsion Wael A. Mahdi, Prawez Alam, Abdullah Alshetaili, Sultan Alshehri, Mohammed M. Ghoneim and Faiyaz Shekel.
5. Enhancing yogurt product's ingredients:preservation strategies, processing condition, analytical detection methods, and therapeutic diversity – an overview September 2022 by Rahul Mehra, Harish Kumar, Shafiya Rafique and Naveen Kumar.
6. https:timesofindia.indiatimes.com/beauty/heres-how-using-body-yogurt-can-benefit-your-skin-in-numerous-ways/articleshow/94537224.cms
7. https:/mamaearth.in/blog/everything-you-need-to-know-about-body-yogurt.
8. Saeedi, Masoumeh Eslamifar, Khadijeh Khezei, Kojic acid applications in cosmetic and pharmaceutical preparations, Biomedicine & pharmacotherapy, volume 110, 2019, pages 582-593, ISSN 0753-3322.
9. Briasco, B; Capra, P; Cozzi, A.C; Mannucci, B; Perugini, P. packaging Evaluation Approach to improve cosmetic product safety. Cosmetics 2016,3,32

14. Synthesis, Spectral Characterization and Antimicrobial Potent Study of Some Novel 7-[(2-Substitutedimino-4-Phenylimino) Amino-1,3,5-Dithiazino)] Along with Coumarin Nucleus

S. A. Waghmarea
Department of Chemistry, Ghulam Nabi Azad Arts, Commerce and Science College Barshitakli Dist. Akola. (M.S.), India.
K. U. Dongareb
Department of Chemistry, Ghulam Nabi Azad Arts, Commerce and Science College Barshitakli Dist. Akola. (M.S.), India.
S. B. Sarkatec
Department of Chemistry, Ghulam Nabi Azad Arts, Commerce and Science College Barshitakli Dist. Akola. (M.S.), India.
R. N. Ingoled
Department of Chemistry, Shri Vitthal Rukhmini College,
Sawana, Mahagaon, Dist.Yavatmal, (M.S.) India

ABSTRACT

In a laboratory novel series of 7-[(2-substitutedimino-4-phenylimino)amino-1,3,5-dithiazino)]-4-methyl-2H-chromen-2-one (IIIa-e) ware synthesized by refluxing 7-(5-substituted-2,4-dithiobiureto)-4-methyl-2H-chromen-2-one (Ia-e) with alkyl/aryl isocyanodichlorides (IIa-e) in acetone medium in 1:1 molar proportion. The structures of all the synthesized compounds were justified on the basis of chemical characteristics, elemental analysis and spectral studies and their antimicrobial screening against the gram positive and gram-negative bacteria such as S. typhi, E. coli, S. aureus, A. Aerogenes, B. Subtilis and B. Megatherium etc.

Introduction

Because they are more convenient in a variety of applications, heterocycles incorporating organic molecules are more fascinating. A wide range of applications are covered by the heterocycles' sizes and the heteroatom variety they include. Five members1-2 that are sulphur and nitrogen-containing six participants,3-4 Six members5-8 fused heterocycles and five

members fused heterocycles containing aromatic rings. Particularly, heterocycles that contain both nitrogen and sulphur in one ring are well-known for their many industrial and biological uses. One of the six member heterocycles, 1,3,5-dithiazine, has one nitrogen atom and two sulphur atoms. Additionally, a review of the literature revealed that the 1,3,5-dithiazino nucleus and its derivatives have beneficial biological and medicinal qualities9-10. It is a powerful medication used in the domains of industry, agriculture and medicine.11-13

Various compounds of 1,3,5-dithiazino moieties were reported by Tayade13 to improve industrial, pharmaceutical, medical and agricultural operations. In addition, 1,3,5-dithiazino compounds were synthesized by Raut14 for their fungicidal characteristics. The 1,3,5-dithiazines were previously created in a lab setting using substituted isocyanodichlorides. Shendge15 research group produced a variety of heterocycles with the primary nucleus being 1,3,5-dithiazines. The uses of each 1,3,5-dithiazino moiety vary depending on the substituent affixed to the 1,3,5-dithiazine's basic nucleus. Additionally, a review of the literature revealed that the 1,3,5-dithiazino nucleus and its derivatives have beneficial biological and medicinal qualities. The synthesis of 1,3,5-dithiazines can be done more quickly, cheaply, easily and with less effort with this approach. A new series of 1,3,5-dithiazine was to be synthesized.

Material and Method

Material

All the chemical used were of loba chemie (AR grade).

Method

In the present experiment for the synthesis of different substituted 1,3,5-dithiazino coumarin is conventional refluxing under electronic water bath for different hours for different experiment.

Experimental

All the chemicals used for the synthesis were purified. After refluxing the purity of the compounds were checked by TLC (aluminium TLC) with thin layer thickness of 200 um. The melting points of all synthesize compounds will be recorded using hot paraffin bath. The carbon and hydrogen analysis were carried out on Carlo-Ebra-1106 analyser Nitrogen estimation were carried out with colmon-N-analyzer-29. IR spectra were recorded with Bruker spectrometer in the range 4000-400 cm-1. PMR spectra were recorded on VARIAN 400 MHz spectrometer with TMS as internal standard using CDCL3 and DMSO Solvent.

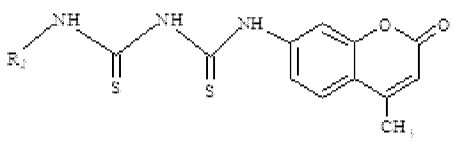
General Procedure

A reaction of 7-[(5-phenyl)-2,4-dithiobiureto]-4-methyl-2H-chromen-2-one (Ia) and N-phenyl isocyanodichloride (IIa) in 1:1 molar ratio refluxed on water bath in acetone medium for 2 hours. The evolution of the hydrochloride gas was clearly observed during refluxtion. After distillation of excess solvent shining yellow product isolated which on basification with dilute ammonium hydroxide yellow crystalline products afforded.

Similar, procedure was adopted for the synthesis of all the derivatives in the series.

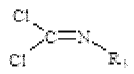
The tentative reaction for the formation of product is depicted below,

Reaction



7-[(5-phenyl)-2,4-dithiobiureto]-4-methyl-2*H*-chromen-2-one

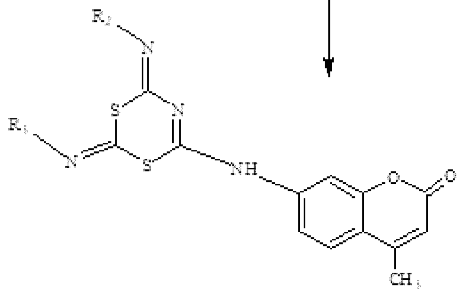
(Ia-e)



Substituted isocynodichloride

(IIa-e)

Acetone | Refluxed 2 hrs.



7-[(2-Substituedimino-4-phenylimino)amino-1,3,5-dithiazino]-4-methyl-2*H*-chromen-2-one

(IIIa-e)

where R_2= -phenyl

where R_1= -phenyl,-4-chlorophenyl, -4-methylphenyl, -ethyl, -*tert*-butyl

Similarly, 7-[(5-phenyl)-2,4-dithiobiureto]-4-methyl-2H-chromen-2-one (Ia) was interacted with N-ethyl isocyanodichloride (IIa), N-phenyl isocyanodichloride (IIb), N-tert-butyl isocyanodichloride (IIc), N-4-methylphenyl isocyanodichloride (IId) and N-4-chlorophenyl isocyanodichloride (IIe) by above mentioned method to isolate 7-{[2-(ethylimino)-4-(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one(IIIa), 7-{[2,4-

di(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one (IIIb), 7{[2-(tert-butylimino)-4-(phenylimino)-1,3,5-dithiazin-6-yl]amino}4-methyl-2H-chromen-2-one (IIIc), 7-{2-[(4-methylphenyl)imino]-4-[(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one (IIId) and 7-{2-[(4-chlorophenyl)imino]-4-[(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one (IIIe).

Result and Discussion

Spectral characterization results for all the synthesized compounds are given below

Spectral Characterization

1. 7-{[2-(Ethylimino)-4-(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one(IIIa)

   Colour- Brown red crystalline solid, Molecular formula- C21H18N4O2S2, yield 83%, M.P. 160 0C. FTIR (Kbr) υ cm-1 3443.22 N-H stretching, 3057.52 (C-H Ar Stretching), 1977.07 (C-H Ar Bending,), 1615.05 (N-H bending), 1735.35 (C=O stretching), 1631.13 (C=N stretching); 1H NMR (400 MHz CDCL3 δ ppm)- 3 protons of -CH3 gives singlet at δ 2.33 ppm due to attachment with aromatic ring, 2 protons of two -CH2 gives quartet at δ 3.7 ppm, aromatic protons of -CH= of two aromatic ring gives doublet at δ 7.75, 7.3 7.2, 7.3 and 7.74 ppm, 1 proton of -CH= of conjugated lactone gives singlet at δ 5.60 ppm, proton -NH attached between thionyl group and phenyl ring also desheilded due to thioamide position and gives signal at δ 3.73 ppm. Mol. Wt.: 422.52

2. 7-{[2,4-Di(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one (IIIb)

   Colour- Brown red crystalline solid, Molecular formula- C24H17N4O2S2, yield 86 %, M.P. 147 0C. FTIR (Kbr) υ cm-1 3370.70 N-H stretching, 3030.12 (C-H Ar Stretching), 1570.80 (N-H bending), 1738.45 (C=O stretching), 1607.19 (C=N stretching); 1H NMR (400 MHz CDCL3 δ ppm)- 3 protons of -CH3 gives singlet at δ 2.41 ppm due to attachment with aromatic ring, aromatic protons of -CH= of aromatic ring gives doublet at δ 7.32, 7.4, 7.42 and 7.40 ppm, aromatic protons of -CH= of aromatic ring gives triplet at δ 7.26 and 7.18 ppm, 1 proton of -CH= of conjugated lactone gives singlet at δ 5.84 ppm, proton -NH attached between thionyl group and

phenyl ring also desheilded due to thioamide position and gives signal at δ 3.4 ppm. Mol. Wt.: 470.56

3. 7{[2-(tert-butylimino)-4-(phenylimino)-1,3,5-dithiazin-6-yl]amino}4-methyl-2H-chromen-2-one (IIIc)

   Colour- Brown red crystalline solid, Molecular formula- C23H22N4O2S2, yield 88 %, M.P. 137 0C. FTIR (Kbr) υ cm-1 3370.63 N-H stretching, 3033.23 (C-H Ar Stretching), 1572.23 (N-H bending), 1739.36 (C=O stretching), 1609.96 (C=N stretching); 1H NMR (400 MHz CDCL3 δ ppm)- 3 protons of -CH3 gives singlet at δ 2.25 ppm due to attachment with aromatic ring, 9 protons of three -CH3 gives singlet at δ 1.38 ppm due to attachment with aromatic ring, aromatic protons of -CH= of two aromatic ring gives doublet at δ 7.7, 7.33 and 7.63 ppm, 1 proton of -CH= of conjugated lactone gives singlet at δ 5.56 ppm and proton -NH attached between thionyl group and phenyl ring also desheilded due to thioamide position and gives signal at δ 3.69 ppm. Mol. Wt.: 450.52

4. 7-{2-[(4-Methylphenyl)imino]-4-[(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one (IIId)

   Colour- Brown red crystalline solid, Molecular formula- C26H20N4O2S2, yield 87 %, M.P. 122 0C. FTIR (Kbr) υ cm-1 3372.62 N-H stretching, 3090.55 (C-H Ar Stretching), 1955.59 (C-H Ar Bending,), 1657.30 (N-H bending), 1735.87 (C=O stretching), 1642.57 (C=N stretching); 1H NMR (400 MHz CDCL3 δ ppm)- 6 protons of two -CH3 gives singlet at δ 2.33 and 2.14 ppm due to attachment with aromatic ring, aromatic protons of -CH= of two aromatic ring gives doublet at δ 7.55, 7.63 7.22, 7.36 and 7.76 ppm, 1 proton of -CH= of conjugated lactone gives singlet at δ 5.56 ppm, proton -NH attached between thionyl group and phenyl ring also desheilded due to thioamide position and gives signal at δ 3.56 ppm. Mol. Wt.: 484.59

5. 7-{2-[(4-Chlorophenyl)imino]-4-[(phenylimino)-1,3,5-dithiazin-6-yl]amino}-4-methyl-2H-chromen-2-one (IIIe)

   Colour- Brown red crystalline solid, Molecular formula- C25H17N4O2S2 Cl, yield 88 %, M.P. 157 0C. FTIR (Kbr) υ cm-1 3375.82 N-H stretching, 3092.40 (C-H Ar Stretching), 1940.39 (C-H Ar Bending,), 1655.35 (N-H bending), 1737.32 (C=O stretching), 1634.87 (C=N stretching); 1H NMR (400 MHz CDCL3 δ ppm)- 3 protons

of -CH3 gives singlet at δ 2.85 ppm due to attachment with aromatic ring, aromatic protons of -CH= of two aromatic ring gives doublet at δ 7.69, 7.86 7.25, 7.39 and 7.69 ppm, 1 proton of -CH= of conjugated lactone gives singlet at δ 5.49 ppm, proton -NH attached between thionyl group and phenyl ring also desheilded due to thioamide position and gives signal at δ 3.96 ppm. Mol. Wt.: 505.01

Conclusion

In the present work is cheaper and less time-consuming method for synthesis of organic compound (IIIa-e). All the synthesized compound excellent anti-bacterial results in compare with the ciprofloxacin as a standard drug. After studying zone of inhibition these compounds may be act as finest drugs for the living beings.

Antimicrobial activity

All the synthesized compounds (III-a) to (III-e) were screened for antibacterial activity against S. typhi, E. coli, S. aureus, A. Aerogenes, B. Subtilis and B. Megatherium by disc diffusion method was performed using Mueller Hinton agar as well as nutrient agar medium. Each and every compound was tested at conc. 50 µg/ml in ethanol. The zone of inhibition of all the synthesized compounds were measured after 24-hour incubation at 37 0C. Standard drug used for comparison the activity was Ciprofloxacin.

Table No. 1: Synthesized compound IIIa-e activity against gram-negative and gram-positive bacteria.

Table No. 1. Antibacterial activity of synthesized compound against bacteria (Zone of inhibition in mm after 24 hrs at 37 ^{0}C temp.)

SR No.	Compd.	Gram positive			Gram negative		
		S. aureus	*B. subtilis*	*B. megatherium*	*S. typhi*	*E. coli*	*A. aerogenes*
1	**KUD-IIIa**	11	11	14	12	00	00
2	**KUD-IIIb**	14	00	12	11	00	00
3	**KUD-IIIc**	16	11	00	12	00	11
4	**KUD-IIId**	00	00	11	12	12	00
5	**KUD-IIIe**	14	12	11	14	12	14
6	**Std Ciprofloxacin**	18	16	20	18	20	14

Table No. 1. Antibacterial activity of synthesized compound against bacteria

Referance

1. Sayed, M. T., Elsharabasy, S. A., & Abdel-Aziem, A. (2023). Synthesis and antimicrobial activity of new series of thiazoles, pyridines and pyrazoles based on coumarin moiety. Scientific Reports, 13(1), 9912, 1-9.
2. Gujjar, K., N., & Narasimha S M. (2023). A Review: Important applications of Heterocyclic Compounds, Eur. Chem. Bull., 12(12), 625-630.
3. Sharma, P. K., Amin, A., & Kumar, M. (2020). A review: Medicinally important nitrogen sulphur containing heterocycles. The Open Medicinal Chemistry Journal, 14(1), 49-64.
4. Amin, A., Qadir, T., Sharma, P. K., Jeelani, I., & Abe, H. (2022). A Review on The Medicinal and Industrial Applications of N-Containing Heterocycles. The Open Medicinal Chemistry Journal, 16(1), 1-27.
5. Matin, M. M., Matin, P., Rahman, M. R., Ben Hadda, T., Almalki, F. A., Mahmud, S. & Alshehri, S. (2022). Triazoles and their derivatives: Chemistry, synthesis, and therapeutic applications. Frontiers in molecular biosciences, 9, 864286, 1-8.
6. Bhadoriya, U., & Jain, D. K. (2016). Fused heterocycles as a potent biological agent; recent advancement. International Journal of Pharmaceutical Sciences and Research, 7(5), 1874-1880.
7. El-Sawy, E. R., Abdelwahab, A. B., & Kirsch, G. (2021). Synthetic Routes to Coumarin (Benzopyrone)-Fused Five-Membered Aromatic Heterocycles Built on the α-Pyrone Moiety. Part 1: Five-Membered Aromatic Rings with One Heteroatom. Molecules, 26(2), 483, 1-21.
8. Abu-Hashem, A. A., Hussein, H. A., Aly, A. S., & Gouda, M. A. (2014). Reactivity of benzofuran derivatives. Synthetic Communications, 44(20), 2899-2920.
9. Rakhimova, E. B., Vasil'eva, I. V., Khalilov, L. M., Ibragimov, A. G., & Dzhemilev, U. M. (2011). Effective synthesis of N-substituted 1, 3, 5-dithiazinanes by reactions of N-methyl-1, 3, 5-dithiazinane and 1, 3, 5-trithiane with aromatic amines. Russian Journal of Organic Chemistry, 47, 1300-1304.
10. Tayade, D, T. & Waghmare, S. A. (2016) Synthesis and Spectral Characterization of Some 1,3,5-Dithazines with Chalcone Backbone, Journal of Chemical and Pharmaceutical Research, 4(6), 233–235.

11. Heravi, M. M., Zadsirjan, V., Hamidi, H., & Amiri, P. H. T. (2017). Total synthesis of natural products containing benzofuran rings. RSC advances, 7(39), 24470-24521.
12. Yan, J., Si, W., Hu, H., Zhao, X., Chen, M., & Wang, X. (2019). Design, synthesis and antimicrobial activities of novel 1, 3, 5-thiadiazine-2-thione derivatives containing a 1, 3, 4-thiadiazole group. PeerJ, 7, 7581, 1-18.
13. Tayade, D., T. (2016). Synthesis and Spectral Characterization of Some 1,3,5-Dithazines with Chalcone Backbone, International Journal of Chemistry and Pharmaceutical Sciences, 4(6), 333-335.
14. Raut, P. V., Waghmare, S. A., & Tayade, D. T. (2017). Synthesis of 6-{4-Amino-N-[2-(Diethylamino) Ethyl]-O-Anisamido-5-Yl}- Amino-2-Thio-3-Substitutedamino,4-Substitutedimino-1,3,5-Thiadizines, International Journal of Medical Science and Clinical Invention, 4(12), 3355-3357
15. Shendge, A., S. & Tayade, D., T. (2018). Synthesis and Characterization of 2-(3-Substituted thioamidoformamidino-4- isobutoxyphenyl)-4-methyl-5-carboxy-1,3-thiazoles., Asian Journal of Organic & Medicinal Chemistry, 3(4), 187-189.

15. Synthesis, Characterization and Biological Evaluation of Chromene -2- Carbonitrile and Their Derivatives

S. G. Badne
Department of Chemistry, Shri Shivaji college of Arts, Commerce and Science, Akola.
G. W. Belsare
Department of Chemistry, Shri Shivaji college of Arts, Commerce and Science, Akola.

Abstract

In the present study, an attempt has been made to synthesize and characterize some chromene -2- carbonitrile derivatives, and to evaluate them for their anti-microbial activity. The physicochemical characteristic like melting point, percentage yield, Rf value were evaluated. The synthesized compounds were characterized by IR, NMR and Mass spectroscopy. Compounds exhibited good antimicrobial activity when compared with standard. Further, there is a large scope for the development of other derivatives and their pharmacological screening. Since, the synthesized scheme is simple and now well established it would be easy to synthesize other derivatives by incorporating various substitutions and screenings them for other pharmacological activities like Antibacterial, antiviral, anti- tumor, anti-hyperglycemic, analgesic, anti-inflammatory, for specific target. 2-(-2-cyano-1-phenyl-1H- benzo chromene -3yl)-5-(methylthio)-3-oxo-1 phenyl-2,3-dihydro-1H-pyrazole-4-carbonitrile by using 1- phenyl-3-(-2- phenylhydrazinyl)-4a,10b-dihydro-1H benzo chromene -2- carbonitrile with ethyl 2-cyano-3,3- bis (methylthio) acrylate using K2CO3 as catalyst and DMF solvent. Here 3-hydrazynyl -1- phenyl-4a,10b-dihydro-1H-benzo chromene -2- carbonitrile was prepared by the reaction3- amino -1- phenyl-1H benzo chromene -2- carbonitrile with hydrazine hydrate and 3-amino-1-phenyl-1H benzo chromene -2-carbonitrile was prepared from the mannich base of β-napthol,benzaldehyde and dimethylamine which was reacted with malononitrile.

Keywords – Chromene, Methyl thio, Carbonitrile etc.

Introduction

Chromene is one the privileged medicinal pharmacophore which appear as an important structural component in natural compound and generate great attention because of their interesting biological activity. It is a heterocyclic ring, chromene constitute the basic backbone of various type of polyphenol and widely found in natural alkaloid tocopherol flavonoid and

anthocyanin. Cancer constitutes the second main mortality cause in the word chromene derivative are an attractive template for the identification of potential anticancer agent. In recent year there has been much interest in the class of compound and their potential utility as anti-cancer, many of the natural and synthetic compound contain chromene moiety have been reported with anticancer activity, fused chromene are interesting due to their significant antibacterial and novel biological activity.

Studies on the synthesis of fused amino chromenes are stimulated by diverse biological activity of these compounds. In particular, they exhibit antioxidant properties, while substituted 2-amino-4-H- benzochromenes were proposed as medicine treatment of immune disorders and diabetes complication. Some 3-amino -1H-benzo chromene-2- carbonitriles were reported to possess anti-cancer and anti- bacterial activity. Furthermore,3- amino-1H-benzo chromene-2-carbonitrile may be regarded as heterocyclic β-enamino nitriles that are promising as building blocks for the synthesis of fused chromenes.

Several procedures for the synthesis of 3-amino -1H-benzo chromene-2- carbonitriles have been reported. Among these, the most commonly used in three component condensation of malononitrile with an aldehyde, primarily aromatic one, and naphthalene-2-ol. This reaction is generally carried out in ethanol, acetonitrile, or water in the presence of the base. 3-amino -1H-benzo chromene- 2- carbonitriles having no substituent on C1 was synthesized from 2-hydroxynapthalene-1- carbaldehyde, malononitrile, and the Hantzsch ester in the presence of InCl3. Enantioselective synthesis of 3-amino -1H-benzo chromene-2- carbonitriles from benzylidene malononitriles was also reported.

In our, synthesis of parent compound; we used the ethyl 2 cyano-3,3-bis methylthio acrylate reagent was prepared by the reaction of ethyl cyano acetate, carbon disulphide and dimethyl sulfate in the presence of a base. The thiomethyl group (best leaving group) on C2 position makes it very useful reagent for the preparation of heterocyclic compounds. Moreover, ethyl -2- cyano,3,3- bis methylthio acrylate can also be prepared efficiently using sodium ethoxide as a base.

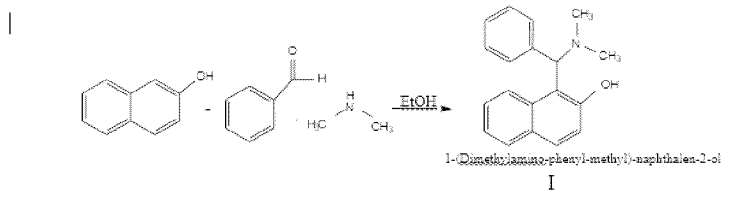
Material and Methods

General Procedure

In continuation with this we have to synthesize 2-(-2- cyano-1- phenyl- 1-H benzo chromene- 3-yl)-5- (methylthio)-3- oxo-1- phenyl-2,3-dihydro-1H-pyrazole-4- carbonitriles, by using 1-phenyl-3- (-2- phenyl hydrazinyl)-4a,10b-dihydro-1H-benzo chromene-2-carbonitriles with ethyl2-cyano-3,3- bismethylthio acrylates using K2CO3 as catalyst and DMF as a solvent.Here 3-hydrazinyl-1-phenyl- 4a,10b-dihydro-1H-benzochromene-2-carbonitrile was

prepared by the reaction of 3-amino-1-phenyl- 1H-benzochromene-2-carbonitrile with hydrazine hydrate and the 3-amino-1-phenyl-1H-benzo chromene-2-carbonitrile was prepared from the mannich base of β-naphthol, benzaldehyde and dimethylamine was reacted with malononitrile.

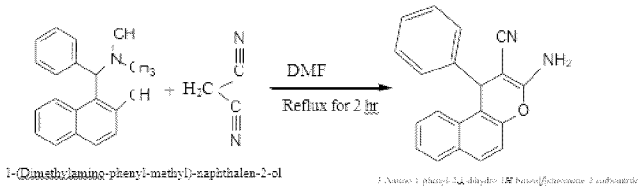
β-naphthol is dissolved in minimum quantity of ethanol then benzaldehyde and dimethyl amine are added now the content is reflux for 2 hrs. and kept for 24 hrs.



1-(Dimethylamino-phenyl-methyl)-naphthalen-2-ol

I

Mannich base and malononitrile are refluxed for 2 hrs. in presence of DMF as a solvent.



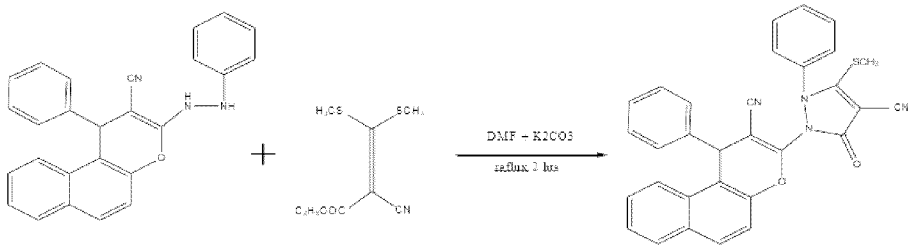
1-(Dimethylamino-phenyl-methyl)-naphthalen-2-ol

I

II

3-amino-1-phenyl-1H-benzo chromene-2-carbonitrile and phenyl hydrazine are refluxed for 2 hours using DMF as a solvent.

2-(- cyano-1- phenyl-1H-benzo chromene-3-yl)-5-methylthio-3- oxo-1- phenyl-2,3-dihydro-1H-Pyrazole-4- carbonitrile by reaction of 1-phenyl-3-(-2-phenylhydrazinyl)-4a. 10b-dihydro-1H-benzo chromene 2-carbonitrile with ethyl-2-cyano-3,3-bis methyl thio acrylate in the presence of potassium carbonate and DMF. The mixture was refluxed for 2-3 hrs.



Antibacterial Study of Synthesized Compounds

An antimicrobial is an agent that kills microorganisms (microbicide) or stops their growth (bacteriostatic agents). Antimicrobial medicines can be grouped according to the microorganisms they act primarily against. Chemical agents not only provide the structural basis and energy supply to leaving organism, but also regulate their functional activities. The interaction between potent chemical and leaving system contribute in understanding the life processes and provide effective method for treatment, prevention, and diagnosis of many diseases.

Chemical compound used for these purpose is called as drugs and their action on leaving system called as drug effect. Any chemical substance inhibiting the growth causing death of microorganisms is known as antibacterial agent although a wide range of chemicals have these properties. It is possible to sub divided antimicrobial agent into various group according to the action and purpose for which they are employed. Sub division can be based upon the group of microorganism affected. Thus agents acting on the bacteria are called bacteriostatic or bactericidal, thus acting on fungi static or fungicidal.

Test Procedure

The medium was prepared by dissolving weighed ingredients and was sterilised at 121oC temperature and 15 lbs/ inch pressure for 15 minutes. After sterilization it was cooled down about 50oC and poured at sterilized petri-plates and allow solidifying.

The media plates were seeded with 24hrs old active nutrient both culture of the test organism in order to obtain low culture. A stainless steel crock borer of 6mm diameter was used to bore those cavities. The compounds where taken at a concentration of 1gm/mm using dimethyl sulfoxide DMF as a Solvent. In to the well were added 0.1 ml portion of test compounds in Solvent. The plate was incubating at 37oC for 24hrs.for antimicrobial activity. The zone of inhibition observed around the well after respective incubation was measured in mm by using antibiotic zone order.

The compound was screen for antibacterial activity against Staphylococcus aureus, Kocuria rosea species and Pseudomonas aeruginosa species by using Nutrient agar broth medium.

Result and Discussion

We describe the result of 6-(8-methoxy-2-oxo-2H-chromen-3yl)-4methyl sulfanyl -2H pyran- 2,3dicarbonitrile, which show antibacterial activities. This suggest that compound having potent biological activity.

The salicylaldehyde reacted with ethyl acetoacetate without using Solvent that is Solvent free in 100oC and to formed 3-acetyl coumarine. The reaction condition for 4-methyl sulfanyl-2-oxo-6-(2oxo-2H- chromen-3yl)-2H pyran-2,3dicarbonitrile is formed and use the reactant compound 3-acetyl coumarine and ethyl 2-cyno-3,3biethyl thio acrylate in the presence of pottasium hydroxide and pottasium thiocynide.

In the continuation with this work the compound obtained 6-(8-methoxy-2-oxo2H-chromen-3yl)4- methyl. sulfanyl-2H-pyran-2,3-dicarbonitrile which show antimicrobial activity against S.aureus and K.roses.

The 6- (8-methoxy-2-oxo-2H-chromen-3yl) -4methyl sulfanyl-2H-pyran-2,3-dicarbonitrile was synthesized and characterised for their structure elucidation with their antibacterial study. Various chemical and spectral data supported the structure, it is efficient, inexpensive and is useful in synthesizing pharmacologically important molecule.

References

1. Cintas P. Activated metals in organic synthesis. CRC Press; 2020 Jan 29.;7-10
2. Bhat BA, Dhar KL, Puri SC, Saxena AK, Shanmugavel M, Qazi GN. Synthesis and biological evaluation of chalcones and their derived pyrazoles as potential cytotoxic agents. Bioorganic & medicinal chemistry letters. 2005 Jun 15;15(12):3177-80.
3. Monica Kachroo, Synthesis of some new chalcone derivatives and evaluation of their anticancer activity. Int. J. Drug Dev. and Res, (2013); 5(3):309-315.
4. Mokle SS. Sayeed MA. Kothawar and Chopde. Int. J. Chem. So 2004;2(1):96-100
5. Cheng JH, Hung CF, Yang SC, Wang JP, Won SI, Lin CN. Synthesis and eytotoxic, anti- inflammatory, and anti-oxidant activities of 2, 5% dialkoxyfchalcones as cancer chemo preventive agents. Hioorganic & medicinal chemistry. 2008 Ang 1:16(15):7270-6
6. Seema 1. Habib et al. Chemical and biological potential of chalcone as a source of Drug: A review. LIPPR, (2018); 11(02):104-118.
7. Rajendra Prasad Yejella et al. Synthesis, antimicrobial, and computational evaluation of novel Isobutyl chalcones as antimicrobial agents, UMC, (2017), 1- 14.
8. Sunny Jalhan et al. Various Biological activities of coumarin and Oxadiazole derivatives. Asian J. Pharm Clin Res, (2017); 10(7):38-43)
9. Chapter 5 Synthesis of 7-hydroxy-4-methyl coumarin over Zapo-5 and Lewis acid metal ion-exchanged Zapo-5 molecular sieves 79.90.
10. Antimicrobial Merriam-Webster online dictionary. Archived from the original on (2009).
11. Alivelu Samala et al. Synthesis, characterization of some novel coumarin derivatives and evaluation of their Pharmacological activities. Der Pharma chemical, (2016), 8(12):19-24.
12. Kubba et al. Synthesis and characterization of new coumarin derivatives containing various moieties with antibacterial activities. Int. J. Pharm, Pharm sci, (2015); 7(8):70-74

16. Acoustic Parameters of 0.001M Aqueous Solution of Hydroxichloroquine at Different Temperatures

S. H. Shrirame
Nilkanthrao Shinde Science & Arts College, Bhadrawati Dist.-Chandrapur.
A. B. Dhote
Nilkanthrao Shinde Science & Arts College, Bhadrawati Dist.-Chandrapur.

Abstract

Nowadays ultrasonic velocity plays an majar role in understanding strength and molecular interactions in solutions. Medicines are compounds that are used to dingoes diseases. Hydroxychloroquine is an anti-malarial and antibiotic drug. The ultrasonic velocity, density and viscosity of aqueous solution of hydroxychloroquine was measured at different temperatures. Thermodynamic parameters i.e Relative associations, Specific relaxation time, Rao's Constant, Wada Constant were calculated from the experimentally observed values. It is help to study molecular interactions between hydroxychloroquine and water.

Key Words: antimalarial, Hydroxichoroquine, ultrasonic, molecular interaction.

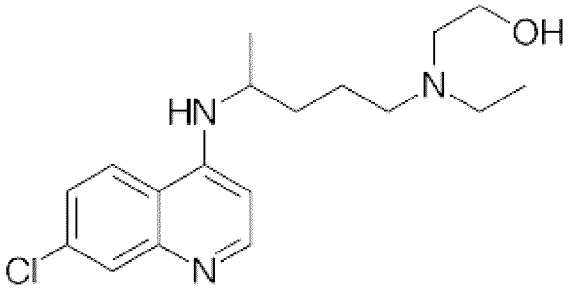
Introduction

In present era ultrasonic velocity, density, viscosity and acoustic parameters play a very important role because of which it is possible to know the molecular interaction in a solution it has application in various fields like medical field, food processing, oceanography[1-3] etc. There is some considerable interest to aware the intermolecular interaction in liquid mixtures. The main usage of organic mixtures have been used for processing and further formulations of product. Physico-chemical properties of pure and mixtures of organic liquids are having great importance in the field of science and industrial engineering. The thermodynamic properties like Relative associations, Rao's Constant and Wada Constant are used to classify the various intermolecular interactions between solute and solvent in solution.[4-5]

Medication is a very important part in today's modern life, it is used for treatment of human and animal diseases. A drugs is substance that can diagnose various diseases in the human body when it consumed drugs are typically distinguished from food and substances that provide nutritional support.[6-9] Anti-malarial drugs such as Hydroxichloroquine are used to treat malarial infection. This research paper studies the temperature at which 0.001M concentration of Hydroxichloroquine has maximum molecular interactions with water.

In the present research paper ultrasonic velocity, density and viscosities of 0.001M aqueous solution of Hydroxychloroquine at different temperature was measured. This data is useful to calculate thermodynamic parameters such as Relative associations, Specific relaxation time, Rao's Constant and Wada Constant. From these reactivity and molecular interaction of the drug is predicted.

The structure of Hydroxychloroquine is



Experimental

Ultrasonic velocities (U) in liquid mixtures prepared with pure AR grade samples were measured using an ultrasonic interferometer (Mittal type, model F-81) operating at 2MHz frequency and temperature 298.15K,303.15K and 308.15K. The accuracy of the speed of sound was ±0.1 ms-1. An electronically digitally controlled constant temperature water bath is used to circulate water through a steel double-walled measurement chamber containing the experimental solution at the desired temperature[10-11]. Density of pure liquid and liquid mixtures was determined using density bottle by relative measurement method with an accuracy of ±0.1Kgm-3.

Ultrasonic velocity

Ultrasonic velocity in liquid and liquid mixtures can be directly measured by ultrasonic interferometer. From the knowledge of wavelength (λ), the velocity of ultrasonic waves in liquid can be calculated by relation,

$$V = \lambda . f \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

λ is the wave length of ultrasonic wave to excite the crystal.

f is the frequency of generator.

Relative associations

Relative association is the measure of extent of association of components in the medium. It is used to assess the association in any solution relative to the association existing in water at 0°C. It is a property of understanding the molecular interaction in liquid mixtures and solutions. The relative association depends on either of breaking up of the solvent molecules on addition of

solute to it or the salvation of ions that are present.[12] It is a function of ultrasonic velocity and is calculated by equation

$$RA = \frac{d_s}{d_o}\left[\frac{v_0}{v_s}\right]^{1/3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where,

v_0 is the ultrasonic velocity in solvent.

vs is the ultrasonic velocity in solution.

Specific relaxation time

Specific relaxation time is the time taken for the excitation energy to appear as translational energy. It is absorption of sound wave, the result of a time lag between the passing the ultrasonic wave and return of the molecules to their original position. It is the time constant of an exponential return of a system to equilibrium after a disturbance. It depends on temperature and on impurities. The dispersion of the ultrasonic velocity in solutions and liquid mixtures reveals information about the characteristic time of relaxation process that cause dispersion. It can be calculated from the relation.

$$\tau = 4/3\beta.\eta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Rao's Constant

Molar sound velocity is also called Rao's constant. It is calculated by using the equation

$$R = [Meff/ds]v^{1/3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where,

Meff is the effective molar volume.

ds is a density.

v is the ultrasonic velocity.

Wada Constant

Molar compressibility is also known as Wada's constant.

$$W = [M_{eff}/ds]\ ß^{-1/7} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where,

M_{eff} is the effective molar volume.

ß is the adiabatic compressibility.

ds is density

Result & Discussion

Table 1: Ultrasonic velocity, densities, viscosities Relative associations, Specific relaxation time, Rao's Constant, Wada Constant of aqueous solution of Hydroxichoroquine at 0.001M concentrations and different Temperature

Sr. No	Temperature (K)	Ultrasonic Velocity (m/s)	Density (Kg)	Viscosity (N/m^2)	Relative associations	Specific relaxation time (S)	Rao's Constant	Wada Constant
1	298.15	1325.2	1049.2	0.094	1.096	6.8021	0.1884	0.3615
2	303.15	1331.92	1047.2	0.080	1.095	5.7416	0.1891	0.3626
3	308.15	1380.56	1045.2	0.070	1.084	4.685	0.1918	0.3670

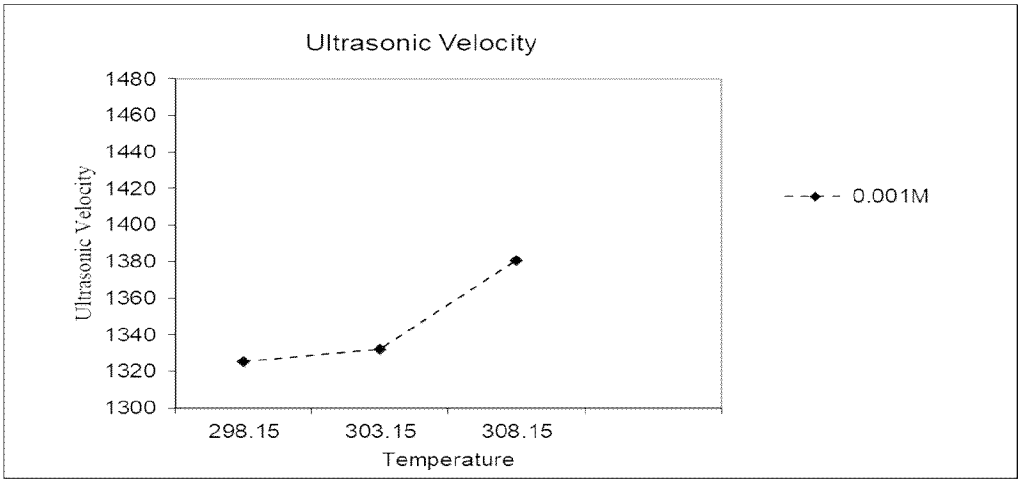


Fig. 1: Variation of ultrasonic velocity with temperature

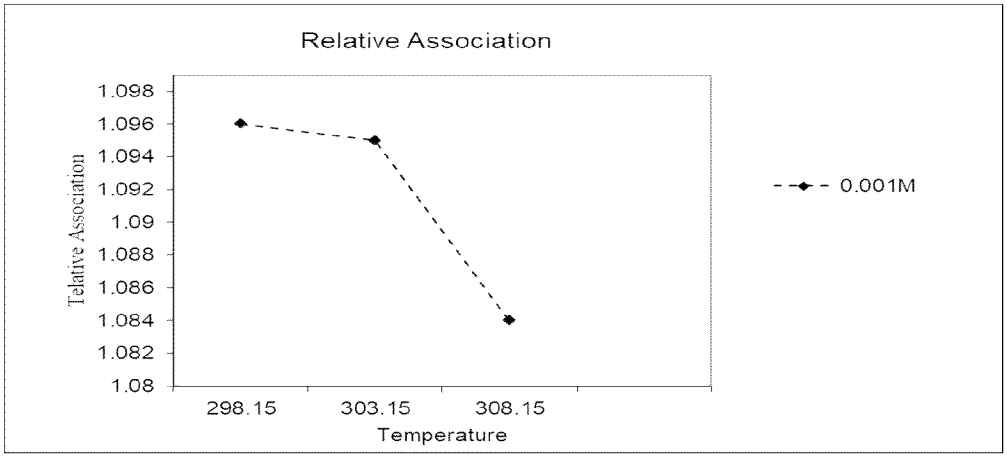


Fig. 2: Variation of relative association with temperature

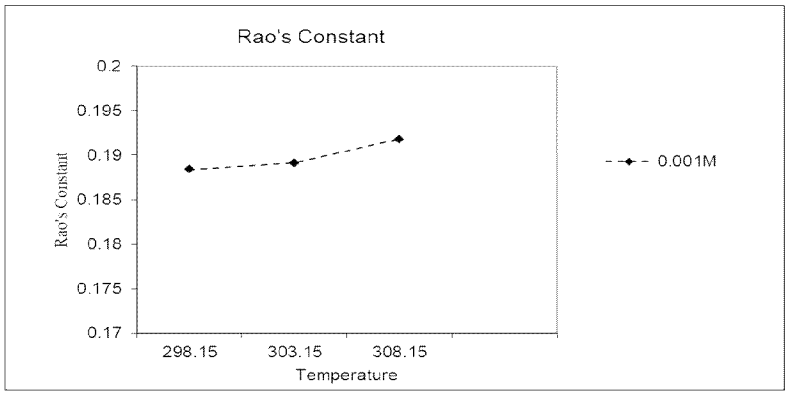


Fig. 3: Variation of Rao's constant with temperature

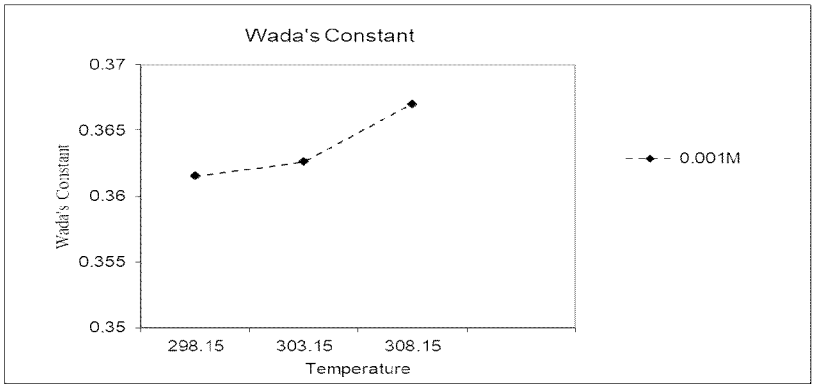


Fig. 4: Variation of Wada's constant with temperature

From table number 1 and figure number 1 we can see that ultrasonic velocity increases with temperature and density and viscosity decrease with temperature, which suggests that the Strong molecular interaction.

From table number 1 and figure 2 we understood that the relative association decreases with temperature which means that this solvent is showing a breaking structure.

From table number 1 figure 3 and 4 we understood that Rao's constant and Wada's constant increase with temperature which means that strong molecular interaction is taking place.

Conclusion

From the above table and figures it is cleared that 0.001M Hydroxichoroquine at different temperatures value of ultrasonic velocity, Rao's constat, Wada's constat increases it suggest that the strong molecular interaction at 308.15 K temperature and Relative Association value decreases it suggest that solvent breaking structure.

Reference

1. G. Thomas, Chemistry for Pharmacy and the Life Sciences, Prentice Hall, London, uk, 1996.

2. A. M. Ababneh, C. C. Large, and S. Georghiou, "Solvation of nucleosides in aqueous mixtures of organic solvents: relevance to DNA open basepairs," Biophysical Journal, vol. 85, no. 2, pp. 1111–1127, 2003.
3. T. B. Thoe, D. K. Aspinwall, and M. L. H. Wise, "Review on ultrasonic machining," International Journal of Machine Tools and Manufacture, vol. 38, no. 4, pp. 239 –255, 1998.
4. Dhote AB , Study of Acoustic Parameters of Rabeprazole Sodium in Different Solvents at 298.15K, Int. Res. J. of Science & Engineering, 2020; Special Issue A7: 860 -863 ISSN: 2322-0015
5. Drug". Dictionary.com Unabridged. v 1.1. Random House. 20 September 2007. Archived from the original on 14 Sep. 2007
6. A. B. Dhote, G. R. Bedare, K. P. Jumde Ultrasonic Velocity and Jones-Dole Equation B Coefficients for Aqueous Solution of Piperacillin and Tazobactam at Different Temperatures, hInternational Journal of Scientific Research in Science and Technology 9 (6) Print ISSN: 2395-6011 | Online ISSN : 2395-602X, 1104 -1106
7. Doxycycline for Malaria Chemoprophylaxis and Treatment: Report from the CDC Expert Meeting on Malaria Chemoprophylaxis Kathrine R. Tan,* Alan J. Magill, Monica E. Parise, and Paul M. Arguin, Am J Trop Med Hyg. 2011 Apr 5; 84(4): 517 – 531.doi: 10.4269/ajtmh.2011.10 -0285
8. U. G. Pathak, J. V. Patel, and P. H. Parsania, "Ultrasonic speed and thermodynamic parameters of novel epoxy resin solutions based on cardo symmetric double Schiff bases at 308.15 K," Journal of Solution Chemistry, vol. 41, no. 5, pp. 755 –765, 2012.
9. "Drug Definition". Stedman's Medical Dictionary. Archived from the original on 2014-05-02. Retrieved 2014 -05-01
10. C. Senthamil Selvi, K. Venkataramanan, V. Kannappan, C.Thenmozhi and S. Ravichandran, Asian Journal of Chemistry, 26 (8), 2471 (2014).
11. J. F. Kincaid and H. Eyring, "Free volumes and free angle ratios of molecules in liquids," The Journal of Chemical Physics, vol. 6, no.620, 1938.
12. Study of Relative Association, Apparent Molar Compressibility and Free Length of Entacapone API in alcohols at different Frequencies Sachin Deorao Zade, Padma Sachin Zade, Pravin J. Ganjre, Sunanda Shashikant Aswale and Shashikant Rajeshwar Aswale Indian Journal of Pharmaceutical Education and Research | Vol 50 | Issue 4 | Oct-Dec, 2016

17. Studies and Assessment of Water Quality Parameters of Akola District Region (Maharashtra)

S. J. Patil
Department of Chemistry Balapur (M.S.) India.

Abstract

Water is essential for all living being. Human need water in many daily activities like farming, drinking, cooking, etc. Quality of water is directly related to the life of human being. If the quality of water is not good then it affects the human life. During 10/07/2023 to 23/10/2023 surface water samples and open well water samples were collected from different sampling point in the range of 30km of Akola district region. Twenty water samples were analysed in the laboratory for their physical and chemical properties. Tests were performed in the laboratory for analysis of pH, EC, ORP, BOD, Hardness, Chlorides, TDS, DO etc. All the results were compared to the results against drinking water quality standard WHO (World Health Organization) and ISI Standard. The usefulness as well as un-usefulness, and importance of these parameters were discussed in predicting surface water and open well water quality characteristics.

Key Words; Drinking Water, BOD, COD, Physico-chemical study.

Introduction

Generally water is available in the form of ground water, surface water, springs, and atmospheric water. The quality of the water vary widely depending on the location and environmental factors.Water is absolutely essential not only for survival of human beings but also for animals, plants and all other living things. Water is transparent, tasteless, colourless, odourless inorganic chemical substance.In developing countries many water resources are not good for human being because they contain harmful biological, chemical and physical agent . Polluted water decreases the quality of water. i.e it is not potable for human being.For good health water should be safe. The river carries and assimilates industrial waste, festival waste and runoff from agricultural land. The water in that region becomes unhealthy for human being. The season wise variation always occurs in water quality. To control the variation (spatial or temporary) regular monitoring is essential.

Experimental

During 10/07/2023 to 23/10/2023 twenty water samples were collected of Akol district region. All samples collected in glass bottles as per standard. Presentation and transportation of water samples to the laboratory were as per standard methods. The bottles marked for the study of ground water and surface water stability for drinking and other domestic purpose. Water temperature was measured on the site by using mercury thermometer. Oxidation-reduction potential measured by potentiometer. Conductance measured by conductometer. pH measured by pH meter. Distilled water and A.R. grade samples were used. Parameters and method used to analyse samples are given below in the tables 1 & 2.

Hardness was varied in various regions. It was 82.6 ppm to 388 ppm. Hardness is due to presence of magnesium carbonate, calcium carbonate and bicarbonates. When decomposition rate and evaporating rate increases the concentration of magnesium and calcium increases.

Dissolved solids or total dissolved solids (TDS) due to the various types of, natural sources, minerals, sewage, urban runoff and industrial waste present in the water in dissolve form. The range of TDS was varied in various region. The range of TDS was 412.1 mg/L to 550 mg/L. Chloride is very important parameter for assessing the water quality. Higher concentration of chloride shows higher degree of organic pollution Percentage of chloride was varied in different region. In high evaporation the sodium and chloride ions attract each other and form salt crystal or it may be due to natural processes such as the passage of water through natural salt formation in the earth or it may be pollution from industrial waste. High chloride content may lead to laxative effects

Results and Discussion

The results of physical and chemical parameters are given in the table. All samples were odourless and colourless.The ph is important parameter of water which determine the suitability of water for human being for various purpose like drinking, cooking, bathing and agricultural purpose.The ph value of pure and neutral water is 7. The pH values of the water samples recorded in the range 7.21 to 7.42. Most of the water samples were alkaline in nature. The D.O. concentration of water samples varied from 6.55mg/L to 8.35 mg/L. The magnesium concentration and calcium concentration in the water samples ranges from 63.3mg/L to 161 mg/L and 17.3 to 161mg/L

Table 1

Parameters	Method	Standard values (WHO 1993)	ISI 1991
Colour	colorimeter		-
Odour	By smelling		-
Temperature	Thermometer	100°C	-
pH	pH meter	7.5 to 8.5	6.5 to 8.5
D.O.	Winkler method	< 5.0 mg/L	< 5.0
Alkalinity	Titrimetric	-	-
Chlorides	Titrimetric	250 mg/L	250
TDS	-	500 mg/L	500
Total hardness (as $CaCO_3$)	Titrimetric	100 mg/L	300
Total magnesium	Titrimetric	150 mg/L	30
Total Calcium	Titrimetric	100 mg/L	75 mg/L
BOD	Titrimetric	Not more than 8 mg	-
COD	Titrimetric	Not more than 250 mg/L	-
ORP	Potentiometer	-	-

Sr. No	**Location**	**pH**	**Conductance(ʊ)**	**ORP (mv)**	**TDS (mg/L)**	**DO (mg/L)**	**Chlorides (mg/L)**	**TH (ppm)**	**Mg (mg/L)**	**Ca (mg/L)**	**BOD (mg/L)**	**COD (mg/L)**
1	Bordi river,Bodkha	7.4	375	47.4	425	7.18	31.4	361	151	108	1.80	16.2
2	Bordi river,Chinchkhed	7.3	377	58.6	475	7.29	21.61	388	159	161	2.59	14.2
3	Bordi river,Patur	7.39	311.5	49.6	436.1	7.42	24.6	371	161	141	1.68	17.3
4	Bordi river,Shirla	7.40	390.1	51.3	492	7.39	28.6	362	126	148	1.74	16.1
5	Bordi river,Tandali	7.3	429.6	51.8	495	7.65	27.9	277	136	128	2.11	15.9

6	Morna river,Astool	7.38	430	63.5	462.5	7.79	29.1	226	91	69	1.73	20.1
7	Morna river,Pardi	7.39	420	57.5	475	7.2	28.6	235	96	56	2.55	16.1
8	Morna river,Agikhed	7.28	441.6	54.2	462.1	7.15	26.7	285	101	56	2.35	18.3
9	Morna river,Khamkhed	7.31	416.4	54	537	7.6	27.6	211	111.3	49	2.52	18.8
10	Morna river,Warkhed	7.34	430.1	52.2	412.1	7.25	30.1	235	116	55	2.23	17.1
11	Nakashi	7.26	466.6	56	420	7.93	115.5	85.3	97.8	17.3	2.01	21.83
12	Mazod	7.32	448.6	54.6	451	7.35	67	171.5	110.1	76.3	1.88	21.46
13	Indira nagar	7.39	451	56	506	7.10	42.9	211.3	88	58.6	2.01	21.53
14	Wadegaon	7.26	423.1	59.3	511	8.35	82.9	242	76.6	121	2.11	22.1
15	Channi phata	7.31	437	57.2	526	6.15	65.4	269.3	74	101	1.89	22.23
16	Chikhalgaon	7.36	514	55.6	293.1	7.85	54.1	118	85	62	1.77	23.3
17	Patur	7.40	543.6	57.8	473.3	7.52	61	98.6	63.3	44.3	1.98	23.3
18	Pardi	7.42	474	51.6	550	8.01	51.5	82.6	88	24.6	2.01	22.16
19	Khanapur	7.29	521.6	52.2	501.6	7.83	49	111.3	85	38.3	2.03	22.11
20	Tapalpatur	7.21	567	60	479	8.11	82.6	115.3	81	29.3	2.10	21

Conclusion

According to the various parameters studied, it is concluded that the TDS in some region is high. High value of TDS may cause gastrointestinal troubles. There are few treatment options

to reduce TDS in water, such as reverse osmosis system, Water filters and softners. Both water sources are useful for human consumption.

Acknowledgement

Authors are thankful to Principal of Shri Shivaji College, Akot for encouragement and providing necessary facilities

References

1. S.S.Castaneda, R.J.Sucgang, R.V.Almoneda, N.D.S.Mendoza and C.P.C.David, "Environmental Isotopes and measure ions for tracing leachate contamination from a municipal landfill in metro Manila, Philippines" Gernal of Environmental Radioactivity 110(2012), pp.30-37
2. Mane T.T. and Hingane Hemlata N, "Existing situation of solid waste management in pune city, India" Research journal of recent sciences, Volume-1, 2012, pp.348-351
3. Mona A, Hagras Assistant Professor, Irrigation and Hydraulics Departament, Faculty of Engineering, Ain Shams University, Cairo-Egypt
4. Jayant chutia, Mrudal Buragohain & Siba Prasad sharma Chem. Sci. 7(2) 1143-1152 (2009)
5. S.D. Dara, "Environmental Chemistry and Pollution Control", S.Chand and Company Publication
6. L.K. Gupta, D.P.Upadhyay, int. J.Chem. 9(4).2011
7. NEERI (1986) manual on water and waste water analysis Nagpur
8. Rajdeep Kumar and R.V.Singh int J chem, sci 7(4) 2534(2009)
9. Jadhavar, V.R. Ghorade, I.B and Patil S.S. ,(2010), Assessment of groubd water quality in and around Nagothane Region Dist Raigadh, Maharashtra, J.Aqua.Biol.,25(2);91-99

18. Recent Trends in Internet of Things: Issue Challenges and Applications

S. M. Dhakulkar
Assistant Professor, Department of Computer Science, G. S. Tompe Arts, Commerse and Science College, Chandur Bazar.
A. P. Fulari
Assistant Professor, Department of Computer Science, G. S. Tompe Arts, Commerse and Science College, Chandur Bazar.

Abstract

The world is undergoing towards modern technology, while specialized companies are existing a terrible rush in the information technology towards the so-called Internet of things IoT or Internet of objects, which is the integration of things with the world of Internet, by adding hardware and software. To be smart and able to communicate with each other and participate effectively in all aspects of daily life, new forms of communication between people and things, and between things themselves is required. Which will change the traditional life into a high style of living. In this review paper various application, challenges and issues of IoT were discussed.

Keywords: Internet of things (IoT), Smart Communication, Smart city, Network interface

1. Introduction

In Today's Day to day life Internet of Things is an emerging topic of technical, social and economic importance. IoT is everywhere, although we know that a device is part of it. For consumers, new IoT goods like Internet-enabled devices, home automation components and power management devices take initiative toward seeing "Smart home", which provides us more security and energy efficiency.

The IoT technology improved levels of independence quality of life at reasonable cost [1]. Internet of things systems such as networked vehicles, smart traffic systems, and sensors embedded in roads and bridges bring us closer to the idea of "smart cities", which reduce congestion and energy consumption. IoT technology offers the potential to transform agriculture, industry, and energy production and distribution is increasing availability of information along

the production value chain using networked sensors. A number of companies and research organizations have a wide range of expectations about the potential impact on Internet of Things over the next decade. [2].

2. Issues and Challenges of IoT

In all aspects of human lives, the sharing of IoT based systems and the various technologies involved in transferring data between embedded devices made it complex and directed to many problems and challenges.

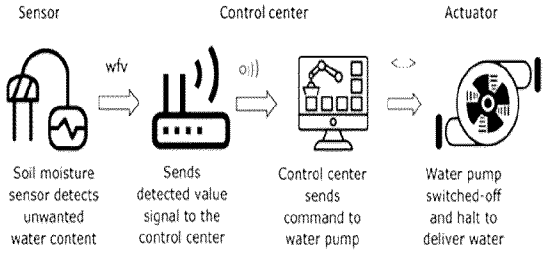


Figure 14. Example of an actuator (pump water).

2.1 Security

While security aspect is older in the IT context, The features of many IoT applications present new and unique security challenges. Poorly secured IoT devices and services can act as potential entry points for a cyber attacker and expose user data to theft by leaving data flow inadequately protected [6]. Every poorly secured device connected to the Internet has the potential to affect Internet security. The ability of some devices to automatically connect to others, and the potential for deploying these devices in insecure environments [7].

2.2 Privacy

The data flows and user confidentiality that IoT devices provide can open up unbelievable and exceptional value for IoT users, but concerns about privacy and potential harms may hinder the full adoption of IoT. This means that privacy rights and respect for user privacy expectations are integral to ensuring user confidence in the Internet, connected devices, and related services [8].

2.3 Interoperability and Standards

The ability to exchange information between various IoT devices and systems is called interoperability. This exchange of information is not dependent on published software and hardware. The four levels of interoperability are technical, semantic, syntactic, and organizational [9]. Interoperability as an important issue, so researchers have several solutions

such as adaptive, gateway based, virtual network and service-based architecture. [10]. There are still some challenges that remain with the possibility of interoperability which could be major area for future studies [11].

2.4 Legal, Regulatory, and Rights

Many real-life problems have been solved with the development of the Internet of Things but have also given rise to critical and legal challenges such as data security, privacy protection, trust, security, and data usability [12]. It has observed that the main IoT users support privacy, safety government rules and regulations regarding data protection due to mistrust of IoT devices.

2.5 Emerging Economies and Development

The Internet of Things holds great promise to deliver social and economic benefits to emerging and developing economies areas such as sustainable agriculture, water quality and use, health care, manufacturing, and environmental management, among others. [13].

3. Application of IoT

IoT applications promise to make our lives easier and bring enormous value with new wireless networks, high sensors, and superior capabilities. IoT applications uses several important areas. The following application areas are the top for 2020 analysis [14].

3.1 Manufacturing/Industrial

The IoT manufacturing application area covers a widespread range connection from objects to objects, projects from inside and outside. For the inside, many IoT-based factory automation and control projects include comprehensive smart factory solutions with many elements such as production floor monitoring, wearable devices and augmented reality in the shop floor, remote PLC or automated quality control systems.

Autonomous vehicles with the convergence of technologies like robotics, sensors, 3D cameras, 5G connectivity, software and artificial intelligence, autonomous vehicles having found their way safely onto factory floors as a means of increasing the speed and accuracy of routine operation [15].

Machine utilisation IoT architecture has emerged as a popular and powerful way to monitor machine usage. They can also be used to compare the performance of devices across one or more sites [16].

3.2 Transportation/Mobility

Maintaining vehicle health relies on the use of Internet of Things (IoT) communication tools that collect data about the performance of different parts, transfer that data to the cloud in real time and assess the risk of a possible malfunction of the vehicle's hardware or software. [17].

According to a recent study by Tony and James [18], car ownership will decrease by 80% by 2030. You can see that actually happen. City dwellers sell or never buy cars. They choose to use ride-sharing like Uber, DiDi and Alibaba bikes, in addition to relying on steadily improving public transportation services.

3.3 Energy

With energy consumption worldwide expected to grow by 40% over the next 25 years, the need for a smarter energy solution has reached an all-time high. Fortunately, there are some major shifts towards more efficient energy management from smart light bulbs to fully autonomous offshore oil platforms. Overall, IoT is transforming nearly every part of the energy industry from generation to transmission to distribution and changing how energy companies and customers interact. Safety drones [19] that can be used as part of a risk management system to reduce employee risks at nuclear plants or on mining sites.

3.4 Retail

More retailers are realized that, they can improve their cost efficiency and customer experience through use of IoT. Retail now accounts for 9% of selected projects, up from 5%. [20].

3.5 Smart Cities

A study shows that using existing smart city applications, cities improve quality of life indicators (such as crime, traffic, and pollution) by between 10% and 30%. Internet of Things in our day to day life as part of your home, transportation, or city, relate to a more efficient and enjoyable life experience [21].

3.6 Healthcare

For specific IoT health applications such as telehealth consulting, digital diagnostics, remote monitoring, and robotic assistance demand is increasing. IoT Healthcare apps help to decrease waiting time for the emergency room, tracking the patients, employees, and inventory;

Strengthening drug management. IoT has also introduced several wearables and devices which has made lives of patients and doctors comfortable [22].

3.7 Supply Chain

Internet of Things devices are an operative way to track and authenticate products and shipments using GPS and other technologies in the supply chain. Also, they can monitor product storage conditions which enhance quality management throughout the supply chain.

3.8 Agriculture

The current population of the world is 7.8 billion in 2020 and it is expected to reach 8.6 billion in 2030, 10 billion in 2050 and 11.2 billion in 2100 [24]. So, to satisfy feed of this huge population required to marry agriculture to technology and obtain good results.

One of many possibilities that exist for solving this problem is a smart greenhouse. Which is a revolution in agriculture, creating a self-regulating microclimate suitable for plant growth through the use of sensors, motors, and monitoring and control systems that and automate the growth process improve growing conditions [25].

3.9 Buildings

Smart building technology can achieve higher levels of integration between existing building systems. However, smart building technology will go beyond those concepts have an amazing ability to connect people with technology. [26].

4. Conclusion

The Internet of Things holds an important promise to provide social and economic benefits to the emerging and developing economy. Areas such as sustainable agriculture, water quality and use, health care, manufacturing and environmental management, needs to be addressed also the issues and challenges associated with IoT must be considered.

References

1. Domingo, M.C., "An Overview of the Internet of Things for People with Disabilities." Journal of Network and Computer Applications, 35, 584-596. 2012
2. Manyika, et al. (2015) The Internet of Things: Mapping the Value Beyond the Hype. Mckinsey Global Institute, San Francisco.
3. Global Connectivity Index. Huawei Technologies Co., Ltd., 2015.
4. IEEE Communication Society—IEEE Communication Magazine.

5. Bradbury, D. (2015) How Can Privacy Survive in the Era of the Internet of Things? The Guardian, April 7, Sec. Technology.
6. Gatsis, K. and Pappas, G.J. (2017) Wireless Control for the IoT: Power Spectrum and Security Challenges. 2017 IEEE/ACM Second International Conference on Internet-of-Things Design and Implementation (IoTDI), Pittsburgh, 18-21 April 2017, 341-342.
7. Babovic, Z.B., Protic, V. and Milutinovic, V. (2016) Web Performance Evaluation for Internet of Things Applications. IEEE Access, 4, 6974-6992.
8. Wilton, R. (2014) CREDS 2014-Position Paper: Four Ethical Issues in Online Trust. Issue Brief No. CREDS-PP-2.0. Internet Society.
9. Van-der-Veer, H. and Wiles, A. (2008) Achieving Technical, Interoperability-The ETSI Approach.
10. Noura, M., Atiquazzaman, M. and Gaedke, M. (2017) Interoperability in Internet of Things Infrastructure: Classification, Challenges and Future Work. Third International Conference, IoTaaS 2017, Taichung, 20-22 September 2017, 11-18.
11. Noura, M., Atiquazzaman, M. and Gaedke, M. (2019) Interoperability in Internet of Things: Taxonomies and Open Challenges. Mobile Networks and Applications, 24, 796-809.
12. Tzafestad, S.G. (2018) Ethics and Law in the Internet of Things World. Smart Cities,
13. The Internet Governance Forum Dynamic Coalition on the Internet of Things (DC IoT) Has Been Particularly Active in Considering the Impact and Challenges of IoT in Emerging and Developing Economies. http://www.iot-dynamic-coalition.org
14. IOT Analytics: Market Insight for IOT; Top 10 IoT Applications in 2020. https://iot-analytics.com/top-10-iot-applications-in-2020
15. Automotive Systems Manufacturer Faurecia (ASMF). https://www.mobile-industrial-robots.com/en/about-mir/news/mobile-industrial-robots-announces-strategic collaboration-with-faurecia-to-optimize-its-internal-logistics-globally
16. IoT in Manufacturing. https://www.scnsoft.com/blog/iot-in-manufacturing
17. The Next Level of Predictive Maintenance. https://connectitude.com/sv/the-next-level-of-predictive-maintenance

18. Tony Seba and James Arbib; Rethinking Transportation 2020-2030. https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/591a2e4be6f2e1c13df930c5/1494888038959/RethinkX+Report_051517.pdf
19. Public Safety Drones Use: Policy and Legal Challenges.https://medium.com/homeland-security/public-safety-drone-use-policy-legal-challenges-491a504a1b3c
20. The Internet of Things (IoT) in the Retail Industry—Evolutions and Use Cases. https://www.i-scoop.eu/internet-of-things-guide/internet-things-retail-industry
21. Durán-Sánchez, A., et al. (2017) Sustainability and Quality of Life in Smart Cities: Analysis of Scientific Production. In: Sustainable Smart Cities. Creating Spaces for Technological, Social and Business Development, Springer, Berlin, 159-181.
22. https://econsultancy.com/internet-of-things-healthcare
23. The Internet of Things Changing the Future of Supply Chain.https://cerasis.com/future-of-the-supply-chain
24. Projections of Population Growth. https://en.wikipedia.org/wiki/Projections_of_population_growth
25. Smart Greenhouse Remote Monitoring Systems.https://www.postscapes.com/smart-greenhouses
26. What Is Smart Home Technology?https://www.pcmag.com/news/the-best-smart-home-devices.

19. Study the Acoustic Parameters of Li, Na, K ion Salts in Aqueous of Different Concentration at 303K

S. P. Burad
Nilkanthrao Shinde Science & Arts College, Bhadrawati.
A. B. Dhote
Nilkanthrao Shinde Science & Arts College, Bhadrawati.

Abstract

The use of Ultrasonic Velocity study is well recognized approach for the study of molecular interaction in fluids. Thermodynamic properties are convenient parameter for interpreting solute-solvent and solute-solute interaction in solution phase. The density, velocity and viscosity of Lithium ,Sodium and Potassium salt in water of different concentration are calculated at 303K .Acoustic parameter were calculated from experimental data which help to predict molecular association.

KeyWords: Aqueous Lithium solution, AqueousSodium solution, Aqueous Potassium solution, Ultrasonic, Molecular interaction, acoustic parameter.

Introduction

Ultrasonic waves sound waves too high pitched for human ears to detect. Their frequencies range from 20,000 Hertz to about 10 trillion Hertz. Ultrasonic waveswork on the principle that sound is reflected at different speed by tissues or substances ofdifferent densities. The use of Ultrasound is one of the important tool for study of molecular interaction in different binary mixture of solution. In industry ultrasonic waves have been used in the testing of machinery and machine part. In medical, analyticaland different field ultrasonic investigations are very useful.

The ultrasonic waves helps the study of molecular interaction in liquids provide valuable information regarding internal structure, internal pressure, molecular association,complex formation etc.The ultrasonic techniquesalso reveal weak interaction due to its useful wave length range. Moreover ultrasonic parametersare directly related to a large number of molecule or thermodynamic parameter. Since various liquid state theories are based upon thermodynamic consideration, ultrasonic absorption, coefficients and velocities provide means to study them.

The Ultrasonic study of binary liquid mixture is important in understanding the nature of molecular interaction. The nature and degree of molecular interaction of different salt in the solution depend upon the nature of ions and nature of solvent. Ultrasonic velocity and derived acoustic parameter provide valuable information about the molecular interaction. This has been studied for various binary mixtures with respect to variation in concentration of liquid. The acoustic thermodynamic parameter have been used to study different kinds of association , molecular motion and various types of interaction and their strength influenced by the size of different ions and the solvent

Inpresentinvestigation Ultrasonicvelocityandrelatedacousticparametersof LiCl, NaCl and KCl with water havebeencalculatedat303Kfor differentmolefraction (0.06 to 0.09) concentration.

Materialand Experimental Method

Inthepresentexperimental work the different molefractionof LiCl, NaCl and KCl inwater has been prepared. All the salt and solvent used are of AR Grade sample. All thesolutions werepreparedindeionizedanddistilledwater. Following parameterswerecalculated

Velocitymeasurement

The ultra sonicve locity of binary mixture for Li Cl in water, Na Cl in water and KCl in water has been measured using an ultrasonic inter ferometer (Mittal type, Model F-81) working at 2MHz fre quency and attemperature 303K.The accuracy of sound velo city was+0.1ms-1. An electronically digital operated constanttem perature water bathhas beenused to circulate water through the double walled measuring cell made up of steel containing the experimental solution at the desiredtemperature.

Density Measurement

The densities was measuredusinga 25 mlspe cificdensity bottle by measuremen twithanac curacy of + 0. 01 Ns-1m- 2 relative specific gravityof 0.01Kg. The weigh tof the sample was measure dusingan electronic digital balance withana ccuracyof+0.1mg

Viscosity Measurement

Ostwald Viscometer was used for measuring viscosity of flowing time with the accuracy of +0.1 by usingdigitalstopwatch.

The parameters such as adiabatic compressibility (β), inter molecular free length (Lf), andacousticimpedance (Z), arecalculatedbyusingthefollowing

Relation (1- 3).

$\beta=(U2\rho)-1$ .....(1)

$Lf=KT\beta a½$ ……(2)

$Z=U\rho$ …… (3)

Result and Discussion

The experimentally measured values of ultrasonic velocity density and viscosity of the solution and calculated values of acoustic parameter such as adiabatic compressibility, acoustic impendence intermolecular free length for LiCl in water are reported in TableI NaCl in water are reported in Table IIand KCl in water are reported in Table III for different molar concentration (0.06 to 0.09 Mole fraction) at temperature 303K.

Table I,II and III and fig 1 shows that ultrasonic velocity increases with increase in concentration of aqueous solution of LiCl, NaCl , and KCl shows that as concentration increases there is strong molecular association between solute and solvent. Hence strong molecular interactions exist in aqueous solution of LiCl as compared to NaCl and KCl.

The variation of ultrasonic velocity in mixture depends upon the increase or decrease in intermolecular free length as there is gradual decrease it also indicate strong molecular interaction in the solution with increase in concentration. The increase in viscosity with increase inconcentration also indicate the good molecular forces between the solute and solvent molecule.

From Table I,II and III it is observed that Acoustic impendence increases with increase in concentration of aqueous solution of LiCl, NaCl and KCl respectively .Acoustic impendence have opposite behavior of that adiabatic compressibility and intermolecular free length.

As the calculated values of adiabatic compressibility and intermolecular free length are continuously decreases in table I,II and III it shows greater molecular interaction ions and solvent .The values of above acoustic parameter for Li is less as than Na and K ion hence the Li ion salt interact more as compared Na and K ions salts

According to coulombs law, the smaller an ions the greater molecular interaction it will have the larger is ion the weaker is the attraction. By using the charges on ions and its size we can determine which ion will have the strongest and weakest ion-dipole interaction force .Due to smaller in size of Li+ ion it has more intermolecular interaction with polar solvent water as compared to Na+ ion and K+ ion.

Table I:Measured values of ultrasonic velocity (U), Density (ρ), Viscosity (η), Adiabaticcompressibility (β), Acoustic Impendence (z), Mean Free length (Lf) of aqueous solution LiCl at 303K

LiCl in H_2O at 303K						
Mole Fraction	Veocity	Density	Viscocity	Adiabatic compressibility	Acoustic Impendence	Free Length
0.06	1586.32	1026.14	1.1204	3.872681521	1.62778640	0.41214198
0.07	1592.32	1031.21	1.1485	3.824654278	1.64201631	0.40957841
0.08	1596.14	1035.06	1.1531	3.792211158	1.65210067	0.40783756
0.09	1601.02	1037.41	1.1841	3.760590596	1.66091416	0.40613367

TableII: Measuredvaluesofultrasonicvelocity (U), Density (ρ), Viscosity (η), Adiabatic Compressibility (β), AcousticImpendence (z), Mean Freelength (Lf) of aqueous solution of NaClat303K

NaCl in Water at 303K						
Mole Fraction	Veocity	Density	Viscocity	Adiabatic compressibility	Acoustic Impendence	Free Length
0.06	1550.31	1037.61	1.1201	4.009855796	1.608617159	0.41937771
0.07	1554.12	1039.26	1.1445	3.983884042	1.615134751	0.41801735
0.08	1560.71	1042.18	1.1532	3.939243611	1.626540748	0.41566876
0.09	1565.32	1045.32	1.171	3.904311606	1.636260302	0.41382164

TableIII: Measuredvaluesofultrasonicvelocity (U), Density (ρ), Viscosity (η), Adiabatic Compressibility (β), AcousticImpendence (z), MeanFreelength (Lf) of) of aqueous solution KCl at303K

KCl in Water at 303K						
Mole Fraction	Veocity	Density	Viscocity	Adiabatic compressibility	Acoustic Impendence	Free Length
0.06	1534.61	1047.23	1.0658	4.054729412	1.60708963	0.42171777
0.07	1542.81	1049.32	1.0981	4.003751912	1.618901389	0.41905840
0.08	1551.16	1051.32	1.1189	3.953228154	1.630765531	0.41640593
0.09	1557.2	1053.26	1.1256	3.915395332	1.640136472	0.41440862

Conclusion

In present investigation the various acoustic parameters such as adiabatic compressibility, Intermolecular free length, Acoustic impendence have been evaluated from Ultrasonic velocity, Density and viscosity for aqueous solution of LiCl, NaCl and KCl at 303K. From the study it is concluded that Values of ultrasonic velocity, viscosity and acoustic impendence are gradually

increases with increase in concentration of aqueous solution of Li, Na and K and decrease ofIntermolecular free length, Adiabatic compressibility which indicate strong molecular interaction between solute and solvent in of each salt aqueous solution y increase in mole fraction concentration at constant temperature.

The study of all the acoustic parameter concludes that Salt of Li ions interact more with solvent has strong intermolecular interaction as compared to salt of Na ion and K ion due to smaller in ion size.

References

1. J.Blitz, FundamentalsofUltrasonic, Butterworth&Co.Ltd. London, (1963).
2. M.K.S.Suslick, Ultrasound: It's Chemical, Physicaland BiologicalEffects, VCH, Weinheim, (1988).
3. T.J.Mason; Ed., Sonochemistry. Theuseofultrasoundinchemistry, Roy. Soc. Chem., (1990).
4. N., Kulkarni, B. Moudgil, M. Bhardwaj, Am. Cer. Soc., Cer. Bull73, 6 (1994).
5. M.C., Bhardwaj, Proc. Am. CeSoc89 (1998)
6. S. Acharya, R. Palikray., G. C. Mohanty, Ind. J.PureandAppl. Phys.,41,855–857
7. Sunanda S. Aswale, Shashikant R. Aswale Aparna B. Dhote, International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064,464-467
8. Sunanda S. Aswale, Shashikant R. Aswale Aparna B. Dhote 0971-9563) Vol 14 (2), December 2014, pp. 251-254
9. Ubagaramary D, Muthu Vijayan Enoch IV, Mullainathan S, Kesavaswamy,

20. GIS Based Morphometric Analysis of Pili Watershed in part of Sapan River, Amravati District, Maharashtra, India

S. R. Warghat
Department of Geology, Bharatiya Mahavidyalaya, Amravati.
S. V. Kulkarni
Department of Geology, Bharatiya Mahavidyalaya, Amravati.
A. A. Gawande
Department of Geography (Geoinformatics), Savitribai Phule Pune University, Pune.
Y. K. Mawale
Department of Geology, Sant Gadge Baba Amravati University, Amravati.
P. S. Tidke
Department of Geology, Sant Gadge Baba Amravati University, Amravati.

Abstract

The present paper deal with the morphometric analysis of the Pili watershed, it is tributary of Sapan River, Achalpur Taluka, Amravati District, Maharashtra, India. The study area is situated in the Survey of India Toposheet nos. 55G/7, 55G/11, and 55G/10 lie between latitude 21°24'0" N, 21°12'0" N longitude 77°30'0" E, and 77°39'0" E. The main purpose of the work is to determine the complete stream properties from the measurement of various stream attributes. The quantitative drainage analysis is done aspects wise such as linear aspects, aerial aspects and relief. The linear aspects include stream order, stream number, stream length, bifurcation ratio, mean length of stream orders, stream length ratio, mean stream length ratio, and form factor. The areal aspects involve drainage density, stream frequency, and texture ratio, as well as the constant channel maintenance and length of overland flow. The relief aspects include relief ratio, relative relief, ruggedness number and melton ruggedness number. Morphometric analysis is carried out using ArcGIS software, an advanced tool for measuring the drainage basin, the earth's surface dimensions of landform, and shape within a short time. The direction of the basin is from North to South. Based on the above results, it is inferred that in the study area, groundwater prospects are good.

Key Words: Morphometric Analysis, Remote Sensing, G.I.S., Pili River, Achalpur

Introduction

Morphometry is the measurement and mathematical analysis of the configuration of the Earth's surface and the shape dimensions of its landforms. Morphometric analysis is a significant tool to understand channel networks, ground slopes, structural control, geologic and geomorphic history of a drainage basin (Strahler, 1957, 1964). Pioneering work in the field of Morphometric characteristics has been carried out by Horton (1932 and 1945). He has carried out a revolutionary study for evaluating the morphometric setup. Schumm (1956) investigated the evolution of the drainage system as per the slope. Melton (1958) studied the geomorphic properties of the matured drainage system. Strahler (1952, 1956). Miller (1953) and others are based on the premise that for the given conditions of lithology, climate, rainfall, and other relevant. Morphometric analysis of a watershed provides a quantitative description of the drainage system which is an important aspect of the characterization of watersheds (Strahaler, 1952, 1957, 1964).

The morphometric analysis is performed successfully through the measurement of linear, aerial, relief aspects (Pareta and Pareta, 2012; Magesh et al., 2011; Prakash et.al., 2016). The basin morphometric parameters are strongly associated with basin hydrologic processes (Altaf et al. 2013; Pophare and Balpande, 2014; Prakash et al. 2017; Kaushik and Ghosh, 2018). Remote sensing (RS) and GIS technology have been playing an effective role in the morphometric analysis and it has great potential as it gives cost-effective results (Pankaj and Kumar, 2009; Sangita and Nagarajan, 2010; Samal and Nagarajan, 2015). Digital elevation model (DEM) is the dataset used for making the stream network, creating slope map and also for various studies (Jensen 1991; Pareta and Pareta, 2011, Forkuor and Maathuis, 2012; Kaushik and Ghosh 2015; Patel et al. 2016;). Using GIS software exact representation and quantitative measurements with more accurate results are possible in less time. Morphometric analysis using remote sensing and GIS techniques have been well demonstrate recently by some of the researchers (Sarmah and Tiwari 2012; Vandana, 2013; Singh and Kanhaiya, 2015; Chandrashekar et. Al., 2015; Sahu et.al., 2016; Moharir et.al 2017; Kumar 2018; Prakash et al 2019; Gautam et. al., 2020; Bhatt et.al., 2021; Shelar et.al., 2022)

Study Area

The Pili River rises in the Satpura range in Madhya Pradesh at an elevation of about 340 m to 750 m. The study area is located in Achalpur and Chandur Bazar talukas of Amravati

district, Maharashtra. It is sub tributary of the Sapan River, with a basin area covering a total of 250.89 sq.km area. The study area comes under Survey of India Topographic sheets Nos. 55G/7, 55G/10, 55G/11. It falls between latitude 21°24'0" N, 21°12'0" N longitude 77°30'0" E and 77°39'0" E.

Aim and Objective of the study

Aim – GIS based morphometric analysis Pili watershed part of Sapan River, Amravati district Maharashtra.

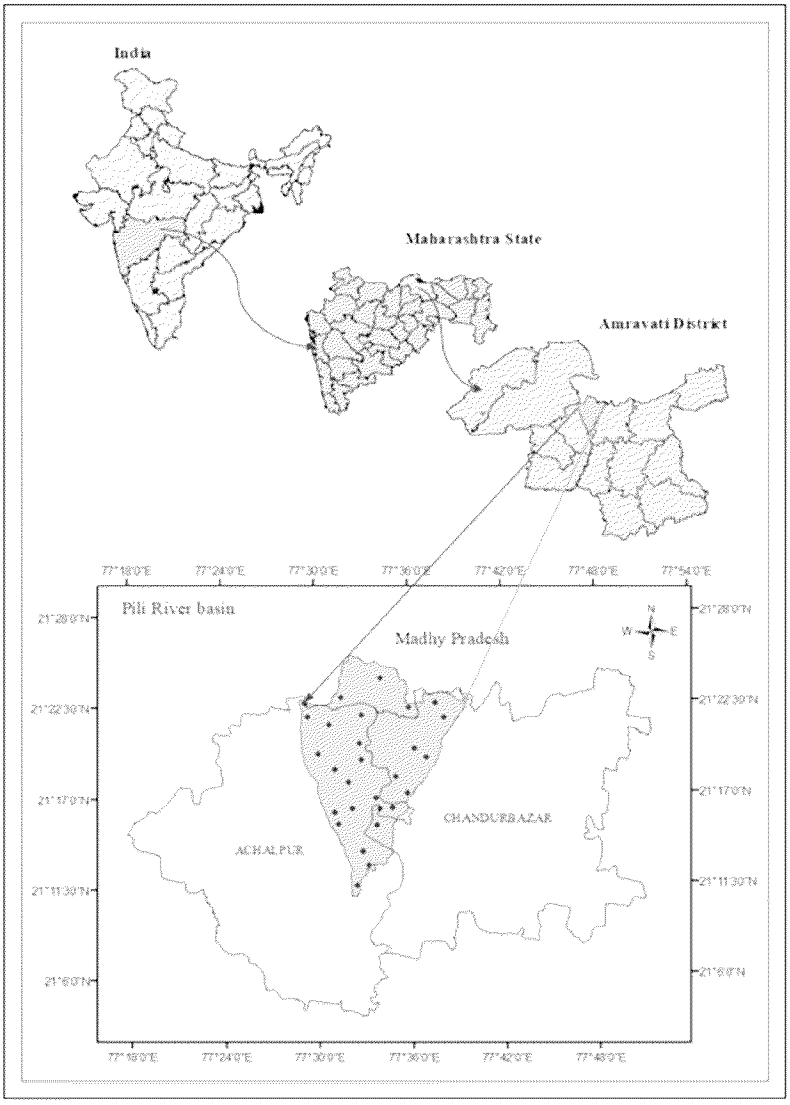


Figure 1: Study area Location map

Objectives

- To study morphometric analysis of the Pili River basin.
- To assess the hydrodynamic condition of surface and groundwater reserves of the study area.
- To understand the water scarcity in the study area.
- Synthesize and compilation of all the data for the management of hydrogeological resources and sustainable development of the study area.

Materials and Methods

The following material and methodology will be adopted to achieve the various objectives of the proposed research.

Data and Software Used

- Topographical Map: Survey of India (1:50,000) 55G/11, 55G/10, 55G/7.
- ASTER (DEM) with 30m spatial resolution.
- LISS-IV Mx satellite imagery with30m spatial resolution
- ArcGIS 10.3 software

Methodology

The morphometric parameter such as linear, aerial, and relief aspects of the study area were determined and computed using the GIS approach. The methodology adopted for the morphometric analysis is described as follows;

- The entire study area is delineated from the rectified mosaic survey of India topographic maps 55H/7, 55H/13 on a scale of 1:50000 with help of ArcGIS environment assigning using projection UTM, WGS 1984, 43 N Zone.
- Digitization of drainage in the study area from the geo-reference survey of India toposheet.
- Various Morphometric parameters such as linear, aerial, and relief aspects for the study area were computed as per the methodology suggested by Horton, Strahler, etc.

Firstly, from the satellite image, the drainage characteristics have been extracted and a drainage map has been prepared. This was used to confirm the morphometric characteristics from the survey of India toposheet. The linear, aerial, and relief aspect of the taluka has been determined on a grid basis.

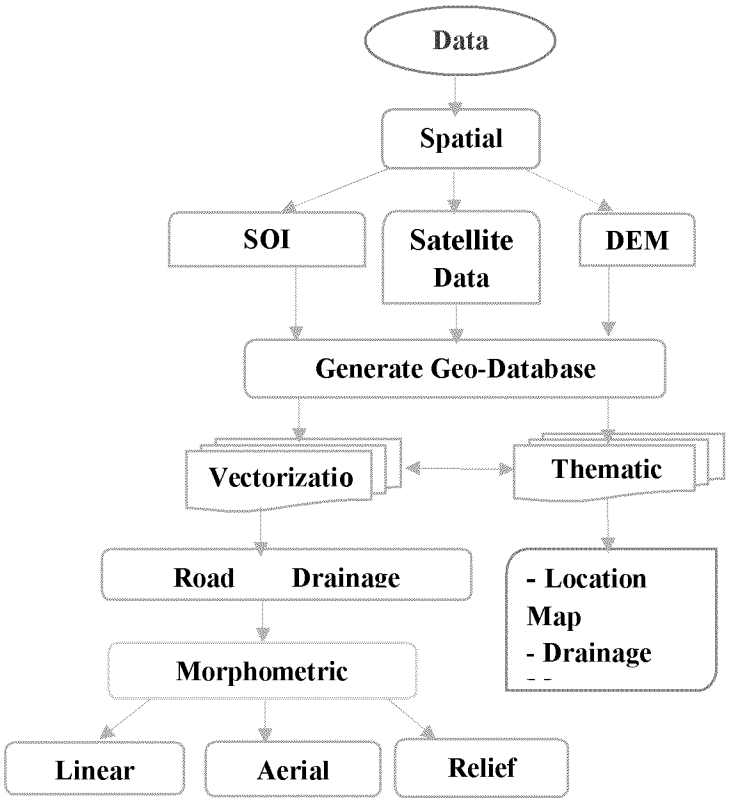


Figure 2: Flow chart of the Morphological analysis.

Results and Discussion

The present study integrated the use of the GIS technique and the results of morphometric parameters that have been determined are discussed and briefly described. Results of morphometric parameters such as linear, aerial, and relief aspects for the study area are shown in Table 2, Table 3, and Table 4. The study of the Pili river is the 6^{th} order basin. The total drainage basin area of the Pili River basin is 250.89km. Morphometric parameters such as linear, areal, and relief for the basin area were calculated based on the formula suggested by Horton (1945), Strahler (1964), Schumn (1956), and Miller (1953). In the present study, the morphometric analysis is carried out using mathematical formulae given in Table 1.

Table 1: The different parameters executed for morphometric analysis

Sr. No	Morphometric Parameters	Methodology	References
1.	Area (A)	Calculate in GIS	-
2.	Perimeter (P)	Calculate in GIS	-
3.	Basin length (Lb) (km)	Lb= 1.312*A	Nookaratnam et.al (2005)
4.	Stream order (Nu)	Hierarchical rank	Strahler (1957)
5.	Stream length (Lu) (km)	Length of the stream	Horton (1945)
6	Mean stream length	Lsm = Lu/Nu	Strahler (1957)
7	Bifurcation ratio (Rb	Rb=Nu/N(u+1)	Horton (1945)
8.	Stream length ratio (Rl)	RL = Lu/Lu-1	Horton (1945)
10.	Drainage density (Dd)	Dd=∑Lt/A,	Horton (1945)
11	Stream frequency (Fs)	Fs=N /A	Horton (1945)
12.	Drainage texture (Rt)	Rt = Nu/P	Horton (1945)
13.	Length of Overland Flow (Lo):	Lo = 1/D*2	Horton (1945)
14.	Constant Channel Maintenance (C)	C=1/Dd	Horton (1945)
15.	Form factor (Ff)	Rf = A/Lb2	Horton (1945)
16.	Circulatory ratio (Rc)	Rc = 4*Pi*A/p2	Strahler (1964)
17.	Elongation ratio (Re)	Re = (2/Lb) *(A/pi)0.5	Schuman (1956)
18.	Shape index (Sw):	Sw=1/Ff	Horton (1932)
19.	Texture ratio (T):	T= Nu/P	Horton (1945)
20.	Compactness Coefficient (Cc):	$Cc = Pc/Pu$	
21.	Height of basin mouth (z):	The lowest elevated point of the basin	Schumm (1956)
22.	Height of highest point of the basin (Z):	The heights elevated point of the basin	Schumm (1956)
23.	Basin relief (R):	R= H-h	Schumm (1956)
24.	Relief ratio (Rh):	Rr= R/Lb	Schumm (1956)
26.	Ruggedness number (RD):	HD= H×Dd	Strahler (1964)
27.	Coarse ratio (Cr):	R*Dd/1000	Choreley (1986
28.	Melton Ruggedness Number (MRn):	MRn=H-h/A0.5	Melton (1965)

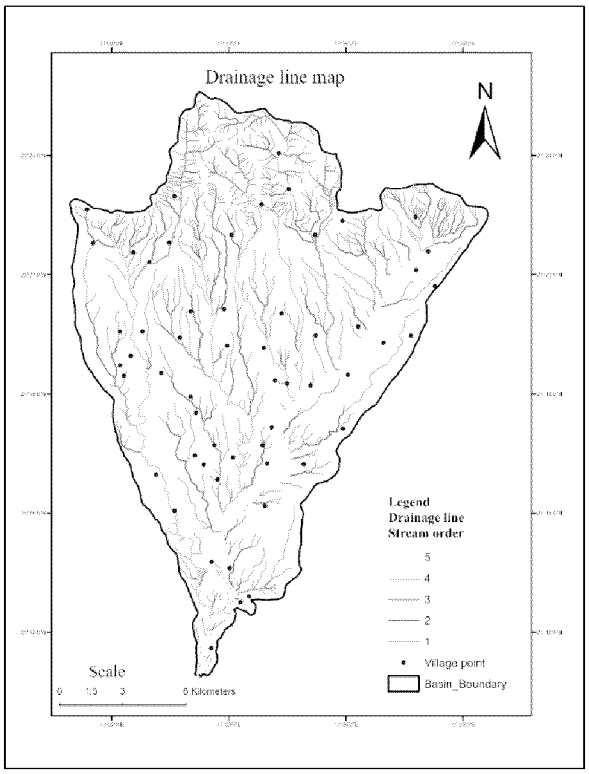


Figure 3. Drainage map of Pili River Basin

Morphometric Analysis

1. Linear Aspect

Stream ordering (Nu)

Stream order is the first step of quantitative morphometric analysis. It is observed that as the stream order increases, the number of segments. The number of streams of any certain order will be fewer than for the next lower order but it is more numerous for the next higher order. In the present study, the order-wise stream numbers estimated are given in Table 2.

Stream length (Lu)

Stream length (Lu) is defined as the total length of all streams of each order in the drainage basin. The length of each stream was calculated by the law proposed by Horton (1945). The stream length of the basins was measured with the help of GIS software. Generally, the total length of stream segments in first-order streams is maximum and decreases as the stream order increases. The maximum length of the Pili River basin is 604.98 km. Where the length of the I order is 339.06 Km, the II order stream is119.64 Km, the III order stream is 51.80 Km, the IV order stream is 64.68 Km, V order stream is 29.80 Km.

Mean stream length (Lsm)

The mean stream length is calculated by dividing the total stream length of order 'u' and the number of streams of the segment of order 'u'. In the study area, it is needed that Lsm varies from 0.6820 to 29.802 km.

Stream length ratio (RL)

The stream length ratio (RL), is the ratio of the mean length of the stream of a given order (Lu) to the mean length of the stream of the next lower order (Lu-1). The stream length ratios between the streams of different orders of the study area show a change in the basin. This change might be attributed to a variation in slope and topography, indicating the late youth stage geomorphic development in the stream of the study area. The stream length ratio for orders II/I is 00.23, and for III/II, IV/III, and V/IV are 0.24, 0.20, and 0.16 respectively.

Bifurcation ratio (Rb)

The bifurcation ratio is the ratio between the number of streams in the previous order and the next. The bifurcation ratio of a large basin is generally is average of the bifurcation ratio of the order of the streams within it. The higher value of the bifurcation ratio indicates a strong structural control in the drainage pattern whereas the lower value indicates less affected drainage by structure disturbances (Strahler1964). In the present study area, the ratio varies from 4 to 6 in the basin area.

Mean Bifurcation ratio (Rb)

The mean bifurcation ratio is the arithmetic mean of bifurcation ratios. In the present study, the mean bifurcation ratio of the Pili basin is 4.77.

Table 2: Linear aspect of the morphometric parameter of the study area

Parameter	**Results**				
Stream order (U)	I	II	III	IV	V
Stream number (Nu)	497	119	29	6	1
Stream length (Lu) in km.	339.06	119.64	51.80	64.68	29.80
Mean stream length (Lu)	0.682	1.005	1.786	10.786	29.802
Bifurcation ratio (Rb)	I/II	II/III	III/IV	IV/V	V
	4.18	4.10	4.8	6	-
Mean Bifurcation ratio (Rb)	4.77				
Stream length ratio (Rl)	II/I	III/II	IV/III	V/IV	-
	0.23	0.24	0.20	0.16	
Área (A)	250.89 sq. km				
Perímeter (P)	81.45m.				

2. Aerial aspect

Drainage density (Dd)

Drainage density is defined as the ratio of the total length of the streams of all orders of the basin to the area of the basin. The drainage density is a quantitative measure of the average length of stream channel for the whole basin. Low drainage density generally results in areas highly resistant to permeable subsoil material, dense vegetation, low relief, and coarse drainage texture. High drainage density is resultant of weak or impermeable subsurface material, thin vegetation, hilly relief, and fine drainage texture. The drainage density of the present study is 2.41 indicating low drainage density.

Stream frequency (Fs)

Stream frequency is the number of streams per unit area of the basin (Horton, 1945).It mainly depends upon the lithology of the basin and reflects the texture of the drainage network. The stream frequency of the study area is 2.60. An increase in stream frequency concerning an increase in drainage density has been noticed in all sub-study areas.

Drainage texture (Rt)

Horton (1954) defines drainage texture as the total number of segments all the order to perimeter of the area. The drainage texture of the pili river basin has a value of 6.17, falls under the moderate coarse drainage texture category. In present study shows the density is variable and suggests moderate coarse drainage texture.

Length of Overland Flow (Lo)

The length of overland flow is approximately equal to half of the average distance between the channels and reciprocal of the drainage density (Horton, 1945). The higher value of Lo is indicative of true relief, whereas the low value of Lo is indicative of high relief. The value of overland flow is found to be 0.82 indicating low relief.

Constant channel maintenance (C)

Channel maintenance constant is inversely proportional to drainage density. The constant of channel maintenance (C) depends on the slope of the basin, the nature of the rocks, and the duration of erosional activity. The C value of the study area is 0.41. Areas with a low value of constant channel maintenance are categorized as regions with close dissection and somewhat influenced by structural constraints. The large value of C signifies a higher infiltration rate and maturity to an old stage of the river.

Form factor (Ff)

Rf is the ratio of basin area to the square of the basin length and is a quantitative expression of drainage basin outline (Horton 1932). During the present study, the value of the form factor in the study area is 0.36 which indicates that the area is nearly circular.

Circulatory ratio (Rc)

It is influenced more by the length, frequency, and gradient of streams than the slope and drainage pattern of the basin (Strahler, 1957). It is a ratio, which indicates the stage of dissection in the study region. If, the Rc values approach 1, which indicates that, the basin shapes are circular with uniform infiltration for the present study the value of the circulatory ratio is found 0.47 and it indicates that, the basin is nearly circular.

Elongation ratio (Re)

Schumm (1956) defined elongation ratio as the ratio of the diameter of a circle of the same area as the drainage basin and the maximum length of the basin. The Re values generally range between 3.4 which shows the study area basin is elongated in shape.

Shape index (Sw)

The shape index of the area is 2.77. The shape index refers to the elongated basin with high peak discharge.

Texture ratio

The texture ratio is one of the most important factors in the drainage morphometric analysis, which depends on the underlying lithology infiltration capacity, and the relief aspect of the terrain. The texture ratio of the study area is 6.17.

Table: 3. Aerial aspect of the morphometric parameter of the study area

Parameters	Results
Drainage density (Dd)	2.41
Stream frequency (Fs)	2.60
Drainage texture (Rt)	6.17
Length of Overland Flow (Lo)	0.82 sq. km
Constant Channel Maintenance (C)	0.41
Form factor (Ff)	0.36
Circulatory ratio (Rc)	0.47
Elongation ratio (Re)	3.03
Shape index (Sw)	2.77
Texture ratio (T)	6.17
Compactness Coefficient (Cc)	0.04

3. Relief aspects

The relief aspect of drainage basins relates to the three-dimensional characteristics of the basin, including landform area, volume, and altitude, and involves the use of morphometric methods to determine the terrain characteristics of the basin. With the help of slope and DEM maps, we are able to calculate relief factors.

Basin relief (R)

Basin relief is a parameter that determines the stream gradient and influences, the flood pattern, and the volume of transported sediment (Hadley and Schumm, 1961). Basin relief understanding the denudational characteristics of the basin. The pili basin relief value is 295 m.

Relief ratio (Rh)

According to Schumm (1954) noted relief ratios can be calculated by multiplying the maximum basin length (Lb) by the basin relief 'H', resulting in a dimensionless ratio equal to the tangent of the angle formed by the intersection of two planes at the basin's mouth. An indicator of erosion intensity on a drainage basin's slope is the relief ratio, which measures the overall steepness of the drainage basin. The relief ratio for the exciting study is 11.19.

Relative relief (Rhp)

This term was given by Melton (1957) and in the present study, it is noted that the Pili basin area has maximum relative relief of 2.13.

Ruggedness number (RD)

It is the product of maximum basin relief (H) and drainage density (D) (Strahler, 1958). ruggedness number values are high which indicates the slope issteep and long as well. In the present study, the value of the ruggedness number is 0.79, which indicates a gentle slope of the area.

Melton Ruggedness Number (MRn)

According to Melton (1965), the MRn is calculated by using the total basin relief divided by the total basin area of the watershed in which the basin is located. The Melton Ruggedness Number of Pili Basin is 0.68.

DEM (Digital Elevation Model) Map

In the study area, a DEM map was prepared based on the 30-meter resolution of ASTER DEM data. DEM map shows the elevation of the study area, the highest point is 640 m on elevation and the lowest point is 340 m on elevation. The DEM map is shown in fig. 4.

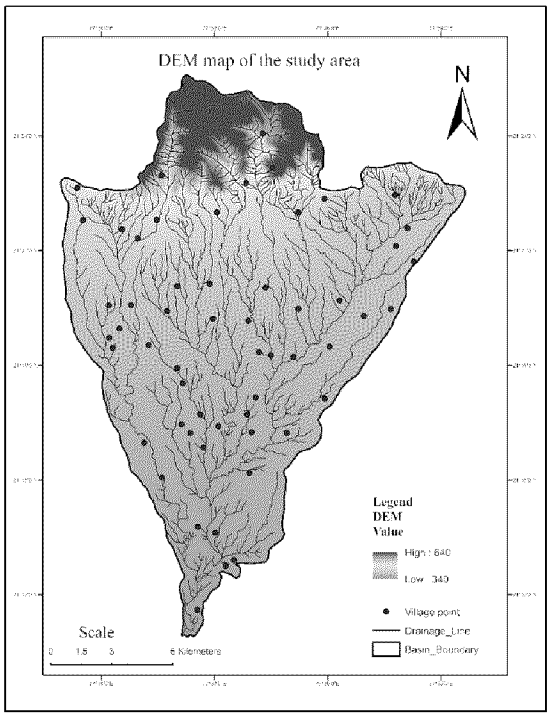


Figure 4: DEM map of the study area

Table 4: Relief parameters of the Pili basin

Parameters	Results
Height of basin mouth (z)	340 m
Height of highest point of the basin (Z)	635 m
Basin relief (R)	295 m
Relief ratio (Rh)	11.19
Relative relief (Rhp)	2.13
Ruggedness number (RD)	0.79
Melton Ruggedness Number (MRn)	0.68

Conclusion

The present study demonstrates that remote sensing techniques and GIS play a vital role in the study of Morphometric analysis of the Pili River Sub-tributary of Sapan River. The morphometric analysis studies are helpful for the occurrences of the porous and permeable zone in the rock formation and morphometric studies direct control of groundwater movement and occurrences. The result of the analysis shows that the Pili River has a dendritic drainage pattern

and 6th order basin. It Indicates homogenous lithology and variations in the values of Rb among the study area attributed to the difference in topography and geometric development. In all areas of the study, the Fs values demonstrate a positive correlation with the Dd values, indicating an increase in the stream population, which is related to an increase in drainage density. On the other hand, the values of Dd indicate that the region has highly permeable subsoil, dense vegetation, and low relief, indicating a highly permeable subsoil. Drainage texture varies from very coarse to fine and shape parameters of the study area viz; Re, Rc, and Rf values indicate that the Pili River basin is more or less elongated. Relief aspects and visual interpretation of the DEM of the study area indicate gentle to moderate slope, low runoff, and high infiltrations.

References

1. Altaf F, Meraj G, Romshoo AS (2013). Morphometric analysis to infer the hydrological behaviour of Lidder Watershed, Western Himalaya, India. Geography J 2013:1–14
2. Bhatt S.C., Rubal Singh, Rahul Singh, Mohd Saif, and M. M. Singh (2021). GIS-based Approach for Morphometric Analysis of Jamini Basin and Its Sub watersheds: Implication for Conservation of Soil and Water Resources. Geological and Geo-Environmental Processes on Earth pp 243–257, Springer Natural Hazards, https://doi.org/10.1007/978-981-16-4122-0_16
3. Chandrashekar H, Lokesh VK, Sameena M, Roopa J, Ranganna G (2015). GIS based morphometric analysis of two reservoir catchments of Arkavati River, Ramanagaram District, Karnataka. International Conference on water resources, Coastal and Ocean Engineering (ICWCOE2015). Aquat Procedia 4:1345–1353
4. Forkuor, J. and Maathuis, B. (2012). Comparison of SRTM and ASTER Derived Digital Elevation Models over Two Regions in Ghana—Implications for Hydrological and Environmental Modeling. In: Piacentini, T. and Miccadei, E., Eds., Studies on Environmental and Applied Geomorphology, In Tech, London, Chapter 9, 219-240.
5. Gautam, P.K., Singh, D.S., Kumar, D., Singh A.K. (2020). A GIS-based Approach in Drainage Morphometric Analysis of Sai River Basin, Uttar Pradesh, India. J Geol Soc India 95, 366–376. https://doi.org/10.1007/s12594-020-1445-9
6. Horton, R.E. (1932). Drainage basin characteristics Trans. Am. Geophys. Union, v. 13, pp. 350-361.

7. Horton, R.E. (1945). Erosional development of streams and heir drainage basins. Bulletin of the Geological Society of America, 56, 275-370
8. Jensen SK (1991). Applications of hydrologic information automatically extracted from digital elevation models. Hydrol Process 5(1):31–44
10. Kaushik P and Ghosh P (2015). 3D DEM delineation of Chambal river basin from SRTM data using remote sensing and GIS technology. Int J Remote Sens Geosci 4(4):1–6
11. Kaushik P and Ghosh P (2018). Morphometric analysis of Shipra River sub-basin, India, remote sensing and GIS approach. Int J Creat Res Thoughts 6(1):1536–1546
12. Kumar, Bijendra & Tripathi, Anshuman. (2018). A GIS-based approach in drainage morphometric analysis of Rihand River Basin, Central India. Sustain. Water Resour. Manag.. 4. 10.1007/s40899-017-0118-3.
13. Magesh N.S., Chandrasekar N. and Soundranayagam J.P. (2011). Morphometric evaluation of Papanasam and Manimuthar watersheds, parts of Western Ghats, Tirunelveli district, Tamil Nadu, India: a GIS approach. Environ Earth Sci 64(2): 373-381
14. Melton, M.A. (1958). Correlating the structure of morphometric properties of the drainage system and their controlling agents.Jour. Geol., v. 66, pp. 442-460.
15. Miller, V.C. (1953). A quantitative geomorphic study of drainage basin characteristics in the Clinch Mountain area, Virginia and Tennessee, Proj. NR 389-402, Tech Rep 3, Columbia University, Department of Geology, ONR, New York.
16. Moharir, Dr. Kanak & Pande, Dr. Chaitanya & Varade, Abhay & Pande, Rajeshwari. (2017). Morphometric analysis in Koldari watershed of Buldhana district (MS), India using geoinformatics techniques. Journal of Geomatics. 11 (1).
17. Pankaj A, Kumar P (2009). GIS-based Morphometric Analysis of five major-watersheds of Song river, Dehradun District, Uttarakhand with special reference to landslide incidences. J Indian Soc Remote Sens 37:157–166
18. Pareta K, Pareta U (2011). Quantitative morphometric analysis of watershed of Yamuna basin, India using ASTER (DEM) data and GIS. Indian Journal Geomatics Geosciences 2(1):248–269

19. Pareta K, Pareta U (2012). Quantitative geomorphological analysis of watershed of Ravi River basin, HP India. Int J Remote Sensing GIS 1:47–62
20. Patel A, Katiyar KS, Prasad V (2016). Performances evaluation of different open source DEM using differential global positioning system (DGPS). Egypt J Remote Sens Space Sci 19(1):7–16
21. Pophare AM, Balpande US (2014). Morphometric analysis of Suketi river basin, Himachal Himalaya, India. J Earth Syst Sci 123:1501–1515
22. Prakash K, Mohanty T, Singh S, Chaubey K, Prakash P (2016) Drainage morphometry of the Dhasan river basin, Bundelkhand craton, central India using remote sensing and GIS techniques. Journal of Geomatica 10:21–132
23. Prakash K, Rawat D, Singh S et al (2019). Morphometric analysis using SRTM and GIS in synergy with depiction: a case study of the Karmanasa River basin. North Central India Apply Water Sci 9 (1):13. https://doi.org/10.1007/s13201-018-0887-3
24. Prakash K, Singh S, Mohanty T, Chaubey K, Singh CK (2017) Morphometric assessment of Gomati river basin, middle Ganga plain, Uttar Pradesh, North India. Spat Inf Res 25:449–458
25. Sahu N, Reddy O, Kumar N et al (2016). Morphometric analysis in basaltic terrain of central India using GIS techniques: A case study. Appl Water Sci. https://doi.org/10.1007/s13201-0160442-z
26. Samal DR, Gedam SS, Nagarajan R (2015). GIS based drainage morphometry and its influence on hydrology in parts of Western Ghats region, Maharashtra. India. Geoc Int 30(7):755–778
27. Sangita Mishra.S. and Nagarajan, R., (2010). Morphometric analysis and priotization of sub- watersheds using GIS and Remote Sensing techniques: a case study of odisha, India, International Journal of Geomatics and Geosciences Vol 1, No3. pp501-510.
28. Sarmah K, Jha LK, Tiwari BK (2012) Morphometric analysis of a highland micro watershed in East Khasi Hills District of Meghalaya, India: using remote sensing and geographic information system (GIS) techniques. J Geol Reg Plan 5:142–150
29. Schumm SA (1956) Evolution of drainage systems and slopes in Badlands, at Perth Amboy, New Jersey. Geol Soc Am Bull 67:597–646

30. Shelar RS, Shinde SP, Pande CB, Moharir Kanak N, Orimoloye Israel R, Mishra Arun P, Varade Abhay M (2022). Sub-watershed prioritization of Koyna river basin in India using multi criteria analytical hierarchical process, remote sensing and GIS techniques. Physics and Chemistry of the Earth, Parts A/B/C. Elsevier, Volume 128, December 2022, 103219. https://doi.org/10.1016/j.pce.2022.103219
31. Singh S, Kanhaiya S (2015) Morphometry of the Barakar river basin, India: a remote sensing and GIS approach. Int J Curr Res 7(7):17948–17955
32. Strahler A. N (1957) Quantitative analysis of watershed geomorphology. Trans Am Geophys Union 38:913–920
33. Strahler AN (1952) Hypsometric Analysis of Erosional Topography. Bulletin of the Geological Society of America 63:1117–1142
34. Strahler AN (1956) Quantitative Slope Analysis. Bulletin of the Geological Society of America 67:571–596
35. Strahler, A.N., (1964).Quantitative geomorphology of drainage basins and channel networks In. Handbook of Applied Hydrology:39–76, McGraw Hill Book Company, New York, Section 4-II, (9).
36. Vandana M (2013) Morphometric analysis and watershed prioritization: a case study of Kabani river basin, Wayanad district, Kerala, India. Indian J Geo-Mar Sci 42:211–222

21. A Study of Lineaments or Fracture Zones Regime of Ground Water Potential in Katepurna River Basin, Akola District, Maharashtra, India

Dr. S. S Deshmukh
Ghulam Nabi Azad Arts, Commerce and Science College, Barshitakli, Dist. Akola.
Dr. Tejas R. Patil
Ghulam Nabi Azad Arts, Commerce and Science College, Barshitakli, Dist. Akola.
Dr. G. D. Gaikwad
Shri Shivaji Arts, Commerce and Science College, Akola.
P. P. Pali
Shri Shivaji Arts, Commerce and Science College, Akola.

Abstract

This investigation determines the ground water potential zone of in Katepurna River Basin, Akola district in Maharashtra were individually demarcated and their area computed, with the aided by using remote sensing & GIS mapping. Satellite imagery and landsat image of the study area shown that small lineaments 20-22 and big lineaments 15-18 which have S-N and E-W trend which appear to have been emplaced in fracture zones. Length of these lineaments ranges from varies lengths with width. Bore wells constructed on and near the lineaments show that vertical extension depth ranges from 30m to 60m bgl. Similarly number of high yielding borewell and dug well fall on straight line which is actually the lineaments of fracture zone trend in study area. It is also commonly seen that the fracture zones generally have dance vegetation cover, irrigation, etc. than other areas. Thus their cumulative ground water capacity or ground water potential is very high in this study area along the lineaments or fracture zone. Our secondary objective is to cement a link between the fracture zone and the infiltration zones of deep aquifers, to establish its impotence in the hydrodynamic functioning of hydrogeological system. Samples collected from various bore wells that were used for drinking purposes.

Keywords: DEM data, GIS, LANDSAT 8, lineaments, infiltration.

Introduction

Water plays a vital role in the development of any activity in the area. Thus the availability of surface and ground water governs the process of planning and development. The surface water resources are inadequate to fulfill the water demand. Productivity through

groundwater is quite high as compared to surface water, but groundwater resources have not yet been properly developed through exploration. Keeping this in view, the present study attempts to select suitable locations for groundwater exploration in hard rock areas using an integrated approach through field investigations, geomorphological, petrographic, geochemical, stratigraphic, remote sensing, geoelectrical soundings and GIS techniques. Lineaments typically refer to the prominent features or characteristics of something, wuch as the distinguishing features of a face or the main elements of a system. Watershed management is the process of creating and implementing plans, programs, and projects to sustain and enhance watershed function that affect the plant, animal, and human communities within a watershed boundary. Features of a watershed that agencies seek to manage include water supply, water quality, drainage, storm water runoff, water rights and the overall planning and utilization of watersheds. Landowners, land use agencies, storm water management experts, environmental specialists, water use surveyors and communities all play an integral part in the management of a watershed. Ground water has and would continue to pay a crucial role for food and fodder production, drinking water supply, drought mitigation and economic development of the country. The ground water being relating to subterranean resource, it needs to be explored through sub surface techniques of ground water exploration.

Study Area

The study area, Katepurna River basin is located within the Akola district of Maharashtra covered under the Survey of India toposheet nos.55H/2, H/3, H/5 and H/6 and bounded by latitude 20° 25" - 20°47" 50’ and longitude 77° - 77° 25”. The Akola district falls in the Western part of Vidarbha region and it is bounded by Amravati in the East, Washim in the South and Buldana in the West (Fig 1.1).

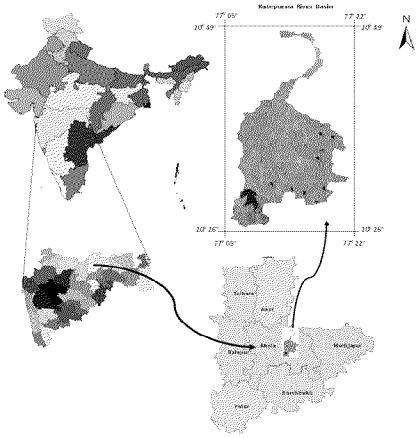


Fig. 1 Location Map of Study Area

Results and discussion

Delineating lineaments is the initial step in defining the intricate groundwater potential in the crystalline terrain of the basaltic region. Remote sensing data provides spectral and spatial coverage of the study area, offering cost-effective information on the various factors that govern groundwater movement and occurrence.

Geomorphologic studies have demonstrated the presence of five distinct landforms namely shallow dissected plateau, moderately dissected plateau, highly dissected plateau, undulations and valley fills. The shallow dissected plateau is characterized by the presence of thick weathered mantle ranging from 4 to 8 mtr with less dissection, and intersecting lineaments indicating a potential storage zone. The depth to water level ranges from 5- 10 m bgl during post monsoon and 12 – 18 m bgl. In pre monsoon. The safe yield in the open dug wells various from 45 – 70 m/d with sustained discharge of over 3-5 hours indicating pheratic and confined to semi confined aquifer conditions. The moderately dissected plateau occurs along the fringes of steep scarps indicating moderate thickness of the weathered horizons showing 3-5m. The bed rock is shallow and depth to water level various from 3-8 m bgl with moderate water bearing horizons depending upon the placement of interflow zone suggesting the recharge nature and higher hydraulic potential. The highly dissected plateau is characterized by the presence of compact and massive lava flows showing intricate network of dissection. The availability of groundwater is scare due to negligible weathered mantle except where the top portion is either altered or due to the presence of vesicular horizon, which may retain some groundwater.

The lineaments gives the results as presented in Fig. 2. This concerns the study area to better illustrate the automatically extracted lineaments. The obtained results from the satellite image interpretation are discussed to reveal the applicability of remote sensing in the mapping and analysis of lineament with a view to delineating zones that are suitable for groundwater development in the study area. The lineament map generated from the study area was used as a confirmatory tool on the possible reasons for general low groundwater yield in the area. The map provides necessary information, for a better understanding of how the interrelationship could be a major contributing factor to the groundwater prospect of the area. The lineaments are oriented in the SN and EW direction, especially for the macro structures which account for about 2 to 4% of the structures. These macro structures occur mainly at the SN end to the EW part of the study area with length varies meter to km. On the basis of above finding, a bore well and dug well highly potential along lineaments or fracture zones. This lineaments may act as a good aquifer which could be tapped through bore well and dug well.

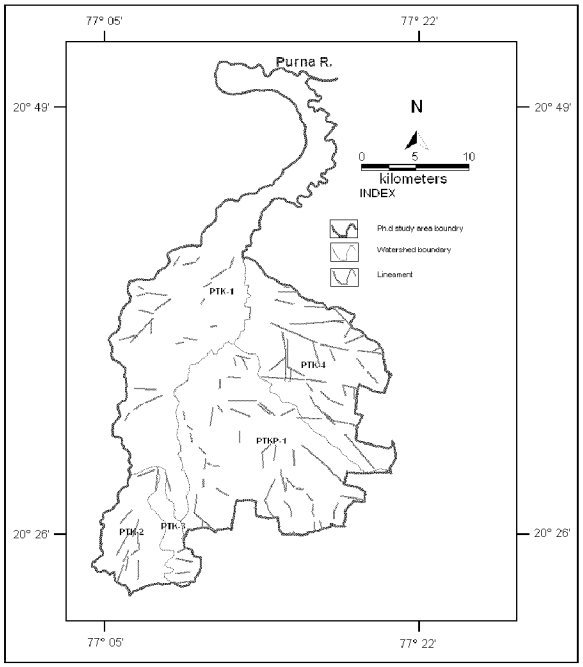


Fig. 2 Lineament Map of the Study area

Conclusion

The use of GIS and remote sensing in the research of productive aquifers in the study area, allowed us to make some observations on the optimization of the positioning of water drillings in this region. The results show that this area has been affected by intense tectonic activity. The structural lineaments of the region are mostly "North- south and East -west" direction. Many additional details can be extracted from radar interferometry images such as SRTM. We mean the topography, lineaments and watersheds that will play an important role in the choice of the high flow water-drilling site. We got good results that can serve as a guide or decision-making tools for future field investigations in the study area. The results obtained after satellite image processing are reliable and are close to the reality of the field. That is why satellite images are therefore a privileged tool for acquiring information capable of assisting decision-makers. It is concluded that the lineament and drainage pattern play a significant role in the groundwater development of this study location and may be responsible for the generally low groundwater prospect in the study area. The lineaments intersection results and the drainage pattern orientation explained the cause of failure/low yield of the wells/borehole in the area. This phenomenon is due to huge disagreement between the lineament and surface water flow direction. Most of the lineaments are in north-south and eastern-western direction while the drainage orientation is in east west direction, arising from this, large number of the available structures do not interact effectively with the surface water and therefore liable to dry up in the

dry season. In other words, the area with ineffective interaction between the lineament and drainage system showed low groundwater potential while area with reasonable interaction displayed moderate to high groundwater potential. North-western part, central part and some part of the southern region of the study area are characterized with high groundwater potential while the remaining part are characterized with moderate groundwater potential except small portion to the south-western part which is of low groundwater potential.

References

- Adyalkar P.G. 1984. "Hard rock hydrogeology in Indian Scenario, Presidential address, section of Geology of Geography, 71st session, Ind. Sci. Cong., Ranchi; pp. 52.
- Adyalkar, P.G., Ayyangar, R.S., Tikekar, S.S. and Khare, Y.D. (1996). Groundwater potential of Deccan Flood Basalt of Nagpur District in Maharashtra: An imprint derived from satellite imagery In Deccan basalt, Gondwana Geol. Soc. Sp. Vol. 2, pp. 485-492.
- Alexander, P. 0., 1981. Age and duration ofDeccan Volcanism: K - Ar evidence. Mem. Geo. Soc. India, Vol. 3, pp. 244-258
- Alexander, P.O., 1981. Age and duration of Deccan Volcanism : K-Arevidence. Mem. Geal. Sac. India, Val. 3, pp. 244-258.
- Aliden, J, B, 1949. Dyke in Western India - A discussion of their relationship with the Deccan Traps. Trans. Nat. Inst. Sci. Ind., Vol :3, pp. 123-157.
- Allegre C.J. M. Trevor, J.F. Minster, B. Minister and F. Albarede 1977, Systematic use of trace elements in igneous processes. Contrib. Mineral Petrol. Vol : 60 pp. 55-75.
- Baker, B.H., Goles, G.C., Leeman, W.T. and Lindstorm, M.M., (1977). Geochemistry and petrogenesis of a basalt-Bemoreite Trachyte suit from the southern part of the Gregory Rift. Keneya. Contrib. Mineral. Petrol., Vol:64, pp.303302.
- Baker, B.H., Goles, G.C., Leeman, W.T. and Lindstrom, M.M., 1977. Geochemistry and Petrogenesis of a Basalt-Benmoreite Trachyte Suite from the southern part of the Gregory Rift, Kenya. Contrib. Mineral. Petrol., Vol: 64, pp.303-332.
- Balasubramanium, A., Thiruganana Sambandan, R., Chellaswamy, R. and Sastry, J. C. V. 1989. Digital modelling of the hydrogeochemical facies of groundwater of Tamilnadu, India. Int. Nat. Workshop on Appropriate Methodologies of GWRM. Hyderabad, Vol. II. pp. 761-767.

- Cain D., Helsel, D.R. and Regone, S. E. (1989). Preliminary evaluation of regional groundwater quality in relation to land use. Groundwater, v.27, pp.230-244.
- Cambell, I.H., 1977. A studyofMacro-rythmic layering and cumulate process in the Jimberlana intrusion, Western Australia: The upper layered series Petrol. Vol.l8, pp. 183-215.
- Canter A.D,, Palmer R.C. and Monkhous R.A., 1987. Mapping the vulnerability of groundwater to pollution from agriculture practice, particularly with respect to nitrate. In: Vulnerability of sol and groundwater to pollutants (W.van Duijvendooden and II.G. Van Waegcningh. cd.s.). TNO committee on hydrogeological research. The Hague, nroceeding and inlomialion No. 3H, pp. 333-342.
- Chandra, S., Anand Rao, V. and Singh, V. S., A combined approach of Schlumberger and axial pole–dipole configurations for groundwater exploration in hard-rock areas. Curr. Sci., 2004, 86, 1437–1443.
- Ihekoronye, A. I., & Ngoddy, P. O. (1985). Integrated food science and technology for the tropics. Macmillan.
- Mahanta, C., Enmark, G., Nordborg, D., Sracek, O., Nath, B., Nickson, R. T., & Bhattacharya, P. (2015). Hydrogeochemical controls on mobilization of arsenic in groundwater of a part of Brahmaputra river floodplain, India. Journal of Hydrology: Regional Studies, 4, 154-171.
- Oladipo, I. C., & Adeboye, O. A. (2015). Physico-chemical and bacteriological analysis of well water used for drinking and domestic purposes in Ogbomosho, Nigeria. International Journal of Current Microbiology and Applied Sciences, 4(9), 136-145.
- Pandey, V. P., Chapagain, S. K., & Kazama, F. (2010). Evaluation of groundwater environment of Kathmandu Valley. Environmental Earth Sciences, 60, 1329-1342
- Rao, S. M., & Mamatha, P. (2004). Water quality in sustainable water management. Current science, 942-947.
- Tebutt, T. H. Y. (1983). Principles of quality control. Pergalmon, England, 235.

22. Viscometric Studies of 1-Phenyl-3-[4-(3-Allylimino-1,2,4-Dithiazolo) Aminophenyl]-Prop-2-Ene-1-One At Various Molar Concentrations and At 250c in 70 % Ethanol–Water Mixture

S. S. Padhena
Department of Chemistry, Rajarshee Shahu Science College,
Chandur Railway, Dist. Amravati.
S. A. Waghmareb
Department of Chemistry, Ghulam Nabi Azad Arts, Commerce & Science College,
Barshitakli, Dist. Akola.

Abstract

Present research comprises the viscometric study of 1-phenyl-3-[4-(3-allylimino-1,2,4-dithiazolo)aminophenyl]-prop-2-ene-1-one, at different molar concentrations (0.1M, 0.05M, 0.025M and 0.012M) by keeping constant temperature (250C) in 70 % ethanol-water system. This viscometric investigations help to study the solute–solute, solute-solvent interactions of solute with solvent and effect of dilution of solvent. This investigation directly gave the information regarding to the pharmacodynamic of this drug.

Keywords: 1,2,4-dithiazolo, ethanol-water mixture, viscometric measurements.

Introduction

The viscosity of a fluid is a measure of its resistance to gradual deformation by shear stress or tensile stress. The technique of viscosity measurements plays a vital role in pharmaceutical, industrial, medicinal, agricultural, biochemical and drug sciences. The viscosity measurement of solution provides brief information regarding molecular weight of the solute, solute-solute, solute-solvent and solvent-solvent interactions. Hence, Viscosity measurement is very essential to know the constituents and arrangement of any molecule. The number of in vivo activities of the drug like absorption, transmission and its effect will directly relate to viscosity measurements and solvent interactions in the human anatomy. Study of the viscosity measurements is user-friendly, sensitive and precise.

The major role of viscosity measurement is in the study of various interactions between solute and solvent. Polar solute readily dissolves in water resulting strong interaction between solute and solvent, hence cause structuredness. While, non-polar solute does not dissolves in

water readily. Determination of viscosity of an electrolyte in a solution is a smart way to obtain data on solute-solute and solute-solvent interactions. We know that, drug's activity and viscosity is concerning with drug-receptor interactions. The electrolytic interactions in liquid binary mixtures explained in terms of β-coefficient of viscosity

Several numbers of properties provide information about the nature of liquid. Viscosity is one of the important physical properties of liquids and solutions. Aqueous and non aqueous solutions are the bulk phenomena. Bulk Phenomena involves various types of interactive forces. It also provides brief information about aqueous and non aqueous solute-solute and solute-solvent interactions and information regarding the transport property of the drugs and ion-solvent interactions.

1-phenyl-3-[4-(3-allylimino-1,2,4-dithiazolo)aminophenyl]-prop-2-ene-1-one nucleus containing drug create their own identity and importance in drug and pharmaceutical chemistry. Accounting all these things it became very interesting to carry out the viscometric measurements of 1-phenyl-3-[4-(3-allylimino-1,2,4-dithiazolo)aminophenyl]-prop-2-ene-1-one at various concentrations (0.1M, 0.05M,0.025M and 0.012 M) by keeping constant temperature(25^0C) in 70% ethanol-water system. This investigation helps to examine the pharmacodynamic and pharmacokinetic of the drug.

Materials and Methods

Experimental

All chemicals used in investigation are AR grade. Solutions prepared fresh at each experiment. In this work, all solutions are prepared by using double distilled water. Mechaniki Zaktady Precyzyjnej Gdansk balance (Poland make [±0.001gm]) is used for taking weights and density is measured by Bicapillary method (Internal diameter of bicapillary is of 1 mm). Viscosity measurements are carried out by Ostwald's viscometer. Elite themostatics water bath is used for temperature maintenance. Ample time was allowed to attain thermal equilibrium in between viscometer and water bath.

Present research work is carried out for the viscometric measurements of 1-phenyl-3-[4-(3-allylimino-1,2,4-dithiazolo)aminophenyl]-prop-2-ene-1-one, at different molar concentrations (0.1M, 0.05M, 0.025M and 0.012M)by keeping constant temperature (25^0C) in 70 % ethanol-water system .The viscometric readings were taken as described in literature.

Observations and Calculations

The molecular interactions values in terms of β-coefficient of drugs obtained by viscometric investigation data, which is tabulated in following manner. The result obtained was

mentioned in **Table No. 1**. According to Jone's-Dole equation, $(\eta r-1)/\Gamma C = A+\beta\Gamma C$ at different concentration and different percentage. A and β-coefficient values calculated and are enlisted in **Table No.2.**

Table No.1

Viscosity Measurements At Different Concentrations And Determination Of Relative And Specific Viscosities At Different Concentrations At 25^0c

Medium - 70% Ethanol-Water

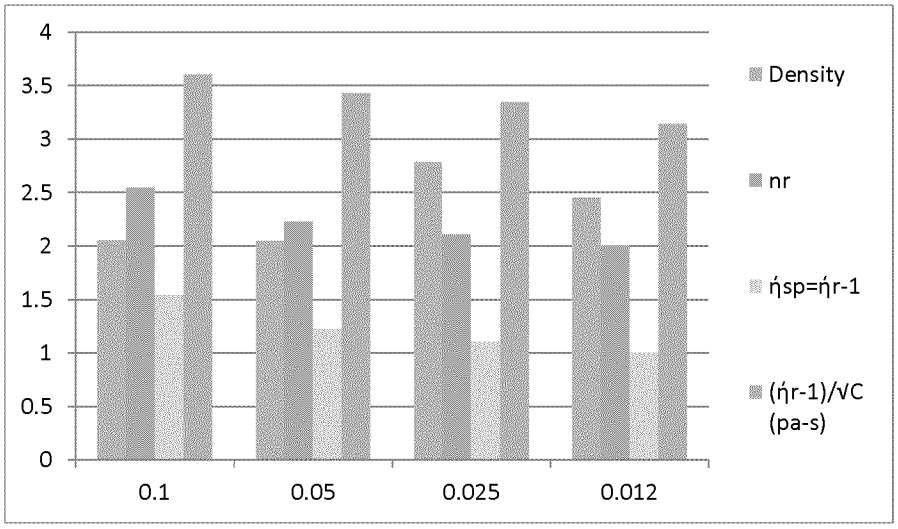
Temp T(°C)	Conc. C (M)	√C	Time t (sec.)	Density ρx10^{-3} (kg.cm $^{-3}$)	ή$_r$	ή$_{sp}$=ή$_r$-1	(ή$_r$-1)/√C (pa-s)
25	0.100	0.3178	472	2.05442	2.4235	1.4812	3.65855
	0.050	0.2476	356	2.05120	2.5214	1.2014	3.40125
	0.025	0.2225	342	2.65205	2.2014	1.0915	3.28952
	0.012	0.2104	482	2.42512	2.1214	1.1252	3.09452

A and β Co-Efficient Values from Graphs for 70%

TABLE NO.2 - FOR [1-phenyl-3-[4-(3-allylimino-1,2,4-dithiazolo)aminophenyl]-prop-2-ene-1-one]

W-E Mixture(%)	Temp° C	Mean "A"	β (Slope "m")
70	25	3.3849	-3.1524

Graphical Representation



Result and Discussion

The relative viscosity was determined by using following formula

η_r = Ds x ts / Dw x tw

And the relative viscosities have been analyzed by Jone's-Doles equation as ,

$(\eta r-1)/\Gamma C = A+\beta\Gamma C$

The graphs are plotted between $(\eta r-1)/\Gamma C$ versus ΓC. The graph for each system gave linear straight line gave value of β-coefficient.

Conclusion

In present investigation it is concluded that at constant temperature the density and relative viscosity of drugs decreases along with decreasing concentration as (0.1M, 0.05M, 0.025M and 0.012 M).When concentration decreases the number of solute molecules in solution decreases simultaneously increases percentage of solvent molecule as a result solvation effect increases . From this investigation we can examine the pharmacodynamic of drug. The potency of these drug can be increased by substituting different substituent on the parent drug.

References

1. D.M.Tigellar, A.E.Palker, C.M.Jackson, K.M.Anderson, J.W. Ight and R.F. Savinell, Macromolecules, 2009, 42(06), 1888.
2. A. Pal and S. Kumar, J. Indian Chem. See., 2004, 81, 1019.
3. F Saleem. Eur. Pot., CHAPPL, 2008, 87, 19.
4. M. Imran, T. Kokab, S. Latif, M. Liviu and Z.Mahmood. J.Chem.Soc.Pak. 2010, 32(2), 223-228.
5. W.A.L. Izonfuo and C.C. Obunwa, Ind.J.Chem. 1999, 38A, 939.
6. A.H.F. Abd El-Waheb, A.H. Bedair, F.A.Eid, A.F.El-Haddad, A.M.Adawy El-deeb, Journal of Serbian Chemical Society, 2006, 71(5), 471-481.
7. U.N.Dash and S.Supkar, Proc.Ind.Acad.Sci.Chem.Soc. 1995, 107,541.
8. E.A.Gonna and B.M, Al-Jahadalli, Am.J.Condenced Matter Physics, 2012, 2(1), 16-21.
9. J. Singh, T. Kaur, V. Ali and D.S. Gill, J. Chem. Soc, Faraday Tram., 1994, 90(4), 579.
10. B.B. Baldaniya and P.K. Patel, E-Journal of Chemistry, 2009, 6(3), 673-680.
11. H.K. Semwal, S.C. Bhatt and B.S. Semwal, J. Pure Appl. Ultrason., 2003, 25, 6.
12. G. Jones and M. Doles, Journal of American Chemical Society, 1929, 51, 2950.
13. M.N. Roy, D.Nandi and D.K. Hazra, J.Ind.Chem.Soc. 1993, 70,121.
14. Parajuli R. and Medhi C., Journal of Chemical Sciences, 2004, 116(4), 235-241.
15. Solanki and I. Thakur, Indian Journal of Chemistry, 2007, 45B, 517.

ISSN 2319 - 359X

AN INTERNATIONAL MULTIDISCIPLINARY
HALF YEARLY RESEARCH JOURNAL

IDEAL

Volume - XII Issue - II March - August - 2024

ENGLISH PART - IV

Peer Reviewed Referred and
UGC Listed Journal No. 47026

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING
2023 - 7.537
www.sjifactor.com

❖ EDITOR ❖

Assit. Prof. Vinay Shankarrao Hatole
M.Sc (Math's), M.B.A. (Mkt), M.B.A (H.R),
M.Drama (Acting), M.Drama (Prod & Dirt), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan
Aurangabad. (M.S.)

6. A Case Study on Integrative Hydrogeo-Ecological Analysis of the Melghat Tiger Reserve Using Geo-Spatial Analysis

Ganesh Gaikwad
Shri. Shivaji College of Arts, Commerce & Science, Akola (MS), INDIA.
Gulam Nabi Azad College, Barshitakli, Dist- Akola.
Zaid Imran Ahmed
Shri. Shivaji College of Arts, Commerce & Science, Akola (MS), INDIA.
Gulam Nabi Azad College, Barshitakli, Dist- Akola.
Sakshi. G. Badmera
Shri. Shivaji College of Arts, Commerce & Science, Akola (MS), INDIA.
Gulam Nabi Azad College, Barshitakli, Dist- Akola.
Sanjay S. Deshmukh
Shri. Shivaji College of Arts, Commerce & Science, Akola (MS), INDIA.
Gulam Nabi Azad College, Barshitakli, Dist- Akola.

Abstract

The Melghat Tiger Reserve (MTR), situated on the Deccan Plateau, represents a complex ecological system where the intricate interplay between hydrology and ecology shapes the dynamics of the landscape. This research employs advanced Geographic Information Systems (GIS) techniques, with a focus on Digital Elevation Models (DEMs), to unravel the hydro-ecological intricacies within the MTR. The study transcends traditional cartography, aiming to provide a comprehensive understanding of the basin's hydrogeological rhythm and its profound ecological implications. Through meticulous analysis of DEMs, we construct a digital representation of the MTR's stream network, emphasizing bifurcation ratios and drainage density. These quantitative metrics serve as the foundation for revealing the unique basin dynamics, portraying an evolving narrative of channel development etched upon the terrain. However, our investigation extends beyond mere measurements, seeking to establish a symbiotic relationship between quantitative data and ecological insights. By integrating erosion patterns with habitat suitability assessments, this study unveils the intricate interdependence between

landforms and biodiversity. Flood risk assessments further contribute to the elucidation of vulnerable ecosystems, guiding the formulation of informed conservation strategies. The implications of this research resonate beyond academic realms, offering invaluable insights to water resource managers for the implementation of sustainable practices that harmonize human needs with ecological well-being. Conservationists, armed with the profound ecological wisdom derived from this data fusion, can formulate holistic strategies that acknowledge and address the delicate balance between water resources and life within the MTR. Local communities, benefiting from improved flood risk assessments, gain knowledge essential for responsible water stewardship, thereby fostering sustainable coexistence. This study, extending beyond traditional scientific inquiry, serves as a luminous bridge linking hydrology and ecology within the MTR. By meticulously unravelling each thread, from quantitative metrics to nuanced ecological data, we aspire to provide a clarion call for the mindful stewardship of this irreplaceable ecological treasure, paving the way for a sustainable future where human aspirations resonate harmoniously with ecological integrity.

Keywords Hydrogeo-Ecology, DEM (Digital Elevation Model), Melghat Tiger Reserve (MTR), Geo-spatial analysis.

Introduction

Nested within the Indian state of Maharashtra, the Melghat Tiger Reserve (MTR) embodies a vital sanctuary for biodiversity conservation. The Gavilgarh Hill, a southern offshoot of the Satpura Hill Range, marks the geographical origin of the reserve, situated within the Amravati district of Maharashtra (21°26′45″N 77°11′50″E), the MTR encompasses a vast expanse of 1677 sq km (Kazi et al,2012). It is meticulously divided into distinct zones: a core area of 361.28 sq km, a buffer zone spanning 788.28 sq km, and a multiple-use area occupying the remaining territory. Its evocative name, "Melghat," signifies the convergence of numerous valleys sculpting its unique landscape (Read, et al, 2016). Five significant rivers – Khandu, Khapra, Sipna, Gadga, and Dolar – serve as the MTR's lifeblood, carving their paths eastward before merging with the Tapti River, ultimately draining into the Arabian Sea. This study delves into the intricate tapestry of the reserve, exploring its geological foundation, diverse ecological niches, and remarkable faunal composition (Swain, et al, 2009). The MTR's heritage dates back to 1974, witnessing its initial designation as a wildlife sanctuary. Subsequently, under Project Tiger, it was elevated to a Tiger Reserve in the same year, becoming one of India's nine

inaugural reserves (Musavi, et al,1999). This pivotal event ensured the protection of the majestic tiger and its delicate ecosystem. Through time, MTR has blossomed into a comprehensive centre for biodiversity conservation and a hub for scientific research endeavours. Each river exhibits distinct characteristics and contributes to the well-developed dendritic drainage system that criss-crosses the reserve. This intricate network ensures efficient water flow and fosters ecological equilibrium.

Study Area

The Melghat Tiger Reserve is located in the Amravati district of Maharashtra, India, on the southern offshoot of the Satpura Hill Range. It was declared a tiger reserve in 1974 and is one of the first nine tiger reserves in India under Project Tiger. The reserve covers an area of 2768 km2, including a core area of 1550 sq. km and a buffer area of 1268 sq. km (Ingale, et al,2020).The terrain is characterized by unending hills, ravines, and steep climbs, with a rugged portion of the Gavilgarh hills forming part of the Satpuras. The Melghat Tiger Reserve, situated in the Indian state of Maharashtra, is a catchment area for five major rivers: the Khandu, Khapra, Sipna, Gadga, and Dolar, all of which are tributaries of the Tapti River (Joshi, et al,1974). The forest in the reserve is tropical dry deciduous, primarily dominated by teak (Musavi, et al,2016) .

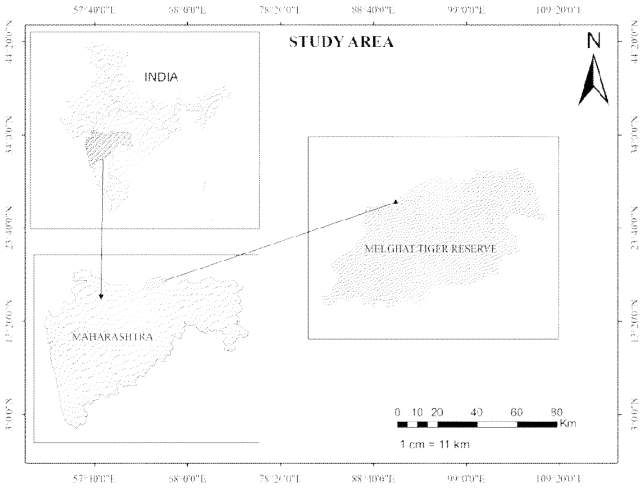


Fig 1.0: Study area map.

Melghat experiences a good monsoon rainfall ranging from 950 mm to 1400 mm, with an average of 60 to 65 rainy days. The reserve is home to a diverse range of wildlife, including the Bengal tiger, Indian leopard, sloth bear, Indian gaur, and a rich birdlife (Shirbhate,,et al. 2007).The human component of the Melghat landscape includes a large number of villages, with the community consisting of a variety of Central Indian tribes and forest-dwelling communities,

such as the Korkus, Gawli, and Gond tribes (Choudhary, et al, 2020).The Melghat Tiger Reserve offers various activities for tourists, such as day safaris, night machaan stays, kayaking, elephant rides, trekking, and adventure activities like zorbing and river crossing

Methodology

The comprehensive analysis of the Melghat Tiger Reserve involves a systematic approach encompassing data acquisition, preprocessing, hydrological analysis, ecological assessment, geospatial analysis, and integrative analysis. To begin with, high-resolution Digital Elevation Models (DEMs) and land use/land cover data are sourced from reputable platforms such as the United States Geological Survey (USGS) Earth Data platform and the Indian Space Research Organisation's Bhuvan portal (Kayet, et al, 2021). Ensuring uniform spatial resolution and compatibility through preprocessing is essential for subsequent analysis. The hydrological analysis phase involves the calculation of various parameters, including stream lengths, sinuosity index, and drainage density, utilizing DEM data. This step provides valuable insights into the river network, erosional processes, and runoff tendencies within the reserve. Simultaneously, the land use/land cover data is employed for ecological analysis, allowing for an assessment of the distribution of different land cover types within the reserve. Geospatial Information Systems (GIS) techniques are then applied to integrate the hydrological and ecological data (Nikhl, et al ,2021). This involves generating spatial layers and maps to visualize the distribution of key parameters and their interrelationships within the reserve (Dakey, et al, 2023). The integrative analysis phase involves merging hydrological and ecological datasets to unravel the complex interactions between the water system and the reserve's ecosystem this facilitates evidence-based decision-making for sustainable water resource management and environmental protection.

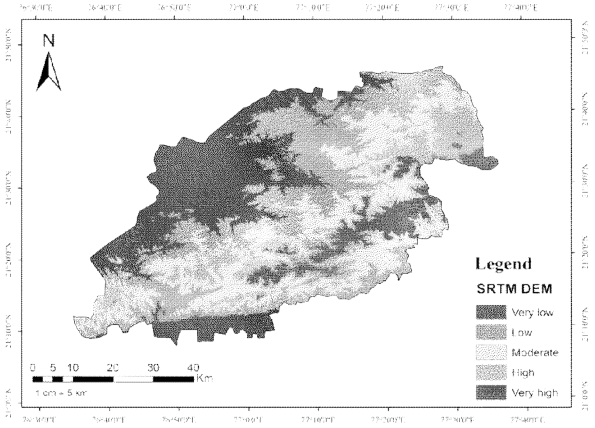


Fig 1.1: Digital elevation map

Morphometric Parameters

The morphometric characteristics of the Melghat Tiger Reserve play a crucial role in understanding its hydro-ecological dynamics (Pandey, et al,2021). The linear aspects, such as the length of rivers, and the areal aspects, including the area of the reserve, are essential parameters for hydrological and ecological studies (Mohairi, et al,2022).Similarly, the relief aspects, which encompass the rugged terrain and elevation variations, significantly influence the hydrological and ecological processes within the reserve.

Table 1 : Linear aspects

A) Linear aspects			
Stream Order	Number of streams	Total stream length (KM)	Mean of stream length (KM)
1	282	905.186517	3.2099
2	61	338.451219	5.5484
3	15	240.859962	16.0573
4	1	81.09917	81.0992
Bifurcation ratio			Mean of bifurcation ratio
1st order/2nd order	2nd order/3rd order	3rd order/4th order	
4.622	4.066	15	7.896

Stream Length ratio		
2nd order/1st order	3rd order/2nd order	4th order/3rd order
0.216	0.245	0.066
Stream frequency		0.083102429
Textural Ratio		0.735601002

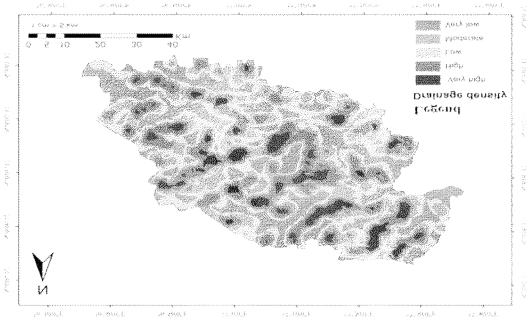


Fig 1.2: Drainage density map

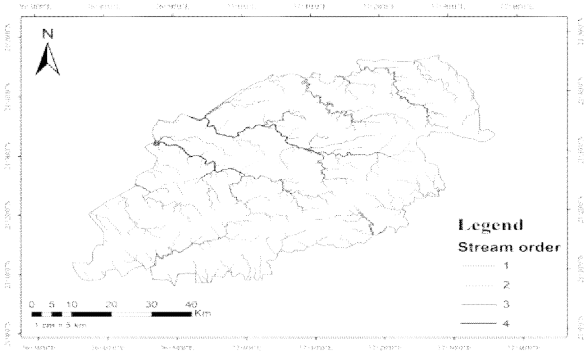


Fig 1.3: Stream order map

Table 1.1: Areal aspects

B) Areal Aspects	
Area	4319.97
Perimeter	383.36
Length of Basin	114.84
Form Factor	343.9466561
Circulatory Ratio	0.369195822
Elongation Ratio	0.322979798
Drainage Density	0.362
constant channel maintenance	2.762430939

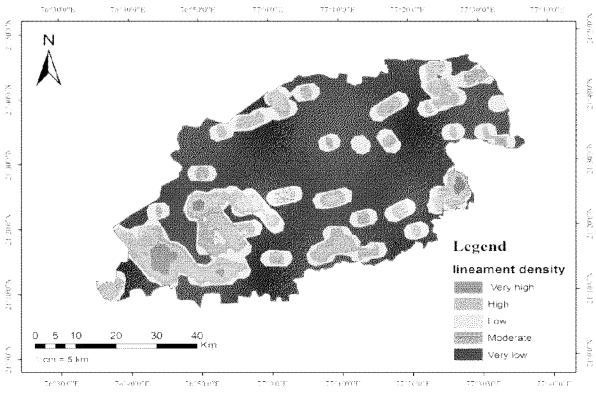


Fig 1.4 : Lineament density map

Table 1.2: Linear Aspects

C) Relief Aspects	
Basin Relief	906
Relief Ratio	7.8892372
Ruggedness number	327.972
Length of overland flow	0.181

In this hydrogeo-ecological investigation of the Melghat Tiger Reserve, the higher bifurcation ratios observed herein delineate a pronounced downstream branching tendency within the stream network, influencing hydrological and groundwater dynamics (Joy, et al, 2023). The distribution of stream orders and associated lengths yields crucial insights into the connectivity between streams, thereby contributing to the assessment of groundwater recharge and discharge processes (Arefin, et al, 2023). However, bifurcation ratios which is indicative of branching behaviors, significantly influence the intricate network of aquifers and subsequently impact groundwater flow paths. The stream length ratios discerned in this study elucidate scaling relationships among different stream orders, furnishing pivotal information for modeling flow dynamics and predicting subsurface water movement (Kant, et al, 2023) . Furthermore, the identified low stream frequency signifies a reduced density of surface water features, with potential repercussions on groundwater availability and recharge rates, thereby offering valuable insights into surface-water/groundwater interactions (Shekar, et al, 2023).

In the realm of ecology, the nuanced impact of stream order and length on habitats is highlighted, with distinct ecological communities supported by varying stream orders. The bifurcation ratios contribute to biodiversity considerations, influencing the presence and diversity of aquatic organisms, while stream length ratios establish connections to riparian zones and their associated vegetation (Erosmiah, et al, 2023). The stream frequency findings accentuate ecosystem service contributions, emphasizing the role of a dense stream network in water purification, nutrient cycling, and habitat connectivity (Selva, et al, 2023). The textural ratio, with its potential implications for sediment transport and substrate composition, further underscores the intricate interplay between hydrogeological processes and ecological dynamics. In conclusion, this comprehensive analysis contributes significantly to the understanding of the synergistic relationship between hydrogeological and ecological processes in the Melghat Tiger Reserve. The findings presented herein offer critical insights that can inform conservation

strategies tailored to protect and sustain the unique ecosystem of this region, thereby providing a foundation for impactful conservation measures

Ground Water Potential Zone

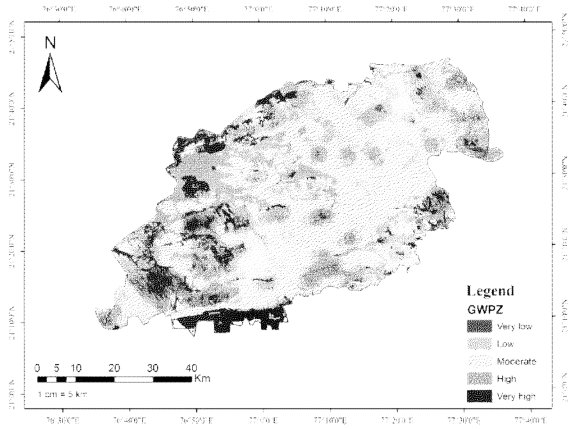


Fig 1.5 : Ground water potential zone map

The groundwater potential zone map of the Melghat Tiger Reserve was created using Analytical Hierarchical Process (AHP) by combining seven maps, including slope, soil, geology, geomorphology, lineament density, drainage density, and LULC. The weightage was given according to the preferences in the area, and the study area was divided into five classes ranging from very low to very high.

Groundwater availability plays a crucial role in shaping the ecological dynamics within the Melghat Tiger Reserve & Tigers are apex predators in the reserve (Ahmad, et al, 2023). Their survival depends on an abundant prey base, including deer species (such as sambar, chital,and muntjac).Groundwater availability directly influences vegetation growth, which, in turn, affects herbivore populations (Nahid, et al, 2023). Adequate water ensures healthy vegetation, which supports prey species.Waterholes created by groundwater seepage become essential gathering points for herbivores. Tigers often frequent these areas for hunting.Water-dependent habitats, such as riverbanks, wetlands, and riparian zones, are critical for various wildlife species.Groundwater availability determines the presence of riparian vegetation, which provides cover, nesting sites, and food for birds, reptiles, and small mammals.

FACTORS	Geomorphology	LD	Lithology	Slope	Soil	LULC	DD	Weight
Geomorphology	7	6	5	4	3	2	1	0.38
Lineament density	7/2	6/2	5/2	4/2	3/2	2/2	1/2	0.19

Lithology	7/3	6/3	5/3	4/3	3/3	2/3	1/3	0.12
Slope	7/4	6/4	5/4	4/4	3/4	2/4	1/4	0.10
Soil	7/5	6/5	5/5	4/5	3/5	2/5	1/5	0.08
LULC	7/6	6/6	5/6	4/6	3/6	2/6	1/6	0.066
Drainage density	7/7	6/7	5/7	4/7	3/7	2/7	1/7	0.064
TOTAL								1

Table 1.3:- AHP Weightages

ACTORS	WEIGHT	RANK	OVERALL
	GEOMORPHOLOGY		
Alluvial Plain	38	5	190
Flood Plain		4	152
Dam And Reservoiur		4	152
Pediment Pediplain Complex		3	114
Waterbody - River		3	114
Waterbodies - Other		2	76
Highly Dissected Plateaus		2	76
Moderately Dissected Plateaus		2	76
Anthropogenic Terrain		1	38
Low Dissected Plateau		1	38
	LINEAMENT DENSITY		
Very High	19	5	95
High		4	76
Moderate		3	57
Low		2	38
Very Low		1	19
	LITHOLOGY		
Late Cretaceous	12	4	48
Quaternary		5	60
	SLOPE		
0-1	10	5	50
1-2		4	40
2-3		3	30
3-5		2	20
>5		1	10
	SOIL		
Clayey	8	3	24
Clayey Loam		4	32
	LULC		
Waterbody	6.6	5	33

Agriculture		4	26.4
Bareland		3	19.8
Built Up Area		2	13.2
	DRAINAGE DENSITY		
Very High	6.4	1	6.4
High		2	12.8
Moderate		3	19.2
Low		4	25.6
Very Low		5	32

Table 1.4:- AHP Prefernces

Conclusions

The research emphasizes the significance of the stream network in shaping the reserve's biodiversity. It is observed that first-order streams may have specialized species, while larger streams (higher orders) provide diverse habitats. The branching behaviour of streams, as indicated by bifurcation ratios, significantly influences the network of aquifers and subsequently impacts groundwater flow paths (Mohammad, et al, 2023). This, in turn, affects the presence and diversity of aquatic organisms, emphasizing the critical role of the stream network in supporting the reserve's biodiversity. The conservation of riparian zones along streams is highlighted as essential for maintaining wildlife corridors and ensuring connectivity within reserves (Xu Q, et al, 2023). The presence of riparian vegetation, which is influenced by stream length and frequency, provides cover, nesting sites, and food for various wildlife species, including birds, reptiles, and small mammals. Therefore, the availability of groundwater, which determines the presence of riparian vegetation, plays a crucial role in shaping the ecological dynamics within the Melghat Tiger Reserve. The study underscores the direct influence of groundwater availability on wildlife habitats within the reserve. Adequate water ensures healthy vegetation, which supports prey species, and creates essential gathering points for herbivores. Tigers, as apex predators in the reserve, depend on an abundant prey base, the availability of which is directly influenced by groundwater availability and its impact on vegetation growth (Lobo, et al, 2023). . Water-dependent habitats, such as riverbanks, wetlands, and riparian zones, are critical for various wildlife species, further emphasizing the indispensable link between groundwater availability and the preservation of wildlife habitats

The research unequivocally demonstrates the profound relationship between hydrology and ecology within the Melghat Tiger Reserve. The findings and calculations presented in the

study offer critical insights that can inform conservation strategies tailored to protect and sustain the unique ecosystem of this region, thereby providing a foundation for impactful conservation measures. The integration of hydrogeological and ecological data not only enhances our understanding of the reserve's dynamics but also paves the way for evidence-based decision-making for sustainable water resource management and environmental protection.

Results

The research on the hydrogeo-ecological investigation of the Melghat Tiger Reserve has revealed a profound interdependence between hydrogeological processes and ecological dynamics within the reserve. The comprehensive analysis of the reserve's morphometric parameters, including stream network characteristics, drainage density, and relief aspects, has provided critical insights into the interconnectedness of hydrology and ecology. The study's findings demonstrate that the branching behavior of the stream network significantly influences the network of aquifers and subsequently impacts groundwater flow paths, directly affecting the reserve's ecological well-being. Additionally, the analysis of stream length ratios has elucidated scaling relationships among different stream orders, providing essential information for modeling flow dynamics and predicting subsurface water movement, which is directly linked to the availability of water for wildlife habitats and the overall ecological equilibrium within the reserve. The identified low stream frequency, indicative of a reduced density of surface water features, has potential repercussions on groundwater availability and recharge rates, emphasizing the critical interplay between surface water and groundwater systems, which directly influences water availability, habitat suitability, and the overall ecological balance within the Melghat Tiger Reserve. In conclusion, the results of this research unequivocally demonstrate the profound relationship between hydrology and ecology within the Melghat Tiger Reserve. The findings offer critical insights that can inform conservation strategies tailored to protect and sustain the unique ecosystem of this region, thereby providing a foundation for impactful conservation measures. The integration of hydrogeological and ecological data not only enhances our understanding of the reserve's dynamics but also paves the way for evidence-based decision-making for sustainable water resource management and environmental protection.

Implications for Future Research

The research on the hydrogeo-ecological investigation of the Melghat Tiger Reserve has significant implications for future research. The comprehensive analysis of the reserve's

morphometric parameters, including stream network characteristics, drainage density, and relief aspects, has provided critical insights into the interconnectedness of hydrology and ecology. The study's findings demonstrate the profound relationship between hydrology and ecology within the reserve, emphasizing the critical role of water resource management in preserving the reserve's unique ecosystem. The research highlights the need for further investigation into the complex interactions between hydrogeological processes and ecological dynamics, paving the way for evidence-based decision-making for sustainable water resource management and environmental protection. The integration of hydrogeological and ecological data offers a promising avenue for future research, providing a foundation for impactful conservation measures and sustainable coexistence between human needs and ecological well-being.

References

- Ahmad, I., Hasan, H., Jilani, M. M., & Ahmed, S. I. (2023). Mapping potential groundwater accumulation zones for Karachi city using GIS and AHP techniques. Environmental Monitoring and Assessment, 195(3), 381.
- Arefin, R., Seker, D. Z., Hore, R., & Meshram, S. G. (2023). GIS and remotely sensed data-based morphometric elements analysis for determination of Bengal Basin evolution. Environment, Development and Sustainability, 1-34.
- Choudhary, H. R., & P, A. A. E. (2020). The Korku tribe of Melghat region in India and their current state: an ethnographic study. The Oriental Anthropologist, 20(1), 97-112.
- Dakey, S., Morey, B., Sukhwani, V., & Deshkar, S. (2023). Applying Socio-Ecological Perspective for Fostering Resilience in Rural Settlements—Melghat Region, India. Sustainability, 15(3), 1812.
- Erosemiah, D., & Viji, R. (2023). Study on drainage network pattern and morphometric analysis by using hydrology support algorithm. Journal of the Geological Society of India, 99(7), 1006-1014.
- Ingale, R. D. Tourism Potential Assessment inThe Melghat Tiger Reserve at Amravati, Maharashtra.(2020)
- Javed, A., Khanday, M.Y. & Ahmed, R. Prioritization of sub-watersheds based on morphometric and land use analysis using remote sensing and GIS techniques. J Indian Soc Remote Sens 37, 261–274 (2009). https://doi.org/10.1007/s12524-009-0016-8

- Joy, M. A. R., Upaul, S., Fatema, K., & Amin, F. R. (2023). Application of GIS and remote sensing in morphometric analysis of river basin at the south-western part of great Ganges delta, Bangladesh. Hydrology Research, 54(6), 739-755.
- Kant, C., Kumar, G., & Meena, R. S. (2023). Modeling morphometric and geomorphological parameters of mountainous river basin for water resource management using remote sensing and GIS approach. Modeling Earth Systems and Environment, 9(2), 2151-2163.
- Kayet, N. (2021). Forest Fire Risk Assessment for Effective Geoenvironmental Planning and Management using Geospatial Techniques. Spatial Modeling in Forest Resources Management: Rural Livelihood and Sustainable Development, 281-295.
- Kazi, N. J. (2012). Integrated Biodiversity Management A case study of Melghat Tiger reserve as a protected area, India. Res. J. Recent Sci, 2277, 2502.
- Lobo, M., Alam, A., & Bandyopadhyay, S. (2023). Tiger atmospheres and co-belonging in mangrove worlds. Environment and planning E: Nature and space, 6(2), 736-755.
- Mohairi, K. N., Madguni, O., & Pande, C. B. (2022). Assessment of Groundwater Potential Zone Mapping for Development of Semi-Arid Region Through AHP and GIS Techniques. In Climate Change Impact on Groundwater Resources: Human Health Risk Assessment in Arid and Semi-arid Regions (pp. 373-386). Cham: Springer International Publishing.
- Mohammed, M. A., Szabó, N. P., & Szűcs, P. (2023). Characterization of groundwater aquifers using hydrogeophysical and hydrogeochemical methods in the eastern Nile River area, Khartoum State, Sudan. Environmental Earth Sciences, 82(9), 1-21.
- Musavi, A. (1999). A Socio-economic Study of Tribes and Non-tribes in Melghat Tiger Reserve and Adjoining Areas (Doctoral dissertation, Department of Sociology and Social Work, Aligarh Muslim University).
- Musavi, A. (2016). Assessment of Resource Use Impact on Vegetation in Dry and Moist Tropical Forests in Satpura Conservation Area, India. International Journal of Ecology and Environmental Sciences, 42(2), 109-118.
- Nahid, R., Sharma, N., & Warghat, N. (2023). HABITAT SURVEY AND NON-INVASIVE SAMPLING PROTOCOLS OF BOS Gaurus gaurus FROM MELGHAT

TIGER RESERVE, AMRAVATI, INDIA. Journal of Global Biosciences Vol, 12(3), 9730-9734.

- Nikhil, S., Danumah, J. H., Saha, S., Prasad, M. K., Rajaneesh, A., Mammen, P. C., ... & Kuriakose, S. L. (2021). Application of GIS and AHP method in forest fire risk zone mapping: a study of the Parambikulam tiger reserve, Kerala, India. Journal of Geovisualization and Spatial Analysis, 5(1), 14.
- Pande, C. B., Moharir, K. N., & Khadri, S. F. R. (2021). Watershed planning and development based on morphometric analysis and remote sensing and GIS techniques: a case study of semi-arid watershed in Maharashtra, India. In Groundwater resources development and planning in the semi-arid region (pp. 199-220). Cham: Springer International Publishing.
- Read, D. J. (2016). Legitimacy, access, and the gridlock of tiger conservation: lessons from Melghat and the history of central India. Regional Environmental Change, 16, 141-151.
- Selva Prakash, M. L., Miranda, R., Karthick, S., & Padamanaban, R. A GIS Based Approach in Drainage Quantitative Morphometric Analysis of Thamirabarani River Basin, India.
- Shekar, P. R., & Mathew, A. (2023). Assessing groundwater potential zones and artificial recharge sites in the monsoon-fed Murredu river basin, India: An integrated approach using GIS, AHP, and Fuzzy-AHP. Groundwater for Sustainable Development, 23, 100994.
- Shirbhate, M. V. (2007). Quantification of predation and incidence of parasitic infestation in Melghat Tiger Reserve with special reference to leopards (Panthera pardus). The Bioscan, 2(1), 41-46.
- Swain, D. (2009). Role of India's tiger reserves in the protection of origin/catchment of water courses: A case study of the Similipal Tiger Reserve. In XIII World Forestry Congress, Buenos Aires, Argentina (Vol. 13).
- Xu, Q., Yan, T., Wang, C., Hua, L., & Zhai, L. (2023). Managing landscape patterns at the riparian zone and sub-basin scale is equally important for water quality protection. Water Research, 229, 119280.

International Journal of Scientific Research in Science and Technology
Available online at : www.ijsrst.com
OPEN ACCESS
Print ISSN: 2395-6011 | Online ISSN: 2395-602X
doi : https://doi.org/10.32628/IJSRST173876

$MnFe_2O_4$ Nanoparticle as a New and Magnetically Separable Nanocatalyst for Solvent-Free Synthesis of dihydropyrano[2,3-c] Pyrazole Derivatives

Santosh B. Gaikwad [1,2] and Kishore Puri [2*]

[1, 2]Department of Chemistry, Late Pundalikrao Gawali Arts and Science College, Shirpur (Jain), Washim – 444 504 (Maharashtra), India

[*2]Department of Chemistry, Shri Shivaji College of Arts, Commerce and Science, Akola – 444 003 (Maharashtra), India

*Corresponding Author: knpuri333@rediffmail.com

ARTICLEINFO

Article History:
Accepted: 22 Jan 2024
Published : 29 Jan 2024

Publication Issue :
Volume 11, Issue 1
January-February-2024
Page Number :
318-326

ABSTRACT

This study focused on synthesising $MnFe_2O_4$ (Manganese Ferrite) nanoparticles using the sol-gel method. We then applied these nanoparticles as a catalyst for synthesising dihydropyrano[2,3-c]pyrazole derivatives at a specific temperature. The significant advantage of this process is that it requires only short reaction times and no solvents. Additionally, the crude pyranopyrazole derivatives can be purified through a simple recrystallization process. The catalyst is reusable, magnetically separable and maintains its activity even after five uses. The chemical integrity of the catalyst was confirmed through FT-IR, ^{1}H NMR, and ^{13}C NMR techniques.

Keywords: Solvent-free synthesis, Magnetically separable, Manganese Ferrite, Pyranopyrazole, Nanocatalyst

I. INTRODUCTION

Multicomponent reactions (MCRs) are considered one of the best ways to synthesize heterocyclic compounds using simple and easily available materials. MCRs are highly efficient as they reduce the number of synthesis steps required to form complex compounds, which makes them time-saving and environmentally friendly. Therefore, there is a growing interest in designing new MCRs that follow the principles of green chemistry [1, 2]. Pyranopyrazole, which could be synthesized through a four-component reaction, is one of the most important types of oxygen–nitrogen heterocyclic compounds with lots of biological, pharmaceutical, and agrochemical applications. For instance, antimicrobial, antiplatelet, anti-inflammatory, antitumor, antibacterial, insecticidal, fungicidal, antitubercular agent, herbicidal, and inhibitor of human chk1 kinase, as well as UV absorber are some of the important activities of pyranopyrazole and its derivatives (Fig. 1). Because of the great importance and numerous utilizations of

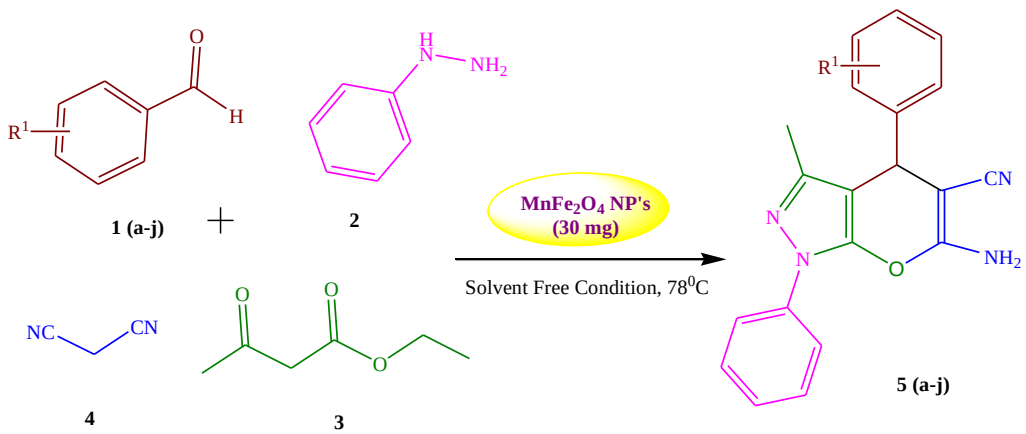
Copyright © 2023 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

pyranopyrazole and its derivatives, modifying the procedure for its synthesis are at the top of scientific research [3, 4]. Using heterogeneous nanocatalysts to synthesize pyranopyrazole has attracted great importance among previous methods on account of high efficiency.

Manganese and ferric oxide are commonly used metal oxides due to their practical advantages such as being readily available, low cost, less toxic, and easy to synthesize. In recent times, binary metal oxide photocatalysts have gained significant attention for their efficient catalytic activity and stability in removing organic pollutants from the air and sewage [5-6]. Spinel structures with the formula AB_2O_4 are well-known materials for their ability to incorporate various ions into their crystal structure. In the $MnFe_2O_4$ structure, Mn^{2+} and Fe^{3+} are distributed in tetrahedral and octahedral sites respectively, which is a typical spinel structure. The corresponding general formula is written as $A_{tet}B_{2oct}O_4$ [7]. The high activity of this spinel compound is due to the high amounts of Fe^{3+} species and compositional homogeneity. Magnetic nanoparticles possess unique physicochemical properties and have attracted the attention of various researchers [8-10]. Spinel ferrite compounds show great potential as green heterogeneous catalysts in various organic functional group transformations and as catalytic supports [11-14].

Pyrano[2,3-c]pyrazoles are a type of heterocycles that have great potential for use in the pharmaceutical field. They exhibit a wide range of biological activities such as anti-inflammatory [15], anticancer [16, 17], inhibition of human Chk1 kinase [18], antimicrobial [19], and also as biodegradable agrochemicals [20]. It has been reported that pyrazoles play a vital role as essential synthetic intermediates [21]. One of the methods used for their production involves the base-catalyzed cyclization of 4-aryliden-5-pyrazolone [22]. However, new approaches have been developed for the synthesis of pyrazoles, including processes based on β-cyclodextrin[23], cinchona alkaloid derivatives[24], $Sc(OTf)_3$ [25], triethylamine [26], water or ethanol media [27, 28], imidazole [29], CuO/ZrO_2 [30] and triethyl benzyl ammonium chloride [31].

As part of our ongoing research into the development and use of nanoparticles and their application [32-35], we have decided to use these nanomaterials as a nanocatalyst in organic transformation. Hence, We used one of the new nanocatalysts for the synthesis of dihydropyrano[2,3-c]pyrazole derivatives under solvent-free conditions at specific temperature conditions. (**Scheme-1**).



Scheme-1: Schematic representation of Manganese ferrite catalysed synthesis of dihydropyrano[2,3-c]pyrazole derivatives

II. METHODS AND MATERIAL

A) Materials:

All chemicals were purchased from Sigma-Aldrich and SD-Fine Chemical in Mumbai, India, and used without purification. All the aqueous solutions were prepared in distilled water.

B) Characterisation Methods:

Fourier transform infrared (FT-IR) spectra of dihydropyrano[2,3-c]pyrazole derivatives were recorded on the Shimadzu IR spectrophotometer. ^{1}H and ^{13}C NMR spectroscopy performed by Bruker Advance Neo 500 MHz NMR Spectrophotometer, SAIF, Chandigarh.

C) Synthesis of magnetic separable $MnFe_2O_4$ nanocatalyst:

The sol-gel method was employed to synthesize nanoparticles of manganese ferric oxide ($MnFe_2O_4$). The procedure involved dissolving 0.25 M of manganese chloride and 0.25 M of ferric chloride separately in 100 ml of distilled water. The solubility of manganese chloride and ferric chloride in water was improved by adding 0.1 N hydrochloric acid. Two solutions were mixed together with constant stirring. After the solutions were mixed, 1 gram of citric acid solution was added as a surfactant. The pH of the solution was then adjusted to be 8-8.5 (basic) using 3-3.5 ml of NH_4OH solution. The mixture formed a precipitate which was stirred constantly for an hour at room temperature. The mixture was then filtered using Whatman filter paper No. 42 and washed with deionized water 2-3 times. Finally, the obtained product was dried in an oven at 100°C for 2 hours. After drying, the material was calcinated for 3 hours at 500°C. The final product was a black precipitate, which was used as a magnificent for the synthesis of dihydropyrano[2,3-c]pyrazole derivatives.

D) Synthesis of dihydropyrano[2,3-c]pyrazole derivatives:

Magnetic separable $MnFe_2O_4$ nanocatalyst as catalyst (30 mg) was added and mixed to a mixture of aromatic aldehyde (1 mmol), malononitrile (1 mmol), ethyl acetoacetate (1 mmol) and phenylhydrazine (1 mmol) under solvent-free conditions at 78°C temperature for the suitable time. After completion of the reaction, which was identified by TLC (n-hexane/ethyl acetate: 8:2), the magnetically separable nanocatalyst was separated by external magnetic material and washed with aqueous ethanol. After confirmation of product formation, recrystallised from ethanol which resulted in precipitation of the desired dihydropyrano[2,3-c]pyrazole derivatives. All of the obtained product(s) are known and were identified by comparison of their physical data with those reported in the literature (see Table 1). Some of the synthesized compounds were characterized by IR and NMR data. Given below are spectral data for some selected pyranopyrazole derivatives.

E) Spectral data analysis for compounds:

6-Amino-3-methyl-4-(4-nitrophenyl)-1-phenyl-1,4 dihydropyrano[2,3-c]pyrazole-5-carbonitrile ***(5c)****:*

^{1}H NMR (500 MHz, DMSO-d6): δ = 8.21 (d, J = 8.8 Hz, 2H), 7.72 (d, J = 8.4 Hz, 2H), 7.51 (d, J = 8.8 Hz, 2H), 7.43 (t, J = 7.6 Hz, 2H), 7.21 (s, NH2), 7.16 (t, J = 6.4, 1H), 4.91 (s, 1H), 2.35 (s, 3H) ppm. **^{13}C NMR (500 MHz, DMSO-d6):** δ = 168.85, 159.62, 150.28, 145.80, 144.33, 142.49, 133.49, 128.80, 125.87, 123.91, 120.49, 97.43, 67.69, 33.13, 13.90 ppm. **FT-IR (KBr):** $\bar{\nu}$ = 3227, 2921, 2193, 1685, 1566, 1506, 1415, 1347, 1267, 1105, 847 cm^{-1}.

III.RESULTS AND DISCUSSION

The study investigated the impact of $MnFe_2O_4$ magnetic nanoparticle catalyst with different concentrations (10-30 mg) on the one pot four-component reaction of substituted benzaldehyde, phenylhydrazine with Malononitrile and ethyl acetoacetate under various conditions (**Table 1**). The

results clearly indicate that the best yield of 6-amino-3-methyl-1, 4-diphenyl-1, 4-dihydropyrano[2,3-c]pyrazole-5-carbonitrile (5a) was achieved by carrying out the reaction in the presence of 10 mol% of $MnFe_2O_4$ magnetic nanoparticle without solvent. (**Table 1, run no. 8**). The yield increased as the catalyst load was raised from 10 to 30 mg, while with the use of larger amounts of the catalyst (35 mol %), the yield of the product remained the same.

Table 1:

Synthesis of dihydropyrano[2,3-c]pyrazole (**5a**) using different conditions with different concentrations of Manganese ferrite nanocatalyst at 78°C temperature.

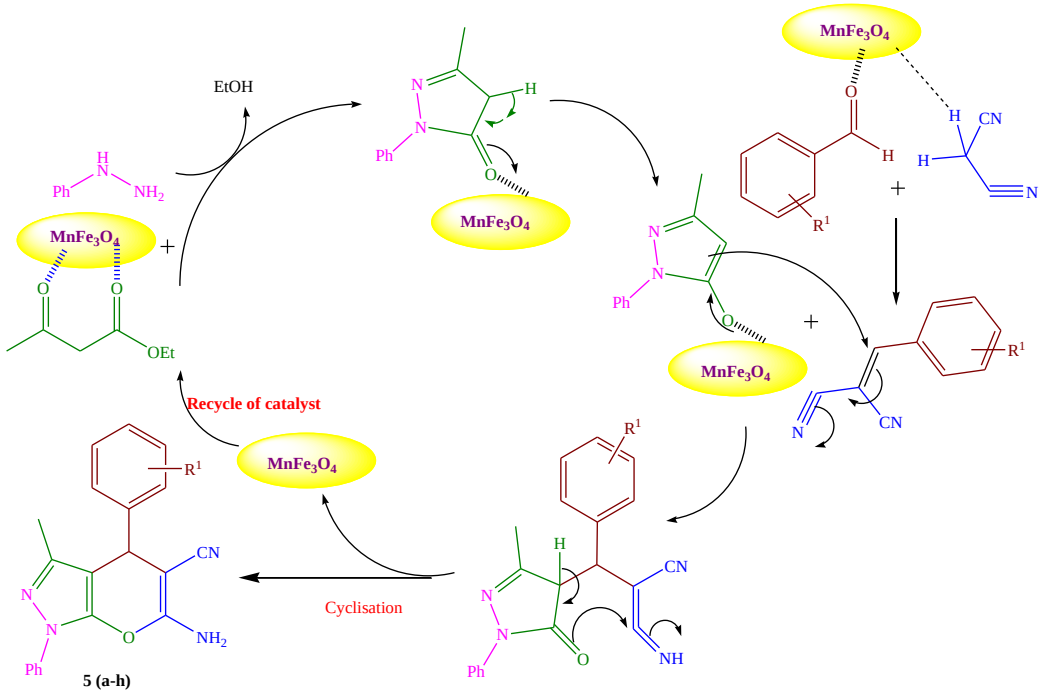
Sr. No.	Solvents	Catalyst (mg)	Time (min)	Yield (5a)
1.	DCM	10	68	58
2.	CH_3CN	10	74	64
3.	THF	10	46	67
4.	H_2O	10	49	70
5.	EtOH	10	40	74
6.	Solvent-free	10	37	80
7.	Solvent-free	20	30	90
8.	Solvent-free	30	22	98
9.	Solvent-free	40	21	98

After optimizing the reaction conditions, we aimed to investigate the efficiency and scope of a procedure that resulted in the production of numerous dihydropyrano[2,3-c]pyrazole derivatives. This was achieved through a one-pot four-component condensation reaction involving substituted benzaldehyde, phenylhydrazine, Malononitrile, and ethyl acetoacetate. The reaction was catalysed by a small amount of $MnFe_2O_4$ magnetic nanoparticle catalyst and carried out under solvent-free conditions. The results are displayed in **Table 2**. The impact of substituents on the aromatic ring was evaluated in terms of yields under these reaction conditions. Both types of aromatic aldehydes, including those with electron-releasing and electron-withdrawing substituents on their aromatic ring, produced the desired products in high to excellent yields in a short reaction time. The reaction time of aromatic aldehydes with electron-withdrawing groups was faster than those with electron-donating groups. Moreover, the recyclability and reusability of the catalyst were also considered in the condensation of benzaldehyde, phenylhydrazine, Malononitrile, and ethyl acetoacetate. Similarly, the magnetic nanoparticle catalyst was separated and reused for an alternative reaction.

TABLE 2:

Synthesis of numerous dihydropyrano[2,3-c]pyrazole derivatives using 30 mg of manganese ferrite nanocatalyst with solvent-free reaction conditions at 78°c temperature.

Sr. No.	Aldehyde	Product (5a-5h)	Time (min)	Yield (%)	Melting Points (°C)	
					Found	Reported
1.	Benzaldehyde	5a	21	98	170-173	(169-171) [36]
2.	4-Methoxybenzaldehyde	5b	23	91	173-175	(174-176) [37]
3.	4-Nitrobenzaldehyde	5c	14	95	196-198	(197-198) [38]
4.	2-Chlorobenzaldehyde	5d	12	98	138-140	(140-142) [36]
5.	4-Chlorobenzaldehyde	5e	17	95	173-176	(175-178) [36]
6.	4-Hydroxybenzaldehyde	5f	28	89	211-214	(213-215) [39]
7.	4-Methylbenzaldehyde	5g	39	85	168-170	(170-171) [38]
8.	4-Bromobenzaldehyde	5h	18	93	181-185	182–184 [40]



Scheme 2: The probable mechanism for the synthesis of dihydropyrano-[2,3-c]-pyrazole derivatives using the magnetically separable $MnFe_2O_4$ catalyst

In addition to performing a one-pot four-component reaction of substituted benzaldehyde, phenylhydrazine with Malononitrile and ethyl acetoacetate, we isolated the magnetic nanoparticle catalyst using magnetic separating material upon completion of the reaction and studied the feasibility of reusing and recycling the catalyst for several runs. The results, illustrated in **Table 3**, demonstrate that the magnetically separable $MnFe_2O_4$ catalyst could be recycled and reused for up to five runs without significant loss of its catalytic activity. The results are summarized in **Table 3**.

TABLE 3:

Reusability of the magnetically separable $MnFe_2O_4$ catalyst for the Synthesis of dihydropyrano[2,3-c]pyrazole derivatives

Run of typical reaction **(5a)**	1	2	3	4	5
Isolated % of yields (%)	98	97	97	95	94

IV. CONCLUSION

In conclusion, firstly, we have synthesised $MnFe_2O_4$ magnetic nanoparticles using the sol-gel method via the eco-friendly method. A new and efficient protocol for the solvent-free one-pot four-component synthesis of dihydropyrano[2,3-c]pyrazole derivatives at 78°C in the presence of the magnetically separable $MnFe_2O_4$ catalyst. Its catalytic investigation was done in the organic transformation of the synthesis of one-pot four-component dihydropyrano[2,3-c]pyrazole derivatives under solvent-free conditions at 78°C. One of the noteworthy advantages of this study is the easy product isolation, cleaner reaction profile, eco-friendliness, high yield, short reaction time, and recycling and reusability of the $MnFe_2O_4$ magnetic nanocatalyst.

V. ACKNOWLEDGEMENT

We thank the Principal, Shri Shivaji College of Arts, Commerce and Science, Akola, for providing the Research Laboratory facility and the Sophisticated

Analytical Instrumentation Facility (SAIF) and CIL, Chandigarh, for their characterisation facility.

VI. CONFLICTS OF INTEREST

The authors declare no conflict of interest.

VII. REFERENCES

[1] R. Afshari, and A. Shaabani, Materials functionalisation with multicomponent reactions: State of the art. ACS Comb. Sci. 20, 499–528 (2018).

[2] A. Dömling, W. Wang, and K. Wang, Chemistry and biology of multicomponent reactions. Chem. Rev. 112, 3083–3135 (2012).

[3] M. Mamaghani, and R. Hossein Nia, A review on the recent multicomponent synthesis of pyranopyrazoles. Polycycl. Aromat. Compd. 41, 223–291 (2019).

[4] M. Koohshari, M. Dabiri, and P. Salehi, Catalyst-free domino reaction in water/ethanol: An efficient, regio- and chemoselective one-pot multicomponent synthesis of pyranopyrazole derivatives. RSC Adv. 4, 10669 (2014).

[5] A. Mary Jacintha, A. Manikandan, K. Chinnaraj, S. Arul Antony, P. Neeraja, Comparative studies of spinel MnFe2O4 nanostructures: structural, morphological, optical, magnetic and catalytic properties. Journal of nanoscience and nanotechnology 15 (12), 9732-9740 (2015)

[6] L. Zhang, Y. Wu, Sol-gel synthesised magnetic MnFe2O4 spinel ferrite nanoparticles as a novel catalyst for oxidative degradation of methyl orange. Journal of Nanomaterials 2013, 2-2 (2013).

[7] Y. Zhang, J. Wang, Z. Su, M. Lu, S. Liu, F. Gu, J. Liu, Y. Tu, T. Jiang, Spinel MnFe2O4 nanoparticles (MFO-NPs) for CO2 cyclic decomposition prepared from ferromanganese ores. Ceramics International 46 (9), 14206-14216 (2020).

[8] A. Maleki, Z. Hajizadeh, and P. Salehi, Mesoporous halloysite nanotubes modified by CuFe2O4 spinel ferrite nanoparticles and study of its application as a novel and efficient heterogeneous catalyst in the synthesis of pyrazolopyridine derivatives. Sci. Rep. 9, 1 (2019).

[9] A. Maleki, and R. Firouzi-Haji, L-Proline functionalised magnetic nanoparticles: A novel magnetically reusable nanocatalyst for one-pot synthesis of 2, 4, 6-triarylpyridines. Sci. Rep. 8, 1 (2018).

[10] Z. Hajizadeh, F. Radinekiyan, R. Eivazzadeh-keihan, and A. Maleki, Development of novel and green NiFe2O4/ geopolymer nanocatalyst based on bentonite for synthesis of imidazole heterocycles by ultrasonic irradiations. Sci. Rep. 10, 1 (2020).

[11] F. Xiao-Jun, H. Xiao, L. Lu, L. Qingye, C. Li, W. Juan, Polydopamine-anchored polyether on Fe3O4 as magnetic recyclable nanoparticle-demulsifiers, Colloids and Surfaces A: Physicochemical and Engineering Aspects 617 126142 (2021).

[12] S.A. Nining, P.T. Anggito, E. Agung, A. Muhammad, A.S. Eko, B.K.P. Witha, G. Masno, S. Perdamean, Syntheses of ferrofluids using polyethylene glycol (PEG) coated magnetite (Fe3O4), citric acid, and water as the working liquid in a cylindrical heat pipe, Nano-Structures & Nano-Objects 25, 100654 (2021).

[13] P. N. Anantharamaiah, H. M. Shashanka, R. Kumar, J. A. Chelvane, and B. Sahoo, Chemically enabling CoFe2O4 for magnetostrictive strain sensing applications at lower magnetic fields: Effect of Zn substitution. Mater. Sci. Eng. B Solid State Mater. Adv. Technol. 266, 115080 (2021).

[14] B. N. Sahu, S. C. Sahoo, N. Venkataramani, S. Prasad, & R. Krishnan, Observation of

extraordinarily large magnetisation in CoFe2O4/ ZnFe2O4 bilayers. J. Magn. Magn. Mater. 523, 167629 (2021).

[15] F. Nicolas, M.F. Lisa, H. Rob, P. Andrew, G.S.R. Alan, E.S. Allan, Identification of chemically diverse Chk1 inhibitors by receptor-based virtual screening, Bioorganic & Medicinal Chemistry 14 4792-4802 (2006).

[16] M.E.A. Zaki, E.M. Morsy, F.M. Abdel-Motti, F.M.E. Abdel-Megeid, The Behaviour of Ethyl 1-acetyl-4-aryl-5-cyano-3-methyI-1,4-dihydropyrano 2,3-c pyrazol-6-ylimidoformate Towards Nucleophiles, Heterocyclic Communications 10, 97-102 (2004).

[17] J.L. Wang, D. Liu, Z.J. Zheng, S. Shan, X. Han, S.M. Srinivasula, C.M. Croce, E.S. Alnemri, Z. Huang, Structure-based discovery of an organic compound that binds Bcl-2 protein and induces apoptosis of tumor cellsProc. Natl. Acad. Sci. U.S.A. 97(13), 7124-7129 (2000).

[18] (a) E.A.Z. Magdy, A.S. Hanan, A.H. Ola, E.R. Aymn, Pyrazolopyranopyrimidines as a Class of Anti-Inflammatory Agents, Zeitschrift für Naturforschung C, 61, 1-5 (2006); (b) C.K. Sheng, J.H. Li, N. Hideo, Studies on heterocyclic compounds. 6. Synthesis and analgesic and antiinflammatory activities of 3,4-dimethylpyrano[2,3-c]pyrazol-6-one derivatives, J. Med. Chem. 27(4), 539-544 (1984).

[19] (a) W.P. Smith, L.S. Sollis, D.P. Howes, C.P. Cherry, D.I. Starkey, N.K. Cobley, Dihydropyrancarboxamides Related to Zanamivir: A New Series of Inhibitors of Influenza Virus Sialidases. 1. Discovery, Synthesis, Biological Activity, and Structure–Activity Relationships of 4-Guanidino- and 4-Amino-4H-pyran-6-carboxamides, J. Med. Chem. 41(6), 787-797 (1998); (b) K. Mazaahir, S. Shilpi, R.K. Khalilur, S.T. Sharanjit, Aqua mediated synthesis of substituted 2-amino-4H-chromenes and in vitro study as antibacterial agents, Bioorg. Med. Chem. Lett. 15(19), 4295-4298, (2005).

[20] (a) H. Junek, H. Aigner, Syntheses with Nitriles, XXXV. Reactions of Tetracyanoethylene with Heterocyclic Compounds, Chem. Ber. 106(3), 914-921 (1973); (b) H. Wamhoff, E. Kroth, K. Strauch, Dihalogentriphenylphosphorane in der Heterocyclensynthese; 271: Heterokondensierte 1,2,4-Triazolo[1,5-c]pyrimidine aus Enaminonitrilen via O-Ethylformimide, Synthesis, 1993(11), 1129-1132 (1993).

[21] A.V. Stachulski, N.G. Berry, A.C.L. Low, S.L. Moores, E. Row, D.C. Warhurst, I.S. Adagu, J.F. Rossignol, Identification of isoflavone derivatives as effective anticryptosporidial agents in vitro and in vivo, J. Med. Chem. 49 (2006) 1450-1454.

[22] H.H. Otto, Synthesis of Some 4H-Pyrano[2.3-c]pyrazoles, Arch. Pharm. 307 (1974) 444-447.

[23] G. Vasuki, K. Kumaravel, Rapid four-component reactions in water: synthesis of pyranopyrazoles, Tetrahedron Lett. 49 (2008) 5636-5638.

[24] G. Sanjib, Z. Cong-Gui, Organocatalysed enantioselective synthesis of 6-amino-5-cyanodihydropyrano 2,3-c pyrazoles, Tetrahedron Letters 50 (2009) 2252-2255.

[25] K. Kumari, D.S. Raghuvanshi, V. Jouikov, K.N. Singh, Sc(OTf)3-catalyzed, solvent-free domino synthesis of functionalized pyrazoles under controlled microwave irradiation, Tetrahedron Lett. 53(9), (2012) 1130-1133.

[26] A.M. Shestopalov, Y.M. Emeliyanova, A.A. Shestopalov, L.A. Rodinovskaya, Z.I. Niazimbetova, D.H. Evans, Cross-condensation of derivatives of cyanoacetic acid and carbonyl compounds. Part 1: Single-stage synthesis of 1′-substituted 6-amino-spiro-4-(piperidine-4′)-2H, 4H-pyrano[2,3-c]pyrazole-5-carbonitriles, Tetrahedron. 59(38) (2003) 7491-7496.

[27] Y. Peng, G. Song, R. Dou, Surface cleaning under combined microwave and ultrasound

irradiation: flash synthesis of 4H-pyrano[2,3-c]pyrazoles in aqueous media, Green Chem. 8 (2006) 573-575.

[28] A.M. Shestopalov, Y.M. Emeliyanova, A.A. Shestopalov, L.A. Rodinovskaya, Z.I. Niazimbetova, D.H. Evans, One-Step Synthesis of Substituted 6-Amino-5-cyanospiro-4-(piperidine-4‘)- 2H,4H-dihydropyrazolo[3,4-b]pyrans, Org. Lett. 4(3), (2002) 423-425.

[29] A. Siddekha, A. Nizam, M.A. Pasha, An efficient and simple approach for the synthesis of pyranopyrazoles using imidazole (catalytic) in aqueous medium, and the vibrational spectroscopic studies on 6-amino-4-(4′-methoxyphenyl)-5-cyano-3-methyl-1-phenyl-1,4-dihydropyrano[2,3-c]pyrazole using density functional theory, Spectrochem. Acta. A.: Molecular and Biomolecular Spectroscopy, 81(1), (2011) 431-440.

[30] S. Maddila, S. Rana, R. Pagadala, Sh. Kankala, S. Maddila, S.B. Jonnalagadda, Synthesis of pyrazole-4-carbonitrile derivatives in aqueous media with CuO/ZrO2 as recyclable catalyst, Catal. Commun. 61 (2015) 26-30.

[31] D. Shi, J. Mou, Q. Zhuang, L. Niu, N. Wu, X. Wang, Three-Component One-Pot Synthesis of 1,4-Dihydropyrano[2,3-c]pyrazole Derivatives in Aqueous Media, Synth. Commun. 34 (2004) 4557-4563.

[32] J. S. Godse, S. B. Gaikwad, V. B. Bhise, S. T. Gaikwad, R. P. Pawar, S. B. Ubale, synthesis and comparative study of nano zinc oxide structures with and without cetyltrimethylammonium bromide using sol-gel method, Heterocyclic Letters, 9(4) (2019) 455-460.

[33] J. S. Godse, S. B. Gaikwad, V. B. Bhise, R. P. Pawar and S. B. Ubale, Synthesis of Co3O4 Nanomaterial with Cetyltrimethylammonium Bromide Using Sol–Gel Method in Environmentally Benevolent Aqueous Media, Advanced Science, Engineering and Medicine, 12(6) (2020) 719-722.

[34] J. S. Godse, S. B. Gaikwad, V. B. Bhise, R. Suryawanshi, S. B. Ubale and R. P. Pawar, Synthesis of Binary Manganese Cobalt Oxide (MnCo2O4) Nanomaterial in Environmentally Benign Aqueous Media, Letters in Applied NanoBioScience, 12(4) (2023) 157.

[35] J. S. Godse, S. V. Pawar, S. B. Gaikwad, V. B. Bhise, S. S. Dhotre, S. B. Ubale and R. P. Pawar, Citric Acid Mediated Synthesis of Spinel Binary Copper Manganese Oxide (CuMn2O4) Nanomaterial using Sol-Gel Method, Letters in Applied NanoBioScience, 12(4) 2023 180.

[36] D. Azarifar, S.M. Khatami, M.A. Zolfigol, R. Nejat-Yami, Nano-titania sulfuric acid-promoted synthesis of tetrahydrobenzo [b] pyran and 1, 4-dihydropyrano [2, 3-c] pyrazole derivatives under ultrasound irradiation, J. Iran. Chem. Soc. 11 (2014) 1223-1230;

[37] K. Eskandari, B. Karami, S. Khodabakhshi, Novel silica sodium carbonate (SSC): Preparation, characterization and its first catalytic application to the synthesis of new dihydropyrano[2,3-c]pyrazoles, Catal. Commun. 54 (2014) 124-130

[38] D. Azarifar, S.M. Khatami, R. Nejat-Yami, Nano-titania-supported Preyssler-type heteropolyacid: An efficient and reusable catalyst in ultrasound-promoted synthesis of 4H-chromenes and 4H-pyrano[2,3-c]pyrazoles, J. Chem. Sci. 126 (2014) 95-101

[39] A. Hasaninejad, M. Shekouhy, N. Golzar, A. Zare, M.M. Doroodmand, Silica bonded n-propyl-4-aza-1-azoniabicyclo[2.2.2]octane chloride (SB-DABCO): A highly efficient, reusable and new heterogeneous catalyst for the synthesis of 4H-benzo[b]pyran derivatives, Appl. Catal. A. Gen. 402 (2011) 11-22.

[40] F. Karc, Synthesis of some novel pyrazolo[51-c][1,2,4]triazine derivatives and investigation of

their absorption spectra, Dyes Pigm. 76 (2008) 97–103.

Cite this article as :

Santosh B. Gaikwad, Kishore Puri, "MnFe2O4 nanoparticle as a new and magnetically separable nanocatalyst for solvent-free synthesis of dihydropyrano [2,3-c]pyrazole derivatives", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 11 Issue 1, pp. 318-326, January-February 2024. Available at doi : https://doi.org/10.32628/IJSRST173876

Journal URL : https://ijsrst.com/IJSRST173876

International Journal of Scientific Research in Computer Science, Engineering and Information Technology

ISSN : 2456-3307 OPEN ACCESS

Available Online at : www.ijsrcseit.com

doi : https://doi.org/ 10.32628/CSEIT2390445

Energy Efficient Protocols for Wireless Sensor Network : An Overview

Mayuri R. Gudade [1], Chandrakant R. Mankar [2], Dr. D. N. Besekar [3]

[1]Assistant Prof., [2]Research Scholar, [3]Research Guide

[1, 2, 3]Department of Computer Science, Shri Shivaji College, Akola, Maharashtra, India

ARTICLEINFO

Article History:

Accepted: 01 Aug 2023

Published: 20 Aug 2023

Publication Issue

Volume 9, Issue 4

July-August-2023

Page Number

404-408

ABSTRACT

As IoT is accepted across the world and the nodes connected are increasing rapidly through various applications like Smart Homes, Smart Cities, Health Care, and many more. The physical objects have a limited number of resources on which they rely like energy, bandwidth, and memory. The working of physical objects is affected due to these limited resources. Energy Efficient Protocol (EEP) is one solution to it, which is important in increasing the life of a physical object and smooth working of it over the network. This paper gives an overview of EEP that are being used and implemented in WSN.

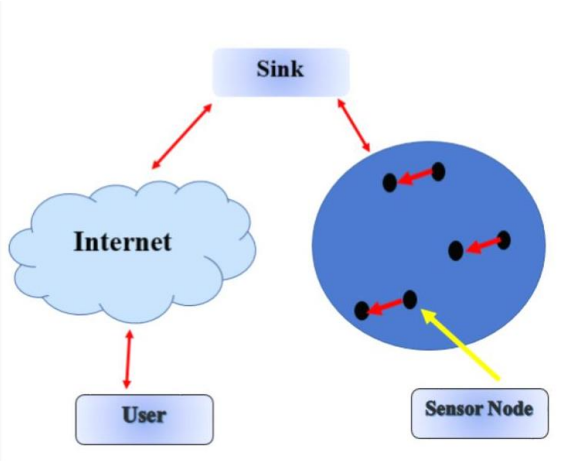
Keywords: Energy-Efficient Protocol (EEP), Wireless Sensor Network (WSN), Internet of Things (IoT)

I. INTRODUCTION

Energy-efficient cluster head selection is crucial for Wireless Sensor Networks (WSNs) in the Internet of Things (IoT) to prolong the network's lifetime and enhance its overall efficiency, since sensor nodes typically operate on limited power sources, such as batteries. Physical objects in WSN have less number of resources available while working to transmit the collected data over the network. Conservation of energy can be done by implementing an EEP, to maximize their life it is important. These protocols are designed such that they work on less energy to be consumed while performing the task like transmitting the collected data across the WSN. These protocols must be reliable in saving energy. Energy-efficient protocols research has made significant progress, but there are still some notable gaps and challenges. This paper provides information about the lacunae in research, the types of EEP, their significance, and their characteristics.

Copyright © 2023 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

Different EEP in WSN: In the WSN model (Fig. 1), In WSN the EEP is used to transmit the data over the network, where the user is having control over the sensor nodes via the internet, connected through a main node called Sink, which acts as a root node.



EEP is classified into three types mainly based on functioning mode, participating style, and network structure as shown in Fig 2. Clustering, Data-Centric, and Medium Access Control are their subtypes, they are described below

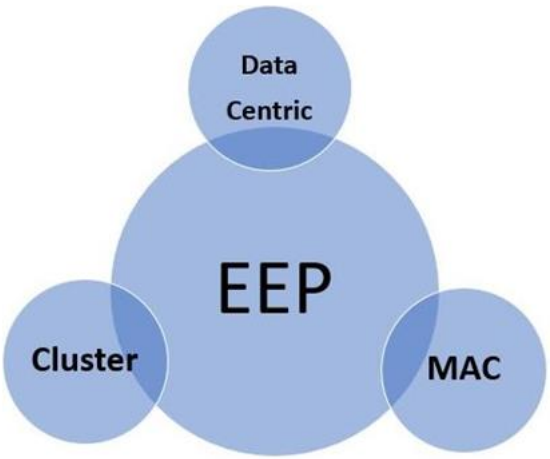


Fig 2. Types of EEP

A. Cluster-Based Protocols: [4,5] Here the nodes are classified into clusters to enhance the EE and scalability of the network, common examples are:

- LEACH: LEACH Stands for Low Energy Adaptive Clustering Hierarchy Protocol. It was designed to provide an improved life span to the physical objects. It works on Time Division Multiplexing, it reports the data to a node called a sink and also partitions the nodes into clusters and cluster heads. The Cluster head creates and maintains the schedule of TDMA. The cluster nodes and cluster heads transmit the data.[6,7]
- HEED: This EEP combines the techniques of randomization and determinism in an aggregation of data. It considers the residual energy and the proximity of cluster heads, to reduce high energy nodes with cluster heads.[8,9]

B. Data-Centric Protocols: [10,11] These EEP's designed to make data dissemination and retrieval efficient, and conservation of energy is done on the propagation of data. Its examples are:

- Directed Diffusion: This EEP uses the user interest in data-driven and gradient in conserving the energy.[12,13]
- SPIN: Sensor Protocol for Information via Negotiation is an EEP, which uses a mechanism called query-response to reduce energy consumption.[14,15]

C. MAC Protocols: [16-21] Medium Access Control Protocols are used to control the communication medium, the sensor nodes communicate via schedules, reduce idle nodes, and lower the number of collisions, its common examples are:

- S-MAC: Sensor MAC, uses a duty cycle to save energy by synchronizing sensor nodes with idle nodes i.e. Active nodes and idle nodes. A mechanism of contention window is used with sleep schedules to save energy consumption.
- T-MAC: These EEPs reduce energy consumption by employing the low duty cycles, idle nodes are in sleep mode

Significance of EEP : Energy-efficient protocols play a crucial role in various domains, particularly in the context of technology and communication systems. The EEPs are designed to enhance the longevity and sustainability of the network, lower energy consumption and achieve reliable communication. The significance of energy-efficient protocols can be

understood from several perspectives:

i) **Sustainability and Environmental Impact**: With the growing concern over climate change and environmental degradation, reducing energy consumption has become paramount. Energy-efficient protocols help minimize the energy required to operate devices, networks, and systems, leading to lower carbon emissions and a smaller ecological footprint.

ii) **Extended Battery Life**: In the realm of mobile devices and wireless sensor networks, energy-efficient protocols can significantly extend the battery life of these devices. This is crucial for devices that are difficult to recharge frequently, such as IoT sensors, remote environmental monitoring devices, or even smartphones and laptops.

iii) **Cost Savings**: Energy-efficient protocols can directly translate into cost savings, especially for large-scale systems like data centers or industrial operations. By reducing energy consumption, businesses can lower their electricity bills and operational expenses.

iv) **Improved Reliability**: In some cases, energy-efficient protocols can improve the reliability of communication systems. For instance, in wireless networks, reducing energy consumption can reduce the risk of signal interference and enhance the overall performance of the network.

v) **Resource-Constrained Environments**: Energy-efficient protocols are essential in resource-constrained environments, where power sources are limited or access to energy is challenging. This is particularly relevant in developing regions or remote areas where electricity supply is unreliable.

vi) **Scalability**: Energy-efficient protocols are crucial for scaling up technology and communication systems. As the number of connected devices and users increases (e.g., in the context of the Internet of Things), energy efficiency becomes even more critical to handle the higher demand without overloading the power infrastructure.

vii) **Regulatory Compliance**: In some cases, energy-efficient protocols may be mandated by regulations or industry standards. Compliance with such requirements ensures that companies and technologies align with energy conservation goals.

viii) **Technological Advancements**: The development of energy-efficient protocols often drives technological advancements and innovations. Researchers and engineers continually strive to create more efficient solutions, leading to new discoveries and improvements in various fields.

ix) **Global Impact**: Considering the vast proliferation of technology and communication systems worldwide, the adoption of energy-efficient protocols can have a significant global impact on energy consumption and environmental preservation.

Some lacunae in energy-efficient protocols research:

a) Cross-Layer Optimization: Energy efficiency often requires optimization across different layers of the communication stack, including physical, MAC, network, and application layers. Various studies using the cross-layer approach in the literature have witnessed the emphasis given to physical layer, link layer, and network layer. Haapola et al. [22]
b) Long-Term Sustainability: Many energy-efficient protocols are designed with the current technology landscape in mind. Research should consider the long-term sustainability of these protocols as new technologies emerge. [23]
c) Multi-Objective Optimization: Energy efficiency is often just one of many objectives. Research could focus on multi-objective optimization, considering factors like throughput, latency, fairness, and reliability alongside energy

consumption.[24]

d) Real-World Implementation and Validation: While there have been many proposed energy-efficient protocols in literature, there's often a gap between theoretical performance and real-world implementation. Research should focus on validating these protocols in practical scenarios, considering factors like hardware limitations, network dynamics, and varying environmental conditions.[25]

Characteristics of EEP:

- Optimize the routing by forwarding the efficient data,
- Using the duty cycle to balance the consumption of energy,
- Schedule the idle nodes in sleeping mode,
- Aggregating data to lower the transmission which can be redundant.
- EEPs must be adaptable to the conditions of network during the deployment.
- Cluster based EEPs can be adapted to ensure improved efficiency with respect to energy consumption and wastage.
- The behavior of EEPs needs to be adaptive to provide Quality of Service during the operational period also ensuring the synchronization to the specific slot of time of operation.

II. Conclusion

As the WSN is accepted widely and the number of physical objects like nodes is increasing rapidly, the long life span of the system can be achieved by ensuring EEP for the communication of physical objects. There's a need to develop such Energy Efficient Protocols which provide sustainable WSNs with reliable ways of communication. Energy-efficient protocols play a crucial role in promoting sustainability, reducing costs, enhancing reliability, and driving technological advancements. By embracing and implementing these protocols, we can create a more sustainable and eco-friendly technological landscape for the future.

III. REFERENCES

[1] Yang Liu, et al., "An Improved Energy Efficient Routing Protocol for Wireless Sensor Network", SENSORS, 2019.

[2] H. M. Yamani et al., "A Survey on Wireless Sensor Network Model", International Journal of Advanced Computer Science and Applications (IJACSA), vol. 12, 2021.

[3] A. Gani et al., "A Comprehensive Survey on Wireless Sensor Network Models," IEEE Access, vol. 9, 2021.

[4] A. Ahmed et al., "A Survey on Cluster-Based Protocols for Wireless Sensor Networks," Journal of Network and Computer Applications, vol. 137, 2019.

[5] A. A. Al-Fayoumi, "A Comprehensive Survey on Cluster- Based Protocols for Wireless Sensor Networks", Future Internet, vol. 12, 2020.

[6] S. Pandit et al., "Optimizing LEACH Protocol for Energy-Efficient Data Transmission in Wireless Sensor Networks," International Journal of Distributed Sensor Networks, vol. 16, no. 5, 2020.

[7] W. B. Heinzelman, "Low Energy Adaptive Clustering Hierarchy for Wireless Sensor Networks", Proceedings IEEE Conference on Wireless Communications and Networking (WCNC), vol. 2, 2000

[8] F. Shahzad et al., "A Hybrid Energy-Efficient Distributed Clustering Algorithm for Wireless Sensor Networks," Sensors, vol. 19, no. 12, 2019.

[9] S. Lindsey, "HEED: A Hybrid Energy-Efficient Distributed Clustering Approach for Ad-hoc Sensor Networks", IEEE transactions on Computing, vol. 3, 2004.

[10] S. Ahmed, “A Survey on Data centric Protocols for Wireless Sensor Networks”, Journal of Network and Computer Applications, vol. 59, 2016.

[11] R. Priya et al., "A Review on Data-Centric Protocols for Wireless Sensor Networks," International Journal of Computer Applications, vol. 182, no. 48, 2019.

[12] M. Z. Chowdhury et al., "A Survey on Directed Diffusion-Based Data Collection in Wireless Sensor Networks," Journal of Network and Computer Applications, vol. 140, 2019.

[13] C. Intanagonwiwat, “Direct Diffusion: A scalable and robust communication Paradigm for Sensor Networks”, Proceedings of ACM MobiCom, 2001.

[14] A. L. López et al., "SPIN-TR: A Trust-Aware SPIN Protocol for Wireless Sensor Networks," IEEE Access, vol. 6, 2018.-

[15] J. Polastre, “SPIN: Sensor Protoco for Information via Negotiation”, Proceedings of ACM SenSys, 2000.

[16] N. S. Thirunavukkarasu et al., "A Review of MAC Protocols for Energy Harvesting Wireless Sensor Networks," Wireless Networks, vol. 25, no. 3, 2019.

[17] P. Kaur et al., "A Survey on MAC Protocols for Wireless Sensor Networks," International Journal of Wireless Networks and Broadband Technologies (IJWNBT), vol. 8, no. 2, 2019.

[18] H. Dong et al., "An Adaptive and Lightweight MAC Protocol for Wireless Sensor Networks," Wireless Personal Communications, vol. 100, no. 1, 2018.

[19] W. Ye et al., "An Energy-Efficient MAC Protocol for Wireless Sensor Networks," Proceedings of the IEEE INFOCOM, vol. 3, 2004.

[20] Y. Zhang et al., "Timeout MAC: A MAC Protocol for Wireless Sensor Networks," Proceedings of the ACM SenSys, 2004.

[21] S. Roy et al., "A Traffic-Aware MAC Protocol for Wireless Sensor Networks with Dynamic Reconfiguration," International Journal of Communication Systems, vol. 32, no. 10, 2019.

[22] J. Haapola, et. al., “Cross layer Energy Analysis of Multi-hop Wire- less Sensor Networks,” Proceedings of the European Workshop on Wireless Sensor Networks, 2005.

[23] M. Bathre and P. K. Das, "Hybrid Energy Harvesting for Maximizing Lifespan and Sustainability of Wireless Sensor Networks: A Comprehensive Review & Proposed Systems," 2020 International Conference on Computational Intelligence for Smart Power System and Sustainable Energy (CISPSSE), Keonjhar, India, 2020.

[24] D. Weikert, C. Steup and S. Mostaghim, "Multi-Objective Task Allocation for Wireless Sensor Networks," 2020 IEEE Symposium Series on Computational Intelligence (SSCI), Canberra, ACT, Australia, 2020.

[25] Ala’ Khalifeh,et, at., Enhancing energy efficiency of IEEE 802.15.4- based industrial wireless sensor networks, Journal of Industrial Information Integration, Volume 33, 2023.

Cite this article as :

Mayuri R. Gudade, Chandrakant R. Mankar, Dipak N. Besekar, "Energy Efficient Protocols for Wireless Sensor Network: An Overview", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 9, Issue 4, pp., July-August-2023.

ISSN 0976-0377
RNI. MAHMUL02805/2010/33461

International Registered & Recognized
Research Journal Related To Higher Education for all Subjects



INTERLINK RESEARCH ANALYSIS

Editor In Chief
Dr. Balaji Kamble

RNI. MAHMUL02805/2010/33461

IMPACT FACTOR 6.20

ISSN 0976-0377

International Registered & Recognized
Research Journal Related to Higher Education for all Subjects

INTERLINK RESEARCH ANALYSIS

UGC APPROVED, REFEREED & PEER REVIEWED RESEARCH JOURNAL

Issue : XXVIII, Vol. II
Year - 14 (Half Yearly)
(July 2023 To Dec. 2023)

Editorial Office :
'Gyandeep',
R-9/139/6-A-1,
Near Vishal School,
LIC Colony,
Pragati Nagar, Latur
Dist. Latur - 413531.
(Maharashtra), India.

Contact : 02382 - 241913
09423346913,09637935252,
09503814000,07276301000

Website
www.irasg.com

E-mail :
interlinkresearch@rediffmail.com
visiongroup1994@gmail.com
mbkamble2010@gmail.com
drkamblebg@rediffmail.com

Publisher :
Jyotichandra Publication,
Latur, Dist. Latur.-415331
(M.S.) India

Price: ₹ 200/-

CHIEF EDITOR

Dr. Balaji G. Kamble
Research Guide & Head, Dept. of Economics,
Dr. Babasaheb Ambedkar Mahavidyalaya, Latur, Dist. Latur (M.S.)
Mob. 09423346913, 9503814000

EXECUTIVE EDITORS

Dr. Aloka Parasher Sen
Professor, Dept. of History & Classics,
University of Alberta, Edmonton,
(CANADA).

Dr. Laxman Satya
Professor, Dept. of History,
Lokhevan University, Loheavan,
PENSULVIYA (USA)

Dr. Huen Yen
Dept. of Inter Cultural
International Relation
Central South University,
Changsha City, (CHAINA)

Bhujang R. Bobade
Director, Manuscript Dept.,
Deccan Archaeological and Cultural
Research Insititute,
Malakpet, Hyderabad. (A.P.)

Dr. Omshiva V. Ligade
Head, Dept. of History,
Shivjagruti College,
Nalegaon, Dist. Latur. (M.S.)

Dr. Sadanand H. Gone
Principal,
Ujwal Gramin Mahavidyalaya,
Ghonsi , Dist. Latur. (M.S.)

Dr. G.V. Menkudale
Dept. of Dairy Science,
Mahatma Basweshwar College,
Latur, Dist. Latur.(M.S.)

Dr. Balaji S. Bhure
Dept. of Hindi,
Shivjagruti College,
Nalegaon, Dist. Latur.(M.S.)

DEPUTY-EDITORS

Dr. S.D. Sindkhedkar
Vice Principal
PSGVP's Mandals College,
Shahada, Dist. Nandurbar (M.S.)

Veera Prasad
Dept. of Political Science,
S.K. University,
Anantpur, (A.P.)

Dr. C.J. Kadam
Head, Dept. of Physics
Maharashtra Mahavidhyalaya,
Nilanga, Dist. Latur.(M.S.)

Johrabhai B. Patel,
Dept. of Hindi,
S.P. Patel College,
Simaliya (Gujrat)

CO-EDITORS

Sandipan K. Gaike
Dept. of Sociology,
Vasant College,
Kej, Dist. Beed (M.S.)

Dr. Shivaji Vaidya
Dept. of Hindi,
B. Raghunath College,
Parbhani,Dist. Parbhani.(M.S.)

Ambuja N. Malkhedkar
Dept. of Hindi
Gulbarga, Dist. Gulbarga,
(Karnataka State)

Dr. Shivanand M. Giri
Dept. of Marathi,
B.K. Deshmukh College,
Chakur Dist. Latur.(M.S.)

RNI. MAHMUL02805/2010/33461
Interlink Research Analysis
IMPACT FACTOR 6.20
ISSN 0976-0377
Issue:XXVIII,Vol.II,July 2023 To Dec.2023

I N D E X

Sr. No	Title for Research Paper	Page No
1	Infected Ginger (Zingiber officinale Roscoe) In Host - Pathogen Interaction Studies on Biochemical Changes In Healthy And in Marathwada Region **Dr. Premnanda G. Ghadsing**	1
2	Recent Trends in human resources Management **Dr. Nagnath M. Adate**	5
3	Impacts of Black Money on Indian Economy **Prachi Anil Katte**	14
4	Literature Review for solid waste Management using Artificial Intelligence and Machine Learning Technique **Vrushali Dilip Wankhede**	19
5	Comparative study of ground and well water quality in Latur Dist. Latur (M.S.) India **Dr. Umakant Pandharinath Kamble**	30
6	आधुनिक युग बोध की अभिव्यक्ती **डॉ. अर्जुन सिताराम पवार**	35
7	हळदीघाटी युध्दाचा रणसंग्राम आणि त्याचे परिणाम **राधिका सुभाषराव धोत्रे, डॉ. एन. टी. वानखडे**	39
8	ग्रामीण दलित कादंबऱ्याची आशय सूत्रे **डॉ. पंडीत जी. राठोड**	45
9	गौंड आदिवासी जमात व त्यांची वैशिष्टये **डॉ. मनीषा मदुसुदन कीर्तने**	49
10	माहिती अधिकाराच्या समस्या आणि उपाय **डॉ. प्रदीप अंबोरे**	56

RNI. MAHMUL02805/2010/33461
Interlink Research Analysis
IMPACT FACTOR 6.20
ISSN 0976-0377
Issue : XXVIII, Vol. II, July 2023 To Dec. 2023

हळदीघाटी युध्दाचा रणसंग्राम आणि त्याचे परिणाम

राधिका सुभाषराव धोत्रे
संशोधक विद्यार्थीनी

डॉ. एन. टी. वानखडे
इतिहास विभाग प्रमुख
श्री. शिवाजी कला, वाणिज्य व विज्ञान
महाविद्यालय, अकोला

7 Research Paper - History

प्रस्तावना

हळदीघाटी चा रणसंग्राम भारतीय इतिहासातील सर्वाधिक प्रसिध्द युध्दापैकी एक युध्द होय. युध्दाच्या दृष्टीकोणातून पाहिल्यास हे युध्द इतर युध्दासारखे दिसते पण ऐतिहासिक दृष्टीकोणातून या युध्दाचा परिणाम अधिक प्रभावी आणि खोलवर दिसून येतो. हे युध्द मेवाडसाठीच नाही तर मुघल सत्तेसाठीही महत्वपुर्ण होते. या युध्दाचा महानायक आणि मध्ययुगीन भारतातील महान हिंदूत्ववादी योध्दा म्हणुन महाराणा प्रताप यांचा नावालौकिक आहे. अकबरासारख्या महान, शक्तीशाली, साम्राज्यवादी आणि विशेषता आशिया खंडातील सर्वात शक्तीशाली बादशाहाचे शत्रुत्व महारणा प्रताप यांनी स्विकारले होते. मध्ययुगीन भारतातील अजरामर व्यक्तीत्व महाराणा प्रताप यांच होत.

महाराणा प्रताप यांचा जन्म ९ मे १५४० मध्ये झाला. महाराणा उदयसिंह आणि जैवंताबाई यांचे जेष्टपुत्र होते. जैवंताबाई ही पाली मारवाड सोनगरा चौहान अक्षयराज यांची पुत्री होती. अक्षयराज यांनी प्रताप यांना सत्ता मिळवून देण्यासाठी आणि पुढे हळदीघाटी युध्दात खुप मदत केली. महाराणा यांच्या जन्म स्थानाविषयी ठोस पुरावा मिळत नाही परंतू राणा उदयसिंह यांनी मावली येथे वनविर याला हरवून संपुर्ण चित्तौड वर अधिकार मिळवला होता. आणि यांच वर्षात मे महिण्यात प्रताप यांचा जन्म झाल्याचा संदर्भ मिळतो. प्रताप यांच लालन पालन चित्तौडगढ़ मध्येच झाले. महाराणा प्रताप यांनी प्रारंभापासूनच एक योग्य शाषक, योध्दा बनण्याचे गुण दिसत होते त्यामुळेच त्यांना अनेक सहकारी लाभले. त्यांच्या सारख्या समविचाराचे लोक त्यांना येवून भेटू लागले. बालपनापासूनच शत्रूची होणारी आक्रमने, चितौडचा साका आणि त्यामुळेच त्यांना मेवाडसाठी एक व्यवस्थीत लष्करी व्यवस्था बनवणे जास्त आवश्यक

वाटत होते.त्यासाठी त्यांनी आधीपासूनच तयारी चालू केली होती की ज्यामुळे अकबराच्या साम्राज्यवादी वृत्तीला सतत अटकाव घालु शकेल.

युध्दाची पार्श्वभूमी

महाराणा प्रताप यांचा राज्यभिषेक २८ फेब्रवारी १५७२ मध्ये झाला आणि त्यावर्षी पासूनच बादशाहा अकबराचे दूतमंडल मेवाडवर गिरटया घालायला लागले. सगळयात पहिल्यांदा जलाल खॉ कोर्ची याला संधी आणि चर्चा हेतू मुघल दरबारातून पाठण्यात आले. शांतीपुर्ण पध्दतीने प्रताप यांना संधी आणि नियंत्रन स्विकारण्यास लावणे हा त्यामगचा हेतू होता पण या भेटीचा काही स्पष्ट निष्कर्ष निघाला नाही. इकडे प्रताप यांनी मेवाड ला संघटित आणि व्यवस्थीत करण्याच्या हेतूने प्रयन्त चालू केले होते हया वार्ता बादशाहा अकबर यांना मिळतच होत्या.साम्राज्यवादी वृत्तीच्या बादशहा अकबराला ही मेवाडची स्वातंत्रता मुळीच मान्य नव्हती.आणि त्यासाठीच त्याने आता हालचाली चालू केल्या होत्या. त्याच हेतूने आता शाही दरबारातून मानसिंहाची भेंट मेवाडला लाभणार होती. गुजरात अभियानवरून परत येतांना एप्रिल १५७३ मध्ये आमेर राजा मानसिंह यांना महाराणा प्रताप यांना मुघल अधिनता स्विकारण्यासाठी आणि शाही दरबारात आणण्यासाठी संधी प्रस्ताव घेउन पाठवण्यात आले होते. परंतू यांचाही जास्त फायदा झाला नाही उलट ही भेंट थोडी वादग्रस्त ठरली. त्यानंतर बादशहा अकबराने चर्चेसाठी वयोवृध्द राजा भगवंतदास यांना सप्टेंबर १५७३ मध्ये पाठवण्यात आले आणि त्यानंतर राजा टोडरमल यांनाही डिंसेबर १५७३ मध्ये गुजरात वरून परत येतांना प्रताप यांच्याशी चर्चा करण्यासाठी त्यांना समजवण्यासाठी पाठवण्यात आले. पण महाराणा ला समजावून बादशाहा कडे घेउन जाण्यात कोनालाच यश आले नाही पण प्रताप च्या लक्षात आले होते कि, आता युध्दाशिवाय पर्याय नाही आणि त्याच माध्यमातून प्रतापने तयारीला सुरवातही केली होती. त्यांनी महत्वाच्या पहाडी भागात, नाक्यावर चौक्या बसवल्या, मैदानी भागातील लोकांचे पहाडी भागात स्थांनातर करण्यास सुरवात केली, शत्रुला रसद मिळू नये याची पुर्ण व्यवस्था प्रताप यांनी केली ,सर्वात महत्वाचे म्हणजे प्रजेलाही मानसिक रूपाने युध्दासाठी तयार करण्यास सुरवात केली.

हळदघाटी युध्दाचा रणसंग्राम

भारतीय इतिहासातील सर्वाधिक प्रसिध्द युध्दापैकी एक युध्द हळदीघाटी च युघ्द होय. महाराणा प्रताप यांची देशरक्षा, देशप्रेम, स्वातंत्र, मातृभूमी रक्षण, ही भावना तर बादशाहा अकबर हा साम्राज्य विस्तार वादी धोरणाचा या दोन वृत्तीचा टकराव आणि याचा परिणाम म्हणजे १५७६ मधिल हळदीघाटी युध्द. या युध्दाची तुलना थर्मोपिली

च्या युध्दाशी केली जाते. जे थिसली च्या पहाडी भागात आणि समुद्र भाग यांच्या मध्ये आहे या युध्दाने रोमचा इतिहास बदलून टाकला होता. याला खमणोर च युध्दही म्हणतात.

हळदीघाटी हे ठिकाण पहाडी भागातील वाळूयुक्त क्षेत्र आहे जे अरावली पर्वतरांगा मध्ये दुर्गम भागात आहे. हया भागातील माती हळदीच्या रंगाप्रमाने पिवळया रंगाची आहे त्यामुळे सर्व जमिन पिवळी दिसते आणि म्हणुनच या भागाला हळदीघाटी असे म्हणतात. त्यानंतर हे ठिकाण खमणोर या गावापासून ८ कोस दूर अंतरावर आहे म्हणून या युध्दाला खमणोरच युध्द म्हणुनही संबोधल्या जाते या भागात भील जमात अधिक संख्येने वास्तव्यास होती या भीलांनी युध्दामध्ये महाराणाला खुप मदत केली या युध्दाच विस्तृत वर्णन तीन भागात पाहू .

युध्दाचा पहिला भाग

महाराणा प्रताप आणि शाही सेना यांच्या लष्कराची निश्चीत संख्या सांगणे कठिण आहे पण गोपिनाथ शर्मा यांच्या नुसार महाराणा प्रताप यांच्या सैन्यात तीन हजार घोडेवाले सैनिक, दोन हजार पैदल, शंभर हत्ती, भालेवाले सैनिक, नगारची, तुरही वाजवनारे, अशी संख्या होती. तर लष्करी सजावट हरावल, चंदावल, वामपार्श्व, द.पार्श्व अश्या वेगवेगळया भागात करण्यात आली होती. त्याच्या सोबतीला हकिम खॉ सूर, सांगा चुण्डावत देवगढ़चा, भाला मानसिंह, भाला मानसिंह मज्जावत देलवाड़ा रावत किशनदास, मुकुन्ददास आणि रामदास, सांगा चूण्डावत दवगढ़, रावत नेतसिंह, भीमसिंह डोडीया, राठौड़ शंकरदास, केनदास, रामदास, आणि नरहरदास, राजा रामशाह तंवर, राठौड बाघसिंह नीमड़ी, हकीम खॉ सूर, भामाशाह, ताराचंन्द, मानसिंह सोनगरा, नरसिंह सोनगरा चौहान, भील सरदार राणा पूंजा अश्या खुप महान योध्दयांनी या युध्दात भाग घेतला यामध्ये हिंदू—मुस्लीम, सांमत—सरदार, अधिकारी सर्वानी या युध्दात भाग घेतला.

राजा मासिंहानेही युध्दाची पुर्ण तयारी केली होती मानसिंहाला महाराणा घाटीपर्यत पोहचल्याचा समाचार मिळताच मानसिंह सेना घेउन एका ठिकानी आला. त्याला आज बादशाहा बाग असे म्हणतात. मानसिंहाने शाही सेना बादशाहा बागेत संघटित केली होती. त्यामध्ये निवडक ८० सैनिकांच एक संघटन होते त्याला.''चुझे हरावल'' असे म्हणतात. या चुझे हरावलला हाशिम बरहाच्या नेत्वृत्वाखाली मेवाड सैण्यावर हल्ला चढवण्यासाठी पाठवण्यात आले होते त्यांच्या मागे राजा जगन्नाथ आणि आणि आसफ खॉ च्या नेत्वृत्वाखाली सैन्य होते. दक्षिणेकडे अहमद खॉ, तर वाम पक्षात पुढे गाजी खॉ

बक्शी आणि लुणकर्ण कछवाह, आरक्षित दलाच नेतृत्व माधोसिंह आणि त्यांच्या मागे मिहत खॉ आणि मानसिंह हत्तीवर केंद्रस्थानी होता. पारंपारिक राजपुती व्यवस्थेपेक्षा वेगळी ही व्यवस्था होती. चुझे हरावल, आरक्षित दल, अंगरक्षक दल विशेष रूपाने बनवल्या गेले होते. शाही सेनेत आनखी एक मुख्य विशेषत: होती की ती म्हणजे सैण्याच्या प्रत्येक गटाच नेतृत्व करणारे एक मुस्लीम आणि त्यासोबत एक हिंदू अधिकारी अशी व्यवस्था करण्यात आली होती. पुढे शाहाजहान आणि औरंगजेबाच्याही काळात ही व्यवस्था चालू होती. स्वत: मानसिंहा सोबत ख्वाजा मुहम्मद, रफी बदक्शी, कशयाबुददीन गुरोह, पसबंदा कज्जाक, अली मुराद,उजबाक असे बरेच योध्दे होते.

सुचना मिळताच हाशिम बराहाच्या नेतृत्वाखाली चुझे हरावल चे योध्दे घेउन पहिला हल्ला मेवड सैण्यावर चढवला गेला मेवाड सैण्यानेही पहिला हल्ला यशस्वीपणे हाणुन पाडला अश्याप्रकारे युध्दाच पहिल चरण हे महाराणाच्या बाजूने पार पडल.

युध्दाचा द्वितीय भाग

मुघल सैण्याच्या चूझे हरावल च्या अंत केल्याने महाराणाच्या सैण्यामध्ये एक प्रकारे जोश आणि उत्साह निर्मान झाला होता. महाराणा प्रताप, मेवाडी सैन्य, हकिम खॉ सूर, बाकी योध्दे आता पहाडी भागातून बाहेर येवू लागली आणि शत्रूवर तूटून पडत होती. शाही सेनेला या पहाडी भागात, उबड—खाबड जमिनीवर लढणे कठिण जात होते आणि मेवाडी सैण्यानेही यांच परिस्थीतीचा फायदा घेउन शाही सेनेला त्यांच्या चौक्यापासून ५—६ कोस दूर खदेडत नेले. या युध्दातील डोळयाने पाहिलेली हकिकत इतिहासकार बदायूनी ने लिहली आहे. राणानेही घाटीच्या बाहेर येवून काजी खा आणि शाही सैन्यावर हल्ला चढवला जो घाटीच्या मुखाशी डेराटाकून बसला होता महाराणा प्रताप युध्द करत मैदानात मध्यभागी पोहोचले .

इतिहासकार बदायूने स्पष्ट वर्णन केले आहे की, मुघल सेना बादशाहा बाग च्या मैदानात पुर्णपने पराजित होउन मैदान सोडून पळू लागली होती पण ऐन वेळेवर संकटाचा वेध घेउन मुघलांच आरक्षित सैन्य मिहतर खॉ च्या नेतृत्वाखाली शाही सेनेच्या मदतीला मैदानात उतरले. पळून जात असलेल्या सैनिकांना पुन्हा संघटित केले सोबतच मिहतर खॉ जोरजोराने सांगू लागला ''बादशाहा सलामत आ पहूचे हैं।'' आणि युक्ती कामात आली पळून जानारी शाही सेना पुन्हा धैर्याने मैदानात येवून लढू लागली. पण युध्दाच्या द्वितीय चरणात विजयश्री च पारड मेवाडच्या पक्षात होत.

युध्दाचा तृतीय भाग

द्वितीय चरणाच्या अंती पळून जाणार मुघल सैण्य आरक्षित सैन्याच्या प्रवेशाने

पुन्हा वापस येवून युध्द करू लागले. महाराणा च सैन्सही अधिक उत्साहाने लढत होते. आणि याच धावपळीत आता युध्द बनास नदी जवळ एका मोठया मैदानात येवून ठेपले होते. हे मैदान म्हणजे ''रक्त तलाई'' होय. पण आता युध्दाचा जोर चांगलाच वाढला होता प्रत्येकजन चांगल्या उत्साहाने लढत होता. स्वत: बदायू लिहतो की,ग्वालियरचा राजा मान चा नातू रामशाहा जो प्रतापच्या हरावल मध्ये होता. युध्दात इतकी विरता दाखवली की त्याच वर्णन करणे मला आणि या लेखणी ला शक्य नाही. महाराणा प्रताप आणि त्यांच्या सहकार्यानी, जंगली जमाती, भील, युध्दभूमीवर आपल्या विर कृत्याने शत्रुचा फडशा पाडला शत्रुला मृत्युच्या दारात पोहोचवतांना कोनतीच कसर सोडली नाही. हळदीघाटीच्या पहाडातून देशरक्षणासाठी झुंडाच्या झुंडा बाहेर पडत होत्या. या युध्दात हत्ती युध्दही झाले या हत्ती युध्दाच वर्णन करतांना मुघल इतिहासकार अबुल फजल लिहतो ''दोनो पक्ष के विरो ने लढाईमे जान सस्ती और इज्जत मंहगी कर दी।'' ज्या प्रमाणे योध्दे पुर्णसामर्थ्यने देशरक्षणासाठी लढले तसेच प्राणी ही आपल्या स्वामीसाठी युध्दात लढले. महाराणा प्रताप जेव्हा मानसिंहाजवळ पोहोचले युध्द करण्यासाठी प्रताप यांच्या घोडयाने अशी उडी मारली की महाराणा आणि प्रताप दोघेही एकमेंकासमोर आले आणि महाराणा ने हीच खरी संधी समजून मानसिंहाच्या दिशेने भाला फेकला मानसिंह हत्तीवर हौदात झुकल्याने थोडक्यात बचावला पण हत्तीच्या सोंडेला आणि दाताला बांधलेल्या तलवारीमुळे महाराणाचा घोडा मात्र खूप जखमी झाला. आणि हीच वेळ पाहून मुघल सैनिक महाराणावर तूटून पडीली आता महाराणा मुघलांच्या पुर्ण घेरावात आले होते. आपल्या स्वामीचे प्राण संकटात पाहून महाराणाचा एक सहयोगी झाला मान या योध्दयाने महाराणाच्या अंगावरची सर्व राजचिन्ह काढून स्वत: परिधान केली सर्वाना आपनच राणा असल्याचे भासवले त्यांचा परिणाम शत्रुच लक्ष झालावर केंद्रीत होउन महाराणा सुरक्षित रक्त तलाईच्या मार्गाने बलीचे गावापर्यत आले पण यांच ठिकाणी महाराणाच्या घोडयाने प्राण सोडले यांच ठिकाणी महाराणाच्या स्वामीभक्त घोडयाचे स्मारक आजही स्वामिभक्तीच स्मरण करून देते.

महाराणा नंतरही त्यांचे सोबती लढत मरण पावले आजही या विरांचे स्मारक येथे आहेत. हकिम खॉ सूर ची मजारही हळदीघाटी या स्थळावर आहे

हळदीघाटी युध्दाचे परिणाम

हळदीघाटीच युध्द जवळ जवळ तीन तासांत संपले इतक्या कमी वेळात दोन असामान्य शक्ती एकमेंकासमोर आल्या. सैनिकी संख्या, आधुनिक शस्त्र, मोठी साम्राज्य शक्ती, अनुभवी सेनापती, मैदानी लढाईचे अनुभव यामुळे शाही सेनेच पारड भारी होत.

सर्वत्र विजयी डंका वाजवणारा मानसिंह यांचा विजयी होण्यावर पुर्ण विश्वास होता.

मुघल इतिहासकारांनी बादशाहा अकबराला विजयी घोषीत केल. तर मेवाडचे शिलालेख, प्रशस्ती, साहित्य, लोकगीत महाराणा यांना विजयी म्हणते. युध्दाचे परिणाम अनिर्णायक असेही म्हणता येणार नाही कारण जेव्हा मुघल सैण्याने राजपुत सैन्याला पराभूत केलं आणि राजपुत सैन्य पहाळी भागात जात असतांना शाही सैनिकांनी त्यांचा पाठलाग केला नाही. युध्दानंतरही शाही सेना भीतीदायक वातावरणात वावरत असे. गोगुदयांला असतांना सुरक्षेसाठी या सैनिकांनी आजूबाजुने भिंती बांधल्या, खोल दरी खोदल्या, गोगुंदयाच्या बाहेर येण्यास सैनिक भीत असत. त्यानंतर रसदीचा तुटवडा, महाराणा प्रताप यांना शाही सेना जिंवत किंवा मृत पकडू शकली नाही. त्याचबरोबर मानसिंह आणि आसफ खॉ यांना युध्दातील चुकामूळे बादशाहाने यांच्यावर काही बंधने टाकली होती. या सगळया वरून हळदीघाटी युध्दात विजय बादशाहा अकबराचा झाला असेही म्हणता येणार नाही.

संदर्भ सूची :-

१. डॉ. देवीलाल पालीवाल — २००१ महाराणा प्रताप महान जीवन — वृत्त और कृतित्व
२. डॉ. देवीलाल पालीवाल — ऑगस्ट १९८० हल्दीघाटी युध्द
३. डॉ. देव कोठारी— जुलै १९९० शोध—पत्रिका साहित्य संस्थान,राजस्थान विदयापिठ.
४. डॉ. गोपीनाथ शर्मा—२९.०२.१९९३ मेवाड महिमा — मेवाड का राजनैतिक इतिहास भाग ९३
५. डॉ. गोपीनाथ शर्मा — मेवाड महिमा — मेवाड का राजनैतिक इतिहास भाग ९४
६. डॉ. गोपीनाथ शर्मा — मेवाड महिमा — मेवाड का राजनैतिक इतिहास भाग
७. डब्ल्यु. एच. मुरलॅड — अकबरकालीन हिंदुस्थान अनुवाद : सुनंदा कोगेकर

ISSN 2231-6671

International Registered and Recognized
Research Journal Related to Higher Education for all Subjects

HI-TECH
RESEARCH ANALYSIS



EDITOR IN CHIEF
DR. BALAJI KAMBLE

IMPACT FACTOR
6.20

ISSN 2231- 6671

International Registered & Recognized
Research Journal Related to Higher Education for all Subjects

Hi-TECH RESEARCH ANALYSIS

UGC APPROVED & PEER REVIEWED RESEARCH JOURNAL

Issue : XXVI, Vol. - III
Year - XIII, (Half Yearly)
Aug. 2023 To Jan. 2024

Editorial Office :
'Gyandev-Parvati',
R-9/139/6-A-1,
Near Vishal School,
LIC Colony,
Pragati Nagar, Latur
Dist. Latur - 413531.
(Maharashtra), India.

Contact : 02382 - 241913
09423346913 / 09503814000
07276305000/ 09637935252

Website
www.irasg.com

E-mail :
interlinkresearch@rediffmail.com
visiongroup1994@gmail.com
mbkamble2010@gmail.com

Published by :
JYOTICHANDRA PUBLICATION
Latur, Dist. Latur - 413531 (M.S.)India

Price : ₹ 200/-

CHIEF EDITOR

Dr. Balaji G. Kamble
Research Guide & Head, Dept. of Economics,
Dr. Babasaheb Ambedkar Mahavidyalaya,
Latur, Dist. Latur.(M.S.) (**Mob. 09423346913**)

EXECUTIVE EDITORS

Dr. B. M. Gore
Principal
Janvikas Mahavidyalaya,
Bansarola, Dist. Beed(M.S)

Dr. Dileep S. Arjune
Professor & Head, Dept. of Economics
J. E. S. College,
Jalna, Dist. Jalna(M.S.)

Scott. A. Venezia
Director, School of Business,
Ensenada Campus,
California, (U.S.A.)

Dr. U. Takataka Mine
Tokiyo (Japan)

Bhujang R. Bobade
Director Manuscript Dept.,
D. A. & C. Research Insititute,
Malakpet, Hyderabad. (A.P.)

Dr. Nilam Chhangani
Head, Dept. of Economics,
SKNG Mahavidyalaya,
Karang Lad, Dist. Washim(M.S.)

DEPUTY-EDITOR

Dr. Murlidhar A. Lahade
Dept. of Hindi,
Janvikas Mahavidyalaya,
Bansarola, Dist. Beed(M.S)

Dr. S.B. Wadekar
Dept. of Dairy Science,
Adarsh College,
Hingoli, Dist. Hingoli.(M.S.)

Dr. Balaji S. Bhure
Dept. of Hindi,
Shivjagruti College,
Nalegaon, Dist. Latur.(M.S.)

Dr. Shivaji Vaidya
Dept. of Hindi,
B. Raghunath College,
Parbhani , Dist. Parbhani.(M.S.)

CO-EDITORS

Dr. V. R. Gawhale
Head, Dept. of Commerce,
G. S. College,
Khamgaon, Dist. Buldana (M.S.)

Dr. Shyam Khandare
Dept. of Sociology
Gondawana University
Gadchiroli, Dist. Gadchiroli (M.S.)

Ghansham S. Baviskar
Dept. of English,
RNC & NSC College,
Nasik, Dist. Nasik.(M.S.)

Dr. Balasaheb Patil
Head, Dept. of Economics
C. K. Thakur College,
Panvel, Dist. Raigad (M.S.)

INDEX

Sr. No	Title for Research Paper	Page No
1	Effect of Alianthus excels Roxb On Leaf Spot of Turmeric Caused by Taphrina macalans Butler **Dr. Premnanda G. Ghadsing**	1
2	Marketing of Library Products and Services for Library Development **Jayant Hansaraj More, Dr. Vikram U. Dahifale**	6
3	Life and Mathematical Works of Prof. Sourav Chatterjee **Navin Limbraj Chavan**	12
4	A comparative study for the effect of Isotonic, Isometric Exercise and Eccentric exercise on physical Fitness **Dr. Ramesh K. Mane**	16
5	मराठी संतो का हिन्दी काव्य **रविशंकर दगडू रोकडे**	24
6	सेंद्रीय शेतीचे आर्थिक फायदे एक अभ्यास **दिनेश भा. खेरडे**	29
7	शेतमजूरांच्या कमतरतेमुळे महाराष्ट्रातील शेतीत झालेल्या बदलाचा अभ्यास **बी. बी. बोबडे**	35
8	महाराणा प्रताप यांची कृषी निती **राधिका सुभाषराव धोत्रे, डॉ. एन. टी. वानखेडे,**	41
9	आंध जमातीत करण्यात येणारे परंपरागत व्यवसाय **डॉ. मनिषा मधुसुदन किर्तने**	45
10	अन्न सुरक्षा एक सामाजिक समस्या **डॉ प्रदीप अंबोरे**	52

8

महाराणा प्रताप यांची कृषी निती

राधिका सुभाषराव धोत्रे
संशोधक विद्यार्थीनी

डॉ. एन. टी. वानखेडे
इतिहास विभाग,
श्री. शिवाजी कला, वाणिज्य व विज्ञान
महाविद्यालय, अकोला

Research Paper - History

प्रस्तावना:

कृषी हा भारतातील सर्वात मोठा उद्योग आहे. भारतात मोठ्या प्रमाणावर शेती हा उदयोग रोजगार पुरवण्याचे काम करते त्याचबरोबर देशाचा कणा असणाऱ्या इतर उद्योगांना कच्चामाल शेती पुरवते त्याचबरोबर भारतीय अर्थव्यवस्थेत शेती क्षेत्राचे स्थान अत्यंत महत्वाचे आहे. एखाद्या वर्षी नैसर्गिक संकटामुळे उत्पन्न कमी झाले तर त्याचा परिणाम संपूर्ण व्यवस्थेवर पडते. आधुनिक काळात शेतीचे तितकेच महत्त्व आहे जेवढे प्राचीन आणि मध्ययुगात होते. प्राचीन आणि मध्य युगात तर शेती हा सर्वात मोठा उद्योग होता. इतर उद्योग यावर अवलंबून होते त्या काळात देशातील बहुसंख्य लोक ग्रामीण भागात राहत होते आणि ग्रामीण भागातील लोक मुख्यत: शेती व त्यावर आधारित उद्योग यावर त्यांचे जीवन चालत असे त्यामुळे शेतीला भारतात खूप महत्त्व आहे. मध्ययुग आणि प्राचीन काळापासून कृषी व्यवस्थेचे महत्त्व ओळखून महाराणा प्रताप यांनी कृषी संबंधित क्षेत्राला जास्त महत्त्व दिल्याचे दिसून येते.

कृषी हा तत्कालीन समाजाचा जगण्याचा खरा आधार असल्याचे दिसून येते त्यामुळे महाराणा प्रताप यांनी कृषी उद्योगाला मोठ्या प्रमाणावर प्रोत्साहन दिले होते. मेवाडच्या गादीवर महाराणा प्रताप आल्यावर त्यांनी आपल्या पूर्वजांप्रमाणे शेतीला प्राधान्य दिल्याचे दिसून येते. कृषी हा मेवाडच्या आर्थिक समस्येवर सर्वात मोठा पर्याय त्यावेळी आणि त्यावेळेच्या परिस्थिती वरून दिसून येते. भारतात प्राचीन काळापासून कृषी हा भारतीयांचा मुख्य आधार होता. प्राचीन काळापासून आधुनिक काळापर्यत अनेक गोष्टीत काळानुरूप बदल झाले पण प्राचीन काळापासून आधुनिक युगापर्यत

कृषीने मानवी जीवनात जी स्थिरता निर्माण केली आहे त्यामध्ये कोणत्याही प्रकारचा बदल झाला नाही. शेती करण्याच्या पध्दतीत बदल झाला त्यात नव—नविन यंत्र तंत्र आले नविन बदल झाले. मेवाडची आर्थिक स्थिती सुधारण्यासाठी महाराणा प्रताप यांनी कृषीवर लक्ष निधारित केले केले होते.

शेतीसाठी आर्थिक मदत:

मैदानी भागावर पुर्णत: मुघलांचे नियंत्रण झाल्याने पहाडी क्षेत्रात शेती करण्याचा मार्ग उरला होता त्यासाठी शेतकऱ्यांनी याच भागात शेती करण्याच्या उद्देशाने या भागातील दऱ्या खोऱ्यांमध्ये शेतीयोग्य जमिनीचे भु—क्षेत्र बणवण्यासाठी पहाड फोडणे त्याचबरोबर नैसर्गिक उत्पादन मिळवण्यासाठी शेतकऱ्यांना प्रोत्साहनपर आर्थिक मदत केल्याचे पुरावे, दस्तावेज मिळतात.

सिंचन विभाग:

जल सिंचनासाठी महाराणा प्रताप आणि प्रशासनाकडून बरेच प्रयत्न करण्यात आले होते. त्याचेच उदाहरण म्हणजे आवरगढ़ येथे जलकुंड बांधण्याचे काम करण्यात आले होते. त्याचबरोबर नैसर्गिकरित्या पाण्याचा संग्रह करून योग्यवेळी त्याचा कृषीसाठी आणि पिण्याच्या पाण्यासाठी उपयोग केल्या जात होता. महाराणा प्रताप यांनी नैसर्गिकरीत्या आणि जलकुंड बांधून १,५१,३४,५९,००० लिटर जलसंग्रहाची व्यवस्था केले गेल्याचे दिसून येते. महाराणा प्रताप यांनी शेतीसाठी काही भागात सिंचनाची व्यवस्था करून दिली होती. त्यामध्ये गिर्वा, छप्पन्न, मगरा या भागात शरदकालीन म्हणजेच रब्बीची पिकं मोठ्या प्रमाणावर घेतल्या जात होती. पहाडी, दऱ्या, खोऱ्यांमध्ये नेहमीच पाण्याची कमतरता भासत होती. विहीरीची संख्या खुप कमी होती अशा भागात दोन नाल्यामध्ये बांध बांधून पाणी साठवल्या जात होते. आवश्यकतेनुसार त्या पाण्याचा वापर होत असे जमिनी आपआपल्या पोतानुसार वेगवेगळया नावाने ओळखल्या जात. 'माल' नावाच्या भूमीला विहीरी द्वारे पाण्याची सिंचाई केली जात असे तसेच पर्वतीय भागात खोऱ्यांमध्ये, नदी—नाल्यामध्ये पाण्याची साठवण करून आवश्यकतेनुसार त्याचा वापर होत असे. पाणी उपसण्यासाठी चामडीच्या मोठचा उपयोग केला जात होता त्याला चड्स असे म्हटल्या जात होते. (चड्स म्हणजे विहीरीतील पाणी उपसण्यासाठी वापरण्यात येणारी चामडीपासून बनवल्या गेलेल एक साधण) चांभार नामक जातीचे लोक त्या काळात शेतीसाठी या साधणाची निर्मिती करत होते. त्याचबरोबर शेती व शेतीशी संबंधीत इतर काम करणारे लोक ग्रामिन भागामध्ये एकमेंकाच्या सहयोगाने राहत असत. मुख्यत: ग्रामिन भागात राहणाऱ्या जनतेची सर्व काम शेती आणि

शेतकऱ्यांशी सबंधित असत. त्यामध्ये लोहार, कुंभार, चांभार हे लोक शेतीची अवजारे बनवित होते त्याचबरोबर खत, बि—बियाण्याची व्यवस्था लावणे, शेतीसबंधीत काम ही लोक करीत होते याबदल्यात या लोकांना वर्षाला आणि सण—समारंभात शेती उत्पन्नातील हिस्सा त्यांना दिला जात होता.

त्यासाठी त्यांनी नव—नवीन योजना आणि नियोजनबद्ध प्रयत्न केल्याचे आढळून आले. मेवाडची धुरा सांभाळतांना त्यांनी मेवाडच्या सीमा सुरक्षित केल्याचे दिसून येते. सोबतच समतोल भूमीवर शत्रूचा हल्ला होण्याची शक्यता जास्त होती त्यासाठी त्यांनी शस्त्र, धान्यसाठा ह्या गोष्टी प्रामुख्याने अरवलीच्या पर्वतरांगांमध्ये दुर्गम भागात स्थलांतरीत केल्याचे दिसून आले. हळदी घाटी युद्धानंतर बरेच दिवस ते या जंगलात राहत होते तेव्हा त्यांनी या पहाडी भागात शेती करण्यासाठी लोकांना प्रोत्साहन दिले. या डोंगरी भागात शेती केली त्याचबरोबर पहाडी भागात उतारावर शेती योग्य जागा मिळेल अशा ठिकाणी, पहाडात मिळेल त्या मैदानी भागात त्यांनी शेती करण्यासाठी लोकांना प्रवृत्त केले. त्याचबरोबर नैसर्गिक शेती करण्यासाठी शेतकऱ्यांना अर्थसहाय्य केल्याचे दिसून आले. महाराणा प्रताप यांना सुरुवातीच्या काळात शत्रूशी सातत्याने युद्ध करावे लागत असल्याने त्यांचे कृषीवर अधिक काळ लक्ष देणे झाले नाही पण मेवाडची राजधानी चावंडची निवड केल्यानंतर या भागात त्याचबरोबर युद्धाचा जोर कमी झाल्यानंतर त्यांनी आपले पूर्ण लक्ष शेती उद्योगांकडे वळवल्याचे दिसते. मेवाडची राजधानी चावंडची निवड केल्यानंतर या भागात त्यांनी मोठ्या प्रमाणावर कृषीचा विकास घडवून आणला महाराणा प्रताप यांना सुरुवातीला शेती योग्य पाण्याची उपलब्धता असणाऱ्या जमिनी लोकांना शासनाकडून उपलब्ध करूण दिल्या. त्याचबरोबर शेतकऱ्यांना बी—बियाणे, शेतीशी संबंधित अवजारे शेतकऱ्यांना पुरवले होते त्याचबरोबर शेतीसाठी आर्थिक सहाय्य केल्याचे दिसून येते. त्याचबरोबर ह्या वस्तु शासनामार्फत लोकांपर्यंत पोहोचवण्याची व्यवस्था महाराणा प्रताप यांच्या काळात करण्यात आली होती. शिवाय मेवाडच्या स्वातंत्र युद्धात ज्या लोकांचे शेती विषयक दस्तावेज, पट्टे, परवाने गहाळ झाले त्या लोकांना हे पट्टे परवाने पुन्हा नव्याने देण्यात आले होते. महाराणा प्रताप यांनी संथाना, मही, पिपली, मृगेश्वर, बांधण, पंडेर, डाईलाणा हया गावच्या जमिनी ब्राम्हण आणि भाटांना भेट केल्या होत्या. या जमिनी आणि गाव भाटांना दान केल्याचे पुरावे मेवाडच्या जागीरदांराच्या कार्यालयात मिळतात. महाराणा प्रताप यांच्या काळात ज्वारी, बाजरी, गहू, हरभरा, मसूर, वटाणा, उडीद, तुर याचे उत्पादन घेतले जात होते तेलबिया म्हणून तिळाची लागवड केल्या जात होती याच काळात ऊस पिकवल्या जात असल्याचे पुरावे

मिळतात. अन्नधान्या सोबत पालेभाज्या ही पिकवल्या जात होत्या.

चक्रपाणी यांच्या ग्रंथानुसार महाराणा प्रताप यांच्या काळात रंगीत कपाशीचे उत्पादन घेतल्या जात होते. त्याचबरोबर महाराणा प्रताप यांनी सिंचन व्यवस्थेकडे लक्ष दिल्याचे दिसून येते. महाराणा प्रताप यांनी शेतीसाठी पाण्याची व्यवस्था केली होती त्याचबरोबर महाराणा प्रताप यांनी कृषी संवर्धन सोबत जल व्यवस्थापनाची मोठ्या प्रमाणात व्यवस्था लावल्याची दिसून येते. महाराणा प्रताप यांनी झाडोल गावाजवळ त्याचबरोबर चित्तोडगड आणि कुंभलगड या गावांच्या आसपासच्या क्षेत्रात जलव्यवस्थापनाची निर्मिती केल्याचे आढळते. महाराणा प्रताप यांच्या काळात सुती, रेशमी व उपदार वस्त्र वापरण्याचे प्रचलन होते महाराणा प्रताप यांनी शेतीसाठी आणि शेतीशी संबंधित बरेच उद्योगधंद्यांना प्रोत्साहन दिल्याचे दिसून आले आहे. शेतीसाठी सिंचन व्यवस्था त्याचबरोबर नवनवीन बी बियाणे अवजारे शेतकऱ्यांना उपयोगी वस्तूंचे वाटप करण्यात येत होते. शेती उद्योगांकडे वेळ मिळेल तेव्हा महाराणा प्रताप यांनी शेतीचा चांगलाच विकास घडवून आणल्याचे दिसून येते. त्यामुळे महाराणा प्रताप यांच्या काळात सतत युद्ध असूनही मेवाड मध्ये विकास हा चालू असल्याचे दिसून येते.

शेतीवर मोठ्या प्रमाणावर राज्याचा राजकोष अवलंबून होता त्यामुळे शेती हा राज्यांच्या राजकीय उत्पन्नाचा प्रमुख भाग होता. शेतकऱ्याजवळून भोग, भाग, भू—राजस्व हे कर शेतीतील उत्पन्नावर लावल्या जात होते भोग किंवा भाग कराच्या रूपाने शेतकऱ्यांजवळून उत्पन्नाचा काही भाग राज्याच्या तिजोरीसाठी घेतला जात होता परंतु मेवाडमध्ये बंटाई, नाप आणि ठेका अशा तीन पध्दतीने कर घेण्याची प्रथा आधीपासून होती. हा कर नगद किंवा शेतमालाच्या रूपात घेतल्या जात होता.

संदर्भ सूची :-

१. भारताचा इतिहास, नी. सी. दिक्षित, पेज. नं. २५
२. प्रारंभिक भारत का परिचय, रामशरण शर्मा, पेज. नं. २०९
३. महाराणा प्रताप महान, देवीलाल पालीवाल, पेज. नं. ६
४. महाराणा प्रताप ऐतिहासिक अध्ययन, डॉ. नरसिंह परदेशी बघेल, पेज. नं. १२०
५. ईश्वर सिंह राणावत राजस्थान के जलसंसाधान, पेज नंबर १४५
६. महाराणा मेवाड हिस्टॉरिकल ट्रस्ट, पुस्तिका ,पेज नं. ४४
७. उदयपुर राज्य का इतिहास, पेज. नं.४३१
८. महाराणा प्रताप स्मृती ग्रंथ, देवीलाल पालिवाल, पेज. नं. २०६
९. मेवाड के महाराणा और शहंशाह अकबर, पेज नंबर ३१३

THE RUBRICS JOURNAL OF INTERDISCIPLINARY STUDIES
International, Indexed and Peer Reviewed e-Journal
ISSN 2454-1974

THE RUBRICS
Journal of Interdisciplinary Studies
Volume 6 Issue 2 March 2024
www.therubrics.in

Review on: Recent Advances in Synthesis of Selenium Nanoparticles and its Therapeutic Applications

Jedhe V. S.[1], Adole S.D.[2] Patil S. M.[3] and Mehere B. A.[4]

[1]Department of Biochemistry, Arts and Science College, Pulgaon Tal. Deoli, Dist. Wardha.
[2]Department of Biochemistry, Dr. R. G. Bhoyar Arts, Commerce and Science College, Seloo, Dist. Wardha.
[3]Department of Biochemistry, Shri. Shivaji Science College, Akola.
[4]Department of Biochemistry, Dr. Ambedkar College, Dikdhabhoomi, Nagpur.

FULL PAPER

1. Introduction

Selenium is a chemical element with the symbol Se and atomic number 34. It belongs to the chalcogen group on the periodic table, which includes oxygen, sulfur, tellurium, and polonium. Selenium is a non-metal and exhibits both metal-like and non-metallic properties, making it a fascinating element with a wide range of applications and importance in biological systems.

Selenium is found in the Earth's crust, often associated with sulfur-containing minerals. It can also be found in some ores like pyrite and is released into the environment through volcanic activity and weathering of rocks [6].

Selenium, a trace element essential for human health, has garnered significant attention in recent years due to its remarkable properties at the nanoscale. Selenium nanoparticles (SeNPs) have emerged as a fascinating and versatile nanomaterial with diverse therapeutic applications. This review aims to provide a comprehensive overview of the recent advances in the synthesis of selenium nanoparticles and their evolving role in therapeutic interventions [1] [14].

Selenium is crucial for various biological processes. It is an essential component of several enzymes, including glutathione peroxidases and thioredoxin reductases. Selenium is an essential component of these selenoproteins, which play critical roles in antioxidant defense, immune regulation, and DNA synthesis [1]. In humans, selenium is required for proper thyroid function and immune system health. Adequate dietary selenium intake is important for human health.

ISSN 2454-1974

Selenium deficiency can lead to conditions like Keshan disease and Kashin-Beck disease, which affect the heart and bones, respectively. However, excessive selenium intake can also be toxic and cause selenosis, leading to symptoms such as hair and nail loss, gastrointestinal issues, and neurological problems [23] [24].

However, the therapeutic potential of selenium extends beyond its traditional role as a dietary supplement. The unique physicochemical properties exhibited by selenium nanoparticles have opened up new avenues in biomedical research and clinical applications. The controlled synthesis of selenium nanoparticles has witnessed significant progress in recent years. Various innovative techniques have been developed, including chemical reduction, green synthesis utilizing plant extracts, and biogenic synthesis involving microorganisms. These advances allow for precise manipulation of SeNPs' size, shape, and surface properties, thereby tailoring them for specific therapeutic purposes [2].

Selenium nanoparticles exhibit a remarkable capacity to combat oxidative stress, making them valuable contenders in the management of oxidative stress-related diseases such as neurodegenerative disorders [3]. Their antioxidant properties, coupled with their low toxicity profile, make them attractive candidates for enhancing cellular protection against reactive oxygen species.

Moreover, SeNPs have demonstrated substantial antimicrobial activity, offering new prospects in addressing antibiotic resistance challenges. Their application extends to drug delivery systems, where they can serve as carriers for targeted and controlled drug release [4]. The inherent biocompatibility of SeNPs further underscores their potential in various medical applications.

Beyond their antioxidant and antimicrobial attributes, selenium nanoparticles have displayed promising outcomes in the treatment of inflammatory conditions and autoimmune diseases. Furthermore, they have emerged as potential adjuvants in cancer therapy, aiding in sensitizing tumors to conventional treatments [5]. Their immune-modulatory properties hold the key to novel therapeutic strategies and vaccine development.

This review aims to provide a comprehensive analysis of the recent advancements in the synthesis of selenium nanoparticles, including the latest breakthroughs in their fabrication methods, and to explore the rapidly evolving landscape of their therapeutic applications in healthcare. The journey through the innovative research and emerging trends in SeNPs promises to shed light on their potential to revolutionize modern medicine.

ISSN 2454-1974

2. Synthesis methods

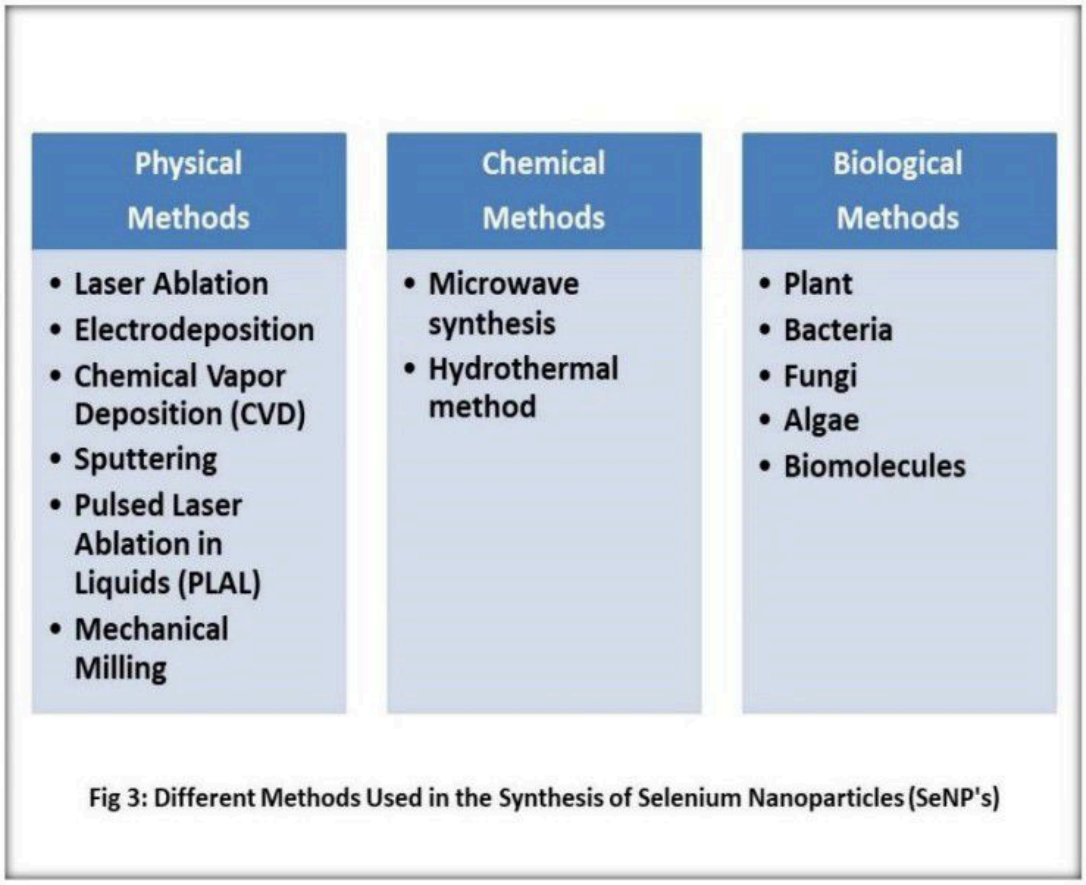


Fig 3: Different Methods Used in the Synthesis of Selenium Nanoparticles (SeNP's)

2.1. Physical Methods:

Physical methods for the synthesis of selenium nanoparticles (SeNPs) offer precise control over their size, shape, and properties. These methods leverage various physical phenomena to create SeNPs. These physical methods offer flexibility in tailoring SeNP properties for diverse applications in fields like nanomedicine, electronics, and catalysis.

2.1.1. Laser ablation:

Laser ablation involves using a high-energy laser to vaporize a selenium target in a liquid medium, leading to the formation of SeNPs. The synthesis of selenium nanoparticles (SeNPs) using the laser ablation method involves several key steps. This method is known for its ability to produce well-defined SeNPs with precise control over size and morphology. Below are the synthesis steps for laser ablation of selenium nanoparticles. [25]

ISSN 2454-1974

1. **Preparation of Selenium Target:** The first step involves preparing a solid selenium target. Typically, high-purity selenium in the form of a disk or pellet is used as the target material.
2. **Liquid Medium Preparation:** A liquid medium is chosen as the environment for SeNP formation. Common choices include deionized water, organic solvents, or surfactant solutions. The choice of liquid medium can influence the properties of the resulting SeNPs.
3. **Laser Ablation Setup:** A high-energy laser source, such as a pulsed laser, is employed. The laser beam is focused on the selenium target. The laser parameters, including energy, pulse duration, and repetition rate, are carefully controlled to optimize the synthesis process.
4. **Laser Ablation:** The laser is directed at the selenium target, leading to rapid vaporization and ablation of selenium material. The energy from the laser is absorbed by the selenium target, causing it to transform into a vapor phase.
5. **Nucleation and Growth:** The selenium vapor produced in the previous step rapidly cools down upon entering the liquid medium. This cooling process leads to the nucleation of selenium species, which subsequently grow into nanoparticles.
6. **Stabilization and Collection:** The resulting selenium nanoparticles are suspended in the liquid medium. Depending on the application and desired properties, stabilizing agents or surfactants may be added to prevent agglomeration and stabilize the nanoparticles. SeNPs can be collected from the suspension by various methods, such as centrifugation or filtration, depending on the specific requirements.

2.1.2. Electrodeposition:

Electrodeposition is an electrochemical method where SeNPs are deposited on a conductive substrate by reducing selenium ions from a solution. Electrodeposition is a well-established method for the synthesis of selenium nanoparticles (SeNPs) by reducing selenium ions from a solution onto a conductive substrate. This method allows for precise control over the size and shape of SeNPs. Below are the synthesis steps for electrodeposition of selenium nanoparticles [35]

1. **Preparation of Electrode:** Select a conductive substrate as the working electrode. Common choices include platinum, gold, or other conductive materials.
2. **Electrolyte Solution Preparation:** Prepare an electrolyte solution containing a selenium precursor, typically in the form of selenium salts (e.g., sodium selenite or selenium dioxide), dissolved in a suitable solvent. The solution may also

ISSN 2454-1974

contain stabilizing agents or surfactants to control particle size and prevent agglomeration.

3. **Electrodeposition Setup:** Assemble an electrochemical cell with the working electrode (substrate), a counter electrode (usually made of a conductive material like platinum), and a reference electrode. Ensure that the electrodes are properly connected to the electrochemical cell.
4. **Electrodeposition Process:** Submerge the working electrode (e.g., platinum) into the electrolyte solution. Apply a controlled electric current or potential between the working and counter electrodes. This initiates the electrodeposition process. Selenium ions from the electrolyte solution are reduced and deposited onto the surface of the working electrode, leading to the formation of selenium nanoparticles.
5. **Control Parameters:** Adjust key parameters such as the deposition time, current density, and potential to control the size, shape, and density of the SeNPs.
6. **Rinsing and Drying:** After the desired deposition time, carefully remove the working electrode from the electrolyte solution. Rinse the electrode with a suitable solvent to remove any excess precursor or impurities. Allow the electrode to dry under controlled conditions to prevent agglomeration of SeNPs.

2.1.3. Chemical Vapor Deposition (CVD):

Chemical Vapor Deposition (CVD) is a versatile method used for the synthesis of selenium nanoparticles (SeNPs) by vaporizing selenium precursors and depositing them onto a heated substrate in a controlled gas-phase environment. This method offers precise control over the size, shape, and composition of SeNPs. Below are the synthesis steps for the CVD method of selenium nanoparticle synthesis [36]

1. **Substrate Preparation:** Start by preparing the substrate onto which the SeNPs will be deposited. Common substrate materials include silicon wafers, glass slides, or other suitable materials.
2. **Precursor Preparation:** Prepare a selenium precursor material that can be vaporized under the chosen CVD conditions. Common precursors include hydrogen selenide (H2Se), selenium tetrachloride (SeCl4), or organoselenium compounds.
3. **CVD Reactor Setup:** Assemble a CVD reactor, which consists of a reaction chamber equipped with heating elements and a controlled gas flow system.
4. **Substrate Loading:** Place the prepared substrate inside the reaction chamber in a location where SeNPs will be deposited.
5. **Precursor Delivery:** Introduce the selenium precursor into the CVD reactor. The precursor can be delivered as a gas or vapor into the reaction chamber.

ISSN 2454-1974

6. **Heating and Deposition:** Heat the substrate to a controlled temperature, typically in the range of 200-600°C. The selenium precursor vapor reacts on the heated substrate, leading to the deposition and growth of selenium nanoparticles.
7. **Controlled Atmosphere:** Maintain a controlled atmosphere inside the CVD reactor. The gas composition and pressure are crucial in determining the characteristics of the synthesized SeNPs.
8. **Growth Duration:** The growth duration is a critical parameter that affects the size and density of SeNPs. Control the growth time to achieve the desired nanoparticle properties.
9. **Cooling and Removal:** After the desired growth period, cool down the substrate to room temperature while maintaining a controlled atmosphere to prevent oxidation. Carefully remove the substrate from the reactor.

2.1.4. Sputtering:

Sputtering is a physical vapor deposition technique used for the synthesis of selenium nanoparticles (SeNPs). In this method, selenium is sputtered from a target material and deposited onto a substrate. Sputtering offers excellent control over the size and composition of SeNPs. Here are the synthesis steps for the sputtering method of selenium nanoparticle synthesis [37]

1. **Target Preparation:** Begin by preparing a selenium target. The target is typically a solid piece of high-purity selenium. Its composition and purity are critical for the quality of the SeNPs.
2. **Substrate Selection:** Choose an appropriate substrate on which the SeNPs will be deposited. Common substrates include silicon wafers, glass slides, or other materials compatible with sputtering.
3. **Sputtering Chamber Setup:** Set up a sputtering chamber, which includes the target holder, substrate holder, and a vacuum system. The chamber should be evacuated to create a low-pressure environment.
4. **Target Sputtering:** Place the selenium target in the sputtering chamber and position it opposite the substrate. Introduce an inert gas, such as argon (Ar), into the chamber to create gas plasma. Apply a high-voltage electrical discharge or radiofrequency (RF) power to the target. This causes the target material (selenium) to be sputtered as atomic or small cluster species.
5. **Nanoparticle Deposition:** The sputtered selenium species travel across the chamber and deposit onto the substrate surface. The deposition process can be controlled by adjusting parameters such as sputtering time, gas pressure, and power levels.

ISSN 2454-1974

6. **Controlled Growth:** Control the growth of SeNPs by monitoring the deposition time. Longer deposition times lead to larger nanoparticles.
7. **Substrate Cooling and Removal:** After the deposition is complete, allow the substrate to cool down to room temperature in the chamber to prevent agglomeration. Carefully remove the substrate from the sputtering chamber.

2.1.5. Pulsed Laser Ablation in Liquids (PLAL):

Pulsed Laser Ablation in Liquids (PLAL) is a method for synthesizing selenium nanoparticles (SeNPs) by using short laser pulses to ablate a selenium target immersed in a liquid medium. This technique allows for the controlled formation of SeNPs with various sizes and shapes. Below are the synthesis steps for the PLAL method of selenium nanoparticle synthesis [38]

1. **Selenium Target Preparation:** Begin by preparing a solid selenium target, typically in the form of a disk or pellet. The quality and purity of the target material are critical for producing high-quality SeNPs.
2. **Liquid Medium Selection:** Choose an appropriate liquid medium in which the SeNPs will be synthesized. Common choices include deionized water, organic solvents, or surfactant solutions. The choice of medium can influence the properties of the SeNPs.
3. **Laser Setup:** Set up a pulsed laser system equipped with the appropriate wavelength for selenium ablation. The laser should be capable of emitting short laser pulses.
4. **Immersion of Selenium Target:** Immerse the selenium target in the selected liquid medium within a suitable reaction vessel.
5. **Pulsed Laser Ablation:** Focus the laser beam onto the selenium target. The high-energy laser pulses cause the target to ablate, generating selenium vapor and plasma.
6. **Nucleation and Growth:** The rapidly formed selenium vapor and plasma cool down quickly upon entering the liquid medium. This cooling process leads to the nucleation of selenium species, which then grow into nanoparticles.
7. **Control Parameters:** Adjust laser parameters, such as pulse duration, energy, repetition rate, and focus, to control the size and morphology of the SeNPs. These parameters have a significant impact on nanoparticle properties.
8. **Stabilization (Optional):** Depending on the application and desired properties, stabilizing agents or surfactants may be added to the liquid medium to prevent nanoparticle agglomeration and ensure stability.

ISSN 2454-1974

9. **Collection of SeNPs:** SeNPs formed in the liquid medium can be collected from the solution by various methods, such as centrifugation, filtration, or ultracentrifugation.

2.1.6. Mechanical Milling:

Mechanical milling is a physical method used for the synthesis of selenium nanoparticles (SeNPs) by grinding solid selenium powder in the presence of a surfactant or protective agent. This method can produce SeNPs with varying sizes and shapes. Below are the synthesis steps for the mechanical milling method of selenium nanoparticle synthesis [39].

1. **Selenium Powder and Additives:** Start by obtaining high-purity selenium powder. The quality of the starting selenium material is crucial for the synthesis of high-quality SeNPs. Optionally, add a suitable surfactant or protective agent to the selenium powder. The surfactant helps prevent agglomeration of nanoparticles and promotes a more controlled synthesis process.
2. **Milling Vessel Setup:** Set up a milling vessel, typically made of stainless steel or other durable materials. The vessel should be equipped with milling balls (e.g., stainless steel balls) that will facilitate the mechanical milling process.
3. **Loading of Materials:** Place the selenium powder and, if used, the surfactant or protective agent into the milling vessel.
4. **Milling Process:** Seal the milling vessel and introduce it into a mechanical milling machine. The milling machine applies mechanical forces, such as impact and attrition, to break down the bulk selenium powder into smaller nanoparticles. The milling balls inside the vessel collide with the selenium powder, leading to the reduction in particle size.
5. **Controlled Milling Duration:** Control the milling duration to achieve the desired size and morphology of SeNPs. Longer milling times generally lead to smaller nanoparticles.
6. **Cooling and Handling:** During milling, the process generates heat. It's important to periodically cool the milling vessel to prevent excessive heating. Once the desired milling duration is reached, remove the milling vessel from the machine.
7. **SeNPs Extraction:** Open the milling vessel and extract the synthesized SeNPs. The SeNPs will be mixed with the milling balls and any remaining surfactant or protective agent.

ISSN 2454-1974

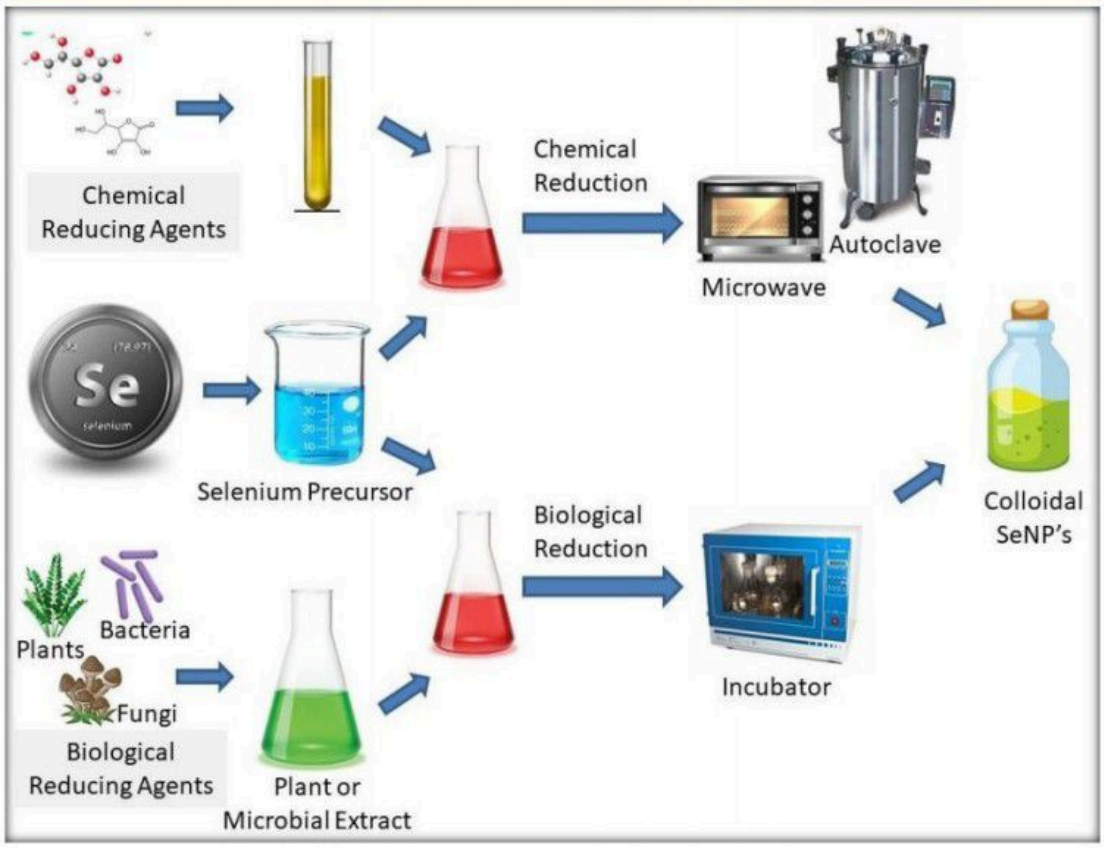


Fig 4: Selenium nanoparticle synthesis (SeNPs): Systematic Representation of Chemical and Biological Methods

2.2. Chemical Methods:

Chemical reduction is a widely employed method for the synthesis of selenium nanoparticles (SeNPs). This technique allows for precise control over the size, morphology, and properties of SeNPs. In this detailed explanation, we will explore the chemical reduction method for SeNP synthesis, including its steps.

2.2.1. Microwave synthesis.

Microwave-assisted synthesis is an efficient and rapid method for producing selenium nanoparticles (SeNPs) with controlled properties. Microwave synthesis offers several advantages, including reduced reaction times, enhanced control over particle size, and improved scalability, making it an attractive method for SeNP production in various applications. Here is a detailed explanation of the microwave synthesis process for SeNPs [40].

1. **Selenium Precursor and Solvent Preparation:** Begin by preparing a selenium precursor solution. Common selenium precursors include selenium dioxide (SeO2) or sodium selenite (Na2SeO3). Dissolve the selenium precursor in a suitable solvent, such as water or organic solvents, to create a precursor solution.

ISSN 2454-1974

2. **Microwave Reaction Vessel Setup:** Transfer the selenium precursor solution into a microwave reaction vessel that is microwave-transparent. Borosilicate glass vessels or polypropylene containers are often used.
3. **Addition of Reducing Agent (Optional):** Depending on the specific synthesis conditions and requirements, a reducing agent such as sodium borohydride (NaBH4) may be added to the precursor solution to facilitate the reduction process.
4. **Surfactant or Stabilizer (Optional):** Optionally, add a surfactant or stabilizer to the precursor solution to control nanoparticle size, prevent aggregation, and improve stability.
5. **Microwave Irradiation:** Place the microwave reaction vessel inside a microwave oven. Subject the precursor solution to microwave irradiation. Microwaves efficiently heat the solution, promoting the reduction of selenium ions and the nucleation of SeNPs. Control the microwave power and irradiation time to achieve the desired size and morphology of SeNPs.
6. **Cooling and Handling:** After microwave irradiation, carefully remove the reaction vessel from the microwave oven. Allow the solution to cool to room temperature.
7. **SeNPs Isolation:** The SeNPs can be isolated from the solution by various methods, such as centrifugation, filtration, or ultracentrifugation.

2.2.2. Hydrothermal method.

The hydrothermal method is a well-established technique for synthesizing selenium nanoparticles (SeNPs). This method involves the use of high-temperature and high-pressure conditions to facilitate the controlled growth and formation of SeNPs. The hydrothermal synthesis method for SeNPs offers several advantages, including the ability to control particle size and shape and produce nanoparticles with high purity. This method has found applications in various fields, including nanomedicine and catalysis. Below is an explanation of the hydrothermal synthesis method for SeNPs [41].

1. **Selenium Precursor Preparation:** Start by preparing a selenium precursor solution. Common selenium precursors include sodium selenite (Na2SeO3) or selenium dioxide (SeO2). Dissolve the selenium precursor in a suitable solvent, typically deionized water, to create a precursor solution.
2. **Adjusting pH (Optional):** Depending on the specific synthesis conditions, adjust the pH of the precursor solution to the desired level using acids (e.g., hydrochloric acid) or bases (e.g., sodium hydroxide). pH adjustment can influence the nucleation and growth of SeNPs.

ISSN 2454-1974

3. **Surfactant or Stabilizer (Optional):** Optionally, add a surfactant or stabilizer to the precursor solution to control nanoparticle size, prevent aggregation, and improve stability.
4. **Sealing the Reaction Vessel:** Transfer the precursor solution into a suitable hydrothermal reaction vessel, such as a Teflon-lined autoclave.
5. **Hydrothermal Reaction:** Seal the reaction vessel to create a closed system. Place the sealed vessel in a high-temperature oven or autoclave and subject it to elevated temperature and pressure conditions. The hydrothermal reaction typically occurs at temperatures ranging from 100°C to 300°C or higher, and at pressures above atmospheric pressure. These conditions promote the reduction of selenium ions and the nucleation and growth of SeNPs.
6. **Cooling and Handling:** After the hydrothermal reaction, allow the reaction vessel to cool down naturally to room temperature. It is important to avoid rapid cooling to prevent agglomeration.
7. **SeNPs Isolation:** The SeNPs can be isolated from the solution by various methods, such as centrifugation, filtration, or ultracentrifugation.

2.3. Biological Methods:

Biogenic reduction, a green and sustainable approach, is gaining attention for the synthesis of selenium nanoparticles (SeNPs). Biogenic reduction offers a sustainable and versatile route for synthesizing SeNPs with potential applications across various domains, from medicine to environmental protection. Here is the explanation of the biogenic reduction method for SeNP synthesis.

1. **Biological Agents:** Biogenic reduction involves the use of biological agents such as microorganisms (bacteria, fungi, algae), plant extracts, or enzymes. These agents play a dual role: they act as both reducing and stabilizing agents in the SeNP synthesis process.
2. **Selenium Precursors:** Sodium selenite (Na2SeO3) or other soluble selenium salts are used as selenium precursors. These precursors are added to the biological agent, which initiates the reduction process.
3. **Reduction and Nucleation:** Biological agents facilitate the reduction of selenium ions to form elemental selenium nanoparticles through enzymatic or metabolic processes. Nucleation and growth of SeNPs occur within the biological medium under mild reaction conditions.
4. **Size and Shape Control:** The size and shape of the SeNPs can be controlled by adjusting reaction parameters such as precursor concentration, temperature, and incubation time. The biological agents also influence the size and characteristics of the synthesized SeNPs.

ISSN 2454-1974

5. **Isolation and Purification:** SeNPs are typically isolated and purified from the biological reaction medium using techniques such as centrifugation or filtration. Any remaining biological components can be removed to obtain purified SeNPs.

Advantages of Biogenic Reduction:

- **Environmentally Friendly:** Biogenic reduction is a green synthesis method that reduces the use of hazardous chemicals and promotes sustainability.
- **Biocompatibility:** SeNPs synthesized via biogenic reduction tend to be biocompatible, making them suitable for biomedical applications.
- **Size Control:** This method allows for precise control over the size and morphology of SeNPs, which is crucial for various applications.

Key Factors Influencing SeNP Synthesis:

1. **Choice of Precursor:** The selection of selenium precursor impacts the reaction kinetics and size distribution of SeNPs.
2. **Reducing Agent:** The type and concentration of reducing agent determine the rate of reduction and, consequently, nanoparticle size.
3. **Stabilizers/Capping Agents:** These molecules influence the stability and dispersibility of SeNPs.
4. **Reaction Conditions:** Temperature, pH, and reaction time play a crucial role in controlling SeNP size and morphology

3. Therapeutic applications

SeNPs have shown promise in drug delivery, cancer therapy, and antimicrobial applications [2].

ISSN 2454-1974

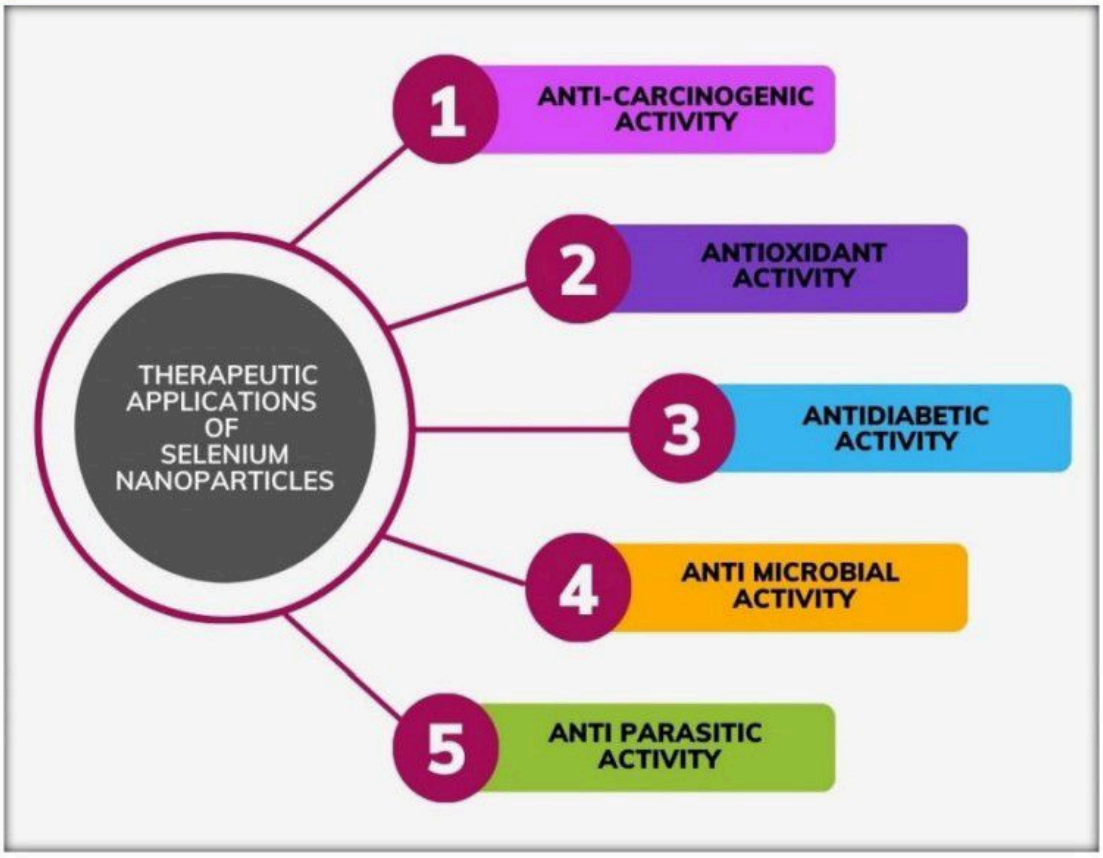


Fig. 5: Systematic Representation of Therapeutic Applications of Selenium Nanoparticles (SeNP's)

3.1. Anti-carcinogenic activity

Selenium nanoparticles (SeNPs) have attracted significant attention due to their potential anti- carcinogenic activity. Extensive research has shown that SeNPs exhibit promising properties in preventing and inhibiting cancer growth. Here, we discuss the anti-carcinogenic activity of SeNPs.

1. **Antioxidant Defense:** Selenium is an essential component of selenoproteins, including glutathione peroxidases and thioredoxin reductases, which are crucial for maintaining cellular antioxidant defense systems. SeNPs enhance the cellular antioxidant capacity, protecting cells from oxidative stress, a known contributor to cancer development [10].
2. **Apoptosis Induction:** SeNPs have been reported to induce apoptosis (programmed cell death) in cancer cells by regulating various apoptotic pathways. They can trigger the expression of pro-apoptotic proteins while inhibiting anti-apoptotic factors, ultimately leading to cancer cell death [11].
3. **Antiangiogenic Activity:** SeNPs can inhibit the formation of new blood vessels (angiogenesis) necessary for tumor growth and metastasis. By

ISSN 2454-1974

disrupting angiogenic processes, SeNPs limit the nutrient supply to tumors, hindering their progression [12].

4. **Immunomodulation:** SeNPs exhibit immunomodulatory effects by enhancing the activity of immune cells such as natural killer (NK) cells and cytotoxic T lymphocytes. This enhanced immune response helps the body recognize and eliminate cancer cells [13].
5. **Cell Cycle Arrest:** SeNPs can arrest the cell cycle of cancer cells, preventing their uncontrolled proliferation. This disruption of the cell cycle checkpoints can lead to cancer cell growth inhibition [5].

3.2. Antioxidant activity

Selenium nanoparticles (SeNPs) have demonstrated significant antioxidant activity, making them valuable in combating oxidative stress and related health issues. Their ability to scavenge free radicals and protect cells from oxidative damage has been widely studied. Here, we discuss the antioxidant activity of SeNPs.

1. **Scavenging Reactive Oxygen Species (ROS):**SeNPs have the ability to neutralize and scavenge reactive oxygen species (ROS), including superoxide radicals (O2•−) and

hydrogen peroxide (H2O2).By reducing the levels of ROS, SeNPs protect cells and tissues from oxidative stress-induced damage [5].

2. **Enhancing Cellular Antioxidant Defense:** Selenium is an essential component of selenoproteins, including glutathione peroxidases (GPx) and thioredoxin reductases (TrxR), which play crucial roles in cellular antioxidant defense.SeNPs can increase the expression and activity of these selenoproteins, enhancing the overall cellular antioxidant capacity [1].
3. **Protection against Lipid Peroxidation:** SeNPs have been shown to inhibit lipid peroxidation, a process that damages cell membranes and contributes to various diseases. By preventing lipid peroxidation, SeNPs help maintain cell membrane integrity [15].
4. **DNA and Cellular Protection:** SeNPs can protect DNA from oxidative damage, which is important for genome stability and cancer prevention.They also shield cells from oxidative stress-induced apoptosis and necrosis [16].
5. **Neuroprotection**:SeNPs have shown potential in protecting neurons from oxidative damage and neurodegenerative diseases.Their antioxidant properties may help preserve cognitive function [17].

ISSN 2454-1974

3.3. Antidiabetic activity

Selenium nanoparticles (SeNPs) have garnered interest in the field of diabetes research due to their potential anti-diabetic activity. Multiple studies suggest that SeNPs may offer benefits in managing diabetes by regulating blood glucose levels and mitigating diabetes-related complications. Here, we discuss the anti-diabetic activity of SeNPs,

1. **Improvement of Insulin Sensitivity:** SeNPs have been shown to enhance insulin sensitivity in diabetic animal models. Improved insulin sensitivity can lead to better glucose uptake by cells and more effective regulation of blood glucose levels [18].
2. **Antioxidant Properties:** Oxidative stress plays a critical role in the development and progression of diabetes. SeNPs, with their strong antioxidant properties, can reduce oxidative stress and protect pancreatic beta cells, which are responsible for insulin production [19].
3. **Protection of Pancreatic Islets:** SeNPs have demonstrated the ability to protect pancreatic islets from damage caused by oxidative stress and inflammation.Preserving the functionality of pancreatic islets is crucial for maintaining insulin production [20].
4. **Anti-Inflammatory Effects:** Chronic inflammation is associated with insulin resistance and diabetes. SeNPs have anti-inflammatory properties that may help alleviate inflammation-related complications in diabetes [21].
5. **Improved Lipid Profile:** SeNPs have been reported to positively influence lipid metabolism, leading to better control of cholesterol and triglyceride levels. Dyslipidemia often accompanies diabetes, and SeNPs may help mitigate these lipid-related issues [22].

3.4. Antimicrobial activity

Selenium nanoparticles (SeNPs) have demonstrated antimicrobial activity against a wide range of microorganisms, including bacteria, fungi, and even some viruses. Their effectiveness in inhibiting microbial growth and their potential applications in medicine and industry have garnered significant attention. Here, we discuss the antimicrobial activity of SeNPs

1. **Antibacterial Activity:**SeNPs have shown potent antibacterial effects against various pathogenic bacteria, including both Gram-positive (e.g., Staphylococcus aureus) and Gram-negative (e.g., Escherichia coli) strains.They can disrupt bacterial cell membranes, inhibit enzyme activity, and generate reactive oxygen species (ROS), leading to bacterial cell death [2][4].

ISSN 2454-1974

2. **Antifungal Activity:** SeNPs exhibit antifungal properties against a range of fungal species, including Candida albicans and Aspergillus spp.They disrupt fungal cell membranes and interfere with cellular processes, resulting in the inhibition of fungal growth [8][26].
3. **Antiviral Activity:** Some studies suggest that SeNPs possess antiviral properties, particularly against certain enveloped viruses.They may interfere with virus attachment and entry into host cells, making them a potential candidate for antiviral therapies [27].
4. **Biofilm Inhibition:** SeNPs have demonstrated the ability to inhibit biofilm formation by bacteria and fungi. Biofilms are protective structures that shield microorganisms from antimicrobial agents, and disrupting them is critical for effective treatment [28].
5. **Combination Therapy:** SeNPs have been explored in combination with antibiotics or antifungal drugs to enhance their effectiveness. Such combination therapies can reduce the development of antibiotic resistance and improve treatment outcomes [29].

3.5. Antiparasitic activity

Selenium nanoparticles (SeNPs) have shown promise in exhibiting antiparasitic activity against various parasitic organisms, including protozoa and helminths. Their potential as an alternative approach to combat parasitic infections is an emerging area of research. Below, we discuss the antiparasitic activity of SeNPs.

1. **Antiprotozoal Activity:** SeNPs have demonstrated effectiveness against protozoan parasites such as Trypanosoma and Leishmania species. They can interfere with the redox balance of these parasites, leading to cellular damage and reduced viability [30].
2. **Antihelminthic Activity:** Helminthic parasites, including nematodes and trematodes, can be targeted by SeNPs. SeNPs may affect the antioxidant defense mechanisms of these parasites, causing oxidative stress and eventual death [31].
3. **Potential for Malaria Control:** Some studies have explored the use of SeNPs as a potential tool for controlling the mosquito vector (Anopheles spp.) responsible for transmitting malaria. SeNPs can disrupt mosquito development and reduce their ability to transmit the malaria parasite (Plasmodium spp.) [32].

3.6. Other biological applications

Selenium nanoparticles (SeNPs) have shown potential in a variety of biological applications beyond those mentioned earlier. Their unique properties, including

ISSN 2454-1974

antioxidant activity, biocompatibility, and low toxicity, make them attractive candidates for various biomedical and environmental purposes. Here, we explore some of the other biological applications of SeNPs.

1. **Environmental Remediation:** SeNPs can be used for the removal of heavy metals and other pollutants from water sources [7][34].
2. **Agricultural Applications:** These nanoparticles may have potential as fertilizers and crop protectants due to their antimicrobial properties [8]. SeNPs have shown promise in agriculture as a means to enhance crop growth and protect plants from pests and diseases [5].
3. **Catalytic Applications:** Biogenically synthesized SeNPs have catalytic applications in organic transformations [9].
4. **Drug Delivery Systems:** SeNPs can be functionalized to carry and deliver drugs or therapeutic agents to specific target sites. Their biocompatibility and controlled release properties make them valuable in drug delivery systems [2].
5. **Radioprotective Effects:** SeNPs have been investigated for their radioprotective properties. They may help reduce the harmful effects of ionizing radiation on healthy tissues during radiation therapy [33].
6. **Neuroprotection:** SeNPs have shown potential in protecting neurons from oxidative damage and neurodegenerative diseases. Their antioxidant properties may help preserve cognitive function [17].
7. **Dermatological Applications:** SeNPs have been explored for their potential in skincare products due to their antioxidant and anti-aging properties. They may help protect the skin from oxidative stress and UV radiation [26].

4. Conclusion and future prospects

It's important to note that while SeNPs show promise in anti-carcinogenic activities, the therapeutic potential and safety of SeNPs in cancer prevention and treatment require further investigation through rigorous preclinical and clinical studies. Additionally, the optimal dosage and administration methods need to be determined for effective and safe use in cancer management.

The antioxidant activity of SeNPs makes them a potential candidate for use in dietary supplements and biomedical applications aimed at mitigating oxidative stress-related diseases and promoting overall health. However, further research is needed to fully understand the mechanisms and optimal dosages for utilizing SeNPs as antioxidants in various contexts.

While SeNPs show promise in managing diabetes and its associated complications, it's important to note that further research, including clinical trials, is

ISSN 2454-1974

needed to fully understand their mechanisms of action, optimal dosages, and long-term safety profiles in diabetic individuals. Always consult with a healthcare professional before considering SeNPs or any other supplements for diabetes management.

The antimicrobial activity of SeNPs holds promise for various applications, including the development of novel antimicrobial agents, wound dressings, and medical implants. However, further research is needed to optimize SeNP formulations, determine their safety, and explore their potential in clinical settings.

While SeNPs show promise in antiparasitic applications, it's essential to conduct further research to fully understand their mechanisms of action, determine optimal dosages, and assess their safety for use in combating parasitic infections in clinical and environmental settings. Collaboration between researchers in nanotechnology and parasitology can pave the way for innovative solutions in the fight against parasitic diseases.

References:

1. Rayman, M. P. "The Importance of Selenium to Human Health." *The Lancet*, vol. 356, no. 9225, 2000, pp. 233–241.
2. Gunti, L, and R S Dass. "Synthesis, Characterization and Applications of Selenium Nanoparticles - A Review." *Journal of Nanomedicine & Nanotechnology*, vol. 8, no. 5, 2017, p. 441.
3. Kheradmand, E., and Rafii, F. "Effects of Selenium Nanoparticles on Neurological Deficit and Oxidative Stress Biomarkers in an Experimental Stroke Model." *Medical Principles and Practice*, vol. 24, no. 2, 2015, pp. 142-147.
4. Tran, P. A., & Webster, T. J. "Selenium Nanoparticles Inhibit Staphylococcus Aureus Growth." *International Journal of Nanomedicine*, vol. 8, 2013, pp. 4077-4086.
5. Zhang, J., & Wang, X. "Selenium Nanoparticles: Current Status and Future Challenges." *Journal of Nanoparticle Research*, vol. 19, no. 11, 2017, p. 391.
6. Reilly, C. Selenium in Food and Health. Springer, 2006.
7. Rathod, D., Mishra, A., Krishna, V., & Kumar, M. "Biogenic Selenium Nanoparticles: Current Status and Future Prospects." *Applied Microbiology and Biotechnology*, vol. 100, no. 6, 2016, pp. 2555-2566.
8. Husen, A., & Siddiqi, K. S. "Phytosynthesis of Nanoparticles: Concept, Controversy and Application." *Nanoscale Research Letters*, vol. 9, no. 1, 2014, p. 229.

ISSN 2454-1974

9. Narayanan, K. B., & Sakthivel, N. "Biological Synthesis of Metal Nanoparticles by Microbes." *Advances in Colloid and Interface Science*, vol. 156, no. 1-2, 2011, pp. 1-13.

10. Rayman, M. P. "Selenium in Cancer Prevention: A Review of the Evidence and Mechanism of Action." *Proceedings of the Nutrition Society*, vol. 64, no. 4, 2005, pp. 527-542.

11. Batra, H., Pawar, S., & Bahl, D. "Role of Selenium Nanoparticles in Regulating Angiogenesis Induced by Fibroblast Growth Factor-2." *Biotechnology Reports*, vol. 8, 2015, pp. 154-161.

12. Kheradmand, E., & Rafii, F. "Effects of Selenium Nanoparticles on Immunocompetent Cells and Angiogenesis In Vitro." *Cell Journal (Yakhteh)*, vol. 17, no. 1, 2015, pp. 141-151.

13. Kheradmand, E., & Rafii, F. "Effects of Selenium Nanoparticles on Proliferation and Apoptosis of Rat Adipose Tissue-Derived Mesenchymal Stem Cells." *Cell Journal (Yakhteh)*, vol. 17, no. 2, 2015, pp. 341-348.

14. Hatfield, D. L., et al. Selenium: Its Molecular Biology and Role in Human Health. *Springer*, 2012.

15. Fazel, S. M., & Mousavi, S. M. "Selenium Nanoparticles: Synthesis, Characterization and Study of Their Anti-oxidative Properties." *Colloids and Surfaces B: Biointerfaces*, vol. 146, 2016, pp. 276-286.

16. Kheradmand, E., & Rafii, F. "Effects of Selenium Nanoparticles on Oxidative Stress-Induced Apoptosis in PC12 Cells." *Biological Trace Element Research*, vol. 167, no. 1, 2015, pp. 1-9.

17. Kheradmand, E., & Rafii, F. "Effects of Selenium Nanoparticles on Cognitive Decline Induced by d-Galactose in Rats." *Journal of Trace Elements in Medicine and Biology*, vol. 29, 2015, pp. 253-259.

18. Sharma, V., Kaur, P., & Sharma, S. "Antidiabetic Potential of Green Synthesized SeNPs Using Phoenix dactylifera in Type 2 Diabetes Mellitus and Their Role as Nano-Catalyst in the Synthesis of Biologically Active Pyrimidines." *Biomedicine & Pharmacotherapy*, vol. 111, 2019, pp. 1343-1356.

19. Bai, K., Hong, B., Hong, Z., & Sun, J. "Anti-diabetic Potential of Selenium Nanoparticles in Type 2 Diabetic Rats." *Journal of Agricultural and Food Chemistry*, vol. 66, no. 31, 2018, pp. 7936-7944.

20. Kheradmand, E., & Rafii, F. "Effects of Selenium Nanoparticles on Oxidative Stress-Induced Apoptosis in Rat Skeletal Muscle." *Biological Trace Element Research*, vol. 166, no. 2, 2015, pp. 292-302.

ISSN 2454-1974

21. Rafii, F., & Kheradmand, E. "Preparation and Characterization of Elemental Selenium Nanoparticles Stabilized by Bovine Serum Albumin." *Journal of Nanotechnology in Engineering and Medicine*, vol. 6, no. 2, 2015, p. 021008.

22. Bai, K., Hong, B., Hong, Z., & Sun, J. "Selenium Nanoparticles for Diabetes-Associated Oxidative Stress and Inflammation." *Advanced Healthcare Materials*, vol. 7, no. 7, 2018, p. 1701155.

23. Fairweather-Tait, S. J., et al. "Selenium in Human Health and Disease." *Antioxidants & Redox Signaling*, vol. 14, no. 7, 2011, pp. 1337-1383.

24. Combs, G. F. "Selenium in Global Food Systems." *British Journal of Nutrition*, vol. 85, no. 5, 2001, pp. 517-547.

25. Sarkar, S., Jana, S., Samanta, S., Mostafa, G., & Chakraborty, A. N. "Laser Ablation Synthesis of Selenium Nanoparticles and Their Antibacterial Properties." *Journal of Nanoparticle Research*, vol. 13, no. 7, 2011, pp. 2747-2755.

26. Shah, M., Fawcett, D., Sharma, S., & Tripathy, S. K. "Green Synthesis of Metallic Nanoparticles via Biological Entities." *Materials*, vol. 7, no. 3, 2014, pp. 2009-2032.

27. Kapil, A., & Sharma, V. "Immunopotentiating and Immunomodulatory Role of Selenium Nanoparticles in Immunized Mice." *Journal of Trace Elements in Medicine and Biology*, vol. 29, 2015, pp. 31-36.

28. Chen, T., & Wong, Y. S. "In vitro Antioxidant and Antiproliferative Effects of Selenium Nanoparticles." *Journal of Trace Elements in Medicine and Biology*, vol. 27, no. 3, 2013, pp. 174-179.

29. Wang, H., Zhang, J., & Yu, H. "Elemental Selenium at Nano Size (Nano-Se) as a Potential Chemopreventive Agent with Reduced Risk of Selenium Toxicity: Comparison with Se-Methylselenocysteine in Mice." *Toxicological Sciences*, vol. 101, no. 1, 2007, pp. 22-31.

30. Naghmouchi, K., Baati, T., Hassen, I., Chtourou, Y., Sefi, M., & Abdelmelek, H. "Biochemical and Histological Changes in the Liver and Kidney of Rats Following Exposure to Selenium Nanoparticles: A Sub-acute Toxicity Study." *International Journal of Molecular Sciences*, vol. 17, no. 8, 2016, p. 1218.

31. Rahman, M. H., Paul, S., Sumi, S. S., Bhoumik, N. C., & Rahman, S. M. "Role of Selenium Nanoparticles in Inhibition of HA Protein Synthesis and Conformational Change against H9N2 Avian Influenza Virus." *Advances in Nanoparticles*, vol. 3, no. 4, 2014, p. 157.

32. Müller, A. S., Thode, S. K., Pfarr, K., Gandasi, N. R., Santos, A., Martin, R. E., ... & Beck, H. P. "Plasmodium berghei P47 Is Essential for Life Cycle Progression

ISSN 2454-1974

in the Mosquito and Parasite Transmission to the Host." *Communications Biology*, vol. 1, no. 1, 2017, p. 42.

33. Koturbash, I., Zemp, F. J., Pogribny, I., & Kovalchuk, O. "Small Molecules with Big Effects: The Role of the MicroRNAome in Cancer and Carcinogenesis." *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis*, vol. 722, no. 2, 2007, pp. 94-105.
34. López, S. G., Hapon, M. B., & Simontacchi, M. "Selenium Nanoparticles as Alternative for Selenium Supplementation in Livestock and Poultry." *World's Poultry Science Journal*, vol. 70, no. 03, 2014, pp. 581-592.
35. Sahu, S. K., Acharya, R., & Panda, A. B. "Electrochemical Synthesis of Selenium Nanoparticles and Their Antimicrobial Properties." *Journal of Nanoscience and Nanotechnology*, vol. 14, no. 2, 2014, pp. 1016-1023.
36. Dinh, C. T., Lee, D. U., & Jeong, S. "Chemical Vapor Deposition Synthesis of Selenium Nanowires." *Journal of Crystal Growth*, vol. 369, 2013, pp. 140-144.
37. Gajewska, M., Jendrzejewska, I., & Staryszak, T. "Structural and Optical Properties of Selenium Thin Films Obtained by Magnetron Sputtering." *Materials Chemistry and Physics*, vol. 214, 2018, pp. 17-25.
38. Le, T. T., Hoang, A. N., & Hieu, N. Q. "Pulsed Laser Ablation in Liquid (PLAL) Synthesis of Selenium Nanoparticles for Potential Applications in Photothermal Therapy." *Journal of Nanoparticle Research*, vol. 20, no. 9, 2018, p. 243.
39. Xu, R. L., Chen, Y., Cui, J., & Cui, F. "High Energy Mechanical Milling as a Simple and Scalable Technique to Produce Bulk Nanostructured Porous Silicon." *Nanoscale Research Letters*, vol. 6, no. 1, 2011, p. 326.
40. Khayati, G. R., Bordbar, M., & Ghorbanpour, M. "Green Microwave-Assisted Synthesis of Selenium Nanoparticles with Sodium Alginate and Their Antioxidant Activity." *Journal of Nanostructure in Chemistry*, vol. 4, no. 1, 2014, p. 84.
41. Wang, H., Yang, Y., Yan, X., Xue, X., & Li, Q. "Hydrothermal Synthesis of Selenium Nanoparticles and Their Antioxidant Activity." *Nano-Micro Letters*, vol. 6, no. 2, 2014, pp. 117-124.

62
Exploring the socio-cultural dynamics in the novels of Perumal Murugan

Aakash Popat Haral
Research Scholar Department of English
Shri Shivaji College of Arts, Commercce & Science, Akola

Dr. P. P. Deshmukh
Ph.D Supervisor, Professor & Head of Department of English
Mahatma Phule Mahavidyalay, Warud. Dist. Amravati

==========

Abstract:

We are living in a society which is immensely diversified in its nature where culture and language both change at regular intervals. We celebrate different festivals; follow different culture and traditions irrespective of caste, creed and region. Therefore it reflects in our literature too. There are many writers who portray the Indian culture in their literature but among them Perumal Murugan has a distinct place as far as depicting the Indian culture and tradition in literature is concerned.

Perumal Murugan is well known for his craftsmanship for portraying the Indian society with its reality. His novels are full of human emotions, values, their suffering along with its cultural values. He highlights the social problems prevalent in society through his novels. He portrays the evil side of society too without any hesitation. As far as his work is concerned he is true in every sense.

The present paper highlights the social issues and problems whichever present in society. The cultural values and the traditions found in Indian society with its both side studied particularly in the present paper.

Key words: socio-cultural, Indian tradition, cultural values, social issue, literature

Introduction:

To explore the socio-cultural dynamics in the novels of Perumal Murugan we have to take a dip into his life experiences, his ideology and the socio-cultural environment of his region where he brought up. Perumal Murugan was born in a town Thiruchengodu, Tamilnadu. He brought up in a farmer family. He studied Tamil literature. He started writing in his early age. He has written twelve novels and six collections of short stories and poetry. He has also written thirteen non-fiction books and edited several non-fiction books relating to literature.

Journey of his career started from publishing short stories in the Tamil journal. His first novel 'Rising Heat' dealt with the theme of family problems, greed and corruption. His second novel 'Current show' derived from his life experience. The third novel 'Season of the palm' gave him recognition in the literary world as it described the story of a boy who bonded to repay his family debt. Basically it dealt with the issue of caste. Perumal Murugan is extensively discussed in the realm of literature because of his novel which stirred the conscience of the society named 'One Part Woman'. The novel represents the ancient culture in Tamilnadu region.

60 AN INDIAN MODEL OF SERVANT LEADERSHIP- MAHATMA GANDHI
Dr. V. G. Wasu Dist. Akola 354

61 Women Entrepreneurship: A Motivational and Challenge Perspective in India
Dr.Dipalee Shah 361

62 Exploring the socio-cultural dynamics in the novels of Perumal Murugan
Aakash Popat Haral, Dr. P. P. Deshmukh Dist. Amravati 369

63 Modernizing Financial Practices: The 2015 Amendment to India's ...
Dr. Sonal Santosh Chandak, Amravati. 373

64 The Innovation and Entrepreneurship in India
Dr. Bharati R. Chokhani, Akola. 378

65 "Woman Empowerment: A Multi-faceted Approach."
Dr. Pooja Anand Deshmukh 384

66 A Study on Work Life Balance of Working Women in Higher ...
Dr. Ramdhan Fakirrao Ambad Miss.Shailaja Pandurang Chikate 388

67 Business Ethics in India: A comparative study
Dr. Vishakha S. Nanir Dr. Uttara Borsarkar 395

68 HINDU MYTHOLOGY MIRRORED IN THE FICTIONAL WORKS OF AMISH TRIPATHI
Gopal Jaysing Rathod Patur. 400

69 Introduction to Modern Agricultural Practices for Indian Farmers
Ku.Vishakha V. Patil Prof.Dr.Prashant S.Vairalkar 404

70 Techniques of Phytochemical Analysis – A Review
M.H.Shaikh 409

71 'Relevance of Moral Values and Ethics in the Indian Knowledge ...
Miss. Aarushi Walgaonkar 422

72 "DIGITALIZATION-AWARENESS IN BANKING CUSTOMERS."
Miss. Soniya M.Gorar, Akot 430

73 Women Empowerment in India: Challenges, Progress and Future Directions.
Mr. Suresh Kisanrao Ingle, Dist. Yavatmal 437

74 Study Initial Public Offering Investment and Analysis (With Special ...
Mr. Umesh Rajesh Dongare, Dr. Chandrakant Babanrao Dhumale 444

As a novelist he portrays the social problems very acutely. As far as his upbringing is concerned he could easily incorporate the social symbols, images and the cultural practices in his novels. He plays his role as a social critic and highlights the socio-cultural dynamics through his works.

Objective:

The present research paper highlights:

1. The socio-cultural dynamics in the novels of Perumal Murugan.
2. Exploring the social impact of the novels of Perumal Murugan.

Caste induced hatred in 'Pyre'

'Pyre' is a story of Saroja and Kumaresan a couple belongs to different castes and marry each other. But their marriage becomes a nightmare to them because of the distinct castes. They have to face the wrath of Kumaresan's village in the hope that their relation will be accepted by them. It highlights the caste reality in the society that the couple faced in the village. In the present day also it would be difficult to survive in the society for a inter-caste marry couple.

Saroja who brought up in city has limited knowing of the idea of caste atrocity. When she enters into the village of Kumaresan all her dreams shatters, she is not used to with the life of village as she has to live in a hut. All the villagers always curious about her white skin as they think she is totally unfit for the work of farming. They used to taunt her and she is indeed fed up by listening. She bears all the things and only sheds tears. Saroja doesn't raise her voice against the torture. Therefore she becomes the victim of honor-killing.

Perumal Murugan portrays the cruel face of casteism in the form of honor-killing. He also highlights the cruelty and the casteist notion of the society which is truly rotten. The society is so orthodox and irrational that it doesn't hesitate in doing such an inhuman act of honor-killing only to retain the caste system. Perumal Murugan presents the Psyche of the community which is so rigid in nature.

Cultural impact of 'One Part Woman'

Perumal Murugan 'One Part Woman' depicts the culture in the region of Kongunadu and the moral values of the people that affects the childless couple Ponna and Kali. The novel based on the story of the childless couple who are in love with each other since twelve years. The author depicts the suffering, agony and emotional turbulence in their life.

Kali and Ponna the protagonists being humiliated by the society due to childlessness. In the name of culture they practiced everything though they are aware about the humiliation has been done by the people. Barrenness is still considered as a stigma for a woman in society. Therefore the couple is worried as they have tolisten many things from people. Because they know it's the part and parcel of their living, the values they respect and the community in which they are living has such kind of mindset towards the childless couple.

Kali belongs to Gonder community which considers son as their heir. Ponna is a strong woman who marries in her early age to Kali. As they are childless the villagers suggest Kali to marry with another girl because to have a male heir has utmost important in the society. They pray various deities only for the sake of child. They practiced everything blindly because they are much desperate for having a baby. Though they are happy in their marriage but it is only because of the humiliation of the society they crave for a child.

There is a chariot festival according to gonder culture at the fourteeth day of the festival a woman can attend the festival and choose a partner for having a child. As far as

the community is concerned it is considered as the god's gift. Ponna's family and mother in law make her to attend the festival on the fourteenth day. However Kali is against the notion of such tradition. But Ponna attends the festival when Kali knows it he is deeply hurt and suffers a lot by the thought.

Perumal Murugan portrays the cultural tradition so vividly that shows the belief of the people of the community. The relationship between Ponna and Kali is enormously depicted. The novel is remarkable for its depiction of culture and the cruelty of the society. The stigma of barrenness still haunts today's woman. The author skillfully portrays the character with their notion. The characters become the mouthpiece of society and thus they create a great cultural impact on the minds of the people.

'Resolve': A Cultural Critique

'Resolve' is a tale that highlights the problems of rural societies regarding marriage and land. Basically it deals with the life of rural people, Marimuthu the protagonist is unmarried of 35 years old. He doesn't get bride for marriage. He is frustrated with the thought even his worker who is merely 20 years old is about to marry. He does all the things to get a bride but all goes in vain, by the end he finds an ancestral disputed land to resolve. He shifts his focus towards it thinking that one day the land dispute will be settled and he will also get marry.

On a surface level it seems to be a typical story that presents rural life, on the other hand it highlights various social issues like female feticide, sex ration of girl child, as it finds only four girls remain in a village to marry for twenty boys. The protagonist doesn't care firstly when Thaatha blames society for such condition, however in the course of time he knows the gravity of the issue. When he remembers many years ago unwanted a baby girl was killed and thinks she could be his wife. Therefore he resolves to have many daughters whenever he gets married that nobody could feel the pain he suffers.

In the hands of Perumal Murugan the question of marriage transforms into a social contract. On the other hand he highlights that it is only the repercussion of patriarchy, inequality and gender biased community that the society has to face. It is a tale told in a comic manner which appeals to the heart of reader and suggests the social change that people have to acquire in their behavior. Thus it's not only a comic story but turns into a cultural critique.

Conclusion:

Perumal Murugan plays his role as social critic along with having consciousness of his responsibilities as a writer. He strongly portrays his characters who become the mouthpiece of Murugan thoughts that he has to convey to society. He thinks in such manner that he want to amend society not create a controversy. He depicts the without any filter the custom, tradition, culture, history of the land and people with truthfully. Pick up his any novel and we come across with the very of idea of its rawness in nature as he handles in skillful manner. He portrays in his novel the characters and plot with his imagination however his ideas speak about the society, the relationship of being with the worldly affairs as found in the real world. He sometimes becomes sarcastic in nature but never shift his focus in preaching that may help to change the socio-cultural dynamics of the society.

Work Cited:

1. Perumal Murugan. (2017). *Pyre.* Penguin Books India Pvt Ltd.
2. Perumal Murugan. (2019). *One part woman*. Pushkin Press.
3. Perumal Murugan. (2021). Resolve. Penguin Random House India.

MAH MUL/03051/2012 Vidyawarta® Jan. To March 2024
ISSN: 2319 9318 Peer-Reviewed International Journal Special Issue

Vidyawarta™

International Multilingual Research Journal

www.विद्यावार्ता.कॉम
YouTube Channel

Vidyawarta is peer reviewed research journal. The review committee & editorial board formed/appointed by Harshwardhan Publication scrutinizes the received research papers and articles. Then the recommended papers and articles are published. The editor or publisher doesn't claim that this is UGC CARE approved journal or recommended by any university. We publish this journal for creating awareness and aptitude regarding educational research and literary criticism.

The Views expressed in the published articles,Research Papers etc. are their writers own. This Journal dose not take any libility regarding appoval/disapproval by any university, institute, academic body and others. The agreement of the Editor, Editorial Board or Publicaton is not necessary. Editors and publishers have the right to convert all texts published in Vidyavarta (e.g. CD / DVD / Video / Audio / Edited book / Abstract Etc. and other formats).

If any judicial matter occurs, the jurisdiction is limited up to Beed (Maharashtra) court only.

Govt. of India,
Trade Marks Registry
Regd. No. 2611690

http://www.printingarea.blogspot.com

ISSN 2277 - 5730

AN INTERNATIONAL MULTIDISCIPLINARY
QUARTERLY RESEARCH JOURNAL

AJANTA

Volume - XIII Issue - II April - June - 2024

ENGLISH PART - VI

Peer Reviewed Referred and UGC Listed Journal

Journal No. 40776

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING

2023 - 7.428

www.sjifactor.com

❖ EDITOR ❖

Asst. Prof. Vinay Shankarrao Hatole

M.Sc (Maths), M.B.A. (Mktg.), M.B.A. (H.R.),
M.Drama (Acting), M.Drama (Prod. & Dir.), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan

Aurangabad. (M.S.)

The information and views expressed and the research content published in this journal, the sole responsibility lies entirely with the author(s) and does not reflect the official opinion of the Editorial Board, Advisory Committee and the Editor in Chief of the Journal **"AJANTA"**. Owner, printer & publisher Vinay S. Hatole has printed this journal at Ajanta Computer and Printers, Jaisingpura, University Gate, Aurangabad, also Published the same at Aurangabad.

Printed by

Ajanta Computer, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Published by

Ajanta Prakashan, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Cell No. : 9579260877, 9822620877

E-mail : ajanta3535@gmail.com, www.ajantaprakashan.in

AJANTA - ISSN 2277 - 5730 - Impact Factor - 7.428 (www.sjifactor.com)

EDITORIAL BOARD

Professor Kaiser Haq
Dept. of English, University of Dhaka,
Dhaka 1000, Bangladesh.

Roderick McCulloch
University of the Sunshine Coast,
Locked Bag 4, Maroochydore DC,
Queensland, 4558 Australia.

Dr. Ashaf Fetoh Eata
College of Art's and Science
Salmau Bin Adbul Aziz University. KAS

Dr. Nicholas Loannides
Senior Lecturer & Cisco Networking Academy Instructor,
Faculty of Computing, North Campus,
London Metropolitan University, 166-220 Holloway Road,
London, N7 8DB, UK.

Muhammad Mezbah-ul-Islam
Ph.D. (NEHU, India) Assot. Prof. Dept. of
Information Science and Library Management
University of Dhaka, Dhaka - 1000, Bangladesh.

Dr. Meenu Maheshwari
Assit. Prof. & Former Head Dept.
of Commerce & Management
University of Kota, Kota.

Dr. S. Sampath
Prof. of Statistics University of Madras
Chennari 600005.

Dr. D. H. Malini Srinivasa Rao
M.B.A., Ph.D., FDP (IIMA)
Assit. Prof. Dept. of Management
Pondicherry University
Karaikal - 609605.

Dr. S. K. Omanwar
Professor and Head, Physics,
Sat Gadge Baba Amravati
University, Amravati.

Dr. Rana Pratap Singh
Professor & Dean, School for Environmental
Sciences, Dr. Babasaheb Bhimrao Ambedkar
University Raebareily Road, Lucknow.

Dr. Shekhar Gungurwar
Hindi Dept. Vasantrao Naik
Mahavidyalaya Vasarni, Nanded.

Memon Sohel Md Yusuf
Dept. of Commerece, Nirzwa College
of Technology, Nizwa Oman.

Dr. S. Karunanidhi
Professor & Head,
Dept. of Psychology,
University of Madras.

Prof. Joyanta Borbora
Head Dept. of Sociology,
University, Dibrugarh.

Dr. Shrikrishna S. Bal
I/C Principal (Retd.),
Head, Department of Psychology,
D.B.J.College, Chiplun, Dist. Ratnagiri (M.S.)

Dr. Manoj Dixit
Professor and Head,
Department of Public Administration Director,
Institute of Tourism Studies,
Lucknow University, Lucknow.

Prof. P. T. Srinivasan
Professor and Head,
Dept. of Management Studies,
University of Madras, Chennai.

Dr. P. Vitthal
School of Language and Literature
Marathi Dept. Swami Ramanand
Teerth Marathwada University, Nanded.

EDITORIAL BOARD

Dr. B. R. Kamble
Kirti M. Doongursee College,
Dadar, Mumbai-28.

Dr. Sadique Razaque
Univ. Department of Psychology,
Vinoba Bhave University,
Hazaribagh, Jharkhand.

Prof. Ram Nandan Singh
Dept. of Buddhist Studies University of Jammu.

Dr. Safiqur Rahman
Assistant Professor, Dept. of Geography,
Guwahati College Bamunimaidam, Guwahati,
Assam.

Dr. Jagdish R. Baheti
H.O.D. S. N. J. B. College of Pharmacy,
Meminagar, A/P. Tal Chandwad, Dist. Nashik.

Dr. Vimal K. Lahari
Assistant Professor, Department of Sociology,
Banaras Hindu University, Varanasi, Uttar Pradesh.

Dr. Pandit Sheshrao Nalawade
I/C Principle,
Pandit Jawaharlal Neharu Mahavidyalay,
Aurangabad.

Dr. Sanjay Patil
Principal,
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. V. D. Nanoty
Principal,
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Sunil Somani
Principal,
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Dayanand Raut
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. Pradip Deohate
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Saurabh Jadhao
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Nilima Deshmukh
Associate Professor,
Sahakar Maharshi Late Bhaskarrao Shingne
Arts College, Khamgaon, Dist. Buldana. (M.S.)

Prof. Harshali Akhare
Assistant Professor, Department of English,
Applied Sciences and Humanities, Shri Sant Gajanan
Maharaj College of Engineering, Shegaon. (M.S.)

Mr. Sachin Bhagat
Department of Applied Sciences and Humanities,
Shri Sant Gajanan Maharaj College of Engineering,
Shegaon. (M.S.)

PUBLISHED BY

Ajanta Prakashan
Aurangabad. (M.S.)

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
1	An Impact and Challenges of New Education Policy 2020 on Higher Education System **Digwa Soniyakaur Satnamsingh**	1-6
2	The Study of Ruskin Bond's Selected Short Stories in the Light of Eco-Criticism **Mr. Dinesh Atmaram Borase**	7-11
3	A Study of Pradhan Mantri Mudra Yojana **Gaikwad S. V.** **Dr. Pawale V. A.**	12-18
4	Physical Education and Sports Sciences: Innovations and Trends **Ganesh S. Vishwakarma**	19-24
5	Application of Ethanolic Plant Extracts as a Biological Stain **Malpani H. S.** **S. V. Dalal** **Gawande S. N.** **Nanoty V. D.**	25-33
6	Automation and Monitoring of Gas Geyser Leakage Detection with Arduino **J. D. Nehete** **Dr. Milind Kale** **N. O. Chimankar** **S. R. Supe**	34-37
7	Enhancing Database Maintenance: Leveraging ChatGPT for Real-Time Verification and Updates of End-of-Life (EOL) Data **Gauri Borle** **Juee Gore** **Riya Dangra** **Amit Manekar**	38-46

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
8	Food Recommendation System Based on Geographical Location - DineLocate **Harshit Dharmik** **Karan Motwani** **Khushbu Pareek** **Shraddha Tikar** **M. Faizan I. Khandwani**	47-53
9	Microwave Assisted Synthesis, Characterization and Biological Activities of Some Newly Synthesized 3-Aryl-Substituted Benzothiazolyl Thiocarbamide **Kavita M. Heda**	54-58
10	The Curse of Gandhari - A Psychoanalytic Approach **Keerthana. K**	59-63
11	An Analysis on Sustainable Development towards Education in India **Dr. Kumaraswamy Mora**	64-70
12	Democracy Unveiled: Bridging the Nexus of Laws and Practice in India **Adv. Dr. Mahesh Pralhad Bhagwat**	71-79
13	The Study of Ichthyofaunal Diversity in Khadakpurna Canal near Chikhali Dist. Buldhana **Dr. Tushar Deshmukh** **Miss. Megha Ingle** **Mr. Sachin Bhutekar**	80-88
14	Environmental Importance in India: Through the Eyes of Union Budgets **Dr. Nitin R. Suba**	89-95
15	Studies of Relative and Specific Viscosities of Tazobactum 70% Dioxane Water Mixture at Different Temperature **Noor Mohammad**	96-98
16	Review: Text to Image Generation **Ms. Pallavi Borse** **Ms. Akansha Timande** **Ms. Vaishnavi Lande**	99-107
17	Feminist Historiography New Thought in Historiography **Dr. Pramod Rameshwar Chavan**	108-112

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
18	A Survey of Integration into 3D Printing for Image Processing using AI ML **Abhay Kadu** **Pranav Kaware** **Rushikesh Kaldate** **Ayush Solav** **Mrs. S. N. Khandare**	113-119
19	Food Recommendation System using Ahpsort Algorithm **Prasad Narkhede** **Pratham Paunikar** **Gaurav Surkar** **Prajwal Katakpure**	120-126
20	Library Automation: An Overview **Dr. Harshal R. Nimbhorkar**	137-131
21	The Wave of Ecocriticism in Indian Novel **Dr. Manohar A. Wasnik**	132-137
22	The Study of Fish Diversity in Yelgaon Dam District Buldhana **Dr. Tushar Deshmukh** **Miss. Anjali Jain** **Dr. A. A. Balode** **Mr. R. L. Dabhade**	138-147

22. The Study of Fish Diversity in Yelgaon Dam District Buldhana

Dr. Tushar Deshmukh
Department of Zoology, Shri Shivaji College of Art's, Commerce and Science, Akola.
Miss. Anjali Jain
Department of Zoology, Shri Shivaji College of Art's, Commerce and Science, Akola.
Dr. A. A. Balode
Department of Biochemistry, Shri Shivaji College of Art's, Commerce and Science, Akola.
Mr. R. L. Dabhade
Department of Biochemistry, Shri Shivaji College of Art's, Commerce and Science, Akola.

Abstract

To carry out the freshwater diversity, species abundance and the various aspects of fish of Yelgaon Dam was selected for the research work in region of Buldhana district. The order Cypriniformes was dominant with 15 species to be followed by order Perciformes with 03 species while order Siluriformes with 03 species and Synbranchiformes with 02 species and Cichliformes with 02 species and Anguilliformes, Carangiformes, Clupeiformes, Anabantiformes with 01 species respectively. During the present investigation the order of dominance is as follows

Cypriniformes > Siluriformes > Cichliformes = Synbranchiformes = Perciformes > Anguilliformes = Carangiformes = Clupeiformes = Anabantiformes. As for, the status of biodiversity was concerning about the availability species were categorized as throughout the study period included species of Least Concern (LC) category and Food fish (29) Highly native fish (HNF1) Highly economic IMP (29) Larvivorous fish (1), Threatened fish (1) Common fish (5)were recorded. Likewise, another group of vulnerable fish (4) was recorded.

Keywords : Yelgaon Dam, Larvivorous, Threatened.

Introduction

Fish are an important ecological link in the food chain. They have good taste and are easily digestible and growth promoting value. Fish is valuable source of protein, in addition to being an important food items, for the human consumption. They are part of aquatic food chain, nutrient cycling and ecosystem services. Fish also used as genetic library for possible future use in medicine and aquaculture, stimulate human interest in nature Chandrasekhar et al., (2013).

Fishing in India is a major industry employing 14.5 million people. India ranks second in aquaculture and third in fisheries contribute to 1.07% of the total GDP of India. According to the national fisheries development board the fisheries industry generate an export earnings of Rs.334.41 billion. Freshwater fishing consists of 55% of the total fish production. India is rich with inland freshwater fish with about 940 species known from its rivers, lakes and dams. This constitutes about 38.0% of the Indian ichthyofaunal and is of considerable economic and scientific value of the sea bout 500s peciesis primary fresh water fish. Rivers conserves a rich variety of fish species which also support the commercial fishery. India is one of the mega biodiversity countries in the world and occupies in the ninth position in terms of freshwater mega diversity (Mittermeier and Mittermeier, 1997).

The Maharashtra state holds a prominent position among Indian states with second largest geographical area (10%) occupying the western and central part of the country (londheand Sathe, 2015). The number of rivers dams has significantly increased in last few years. Theaquatic ecosystem is important animals especially fishes. The development of fisheries in these freshwater resources needs to be increases through the scientific development. Fish consists almost all conceivable aquatic habitat. They exhibit enormous diversity of sizes, shape and biology and in the habitat they occupy. The diversity is not only the wealth of our world but it also has some series implications on fishery.

The objective of present study is to document the fish species and to know the knowledge regarding fish study in Yelgaon Dam with reference to their economic importance. However, studies focusing on small river in fisheries are rare probably due to perception that fisheries of small rivers are not economically viable although fish from such rivers may grow to large sizes. Despite these fisheries production opportunities, these ecosystem are currently faced with series anthropogenic degradation, including poor agricultural activities, nutrient enrichment and climate change.

Material & Method

To carry out the Ichthy of aunal diversity, species abundance and the various aspects of fisheries of Yelgaon Dam will be selected for the research work in the region of Buldhana district of Maharashtra state.

Study Area

Yelgoan is just 6 km away from the Buldhana district. The height of the dam aboveits lowest foundation is 29.74m (97.6ft) while the length is 4, 5 11m (14,800ft). The volume content is 241cu mi and gross storage capacity is 22,415.05 cu.m. Dam volume 24cu.mi Total capacity 19,010cu.mi Latitude-20.479202°, Longitude-76.190261°

Collection of Fish Samples

From January 2022toMarch2022Fishsampleswere collected from dam. Fish samples were collected every day during the study period from the fish landing centers with the help of skilled local fisherman by various fishing grafts, gears, with variable mesh size. Location were changed for the collection of fish fauna. 0.1 %formalin is inserted bythesyringeand kept in polythenebags.

Identification of fish Samples

Identification of fishes was done up to species level at fish landing centre to get its natural colour, patterns of scales, fins, mouth patterns, identification mark like black spot. Fish species which was not identified on the field were preserved in 10% formalin. These fish samples were brought to the laboratory for detailed examination and identification by using standard literature of Day (1878), Jayaram (2010) and Talwar and Jhingran (2001) and Manual of Laboratory Specimens by Gurudarshan Singh, Management Practices in Fish Farming by N. K. Yadava and co-author's, Fishes and Fisheries of India by Pandey and Sandhu.

Observations and Results

The present investigation was undertaken to prepare a checklist of fishes from Yelgoan Dam and it is the first effort in this direction. The results of the present study confirm the occurrences of 29 fishes species belonging to different orders and families (Table1). The order Cypriniformes was dominant with 15 species to be followed by order Perciformes with 03 species while order Siluriformes with 03speciesandSynbranchiformes with 02 species and Cichliformes with 02 species and Anguilliform, Carangiformes, Clupeiformes, Anabantiformes with 01 species respectively. The result of the present study were focused on the descriptive statistical analysis to assess and compared to various sampling region of the fish species diversity in Table 1. Secondly, species richness were analyzed and compared to sampling location was summarized in Table 2 and also were monitored fluctuate level of species richness was observed. A total of 29 species under 9 orders and 13 families were recorded from Yelgoan Dam during the study period (Tables 1& 2).

The species were analyzed by percentage of number of individual sineachorder and family. Following, family wise analys is of percentage composition the Siluriforms was the most dominant order constituting about 23.07 % of the total fish population followed by the Synbranchi forms 15.38%, Perciformes 15.38%, Anguilliformes 7.69%, Carangiformes. 7.69%, Cichliformes 7.69%, Anabantiformes 7.69%, Cypriniformes 7.69%, Clupeiformes 7.69%, were the least numerous order and also it constituting only 01 individuals of the total order of fish population. On the other hand, genera wise percentage composition analysis were referred as the Cyprini for mesas the most dominator derconcerning about 38.09% number of genera were occurred. Subsequently, Siluriformes 14.28%, Perciformes 9.52% Synbranchiformes 9.52%

Cichliformes 4.76%, Clupeiformes 4.76%, Anabantiformes 4.76%, Anguilliformes 7.76%, Carangiformes 4.76%,, werere corded. During the present investigation the order of dominance is as follows:

Cypriniformes > Siluriformes > Cichliformes = Synbranchiformes = Perciformes > Anguilliformes = Carangiformes = Clupeiformes = Anabantiformes. The family Cyprinidae under order Cypriniformes wasre presented by species, Catlacatla, Labeorohita, Labeobata, Labeoboga, Cyprinuscarpio, Puntitusdorsalis, Puntituschola, Puntitusticto, Torkhundree, Osteobrama catiopeninsularis, almost omaboopis, Lepidoce phallus the rmalis, Thynrichthys sandkhol, Puntitusdorsalis, Cirrhinusmrigala. Underorder Synbranchi formes family Mostacembelidae was represented by 01 species, Macrognat huspan calus, and family Channidae was Channamaruliusand family Heteropneustidae was represented by 01 species Heteropneustes fossilis. Family Schilbeidae represented by 01 species Clupisomagarua, under order Perciformes family Chehlidae was represented by 02 species Oreochromismossambica, Tilapiamossambica. And family gobiidae wasre presented by 01 species Glossogobinusgiuris. Underorder Anabanti forms family Channidae was represented by 01 species Channapunctatus, under order Siluri forms family Siluridae, Bagridae, Clariidae was represented by 03 species Ompokbimaculatus, Mystuscavasius, Clariasbatrachus. Order Anguilliformes was represented by 01 family Anguillidae and 01 species Anguilla Bengalensisbengalensis. Order Carangi formes is represented by 01 family Rachycen tridae and represented by one species Rachycen troncanadum. Order Cichli for me sisre presented by 01 family Cichlidae and 02 species Tilapinitilapia, Oreochromisniloticus. Order clupeiformes is represented by 01 family Engraulidae and 01 species Stolephorusindicus. Order Anabantifor mesisre presented by 01 family Channidaeand 01 species

Channa punctatus. As for, the status of biodiversity was concerning about the availability species were categorized as through out the study period included species of Least Concern (LC) categoryand Foodfish (29) Highlynativefish (HNF1) Highlyeconomic IMP (29) Larvivorous fish (1), Threatened fish (1) Common fish (5) were recorded. Likewise, another group of vulnerable fish (4) was recorded.

Table1:Fish Status of Yelgaon Dam from Buldhana District Maharashtra (India)

Order	Family	Species Name	Common Name	Local Name
Cypriniformes	**Cyprinidae**	*Catlacatla*(Hamilton-Buchanan)	Catla	Catla
		Labeorohita(Hamilton-Buchanan)	Rohu	Rohu
		Labeobata(Hamilton-Buchanan)	BataLabeo	Tembti
		Labeoboga(Hamilton-Buchanan)	BogaLabeo	Chankora
		Cyprinuscarpio(Linnaeus)	Commoncarp	Cyprinus
		Puntitusdorsalis(Jerdon)	LongSnoutedbarb	Podshi
		Puntituschola(Hamilton-Buchanan)	Swampbarb	Tepri
		Puntitusticto(Hamilton-Buchanan)	Tictobarb	Tepdi
		Torkhudree(Sykes)	Yellowmasheer	Temri
		Osteobramacatiopeninsularis(Silas)	Penisularosteobrama	Kharpati
		Salmostomaboopis(Day)	Boopisrazor	Chal/Udan
		Lepidocephalusthermalis(Valencinnes)	Malabarloach	Girgos
		Thynrichthyssandkhol(Sykes)	Sandkholcarp	Sandkoli
		Puntitusdorsalis	Lalpari	Lalpari
		Cirrhinusmrigala	Mrigal	Mrigal
Perciformes	**Chehlidae**	*Tilapiamossambica*(Jhingran)	Tillapia	Talapia
		Oreochromismossambica(peters)	Mozambiquecichlid	Kombada
	Gobiidae	*Glossogobinusgiuris*(Hamilton-Buchanan)	Tankgoby	Dhangarya
Synbranchiformes	**Mostacembelidae**	*Macrognathuspancalus*(H &B)	StripedSpinyEel	Bam
	Channidae	*Channamarulius*(H &B)	GiantSnakehead	Dokh
Siluriformes	**Siluridae**	*Ompokbimaculatus*(Bloch)	Indianbuttercatfish	Patola

	Bagridae	*Mystuscavasius*	Katarni	Katarni
	Clariidae	*Clariasbatrachus*	Magur	Magur
Anguilliformes	**Anguillidae**	*Anguillabengalensisbengalensis*	Bam	Bam
Carangiformes	**Rachycentridae**	*Rachycentroncanadum*	Modha	Modha
Cichliformes	**Cichlidae**	*Tilapiinitilapia*	Jilebi	Jilebi
		Oreochromisniloticus	Kombada	Kombada
Clupeiformes	**Engraulidae**	*Stolephorusindicus*	Muchakada	Muchakada
Anabantiformes	**Channidae**	*Channapunctata*	Dok	Dok

Table2: Fish Status of Yelgaon Dam from Buldhana District Maharashtra (India)

Sr no	Nameof fish	FF	HEI	HNF	CF	HSF	OF	LF	EXPTF	MCF	TR	EN	VU	R	LC	C	UNC	EX
1	*Catlacatla*(Hamilton-Buchanan)	✓	✓	✓					✓							✓		
2	*Labeorohita*(Hamilton-Buchanan)	✓	✓						✓							✓		
3	*Labeobata*(Hamilton-Buchanan)	✓	✓					✓	✓							✓		
4	*Labeoboga*(Hamilton-Buchanan)	✓	✓									✓	✓	✓	✓			
5	*Cyprinuscarpio*(Linnaeus)	✓	✓										✓	✓	✓			✓
6	*Puntitusdorsalis*(Jerdon)	✓	✓										✓	✓	✓			
7	*Puntituschola*(Hamilton-Buchanan)	✓	✓												✓			
8	*Puntitusticto*(Hamilton-Buchanan)	✓	✓												✓			
9	*Torkhudree*(Sykes)	✓	✓												✓			
10	*Osteobramacatiopeninsularis*(Silas)	✓	✓												✓			
11	*Salmostomaboopis*(Day)	✓	✓												✓			
12	*Lepidocephalusthermalis*(Valencinnes)	✓	✓												✓			
13	*Thynrichthyssandkhol*(Sykes)	✓	✓									✓	✓					
14	*Puntitusdorsalis*	✓	✓															
15	*Cirrhinusmrigala*	✓	✓									✓			✓			
16	*Tilapiamossambica*(Jhingran)	✓	✓										✓		✓			✓

17	*Oreochromismossambica*(peters)	✓	✓									✓			✓			
18	*Glossogobinusgiuris* (Hamilton-Buchanan)	✓	✓												✓			
19	*Macrognathuspancalus*(H&B)	✓	✓												✓			
20	*Channamarulius*(H &B)	✓	✓												✓			
21	*Ompokbimaculatus*(Bloch)	✓	✓												✓	✓		
22	*Mystuscavasius*	✓	✓												✓			
23	*Clariasbatrachus*	✓	✓									✓			✓	✓		
24	*Anguillabengalensis bengalensis*	✓	✓								✓				✓			
25	*Rachycentroncanadum*	✓	✓									✓			✓			
26	*Tilapiinitilapia*	✓	✓												✓	✓		
27	*Oreochromisniloticus*	✓	✓										✓		✓			
28	*Stolephorusindicus*	✓	✓															
29	*Channapunctatus*	✓	✓										✓	✓	✓	✓		

Food fish FF, Exotic fish EX, Highly native fish HNF, Coarse food fish CF, Mosqui to control fish MCF, Forage fish FR, Highly economic IMP, HEI, Experimental fish EXPTF, Hillstream fish HSF, Threatened fish TR, Larvivorous fishes LF, Vulnerable fishes VU, Ornamental fish OF, Endangered fish EN, Lower risk near threatened LR-NT, Rare R, Common C, Uncommon UNC.

Table3 : Descriptive statistics for species diversity in Yelga on Dam Buldhana District

Sampling sites	'N' species	Mean	SD	SE of Mean	'N' Individuals	Mean	SD	SE of Mean
Site1	8	0.26	0.012	0.008	20	0.23	0.023	0.013
Site2	6	0.21	0.011	0.006	30	0.25	0.020	0.011
Site3	6	0.21	0.011	0.006	32	0.25	0.020	0.009
Site4	9	0.31	0.015	0.009	39	0.27	0.021	0.009
Total	28	0.99	0.049	0.029	121	1.00	0.084	0.042

Discussion

In the present investigation it was observed that the ichthy of aunal diversity belongs to 9 orders 13 families 21 genus 29 species. Where family is dominant Siluri formes (23.07) followed by My stuscavasius, Mystusbleekeri, Ompokbimaculatus, Clariasbatrachus.

The similar results were reported by Mane and Pawar, (2007) with 36 species under 19genera of Manar river of Nanded district. Hiware and Pawar (2006) recorded 7 speciesunder 7 genera under the order Siluriformes from Thodga river reservoir Ahmedpur districtLatur Maharashtra. Vijaylaxmiet al., (2008) reported 6 species under4 genera underfamily Cyprinidae from Bheema river Gulbarga district Karnataka. Our results are also inagreement with Shaikh et al., (2011) who found near about same results like Siluri forms order is dominant so ther orders. Ubharhande and Sonune (2012) found 7 orders, 10 families, 19 genera and 21 species and dominance of Cyprinidae family from Paintakli dam from Buldhana district Maharashtra. The fish Anguillabengalensis bengalensis which is endangered (threatened) in Western Ghats of India (Dahanukaretal.,2004) it is also recorded in the presence study at end angered status in the study are as we chosen, suggesting a dire need of its conservation and awareness in the human population. Clariusbatrachus has been listed endangered (Menon 2004), the exotic fishes like Cyprinuscarpio, Tilapia mossambica, Oerochromismossambica, Channapunctata where also reported during presentinvestigation (Jingran,1983) out of 29 species recorded 29(100%) species are recognized by food fishes (FF)29, Highly native fish 01, Highly economically important fish 29, Carnivorous fish1,experimental fish3,Threatened fish 01, common fish 04, exotic fish 02, experimental fish 03,vulnerable fish 04,endangered fishes 06, rare fishes 01, uncommon fishes 01. The Same result was recorded by Kalayankaret.al., (2012). Our study is also in agreement with Rao et.al., (1998), Sakhare (2001) and Kadam and Gaikwad (2006).

Presently, decline the richness of species were observed to the present two reduce to proximately to human invention, shortage of food availability, excessive fishing and scarcity of water in this reservoir. Thus, the biological diversity appears to play a substantial role in ecosystem plasticity. Sandmining is common in most of the stretches of the river, which is the determining factor for habitat destruction leading to the loss of habitat and breeding grounds of several fish species in the river. Loss of breeding grounds would have negative impact on the fish populations. Over fishing for consumption is another factor for fish biodiversity loss. Native fish fauna of the river is severely threatened by the introduction of exotic species due to predation, competition for food and habit and in production of pathogens.

Conclusion

The diversity and abundance of fishes in Yelgoan Dam represents the suitability of water of Yelgoan Dam for Aquaculture practices. But the fish fauna of this Dam are being threatened

due to several anthropogenic activities the fish diversity of this water body as in declining mode. Preservation and processing center must be establish in this region which will help to keep fish for long tiny and better marketing opportunities to those persons engaged with fish farming. The study of biodiversity programmers must be continuing in future which will help to assess the loss of biodiversity with respect of time.

References

- Chandrashekhar, E., Prasad, P., and Gurijala, V.G., (2013): Geomagnetic jerks: Astudy using complex wavelets, In Wavelets and Fractals in Earth system Sciences, (Eds.), 195-217.
- Dahanukar, N., R. Raut and A. Bhat, (2004): Distribution, endemism and threat status off freshwater fishes in the Western Ghats of India. Journal of Biogeography,31:123-136
- Day FS. (1878) :The fishes of India, being a natural history of fishes found to inhabit the seas and freshwater of India, Burma and Ceylon: Text and atlas in 4 parts. London,1878,778
- Hiware, C. J., and R. T. Pawar (2006): Ichthyofaunal of paithan Reserviour (Nathsagardam) in Aurangabad district of Marathwada. Ecology and Environment, APH Publishing corporation New Delhi. Homalopteridae ZSI, Culcuttapp-306, ISBN:81-858774-15-8.
- Jayaram, K. C. (1999) : The fresh water fishes of the Indian Region. Narendra Journal of Environmental Sciences, 2 (6): 61-70
- Kadam, S. U. and Gayakwad, J. M., 2006. Ichthyofauna of Masooli Reservoir, District Parbhani, Maharashtra- A Study of inland reservoir, fishery in India. J. Aqua. Biol., 21(2); 59-61.
- Kalyankar V. B., Nagale D., Dhodange T.B and Akhade S. S. (2012): Study of Fish diversity from Lower Dudhava project at Parbhani Dis. India World J. of 2001.7 (4): 320-322.
- Mane A. M. and Pawar S. K. 2007. Some Physiochemical properties of Manar River of Nanded district. Maharashtra. J. Aqua. Biol. Vol.22 (2), 2007:88-90.
- Mane A.V., R. G. Pardeshi, V. R. Gore, R. L. Walave, S. S. Manjrekar and G.. N. Manjusha Bhor, Prakash Kadave, AbhijitBhor, SheetalBhor, Manisha.
- Menon, A. G. K. (1999): Checkl is to ffresh water fishes of India. Z. S. I. Kolkata.

- Mittermeier, R. A. and Mittermeier, C. G. (1997): Megadiversit year this biologically wealth is nation in Mc Allister, Hamiliton and B. Harvey (Eds.) Global fresh water biodiversity Seawind, Cemex, Mexico City(11): Pp. 1-140.
- Rao, J. C. S., Simhachalam, J. G., & Raju, C. S. (2013). A Study on Ichthyof aunal Diversity, Conservation Status and Anthropogenic stress of River Champavathi, Vizianagaram District (AP) India. Asian Journal of Experimental Biological Sciences 2013 b, 4(3), 418-425.
- Sakhare, V. B., (2001): Ichthyofaunal of Jawalgoan of Maharashtra. J. Aqua. Biol., 16(1) 31-33
- Shaikh et al., (2011) : The study of Ichthyofauna diversity in upper Dudhana project water reserve our near somthana in Jalna District (M.S), India. Jour. Of fisheries andAquaculture,2(1):08-10
- Talwar, P. K. and A. G. Jhingran (1991): In land fishes of India and adjacent Tank of Warangal, Andhra Pradesh. Journal of Environmental Science, Toxicology test and at last in 4 pts. London. E. O. (ed.) Biodiversity.
- Ubharhande S. B. and S. R. Sonawane (2012) : Study of Fresh water fishfauna University Press, Ames, Iowa, USA,. 246-247.
- Vijaylaxmi G. M. 1985. Fishes of Khasi Hills records of Zoological survey of India Occasial paper no.70. Issued by the Director ZSI, Calcutta, 40pp.

ISSN 2277 - 5730

AN INTERNATIONAL MULTIDISCIPLINARY
QUARTERLY RESEARCH JOURNAL

AJANTA

Volume - XIII Issue - II April - June - 2024

ENGLISH PART - VI

Peer Reviewed Referred and UGC Listed Journal

Journal No. 40776

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING

2023 - 7.428

www.sjifactor.com

❖ EDITOR ❖

Asst. Prof. Vinay Shankarrao Hatole

M.Sc (Maths), M.B.A. (Mktg.), M.B.A. (H.R.),
M.Drama (Acting), M.Drama (Prod. & Dir.), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan

Aurangabad. (M.S.)

The information and views expressed and the research content published in this journal, the sole responsibility lies entirely with the author(s) and does not reflect the official opinion of the Editorial Board, Advisory Committee and the Editor in Chief of the Journal **"AJANTA"**. Owner, printer & publisher Vinay S. Hatole has printed this journal at Ajanta Computer and Printers, Jaisingpura, University Gate, Aurangabad, also Published the same at Aurangabad.

Printed by

Ajanta Computer, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Published by

Ajanta Prakashan, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Cell No. : 9579260877, 9822620877

E-mail : ajanta3535@gmail.com, www.ajantaprakashan.in

AJANTA - ISSN 2277 - 5730 - Impact Factor - 7.428 (www.sjifactor.com)

EDITORIAL BOARD

Professor Kaiser Haq
Dept. of English, University of Dhaka,
Dhaka 1000, Bangladesh.

Roderick McCulloch
University of the Sunshine Coast,
Locked Bag 4, Maroochydore DC,
Queensland, 4558 Australia.

Dr. Ashaf Fetoh Eata
College of Art's and Science
Salmau Bin Adbul Aziz University. KAS

Dr. Nicholas Loannides
Senior Lecturer & Cisco Networking Academy Instructor,
Faculty of Computing, North Campus,
London Metropolitan University, 166-220 Holloway Road,
London, N7 8DB, UK.

Muhammad Mezbah-ul-Islam
Ph.D. (NEHU, India) Assot. Prof. Dept. of
Information Science and Library Management
University of Dhaka, Dhaka - 1000, Bangladesh.

Dr. Meenu Maheshwari
Assit. Prof. & Former Head Dept.
of Commerce & Management
University of Kota, Kota.

Dr. S. Sampath
Prof. of Statistics University of Madras
Chennari 600005.

Dr. D. H. Malini Srinivasa Rao
M.B.A., Ph.D., FDP (IIMA)
Assit. Prof. Dept. of Management
Pondicherry University
Karaikal - 609605.

Dr. S. K. Omanwar
Professor and Head, Physics,
Sat Gadge Baba Amravati
University, Amravati.

Dr. Rana Pratap Singh
Professor & Dean, School for Environmental
Sciences, Dr. Babasaheb Bhimrao Ambedkar
University Raebareily Road, Lucknow.

Dr. Shekhar Gungurwar
Hindi Dept. Vasantrao Naik
Mahavidyalaya Vasarni, Nanded.

Memon Sohel Md Yusuf
Dept. of Commerece, Nirzwa College
of Technology, Nizwa Oman.

Dr. S. Karunanidhi
Professor & Head,
Dept. of Psychology,
University of Madras.

Prof. Joyanta Borbora
Head Dept. of Sociology,
University, Dibrugarh.

Dr. Shrikrishna S. Bal
I/C Principal (Retd.),
Head, Department of Psychology,
D.B.J.College, Chiplun, Dist. Ratnagiri (M.S.)

Dr. Manoj Dixit
Professor and Head,
Department of Public Administration Director,
Institute of Tourism Studies,
Lucknow University, Lucknow.

Prof. P. T. Srinivasan
Professor and Head,
Dept. of Management Studies,
University of Madras, Chennai.

Dr. P. Vitthal
School of Language and Literature
Marathi Dept. Swami Ramanand
Teerth Marathwada University, Nanded.

EDITORIAL BOARD

Dr. B. R. Kamble
Kirti M. Doongursee College,
Dadar, Mumbai-28.

Dr. Sadique Razaque
Univ. Department of Psychology,
Vinoba Bhave University,
Hazaribagh, Jharkhand.

Prof. Ram Nandan Singh
Dept. of Buddhist Studies University of Jammu.

Dr. Safiqur Rahman
Assistant Professor, Dept. of Geography,
Guwahati College Bamunimaidam, Guwahati,
Assam.

Dr. Jagdish R. Baheti
H.O.D. S. N. J. B. College of Pharmacy,
Meminagar, A/P. Tal Chandwad, Dist. Nashik.

Dr. Vimal K. Lahari
Assistant Professor, Department of Sociology,
Banaras Hindu University, Varanasi, Uttar Pradesh.

Dr. Pandit Sheshrao Nalawade
I/C Principle,
Pandit Jawaharlal Neharu Mahavidyalay,
Aurangabad.

Dr. Sanjay Patil
Principal,
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. V. D. Nanoty
Principal,
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Sunil Somani
Principal,
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Dayanand Raut
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. Pradip Deohate
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Saurabh Jadhao
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Nilima Deshmukh
Associate Professor,
Sahakar Maharshi Late Bhaskarrao Shingne
Arts College, Khamgaon, Dist. Buldana. (M.S.)

Prof. Harshali Akhare
Assistant Professor, Department of English,
Applied Sciences and Humanities, Shri Sant Gajanan
Maharaj College of Engineering, Shegaon. (M.S.)

Mr. Sachin Bhagat
Department of Applied Sciences and Humanities,
Shri Sant Gajanan Maharaj College of Engineering,
Shegaon. (M.S.)

PUBLISHED BY

Ajanta Prakashan
Aurangabad. (M.S.)

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
1	An Impact and Challenges of New Education Policy 2020 on Higher Education System **Digwa Soniyakaur Satnamsingh**	1-6
2	The Study of Ruskin Bond's Selected Short Stories in the Light of Eco-Criticism **Mr. Dinesh Atmaram Borase**	7-11
3	A Study of Pradhan Mantri Mudra Yojana **Gaikwad S. V.** **Dr. Pawale V. A.**	12-18
4	Physical Education and Sports Sciences: Innovations and Trends **Ganesh S. Vishwakarma**	19-24
5	Application of Ethanolic Plant Extracts as a Biological Stain **Malpani H. S.** **S. V. Dalal** **Gawande S. N.** **Nanoty V. D.**	25-33
6	Automation and Monitoring of Gas Geyser Leakage Detection with Arduino **J. D. Nehete** **Dr. Milind Kale** **N. O. Chimankar** **S. R. Supe**	34-37
7	Enhancing Database Maintenance: Leveraging ChatGPT for Real-Time Verification and Updates of End-of-Life (EOL) Data **Gauri Borle** **Juee Gore** **Riya Dangra** **Amit Manekar**	38-46

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
8	Food Recommendation System Based on Geographical Location - DineLocate **Harshit Dharmik** **Karan Motwani** **Khushbu Pareek** **Shraddha Tikar** **M. Faizan I. Khandwani**	47-53
9	Microwave Assisted Synthesis, Characterization and Biological Activities of Some Newly Synthesized 3-Aryl-Substituted Benzothiazolyl Thiocarbamide **Kavita M. Heda**	54-58
10	The Curse of Gandhari - A Psychoanalytic Approach **Keerthana. K**	59-63
11	An Analysis on Sustainable Development towards Education in India **Dr. Kumaraswamy Mora**	64-70
12	Democracy Unveiled: Bridging the Nexus of Laws and Practice in India **Adv. Dr. Mahesh Pralhad Bhagwat**	71-79
13	The Study of Ichthyofaunal Diversity in Khadakpurna Canal near Chikhali Dist. Buldhana **Dr. Tushar Deshmukh** **Miss. Megha Ingle** **Mr. Sachin Bhutekar**	80-88
14	Environmental Importance in India: Through the Eyes of Union Budgets **Dr. Nitin R. Suba**	89-95
15	Studies of Relative and Specific Viscosities of Tazobactum 70% Dioxane Water Mixture at Different Temperature **Noor Mohammad**	96-98
16	Review: Text to Image Generation **Ms. Pallavi Borse** **Ms. Akansha Timande** **Ms. Vaishnavi Lande**	99-107
17	Feminist Historiography New Thought in Historiography **Dr. Pramod Rameshwar Chavan**	108-112

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
18	A Survey of Integration into 3D Printing for Image Processing using AI ML **Abhay Kadu** **Pranav Kaware** **Rushikesh Kaldate** **Ayush Solav** **Mrs. S. N. Khandare**	113-119
19	Food Recommendation System using Ahpsort Algorithm **Prasad Narkhede** **Pratham Paunikar** **Gaurav Surkar** **Prajwal Katakpure**	120-126
20	Library Automation: An Overview **Dr. Harshal R. Nimbhorkar**	137-131
21	The Wave of Ecocriticism in Indian Novel **Dr. Manohar A. Wasnik**	132-137
22	The Study of Fish Diversity in Yelgaon Dam District Buldhana **Dr. Tushar Deshmukh** **Miss. Anjali Jain** **Dr. A. A. Balode** **Mr. R. L. Dabhade**	138-147

22. The Study of Fish Diversity in Yelgaon Dam District Buldhana

Dr. Tushar Deshmukh
Department of Zoology, Shri Shivaji College of Art's, Commerce and Science, Akola.
Miss. Anjali Jain
Department of Zoology, Shri Shivaji College of Art's, Commerce and Science, Akola.
Dr. A. A. Balode
Department of Biochemistry, Shri Shivaji College of Art's, Commerce and Science, Akola.
Mr. R. L. Dabhade
Department of Biochemistry, Shri Shivaji College of Art's, Commerce and Science, Akola.

Abstract

To carry out the freshwater diversity, species abundance and the various aspects of fish of Yelgaon Dam was selected for the research work in region of Buldhana district. The order Cypriniformes was dominant with 15 species to be followed by order Perciformes with 03 species while order Siluriformes with 03 species and Synbranchiformes with 02 species and Cichliformes with 02 species and Anguilliformes, Carangiformes, Clupeiformes, Anabantiformes with 01 species respectively. During the present investigation the order of dominance is as follows

Cypriniformes > Siluriformes > Cichliformes = Synbranchiformes = Perciformes > Anguilliformes = Carangiformes = Clupeiformes = Anabantiformes. As for, the status of biodiversity was concerning about the availability species were categorized as throughout the study period included species of Least Concern (LC) category and Food fish (29) Highly native fish (HNF1) Highly economic IMP (29) Larvivorous fish (1), Threatened fish (1) Common fish (5)were recorded. Likewise, another group of vulnerable fish (4) was recorded.

Keywords : Yelgaon Dam, Larvivorous, Threatened.

Introduction

Fish are an important ecological link in the food chain. They have good taste and are easily digestible and growth promoting value. Fish is valuable source of protein, in addition to being an important food items, for the human consumption. They are part of aquatic food chain, nutrient cycling and ecosystem services. Fish also used as genetic library for possible future use in medicine and aquaculture, stimulate human interest in nature Chandrasekhar et al., (2013).

Fishing in India is a major industry employing 14.5 million people. India ranks second in aquaculture and third in fisheries contribute to 1.07% of the total GDP of India. According to the national fisheries development board the fisheries industry generate an export earnings of Rs.334.41 billion. Freshwater fishing consists of 55% of the total fish production. India is rich with inland freshwater fish with about 940 species known from its rivers, lakes and dams. This constitutes about 38.0% of the Indian ichthyofaunal and is of considerable economic and scientific value of the sea bout 500s peciesis primary fresh water fish. Rivers conserves a rich variety of fish species which also support the commercial fishery. India is one of the mega biodiversity countries in the world and occupies in the ninth position in terms of freshwater mega diversity (Mittermeier and Mittermeier, 1997).

The Maharashtra state holds a prominent position among Indian states with second largest geographical area (10%) occupying the western and central part of the country (londheand Sathe, 2015). The number of rivers dams has significantly increased in last few years. Theaquatic ecosystem is important animals especially fishes. The development of fisheries in these freshwater resources needs to be increases through the scientific development. Fish consists almost all conceivable aquatic habitat. They exhibit enormous diversity of sizes, shape and biology and in the habitat they occupy. The diversity is not only the wealth of our world but it also has some series implications on fishery.

The objective of present study is to document the fish species and to know the knowledge regarding fish study in Yelgaon Dam with reference to their economic importance. However, studies focusing on small river in fisheries are rare probably due to perception that fisheries of small rivers are not economically viable although fish from such rivers may grow to large sizes. Despite these fisheries production opportunities, these ecosystem are currently faced with series anthropogenic degradation, including poor agricultural activities, nutrient enrichment and climate change.

Material & Method

To carry out the Ichthy of aunal diversity, species abundance and the various aspects of fisheries of Yelgaon Dam will be selected for the research work in the region of Buldhana district of Maharashtra state.

Study Area

Yelgoan is just 6 km away from the Buldhana district. The height of the dam aboveits lowest foundation is 29.74m (97.6ft) while the length is 4, 5 11m (14,800ft). The volume content is 241cu mi and gross storage capacity is 22,415.05 cu.m. Dam volume 24cu.mi Total capacity 19,010cu.mi Latitude-20.479202°, Longitude-76.190261°

Collection of Fish Samples

From January 2022toMarch2022Fishsampleswere collected from dam. Fish samples were collected every day during the study period from the fish landing centers with the help of skilled local fisherman by various fishing grafts, gears, with variable mesh size. Location were changed for the collection of fish fauna. 0.1 %formalin is inserted bythesyringeand kept in polythenebags.

Identification of fish Samples

Identification of fishes was done up to species level at fish landing centre to get its natural colour, patterns of scales, fins, mouth patterns, identification mark like black spot. Fish species which was not identified on the field were preserved in 10% formalin. These fish samples were brought to the laboratory for detailed examination and identification by using standard literature of Day (1878), Jayaram (2010) and Talwar and Jhingran (2001) and Manual of Laboratory Specimens by Gurudarshan Singh, Management Practices in Fish Farming by N. K. Yadava and co-author's, Fishes and Fisheries of India by Pandey and Sandhu.

Observations and Results

The present investigation was undertaken to prepare a checklist of fishes from Yelgoan Dam and it is the first effort in this direction. The results of the present study confirm the occurrences of 29 fishes species belonging to different orders and families (Table1). The order Cypriniformes was dominant with 15 species to be followed by order Perciformes with 03 species while order Siluriformes with 03speciesandSynbranchiformes with 02 species and Cichliformes with 02 species and Anguilliform, Carangiformes, Clupeiformes, Anabantiformes with 01 species respectively. The result of the present study were focused on the descriptive statistical analysis to assess and compared to various sampling region of the fish species diversity in Table 1. Secondly, species richness were analyzed and compared to sampling location was summarized in Table 2 and also were monitored fluctuate level of species richness was observed. A total of 29 species under 9 orders and 13 families were recorded from Yelgoan Dam during the study period (Tables 1& 2).

The species were analyzed by percentage of number of individual sineachorder and family. Following, family wise analys is of percentage composition the Siluriforms was the most dominant order constituting about 23.07 % of the total fish population followed by the Synbranchi forms 15.38%, Perciformes 15.38%, Anguilliformes 7.69%, Carangiformes. 7.69%, Cichliformes 7.69%, Anabantiformes 7.69%, Cypriniformes 7.69%, Clupeiformes 7.69%, were the least numerous order and also it constituting only 01 individuals of the total order of fish population. On the other hand, genera wise percentage composition analysis were referred as the Cyprini for mesas the most dominator derconcerning about 38.09% number of genera were occurred. Subsequently, Siluriformes 14.28%, Perciformes 9.52% Synbranchiformes 9.52%

Cichliformes 4.76%, Clupeiformes 4.76%, Anabantiformes 4.76%, Anguilliformes 7.76%, Carangiformes 4.76%,, werere corded. During the present investigation the order of dominance is as follows:

Cypriniformes > Siluriformes > Cichliformes = Synbranchiformes = Perciformes > Anguilliformes = Carangiformes = Clupeiformes = Anabantiformes. The family Cyprinidae under order Cypriniformes wasre presented by species, Catlacatla, Labeorohita, Labeobata, Labeoboga, Cyprinuscarpio, Puntitusdorsalis, Puntituschola, Puntitusticto, Torkhundree, Osteobrama catiopeninsularis, almost omaboopis, Lepidoce phallus the rmalis, Thynrichthys sandkhol, Puntitusdorsalis, Cirrhinusmrigala. Underorder Synbranchi formes family Mostacembelidae was represented by 01 species, Macrognat huspan calus, and family Channidae was Channamaruliusand family Heteropneustidae was represented by 01 species Heteropneustes fossilis. Family Schilbeidae represented by 01 species Clupisomagarua, under order Perciformes family Chehlidae was represented by 02 species Oreochromismossambica, Tilapiamossambica. And family gobiidae wasre presented by 01 species Glossogobinusgiuris. Underorder Anabanti forms family Channidae was represented by 01 species Channapunctatus, under order Siluri forms family Siluridae, Bagridae, Clariidae was represented by 03 species Ompokbimaculatus, Mystuscavasius, Clariasbatrachus. Order Anguilliformes was represented by 01 family Anguillidae and 01 species Anguilla Bengalensisbengalensis. Order Carangi formes is represented by 01 family Rachycen tridae and represented by one species Rachycen troncanadum. Order Cichli for me sisre presented by 01 family Cichlidae and 02 species Tilapinitilapia, Oreochromisniloticus. Order clupeiformes is represented by 01 family Engraulidae and 01 species Stolephorusindicus. Order Anabantifor mesisre presented by 01 family Channidaeand 01 species

Channa punctatus. As for, the status of biodiversity was concerning about the availability species were categorized as through out the study period included species of Least Concern (LC) categoryand Foodfish (29) Highlynativefish (HNF1) Highlyeconomic IMP (29) Larvivorous fish (1), Threatened fish (1) Common fish (5) were recorded. Likewise, another group of vulnerable fish (4) was recorded.

Table1:Fish Status of Yelgaon Dam from Buldhana District Maharashtra (India)

Order	Family	Species Name	Common Name	Local Name
Cypriniformes	**Cyprinidae**	*Catlacatla*(Hamilton-Buchanan)	Catla	Catla
		Labeorohita(Hamilton-Buchanan)	Rohu	Rohu
		Labeobata(Hamilton-Buchanan)	BataLabeo	Tembti
		Labeoboga(Hamilton-Buchanan)	BogaLabeo	Chankora
		Cyprinuscarpio(Linnaeus)	Commoncarp	Cyprinus
		Puntitusdorsalis(Jerdon)	LongSnoutedbarb	Podshi
		Puntituschola(Hamilton-Buchanan)	Swampbarb	Tepri
		Puntitusticto(Hamilton-Buchanan)	Tictobarb	Tepdi
		Torkhudree(Sykes)	Yellowmasheer	Temri
		Osteobramacatiopeninsularis(Silas)	Penisularosteobrama	Kharpati
		Salmostomaboopis(Day)	Boopisrazor	Chal/Udan
		Lepidocephalusthermalis(Valencinnes)	Malabarloach	Girgos
		Thynrichthyssandkhol(Sykes)	Sandkholcarp	Sandkoli
		Puntitusdorsalis	Lalpari	Lalpari
		Cirrhinusmrigala	Mrigal	Mrigal
Perciformes	**Chehlidae**	*Tilapiamossambica*(Jhingran)	Tillapia	Talapia
		Oreochromismossambica(peters)	Mozambiquecichlid	Kombada
	Gobiidae	*Glossogobinusgiuris*(Hamilton-Buchanan)	Tankgoby	Dhangarya
Synbranchiformes	**Mostacembelidae**	*Macrognathuspancalus*(H &B)	StripedSpinyEel	Bam
	Channidae	*Channamarulius*(H &B)	GiantSnakehead	Dokh
Siluriformes	**Siluridae**	*Ompokbimaculatus*(Bloch)	Indianbuttercatfish	Patola

	Bagridae	*Mystuscavasius*	Katarni	Katarni
	Clariidae	*Clariasbatrachus*	Magur	Magur
Anguilliformes	**Anguillidae**	*Anguillabengalensisbengalensis*	Bam	Bam
Carangiformes	**Rachycentridae**	*Rachycentroncanadum*	Modha	Modha
Cichliformes	**Cichlidae**	*Tilapiinitilapia*	Jilebi	Jilebi
		Oreochromisniloticus	Kombada	Kombada
Clupeiformes	**Engraulidae**	*Stolephorusindicus*	Muchakada	Muchakada
Anabantiformes	**Channidae**	*Channapunctata*	Dok	Dok

Table2: Fish Status of Yelgaon Dam from Buldhana District Maharashtra (India)

Sr no	Nameof fish	FF	HEI	HNF	CF	HSF	OF	LF	EXPTF	MCF	TR	EN	VU	R	LC	C	UNC	EX
1	*Catlacatla*(Hamilton-Buchanan)	✓	✓	✓					✓							✓		
2	*Labeorohita*(Hamilton-Buchanan)	✓	✓						✓							✓		
3	*Labeobata*(Hamilton-Buchanan)	✓	✓					✓	✓							✓		
4	*Labeoboga*(Hamilton-Buchanan)	✓	✓									✓	✓	✓	✓			
5	*Cyprinuscarpio*(Linnaeus)	✓	✓										✓	✓	✓			✓
6	*Puntitusdorsalis*(Jerdon)	✓	✓										✓	✓	✓			
7	*Puntituschola*(Hamilton-Buchanan)	✓	✓												✓			
8	*Puntitusticto*(Hamilton-Buchanan)	✓	✓												✓			
9	*Torkhudree*(Sykes)	✓	✓												✓			
10	*Osteobramacatiopeninsularis*(Silas)	✓	✓												✓			
11	*Salmostomaboopis*(Day)	✓	✓												✓			
12	*Lepidocephalusthermalis*(Valencinnes)	✓	✓												✓			
13	*Thynrichthyssandkhol*(Sykes)	✓	✓									✓	✓					
14	*Puntitusdorsalis*	✓	✓															
15	*Cirrhinusmrigala*	✓	✓									✓			✓			
16	*Tilapiamossambica*(Jhingran)	✓	✓										✓		✓			✓

17	*Oreochromismossambica*(peters)	✓	✓									✓			✓			
18	*Glossogobinusgiuris* (Hamilton-Buchanan)	✓	✓												✓			
19	*Macrognathuspancalus*(H&B)	✓	✓												✓			
20	*Channamarulius*(H &B)	✓	✓												✓			
21	*Ompokbimaculatus*(Bloch)	✓	✓												✓	✓		
22	*Mystuscavasius*	✓	✓												✓			
23	*Clariasbatrachus*	✓	✓									✓			✓	✓		
24	*Anguillabengalensis bengalensis*	✓	✓								✓				✓			
25	*Rachycentroncanadum*	✓	✓									✓			✓			
26	*Tilapiinitilapia*	✓	✓												✓	✓		
27	*Oreochromisniloticus*	✓	✓										✓		✓			
28	*Stolephorusindicus*	✓	✓															
29	*Channapunctatus*	✓	✓										✓	✓	✓	✓		

Food fish FF, Exotic fish EX, Highly native fish HNF, Coarse food fish CF, Mosqui to control fish MCF, Forage fish FR, Highly economic IMP, HEI, Experimental fish EXPTF, Hillstream fish HSF, Threatened fish TR, Larvivorous fishes LF, Vulnerable fishes VU, Ornamental fish OF, Endangered fish EN, Lower risk near threatened LR-NT, Rare R, Common C, Uncommon UNC.

Table3 : Descriptive statistics for species diversity in Yelga on Dam Buldhana District

Sampling sites	'N' species	Mean	SD	SE of Mean	'N' Individuals	Mean	SD	SE of Mean
Site1	8	0.26	0.012	0.008	20	0.23	0.023	0.013
Site2	6	0.21	0.011	0.006	30	0.25	0.020	0.011
Site3	6	0.21	0.011	0.006	32	0.25	0.020	0.009
Site4	9	0.31	0.015	0.009	39	0.27	0.021	0.009
Total	28	0.99	0.049	0.029	121	1.00	0.084	0.042

Discussion

In the present investigation it was observed that the ichthy of aunal diversity belongs to 9 orders 13 families 21 genus 29 species. Where family is dominant Siluri formes (23.07) followed by My stuscavasius, Mystusbleekeri, Ompokbimaculatus, Clariasbatrachus.

The similar results were reported by Mane and Pawar, (2007) with 36 species under 19genera of Manar river of Nanded district. Hiware and Pawar (2006) recorded 7 speciesunder 7 genera under the order Siluriformes from Thodga river reservoir Ahmedpur districtLatur Maharashtra. Vijaylaxmiet al., (2008) reported 6 species under4 genera underfamily Cyprinidae from Bheema river Gulbarga district Karnataka. Our results are also inagreement with Shaikh et al., (2011) who found near about same results like Siluri forms order is dominant so ther orders. Ubharhande and Sonune (2012) found 7 orders, 10 families, 19 genera and 21 species and dominance of Cyprinidae family from Paintakli dam from Buldhana district Maharashtra. The fish Anguillabengalensis bengalensis which is endangered (threatened) in Western Ghats of India (Dahanukaretal.,2004) it is also recorded in the presence study at end angered status in the study are as we chosen, suggesting a dire need of its conservation and awareness in the human population. Clariusbatrachus has been listed endangered (Menon 2004), the exotic fishes like Cyprinuscarpio, Tilapia mossambica, Oerochromismossambica, Channapunctata where also reported during presentinvestigation (Jingran,1983) out of 29 species recorded 29(100%) species are recognized by food fishes (FF)29, Highly native fish 01, Highly economically important fish 29, Carnivorous fish1,experimental fish3,Threatened fish 01, common fish 04, exotic fish 02, experimental fish 03,vulnerable fish 04,endangered fishes 06, rare fishes 01, uncommon fishes 01. The Same result was recorded by Kalayankaret.al., (2012). Our study is also in agreement with Rao et.al., (1998), Sakhare (2001) and Kadam and Gaikwad (2006).

Presently, decline the richness of species were observed to the present two reduce to proximately to human invention, shortage of food availability, excessive fishing and scarcity of water in this reservoir. Thus, the biological diversity appears to play a substantial role in ecosystem plasticity. Sandmining is common in most of the stretches of the river, which is the determining factor for habitat destruction leading to the loss of habitat and breeding grounds of several fish species in the river. Loss of breeding grounds would have negative impact on the fish populations. Over fishing for consumption is another factor for fish biodiversity loss. Native fish fauna of the river is severely threatened by the introduction of exotic species due to predation, competition for food and habit and in production of pathogens.

Conclusion

The diversity and abundance of fishes in Yelgoan Dam represents the suitability of water of Yelgoan Dam for Aquaculture practices. But the fish fauna of this Dam are being threatened

due to several anthropogenic activities the fish diversity of this water body as in declining mode. Preservation and processing center must be establish in this region which will help to keep fish for long tiny and better marketing opportunities to those persons engaged with fish farming. The study of biodiversity programmers must be continuing in future which will help to assess the loss of biodiversity with respect of time.

References

- Chandrashekhar, E., Prasad, P., and Gurijala, V.G., (2013): Geomagnetic jerks: Astudy using complex wavelets, In Wavelets and Fractals in Earth system Sciences, (Eds.), 195-217.
- Dahanukar, N., R. Raut and A. Bhat, (2004): Distribution, endemism and threat status off freshwater fishes in the Western Ghats of India. Journal of Biogeography,31:123-136
- Day FS. (1878) :The fishes of India, being a natural history of fishes found to inhabit the seas and freshwater of India, Burma and Ceylon: Text and atlas in 4 parts. London,1878,778
- Hiware, C. J., and R. T. Pawar (2006): Ichthyofaunal of paithan Reserviour (Nathsagardam) in Aurangabad district of Marathwada. Ecology and Environment, APH Publishing corporation New Delhi. Homalopteridae ZSI, Culcuttapp-306, ISBN:81-858774-15-8.
- Jayaram, K. C. (1999) : The fresh water fishes of the Indian Region. Narendra Journal of Environmental Sciences, 2 (6): 61-70
- Kadam, S. U. and Gayakwad, J. M., 2006. Ichthyofauna of Masooli Reservoir, District Parbhani, Maharashtra- A Study of inland reservoir, fishery in India. J. Aqua. Biol., 21(2); 59-61.
- Kalyankar V. B., Nagale D., Dhodange T.B and Akhade S. S. (2012): Study of Fish diversity from Lower Dudhava project at Parbhani Dis. India World J. of 2001.7 (4): 320-322.
- Mane A. M. and Pawar S. K. 2007. Some Physiochemical properties of Manar River of Nanded district. Maharashtra. J. Aqua. Biol. Vol.22 (2), 2007:88-90.
- Mane A.V., R. G. Pardeshi, V. R. Gore, R. L. Walave, S. S. Manjrekar and G.. N. Manjusha Bhor, Prakash Kadave, AbhijitBhor, SheetalBhor, Manisha.
- Menon, A. G. K. (1999): Checkl is to ffresh water fishes of India. Z. S. I. Kolkata.

- Mittermeier, R. A. and Mittermeier, C. G. (1997): Megadiversit year this biologically wealth is nation in Mc Allister, Hamiliton and B. Harvey (Eds.) Global fresh water biodiversity Seawind, Cemex, Mexico City(11): Pp. 1-140.
- Rao, J. C. S., Simhachalam, J. G., & Raju, C. S. (2013). A Study on Ichthyof aunal Diversity, Conservation Status and Anthropogenic stress of River Champavathi, Vizianagaram District (AP) India. Asian Journal of Experimental Biological Sciences 2013 b, 4(3), 418-425.
- Sakhare, V. B., (2001): Ichthyofaunal of Jawalgoan of Maharashtra. J. Aqua. Biol., 16(1) 31-33
- Shaikh et al., (2011) : The study of Ichthyofauna diversity in upper Dudhana project water reserve our near somthana in Jalna District (M.S), India. Jour. Of fisheries andAquaculture,2(1):08-10
- Talwar, P. K. and A. G. Jhingran (1991): In land fishes of India and adjacent Tank of Warangal, Andhra Pradesh. Journal of Environmental Science, Toxicology test and at last in 4 pts. London. E. O. (ed.) Biodiversity.
- Ubharhande S. B. and S. R. Sonawane (2012) : Study of Fresh water fishfauna University Press, Ames, Iowa, USA,. 246-247.
- Vijaylaxmi G. M. 1985. Fishes of Khasi Hills records of Zoological survey of India Occasial paper no.70. Issued by the Director ZSI, Calcutta, 40pp.

International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Preliminary Phytochemistry of Grangea Maderaspatana L. From Family Asteraceae

Rasika N. Patil[1], Rutuja G. Lale[2]

[1,2]Assistant Professor, Shri Shivaji College of Arts Commerce and Science, Akola

Abstract:
Grangea maderaspatana L. is a popular Indian medicinal plant belonging to the Asteraceae family. This plant is commonly known as Madras Carpet growing in sandy lands and waste places. It is reported to contain flavonoids, diterpenes, sesquiterpenoids, steroid, and essential oil. The herb is good for pain in the eyes and ears. The root is an appetizer; astringent to the bowels, diuretic, anthelmintic, Emmenagogue, galactagogue, stimulant; useful in griping, in troubles of the chest and lungs, headache, Paralysis, rheumatism in the knee joint, piles, pain in the muscles, diseases of the spleen and the liver, the troubles of the ear, the mouth and the nose; lessens perspiration (Unani). The plant is stomachic and uterine stimulant. Secondary metabolites are also differing from primary metabolites in having restricted distribution in the plant kingdom. Secondary metabolites are found throughout the plant kingdom. Herbal medicines play an important role in health care programs in the developing countries.

Keywords: Madras Carpet, astringent, galactagogue, secondary metabolites, medicinal plants, etc.

Introduction:

Phytochemicals (Greek: phyton = plant) are chemical compounds naturally present in the plants attributing to positive or negative health effects. Medicinal plants used in different diseases and ailments are the richest bio reservoirs of various phytochemicals. The medicinal properties of the plants are determined by the phytochemical constituents. Some of the important phytochemicals include alkaloids, flavonoids, phenolics, tannins, saponins, steroids, glycosides, terpenes, etc. which are distributed in various parts of the plants. Nature is a unique source of structures of high phytochemical diversity representing phenolics (45%), terpenoids and steroids (27%) and alkaloids (18%) as major groups of phytochemicals. Although, these compounds seem to be non-essential to the plant producing them, they play a vital role in survival by mediation of ecological interactions with competitors, protect them from diseases, pollution, stress, UV rays and also contribute for colour, aroma and flavour with respect to the plant. The metabolites produced by the plants to protect themselves against biotic and abiotic stresses have turned into medicines that people can use to treat various diseases.

Photochemistry is a branch of science that deals with the study of chemicals obtained from plants with desirable biological activities. These phytochemicals are mainly the secondary metabolites offering medicinal attributes to the plants. Amongst the indefinite plants claimed for their medicinal potential, *Grangea maderaspatana* L. belonging to family Asteraceae is screened for its biochemical Contents.

It will be recalled that in the food chain, plants are referred to as the producers because they had the ability to trap energy from sunlight, harness and assemble some basic units which they transform through some chemical process in to complex high energy-yielding compounds that are readily available to

organisms. Their generosity became overwhelmingly and practically complex to comprehend at a glance. A field has to emerge – "phytochemistry." Phytochemistry is the study of chemicals produced by plants, particularly the secondary metabolites. It takes into account their structural composition. The biosynthetic pathways, functions, and mechanisms of actions in the living system. The study of phytochemicals has been instrumental in the discovery of new plant natural products which are of commercial values in various industries such as the traditional and complementary medicine Systems, pharmaceutical industries, nutraceuticals, and dietary supplement Industries (Hopkins 1995).

Unlike the primary metabolites the secondary metabolite absence does not leads to instantaneous fatality. However, there may be an impairment of organism survivability and fecundity in long term. They are often constrained to a narrow set of species with in a poly-genetic group and often play a vital role in plant defense against other species and herbivores. They are also useful to human beings as recreational drugs, medicines and flavorings. Most of the secondary metabolites of interest to human kind fit into categories which classify secondary metabolites based on their bio-synthetic origin (Adcock et.al. 2001).

The literature survey revealed that the phytochemical analysis of seeds has been studied thoroughly, whereas no work has been done on the other plant parts such as leaves, stem and root of peanut. Hence, the present investigation has been under taken to find out the various phytochemicals present in them for the purpose of using these bioactive substances in different food items as supplements to reduce the anti-nutritional effects (Stump 2000, Gibson 1998).

Review of Literature:

Oke and Dinesh D. Khedkar in 2013 worked on was carried out with five different solvent extracts. Overall analysis revealed absence of tannins in almost all plant parts with the exception of water and ethanol extracts from the leaf. The alkaloids, steroids, Terpenoids, cardiac glycosides, flavonoids, triterpenoids, etc. were reported in various plant parts in different extraction systems. Varsha J. Galani1 in 2015 worked on *Grangea maderaspatana* L. is a popular Indian medicinal plant belonging to the Asteraceae family. He observed the Phytochemical analysis of aqueous, petroleum ether and dichloromethane extracts were positive for alkaloids, phenol, steroid's, flavonoids in all the extracts. Sindhu. V et.al., in 2012 worked on Preliminary Phytochemical screening of *Grangea* maderaspatana L. (Asteraceae) found that the Phytochemical screening of various extracts show the presence of flavonoids, alkaloids, glycosides, protein and amino acid in benzene extract.

Prabhavathi R.M et.al., in 2016 worked on studied on Qualitative and Quantitative Phytochemical analysis of Cissus quadrangularis observed that the Phytochemical analysis of Cissus quadrangularis was carried out as these plants have been proved to be one of the important medicine for treatment of bone fractures. Tamanna Talreja et.al., in 2016 worked on the Preliminary Phytochemical analysis of Achyranthes aspera and Cissus quadrangularis revealed that the extracts of A.aspera seeds and C. quadrangularis stem contain alkaloids, phenolic compounds and tannins, steroids and terpenoids, flavonoids, reducing sugars and saponins in appreciable, moderate and trace amount.

Saranyal et.al., 2017 worked on the Preliminary Phytochemical and biochemical studies of Cissus quadrangularis, Linn (Family- Vitaceae) revealed the presence of phenols, proteins, tannins, flavonoids and starch. Biresh Kumar Sarkar et.al., in 2018 worked on Antimicrobial and Phytochemical evaluation of Cissus quadrangularis L. In view of the result of study indicated that the methanolic extract possessed most potent antibacterial activity as compared to other extract.

Cezary Toma et. al., in 2019 worked on Interdisciplinary research was carried out on the impact of climate on the diversity and morphology of Stratiotes alkaloids. The objectives of the research were: 1. To determine whether the climate influences the diversity of emergent forms, 2. To determine the diversity of morphological and anatomical traits and chemical composition of S. aloides specimens in poland and Russia, 3. To examine the content of, and determine the correlation between phenols, phenolic acids, flavonoids, anthocyanins, And tannins in S. aloides. The research demonstrated the substantial diversity of 13 morpho-anatomical traits, and 5 phytochemical traits, both between regions, and individual habitats. Rajeswara Reddy Erva1 et. al., in 2020 worked on the aqueous extract of velvet bean (Mucuna pruriens) leaves and roots revealed the presence of alkaloids, saponins, flavonoids, phytosterols, carbohydrates, proteins, terpenoids and anthraquinones while tannins, glycosides were found absent. Similarly, the aqueous roots extract revealed all the phytochemical tested except flavonoids, terpenoids. were absent in the roots of velvet bean (*Mucuna pruriens).* Results of this study may provide a foundation for designing new drugs for several diseases.

Camil Rex M et.al. in 2020 worked on a review on Cissus quadrangularis L. as herbal medicine showed the extract from roots and stem of the plant consist of various medicinal efficacies and are known to have antioxidants, accelerate the process of bone fracture healing, wound healing, antimicrobial activity and antiulcer activity.

Susan A. Timmons et al., in 2020 worked on Morphological and anatomical development in the vitaceae. X. Comparative ontogeny and phylogenetic implications of *Cissus* quadrangularis L. observed the comparison of C. Antarctica and C. quadrangularis supports the division of Cissus into two clades based on supernumerary buds, stipule connectivity, uncommitted primordium shape, and inflorescence branching patterns.

MATERIAL AND METHODS

Collection of plant: -

The plants selected for the study Grangea maderaspatana L. belonging to the family Asteraceae were collected in the month of February 2023 From Akola city.

Identification:

Samples were brought to laboratory and were identified by using standard floras of Naik (1989), Singh and Kartiyeyon (2000).

Drying:

The collected plant part was shade dried for 8-10 days and grinded well to obtain homogeneous fine grade powder.

Extraction:

Material was subjected to solvent extraction. Four different solvent i.e., Distilled Water, Acetone, Ethanol, Chloroform were used. The sample: solvent ratio was 1:10(w/v) Solvents were soaked for 72 hrs. with regular shaking followed filtration with Whatmann's filter paper no.1. Extract thus obtained were subjected to quantitative analysis using standard protocols

Material used:

Plants belongs to Asteraceae family are used for preliminary test of phytochemistry.

Grangea maderaspatana L.:

Grangea maderaspatana, L. commonly known as Madras carpet, is a flowering plant in the family Asteraceae.

Grangea maderaspatana L. (Asteraceae), a popular Indian medicinal plant is traditionally used for rheumatism in the knee joint and pain in the muscles.

Systematic Classification of plant selected for study:
Grangea maderaspatana L.

Kingdom -	Plantae
Order -	Asterales
Family -	Asteraceae
Genus -	*Grangea*
Species -	*maderaspatana L.*



Phytochemical Analysis:
Tannins :
To the 2 ml of extract, 2 ml FeCl3 was added. Color change from blue to black indicates presence of tannin.

Alkaloids :
2 ml extract was hydrolyzed by 1% HCl, addition of Mayer's, Wagner's, Dragendorff's Reagent individually to each of sample produces creamish, brown, red / orange precipitates indicates presence of alkaloids.

Saponins :
0.5ml of extract was shaken well with 5 ml of distilled water, persistent frothing indicates presence of saponins.

Terpenoids (Salkowski test):
2 ml of Chloroform was added to 0.2 ml of extract and concentrated H2so4 was added from sides of the test tube. Appearance of reddish – brown coloration at interface denotes presence of terpenoids.

Cardiac glycosides (Keller – Killiani test) :
To the 2 ml of extract, 1ml of glacial acetic acid and a few drops of FeCl3 were added and concentrated H2SO4 added from the sides of test tube, green, blue precipitate shows the presence of cardiac glycosides.

Steroids (Salkowski test) :
To the 2 ml chloroform and 0.5 ml extract, concentrated H2SO4 was added from sides of the test tube to form lower layer, reddish – brown coloration at interface reveals the presence of steroids.

Flavonoids:
When dilute sodium hydroxide was added to 0.2 ml of extract creates intense yellow colour, which on addition of HCl turns colourless suggests
Tri-Terpenoid: 100roform and later 1 ml of acetic anhydride was added followed by 2 ml of concentrated H2SO4 from sides of the test tube creating reddish violet color, infers the presence of triterpenoids.

Glycosides:
Extract was hydrolysed by HCl and neutralized with NaOH followed by addition of fehling's solution A and B in 1:1 proportion, produces a red precipitate, indicating presence of glycosides.
Reducing Sugars (Fehling's Test):
Extract shaken with distilled water and filtered, it was boiled on the addition of Fehling's solution A and B in equal quantity, appearance of orange red precipitate positively detects reducing sugars.

Phlobatannins:
Distilled water was added to extract, shaken and filtered, 2% HCl added and boiled, development of red color confirmed phlobatannins.

Anthraquinones (Borntrager's test) :
To the 1 ml extract 10 ml benzene was added and shaken vigorously followed by filtration and the addition of 5 ml of 10% ammonia and shaken again, the appearance of pink/red/violet coloration in ammonia layer indicates anthraquinones in the extract.

Leucoanthocyanins:
5 ml of isoamyl alcohol was added to an equal volume of extract, if an upper layer turns red, shows that leucoanthocyanins reside here.

Fatty acid:
5 ml of extract was added to 5 ml of ether and poured on filter paper placed in petri dish, on evaporation of ether, if filter paper becomes transparent it indicates presence of fatty acids.

Coumarins:
To the 2 ml of extract, 3 ml of 10% NaOH was added; appearance of yellow colour indicates Presence of coumarins.

Emodins:
2ml of ammonium hydroxide and 3 ml of benzene were added to the extract, a color change to red indicates presence of emodins

OBSERVATION & RESULTS

Table No.1 Aerial phytochemistry of *Grangea maderaspatana* L.

Sr. No.	Phytochemicals	Water	Acetone	Ethanol	Chloroform
1	Tannins	+	-	-	-
2	Alkaloid	-	+	-	+
3	Saponin	+	+	+	+
4	Terpenoid	-	+	-	+
5	Cardiac glycoside	+	-	-	+
6	Steroids	+	-	-	-
7	Flavonoid	-	-	-	+
8	Triterpenoid	-	-	-	-
9	Glycosides	-	-	-	-
10	Red.sugar	-	+	-	+
11	Phlobatannins	-	-	-	-
12	Anthocumerins	-	-	-	-
13	Leucoanthacyanins	-	-	-	-
14	Fatty acids	-	-	-	-
15	Coumarins	-	-	-	-
16	Emodins	-	-	-	-

Table No.2 Root phytochemistry of *Grangea maderaspatana* L.

Sr. No.	Phytochemicals	Water	Acetone	Ethanol	Chloroform
1	Tannins	-	-	-	-
2	Alkaloid	-	+	-	+
3	Saponin	+	+	+	+
4	Terpenoid	-	+	-	+
5	Cardiac glycoside	-	-	-	-
6	Steroids	-	-	-	-
7	Flavonoid	+	+	-	+
8	Triterpenoid	-	-	+	-
9	Glycosides	-	-	-	-
10	Red.sugar	-	-	+	-
11	Phlobatannins	-	-	-	-

12	Anthocumerins	-	-	-	-
13	Leucoanthacyanins	-	-	-	-
14	Fatty acids	-	+	-	-
15	Coumarins	-	+	-	-
16	Emodins	-	-	-	-

DISCUSSION

The phytochemical analysis was studied for aerial parts and roots of plant sps. *Grangea maderaspatana* L. for the analysis four solvents were analyzed. The saponins were found present in both aerial parts and root in all four solvents. Alkaloids and Terpenoids are prominently seen in both aerial and underground parts only in acetone and chloroforms. In solvent chloroform as a solvent phytochemical besides alkaloids, terpenoids and Saponins, flavonoids were also seen. While the presence of reducing sugar was seen in solvent acetone and chloroform in aerial parts. In Phlobatannins, Anthocumerins, leucoanthocyanins, fatty acids, coumarins, Emodins these phytochemicals were not seen in any of four solvents prominently.

CONCLUSION

The saponins were found present in both aerial parts and root in all four solvents. Alkaloids and Terpenoids are prominently seen in both aerial and underground parts only in acetone and In solvent chloroform as a solvent phytochemical basides alkaloids, terpenoids and Saponins, flavonoids were also seen. While the presence of reducing sugar was seen in solvent acetone and chloroform in aerial parts. Presence of Alkaloid showed that they are used in medicine as stimulant, diuretic, and as muscle relaxant. Phytochemical constituents such as tannins, flavonoids, alkaloids and several other aromatic compounds are secondary metabolites of plants that serve as defence mechanism against predation by many micro-organisms' insect and herbivores. The present study was concluded that the extract of *Grangea maderaspatana* L. which of phytochemical compounds especially in acetone and chloroform extract of aerial part shows maximum number of phytochemical compounds.

REFERENCES

1. Astuti SM, Sakinah MA, Andayani RB, Risch A. Determination of saponin compound from Anredera cordifolia (Ten) steenis plant (binahong) to potential treatment for several diseases. J Agric Sci 2011; 3:224-32.
2. Chintawar, S. D., Somani, R. S., Kasture, V. S., & Kasture, S. B. (2002). Nootropic activity of Albizzia lebbeck in mice. Journal of Ethnopharmacology, 81(3), 299-305.
3. Da-Costa-Rocha I, Bonnlaender B, Sievers H, Pischel I, Heinrich M. Hibiscus sabdariffa L. – A phytochemical and pharmacological review. Food Chemistry.2014; 165:424-443
4. Dahanukar, E.A.and Khare, D. (2000). Preliminary phytochemistry of some indian medicinal plants, Indian phytochemistry research, 22: 98-104.

5. Daniel SF (1998). Therapeutic Administration of a Selective Inhibitor of Nitric Oxide Synthase Does Not Ameliorate the Chronic Inflammation and Tissue Damage Associated with Adjuvant Induced in Rats. J. Pharmacol. Exp. Ther.,2849(32): 714-72 In African Medicinal Plants.Ife-Ife; Univ Ife.
6. Edeoga, H. O., Okwu, D. E., & Mbaebie, B. O. (2005). Phytochemical constituents of some Nigerian medicinal plants. African journal of biotechnology, 4(7), 685-688
7. Edwin, S., Jarald, E. E., Deb, L., Jain, A., Kinger, H., Dutt, K. R., & Raj, A. A. (2008). Wound healing and antioxidant activity of Achyranthes aspera. Pharmaceutical biology, 46(12), 824-828.
8. Harborne JB. Phytochemical methods. London Chapman and Hall, Ltd; 1973. p. 49-188.
9. Heatley NG. A method for the assay of penicillin. Biochem J 1944; 38:61-5.
10. Hopkins, W.G. (1995) Introduction to Plant Physiology. John Wiley e Sons, New York, 464.
11. Kasture, V. S., Kasture, S. B., & Chopde, C. T. (2002). Anticonvulsive activity of Butea monosperma flowers in laboratory animals. Pharmacology Biochemistry and Behavior, 72(4), 965-972
12. Motegaonkar M. B., Salunke S. D., The Ash and Iron Content of Common Vegetable Grown in Latur District, India. Res. J. Recent. Sci., 1(4):60-63, (2012).
13. Rout, S., Sahoo, G., Mishra, U. N., Sheera, A., & Prusty, A. K. (2021). An Overview of Acacia. Research Today, 3(8), 691-693.
14. Saini, M. L., Saini, R., Roy, S., & Kumar, A. (2008). Comparative pharmacognostical and antimicrobial studies of Acacia species (Mimosaceae). Journal of Medicinal Plants Research,2(12), 378-386.
15. Sandhar H. K., Kumar B., Prasher S., Tiwari P., Salhan M., Sharma P., A Review of Phytochemistry and Pharmacology of Flavonoids. Int. Pharma. Sci. 1:1, (2011).
16. Shah P., Modi H. A., Shukla M. D., Lahiri S. K., Preliminary Phytochemical Analysis and Antibacterial Activity of Ganoderma lucidum collected from Dang District of Gujarat, India. Int. J. Curr. Microbiol. App. Sci., 3(3): 246-255, (2014).
17. Soni A., Sosa S., Phytochemical Analysis and Free Radical Scavenging Potential of Herbal and Medicinal Plant Extracts. J Pharma. Phytochem.,2 (4): 22-29 , (2013)
18. Tiong S. H., Looi C. Y., Hazni H., Arya A., Paydar M., Wong W. F., Cheah S. C., Mustafa M. R., Awang K., Antidiabetic and Antioxidant Properties of Alkaloids from Catharanthus roseus (L.) G. Don. Mol., 18:9770-9784, (2013).
19. Van Buren JP, Robinson WB. Formation of complexes between protein and tannic acid. J Agric Food Chem 1969; 17:772-7.

ORIGINAL RESEARCH PAPER Volume - 12 | Issue - 12 | December - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ANALYSIS OF TRACE ELEMENT CONTENT IN FINGERNAILS AND HAIR OF A NON INDUSTRIALIZED POPULATION FROM AKOLA DISTRICT.

Zoology

Asarkar G.M Research Student, Department of Zoology, Shri Shivaji College, Akola. (MS)

Sapkal H.P. Professor, Dept. of Zoology, Shri Shivaji college, Akola (MS).

ABSTRACT

Sampling of human beings for trace element content can be a complex and costly procedure. The use of hair and nails simplifies the process and it is for this reason that such samples are extensively used. It is observed that there exists some positive correlation between element levels in hair and nails, hypertension, and diabetes of these subjects. When studying the relationship of minerals to human health, it becomes increasingly evident that keeping a balance level of minerals in every organ, tissue and cell of the human body may be a prominent key to maintaining a healthy existence.

KEYWORDS

Trace elements, hairs, nails, spectrophotometer.

INTRODUCTION

Much of what is "known" about the biological trace elements is a mixture of improbable fact and plausible nonsense. Over 99% of all animal matter, including the human body is constructed from just 11 elements-hydrogen, oxygen, nitrogen, sodium, potassium, chlorine, sulphur, phosphorus, magnesium, calcium, and carbon-but about half the periodic table is represented in the remaining 0-01%. With greater or lesser certainty about 10 elements have been recognized as essential-copper, iron, zinc, cobalt, iodine, molybdenum, manganese, selenium, chromium, and fluorine-but even this subgroup is heterogenous. Zinc, iron, and copper are built into many enzymes, whereas cobalt is found in only one molecule and iodine too has only one function. The inessential elements include: environmental hazards (lead, mercury, and cadmium); some that are given as drugs (bromine, aluminum, and gold); and popular poisons (arsenic and antimony). The rest seem to be contaminants. What the trace elements have in common is a capacity to enthrall both laymen and scientists. Over 2000 years ago the Greeks burnt sea sponges as a prophylactic against goiter, rightly divining a magic element in the vapor; and as recently as the 1960s a locally common cardiomyopathy was traced to selenium deficiency in central China. Against this background of legend and newsworthiness the analytical advances of the past decades have created new problems as well as new knowledge. Only eight trace elements are generally accepted as being essential for health and wellbeing in higher animals through the consumption of food and beverages; these are cobalt, copper, iodine, iron, manganese, molybdenum, selenium, and zinc. Persuasive evidence has recently appeared that indicates two other trace elements, boron and chromium, may also be essential; however, general acceptance of their essentiality is still lacking. (Weiss D, Whitten B, Leddy D,1972).

The objective of this study was to assess the relationships between lead, cadmium, zinc, and copper and other trace elements contents in fingernails and hair, and the level of environmental exposure in the subjects' places of residence. After hundreds of fingernails and hair analysis, Trace Elements has created a unique system of interpreting nail mineral analysis results. Each test report will provide the clinician with the most complete and comprehensive evaluation and discussion of significant mineral levels, ratios and toxic metals as tested in the fingernails and hair. Included is a listing of individual foods and food groups that the doctor can recommend to eat or avoid in accordance with food allergy indicators and individualized metabolic requirements.

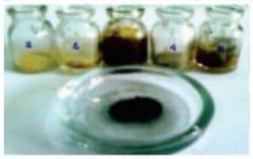
MATERIAL AND METHOD

2.1 Sampling Procedure

Contamination of the nail can occure from air, water and nail paints. This type of contamination is removed during sample washing procedure. Nails, particularly toenails, are relatively sheltered from environmental contaminants. They are free from or less likely to have contaminants introduced through shampooing, hair treatments and medication. As for nail polish, the chemicals introduced by polishing can be largely washed out in the laboratory, and the element contents in nails are less likely to be affected. For instance, any external contamination in most nail specimens can be removed using ultrasonic cleaning protocols with both polar and nonpolar solvents. To obtain more nail masses, participants should be asked in advance not to trim their nails for a couple of weeks or longer. Nails are collected by clipping with a stainless steel clipper from the two great toes (or thumbs) and small toes (or other fingers) (Hambidge et al., 1987; Miller et al.,1979).

Contamination of the hair can occur from air, water, perspiration and shampoos. This type of contamination is removed during sample washing procedure. Howere, contamination from dyes, permanents or bleaching of hair cannot be removed. These cosmetic procedure permanently change the structure of the hair and therefore, only natural hair (head, pubic or beard hair) is suitable for hair minerals analysis. Underarm hair is unsuitable for analysis. As hair grows, nutrient and toxic elements are deposited from the blood stream into the hair follicle and hair shaft. Once a trace element has been incorporated into the hair, it remains fixed.

After drying of fingernails and hair samples, add few drops of concentrated nitric acid on the samples which is kept in vials .The procedure is used for the digestion of samples.

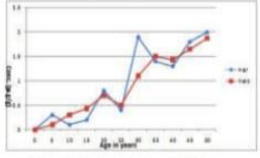




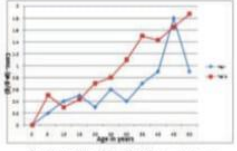
These ash samples now ready for atomic absorption spectro photometer analysis
(Yoshinaga J, Shibata Y, Morita M 1993).

OBSERVATION AND RESULT

Lead and zinc concentrations in hair and nail samples were determined by atomic absorption spectrophotometer (AAS). The mean zinc concentration in hair and nail were 0.743 ± 0.23 mg/g and 0.7820± 0.67 mg/g respectively while the mean lead concentrations in hair and nail were 0.334 ±0.44 and 0.460 ± 0.304 mg/g respectively. A progressive increase in zinc concentrations in hair and nails with age indicated no significant difference when their means were compared suggesting that zinc in hair and nails originate from a common source, comparing the mean lead concentrations in hair with the nails a significant difference is indicated in the 2 tissues (Strain et al., 1972) . Human hair and nails are therefore recording filaments that can reflect metabolic changes of many elements over long periods of time and hence furnish a print out of post nutritional event as dietary levels of some of the essential micro-elements.



Concentration of Zinc with respect to age



Concentration of Lead with respect to age



Fig. :- Nails sample collected.

A progressive increase in zinc concentrations in hair with age indicated no significance difference indicated. Our results are in agreement with several other authors who reported varying concentrations of these metals in hair samples. From the zinc levels in nail, it is reasonable to believe that zinc in human tissues may be playing some physiological roles (Vivoli et al., 1990).

Table:- Showing the concentration of trace elements

Sample No. And	Concentration In Pbb							
(Age In Years)	Cr	Cu	Zn	I	Fe	Mn	Cd	Pb
1(21)	203	562	960	703	204	67	20	11
2(45)	112	360	760	813	112	110	32	17
3(27)	304	262	863	790	127	37	11	02
4(45)	412	317	560	803	97	22	55	07
5(11)	167	503	817	619	15	90	50	--
6(54)	234	654	987	456	28	76	32	32
7(46)	241	590	890	413	22	71	29	27
8(48)	109	312	613	503	197	87	60	22
9(10)	432	657	872	768	145	83	45	19
10(29)	569	893	1002	987	90	39	12	05
11(65)	909	904	873	723	61	23	19	02
12(09)	365	893	781	632	89	45	28	18
13(35)	512	734	908	561	21	78	11	09
14(56)	187	564	343	654	11	12	09	--
15(21)	239	368	789	732	23	06	03	--
16(54)	412	872	835	474	13	04	02	--
17(22)	219	321	903	652	54	21	15	05
18(20)	112	874	673	342	21	04	--	--
19(59)	897	654	987	904	45	67	--	--
20(72)	672	874	789	456	77	87	07	--
21(19)	453	654	651	342	34	81	06	--
22(49)	390	637	702	514	12	13	02	02
23(51)	430	718	639	539	47	16	03	02

Elevations of nail zinc have been reported only during the special metabolic needs of pregnancy, where the high values were present with evidence of zinc deficiency. Such a "false" high value in a tissue like hair is not indicative of systemic elevation, but possibly of the system depletion. Inadequate dietary intake or absorption problems may cause zinc deficiency. An imbalance in zinc and copper metabolism contributes to the risk of coronaryheart disease (CHD). Some Indian diets have zinc-copper ratios in excess of those that produce hypercholesterolemia.

REFERENCES:-

1) Abe T, Ohtsuka R, Hongo T, Suzuki T, Tohyama C, Nakano A, Akagi H, and Akimichi T (1995) High hair and urinary mercury levels of fish eaters in the nonpolluted environment of Papua New Guinea. Arch. Environ. Health. 50:367-373.
2) Agency for Toxic Substances and Disease Registry (ATSDR) (1988) The nature and extent of lead poisoning in children in the U.S. A report to Congress. U.S Dept, of Health and Human Services, Public Health Service, Atlanta, Georgia.
3) Aggett PJ (1979) Trace elements in medicine. Hosp. Update. 5:981-984.
4) Bache CA, Lisk DJ, Scarlett JM, and Carbone LG (1991) Epidemiological study of cadmium and lead in the hair of ceramists and dental personnel. J. Toxicol. Environ. Health. 34:23-31.
5) Bencko V (1995) Use of human hair as a biomarker in the assessment of exposure to pollutants in occupational and environmental exposure. Toxicology. 101:29-39.
6) Cikrt M and Bencko V (1990) Biological monitoring of human exposure to metals. J. Hyg. Epidemiol. Microbiol. Immunol. 34:233-241.
7) Coleman DO (1985) Human remains. In: Historical monitoring, MARC Report no. 31, pp. 282-315.
8) Das Chaudhuri AB (1978) A supplementary note on human hair medulla. Hum. Hered. 28:36-88.
9) Garcia de Alba JE, Rivas Solis F, and Olivares N (1983) Concentraciones de ploma en el cabello. Salud. Publics. Mex. 25:393-399.
10) Harris ED (1991) Copper transport: An overview. Proc. Soc. Exp. Biol. Med. 196:130-140.
11) Koons RD and Peters CA (1994) Axial distribution of arsenic in individual human hairs by solid sampling graphite furnace AAS. J'.Anal. Toxicol. 18:36-40.
12) Petrukhin K and Gilliam TC (1994) Genetic disorders of copper metabolism. Curr. Op. In Pediatr. 6:698-701.
13) Williams-Blangero S and Blangero J (1989) Anthropometric variations and the genetic structure of the Jirels of Nepal. Hum. Biol. 61:1-12.
14) Wolfsperger M, Hauser G, Gossler W, and Schlagemhaufen C (1994) Heavy metals in human hair samples from Austria and Italy: influence of sex and smoking habits. Sci. Tot. Environ.

THE RUBRICS JOURNAL OF INTERDISCIPLINARY STUDIES
International, Indexed and Peer Reviewed e-Journal
ISSN 2454-1974

THE RUBRICS
Journal of Interdisciplinary Studies
Volume 6 Issue 2 March 2024
www.therubrics.in

E-Teaching, E-Learning & E-Evaluation in Commerce Education

Sangita M. Shegokar
Assistant Professor
Shri Shivaji College of Arts, Commerce & Science, Akola

FULL PAPER

Introduction :

Most of countries are experiencing significant shifts in the global economic environment due to fastest changing information and communication technology after covid pandemic. ICT made tremendous changes in trade and commerce which makes globe as a village. While it produces developments those make worlds high speed, knowledge driven and competitive. These innovations of ICT easily adopt by the education system in commerce teaching, learning and evaluation systems.

Figures about enrollment showed remarkable growth in the gross enrollment in commerce higher education which made challenge before education system to make education environment more effective and efficient. ICTs are most powerful tool to make teaching learning and evaluation process more interactive, learner centered, well designed for facilitating to learners at anytime and anywhere they wants. It would enhance the efficiency and efficacy of teaching, learning and evaluation process of commerce education by making electronic mode. The present study deals with a need of E-teaching, E-learning & E-evaluation in commerce.

Objectives of Study :

1) To review current scenario of E-teaching, E-learning & E-evaluation.
2) To study the significance of E-teaching, E-learning & E-evaluation in commerce.
3) To identify the problems of E-teaching, E-learning & E-evaluation in commerce.

Current Scenario of E-Teaching, E-Learning & E-Evaluation :

ISSN 2454-1974

Many universities like Indira Gandhi National Open University, Yashwantarao Chavhan Mukt Vidyapeeth uses internet and e-material for teaching, learning and evaluation techniques. IIT such as Madras (Channai) NPTEL, Kanpur, Bombay (Mumbai) developed online course and uses an open source e-learning. ICTs especially computers, and internet enables new way of teaching and learning. For examples, many videos and educational movies are available on youtube which may help teaching learning process. Google forms helps for making online survey, questionnaire, assignments, feedbacks etc by the learners. Moodle (modular object oriented dynamic learning environment) is the one of the most powerful tool for creating e-material as well as for evaluation. Edusat is India's first education satellite used for direct to home broadcasts of educational programs using any television set. Different ICTs such as audio, video, mobiles, gazettes, radio TV broadcasts, computers and the internet are developed and used by education system.

Need of E-Teaching of Commerce :

On basis of AISHE's statistics 2021-22 ministry of education published in 2023, among disciplines at undergraduate level in, enrolment is highest in Arts (34.2%), followed by science (14.8%). In our countries out of gross enrollment in higher education of 13.3 percent students were in commerce education. The number of students aspiring for commerce education is fetching larger and larger and it is not possible to develop the infrastructure to cater to ever growing need. For reaching to them, ICT uses as an instruments, instructional and dissemination technologies in teaching process in commerce subject. Many concepts in commerce related to advertising, marketing, etc. need to have demonstration and adoption of ICT makes it easy to demonstrate. To reach the mass of students, adoption of ICT helps to reach at them efficiently. Online course teaching materials in commerce would be available and accessible twenty four in to seven; it would more helpful to access the resources by learners at remote places. It will also work as a supplementary teaching method that strengthening the conventional teaching methods and provides a flexibility in the delivery of knowledge.

Need of E- Learning of Commerce :

Now a days, commerce became e-commerce (electronic commerce), m-commerce (mobile commerce) due to wide range application of computer, internet and electronic gazettes in commerce. This changing scenario of commerce needs increasing quantitative and qualitative change in commerce human resources. Students or commerce human resources must have competent qualities, technosavy qualities etc. If the appropriate use of ICT in commerce education can promote to student for becoming future human resources. It will also promote to acquire the skillful knowledge and to empower the students.

ISSN 2454-1974

Need of E- Evaluation Process :

ICTs have a most important feature that is to go beyond time and space which make it possible to evaluate students twenty four by seven. It helps to remove stress of exam in the students. ICTs in evaluative process help to minimize cost of traditional evaluative techniques. It is high cost effective, more innovative and more efficient than ever conventional evaluative tool of education.

The rationales and realities of E-Teaching, Learning & Evaluation Process in Commerce in Indian Scenario :

1. The research statistics showed that the penetration of personal computers having only 47 per 1000 people much lower than developed countries.
2. The internet penetration is concerted in urban areas as well as the rate of expansion internet access is slow at rural areas. So that it makes hard to adopt ICT use in teaching and evaluation process.
3. Low Literacy rate is the serious problem in the Indian economy and making people digital literate is quite challenging due to contents are largely available in English language and not in regional languages.
4. Lack of computer and internet access at rural and remote places in India.
5. Rate of adoption of ICTs is quite low. Generally, Lack of equipped with ICT skilled and trained personal resources is another problem for use of ICT in commerce education. The demand of skilled teachers are
6. The main challenges for ICTs enhanced education is availability of ICT infrastructures. scare of financial resources is one of the most strong reason affecting the ICT infrastructures

References:-

1. https:// www.oecd.org
2. https:// www.uoc.org
3. Ministry of Education, GOI. All India Survey on Higher Education (AISHE) 2021-2022 (press release) 2024 Jan. 25.

   https://pib.gov.in/PressReleasePage.aspx?PRID=1999713#:~:text=Among%20Disciplines%20at%20undergraduate%20level,followed%20by%20science%20(14.7%25).
4. P. Praksh & Reddy G. Information and Communication Technology in ODL: Contextualizing Framework, University News Vol. 51 No.21. 2013, p. 3-7.

ISSN 2454-1974

5. Jeelani S. ICT based Higher Education for Transforming India: Challenges and Opportunities University News Vol. 51 No.21, 2016, p. 186- 190.

6. Sahin S. & Mete J. The Role of ICT as a Change Agent for Education University News Vol. 53 No.6. , 2015, p. 17-23.

7. Jain S. Inclusion of ICT in Higher Education: Technology Literacy for Today and Tomorrow University News Vol. 54 No.05. 2012, p. 16-22,

8. Patil S. Revolutionize Higher Education with Use of ICT- Convocation Address, University News Vol. 52 No.6, 2014.

9. Zafar T. & Mahapatra B. Information Communication Technology in Higher Education University News Vol. 54 No.02. 2016, p. 1-7.

ISSN 2277 - 5730

AN INTERNATIONAL MULTIDISCIPLINARY
QUARTERLY RESEARCH JOURNAL

AJANTA

Volume - XIII Issue - II April - June - 2024

ENGLISH PART - VI

Peer Reviewed Referred and UGC Listed Journal

Journal No. 40776

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING

2023 - 7.428

www.sjifactor.com

❖ EDITOR ❖

Asst. Prof. Vinay Shankarrao Hatole

M.Sc (Maths), M.B.A. (Mktg.), M.B.A. (H.R.),
M.Drama (Acting), M.Drama (Prod. & Dir.), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan

Aurangabad. (M.S.)

The information and views expressed and the research content published in this journal, the sole responsibility lies entirely with the author(s) and does not reflect the official opinion of the Editorial Board, Advisory Committee and the Editor in Chief of the Journal **"AJANTA"**. Owner, printer & publisher Vinay S. Hatole has printed this journal at Ajanta Computer and Printers, Jaisingpura, University Gate, Aurangabad, also Published the same at Aurangabad.

Printed by

Ajanta Computer, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Published by

Ajanta Prakashan, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Cell No. : 9579260877, 9822620877

E-mail : ajanta3535@gmail.com, www.ajantaprakashan.in

AJANTA - ISSN 2277 - 5730 - Impact Factor - 7.428 **(www.sjifactor.com)**

EDITORIAL BOARD

Professor Kaiser Haq
Dept. of English, University of Dhaka,
Dhaka 1000, Bangladesh.

Roderick McCulloch
University of the Sunshine Coast,
Locked Bag 4, Maroochydore DC,
Queensland, 4558 Australia.

Dr. Ashaf Fetoh Eata
College of Art's and Science
Salmau Bin Adbul Aziz University. KAS

Dr. Nicholas Loannides
Senior Lecturer & Cisco Networking Academy Instructor,
Faculty of Computing, North Campus,
London Metropolitan University, 166-220 Holloway Road,
London, N7 8DB, UK.

Muhammad Mezbah-ul-Islam
Ph.D. (NEHU, India) Assot. Prof. Dept. of
Information Science and Library Management
University of Dhaka, Dhaka - 1000, Bangladesh.

Dr. Meenu Maheshwari
Assit. Prof. & Former Head Dept.
of Commerce & Management
University of Kota, Kota.

Dr. S. Sampath
Prof. of Statistics University of Madras
Chennari 600005.

Dr. D. H. Malini Srinivasa Rao
M.B.A., Ph.D., FDP (IIMA)
Assit. Prof. Dept. of Management
Pondicherry University
Karaikal - 609605.

Dr. S. K. Omanwar
Professor and Head, Physics,
Sat Gadge Baba Amravati
University, Amravati.

Dr. Rana Pratap Singh
Professor & Dean, School for Environmental
Sciences, Dr. Babasaheb Bhimrao Ambedkar
University Raebareily Road, Lucknow.

Dr. Shekhar Gungurwar
Hindi Dept. Vasantrao Naik
Mahavidyalaya Vasarni, Nanded.

Memon Sohel Md Yusuf
Dept. of Commerece, Nirzwa College
of Technology, Nizwa Oman.

Dr. S. Karunanidhi
Professor & Head,
Dept. of Psychology,
University of Madras.

Prof. Joyanta Borbora
Head Dept. of Sociology,
University, Dibrugarh.

Dr. Shrikrishna S. Bal
I/C Principal (Retd.),
Head, Department of Psychology,
D.B.J.College, Chiplun, Dist. Ratnagiri (M.S.)

Dr. Manoj Dixit
Professor and Head,
Department of Public Administration Director,
Institute of Tourism Studies,
Lucknow University, Lucknow.

Prof. P. T. Srinivasan
Professor and Head,
Dept. of Management Studies,
University of Madras, Chennai.

Dr. P. Vitthal
School of Language and Literature
Marathi Dept. Swami Ramanand
Teerth Marathwada University, Nanded.

EDITORIAL BOARD

Dr. B. R. Kamble
Kirti M. Doongursee College,
Dadar, Mumbai-28.

Dr. Sadique Razaque
Univ. Department of Psychology,
Vinoba Bhave University,
Hazaribagh, Jharkhand.

Prof. Ram Nandan Singh
Dept. of Buddhist Studies University of Jammu.

Dr. Safiqur Rahman
Assistant Professor, Dept. of Geography,
Guwahati College Bamunimaidam, Guwahati,
Assam.

Dr. Jagdish R. Baheti
H.O.D. S. N. J. B. College of Pharmacy,
Meminagar, A/P. Tal Chandwad, Dist. Nashik.

Dr. Vimal K. Lahari
Assistant Professor, Department of Sociology,
Banaras Hindu University, Varanasi, Uttar Pradesh.

Dr. Pandit Sheshrao Nalawade
I/C Principle,
Pandit Jawaharlal Neharu Mahavidyalay,
Aurangabad.

Dr. Sanjay Patil
Principal,
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. V. D. Nanoty
Principal,
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Sunil Somani
Principal,
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Dayanand Raut
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. Pradip Deohate
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Saurabh Jadhao
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Nilima Deshmukh
Associate Professor,
Sahakar Maharshi Late Bhaskarrao Shingne
Arts College, Khamgaon, Dist. Buldana. (M.S.)

Prof. Harshali Akhare
Assistant Professor, Department of English,
Applied Sciences and Humanities, Shri Sant Gajanan
Maharaj College of Engineering, Shegaon. (M.S.)

Mr. Sachin Bhagat
Department of Applied Sciences and Humanities,
Shri Sant Gajanan Maharaj College of Engineering,
Shegaon. (M.S.)

PUBLISHED BY

Ajanta Prakashan
Aurangabad. (M.S.)

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
1	An Impact and Challenges of New Education Policy 2020 on Higher Education System **Digwa Soniyakaur Satnamsingh**	1-6
2	The Study of Ruskin Bond's Selected Short Stories in the Light of Eco-Criticism **Mr. Dinesh Atmaram Borase**	7-11
3	A Study of Pradhan Mantri Mudra Yojana **Gaikwad S. V.** **Dr. Pawale V. A.**	12-18
4	Physical Education and Sports Sciences: Innovations and Trends **Ganesh S. Vishwakarma**	19-24
5	Application of Ethanolic Plant Extracts as a Biological Stain **Malpani H. S.** **S. V. Dalal** **Gawande S. N.** **Nanoty V. D.**	25-33
6	Automation and Monitoring of Gas Geyser Leakage Detection with Arduino **J. D. Nehete** **Dr. Milind Kale** **N. O. Chimankar** **S. R. Supe**	34-37
7	Enhancing Database Maintenance: Leveraging ChatGPT for Real-Time Verification and Updates of End-of-Life (EOL) Data **Gauri Borle** **Juee Gore** **Riya Dangra** **Amit Manekar**	38-46

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
8	Food Recommendation System Based on Geographical Location - DineLocate **Harshit Dharmik** **Karan Motwani** **Khushbu Pareek** **Shraddha Tikar** **M. Faizan I. Khandwani**	47-53
9	Microwave Assisted Synthesis, Characterization and Biological Activities of Some Newly Synthesized 3-Aryl-Substituted Benzothiazolyl Thiocarbamide **Kavita M. Heda**	54-58
10	The Curse of Gandhari - A Psychoanalytic Approach **Keerthana. K**	59-63
11	An Analysis on Sustainable Development towards Education in India **Dr. Kumaraswamy Mora**	64-70
12	Democracy Unveiled: Bridging the Nexus of Laws and Practice in India **Adv. Dr. Mahesh Pralhad Bhagwat**	71-79
13	The Study of Ichthyofaunal Diversity in Khadakpurna Canal near Chikhali Dist. Buldhana **Dr. Tushar Deshmukh** **Miss. Megha Ingle** **Mr. Sachin Bhutekar**	80-88
14	Environmental Importance in India: Through the Eyes of Union Budgets **Dr. Nitin R. Suba**	89-95
15	Studies of Relative and Specific Viscosities of Tazobactum70% Dioxane Water Mixture at Different Temperature **Noor Mohammad**	96-98
16	Review: Text to Image Generation **Ms. Pallavi Borse** **Ms. Akansha Timande** **Ms. Vaishnavi Lande**	99-107
17	Feminist Historiography New Thought in Historiography **Dr. Pramod Rameshwar Chavan**	108-112

CONTENTS OF ENGLISH PART - VI

S. No.	Title & Author	Page No.
18	A Survey of Integration into 3D Printing for Image Processing using AI ML **Abhay Kadu** **Pranav Kaware** **Rushikesh Kaldate** **Ayush Solav** **Mrs. S. N. Khandare**	113-119
19	Food Recommendation System using Ahpsort Algorithm **Prasad Narkhede** **Pratham Paunikar** **Gaurav Surkar** **Prajwal Katakpure**	120-126
20	Library Automation: An Overview **Dr. Harshal R. Nimbhorkar**	137-131
21	The Wave of Ecocriticism in Indian Novel **Dr. Manohar A. Wasnik**	132-137

13. The Study of Ichthyofaunal Diversity in Khadakpurna Canal near Chikhali Dist. Buldhana

Dr. Tushar Deshmukh
Department of Zoology.
Miss. Megha Ingle
Department of Zoology.
Mr. Sachin Bhutekar
Department of Biochemistry, Shri Shivaji College of Art's, Commerce and Science, Akola.

Abstract

To carry out the freshwater diversity, species abundance and the various aspects of fish of Khadakpurna Canal was selected for the research work in region of Buldhana district. The species were analyzed by percentage of number of individuals in each order and family. Following, family wise analysis of percentage composition the Siluriformeswas the most dominant order constituting about 25.00% of the total fish population followed by the Synbranchiformes 16.66%, Perciformes 16.66%, Cypriniformes 8.33%, Anabantiformes 8.33%, Clupeiformes 8.33%, Cichliformes 8.33%, Anguiliformes 8.33%, were the least numerous order and also it constituting only 01 individuals of the total order of fish population. On the other hand, genera wise percentage composition analysis were referred as the Cypriniformes was the most dominant order concerning about 46.15% number of genera were occurred. Subsequently, Siluriformes15.38%, Perciformes 7.69%, Synbranchiformes 7.69%, Anabantiformes 7.69%, Clupeiformes 3.84%, Cichliformes 3.84 %, Anguiliformes 3.84%, were recorded.

Keywords: Habitat, Cypriniformes, Threatened.

Introduction

Fishery is an important source of food for mankind. Fishes have rich source of proteins and other essential nutrients to tide over the nutritional deficiency of man. India is one of the mega biodiversity countries in the world and occupies in ninth position in terms of fresh water mega biodiversity (Mittermeier and Mittermeier 1997). Fishes constitute the most conspicuous component of inland aquatic fauna and rank very high as a source of proteins. For sustain exploitation and simultaneous conservation of fisheries resources, basic scientific information biodiversity is vital (Sone and Malu, 2000; Shendge, 2008).

In country is endowed with vast and varied water resources and rich biodiversity. Fresh water ecosystem is comparatively vast on the mother earth. It is 45,000 km of river, 126334 km of canals, ponds and tanks 2.36 million hectors. Maharashtra is rich in fresh water (rivers, irrigation, canals, dams and lakes) reservoirs and its fish diversity. Therefore, Maharashtra is one of the important states for fish production and natural water resources and there is great scope for developing fisheries in this state. The state of Maharashtra is one of the important aquatic biodiversity hotspots of the country, having the stowed with a large number of water bodies both latic and lentic, the state boasts of a rich fish biodiversity. The richness of fish species has attracted the attention of eminent researchers and state has good contribution in enriching the data bank on the aquatic biodiversity of the nation.

Due to certain factors such as, over exploitation, habitat loss, exotic species and mainly contamination of surface waters, the fish (biodiversity) is great threatened. Ecosystem and species are important for sustaining human life on earth. In order to preserve the biodiversity and fishes it is necessary to conserve the surface water bodies. In general aquatic conservation strategies and watch of diverse species should support sustainable development by protecting biological resources. The present study will be useful to examine factors influencing the structure and interaction of whole ecosystem specially in relation with fish diversity, distribution and endemic species composition of freshwater fishes, as it is closely depends on the different factors such as the availability of food, breeding sites, water current, depth, topography.

Material and Method

To carry out the fish diversity, species abundance and the various aspects of fisheries of Khadakpurna Canal will be selected for the research work in the region of Chikhali Dist. Buldhana of Maharashtra state.

1. Study Area

The Khadakpurna canal is one of the irrigation project being constructed across river Khadakpurna, a tributary of river Godavari in the Godavari basin in Buldhana district of Maharashtra. It is located at latitude 20°34' 62.02" N and longitude 76°27' 15.55" E. The basic purpose of this canal is for drinking water, irrigation, domestic use and fishing to nearby villages.

2. Collection of Fish Sample

From January 2022 to March 2022 fish samples were collected during the study period. The fishes for the present study were collected from different site of Khadakpurna dam. Fishes

were collected with the help of local fisherman by using cast, nets of various sizes. The selected sites were surveyed by walking and some guidelines were also taken from the local fisherman. Local names were also noted after asking from the fisherman.

3. Identification of Fish Sample

Identification of fishes was done up to species level at fish landing center to get its natural colour, patterns of scales, fins, mouthparts identification marks like black spots, paired and unpaired fins. The fishes from dams were collected using various fishing methods. After sampling, photographs of fishes were taken and collected fish samples were preserved in 10% formalin for detailed examination and identification by using standard literature of Day (1878), Jayaram (2010) and Talwar and Jhingran (2001) and Manual of Laboratory Specimens (Chordates) by Gurudarshan Singh, Management Practices in Fish Farming by N. K. Yadava and co-authers , Fishes and Fisheries of India by Pandey and Sandhu.

For the domestic marketing status, the structured interview will be used to collect the information from the wholesale and retail fish markets through key informant survey and local fishermen. The information will be collected on prices, marketing costs and marketing margins for selected fish species using average and percentage analysis.

Observation and Result

Fish diversity depends on the biotic and abiotic factors with age of water body, mean depth, fluctuation of water levels, contamination level etc. In the present Investigation, there were 26 species belonging to different orders and families (Table 1).The results were focused on the descriptive statistical analysis to assess and compared to various sampling region of the fish species diversity in (Table 1). Secondly, species richness were analyzed and compared to sampling location was summarized in (Table 2) and also were monitored fluctuate level of species richness was observed. A total of 26 species under 08 orders and 12 families were recorded from Khadakpurna Canal during the study period (Tables 1 & 2). The species were analyzed by percentage of number of individuals in each order and family. Following, family wise analysis of percentage composition the Siluriformeswas the most dominant order constituting about 25.00% of the total fish population followed by the Synbranchiformes 16.66%, Perciformes 16.66%, Cypriniformes 8.33%, Anabantiformes 8.33%, Clupeiformes 8.33%, Cichliformes 8.33%, Anguiliformes 8.33%, were the least numerous order and also it constituting only 01 individuals of the total order of fish population .

On the other hand, genera wise percentage composition analysis were referred as the Cypriniformes was the most dominant order concerning about 46.15% number of genera were occurred. Subsequently, Siluriformes15.38%, Perciformes 7.69%, Synbranchiformes 7.69%, Anabantiformes 7.69%, Clupeiformes 3.84%, Cichliformes 3.84 %, Anguiliformes 3.84%, were recorded.

During the present investigation the order of dominance is as follows: Cypriniformes>Siluriformes>Perciformes=Synbranchiformes>Anabantiformes>Cichlif ormes = Clupeiformes =Anguiliformes.The family Cyprinidae under order Cypriniformes was represented by 12 species, *Catla catla, Labeo rohita, Labeo bata, Cirrhinus mrigala, Labeo pangusia, Cyprinus carpio, Puntius dorsalis, Amblypharyngodon mola, Puntius chola, Osteobrama catio peninsularis, Hypothalmichthys molitrix, Thynrichthys sandkhol.* Under order Perciformes family Chehlidae was represented by 02 species Tilapia *mossambica, Oreochromis mossambica,* family Gobiidae was represented by 01 Glossogobinus giuris. Under order Synbranchiformes family Mostacembelidae was represented by 01 species *Macrogynathus pancalus.* Family Channidae was represented by 01species *Channa marulius.* Under order Siluriformes family Bagridae was represented by 02 species *Mystus cavasius, Mystus bleekeri.*

Family Siluridae was represented by 01 species *Ompok bimaculatus,* famiy Clariidae was represented by 01 species *Clarias batrachus.* Under order Clupeiformes family Engraulidae was represented by 01 species *Stolephocus indicus.* Under order Anabantiformes family Channidae was represented by 02 species *Channa striata, Channa punctata.* Under Cichliformes family Cichlidae was represented by 01 species *Tilapiini tilapia.* Under order Anguilliformes family Anguillidae was represented by 01 species Anguilla *Bengalensis bengalensis.*

Table 1 : List of Fresh Water fishes from the Khadakpurna Canal Dist Buldhana.

Order	Family	Species Name	Common Name	Local Name
Cypriniformes	**Cyprinidae**	*Catla catla* (Hamilton-Buchanan)	Catla	Catla
		Labeo rohita (Hamilton-Buchanan)	Rohu	Rohu
		Labeo bata (Hamilton-Buchanan)	Bata Labeo	Tembti
		Cirrhinus mrigala	Mrigal	Mrigal
		Labeo pangusia (Hamilton-Buchanan)	Pangusia Labeo	Boharya
		Cyprinus carpio (Linnaeus)	Common carp	Cyprinus
		Puntitus dorsalis (Jerdon)	Long Snouted barb	Podshi
		Amblypharyngodon mola	Begret	Begret
		Puntitus chola	Swamp barb	Tepri
		Osteobrama catio peninsularis (Silas)	Penisular osteobrama	Kharpati

		Hypothalmichthys molitrix (Valencinnes)	Silver carp	Chandera
		Thynrichthys sandkhol (Sykes)	Sandkhol carp	Sandkol
Perciformes	**Chehlidae**	*Tilapia mossambica* (Jhingran)	Tillapia	Talapia
		Oreochromis mossambica (peters)	Mozambique cichlid	Kombada
	Gobiidae	*Glossogobinus giuris*(Hamilton-Buchanan)	Tank goby	Dhangarya
Synbranchiformes	**Mostacembelidae**	*Macrognathus pancalus* (H & B)	Striped Spiny Eel	Bam
	Channidae	*Channa marulius* (H & B)	Giant Snakehead	Dokh
Siluriformes	**Bagridae**	*Mystus cavasius*	Katarni	Katarni
		Mystus bleekeri	Kanheri	Kanheri
	Siluridae	*Ompok bimaculatus*	Pathod	Pathod
	Clariidae	*Clarias batrachus*	Mangur	Mangur
Clupeiformes	**Engraulidae**	Stolephocus indicus	Muchkada	Muchkada
Anabantiformes	**Channidae**	*Channa striata*	Maral	Maral
		Channa punctata	Dok	Dok
Cichliformes	**Cichlidae**	*Tilapiini tilapia*	Tilapi	Jilebi
Anguilliformes	**Anguillidae**	*Anguilla anguilla*	Bam	Bam

Table 2 : Updated Checklists Count Some Freshwater Fishes In Khadakpurna Canal

Sr.No.	Order Families	Genera	Species	Number of	individuals
1	Cypriniformes	1	8	12	33
2	Cypriniformes	2	2	2	12
3	Perciformes	2	2	2	11
4	Synbranchiformes	3	3	4	20
5	Siluriformes	1	1	1	4
6	Clupeiformes	1	1	2	10
7	Anabantiformes	1	1	1	9
8	Cichliformes	1	1	1	4
	total	12	19	26	103

N – Number, SD – Standard Deviation, SE – Standard Error.

Table 3 : Descriptive Statistics for Species Diversity in Khadakpurna Canal

Sampling sites	'N' species	Mean	SD	SE of Mean	'N' individuals	Mean	SD	SE of Mean
Site 1	5	0.19	0.05	0.004	30	0.21	0.022	0.011
Site 2	7	0.24	0.09	0.006	25	0.23	0.018	0.09
Site 3	9	0.31	0.015	0.009	32	0.19	0.017	0.008
Site 4	5	0.19	0.05	0.007	16	0.25	0.021	0.0010
Total	26	0.93	0.025	0.026	103	0.88	0.078	0.038

Discussion

India is one of the mega diversity country in the world and occupies the ninth position in terms of fresh water fish diversity (Mittermier & Mittermier, 1977). In India there are 2500 species

of fishes of which 930 live fresh water 1570 are marine (Kar 2003). The attempt has been made for piscine inventory from this well-known water body i.e Khadakpurna canal.

In the present investigation it was observed that the ichthyofaunal diversity belongs to 8 orders 12 families 19 genus 26 species. Where family is dominant Siluriformes (25.00 %) species followed by Mystus cavasius, Mystus bleekeri, Ompok bimaculatus ,Clarias bratrachus. The similar result were reported by Khedkar (2005) with 28 species under 11 genera from Nathsagar reservoir, Paithan. Jadhav and Yadav (2009) reported 25 species under 11 genera under the order Siluriformes from Solapur district Maharashtra. Vijaylaxmi et al., (2008) reported 6 species under 4 genera under order Siluriformes from Bheema river Gulbarga district Karnataka. Our results are also in agreement with Bhalerao (2012), Sarwade and Khillare (2010), Shaikh et al., (2011) to found near about same result like Siluriformes order is dominant as other families. Shinde et al., (2009) observed 11 species under 10 genera and dominance Siluriformes order from Harsool savangi Dam district Aurangabad. The fish Anguilla bengalensis bengalensis which is endangered in Western Ghats of India.

In the present investigation, we found the most endangered status fish i.e Anguilla bengalensis bengalensis. According to Dahanukar et al.,(2004), there is a dire need of its conservation and awareness in human population. Clarias batrachusas has been listed endangerd the exotic fishes like Cyprinus carpio, Tilapia mossambica, Oreochromis mossambica, Channa punctata, Hypothalmichthys molitrix were also reported during the present investigation (Jhingran,1983).

Sand mining is common in most in the most of the stretches of the river, which is the determining factor for habitat destruction leading to the loss of habitat and breeding grounds of several fish species in the river. Loss of breeding grounds would have a negative impact on the fish population (Arya et al.,2001). Native fish fauna of the river is severely threatened by the introduction exotic species due to the predaction, competition for food and habitat and introduction of pathogens Raghavan et al., (2008) and Knight (2010). Exotics recorded from the river have the status of potential pests and hence pose a serious threat to the fish fauna of the Champavati river. Due attention should be paid to the presence of the exotics, as they may dominate and even elimination of native and small indigenous fish population of the river.

Conclusion

The Present study deals with the ichthyofaunal diversity of Khadakpurna canal. The canal exhibit a good ichthyofaunal diversity represented by 26 species of fishes belonging to 19 genera 12 families and 8 orders. The Present study made a attempt to make a biological database for protection of endangered and threatened fish species from Khadakpurna canal. Under this concept an effective management and conservation of freshwater fishes and fishery have must considered in the management of freshwater of Khadakpurna canal. The data is useful for understanding fish diversity as a aspect for development and sustainability management for the conservation of fresh water fishes. The study of biodiversity programmes must be continuing in future which will help to assess the loss of biodiversity with respect of time.

References

- Arya S.C., Rao K.S and Shrivastava S (2001) Biodiversity and fishery potential of Narmada Basin Western Zone (M.P, India) with special reference to fish conservation. Environment and Agriculture: Agriculture and pollution in South Asia. 108-112.
- Bhalerao S.N (2012) : Study of Fish Diversity and Water Quality at Kasar Sai Dam, Hinjewadi Pune India., International research journal of Biological Sciences vol 1(4),51-55.
- Dahanukar, N., R. Raut and A. Bhat, 2004. Distribution, endemism and threat status of freshwater fishes in the Western Ghats of India. Journal of Biogeography, 31: 123-136.
- Day F. (1889): The fauna of British India including Ceylon and Burma, London Fishes: Vol. 1:548: Vol. 2:509. AHPA (1998) : Standard methods for the examination of water and wastewater. 20thedn. American Public Health Association. Washington D.C.U.S.A.
- Day, F. (1878) : The fishes of India, being A natural history of the fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon. Vol. I & II. Ceylon test and atlas in 4 pts. London. E.O. (ed.) Biodiversity, National Academy Press, Washington. USA.
- Jadhav B.V., Sanjay S., Kharat., Raut R.N., Paingankar N and Dahanukar N. (2011): Studied Freshwater fish fauna of Koyna River, northern Western Ghats, India. Journal of Threatened Taxa, 3 (1): 1449-145 .

- Jadhav S.S. & Yadav B.E. 2009. A note on the Ichthyofauna of Solapur district, with first report of a Cyprinid fish Rasboracaverii (Jerdon) from Maharashtra state India; Journal of Threatened Texa (4): 243-244.
- Jayaram K.C. (1991) : Revision of the genus, Puntius Hamilton from the Indian region (Pisces : Cypriniformes : Cyprindae : Cyprinae) Records of Zoological Survey of India, Occasional paper no. 135, ZSI, Culcutta 178.
- Jayaram K.C. (1999) : The freshwater fishes of the Indian region Narmada Publishing House, New Delhi – 551.
- Jayaram K.C. and AnuradhaSanyal (2003) : A taxonomic revision of the fishes of the genus Mystusscopoli (Family : Begridae) Records of the Zoological survey of India occasional paper no. 207 ZSI Culcutta :141.
- Jayaram, K.C. (1999) : The fresh water fishes of the Indian Region. Narendra Publishing House, Delhi : 551.
- Jayaram, K.C., (1981): The freshwater fishes of India, Pakistan, Burma and Sri Lanka. Hand book of Zoological survey of India. No. 2, xxii+475.
- Kadam, S.U. and Gayakwad, J.M., 2006. Ichthyofauna of Masooli Reservoir, District Parbhani, Maharashtra- A Study of inland reservoir, fishery in India. J. Aqua. Biol., 21(2); 59-61
- Kalyankar V.B, Nagale D., Dhodange T.B and Akhade S.S. (2012): Study of Fish diversity from Lower Dudhava project at ParbhaniDis.India World J.of 2001.7(4):320-322.
- Kar D.(2003) : Fishes of Barak drainage ,Mizoram and Tripura. In Kumar A., C. Bohara and L. K. Singh (Eds.). Env. Pollution and Management. APH Publishing Corp., New Delhi. : Pp 203-211.
- Knight J.D.M (2010) Invasive ornamental fish: a potential threat to aquatic biodiversity in peninsular India. J. Threat. Taxa,2(2):700-70
- Mittemeier, R.A. and Mittermeier,C.G. (1997):Megadiversity earths biologically wealthiest nation in McAllister, Hamilton and B.Harvey (Ed.s) Global fresh water biodiversity seawind,cemex,mexico city(11):Pp.1-140.

- Raghavan,R., Prasad,G., AnvarAli,P.H and Pereira,B (2008) Fish fauna of Chalakudy River, part of Western Ghats biodiversity hotspot, Kerala 131 [, India: Patterns of distribution, threats and conservation needs. J. Biodiv. Conserv. 17:3119-3131.
- Rao, A., Sreenivasa, Rao, P., Rammohan and Somesswara Rao, (1999): Degradation of Kolleru lake, Ind. J. Env, Hlth., 41(4): 300-311.
- Sakhare, V.B. and Joshi, P.K., (2004): Present status of reservoir fishery in Maharashtra. Fishing Chimes, 24(8): 56-60.Sakhare, V.B. and Joshi, P.K., (2004): Present status of reservoir fishery in Maharashtra. Fishing Chimes, 24(8): 56-60.
- Sarwade J.P and Y.K Khillare. 2010. Fish diversity of Ujani Wetland M.S, India:Paper presented in international conference Sambalpur University Department of EVS, Energy Special issue vol 1:173-179.
- Shaikh H.M. Kamble S.M and Renge A.B. (2011): The study of ichthyofaunal diversity in upper dudna project water waterreservivoir near somthana in Jalna District india Journal of Fisheries and Aquaculture vol.2 issue 1, 2011,pp-8-10.
- Shendge, A. N., 2008. Ichthyofaunal diversity of Ujani dam J. Exp. Zool. India. 11(1): 147-150.
- Sone A.A and Malu R.A (2000). Fish diversity in relation to aquaculture in Ekbhurgiireservoir,Washim Maharashtra J..AquaBiol.15 (1 and 2), 44-46.
- Talwar P.K. and A. Jhingran (1991): Inland fishes of India and adjacent countries, Vol.I and II, Oxford and IBH Publisher, New Delhi: 1158.
- Vijaylaxmi C., K. Vijaykumar, ZebaParveen and Anil Kumar Chavan . 2008. Fish Fauna of Bheema river, Gulbarga district, Karnataka. J. Ecophysiol. Occup. Hlth, 8: 237-240.

21. The Wave of Ecocriticism in Indian Novel

Dr. Manohar A. Wasnik
Associate Professor, Department of English,
Sahakar Maharshi Late Bhaskarro Shingne Arts College, Khamgoan, Buldhana.

Abstract

The Indian novelists pay more attention on study and analysis of the strong bond between nature and society. Ecology and ecocriticism are the significant aspects for the literary study and research. Indian Government and People are becoming conscious about the environment. They are conscious about Environment balance in this globalize world. Therefore, so many plans/schemes are being launched for saving the environment and making the people environment-conscious. Many poets and novelists have become eco-conscious or environment conscious. They have used Nature as landscape, as beautiful atmosphere/lively atmosphere such as R.K.Narayan, Raja Rao, Kamala Markanday, Anita Desai, Kiran Desai, Jayant Mahapatra, Ramanujan, Bhavani Bhattacharya. The literature is a reflection of society and environment and it is a mode of expression. Environment balance/protection has become the burning issue of the present time in the whole world. The eco-imbalance and the environmental pollution are the curse of global warming. The world is becoming the victim of the environmental imbalance and destructions. The healthy well balanced environment/atmosphere is the need of time. It is like the life blood for the universe. In June 2013 that ravaged Uttrakhand, the flash flood gave an immense pain to Indians and it has been called as a man-made disaster or an unplanned development by man in political and social context. The research paper reveals aspect of ecocrticism in Indian novels and shows love and inclinations of novelist towards ecology.

Introduction

Glotfelty defines “Ecocriticism is the study of the relationship between literature and the physical environment”.(xviii). One of the implicit goals of the approach is to recoup professional dignity for what Glotfelty calls the ‘undervalued genre of nature writing’. (xxxi). Lawrence Buell’s definition of ‘ecocriticism’ is that it is a study of the relationship between literature and the environment conducted in a spirit of commitment to environmentalist praxis. This is a new field for literary thinkers. Critics and thinkers of Ecocriticism have used the approach and mode

differently. The term Ecocriticism is defined in different ways but their basic concern is similar. Their main focus is on the relationship between man and the earth. Ecocriticism is the discipline of literature and environment.

Ecocriticism has its major concern with writing on nature and ecological themes. The second wave moves from inherent environment to fabricated environment, from wilderness to urban landscape. It ultimately includes all space and also non-space. The environment really means everything that contains everything else and moreover anything. Peter Barry has included a chapter titled Ecocriticism in the second edition of his landmark critical work on recent literary criticism: Beginning Theory: An Introduction to Literary and Cultural Theory (2002). He states that ecocriticism has no universal model. He has listed the acts of ecocritics like reading of literature from an ecocritical point of view. Read literature from an ecocritical point of view. Apply ecological issues to the natural world and show appreciation for ethical positions toward nonhuman nature.

Environment has been part and parcel of Indian life right from ancient days. Worshipping nature and revering earth as 'Mother' has been part of our Indian culture. From Vedic civilization to the present, nature is considered as the incarnation of God and Goddesses. Importance of nature and environment has been reflected in the works of Indian literature vividly. Indian literature has often fathomed with the idea of environment, its importance and subsequent degradation. Raja Rao's novels reflect the importance of nature and environment in his literary works. Rao scintillatingly depicts the culture and environment of a Southern Indian village. Rao tells us that natural resources like mountains, forests, rivers are an integral part of Southern Indian villages. In his novel 'Kanthapura', Rao tells us how rivers and mountains play an important role in people's lives. People in the village call the mountain Goddess Kenchamma and they consider it responsible for both - their prosperity and their adversity. "Kenchamma is our goddess. Great and bounteous is she……never has she failed us in grief. If it rains come not, you fall at her feet and say, 'Kenchamma, you are not kind to us. Our field is full of younglings"(7)

Nature and literature have always shared a close relationship as is evidenced in the works of poets and other writers down the ages in almost all cultures of the world. Today the intimate relationship between the natural and social world is being analyzed and emphasized in all departments of knowledge and development. The literary critic tries to study how this has been textualized by the writers in their works. In this context two terms have become very important

today – ecology and ecocriticism. India is a country with variety of ecosystems which ranges from Himalayas in the north to plateaus of south and from the dynamic Sunderbans in the east to dry Thar of the west. The beauty of ecosystems has been adversely affected due to mankind. Literature could not remain aloof from this depletion. Here my paper deals with the concern for nature changes in Indian novels from reverence to destruction.

Earlier, the writers such as R. K. Narayan, Manohar Malgonkar, Raja Rao, Kamala Markandaya, and Anita Desai have invoked Nature and nature-elements for expressing their views, their contemporary regional and social atmospheres. R.K. Narayan is a very famous regional novelist. His imaginary creation of Malgudi is very popular and it made a house in every reader. It is an imaginary world created by R. K. Narayan. Narayan's novels and short stories move around this Malgudias specific region as a backdrop. The novelist has exploited the entire social, psychological and regional atmosphere in his writing. He has used nature as the setting and background in his novels and short stories. It can be noted in his stories and novels such *Malgudi Days, Man Eater of Malgudi, The English Teacher, and The Guide etc. Malgudi* can be considered as the central setting of his writing. Nature plays both the positive and negative roles. The flowing Saryu River and the ruined temples affected Raju, the guide and transformed him into a saint in the novel, *The Guide.*

Kamala Markandaya is one of the greatest Indian novelists in English. Markandaya has also used Nature and natural elements for her effective and flawless expressions and descriptions of views. She considers nature as a wild animal. She thinks nature a destroyer and preserver both. Her well known novel, Nectar in a Sieve, is the fine example of the depiction and use of nature imagery. There is the touch of environmental issue. She shows the effect of environment on mankind

Nature can be portrayed benign as well as aggressive and destructive. According to the need, mood or situation the qualities are applied by the writers. Bhabani Bhattacharya has depicted the natural calamity realistically in his famous novel, *So Many Hungers*. This novel presents the tragic effects of famine on the inhabitants of Bengal. Actually, this calamity is the factual presentation of the real *Bengal famine of 1943*. The novels deal with the painful, shocking conditions of the people. It reveals the miserable, terrible, gruesome and helpless situations of the famine affected peasants. The writer has employed various nature symbols, imageries for different

types of comparisons. For example, the characters Laxminathan and Samerandra Bose are compared with Jackals and vultures because of their villainy and greed.

Arundhati Roy's best creation The *God of Small Things*, deals with the topics of nature and environment. It points out the environmental pollution through the description of the changed condition of beauty, greenery and the look of Ayemenem and the river Meenachal. She has used nature images not only for describing the beauty or glorious atmosphere of the region and landscape but also for exposing the polluted atmosphere of Ayemenem. Through the depiction of the river Meenachal, She contrasts the earlier condition of the river with its later condition. Earlier Rahel feels: It was warm, the water green like reapplied silk. With fish in it. With the sky and it. And at night, the broken yellow moon in it. (God of Small Things,123). The river, during the childhood of Rahel, has become deformed and repulsive in her adulthood. Its charm and effect was deteriorating due to environmental pollution.

Anita Desai is a very prominent and popular woman Indian novelist in English. Nature which includes animals, plants and birds, has a strong presence in almost all her works. Known in Indian-English fiction for ushering in the psychological novel, Desai uses external landscapes to portray interior states of mind. In Cry, the Peacock, the complexities of Maya's inner life is effectively brought out through the landscape as is her resentment against her husband for his inability to communicate with her. Desai effectively compares Maya with the peacock in the jungle. The peacocks are said to fight before they mate, living they are aware of death and dying they are in love with life. This is reflected towards the end in the novel when one day during a dust storm both husband and wife go up to the roof of their house, she pushes him off the parapet and he dies. In *Voices in the City*, Monalisa is repeatedly compared to the encaged bird in her house who wants to be free. Her condition reflects the plight of the imprisoned bird whose need is no one's concern and its life is for the pleasure of the others. She finally commits suicide to free herself. Baba' the autistic son in Clear Light of Day is described as a harmless spider. In *Where shall We Go* This Summer the island people are described as goats as they listen to Moses.

Thus, Nature is always a supporting element in Literature. It can be seen in multitudinous forms. It reflects various atmospheres, moods, feelings and status. It is an expressive form for literature. It is very significant mode of expression for describing fertile, colorful atmosphere, happiness, gloominess, bitterness, disturbing, lively, tragic atmosphere etc. All types of environment can be presented through the help of nature and various elements of nature. Now-a-

day's ecology, eco-balance, environment concerns are the points of attraction and concern. The prevalent environment imbalance has completed the intellectuals and rational people to consider this seriously. Therefore, the literary figures have used their strength for strengthening the attitude of people towards environment protection and eco-balance. Many poets and novelists have become eco-conscious or environment conscious. They have used Nature as landscape, as beautiful atmosphere/lively atmosphere such as R.K. Narayan, Raja Rao, Kamala Markanday, Anita Desai, Kiran Desai, Jayant Mahapatra, Ramanujan, Bhavani Bhattacharya. The literature has become a mode of expression about environment and its importance in human life and universe. Environmental balance/protection has become the hot issue of the present time in the whole world. It is the issue of international importance. Due to the eco-imbalance and the environmental pollution, the whole world is under the curse of global warming. The world is becoming the prey of the environmental imbalance and destructions. The healthy well balanced environment/atmosphere is the need of time. It is like the life blood for the Universe. The world needs eco-friendly atmosphere for the proper growth, development, sustainability and prosperity.

Thus, we see that Indian fiction writers are greatly concerned with nature, environment and its subsequent degradation. They have tried to address few of environmental concerns in their literary works: Unbridled development, Incessant exploitation of natural resources, Plight of wildlife, Loss of biodiversity, flora and fauna, Women participation in decision making, Apathy by government and society, Psychological problems occurring in urban population due to loss of environment, Uncontrolled urbanization and its aftermath, Capitalism and side effects.

In the twenty-first century, we are witnessing a gradual change in the environment in the form of global warming, acid rains, earthquakes, arid lands, landslides, extinction of species and many more related problems. The exploitation of natural resources is taking its toll and its side effects are now clearly evident. Indian fiction writers have tried to portray subsequent degradation of environment and ecology in India. They also show how it is directly or indirectly affecting people. If humans need to save their earth, they need to change their lifestyle and nonchalant mindset. Issues such as saving the environment and living in harmony with nature are two basic concerns which Ecocriticism is concerned with.

Conclusion

All human and non-human life is surrounded by ecological environment. It is the environment that surrounds the animal kingdom and the plant kingdom; not to speak of the stellar

universe. Earth, water, air, fire and the sky are the marks of the environmental set-up. The balance in ecological conditions guarantees the balanced life for men and other creatures. Peaceful co-existence of the tiger and the lamb, the lion and the squirrel, the wolf and cat, the eagle and the sparrow is the principle of life in Nature. All religions have advocated the balanced relationship between Man and Nature. Indian novelists portray the relationship between Nature and Man.

Works Cited

1. Barry, Peter. *Beginning Theory: An Introduction to literary and Cultural Theory*. Manchestar: Manchester UP, 2002. Print.
2. Glotfelty, Cheryl and Harold Fromm. *The Ecocriticism Reader, Landmarks in Literary Ecology*. Athens: University of Georgia Press, 1996 Print.
3. Rao, Raja. *Kanthapura*; Oxford University Press; New Delh, 1952. Print.
4. Desai, Anita. *Cry, the Peacock*. New Delhi: Penguin Books, 2006. Print.
5. Roy, Arundhati. *The God of Small Things*. New Delhi: Indian Ink, 1997. Print.

ISSN 2277 - 5730

AN INTERNATIONAL MULTIDISCIPLINARY
QUARTERLY RESEARCH JOURNAL

AJANTA

Volume - XIII Issue - II April - June - 2024

ENGLISH PART - VII

Peer Reviewed Referred and UGC Listed Journal

Journal No. 40776

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING

2023 - 7.428

www.sjifactor.com

❖ EDITOR ❖

Asst. Prof. Vinay Shankarrao Hatole

M.Sc (Maths), M.B.A. (Mktg.), M.B.A. (H.R.),
M.Drama (Acting), M.Drama (Prod. & Dir.), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan

Aurangabad. (M.S.)

The information and views expressed and the research content published in this journal, the sole responsibility lies entirely with the author(s) and does not reflect the official opinion of the Editorial Board, Advisory Committee and the Editor in Chief of the Journal **"AJANTA"**. Owner, printer & publisher Vinay S. Hatole has printed this journal at Ajanta Computer and Printers, Jaisingpura, University Gate, Aurangabad, also Published the same at Aurangabad.

Printed by

Ajanta Computer, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Published by

Ajanta Prakashan, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Cell No. : 9579260877, 9822620877

E-mail : ajanta3535@gmail.com, www.ajantaprakashan.in

AJANTA - ISSN 2277 - 5730 - Impact Factor - 7.428 **(www.sjifactor.com)**

EDITORIAL BOARD

Professor Kaiser Haq
Dept. of English, University of Dhaka,
Dhaka 1000, Bangladesh.

Roderick McCulloch
University of the Sunshine Coast,
Locked Bag 4, Maroochydore DC,
Queensland, 4558 Australia.

Dr. Ashaf Fetoh Eata
College of Art's and Science
Salmau Bin Adbul Aziz University. KAS

Dr. Nicholas Loannides
Senior Lecturer & Cisco Networking Academy Instructor,
Faculty of Computing, North Campus,
London Metropolitan University, 166-220 Holloway Road,
London, N7 8DB, UK.

Muhammad Mezbah-ul-Islam
Ph.D. (NEHU, India) Assot. Prof. Dept. of
Information Science and Library Management
University of Dhaka, Dhaka - 1000, Bangladesh.

Dr. Meenu Maheshwari
Assit. Prof. & Former Head Dept.
of Commerce & Management
University of Kota, Kota.

Dr. S. Sampath
Prof. of Statistics University of Madras
Chennari 600005.

Dr. D. H. Malini Srinivasa Rao
M.B.A., Ph.D., FDP (IIMA)
Assit. Prof. Dept. of Management
Pondicherry University
Karaikal - 609605.

Dr. S. K. Omanwar
Professor and Head, Physics,
Sat Gadge Baba Amravati
University, Amravati.

Dr. Rana Pratap Singh
Professor & Dean, School for Environmental
Sciences, Dr. Babasaheb Bhimrao Ambedkar
University Raebareily Road, Lucknow.

Dr. Shekhar Gungurwar
Hindi Dept. Vasantrao Naik
Mahavidyalaya Vasarni, Nanded.

Memon Sohel Md Yusuf
Dept. of Commerece, Nirzwa College
of Technology, Nizwa Oman.

Dr. S. Karunanidhi
Professor & Head,
Dept. of Psychology,
University of Madras.

Prof. Joyanta Borbora
Head Dept. of Sociology,
University, Dibrugarh.

Dr. Shrikrishna S. Bal
I/C Principal (Retd.),
Head, Department of Psychology,
D.B.J.College, Chiplun, Dist. Ratnagiri (M.S.)

Dr. Manoj Dixit
Professor and Head,
Department of Public Administration Director,
Institute of Tourism Studies,
Lucknow University, Lucknow.

Prof. P. T. Srinivasan
Professor and Head,
Dept. of Management Studies,
University of Madras, Chennai.

Dr. P. Vitthal
School of Language and Literature
Marathi Dept. Swami Ramanand
Teerth Marathwada University, Nanded.

EDITORIAL BOARD

Dr. B. R. Kamble
Kirti M. Doongursee College,
Dadar, Mumbai-28.

Dr. Sadique Razaque
Univ. Department of Psychology,
Vinoba Bhave University,
Hazaribagh, Jharkhand.

Prof. Ram Nandan Singh
Dept. of Buddhist Studies University of Jammu.

Dr. Safiqur Rahman
Assistant Professor, Dept. of Geography,
Guwahati College Bamunimaidam, Guwahati,
Assam.

Dr. Jagdish R. Baheti
H.O.D. S. N. J. B. College of Pharmacy,
Meminagar, A/P. Tal Chandwad, Dist. Nashik.

Dr. Vimal K. Lahari
Assistant Professor, Department of Sociology,
Banaras Hindu University, Varanasi, Uttar Pradesh.

Dr. Pandit Sheshrao Nalawade
I/C Principle,
Pandit Jawaharlal Neharu Mahavidyalay,
Aurangabad.

Dr. Sanjay Patil
Principal,
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. V. D. Nanoty
Principal,
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Sunil Somani
Principal,
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Dayanand Raut
S. M. B. S. College,
Khamgaon, Dist. Buldana. (M.S.)

Dr. Pradip Deohate
Shri R. L. T. College of Science,
Akola. (M.S.)

Dr. Saurabh Jadhao
Shri Sant Gajanan Maharaj C.O.E.,
Shegaon. (M.S.)

Dr. Nilima Deshmukh
Associate Professor,
Sahakar Maharshi Late Bhaskarrao Shingne
Arts College, Khamgaon, Dist. Buldana. (M.S.)

Prof. Harshali Akhare
Assistant Professor, Department of English,
Applied Sciences and Humanities, Shri Sant Gajanan
Maharaj College of Engineering, Shegaon. (M.S.)

Mr. Sachin Bhagat
Department of Applied Sciences and Humanities,
Shri Sant Gajanan Maharaj College of Engineering,
Shegaon. (M.S.)

PUBLISHED BY

Ajanta Prakashan
Aurangabad. (M.S.)

CONTENTS OF ENGLISH PART - VII

S. No.	Title & Author	Page No.
1	Benefits of Yogic Practice in Physical Education and Health Empowerment **Dr. R. Aanandhi**	1-5
2	Iris Detection of Left and Right Eye by Using Neural Network Classifier **Om R. Chaudhari** **Dr. R. D. Chaudhari**	6-13
3	A Study on Impact of Health and Safety Programme on Employees of Various Manufacturing Sectors at Kachchh District **Dr. Rajendra Bhupatlal Patoliya**	14-21
4	Existential Threats to the Transgenders: With Special Reference to *Red Lipstick* **Dr. Rajendra Vithal Waghmare**	22-25
5	Investigating Partial and Complete Backordering in an Economic Production Quantity Inventory Model with Exponential Backordering **Dr. Nitin Kumar Mishra** **Renuka Sheshrao Namwad**	26-35
6	Implant Insight: Real-Time Monitoring Dashboard **Riddhi Rajlingu Gadewar** **Pranjal Sanjay Patil** **Sakshi Ramesh Dhakade** **Gaurinandan Chandrashekhar Joshi**	36-44
7	Unveiling the Potential: Harnessing Artificial Intelligence for Teaching, Learning and Research in Management Education **Dr. Ruma Pal**	45-53
8	Clinical Profile of Thyroid Dysfunction: A Cross Sectional Study from Akola District **Kohchale S. R.** **S. R. Rathod** **Devika N. Pathar**	54-58
9	Biochemical and Microbial Examination of Water Extract from Roselle *(Hibiscus Sabdarifa)* **Mr. Sachin S. Bhutekar** **Vaishnavi Deshmukh** **Dr. Tushar G. Deshmukh**	59-64

CONTENTS OF ENGLISH PART - VII

S. No.	Title & Author	Page No.
10	Evaluation of the Efficiency of Some Antiseptics against Selected Bacterial Isolates **Manali Dhoran** **Sandeep A. Toshniwal** **Dr. V. D. Nanoty**	65-73
11	A Survey of Student Education Platform **Sanket Gode** **Prajwal Gawande** **Vaishnavi Dabhade** **Saurabh Wankhade** **M. Faizan I. Khandwani**	74-79
12	Assessment of Some Physico-Chemical Parameters of Drinking Water Samples from Akola (Maharashtra) **Sawarkar A. S.**	80-85
13	Investigation of Phylloplane Mycoflora of Medicinal Plant - Catharanthus Roseus **Shailendra Madavi**	86-90
14	An Analysis of Personalized Product Recommendations to Customer using their Purchase History **Shreya Darodkar** **Gauri Bhoyar** **Manisha Kadam** **Harshada Sawant**	91-97
15	The use of Artificial Intelligence in Digital Forensic **Dr. Shweta Sharma** **Ms. Simran Gianchandani**	98-106
16	Machine Learning Approaches for X-Ray Image Based COVID Disease Identification **Mr. Siddharth K. Ganvir** **Dr. G. K. Reddy**	107-114
17	National Education Policy- Opportunities and Challenges: An Overview **Sonia**	115-120

CONTENTS OF ENGLISH PART - VII

S. No.	Title & Author	Page No.
18	Morphological Observations on Insect Thrips Haplothrips Driesseni from Avenue Flora Cassia Siamea of Akola, Maharashtra **Sushil Maroti Nagrale**	121-126
19	Research on Soybean Seed Grading **Manan Goel** **Tanvi Jeurkar** **Om Amale** **Vaishnavi Khaire** **Prof. Ashwini Deshmukh**	127-134
20	The Contemporary Dynamics in Humanities, Sciences and Technology **Dr. Tejashwini**	135-140
21	A Review on Study of some Phytochemicals in the Aqueous Extract of the Endocarp, Seeds and Exocarp of Watermelon *(Citrullus Lanatus)* Fruit **Mrs. Vaishali N. Badgujar**	141-149
22	Literature and Digital Platform **Prof. Ashwini Kailas Ghule (Lecturer)**	150-154

9. Biochemical and Microbial Examination of Water Extract from Roselle *(Hibiscus Sabdarifa)*

Mr. Sachin S. Bhutekar
Departemnt of Biochemistry.
Vaishnavi Deshmukh
Departemnt of Biochemistry.
Dr. Tushar G. Deshmukh
Department of Zoology, Shri Shivaji College of Arts, Commerce and Science, Akola.

Abstract

Roselle (*Hibiscus sabdarifa*) is a widely consumed plant known for its various health benefits. In this study, we aimed to investigate the antimicrobial properties of water extract from Roselle. The extract was prepared using a standard method and subjected to biochemical analysis to evaluate its efficacy against a range of pathogenic microorganisms. Results revealed significant antimicrobial activity against both gram-positive and gram-negative bacteria. Further investigation into the biochemical constituents of the extract suggested the presence of Phenol compounds. Which are known for their antimicrobial properties these findings highlight the potential of Roselle as a natural antimicrobial agent and underscore its importance in traditional medicine and modern healthcare practices.

Keywords: Roselle, Hibiscus sabdarifa, water extract, antimicrobial, nutritional properties, phenol compound

Introduction

Roselle (*Hibiscus sabdarifa*) is a tropical wild plant belonging to Malvaceae family. (Seema Patel, 2014 et al.), It is a native plant of West Africa and widely cultivated in tropical and subtropical regions around the world. It is valued for its ornamental beauty, culinary applications, and potential health benefits. Roselle is rich in various bioactive compounds which contribute to its antimicrobial properties. The water extract of Roselle has gained attention due to its potential health-promoting effects. Studies have reported its antibacterial activities. However, the biochemical composition and microbial quality of Roselle water extract can vary depending on factors such as plant genotype, growing conditions, and extraction methods.

Biochemical analysis of Roselle water extract involves the quantification of its major bioactive compounds, such as phenol compound using techniques like spectrophotometry. These compounds contribute to the phenol capacity and other biological activities of the extract phenol compounds found in a wide variety of flowers it (Eliana Pereira, Inès Jabeur) et al., analysis involves the detection and enumeration of bacteria, and other microorganisms present in the extract the potential health benefits of Roselle water extract, there is limited research on its biochemical composition and microbial quality. Therefore, comprehensive studies are needed to evaluate its safety, efficacy and potential applications in food, pharmaceutical, and cosmetic industries. The antimicrobial activity of the Roselle water extracts was tested with Staphylococcus aureus and Escherichia coli it (Eunkyung Jung, Youngjun Kim et al).

The emergence of antibiotic-resistant microorganisms poses a significant threat to public health, emphasizing the need for alternative antimicrobial agents. Plants have long been recognized as a potential source of bioactive compounds with antimicrobial properties. Roselle (*Hibiscus sabdarifa*) is one such plant, commonly used in traditional medicine due to its diverse pharmacological activities. Despite its widespread use, there is limited scientific evidence regarding its antimicrobial efficacy. Therefore, this study aimed to evaluate the antimicrobial activity of water extract from Roselle and explore its biochemical constituents. The findings will contribute to a better understanding of its health-promoting properties and facilitate its utilization in various industries.

Materials and Methods

Materials

- Roselle *(Hibiscus sabdarifa)* flowers or dried calyces
- Distilled water
- Sterile containers or bottles
- Sterile sampling equipment (pipettes, swabs, etc.)
- Nutrient Agar plates for microbial culture
- Incubator
- Chemical reagents for biochemical tests (optional depending on the specific tests being conducted)

Preparation of Roselle Extract: Wash the Roselle flowers or dried calyces thoroughly to remove any external contaminants for Make juice of Roselle calyces Water extract was prepared

by boiling the dried calyces in distilled water. Roselle water extracted using distillation assembly.

Biochemical Examination

Perform specific biochemical tests as needed to identify and quantify certain compounds present in the Roselle extract. Common tests might include tests for carbohydrate, proteins, and other organic compounds. Carbohydrate test done by using molish's test and protein test done by using folin lower method. Biochemical analysis of the extract was performed to identify phenol compounds using standard Spectrophotometer assays. it (Alaa G. Al-Hashimi et al).

Microbial Examination

The disc diffusion method, also known as the Kirby-Bauer method, is a widely used technique in microbiology to determine the susceptibility of bacteria to antimicrobial agents. Here's how it works

- **Preparation of Agar Plates:** Agar plates are prepared with a layer of agar medium that contains nutrients necessary for bacterial growth. The medium is poured into sterile Petri dishes and allowed to solidify.
- **Inoculation of Bacteria**: The bacteria to be tested are swabbed onto the surface of the agar plate using a sterile cotton swab. The bacteria are evenly spread across the surface of the agar.
- **Application of Antibiotic Discs**: Small, circular paper discs impregnated with different antibiotics are placed on the surface of the agar plate. Each disc contains a specific concentration of a particular antibiotic.
- **Incubation:** The agar plates are then incubated at the optimal temperature for the growth of the bacteria being tested. This allows the bacteria to grow and form colonies on the agar surface.
- **Measurement of Zones of Inhibition:** After incubation, the plates are examined for zones of inhibition, which are areas around the antibiotic discs where bacterial growth is inhibited. The diameter of these zones is measured using a ruler or a caliper.
- **Interpretation:** The diameter of the zone of inhibition is compared to standardized tables provided by organizations like the Clinical and Laboratory Standards Institute (CLSI) or the European Committee on Antimicrobial Susceptibility Testing (EUCAST). These tables provide interpretive criteria for determining whether the

bacteria are susceptible, intermediate, or resistant to the antibiotics tested. a. Aseptically collect water samples from the Roselle extract for microbial analysis using sterile sampling equipment. b. Plate the samples onto appropriate agar plates using the spread plate or pour plate method. c. Incubate the agar plates at suitable temperatures for the growth of different microorganisms (e.g., 37°C for bacteria, 25°C for fungi). d. After incubation, observe the plates for microbial growth. Colony morphology, color, and other characteristics can provide initial identification clues. e. Further confirm the identity of microbial colonies using biochemical tests, The antimicrobial activity was done by using disc diffusion method against a panel of pathogenic bacteria (both gram-positive and gram-negative

Results and Discussion

The above observation, positive result of the Folin-Lowry method is indicated by the development of a blue color in the reaction mixture. This color change is directly proportional to the concentration of protein present in the sample.

The molisch's test for carbohydrates yields is positive it indicates the presence of carbohydrates in the tested sample. This positive result is typically observed as the formation of a purple or reddish color.

The water sample extracted by Roselle exhibited significant antimicrobial activity against all tested microorganisms. Zones of inhibition were observed in agar diffusion assay, were determined using disc diffusion susceptibility method. The extract demonstrated bacteria effects against both gram-positive (e.g., Staphylococcus aureus) and gram-negative (e.g., Escherichia coli) bacteria

Biochemical analysis revealed the presence of phenol compounds in the extract, which are known for their antimicrobial properties.

This study indicates that water extract from Roselle possesses significant antimicrobial activity against a range of pathogenic microorganisms. The presence of phenol compounds as in the extract likely contributes to its antimicrobial efficacy. These results support the traditional use of Roselle in folk medicine and highlight its potential as a natural antimicrobial agent it (Seema Patel 2014 etal). Further research is warranted to isolate and characterize the active compounds responsible for the observed antimicrobial activity and to explore their mechanisms

of action. Overall, Roselle represents a promising candidate for the development of novel antimicrobial agents to combat infectious diseases.



E. coli
Zone of resistance is 20mm



S. aures
Zone of resistance is 22mm

Conclusion

The biochemical and microbial examination of water extract from Roselle revealed promising results. The extract exhibited notable antimicrobial activity against a range of pathogens, suggesting its potential as a natural antimicrobial agent. Additionally, the biochemical analysis indicated the presence of beneficial compounds such as phenol which could contribute to its health-promoting properties. Further research into the specific mechanisms of action and safety profile of the extract is warranted to fully harness its potential for therapeutic and industrial applications.

Acknowledgement

I would like to express my sincere gratitude to the Principal Dr.A. L. Kulat for providing me with all the resources and facilities needed for my experiment and all those who helped me complete this project successfully. First and foremost, a big thanks to my Guide, Sachin s. Bhutekar, Dr. Ashwini A. Balode, Ravi L. Dabhade Assistant professor, Department of Biochemistry, Shri Shivaji Arts, Commerce and Science college, Akola for giving me valuable guidance and pointing me in the right direction.

Reference

1. D. L. McKay et al. Pharmacological evidences for the extracts and secondary metabolites from plants of the genus *Hibiscus* Food Chemistry (2010)
2. Mohd-Esa et al. *Hibiscus Sabdarifa* L. tea (tisane) lowers blood pressure in hypertensive and mildly hypertensive adults Journal of Nutrition (2010)

3. N. Pellgrini et al. Free radical scavenging properties and phenol characterization of some edible plants Food Chemistry (2009)
4. E. Prenesti et al. Total antioxidant capacity of plant foods, beverages and oils consumed in Italy assessed by three different in vitro assays Journal of Nutrition (2003) E. Prenesti et al.
5. S. P. Wong et al. Antioxidant power quantification of decoction and cold infusions of *Hibiscus sabdarifa* flowers Food Chemistry (2007)
6. D. L. McKay *et al.* Pharmacological evidences for the extracts and secondary metabolites from plants of the genus Hibiscus Food Chemistry (2010)
7. Mohd-Esa *et al. Hibiscus Sabdarifa* L. tea (tisane) lowers blood pressure in hypertensive and mildly hypertensive adults Journal of Nutrition (2010)
8. N. Pellgrini et al. Free radical scavenging properties and phenol characterization of some edible plants Food Chemistry (2009)
9. E. Prenesti et al. Total antioxidant capacity of plant foods, beverages and oils consumed in Italy assessed by three different in vitro assays Journal of Nutrition (2003) E. Prenesti et al.
10. S. P. Wong et al. Antioxidant power quantification of decoction and cold infusions of *Hibiscus sabdarifa* flowers Food Chemistry (2007)

THE RUBRICS JOURNAL OF INTERDISCIPLINARY STUDIES
International, Indexed and Peer Reviewed e-Journal
ISSN 2454-1974

THE RUBRICS
Journal of Interdisciplinary Studies
Volume 6 Issue 2 March 2024
www.therubrics.in

Study of Clinical & Diagnostic Profile of Patients Suffering from β – Thalassemia in and around Akola Region

Dr. Tushar G. Deshmukh
ssistant Professor, Department of Zoology, Shri Shivaji College of Art's, Commerce & Science, Akola

FULL PAPER

Introduction

Thalassemias are inherited blood disorders characterized by abnormal hemoglobin production. There are two main types, α Thalassemia, and β Thalassemia. β Thalassemia Major (also called Cooley's Anemia) is a serious illness. Symptoms of Thalasemia appeared in the first two years of life and include light paleness of the skin, loss of appetite, irritability, and low growth. There is absent or decreased production of normal hemoglobin, resulting in microcytic anemia of varying degrees. The β Thalassemias are seen primarily in the areas surrounding the Mediterranean Sea, Africa, and Southeast Asia The main treatment option for most patients is supportive care consisting of blood transfusion and iron chelation therapy. The resulting clinical manifestations are bone marrow expansion, increased function of the spleen (splenomegaly), and chronic hemolytic anemia (Singh et *al.*, 2019).

Estimates indicate that there would be around 100,000 patient's with α & β Thalassemia syndrome and around 150,000 cases of sickle cell disease in this vast country (Colah *et al.*, 2014,). However, in the absence of National Registries of patients, the exact numbers are not known. Out of the 10,500 to 12,500 Thalassemic children born Annually in India, very few are optimally managed mainly in urban regions although Indian Government has included the care and management of patients of Thalassemia and sickle cell disease in the 12th Five Year Plan. It has been estimated that 2 million units of packed red cells would be needed for transfusion of Thalassemia patient's in the country (Marwaha, 2010).

The carriers of either β° or severe β++ mutations have relatively high red blood cell count (RBC), while (MCV = hematocrit/ RBC number) and mean corpuscular hemoglobin (MCH = Hb/RBC number) are markedly reduced (MCV: 60–70 fl; MCH: 19–23 pg). The Hb levels vary widely and they can be from normal to up to 2 g/dL. Carriers of mild β - mutations have usually higher values of MCV and MCH than β °

Scanned with OKEN Scanner

ISSN 2454-1974

carriers although lower than normal. The most widely used cutoff values of MCV and MCH for indicating Thalassemia are 79 fl and 27 pg, respectively (Oid *et al.*, 2012). There are more than 200 known β - Thalassemia mutations, the majority being single nucleotide substitutions, insertions, or short deletions. Few large b-gene deletions have been identified and most of them can be diagnosed by Gap-PCR (Higgs et *al.*, 2012).

Fortunately, a limited number of point mutations are prevalent in different ethnic group; therefore, for any given ethnic region, a PCR method designed to detect the common-specific mutation simultaneously is initially used. The high cost is also not affordable by majority of the families with a Thalassemia major child. Thus, prevention of the birth of an affected child is a feasible and realist option. The records which are available in hospitals gives a better determination of the pattern of disease in the community and when there is unavailability of formal population-based screening of β Thalassemia . With this background, this study was done in and around Akola city of Vidharbha Region of Maharashtra. The aim of this is study to assess the pattern, clinical presentations, complications, and management practices along with diagnostic & geographical profile among thalassemic cases.

Material and Methods

Type of study

The survey of Thalassemia disorder in various geographical areas was done to study the origin and geography of Thalassemia. This retrospective record based cross sectional study was conducted between December 2022 to march 2023 in and around Akola district. All the data of the confirmed cases of Thalassemia were examined.

Sampling Method

The information regarding socio-demographic details of the patient's, type of Thalassemia, risk factors such as the family history of genetic disorders, history of consanguinity among parents, prenatal analysis, symptoms, signs, and complications associated with Thalassemia, hematological reports, and management practices were recorded in a predesigned validated proforma. The study utilized the data from the medical files of Akola Thalassemia society day care centre, Akola. This study included 122 individuals in which 102 active β thalassemic patient's and 20 β thalassemic carriers for these 20 carriers. We also collected the fetal analysis reports which they have already conducted for the detection of Thalassemia in the families having medical history of β Thalassemia.

Data collection procedure

The study utilized data from the medical files of the Akola Thalassemia society Akola ,Maharashtra India, for 122 patient's with β-Thalassemia covering Akola, Washim and Buldhana districts of Vidharbha Region . The Inclusion criteria of

Scanned with OKEN Scanner

ISSN 2454-1974

patient's in this study included patient diagnosed with β-Thalassemia major and receiving regular or occasional blood transfusion during the study period also included carriers of β Thalassemia who already performed prenatal tests for detection of Thalassemia.

Hematological Tests : Hb total RBC, PCV, MCV, MCH MCHC, RDW-CV, total leucocytes count (TLC). Differential Count included : Polymorphs, Lymphocytes, Monocytes, Eosinophils, Basophils, Platelet count. Biochemical Tests included : Serum creatinine, Blood urea nitrogen (BUN),), serum bilirubin, serum bilirubin direct , serum Bilirubin indirect ,blood sugar Random .

Prenatal Test included :Amniocentesis and chorionic villi sampling test conducted during early pregnancy. Test results were categorized as normal or high according to the reference. Hb levels were categorized according to guidelines of the Thalassemia International Federation (TIF) We also retrieved data regarding the intake of iron chelation therapy. The available iron chelators in Akola are deferasirox (DFX).

The retrieved data included the demographic characteristics of the patient's, laboratory test results, and iron chelation treatment. Demographic characteristics included age, sex, and place of the treatment. The data were arranged and analyzed by statistical method by calculating the arithmetic mean and standard deviation.

Observation & Result

In the geographical study of distribution of β thalassemic patient's in Akola and nearby region we considered 7 taluka's present in Akola district (Akola , Akot , Balapur , Barshitakli, Murtijapur , Telhara , Patur)and two district nearby Akola (Buldhana and Washim). The Taluka wise distribution of patient's was - Akola- 57, Akot- 3, Balapur-8 , Barshitakli-8, Murtijapur-1 , Telhara-1 , Patur-3 . In Buldhana district 16 patient's were present and in Washim district 6 patient's were present. Akola taluka have most number of patient's 55.88 % of total patient's.

Epidemiological profile of β Thalassemic patient's

In the study of epidemiological profile of β Thalassemic patient's we have considered various aspects such as socio-demographic factors, age, sex, geographical location, economic status, iron chelation and consanguineous marriages of the β Thalassemic (major) patient's and their family. Out of the Total 122 patient's 102 were β - Thalassemic major and 20 were β- Thalassemic carriers which were registered at the day care centre of Akola Thalassemia society, Akola. Out of these 102 β-Thalassemic patient's 53 were male and 49 were female. 66 patient's belonging to age group 0.6 to 11 yrs, 20 patient's belonging to age group 12 to 17 yrs and 16 patient's belonging to age group 18 to 32 yrs. Economical status of 73 patient's families was found to be above poverty line and 29 of the patient's were belonging to below poverty line.

Scanned with OKEN Scanner

ISSN 2454-1974

On the basis of geographical location 61 patient's resided in urban areas and 41 patient's resided in rural areas. 97 patient's were on regular oral iron chelator and the drug used was Deferasirox. Out of the 102 patient's; parents of 21 patient's had consanguineous marriage (i.e. marriages between close relatives) and parents of patient's had non-consanguineous marriage. Percentage of Consanguineous marriage was 20.58 % .

Table 1 : Mutations observed in β globin chain of carriers and fetus

Case no	Mother	Father	Cvs /Amniocentesis of mother
1	HETEROZYGOUS FOR 619 bp DELETION	HETEROZYGOUS FOR IVS-1,1 (G-T)	HETEROZYGOUS FOR 619 bp DELETION
2	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR C 92 G>A MUTATION IN HBB GENE
3	HETEROZYGOUS FOR c.92+5G>C/IVS1-5(G>C)	HETEROZYGOUS FOR C 92 G>A MUTATION IN HBB GENE	HETEROZYGOUS FOR C 92 G>A MUTATION IN HBB GENE
4	HETEROZYGOUS FOR CD 41/42 (CTTT)	HETEROZYGOUS FOR 619 bp DELETION	HETEROZYGOUS FOR 619 bp DELETION
5	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)
6	HETEROZYGOUS FOR IVS-1,1 (G-T)	HETEROZYGOUS FOR 619 bp DELETION	NO MUTATION (NORMAL)
7	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)
8	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)	NO MUTATION (NORMAL)

Scanned with OKEN Scanner

ISSN 2454-1974

9	HETEROZYGOUS FOR IVS-1,5 (G-C)	CD 8-9 (+G)	NO MUTATION (NORMAL)
10	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)	HETEROZYGOUS FOR IVS-1,5 (G-C)

Table No 2 : β - globin gene mutation found in Father, Mother and Fetus in prenatal test

β Gene mutation	Father	Mother	Fetus
-619 del	2	1	2
IVS1-nt1 GTA	1	1	0
IVS1-nt 5 GTC	5	6	3
41/42-TTCT	0	1	0
c.92+5G>C/IVS1-5(G>C)	0	1	0
92 G>A MUTATION IN HBB GENE	1	0	2
CD 8-9 (+G)	1	0	0
Total	10	10	7

The above table (table no 3) represents β - globin gene mutation found in father, mother and fetus in prenatal test. Out of 10 tests conducted 9 were of CVS and 1 test was of amniocentesis. CVS was carried out during 10-13 weeks of pregnancy and amniocentesis was carried out during 15 to 20 weeks of pregnancy. Majority of β gene mutation observed were found to be IVS1-nt5 GTC – males- 5, females – 6, fetus – 3. -619 del β gene was found in – males – 2 , females-1 , fetus – 2 . IVS1-nt1 GTA β gene mutation was found in – males -1 female -1. 92 G>A MUTATION IN HBB GENE mutation was found in – male - 1 , fetus-2. c.92+5G>C/IVS1-5(G>C) β gene mutation was found in female – 1. 41/42-TTCT was found in – female – 1. CD 8-9 (+G) β gene mutation was found in –male – 1. Out of the 10 cases analyzed we observed that three fetus showed no mutation for β Thalassemia i.e. they were found to be normal. In 7 cases the fetus was heterozygous for β Thalassemia i.e. the fetus was found to be carrier. Not a single case was found to be homozygous for β Thalassemia.

Scanned with OKEN Scanner

ISSN 2454-1974

Table 3: Hematological characters of β Thalassemic patient's

Indicator	Number of patient's	Category	Frequency N	arithmetic mean ± SD	Range
Hemoglobin (Hb)	19	<6	1	8.8 ± 1.57	5.7-12
		6-9	6		
		>9	12		
RBC	19	Low	11	3.60 ± 0.73	1.99-5.16
		Normal	6		
		High	2		
PCV	19	Low	13	27.8 ± 11.78	17 - 34.4
		lowest	6		
MCV	19	low	7	78.72 ± 7.5	64.3-91.1
		Normal	12		
		High	0		
MCH	19	Low	6	26.26 ± 2.39	21.6-30.2
		Normal	13		
		High	0		
MCHC	19	Low	6	32.22 ± 5.26	11-35.7
		Normal	13		
		High	0		
RDW-CV	19	Low	19	19.82 ± 3.22	15.7-26.8
		Normal	0		
		High	0		
TLC total leucocytes count	19	Low	2	11692.63 ± 9775.67	3290 - 41880
		Normal	12		
		High	5		
Polymorphs	19	Low	4	44.05 ± 9.06	24-64
		Normal	15		
		High	0		
Lymphocytes	19	Low	0	45.68 ± 9.78	24-66
		Normal	11		

Scanned with OKEN Scanner

ISSN 2454-1974

		High	8		
Monocytes	19	Low	1	4.31 ± 1.88	2-9
		Normal	16		
		High	2		
Eosinophils	19	Low	0	5.89 ± 2.84	2-12
		Normal	7		
		High	12		
Basophils	19	Normal	19	0.0526 ± 0.2294	0-1
Platelet count	19	Low	3	3.82 ± 2.30	1.09-8.91
		Normal	11		
		High	5		

Complete Blood Count (CBC)

One patient had hemoglobin less than 6. Six patient had hemoglobin between 6 to 9 twelve patient had hemoglobin more than 9 arithmetic mean value and standard deviation calculated for Hb was found to be - 8.8 ± 1.57 g/dl. In eleven patient's RBC levels were found to be low. Six patient's had normal RBC level .Two patient's had higher RBC level. Arithmetic mean and standard deviation calculated for RBC was found to be - 3.60 ± 0.73 million / mm^3. In thirteen patient's PCV levels were found to be low In six patient's PCV levels were found to be extremely lower arithmetic mean and standard deviation calculated for PCV was found to be - 27.8 ± 11.78 % . In seven patient's MCV level were found to be low. In twelve patient's MCV level were found to be normal arithmetic mean and standard deviation calculated for MCV was found to be- 78.72 ± 7.5 µ m^3. In six patient's MCH level were found to be low. In thirteen patient's MCH level were found to be normal. Arithmetic mean and standard deviation calculated for MCH was found to be -26.26 ± 2.39 .g/dl.

In six patient's MCHC level were found to be low .In thirteen patient's MCHC level were found to be normal. Arithmetic mean and standard deviation calculated for MCHC was found to be -32.22 ± 5.26 g/dl. In nineteen patient's RDW-CV level were found to low. Arithmetic mean and standard deviation calculated for RDW-CV was found to be –19.82 ± 3.22 %. In one patient's TLC level were found to be low . In sixteen patient's TLC level were found to be normal .In patient's TLC level were found to be high . Arithmetic mean and standard deviation calculated for TLC was found to be – 11692.63 ± 9775.67 µl. In four patient's level of polymorphs were found to be low . In fifteen patient's level of polymorphs were found to be normal . Arithmetic mean and standard deviation calculated for polymorphs was found to be – 44.05 ± 9.06 µl.

Scanned with OKEN Scanner

ISSN 2454-1974

In eleven patient's level of lymphocytes were found to be normal .In eight patient's level of lymphocytes were found to be high. Arithmetic mean and standard deviation calculated for lymphocytes was found to be – 45.68 ± 9.78 µl . In one patient's monocytes levels were found to be low .Sixteen patient's had normal monocytes level. Two patient's had higher monocytes level . Arithmetic mean and standard deviation calculated for monocytes was found to be – 4.31 ± 1.88 µl. In seven patient's level of eosinophils were found to be normal. In twelve patient's level of eosinophils were found to be high. Arithmetic mean and standard deviation calculated for eosinophils was found to be – 5.89 ± 2.84 µl. In nineteen patient's level of Basophils were found to be normal. Arithmetic mean and standard deviation calculated for Basophils was found to be – 0.0526 ± 0.2294 µl.

In three patient's platelet levels were found to be low. In 11 patient's level of platelet were found to be normal .In five patient's level of platelet were found to be high. Arithmetic mean and standard deviation calculated for platelet was found to be –3.82 ± 2.30 µl.

Table 4 : Biochemical characters of β Thalassemic patient's

Indicator	Number of patient's	Category	Frequency N	Arithmetic mean ± SD	Range
Serum blood urea	19	Low	0	22.12 ± 7.94	11.2-36.53
		Normal	17		
		High	2		
BUN-blood urea nitrogen	19	Low	2	10.35 ± 3.72	5.23-17.27
		Normal	17		
		High	0		
Serum creatinine	19	Low	1	0.574 ± 0.14	0.39-0.88
		Normal	16		
		High	2		
Serum bilirubin Total	19	Low	0	1.97 ± 1.89	0.39-7.21
		Normal	7		
		High	12		
		Low	13		

Scanned with OKEN Scanner

ISSN 2454-1974

In eleven patient's level of lymphocytes were found to be normal .In eight patient's level of lymphocytes were found to be high. Arithmetic mean and standard deviation calculated for lymphocytes was found to be – 45.68 ± 9.78 µl . In one patient's monocytes levels were found to be low .Sixteen patient's had normal monocytes level. Two patient's had higher monocytes level . Arithmetic mean and standard deviation calculated for monocytes was found to be – 4.31 ± 1.88 µl. In seven patient's level of eosinophils were found to be normal. In twelve patient's level of eosinophils were found to be high. Arithmetic mean and standard deviation calculated for eosinophils was found to be – 5.89 ± 2.84 µl. In nineteen patient's level of Basophils were found to be normal. Arithmetic mean and standard deviation calculated for Basophils was found to be – 0.0526 ± 0.2294 µl.

In three patient's platelet levels were found to be low. In 11 patient's level of platelet were found to be normal .In five patient's level of platelet were found to be high. Arithmetic mean and standard deviation calculated for platelet was found to be –3.82 ± 2.30 µl.

Table 4 : Biochemical characters of β Thalassemic patient's

Indicator	Number of patient's	Category	Frequency N	Arithmetic mean ± SD	Range
Serum blood urea	19	Low	0	22.12 ± 7.94	11.2-36.53
		Normal	17		
		High	2		
BUN-blood urea nitrogen	19	Low	2	10.35 ± 3.72	5.23-17.27
		Normal	17		
		High	0		
Serum creatinine	19	Low	1	0.574 ± 0.14	0.39-0.88
		Normal	16		
		High	2		
Serum bilirubin Total	19	Low	0	1.97 ± 1.89	0.39-7.21
		Normal	7		
		High	12		
		Low	13		

Scanned with OKEN Scanner

ISSN 2454-1974

Serum biliburin direct	19	Normal	6	0.296 ± 0.1158	0.2-0.55
		High	0		
Serum bilirubin indirect	19	Low	0	1.73 ± 1.85	0.9-6.92
		Normal	12		
		High	7		
Serum SGOT	19	Low	0	45.19 ± 25.64	22.03-107.3
		Normal	10		
		High	9		
Serum SGPT	19	Low	0	46.47 ± 34.41	8.8-138.23
		Normal	11		
		High	8		
Blood sugar random	19	Low	0	128.3 ± 87.80	79.3-443.5
		Normal	15		
		High	4		

Blood Biochemistry

In seventeen patient's serum blood urea levels were found to be normal. In two patient's level of serum blood urea were found to be high. . Arithmetic mean and standard deviation calculated for serum blood urea was found to be –22.12 ± 7.94 mg/dl. In seventeen patient's levels of BUN-blood urea nitrogen were found to be normal. In two patient's level of BUN-blood urea nitrogen were found to be low. . Arithmetic mean and standard deviation calculated for BUN-blood urea nitrogen was found to be – 10.35 ± 3.72 mg/dl . In one patient Serum creatinine levels were found to be low. In sixteen patient's level of Serum creatinine were found to be normal .In two patient's level of Serum creatinine were found to be high. Arithmetic mean and standard deviation calculated for Serum creatinine was found to be –0.574 ± 0.14 mg/dl.

In seven patient's level of Serum bilirubin Total were found to be normal. In twelve patient's level of Serum bilirubin Total were found to be high. Arithmetic mean and standard deviation calculated for Serum bilirubin Total was found to be – 1.97 ± 1.89 mg/dl. In thirteen patient's Serum biliburin direct levels were found to be low. In six patient's level of Serum biliburin direct were found to be normal. .Arithmetic mean and standard deviation calculated for Serum biliburin direct was found to be– 0.296 ± 0.1158 mg/dl . In seven patient Serum biliburin indirect levels were found to be high.

Scanned with OKEN Scanner

ISSN 2454-1974

n twelve patient's level of Serum biliburin indirect were found to be normal. Arithmetic mean and standard deviation calculated for Serum biliburin indirect was found to be – 1.73 ± 1.85 mg/dl. In nine patient's Serum (SGOT) levels were found to be high. In ten patient's level of Serum SGOT were found to be normal. .Arithmetic mean and standard deviation calculated for Serum (SGOT) was found to be – 45.19 ± 25.64 U/L

In eight patient Serum (SGPT) levels were found to be high . In eleven patient's level of Serum SGPT were found to be normal. .Arithmetic mean and standard deviation calculated for Serum (SGPT) was found to be - 46.47 ± 34.41 U/L. In four patient's Blood sugar random levels were found to be high . In fifteen patient's level of Blood sugar random were found to be normal. Arithmetic mean and standard deviation calculated for Serum (SGPT) was found to be - 46.47 ± 34.41 mg/dl.

Discussion

The situation of Thalassemia causing hereditary hemolytic anemia is very grim in India. Unfortunately there is no attempt at the national level to enlarge the epidemiological database, establishing specific programmes for screening population at risk, imparting genetic counseling and establishing special treatment centers to alleviate the suffering of dwindling masses in India. Only piecemeal and sporadic studies have been carried out in some communities in India. β Thalassemia represents group of recessively inherited hemoglobin disorders characterized by reduced synthesis of β globin chains resulting in severe anemia which needs repeated blood transfusion. The combination of transfusion and chelation therapy has dramatically improved the life expectancy of thalassemic children.

The present study showed that prenatal carrier screening for β Thalassemia followed by prenatal counseling and diagnosis has helped to prevent β Thalassemia major patient. Thus reducing the burden of the disease in the country as a psychological and financial burden of the family and to society despite efforts to develop gene therapy or bone marrow transplantation, prenatal diagnosis followed by termination of the affected fetus remains the best form of management. This current study has revealed the presence of IVS1-nt5 GTC mutation and 619 deletion mutation, which are comparatively similar to the study conducted in the β -Thalassemia cases from North India by (Verma *et al.*, (1997) and Varawalla *et al.*, (1991

In present investigation we found that percentage of consanguineous marriages in the parents of β thalassemic patient's was 20.58 % which is nearly similar to the study conducted by Kumar *et al.*, 2015 which showed the percentage of consanguineous marriages to be 15 %.This states that consanguineous marriages appear to be an important factor in the high frequency of occurrence of this disease . In this present study we found hemoglobin percentage was 8.8 ± 1.57 g/dl which is correlated to Hemoglobin in other studies which was found to be 8.4±1.4 g/dl in

Scanned with OKEN Scanner

ISSN 2454-1974

Aldwaik *et al.*,2021 , 8.2±1.8 g/dl in Hasan *et al.*20.16, 8.2±1.8 g/dl in Shams *et al.*,2010, 7.7±0.1 g/dl in Asif *et al.*,2014 .

According to the study of Isiklar 2018 the RBC composition of thalassemic patient was found to be 4.61 ± 0.4 this is in agreement with the result of present study which is 3.60 ± 0.73 and which also states that RBC count of thalassemic patient's in this region is low . In present study the MCV , MCH and MCHC was found to be 78.72 ± 7.5 , 26.26 ±2.39 , 32.22 ±5.26 respectively, which showed similarities to the result output of the study of Karim *et al.*, 2016. In the study of Karim *et al, 2016 the* MCV, MCH and MCHC was found to be 70 ± 9.5, 28 ± 5, 36.7 ± 4.6 respectively.

The level of RDW-CV in the present study was found to be 19.82 ± 3.22 which is similar to the study of Isiklar 2018 which was found to be 17.95 ± 2.3. The same results were also found by Vehapoglu *et al., 2014 in* which RDW-CV was 16.76 ± 1.83. Various hematological studies conducted in different parts of the world showed similarities with our present investigation. Accordingly to a study conducted by Ayyash & Sirdah in 2018 the total bilirubin and direct bilirubin was found to be 2.1 ± 0.8 and 0.57 ± 0.22 which is merely similar to the present study in which the total bilirubin and direct bilirubin was found to be 1.97 ± 1.89 and 0.29 ± 0.11 respectively.

Along with this the serum creatinine level also showed similarities in between the study of Ayyash and Sirdah 2018 and the present study. In the study of Ayyash and Sirdah 2018 the serum creatinine was found to be 0.59 ± 0.3 and in the present study the serum creatinine was found to be 0.57 ± 0.14 which shows correlation.In the research of Bekhit *et al* .,2017 showed that serum blood urea was 24.6 ± 5.9 and in the present study the serum blood was found to be 22.12 ± 7.94 which is very nearer to his values.

In this present clinical investigation of the β thalassemic patient's the study showed that Fever was observed in (21.56%). Pallor (92.15%) followed by hepatomegaly (95.09 %). Bone deformities were reported in (22.54 %) cases, all of which were β Thalassemia major cases. Which is merely similar to the study of Singh *et al* .,2016 which showed that fever (18.6 %), Pallor (97.8 %) hepatoegaly (94%) and bone deformities were reported in 19.1 % of the cases .

Conclusion

This study promotes awareness of this condition to improve carrier identification, genetic counseling and prenatal diagnosis among high risk groups carrying Thalassemia traits for minimizing its incidence. It also provides relevant data and information regarding the procedures of carrier detection and management of thalassemic patient's. This study delivers information regarding the genetic mutations which are seen in the β- thalassemic patient's in this particular geographical region. This investigation encourages the study of thalassemic disorder at the genetic level.

Scanned with OKEN Scanner

ISSN 2454-1974

Scanned with OKEN Scanner

References

Ayyash H and Sirdah M . (2018) : Hematological and biochemical evaluation of β-Thalassemia major (βTM) patient's in Gaza Strip: A cross-sectional study International Journal of Health Sciences 18 Vol. 12, Issue 6 (November - December 2018).

Colah R and Italia K.(2017) : Genetic counseling for hematological disorders. In: Lokeshwar MR, Sachdeva A, et al., editors. (2017) Fetal & neonatal hematology, oncology and immunology. Mumbai: J.P.Brothers Medical Publishers; 2017. pp38e42.

Higgs DR, Engel JD and Stamatoyannopoulos G.(2012) : Thalassemia. Lancet 2012;379:373–83.

Isiklar A and Karsidag K . (2018): association between Thalassemia trait and insulin resistance . Acta Medica Mediterranea, 2018, 34: 321

Italia KY, Sawant PM, Nadkarni AH, Ghosh K, Colah RB. (2017) : Is the poly A (T > C) R. Colah et al. / Pediatric Hematology Oncology Journal 2 (2017) 79e84

83 mutation a causative factor for misdiagnosis in second trimester prenatal diagnosis of b-Thalassemia by fetal blood analysis on high performance liquid chromatography? Hemoglobin 2012;36:114e23.

Karim F , Ismail M , Hasan M and Uddin S . (2015) : Hematological and biochemical status of BetaThalassemia major patient's in Bangladesh: A comparative analysis . IJHOSCR 10(1) - ijhoscr.tums.ac.ir – January, 1, 2016

Marwaha N. (2010): Whole blood and component use in resource poor settings.

Biologicals 2010;38:68e71.

Varawalla NY and Weatherall DJ (1990) : Rapid detection and prenatal diagnosis of b-thalassaemia : studies in Indian and Cypriot populations in the UK. Lancet 33:834–837

Olivieri NF. (1999) : The Beta-Thalassemias. N Engl J Med 1999;341:99–109.

Singh M, Dayal R, Kumar N, Singh S.P, Gupta L.K, Nayak M, Sharma R.K and Yadav A. (2019): Clinico-epidemiological profile of Thalassemia patient's in a tertiary care center. Int J Pediatr Res.2019;6(09):484- 488.doi:10.17511/ijpr.2019.i09.08

Sinha S, Black L, Agarwal S, Colah R, Das R and Ryan K (2009) : Profiling β - thalassaemia mutations in India at state and regional levels: implications for genetic education, screening and counseling programmes. Hugo J 2009;3: 51e62.

Varawalla N, Old M, Sarkar R, Venkatesan R and Weatherall J (1991) : The spectrum of b-Thalassemia mutations on the Indian subcontinent: the basis for prenatal diagnosis. Br J Haematol 78:242–247

Varawalla Y, Old M and Weatherall J (1991) : Rare beta-thalassaemia mutations in Asian Indians. Br J Haematol 79:640–644

ISSN 2454-1974

Vecchio F. (1946) : Sulla resistenza della emoglobina alla denaturazione alcalina in alcune sindromi emopatiche. Pediatria 54, 545.

Verma C (1994) : The challenge of genetic disorders in India. In: Molecular genetics and gene therapy—the new frontier. Scientific Communications, Amsterdam, pp 11–20

Scanned with OKEN Scanner

ISSN 2319 - 359X

AN INTERNATIONAL MULTIDISCIPLINARY
HALF YEARLY RESEARCH JOURNAL

IDEAL

Volume - XII Issue - II March - August - 2024

ENGLISH PART - VIII

Peer Reviewed Referred and
UGC Listed Journal No. 47026

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING
2023 - 7.537
www.sjifactor.com

❖ EDITOR ❖

Assit. Prof. Vinay Shankarrao Hatole
M.Sc (Math's), M.B.A. (Mkt), M.B.A (H.R),
M.Drama (Acting), M.Drama (Prod & Dirt), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan
Aurangabad. (M.S.)

The information and views expressed and the research content published in this journal, the sole responsibility lies entirely with the author(s) and does not reflect the official opinion of the Editorial Board, Advisory Committee and the Editor in Chief of the Journal **"IDEAL"**. Owner, printer & publisher Vinay S. Hatole has printed this journal at Ajanta Computer and Printers, Jaisingpura, University Gate, Aurangabad, also Published the same at Aurangabad.

Printed by

Ajanta Computer, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Published by

Ajanta Prakashan, Near University Gate, Jaisingpura, Aurangabad. (M.S.)

Cell No. : 9579260877, 9822620877

E-mail : ajanta2023@gmail.com, www.ajantaprakashan.in

IDEAL - ISSN 2319 - 359X - Impact Factor - 7.537 (www.sjifactor.com)

18. Ichthyofaunal Diversity of Kapsi Lake and its Use in Ecological Assessment

Miss. Prajkta Dhadse
Research Student, Department of Zoology, Shri Shivaji College of Art's, Commerce and Science, Akola.
Dr. Tushar Deshmukh
Assistant Professor, Department of Zoology, Shri Shivaji College of Art's, Commerce and Science, Akola.

To carry out the freshwater diversity, species abundance and the various aspects of Prawns, fish and shrimp of Kapshi lake will be selected for the research work in region of Akola district. The order Cypriniformes was dominant with 15 species to be followed by order Perciformes with 03 specieswhile order Siluriformes with 03 species and Synbranchiformes with 02 species and Cichliformes with 02 species and Anguilliformes, Carangiformes, Clupeiformes, Anabantiformes with 01 species respectively.

During the present investigation the or de of dominance is as, Cypriniformes>Siluriformes>Cichliformes=Synbranchiformes=Perciformes>Anguilliformes=Carangiformes=Clupeiformes=Anabantiformes. As for, the status of biodiversity was concerning about the availability species were categorized as throughout the study period included species of Least Concern (LC) category and Food fish (35) Highly native fish (HNF 1) Highly economic IMP (35) Larvivorous fish (1), Threatened fish (1) Commonfish (5)were recorded. Likewise, the another group of vulnerable fish (4) was recorded. . Native fish fauna of the river is severely threatened by the introduction of exotic species due to predation, competition for food and habit and introduction of pathogens.

Keywords : Habitat, Cypriniformes, Threatened.

Introduction

The fish, prawns & shrimps population of our aquatic system plays a significant role in the human economy. All above have formed an importantitem if human diet from time immemorial, and are primarily caught for this purpose Indian has vast potential for development of inland fisheries. These are valuable sources of high grade proteinand other organic products the fish diet provided proteins, fats and vitamins A and D.

Freshwater prawns farming is an aquaculture and agriculture business mainly designed to raise and produce freshwater prawnsfor the consumption of humans as well as decorative intent. Practically some of the species are marine and some spend their life in fresh and brackish water both. The various features of prawns whichvary physically are rostrum, carapace, adrostral crest, pleoplod, perepod and antenna, etc. For extracting the features of the prawn the information from a prawn is sent to a feature extractor. Mangrove water surf as an essential nursery ground for juvenile of many species of prawns and shrimps. Thus, the prawns or shrimps are highly associated with mangrove ecosystems, leading to make a statement by Macnae 1968 – "No mangroves, so no prawns". The loss of mangrove habitats must have a serious impact on the densities of prawn/ shrimp species.

According to Kannupandi et al (2018) order - Decapoda consist of most commercially important species of prawns, shrimps, crabs and lobsters too. According to Holthuis (1980), the prawns and shrimps included about 33 genera with about 2,500 species, of which less than 300 species are of economic importance throughout the world. The body of the prawns and shrimps is almost laterally compressed with a spiky rostrum and a longerabdomen than the cephalothorax or head. There is wide scope for the further development in the fisheries sector. Thus there is a need to study fish, prawns and shrimps fauna in Kapshi Lake, Akola district Maharashtra.

Materials and Methods

To carry out the freshwater diversity, species abundance and the various aspects of Prawns, fish and shrimp of Kapshi lake will be selected for the research work in regionof Akola district of Maharashtra state.

Study Area

The present study was conducted in Kapshi lake in Akola districts, Maharashtra, India. It comes under Akola community development block. Akola is about 20 km always from Kapshi lake. Latitude and longitude coordinates are: 20.707228, 77.002960 respectively. Total area of Kapshi is 83 lake 6.67 Hectares as per the data available for the year 2009. Total sown/agricultural area is 600.75 ha. About 169.93 ha is un-irrigated area. About 430.82 ha is irrigated area. About 7.8 ha are irrigated by canal water. About 162.13 ha are irrigated by wells/tubewells. About 182.83 ha are in non-agricultural use. About 5.15 ha are used permanent pastures and grazing lands. About 10 ha are lying as current fallow area. About 8 ha is waste

land. About 5 ha is lying as fallow land other than current fallows. About 24.94 ha are covered by barrenand un-cultivable land.

Collection of Prawns, Fish & Shrimp Samples

From August 2022 to March 2023 Prawns, Fish & Shrimp samples were collected from lake. Prawns, Fish & shrimp samples were collected every day during the stud period from the Prawns, Fish & Shrimps landing centers with the help of skilled local fisherman by various fishing grafts, gears, with variable mesh size. Location was changed for the collection of Prawns, Fish & shrimps 0.1% formalin is inserted by the syringe and kept in polythene bags.

Identification of Prawns, Fish & Shrimps Samples.

Identification of Prawns, Fish & Shrimps of fisher was done up to species level at fish landing center to get its natural colour, patterns of scales, fins, mouth patterns, identification mark like black spot. Fish species which was not identified on the field were preserved in 10% formalin. These Prawns, Fish & Shrimps samples were brought to the laboratory for detailed examination and identification by using standard literature of Day (1878), Jayaram (2010) and Talwar and Jhingran (2001) and Manual of Laboratory Specimens by Guru Darshan Singh.

In general, the penaeid prawns and non-penaeid prawns can be identification using morphological. for eg: the pleurae are arranged regularly in the penaeid prawns and in the non-penaeid prawns thepleurae of the second abdomen segment are overlapping those of first and third segment. The third pereopods are not chelated in the non-penaeid prawns but chelated in the penaeid prawns also abdomen segment has a sharp bend in the non-penaeid prawns but not in the penaeid prawns. In penaeid prawns, the distinguished identical characters are rostral structural, rostral teeth, antenna coloration an body colour with strips. In majority of the penaeid prawns rostral teeth areimportant characters to distinguish the different species and also within the group for Eg: in Penaeus species the rostral teeth are present both in upper and lower portions of the rostrum, butin case of metapenaeus species rostral teeth are present only in the dorsal side of the rostrum, but not in the ventral side.

Observations and Results

The results of the present study confirm the occurrences of 35 fish species belonging to different orders and families in Kapsi Lake (Table1). The order Cypriniformes was dominant with 15 species to be followed by order Perciformes with 03 specieswhile order Siluriformes with 03 species and Synbranchiformes with 02 species and Cichliformes with 02 species and

Anguilliformes, Carangiformes, Clupeiformes, Anabantiformes with 01 speciesrespectively. The result of the present study were focused on the descriptive statistical analysis to assess and compared to various sampling region of the fish species diversity in Table 1. Secondly, species richness were analyzed and compared to sampling location was summarized in Table 2 and also were monitored fluctuate level of species richness was observed. A total of 35 species under 9 orders and 13 families were recorded from Kapashi Lake during the study period (Tables1 & 2).

The species were analyzed by percentage of number of individuals in each order and family. Following, family wise analysis of percentage composition the Siluriformeswas the most dominant order constituting about 23.07 % of the total fish population followed by the Synbranchiformes 15.38%, Perciformes 15.38%, Anguilliformes 7.69%, Carangiformes.7.69%,

Cichliformes 7.69%, Anabantiformes 7.69%, Cypriniformes 7.69%, Clupeiformes 7.69%, were the least numerous order and also it constituting only 01 individuals of the total order of fish population. On the other hand, genera wise percentage composition analysis were referred as the Cypriniformes was the most dominant order concerning about 38.09% number of genera were occurred. Subsequently, Siluriformes 14.28%, Perciformes 9.52% Synbranchiformes 9.52% Cichliformes 4.76%, Clupeiformes4.76%,Anabantiformes 4.76%, Anguilliformes
7.76%,Carangiformes 4.76%, , were recorded. During the present investigation the order of dominance is as follows:
Cypriniformes>Siluriformes>Cichliformes=Synbranchiformes=Perciformes>Anguilliformes=Carangiformes=Clupeiformes=Anabantiformes. The family Cyprinidae under order Cypriniformes was represented by species, Catlacatla, Labeorohita, Labeobata, Labeoboga, Cyprinuscarpio, Puntitusdorsalis, Puntituschola, Puntitusticto, Torkhundree, Osteobramacatiopeni nsularis, Salmostomaboopis, Lepidocephalusthermalis, Thynrichthyssandkhol, Puntitusdorsalis, Cirrhinusmrigala. Under order Synbranchiformes family Mostacembelidae was represented by 01 species, Macrognathuspancalus, and family Channidae was Channamaruliusand family Heteropneustidae was represented by 01 species Heteropneustesfossilis. Family Schilbeidae represented by 01 species Clupisomagarua, under order Perciformes family Chehlidae was represented by 02 speciesOreochromismossambica, Tilapiamossambica. And family gobiidae was represented by 01 speciesGlossogobinusgiuris. Under order Anabantiformes family Channidaewas represented by 01 species Channa punctatus, under order Siluriformes

familySiluridae, Bagridae, Clariidae was represented by 03 species Ompokbimaculatus, Mystuscavasius, Clariasbatrachus. Order Anguilliformes was represented by 01 family Anguillidae and 01 speciesAnguilla, Bengalensisbengalensis. Order Carangiformesis represented by 01 family Rachycentridae and represented by one species Rachycentroncanadum. Order Cichliformes isrepresented by 01 family Cichlidae and 02 species Tilapinitilapia, Oreochromisniloticus. Orderclupeiformes is reprented by 01 family Engraulidae and 01 species Stolephorusindicus. Order Anabantiformes is represented by 01 family Channidae and 01 species Channapunctatus. As for, the status of biodiversity was concerning about the availability species were categorized as throughout the study period included species of Least Concern (LC) category and Food fish (35) Highly native fish (HNF 1) Highly economic IMP (35) Larvivorous fish (1), Threatened fish(1) Commonfish (5)were recorded. Likewise, the another group of vulnerable fish (4) was recorded.

Table No. 1 : List of Fresh Water Fishes From Kapshi Lake, Akola District.

Order	Family	Species Name	Common Name	Local Name
Cypriniforms	**Cyprinidae**	*Catla catla*(Hamilton-Buchanan)	Catla	Catla
		Labeo rohita(Hamilton-Buchanan)	Rohu	Rohu
		Labeo bata(Hamilton-Buchanan)	Bata Labeo	Tembti
		Labeo boga(Hamilton-Buchanan)	Boga Labeo	Chankora
		Cyprinus carpio(Linnaeus)	Common carp	Cyprinus
		Puntitus dorsalis (Jerdon)	Long Snouted barb	Podshi
		Puntituschola(Hamilton-Buchanan)	Swamp barb	Tepri
		Puntitus ticto(Hamilton-Buchanan)	Ticto barb	Tepdi
		Tor khudree(Sykes)	Yellow masheer	Temri
		Osteobramacatio peninsularis(Silas)	Penisularosteobrama	Kharpati
		Salmostomaboopis(Day)	Boopis razor	Chal/Udan
		Lepidocephalusthermalis(Valencinnes)	Malabar loach	Girgos
		Thynrichthyssandkhol(Sykes)	Sandkhol carp	Sandkoli
		Puntitus dorsalis	Lalpari	Lalpari
		Cirrhinusmrigala	Mrigal	Mrigal
Perciformes	**Chehlidae**	*Tilapia mossambica*(Jhingran)	Tillapia	Talapia
		Oreochromismossambica(peters)	Mozambique cichlid	Kombada
	Gobiidae	*Glossogobinusgiuris*(Hamilt on- Buchanan)	Tank goby	Dhangarya
	Serranidae	Grouper	Rani Fish	Rani Fish
Synbranchif or mes	**Mostacemb elida e**	*Macrognathuspancalus*(H & B)	Striped Spiny Eel	Bam
	Channidae	*Channamarulius* (H & B)	Giant Snakehead	Dokh
Siluriformes	**Siluridae**	*Ompokbimaculatus*(Bloch)	Indian butter catfish	Patola
	Bagridae	*Mystuscavasius*	Katarni	Katarni
	Clariidae	*Clariasbatrachus*	Magur	Magur
Anguilliformes	**Anguillidae**	*Anguillabengalensisbengalensis*	Bam	Bam

Carangiformes	**Rachycentridae**	*Rachycentroncanadum*	Modha	Modha
	Menidae	Mene Maculates (Mene)	Moonfish	Moonfish
Cichliformes	**Cichlidae**	*Tilapiini tilapia*	Jilebi	Jilebi
		Oreochromisniloticus	Kombada	Kombada
Clupeiformes	**Engraulidae**	*Stolephorusindicus*	Muchakada	Muchakada
Anabantiform es	**Channidae**	*Channapunctata*	Dok	Dok

Table 2 : Fish status of Kapshi lake district Akola Maharashtra (India)

Sr no	Name of fish	FF	HEI	HNF	CF	HSF	OF	LF	EXPTF	MCF	TR	EN	VU	R	LC	C	UNC	EX
1	*Catlac atla*(Hamil ton-Bucha nan)	✓	✓	✓					✓							✓		
2	*Labeor ohita* (Hamilt on-Buchan an)	✓	✓						✓							✓		
3	*Labeo bata*(Hamilt on-Bucha nan)	✓	✓					✓	✓							✓		
4	*Labeob oga*(Hamilt on-Buchan an)	✓	✓									✓	✓		✓			
5	*Cyprinu scar pio*(Lin naeu s)	✓	✓										✓		✓			✓
6	*P un tit us do rs ali s* (J er do n)	✓	✓										✓		✓			
7	*Puntitus chol a*(Hamil ton-Buchan an)	✓	✓												✓			

8	*Puntitusticto* (Hamilton- Buchanan)	✓	✓												✓			
9	*Tor khudree*(Syk es)	✓	✓												✓			
10	*Osteobrama*	✓	✓												✓			
	catiopeninsu laris(Silas)																	
11	*Salmostoma boopis*(Day)	✓	✓												✓			
12	*Lepidocepha lusthermalis* (Valencinne s)	✓	✓												✓			
13	*Thynrichthy ssandkhol*(S ykes)	✓	✓								✓	✓						
14	*Puntitus dorsalis*																	
15	*Cirrhinusmr igala*	✓	✓								✓				✓			
16	*Tilapia mossambica* (Jhingran)	✓	✓									✓			✓			✓
17	*Oreochromi smossambic a*(peters)	✓	✓								✓				✓			
18	*Glossogobin usgiuris*(Ha milton- Buchanan)	✓	✓												✓			
19	*Macrognath uspancalus*(H & B)	✓	✓												✓			

20	*Channamar ulius* (H & B)	✓	✓												✓				

21	*Ompokbima culatus*(Bloc h)	✓	✓												✓	✓			
	Mystuscavas	✓	✓												✓				
22	*ius*																		
23	*Clariasbatra chus*	✓	✓									✓			✓	✓			
24	*Anguilla bengalensis bengalensis*	✓	✓							✓					✓				
25	*Rachycentro ncanadum*	✓	✓									✓			✓				
26	*Tilapiini tilapia*	✓	✓												✓	✓			
27	*Oreochromi sniloticus*	✓	✓										✓		✓				
28	*Stolephorusi ndicus*	✓	✓																
29	*Channa punctatus*	✓	✓										✓		✓	✓			

Sr. no	Name		.	Name	
1)	Food fish	FF	10)	Exotic fish	EX
2)	Highly native fish	HNF	11)	Coarse food fish	CF
3)	Mosquito control fish	MCF	12)	Forage fish	FR
4)	Highly economic IMP	HEI	13)	Experimental fish	EXPTF
5)	Hill stream fish	HSF	14)	Threatened fish	TR

6)	Larvivorous fishes	LF	15)	Vulnerable fishes	VU
7)	Ornamental fish	OF	16)	Endangered fish	EN
8)	Lower risk near threatened	LR-NT	17)	Rare	R
9)	Common	C	18)	Uncommon	UNC

Discussion

India is one of the mega diversity countries with respective fresh water fish species (650+ species) in fresh water fish diversity India is eight in the world and third in the Asia there are plenty of cultivable species. The water bodies harboring endangered fishes must be declared as fish sanctuaries or aquatic diversity management areas. The use of illegal method to catch fish should be banned in these areas to prevent foe the depletion of freshwater fishresources. Fishing of the spawns, fishes, small or immature fishes shouldbe avoided and to around loan facility may provide on large scale which may help in high yield and production of fish production. It was further concluded that studies may developed technique foe fish culturing, protecting and conserving the biodiversity of fish.

In the present investigation it was observed that the ichthyofaunal diversity belongs to9 orders13 families21 genus29 species. Where family is dominant Siluriformes (23.07) followed by Mystus cavasius, Mystus bleekeri, Ompok bimaculatus, Claria sbatrachus. The similar result were reported by Mane and Pawar, (2007) with 36 species under 19 genera of Manar river of Nanded district. Hiware and Pawar (2006) recorded 7 species under 7 genera underthe order Siluriformes from Thodga river reservoir Ahmedpur district Latur Maharashtra. Vijaylaxmi et al., (2008) reported 6species under 4 genera under family Cyprinidae from Bheema river Gulbarga district Karnataka. Our results are also in agreement with Bhalerao (2012), Sarwade and Khillare (2010), Shaikh (2011) who found near about same results like Siluriformes order is dominant as other ordres. Ubharhande and Sonune (2012) found 7 orders, 10 families, 19 genera and 21 species and dominance of Cyprinidae family from Paintakli dam from Buldhana district Maharashtra. The fish Anguilla bengalensis bengalensis which is endangerd (threathened) in Western ghats of India (Dahanukar 2004) it is also recorded in the presence study at endangered status in the study areas we choosen, suggesting a dire need of its conservation and awareness in the human population. Clarius batrachus has been listed endangered (Menon 2004), the exotic fishes like Cyprinus carpio, Tilapia mossambica, Oerochromis mossambica, Channa punctuate where also reported during present investigation (Jingran, 1983) out of 29 species recorded 29(100%) species are recognized by food fishes (FF)29, Highly native fish1, Highly

economically important fish 29, Larvivorous fish1, experimental fish3,Threatened fish 1, common fish 4, exoticfish 2, experimental fish 3, vulnerable fish 4,endangered fishes 6, rare fishes 1, uncommon fishes1. The Same result was recorded by Kalayankaret.al., (2012). Our study is also in agreement with Rao (1998), Sakhare (2001) and Kadam and Gaikwad (2006). Prawns constitute an important export commodity in India. The total average annual estimated landing of prawns was 3,97,524 t (2008-10) of which 60% is contributed by penaeids and the rest by non-penaeids. India exported US $2.8 billion worth marine products in 2010-11, of which shrimp contributed 3.09% in volume and 69.5% in value of the total export. The prawn fauna occurring in Indian subcontinent including the Andaman and Nicobar Islands and the Lakshadweep Islands total 437 species (Table 1). The suborder Dendrobranchiata includes 142 species (122 species of penaeoids including Litopenaeus vannamei, the introduced species for aquaculture and 20 species of sergestoids under 43 genera) and the suborder Pleocyemata with 295 species under 88 genera (Table 2a and 2b). The family Penaeidae with 19 genera and 73 species is the most speciose group among the penaeoids. and many species form commercially important fisheries and some are of interest to aquaculture. The actual number of caridean prawns in Indian waters is still uncertain with more number of species added from freshwater ecosystems. The most speciose group of freshwater prawns are the families Atyidae with a single genus (Caridina) and 28 species and the subfamily Palaemoninae (family Palaemonidae) consisting of 11 genera, 81 species with the genus Macrobrachium numerically dominating the subfamily with 62 species. Freshwater species are also becoming increasingly popular in aquarium trade, especially the species under the genus Caridina and some are being specifically cultured for this purpose. Many species of both family's complete part of their larval cycle in brackishwater or even in fully marine conditions.

The variable quality of the existing data at global level family diversity and the general patterns of species structure in one are well related to other. Presently, decline the richness ofspecies were observed to the present work due to proximately to human invention, shortage of food availability, excessive fishing and scarcity of water in this reservoir. Sand mining is common in most of the stretches of the river, which is the determiningfactor for habitat destruction leading to the loss of habitat and breeding grounds of several fish species in the river. Loss of breeding grounds would have negative impact on the fish populations. Deforestation along the banks of the river is also causing the problem of siltation every year during monsoon in

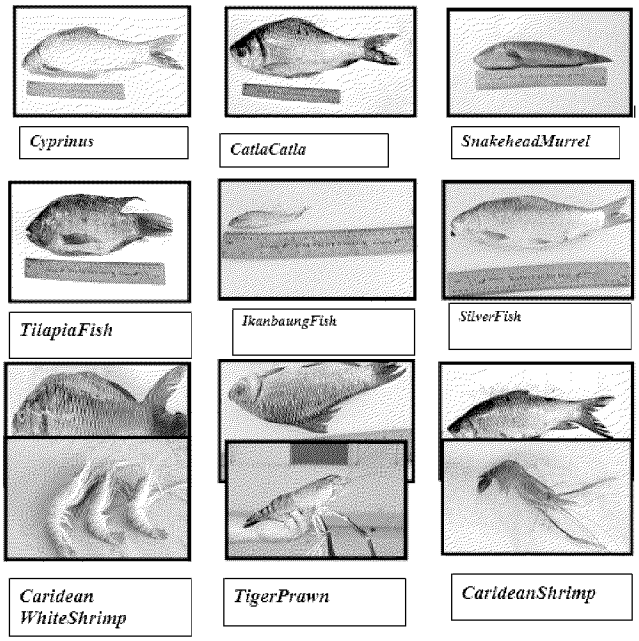
the river. Over fishing for consumption is another factor for fish biodiversity loss. Pollution, a major for fish diversity loss of the river is due to the surface runoff containing various pesticides from nearby agricultural fields. In addition, we observed that workers washing the containers and equipment in the adjacent regulates that finally empty into the river causing large scale molarities and help hazards to the fish. Native fish fauna of the river is severely threatened by the introduction of exotic species due to predation, competition for food and habit and introduction of pathogens.

References

- **AHPA (1998) :** Standard method for the examination of water and waste water in 20th.Ameracian Public Health Associatiom. Washington D.C.U.S.A
- **Arunachalam M (2000) :** Assemblage structure of stream fishes in the Western Ghats (India).Hydrobiologia 430:1-31
- **Chanda, S. and Sekhar Kar, C. (1999) : Bhitarkanika :** Myth and Reality. Nataraj Publishers, Dehradun, 388 pp.
- **Chantarasri, S. (1994) :** Integrated resource development of the Sundarbans Chaube UC (1988) Model study of water use and waterblance in betwa Basin. J Inst Eng Indian Civil Eng Div 69:169-173
- **Dahanukar, N., R. Raut and A. Bhat, 2004:** Distrbution, endemis and threat status of freshwater fishes in the western Ghats of India. Journal of Biolgeographs, 31:123-136.
- FAO (1988). Worldwide compendium of mangrave associated aquatic species of economic importance.FAO fisheries Circular No.814(FIRI-C814),Rome,236pp FAO, UNDP, 171 pp.
- **Harris, J.H., (1995):** The use of fish in ecological assessment. Australian Journal of Ecology, 20: 65-80
- **Jayaram K. C. (1994):** The freshwater fishes of India, A handbook zoological survey Indian culture.
- **Kadam, S.U. ans Gayakwad, j. M., 2006:** Ichthyofauna of masooli Reservior, Distic Parbani, Maharashtra- A study of inland reservoir fishery in India. J. aqua. Biol.,21(2): 56-61
- **Payne AI, Sinha R, Singh HR, Huq S (2004) :** A review of the Ganges basin; its fish and fisheries. In: Welcome RL, Petr R Proceeding of the second international

symposium on the management of large rivers for fishies, vol 1food and agriculture organization of the United Nations,commission (MRC), fisheries Program(FP) pp 229-251.

- **Pandey RP, Mishra SK, Singh R,Ramasasti KS(2008) :** Stream flow drought severity analysis ofBetwa River system (Indian).Water Res Manag 22:1127-1141
- **Duda R. & P. E. Hart :** Pattern Classification and Scene Analysis (Wiley-Interscience, New York, 1973). Still in print after all these years.
- **Sarkar U.K, Gupta BK, lakra ws (2008)** Biodiversity, echydrology,theat status and conservationpriority of freshwater fishes of River Gomti, a tributary of River Ganga (india. Environmentalist)30:3-17
- **Thirumala. S, Kiran, B.R, Kantaraj. G. S. (2011):** Fish diversity in relation to physochemical characteristics of Bhandara reservoir Kamataka, India. Advance in applied science research, 34-47 pp
- **Uttam kumar Sarkar, Rupali Sani Kumar, Ajay Pandey, Vineet kumar Dubey, Om Prakesh Gusain (December 2010):** fish diversity in Fresh water prawns and shrimps conservation and management issue of river in Ganga.
- **Vijaylaxmi G.M. 1985:** fishes of khasi Hills records of zoological survey of Indian occasial paper no.70. Issued by the Director ZSI, Calcutta, 40pp.



VOLUME - 13, ISSUE - 02, FEBRUARY - 2024 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Zoology

BIODIVERSITY OF GRASSHOPPER AROUND SONALA DAM, SONALA, DIST. WASHIM, (M. S.)

Dr. Ujwala P. Lande Assistant Professor, Department of Zoology, Shri Shivaji College of Arts, Commerce & Science, Akola, (M.S.), India

ABSTRACT Grasshoppers belong to order Orthoptera which is one of the largest and diverse groups of insects. They are dominant above ground invertebrates in cultivated and in natural grasslands ecosystems. The study of Biodiversity of grasshoppers around Sonala dam, Sonala was carried for the period of 6 months that is from August 2022 to January 2023.The specimens were collected from the surrounding area of Sonala dam. 13 species of grasshoppers were collected from different habitats and different sites. During the Course of study, 13 species of grasshoppers belonging to 13 Genera, 5 families viz. Acrididae, Tettigoniidae, Mantidae, Pyrgomorphidae and Gryllidae were found to be present in various habitat studied like hilly area, grasslands, grasslands plus shrubby area and agricultural fields.

KEYWORDS : Biodiversity, Grasshopper, Sonala.

INTRODUCTION

Grasshoppers and locusts in the suborder Caelifera, order Orthoptera are one of the most diverse and ecologically important insects found in the grasslands (**Latchininsky *et al.*, 2011**). They are known to be crop pests especially species like Schistocerca gregaria, Locusta migratoria migratorioides, Anacridium spp., Nomadacris septemfasciata, Zonocerus elegans, Zonocerus variegatus, Phymateus viridipes and Phymateus saxosus (**Meynard *et al.*, 2017**). Their defoliation mode reduces the photosynthetic area of the leaves and their ability to aggregate facilitates mass feeding and hence, more crop destruction (**Skaf et al., 1990; Safi, 2017; Lomer *et al.*, 2001**). Moreover, some species of locusts and grasshoppers are used as human food such as Sphenarium purpurascens, Oxya hyla hyla and Acanthacris ruficornis. From literature, they are good sources of amino acids, fatty acids, crude carbohydrates, fibre and ash (**Ghosh *et al.*, 2016**).

The present study on grasshopper diversity was carried out at different sites around Sonala Dam, Sonala , Dist. Washim, (M. S.).The short horned grasshoppers were collected from these areas during the August 2022 to January 2023. Different areas were chosen with the intension of survey amongst different habitats which includes open grasslands, bushy vegetation with grass land patches, bushy areas, ground surfaces and cultivated areas.

MATERIALS AND METHODS

Study area

Sonala Dam reservoir was constructed in the year 1981. Agricultural fields surround the reservoir including dense vegetation. The reservoir is mainly used for drinking water supply to nearby villages and for irrigation. The nearby villages also use the water for bathing and washing purposes. The dam is constructed by irrigation department of Maharashtra Govt. The Sonala dam is located at 77^0, 12', 30" Longitude and latitude of 20^0, 19', 00" in Sonala village of Washim district in Maharashtra (India). It is an earthen dam with 19.20 meter maximum height and 446.90 hector submergence with 132.50 square Km. of catchment area. The dam is presently used for irrigation and drinking for regional rural areas. The reservoir is constructed on the River Aran also known as River Adan a tributary of River Godavari. Adan River in its way runs through the Maraldoh village, before draining in the dam.

Collection and photography of insects:-

Insects are a remarkable group of animals. They occur virtually everywhere and make up more than half of all living things on earth. Methods used for present study insect net, killing jar, forceps, relaxing jar, spreading board and pinning block, insect pins and labels, storage box. Before proceeding to collecting the Grasshoppers the equipments used for collection was assembled. The equipment used were simple and inexpensive. The collecting kit include following items. Collecting net, Sweep Net, Forceps, Thermacol sheath, Pins, Notebook, Pencils, Camera, ethyl acetate, Adhesive solution. All collected grasshoppers specimens were identifying by using the identification key of www.insectidentification.org. also www.biodevercityexplorer.org , while some species are identify by using photographs and available research paper.

OBSERVATION AND RESULT

Diversity of Grasshopper

The study of diversity of grasshoppers around Sonala dam, Sonala was carried for the period of 6 months that is from August 2022to January 2023.The specimens were collected from varoious sites surrounding the dam. There were 13 species of grasshoppers collected from different habitats and different sites. During the Course of study, 13 species of grasshoppers belonging to 13 Genera, 5 families viz. Acrididae, Tettigoniidae, Mantidae, Pyrgomorphidae and Gryllidae were found to be present in various habitat studied like hilly area, grasslands, shrubby area, grasslands plus shrubby area and agricultural fields. The total species were observed and collected tabulated in Table I and Photoplate I, II, III.

Using an identification key

This study reveals that in the morphological identification of Grasshoppers, keys like strong hind legs for jumping, coloration for defensive function from predators as well as to attract the females when mating is required, size, shape plays an very important role. Following are the key identified varieties of grasshoppers from selected area.

Sr no	Common name	Class	Order	Family	Genus	Species	Seasonal occurance	Collection place
1	American bird grasshopper	Insecta	Orthoptera	Acrididae	Schistocerca	S. americana	Aug-jan	Yeoda
2	House cricket	Insecta	Orthoptera	Gryllidae	Acheta	A .domesticus	Aug-jan	Pimpalkhuta
3	Praying mantis	Insecta	Orthoptera	Mantidae	Mantis	M. religiosa	Aug-jan	Sasan
4	Black winged grasshopper	Insecta	Orthoptera	Acrididae	Dissosteira	D. carolina	Aug-jan	Ramagad

5	Bush cricket	Insecta	Orthoptera	Tettigoniidae	Tettigonia	Tettigonia caudata	Aug-jan	J.D patil college
6	Chinese m mantis	Insecta	Orthoptera	Mantidae	Tenodera	T. aridifolia	Aug-jan	Daryapur
7	Tobacco grasshopper	Insecta	Orthoptera	Pyrgomorphidae	Atractomorpha	A.crenulata	Aug-jan	Chandrabhaga river
8	Band winged grasshopper	Insecta	Orthoptera	Acrididae	Oedaleus	O. infernalis	Aug-jan	Daryapur
9	Migratory Locust	Insecta	Orthoptera	Acrididae	Locusta	L. migratoria	Aug-jan	Chandrbhaga river
10	Gaint Asian mantis	Insecta	Orthoptera	Mantidae	Hierodula	H.patellifera	Aug-jan	Chandrbhaga river
11	long headed grasshopper	Insecta	Orthoptera	Acrididae	Acrida	A. cinerea	Aug-jan	Yeoda
12	Differential grasshopper	Insecta	Orthoptera	Acrididae	Melanoplus	M.differentialis	Aug-jan	Pimpalkhuta
13	Velvet-stripped grasshopper	Insecta	Orthoptera	Acrididae	Eritettix	E. simplex	Aug-jan	Chandrbhaga river

- **Spur-throated Grasshopper**

All members of this group have a distinct conical or cylindrical spur between the front pair of legs. The front of the face points straight downward, perpendicular to the long axis of the body. Adults are strong fliers and capable of dispersing long distances. Many members of this group can be economically damaging to rangeland or cropland.



Photo Plate No. 1 Shows Diversity of Grasshopper

- **Band-winged Grasshopper**

The front of the face points straight downward, perpendicular to the long axis of the body. There is no spur between the front pair of legs. The hind wings of adults are often brightly coloured. Some species feed exclusively on grasses and sedges. They are usually present in low numbers and are not economically damaging.



Photo Plate No. 2 Shows Diversity of Grasshopper

- **Slant-faced Grasshopper**

The front of the face slants back toward the body. There is no spur between the front pair of legs.The hind wings on adults are colourless.



Photo Plate No. 3 Shows Diversity of Grasshopper

DISCUSSION

Orthopterans play an important ecological role in many ecosystems. The study of grasshoppers play important ecological role in forest ecosystem in initiating and promoting the decay process of dead specimens. A large number of grasshoppers species are under the risk of extinction is the indication of environment influence. Insect outbreaks may have significant effects on an avian biodiversity, either directly by altering food availability or indirectly by altering habitat suitability. The presence of these species suggest that the study area might have abundant grasshopper's diversity. However it is suggested that the diversity of grasshoppers in these area should be studied exclusively. A long term study is needed to observe the species occurred all season and their interaction with the environment changes. Different habitat should also be studied for better results around Sonala dam.

Grasshoppers are plant-eating insects characterized by long hind legs designed for locomotion by jumping. Like all insects, the body of grasshoppers is divided into three main parts: head, thorax, and abdomen. On the head there are two antennae for feeling and detecting scent, and two compound eyes comprised of many optical units called facets, each of which is like a miniature eye. The chewing mouthparts comprise two sets of jaws which move from side to side. The sides of the mouth have two pulps, tiny appendages for feeling and detecting chemicals, which aid in food selection. There are three pair of legs and two pairs of wings attached to the thorax, although some species are wingless. At the tip of the abdomen there are two appendages called cerci, and the external reproductive organs, Females have an ovipositor at the end of the abdomen through which the eggs are laid. Grasshoppers develop by incomplete metamorphosis passing from egg to a small wingless larval stage through several molts, to the mature adult.

SUMMARY AND CONCLUSION

This study is an preliminary step to explore the Biodiversity of grasshoppers around Sonala dam, Sonala of Maharashtra (India). Study carried out only for short period that is from August to January. This work was an attempt to describe some aspects of biodiversity of Grasshoppers fauna. A lot of further work is necessary in the regard and further collections are essential for getting a detailed periodic estimate of the faunal diversity of grasshoppers in this area. Finally it is hoped that such work may lead to the development of standard monitoring procedure which could be of value in assessing the environmental stability of areas under cultivation of plants and the prediction of the effect on the structure of grasshopper populations of tropical forest destruction.

REFERENCES

1. Latchininsky A, Sword G, Sergeev M, Cigliano MM, and Lecoq M. 2011. Locusts and grasshoppers: Behaviors, Ecology and Biogeography 2011: ID 578327. Doi:10.1155/2011/578327
2. Meynard CN, Gay PE, Lecoq M, Foucart A, Piou C, and Chapuis MP. 2017. Climate-driven geographic Distribution of the desert locust during recession Periods: Subspecies' niche differentiation and Relative risks under scenarios of climate change. Global Change Biology 23(11): 4739-4749. Doi: 10.1111/gcb.13739.
3. Ghosh S, Parimalendu H, and Dipak KM. 2016. Evaluation of nutrient quality of a short Horned grasshopper, Oxya hyla hyla Serville (Orthoptera: Acrididae) in search of new protein Source. Journal of Entomology and

Zoology Studies 4(1): 193–197.
4. Lockwood DR and Lockwood JA. 2008. Grasshopper Population ecology: catastrophe, criticality, and Critique. Ecology and Society 13:34. https://www.jstor.org/stable/26267932.
5. Safi A I A, Mohamed E E, and Hamid A A. 2017. Estimating the area of Hashab tree (Acacia senegal) Defoliated by tree locust using supervised classification. International Journal of Agricultural and Environmental Sciences 2(6): 73-80

04

Advancements in Applications of Arduino Uno: A Comprehensive Review

Prof. Dr. Gajanan S. Wajire
Department of Electronics,
Shri Shivaji College of Arts, Commerce & Science Akola (M.S.)

==========

Abstract:

This research paper explores the evolving landscape of Arduino Uno applications, showcasing the significant advancements in its utilization across various domains. Arduino Uno, a popular open-source microcontroller platform, has witnessed substantial growth in both hardware and software capabilities. The Arduino Uno is a widely used open-source microcontroller board that has played a pivotal role in democratizing electronics and fostering the maker movement. Released in 2010 by the Italian company Arduino LLC, the Arduino Uno quickly gained popularity due to its simplicity, affordability, and versatility.

Latest Arduino Uno used the ATmega328P microcontroller, providing 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM. The key features of Arduino Uno are microcontroller, input/output pins, USB interface, open-sourceavailability, power supply compatibility and so on.The paper delves into innovative projects and emerging trends that leverage Arduino Uno, ranging from Internet of Things(IoT) applications to robotics, automation, wireless communication and even more.

Keywords: Arduino Uno, open-source, microcontroller, interface, hardware enhancements.

1. Introduction:

Key features of Arduino Uno are as advance microcontroller, input/output pins, USB interface, open-source availability, power supply compatibility, easy programming and so on.

i) Microcontroller: At the heart of the Arduino Uno is the ATmega328P microcontroller, providing a balance between processing power and energy efficiency.

ii) Input/Output Pins: The board boasts a range of digital and analog input/output pins, allowing users to interface with a variety of sensors, actuators, and other electronic components.

iii) USB Interface: Arduino Uno comes equipped with a USB interface for programming and serial communication, making it accessible to a broad audience.

iv) Open Source: The Arduino Uno is part of the open-source hardware and software ecosystem. This openness encourages collaboration and the sharing of projects and code among the global community for educational, entertainment and commercial aspects.

2. Hardware Enhancements:

As per the recent updates in 2022, one may be aware of very latest version of Arduino Uno released. However, the general hardware upgrades that were common are available in recent Arduino Uno versions also. Few hardware enhancements with the most recent sources for the latest updates are discussed as below.

i) **Microcontroller Upgrade:**Arduino Uno used the ATmega328P microcontroller, providing 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM. Recent versions might have upgraded to newer models or revisions of the ATmega series, offering enhanced features, performance and power efficiency.

ii) **Memory Expansion:**Some newer versions of Arduino Uno hascome with expanded flash memory or RAM, providing more space for storing code and handling data. This is particularly beneficial for larger and more complex projects.

iii) **Additional I/O Pins:**To accommodate a wider range of projects, recent versions might include additional digital and analog input/output pins. This expansion allows for more connections with sensors, actuators, and other peripherals.

iv) **Improved USB Interface:**Upgraded USB interfaces, including the adoption of USB-C or other modern connectors, can provide faster data transfer rates and improved reliability. This enhances the programming and communication capabilities of the board.

v) **Power Supply Enhancements:**Recent Arduino Uno versions may include improvements in power management, enabling more efficient use of power and potentially supporting a broader range of input voltages. This is beneficial for projects with diverse power requirements.

vi) **Onboard Communication Features:**Integration of additional communication features, such as built-in Bluetooth or Wi-Fi modules, could be present in more recent Arduino Uno versions. This facilitates wireless connectivity and opens up possibilities for Internet of Things (IoT) applications.

vii) **Enhanced Compatibility and Shields:**Improvements in hardware compatibility, including the ability to support a broader range of shields (additional boards that can be stacked on top of Arduino Uno), may be introduced. This allows users to easily extend the functionality of their projects.

viii) **Optimization for Low Power Consumption:**Some newer versions may include features focused on minimizing power consumption, making Arduino Uno more suitable for battery-powered or energy-efficient applications.

ix) **Improved Form Factor:**Changes in the physical design, size, or layout of the board might be introduced in recent versions, providing a more user-friendly or compact form factor.

It's important to consult the official Arduino website or other reliable sources for the most up-to-date information on hardware upgrades in the latest Arduino Uno versions. Hardware enhancements contribute significantly to the board's adaptability and performance, making it a versatile platform for a wide range of projects.

3. Sophisticated hardware design:

As per the latest updates in January 2022, there might not be a standard term like 'advance Arduino Uno' and the 'typical Arduino Uno' board is well-known. However, if there have been developments or new versions released after that date, it may be recommended checking the official Arduino website or documentation for the latest information. For the standard Arduino Uno, here is a more sophisticated hardware overview, which includes:

i) **Microcontroller:** The Arduino Uno is powered by the Atmel ATmega328P microcontroller.

ii) **Clock Speed:** It operates at a high clock speed of about 16 MHz frequency.

iii) **Digital I/O Pins:** There are 14 digital I/O pins that can be used as inputs or outputs.

iv) **Analog Input Pins:** The board has 6 analog input pins.

v) **PWM (Pulse Width Modulation) Pins:** There are 6 PWM output pins for analog simulation.

vi) **Power Jack:** Input for an external power source (typically 7-12V DC).

vii) **USB Connection:** Used for programming and serial communication with the computer.

viii) **Voltage Regulator:** Regulates the voltage supplied to the board.

ix) **Reset Button:** Allows you to restart the program running on the board.

x) **Crystal Oscillator:** Provides the clock signal for the microcontroller.

xi) **TX/RX LEDs:** Indicate the data transmission/reception over the USB connection.

xii) **ICSP Header:** In-Circuit Serial Programming header for advanced users.

xiii) **Power Pins:** 5V, 3.3V, and GND pins for power supply.

xiv) **EEPROM:** The microcontroller has built-in EEPROM for data storage.
xv) **AREF Pin:** Reference voltage for analog inputs.
xvi) **TX/RX Pins:** Serial communication pins
Following figure (a) shows the more sophisticated hardware design of Arduino Uno.

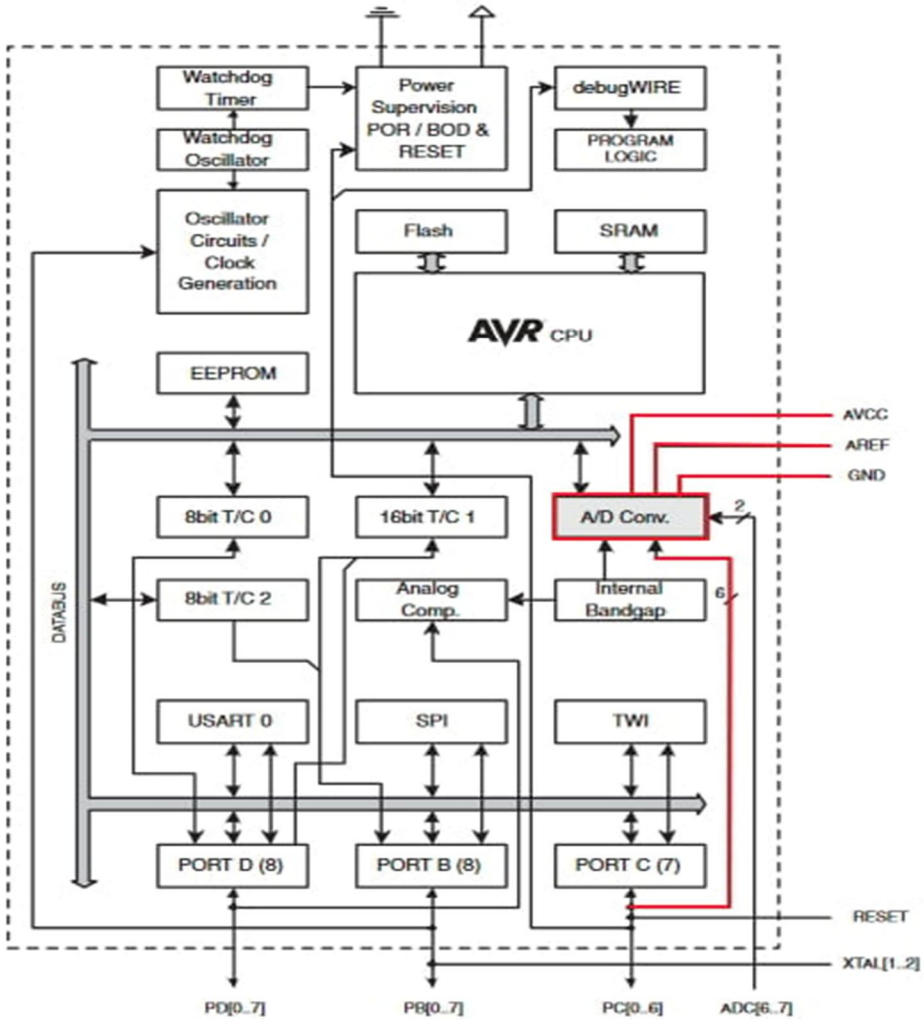


Figure (a): Hardware design of sophisticated Arduino Uno

4. Advanced applications:

The Arduino Uno, being a versatile microcontroller platform, can be employed in various advanced applications. Here is a list of some advanced applications:

i) **Robotics:** Arduino Uno is commonly used in robotics projects for motor control, sensor integration, and decision-making tasks.

ii) **Home Automations:** With its ability to interface with various sensors and actuators, Arduino Uno can be used for home automation projects, including smart lighting, temperature control, and security systems.

iii) **Internet of Things (IoT):** Arduino Uno can be part of IoT projects by connecting it to the internet using shields or modules, allowing remote monitoring and control.

iv) **Data Loggings:** Arduino Uno can be used to log data from various sensors, such as temperature, humidity, and GPS, onto SD cards or send them to cloud services.

v) **Quad-copters and Drones:** Arduino Uno can be employed in building and controlling small-scale drones and quad-copters.

vi) **Biomedical Projects:** In the field of healthcare, Arduino Uno can be used for projects like heart rate monitors, biofeedback systems, or even simple prosthetics.

vii) **Wearable Technology:** Arduino Uno can be integrated into wearable devices for health monitoring, fitness tracking, and other innovative applications.

viii) **Instrumentation and Measurements:** Arduino Uno can be used for creating customized measurement and instrumentation systems for various purposes, including scientific research.

ix) **Voice Recognition:** With additional modules or shields, Arduino Uno can be used for voice recognition applications, allowing you to control devices using voice commands.

x) **Augmented Reality (AR) Projects:** Arduino Uno can be part of AR projects by interfacing with sensors and displays to create interactive augmented reality experiences.

xi) **Gesture Control Systems:** Arduino Uno can be used in projects that involve recognizing and responding to hand gestures, enabling touch less control interfaces.

xii) **Automated Plant Watering System:** Arduino Uno can be employed to build systems that monitor soil moisture and automatically water plants when needed.

xiii) **Smart Farming:** In agriculture, Arduino Uno can be used for applications such as monitoring soil conditions, controlling irrigation systems, and collecting data for precision farming.

xiv) **Art Installations:** Arduino Uno is frequently used in interactive art installations, providing a platform for artists to incorporate technology into their work.

xv) **Industrial Automation:** Arduino Uno can be applied in small-scale industrial automation projects for tasks like controlling machinery, monitoring parameters, and managing processes.

xvi) Wireless Communication: This type of communication may include for audio, video, text matters, images and photos, scanning and so on.

These applications demonstrate the flexibility and adaptability of Arduino Uno in a wide range of advanced projects across different domains. Keeping in mind that as technology evolves, new applications and possibilities may emerge.

5. Conclusion:

Emphasizing the continued relevance and potential of Arduino Uno in diverse applications, this research paper provides a comprehensive overview of the advanced applications of Arduino Uno, offering insights into its evolving capabilities and potential future directions. The exploration of diverse projects across IoT, robotics, sensor integration, wireless communication, and education highlights the versatility and adaptability of Arduino Uno in addressing a wide range of technological challenges.

6. References:

1) *P.A. Wijesinghe, T. Tanaka, K. Nirmalathas, C. Lim, and A. Alphones,'Low-cost real-time environmental monitoring of air and water quality using commercially available sensors', Environmental Monitoring and Assessment, 2019.*

2) *R.R. Ramirez, R. Gonzalez, and S. Garcia-Souto, 'Design and implementation of an open-source wireless Arduino-based ECG monitoring system', CMPB, 2017.*

3) *N. Mirjat, M. A. Uqaili, and M. S. Memon, 'Smart Home Energy Management System Using Arduino and LabVIEW', 2nd International Conference on CAAI, 2018.*

4) *S. P. Mohanty, J. K. Mohapatra, and N. C. Pradhan, 'An IoT-Based Smart Healthcare System WithAuthentication Mechanism', 4th International Conference on Recent Advances in Information Technology (RAIT), 2018.*

5) *M. Ali, M. G. Rabbani, M. M. Rahman, and S. M. Shawkat Ali, 'An Arduino-based Smart Blind Stick With Ultrasonic Sensor for a Visually Impaired Person', IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC), 2018.*

6) *Massimo Banzi and Michael Shiloh, 'Getting Started with Arduino', ESC -2014.*

7) *Paul McWhorter, 'www. Paul McWhorter's Arduino Tutorial Series', on YouTubechannel/site.*

International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 12 Issue 2 \ February 2024 \ PP. 167-176

"Comparative studies on extraction of natural perfume from some aromatic plants found in Akola"

V.S.Patil, G.B.Tupsande
Department of Botany, Shri Shivaji College of Arts, Commerce and Science, Akola.

Abstract- *Natural perfumes are made from plant materials such as flowers, leaves, stems, wood, roots, seeds and resins from which essential oils, absolutes, floral waxes, vegetable oil and water are extracted. Unlike a synthetic perfume whose list of ingredients is very complex that of natural perfumes is much simpler and ensures the absence of harmful chemical components such as synthetic musks, phthalates or parabens. They are used in a wide range of products, including cosmetics, personal care products, and home fragrances. The production method of the oil depends on the botanical source. Several methods are employed in modern perfumery. The majority of essential oils are obtained by steam distillation or hydro-distillation. Many flowers and plant parts are easily available in nature.The enfleurage method of extracting essential oils is both costly and labor-intensive. For small entrepreneur, it is beneficial to rise their earning.*
The present study relates comparative studies on extraction of natural perfume from some easily available plant parts in Akola.

Key words-Natural perfumes, synthetic perfume, extraction

Date of Submission: 08-02-2024 Date of acceptance: 23-02-2024

I. Introduction

Perfumes can be defined as substances that emit and diffuse a pleasant and fragrant odour. It is a fragrant liquid made from an extract that has been distilled in alcohol and water. It is a complex mixture of aldehydes, ketones, hydrocarbons, alcoholic acid and short chain esters. Since the beginning of recorded history, humans have attempted to mask or enhance their own odour by using perfume, which emulates nature's pleasant smells. Many natural and man-made materials have been used to make perfume to apply to the skin and clothing, to put in cleaners and cosmetics, or to scent the air. Because of differences in body chemistry, temperature, and body odour, no perfume will smell exactly the same on any two people. Perfume comes from the Latin "per" meaning "through" and "fume," or "smoke." Many ancient perfumes were made by extracting natural oils from plants through pressing and steaming. They can be found in leaves, flowers, stems, barks, and roots. The oil was then burned to scent the air. Today, most perfume is used to scent bar soaps. Some products are even perfumed with industrial odorants to mask unpleasant smells or to appear "unscented." While fragrant liquids used for the body are often considered perfume, true perfumes are defined as extracts or essences and contain a percentage of oil distilled in alcohol. (Alhassan, et.al. (2018).

Traditionally perfumes were made from plant and animal substances and prepared in the form of waters, oils, unguents, powders, and incense. This last method of fragrance gives us our word 'perfume' which means 'to smoke through'. Most modern perfumes are alcohol-based and contain synthetic scents. While the term 'perfume' usually refers to fragrances in general, in the more technical language of the perfumer, a perfume must contain over 15% of fragrance oils in alcohol. Techniques involved in perfume extraction from plants include; solvent extraction, distillation and effleurage method. These methods to a certain extent, distort the odor of the aromatic compounds that are obtained from the raw materials.

Synthetic perfume can remain on the skin for a long time and in the atmosphere for many days or weeks. These poisonous fragrances are known endocrine disruptors. It can cause allergic reactions in certain people, including rashes and skin irritation. Studies conducted on synthetic fragrances have further shown that some of the ingredients in fragrances can be potentially hazardous or even toxic. Phthalates are a common fragrance ingredient that may be cause for concern. Diethyl phthalate, the one used in fragrances, has been linked to hormone disruption and developmental disorders, particularly in newborn males. According to research, 95 percent of chemicals used in synthetic fragrances are derived from crude petroleum oil. They also happen to contain an absurd variety of carcinogenic chemical additives like benzene derivatives, aldehydes, toluene and a myriad of other toxic substances which have links birth defects, allergies, cancer, nervous system disorders and more. Some fragrances can even cause dizziness and headaches. Another issue is that there is no law that pushes companies to disclose the chemicals used in their fragrances.

International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol.10 No.4 Mar – Apr 2023

" Antibiogram Pattern and Biofilm Formation by Uropathogenic *E.coli*"

Rani. v. jadhao[1] , S. N. Zodpe[2]
Department of Microbiology, Shri Shivaji College of Arts, Commerce and Science Akola 444001 (M.S) India.
***Corresponding Author* - Rani. v. jadhao**
Email- rranivikasjadhao@gmail.com

Abstract
During the current research work total 51 urine sample were collected form different Pathology Laboratories as well as from Government Medical Hospital Akola All the samples were collected using clean and sterilized Plastic bottles with air tight screw cap tops. The samples were collected and classified as per the sex and age of the patient. Total 22 samples from male and 29 samples from female were collected. Similarly samples were collected for low age group of 7 years to 68 years age group, to check the prevalence of E. coli Out of 40 isolates 15 isolates were found to be biofilm producers i.e. 37.50% whereas, 25 isolates i.e. 62.50 were non biofilm producers. The biofilm formation was confirmed on the basis of Congo Red Agar method and Tube method and is graphically represent in frequency distribution pie chart Further we process for the antibiotics susceptibility test again the E coli isolate was checked from the complete study it was observed that Ampicillin was highly resistant were as chloramphenicol was found to be highly sensitive in controlling the E.coli

Keyword: Uropathogenic E.coli, multidrug resistant

Introduction

A biofilm Is a complex aggregate of microorganisms in which cells are adhere to each other and to a surface. These adherent cells are embedded within a self produced matrix of extracellular polymeric substance (EPS)/slime. Slime is made up of proteins and polysaccharides. In a biofilm, bacteria communicate with one another using chemical signal molecules, termed auto-inducers. This process of chemical communication, called quorum sensing, allows bacteria to monitor the environment for other bacteria and to alter the behavior in response to changes in a community (Waters and Bassler, 2005). Availability of key nutrients, chemotaxis towards surface, motility of bacteria, surface adhesions' and presence of surfactants are certain factors which influence biofilm formation (Thomas and Day, 2007). Both the Gram positive and Gram negative bacteria have the capability to form biofilms.

Biofilm-forming activity is a widespread bacterial feature found on natural and artificial surfaces (Stewart and Franklin, 2008). In natural environments, biofilms represent the preeminent lifestyle of bacteria which can have beneficial effects on plant growth promotion (Naseem et al., 2018). Organic compound degradation (Flemming and Wingender 2010), including different aquatic ecosystems (Costerton et al.,1995 and Basemer, 2015). Moreover, microbial biofilms have been found useful in food fermentation, the production of many bio-based materials, bioremediation, wastewater treatment and microbial fuel cells (Van Houdt and Michiels 2010Edwards and Kjellerup, 2010; Karadag et al., 2015; Santoro et al., 2017 and Moradali and Rehm, 2020)

Bacterial biofilms play a significant role in UTIs, being the cause of both acute and persistent infections. Up to 80% of all infections involve biofilm-forming bacteria, and mainly in the urinary tract, biofilm can become a serious problem. The antimicrobial resistance shown by biofilms is one of the most important concerns of these structures. Biofilm can be resistant to antibiotics up to 1,000 –fold more than planktonic cells as a result of several mechanisms (Soto, 2014).

Escherichia coli is the most common organism associated with asymptomatic Bacteria (ABU) in humans. In contrast to uropathogenic E. coli (UPEC) that cause symptomatic urinary tract infection, very little is known about the mechanisms by which these strains colonize the urinary tract.

Drug resistance to commonly used antibiotics among the uropathogens is on the raise (Pramodhini et al., 2012). Biofilms are a complex aggregation of bacteria with unique properties which facilitate them to evade the host immune response and penetration by antimicrobial agents (Panda et al., 2012). Emergence of antibiotic resistance and biofilm formation among the bacterial pathogens implicated in causing urinary tract infection is of serious concern due to the high recurrence rate and chronicity of infections (Niveditha et al., 2012 and Atray and Atray, 2015) Multidrug resistance and spread of antibiotic resistance are higher among biofilm producers. Biofilm producing pathogenic bacteria with high levels of resistance may make treatment options difficult. The present study aims at isolating and identifying the bacteria causing UTI, detect the biofilm producers and beta lactamase production among the gram negative bacterial isolates and to perform antibiotic susceptibility pattern.

MATERIALS AND METHODS

Collection of Samples

Total 40 clinical samples such as urine were collected from Government Medical college and Hospital Akola. Each urine sample cup was labelled with name, age, sex and time of collection.

With the proper precaution and proper handling the clinical specimen were collected by wearing glows, apron and mask. Sterilize plastic container is typically used.

Isolation And Identification of the Isolated Bacteria :

Each of the collected samples without much delay was carried in Microbiology lab for further processing.

The collected urine samples were further processed for isolation of organism.

The selective media used for the isolation of organism was Eosins Methylene Blue Agar (EMB) and MacConkey agar as differential media.

After incubation at 37°C for 24 hrs on EMB Agar green metallic sheen and on MacConkey Agar pink colour colonies were observed.

Identification of the obtained isolates was done on the basis of cultural, Morphological and Biochemical characteristics (Bergey's manual of Determinative Bacteriology, 1939)

Biofilm Detection Methods:

Biofilm detection was carried out by the following methods;

a) **Tube method ™ :**

This is a qualitative method for biofilm detection. A loopful of test organisms inoculated in 10 ml of trypticase soy broth with 1% glucose in test tubes. Incubate the tubes at 37°C for 24 h. After incubation, tubes were decanted and washed with phosphate buffer saline (pH 7.3) and dried. Tubes were then stained with crystal violet (0.1%). Wash excess stain with distilled water. Tubes were dried in inverted position. The scoring for tube method was done according to the results of the control strains. Biofilm formation was considered positive when a visible thick film lined the wall and the bottom of the tube (Christensen et al., 1995).

b)**Congo Red Agar method (CRA**):

CRA medium was prepared with brain heart infusion broth 37 g/L, sucrose 50 g/L, agar 10 g/L and Congo Red indicator 8 g/L. Congo Red stain was prepared as a concentrated aqueous solution and autoclaved separately from the other medium constituents. Then it was added to the autoclaved brain heart infusion agar with sucrose. Inoculate CRA plates with test organisms and incubate at 37oC for 24 h aerobically. Black colonies indicate biofilm production (Freeman et al., 1989).

Antibiotic Susceptibility Test

Antibiotic susceptibility test of biofilm producing bacteria was done on Mueller Hinton agar using the following antibiotic discs: ampicillin colostin, naficillin, nalidixic acid, streptomycin, methicillin, chloramphenicol, clindamycin , cefoxamine, rifampicin, cloxacillin, vancomycin, erythromycin, oxacillin, penicillin. All antibiotic discs were used against E. coli as control strains (Biemer, J. J., 1973).

RESULTS AND DISCUSSION

Table No. 1 : Prevalence and epidermiological studies of *E. coli* from urine sample.

Sr. No.	Sample Collected	Collection Site	Sex	Age
1	Urine	GMC Akola	Male	42
2	Urine	GMC Akola	Male	38
3	Urine	GMC Akola	Female	33
4	Urine	Waichal Pathology, Akola	Female	28
5	Urine	Waichal Pathology, Akola	Male	24
6	Urine	Deshmukh Pathology, Akola	Male	18
7	Urine	Deshmukh Pathology, Akola	Female	23
8	Urine	Deshmukh Pathology, Akola	Male	15
9	Urine	Deshmukh Pathology, Akola	Male	19
10	Urine	Deshmukh Pathology, Akola	Male	27
11	Urine	ICON Hospital, Akola	Male	63
12	Urine	ICON Hospital, Akola	Male	57
13	Urine	ICON Hospital, Akola	Female	29
14	Urine	ICON Hospital, Akola	Female	22
15	Urine	ICON Hospital, Akola	Female	67
16	Urine	ICON Hospital, Akola	Male	56
17	Urine	ICON Hospital, Akola	Male	35
18	Urine	ICON Hospital, Akola	Male	45
19	Urine	ICON Hospital, Akola	Female	7
20	Urine	ICON Hospital, Akola	Female	32
21	Urine	ICON Hospital, Akola	Female	5
22	Urine	ICON Hospital, Akola	Male	39
23	Urine	ICON Hospital, Akola	Male	55
24	Urine	ICON Hospital, Akola	Male	62
25	Urine	ICON Hospital, Akola	Female	25
26	Urine	ICON Hospital, Akola	Female	50
27	Urine	ICON Hospital, Akola	Male	40
28	Urine	ICON Hospital, Akola	Male	26
29	Urine	ICON Hospital, Akola	Female	28
30	Urine	ICON Hospital, Akola	Female	37
31	Urine	ICON Hospital, Akola	Male	56
32	Urine	ICON Hospital, Akola	Male	77
33	Urine	ICON Hospital, Akola	Female	31
34	Urine	ICON Hospital, Akola	Female	24
35	Urine	ICON Hospital, Akola	Male	20
36	Urine	ICON Hospital, Akola	Male	18
37	Urine	ICON Hospital, Akola	Female	12
38	Urine	ICON Hospital, Akola	Female	41
39	Urine	ICON Hospital, Akola	Female	62
40	Urine	ICON Hospital, Akola	Male	21

Table no. confirmation of Biofilm forming isolate by Tube Test and Congo Red Agar Test

Sr. No.	Isolates	Biofilm formation organism positive	
		Tube Test	Congo Red Agar Test
		Dye on wall of test tube	Black Colour Colonies
01	U1	+ve	+ve
02	U2	+ve	+ve
03	U3	+ve	+ve
04	U4	+ve	+ve
05	U5	+ve	+ve
06	U6	+ve	+ve
07	U7	+ve	+ve
08	U8	+ve	+ve
09	U9	+ve	+ve

10	U10	+ve	+ve
11	U11	+ve	+ve
12	U12	+ve	+ve
13	U13	+ve	+ve
14	U14	+ve	+ve
15	U15	+ve	+ve

Table No. 3 :Frequency distribution of Biofilm forming isolates

Sr. No.	Total Sample Collected	Positive Biofilm formation Test	Negative Biofilm formation Test
1	40 (100%)	15 37.50 %	25 62.50%

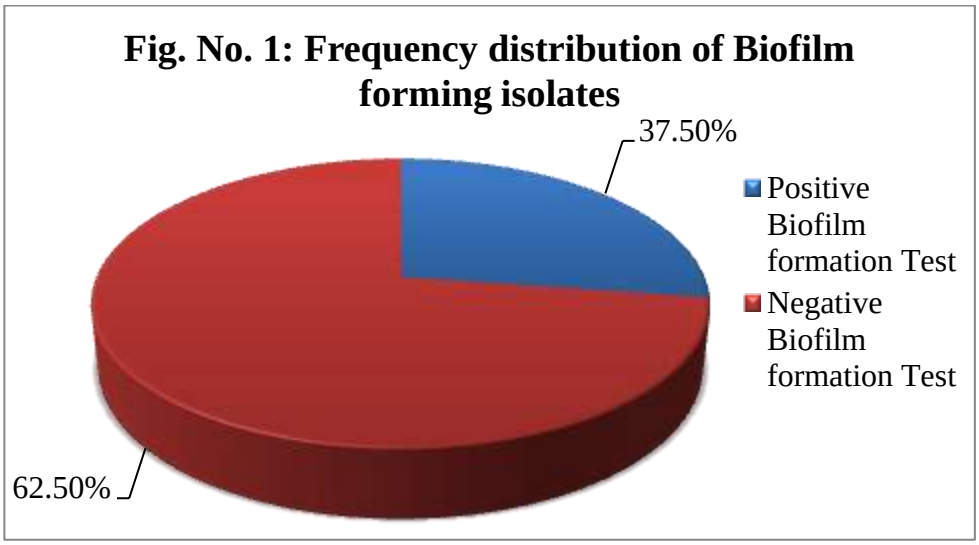
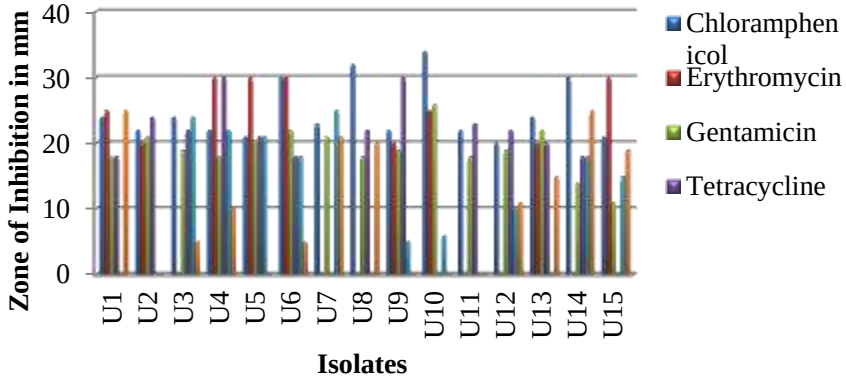


Table No. 4: Antibiotic Susceptibility Test against *E. coli* Isolates

Isolates	Zone of Inhibition in mm					
	Chloramphenicol	Erythromycin	Gentamicin	Tetracycline	Amoxiclave	Ampicillin
U1	24.0	25.0	18.0	18.0	R	25.0
U2	22.0	20.0	21.0	24.0	R	R
U3	24.0	R	19.0	22.0	24.0	5.0
U4	22.0	30.0	18.0	30.0	22.0	10.0
U5	21.0	30.0	20.0	21.0	21.0	R
U6	30.0	30.0	22.0	18.0	18.0	5.0
U7	23.0	R	21.0	R	25.0	21.0
U8	32.0	R	18.0	22.0	20. .0	20.0
U9	22.0	20.0	19.0	30.0	5.0	R
U10	34.0	25.0	26.0	R	6.0	R
U11	22.0	R	18.0	23.0	R	R
U12	20.0	R	19.0	22.0	10.0	11.0
U13	24.0	20.0	22.0	20.0	R	15.0
U14	30.0	R	14.0	18.0	18.0	25.0
U15	21.0	30.0	11.0	R	15.0	19.0

R – No zone of inhibition

Fig. 2 : Antibiotic Susceptibility Test against *E. coli* Isolates



Photoplate
Antibiotics Susceptibility Test



Photoplate
Biofilm Detection Method



Tube Method



Biofilm formation Positive

During the current research work total 40 urine sample were collected form different Pathology Laboratories as well as from Government Medical Hospital Akola (Table No. 1). All the samples were collected using clean and sterilized Plastic bottles with air

tight screw cap tops. The samples were collected and classified as per the sex and age of the patient. Total 22 samples from male and 29 samples from female were collected. Similarly samples were collected for low age group of 7 years to 68 years age group, to check the prevalence of E. coli organism.

The confirmation of Biofilm formation isolate were done on the basis of Biofilm forming ability of the isolate and it was noticed that two different method tube method and Congo red Agar method. Black colour colonies on Congo Red Agar media will confirmed biofilm production ability of isolates whereas visible thick film was obtained inside the wall of tube indicate positive result for tube test (Table No.3)

Out of total 40 sample Positive biofilm test was found for 15 (37.50%) samples and for Negative biofilm test 25 (62.50%) samples were observed (fig.no1)

Further we process for the antibiotics susceptibility test again the E coli isolate which where the biofilm Producer regarding the Choramphenicol u8 show maximum zone of 32 mm were the list zone of 21mm was showed by 2 isolate U5 and U15 indicating that this particular antibiotics is having the ability control E.coli organism regarding the erythromycin we observed U7 U8 and near about 5 isolate show complete resistance toward the erythromycin were as some of the isolate show better sensitivity in zone of 30 mm and list zone of 20mm regarding the gentamicin we observed U10 show maximum zone of 25mm were the list zone of U15 mm was showed by 2 isolate U6 and U13 indicating that this particular antibiotics is having the ability control E. coli organism

Gentamicin U10 show maximum zone of 26mm was showed were the list of zone of 11.mm was showed by 2 isolates U2 and U7 indicating that this particular antibiotics is having the ability control E. coli organisms.

Tetracycline we observed the U7, U10. U15 near about 3 isolate show complete resistance toward the tetracycline we as some of the Isolate the better sensitivity in zone of 30 mm and list zone of 18mm. Amoxyclave we observed the u1. U2, U11, U13 near about 4 isolate show complete resistance toward the amoxyclave we as some of the isolate the better sensitivity in zone of 25mm and list zone of 5.0 mm ampicillin

Amoxyclave we observed U1 U2 u11 near about 3 isolate show complete resistance we as some of the isolate the better sensitivity in zone of 24 mm and list zone of 5.0 mm

Ampicillins we observed U2 U5 U9 U10 U11 near about 5 isolate show complete resistance we as some of the isolate the better sensitivity in zone of 25mm and list zone of 0.5 mm (Table No. 7)

Conclusion

In This Study it has been founded that Gram Negative Bacteria are the commonest Organism isolated from UII Patient

E.Coli are one of the leading causes of the urinary Tract infection in humans the finding of this study Reviled that E.Coli was observed as the most Common etiologic agent of UII the Prevalence of UTIs was High in Female then in Male

Biofilm producing bacteria are responsible for many recalcitrant infections and are difficult to eradicate Biofilm Production in E. coli promotes colonization and lead to increased UTI

Antibiotic susceptibility pattem showed that many isolates showed the multiple drug resistance

Reference:

1. Rafaely, B. (2015). Fundamentals of spherical array processing (Vol. 8, pp. E1-E3). Berlin: Springer
2. Van Houdt, R., Michiels, C.W. Biofilm formation and the food industry, a focus on the bacterial outer surface. J.ApplMicrobiol. 2010,109,1117-1131.
3. Stewart, PS: Franklin, M.J. Physiological heterogeneity in biofilms. Nat Rev Microbiol 2008, 6, 199-210.
4. Panda PS, Chaudhary U, Dube SK. Comparison of four different methods for detection of biofilm formation by uropathogens Indian J Pathol Microbiol 2016;59:177-9.
5. Costerton, J. W., Lewandowski, Z., Caldwell, D. E., Korber, D. R., & Lappin-Scott, H. M. (1995). Microbial biofilms. Annual review of microbiology, 49(1), 711-745.
6. Naseem, H., Ahsan, M., Shahid, M. A., & Khan, N. (2018). Exopolysaccharides producing rhizobacteria and their role in plant growth and drought tolerance. Journal of basic microbiology, 58(12), 1009-1022.
7. Panda, P. S., Chaudhary, U., & Dube, S. K. (2016). Comparison of four different methods for detection of biofilm formation by uropathogens. Indian Journal of Pathology and Microbiology, 59(2), 177.

8. Niveditha, S., Pramodhini, S., Umadevi, S., Kumar, S., & Stephen, S. (2012). The isolation and the biofilm formation of uropathogens in the patients with catheter associated urinary tract infections (UTIs). Journal of clinical and diagnostic research: JCDR, 6(9), 1478.
9. Moradali, M. F., & Rehm, B. H. (2020). Bacterial biopolymers: from pathogenesis to advanced materials. Nature Reviews Microbiology, 18(4), 195-210.
10. Flemming, H. C., & Wingender, J. (2001). Relevance of microbial extracellular polymeric substances (EPSs)-Part I: Structural and ecological aspects. Water science and technology,
11. Waters, C. M., & Bassler, B. L. (2005). Quorum sensing: cell-to-cell communication in bacteria. Annu. Rev. Cell Dev. Biol., 21, 319-346. 43(6), 1-8.

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

The Prevalence of Uropathogenic *E. Coli* and to Study its Antibiogram Pattern

Samiksha s Mohod[1], S. N Zodpe[2]

[1, 2]Department of Microbiology, Shri Shivaji College of Arts, Commerce and Science Akola 444001 (M. S) India

Abstract: ***The study was aimed to determine The prevalence of Uropathogenic E. coli and to study the Antibiogram pattern in Akola city. A total 51 urine sample were collected from different pathology Laboratory as well as from Government medical hospital Akola. Total of 22 samples from male and 29 samples from Female were collected. The isolates were characterized using conventionl Microbiological method. The study was carried out in the Microbiology laboratory of the Department of Microbiology of Shri Shivaji college of Arts, Commerce and Science, Akola (MH) India The Prevalence of E. coli in the urine sample of UTI patients showed 51 out of 15 sample were positive for E. coli. Antimicrobial susceptibility was performed on all isolated bacteria by Disc diffusion method the multiple antibiotic resistance (MAR) index of each antibiotic was calculated.***

Keywords: Uropathogenic *E. coli*, Multi drug resistant

1. Introduction

Urinary tract infection (UTI) can be defined as the process by which microorganisms growing actively within the urinary tract continuously UTIs is one of the most serious and contagious infectious in human population all around world. Urinary tract infections (UTIs), the second - ranked infectious diseases, are recognized as a big concern relating to global healthcare systems. Urinary tract infections (UTIs) are common human microbial diseases that affect the urinary tract the kidneys, bladder, urethra, and prostate. UTIs are widespread globally with direct and indirect social and economic effects. Moreover, these diseases are becoming an emergent cause of morbidity. It is estimated that UTI affect about t 150 million people each year in the world. The healthcare costs are over $6 billion. These human diseases are second only to respiratory tract infections. In the United States. UTIs lead to over 1 million medical examinations in the emergency department and cause over 100, 000 hospital admissions each year. However, UTIs can be clustered into community or nosocomial acquired. The first one, community - acquired urinary tract infections (CA - UTI), occur in community or following less than 48 h of hospitalization (Renner, et al., 2017).

Nosocomial urinary tract infections (N - UTI), instead, appear 48 h after hospital admission or three days after discharge. The UTIs distribution in the population changes depending on age, sex, catheterization, hospitalization, and prolonged use of antimicrobials. Bacteria represent the main cause of UTIs, although viruses, fungi, and parasites may be involved in the development of this infection Gram - negative bacteria are responsible for 90% of UTI cases, while gram - positive bacteria are responsible forthe other 10%. Previous studies suggest that the most common cause of UTIs is Escherichia coli, which represent 65 - 90% of infections. Other uropathogens that cause UTIs include Enterococcus species, Klebsiella pneumoniae, Citrobacter species Pseudomonas aeruginosa and Staphylococcus coagulase negative (CONS). (Gupta, 2010).

The urinary tract is the most common site of E. coli infection and more than 90% of all uncomplicated urinary tract infections (UTIs) are caused by E. coli infection (Madappa et al., 2014). particularly in women because of the proximity of the urethra to the anus (Gould, et. al 2010). E. coli UTIs are caused by uropathogenic strains ofE. coli. The increase in antimicrobial resistance is a worldwide reality that threatens the prevention and effective treatment of an increasing number of infectionschallenging clinical microbiologists and infectious disease specialists (Bihari DJ, 1995). Two of the most common infections are urinary tract (UTI) and intra - abdominal (IAD) infections caused mainly by Enterobacterales, in particular Escherichia coli and Klebsiella species [Meyer KS 1993]. In the 1980s, extended spectrum beta - lactamase (ESBL) - producing Enterobacterales were considered one of the leading causes of nosocomial infections and later also of those acquired in the community [a surveillance study 1996]. These enzymes have the ability to hydrolyze beta - lactam antibiotics, including penicillins, cephalosporins and the monobactam aztreonam but not carbapenems (Shah PM 1991). As a consequence, carbapenems were con - sidered the antimicrobials of choice for the treatment of infections caused by ESBL producers. however the prevalence of carbapenemases, enzymes that inactivate them, continue to in - crease worldwide (Buirma et al., 1991). Hence, the current study was carried out to check the incidences of urinary tract infections, identify the responsible bacteria and to check the antimicrobial profile of organisms.

2. Material and Methods

2.1 Collection of sample

Total 51 urine samples were collected from different pathology laboratory, The age of patients included in the study ranged from 12 to 68 years. The patients on antibiotic therapy were also excluded from the study. Early morning mid - stream urine sample of about ten (10) ml were collected using clean and sterilized plastic bottles with air - tight screw cap tops. Each urine sample bottle was labelled with a reference code, age, sex, and time of collection. The samples were placed in a cold box in the laboratory. The urine sample collected from various pathology laboratories such as Deshmukh Clinical Laboratory. Akola, Nidan

Licensed Under Creative Commons Attribution CC BY

Pathology Laboratory Icon Hospital, Akola Government Medical College, Akola, Samadhan Pathology. Akola, Pride Diagnostic Laboratory, Jatharpeth road, Akola, Global Pathology Laboratory Akola

2.2 Isolation and Identification of Urppathogenic E. coli

Isolation of E. coli was conducted according to the method. During the process, a sterile wire loop was deep into the sediments of urine sample of the patients and streaked onto the surface of Eosin - Methylene Blue Agar, MacConkey Agar. The procedure was repeated for all the sample and the plates were incubated 37°C for 24 hours. The colonies which produce pink colour colonies were selected. The presumptive colony of E. coli from each plate was further sub - cultured toobtained pure culture.

2.3 Characterisation of Isolates

Further the isolates were confirmed on the basis of various biochemical tests. Gram staining was done according to method. A thin smear was made by emulsifying an overnight culture of the isolate in normal saline on a well labeled clean glass slide. The smear was air dried and fixed by heat. This is followed by flooding the slide with crystal violet as primary stain for 30 seconds and then rinsed the slide with distilled water. The smear was flooded with Lugol's iodine as a mordant to fix the primary stain and then rinsed with distilled water after 60 seconds. The slide was decolorized using acetone and rinsed immediately. Counter stain with safranin followed and left for 30 before being rinsed off. The stain smear was air dried and observed under microscope.

The isolates were confirmed by carbohydrate fermentation test as well as IMVIC Test

Conventional methods were used for identification of organism. On the basis of this test the organisms were tentatively confirmed.

Antibiotic Susceptibility Test -

1) Antibiotic susceptibility testing isolates to 6 antibiotic was performed using dise diffusion method.
2) Isolates were enriched in nutrient broth for 24 hours after which each strain of E. coli was uniformly swabbed into the individual plates using sterile cotton swabs.
3) The standard antibiotic sensitivity discs were then aseptically placed equidistance on using sterile forceps the plates and allowed to stand for 1 hour.
4) Sensitivity pattern of the isolates to Gentamicin (10ug), Amplicillin (30ug), Tetracycline (30ug), Ciprofloxacin (10ug), Erythromycin (30ug), Amoxacillin (30ug)
5) The plates were then incubated at 37°C for 24hours. After incubation a clear zone of inhibition was measured and results were (Pitout J. D.2012)

3. Results and Discussion

Table 1: Collection of Urine Samples for Isolation of Uro - pathogenic *E. coli*

Sr. No.	Sample Collected	Collection Site	Sex	Age
1	U1	Deshmukh Pathology, Akola	Male	42
2	U2	Deshmukh Pathology, Akola	Male	38
3	U3	Deshmukh Pathology, Akola	Male	33
4	U4	Deshmukh Pathology, Akola	Female	28
5	U5	Nidan Pathology Lab. Akola	Male	24
6	U6	Nidan Pathology Lab. Akola	Female	18
7	U7	Nidan Pathology Lab. Akola	Female	23
8	U8	Nidan Pathology Lab. Akola	Female	15
9	U9	Nidan Pathology Lab. Akola	Female	19
10	U10	Nidan Pathology Lab. Akola	Male	27
11	U11	Nidan Pathology Lab. Akola	Male	63
12	U12	Nidan Pathology Lab. Akola	Male	57
13	U13	Nidan Pathology Lab. Akola	Female	26
14	U14	GMC, Akola	Male	33
15	U15	GMC, Akola	Male	53
16	U16	GMC, Akola	Female	19
17	U17	GMC, Akola	Female	21
18	U18	GMC, Akola	Female	61
19	U19	GMC, Akola	Male	24
20	U20	GMC, Akola	Female	20
21	U21	GMC, Akola	Male	39
22	U22	Samadhan Clinical Lab. Akola	Male	68
23	U23	Samadhan Clinical Lab. Akola	Male	65
24	U24	Samadhan Clinical Lab. Akola	Male	46
25	U25	Samadhan Clinical Lab. Akola	Female	27
26	U26	Samadhan Clinical Lab. Akola	Female	22
27	U27	Samadhan Clinical Lab. Akola	Female	37
28	U28	Samadhan Clinical Lab. Akola	Male	56
29	U29	Pride Diagnostic Lab., Akola	Female	35
30	U30	Pride Diagnostic Lab., Akola	Female	45
31	U31	Pride Diagnostic Lab., Akola	Female	7
32	U32	Pride Diagnostic Lab., Akola	Male	32
33	U33	Pride Diagnostic Lab., Akola	Female	5
34	U34	Pride Diagnostic Lab., Akola	Female	39
35	U35	Pride Diagnostic Lab., Akola	Female	55
36	U36	Pride Diagnostic Lab., Akola	Female	62
37	U37	Pride Diagnostic Lab., Akola	Male	41
38	U38	Pride Diagnostic Lab., Akola	Female	43
39	U39	Global Pathology Lab., Akola	Female	58
40	U40	Global Pathology Lab., Akola	Male	62
41	U41	Global Pathology Lab., Akola	Female	23
42	U42	Global Pathology Lab., Akola	Male	50
43	U43	Global Pathology Lab., Akola	Male	40
44	U44	Global Pathology Lab., Akola	Female	26
45	U45	Global Pathology Lab., Akola	Female	28
46	U46	Global Pathology Lab., Akola	Female	18
47	U47	Global Pathology Lab., Akola	Female	12
48	U48	Global Pathology Lab., Akola	Male	24
49	U49	Global Pathology Lab., Akola	Female	31
50	U50	Global Pathology Lab., Akola	Female	16
51	U51	Global Pathology Lab., Akola	Male	26

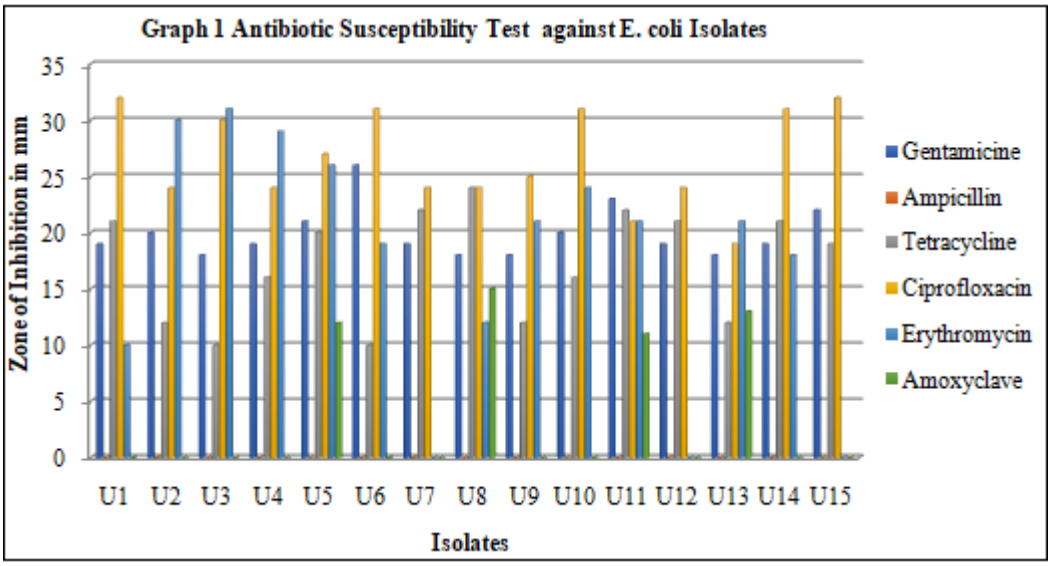
Table 2: Antibiotic Susceptibility Test against *E. coli* Isolates

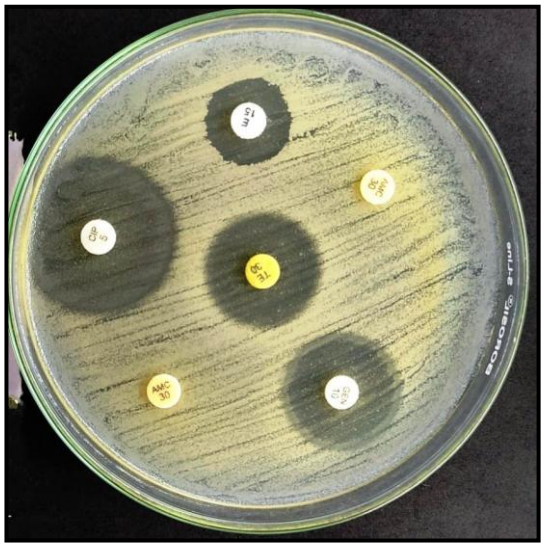
Isolates	Zone of Inhibition in mm					
	Gentamicin	Ampicillin	Tetracycline	Ciprofloxacin	Erythromycin	Amoxiclave
U1	19	- -	21	32	10	- -
U2	20	- -	12	24	30	- -
U3	18	- -	10	30	31	- -
U4	19	- -	16	24	29	- -

Licensed Under Creative Commons Attribution CC BY

U5	21	- -	20	27	26	12
U6	26	- -	10	31	19	- -
U7	19	- -	22	24	- -	- -
U8	18	- -	24	24	12	15
U9	18	- -	12	25	21	- -
U10	20	- -	16	31	24	- -
U11	23	- -	22	21	21	11
U12	19	- -	21	24	- -	- -
U13	18	- -	12	**19**	21	13
U14	19	- -	21	31	18	- -
U15	22	- -	19	32	- -	- -

XZ - - R





Antibiotics Susceptibility test against *E. coli*

During the current research work total 51 urine sample were collected form different Pathology Laboratories as well as from Government Medical Hospital Akola (Table No.1). All the samples were collected using clean and sterilized Plastic bottles with air tight screw cap tops. The samples were collected and classified as per the sex and age of the patient. Total 22 samples from male and 29 samples from female were collected. Similarly samples were collected for low age group of 7 years to 68 years age group, to check the prevalence of *E. coli* organism. Similar studied was carried out by Zorc et al., (2005). They reported that many human diseases are as result of infections caused by pathogenic bacteria, either internal or external of the human host. One of such bacterial infection is urinary tract infection (UTI), involving the presence of bacteria in the urinary tract (UT) which is naturally sterile.

After collection of the sample the study was proceed for the isolation of the organism *E. coli* from urine sample. During the study isolates were grown on various selective media such as EMB Agar and differential media such as MacConkey Agar was used. On EMB agar the greenish Metallic Sheen colour colonies were observed whereas, on MacConkey Agar Pink coloured colonies were observed.

The result for identification of *E. coli* were observed. The isolates were identified on the basis of Cultural and Morphological Characteristics as well as on the basis of Biochemical characteristics which includes sugar fermentation as well as IMViC Test. In sugar fermentation test, of Glucose, Lactose and Mannitol were checked whereas, four different test were performed for IMViC i. e. Indole, MR, VP, Citrate. Almost all the organism shows acid and gas production positive with the fermentation of Glucose and lactose but it was found to be negative for Mannitol fermentation. In case of most of the isolates shows positive for Indole and Methyl Red test were found to be negative for VP test and Citrate Test.

The antibiogram profile of *E. coli* were studied to check the sensitivity and resistance pattern of *E. coli* (Table no.2). During the study different antibiotic were check such as ciprofloxacin, Tetracycline, Ampicillin, Gentamicin, Erythromycin and Amoxiclave. All the isolates were tested against all the antibiotics and it was observed Ampicillin

Licensed Under Creative Commons Attribution CC BY

shows complete resistant towards the *E. coli* organism, followed by Ampicillin Amoxiclave shows most of the resistant towards the *E. coli*, whereas, Gentamicin, Tetracycline, Ciprofloxacin, Erythromycin showed zone of inhibition and Gentamycin, Tetracycline, Ciprofloxacin and Erythromycin shows sensitivity towards the isolates. Gentamycin shows the maximum zone of 26 mm for U6 followed by Tetracycline show the highest zone of 24 mm for isolates U8, whereas, the list zone of only 10 mm showed by isolate number U3. U1 isolates showed 32 mm of zone against the Ciprofloxacin, were as the list zone of 18 mm was shown by isolate Np. U13. Erythromycin shows the highest zone of 31 mm for isolate U3, whereas the list zone of only 10 mm showed by isolate number U1.

The study was aimed to determine the prevalence and antibiotic Susceptibility pattern of *Escherichia coli* isolated from urinary tract infection patients in Akola city. The judicious use of antibiotic is recommended which will help to limit the increasing rate of drug resistance in the Pathogens.

4. Conclusion

In This Study it has been founded that Gram Negative Bacteria are the commonest Organism isolated from UTI Patient. *E. coli* are one of the leading causes of the urinary tract infection in humans, the finding of this study reviled that E. Coli was observed as the most common etiologic agent of UTI. the Prevalence of UTIs was High in Female then in Males. Antibiotic susceptibility pattern showed that many isolates showed the multiple drug resistance pathogens.

References

[1] Renner LD, Zan J, Hu LI, Martinez M, Resto PJ, Siegel AC, et al. Detection of ESKAPE bacterial pathogens at the point of care using isothermal DNA - based assays in a portable degas - actuated microfluidic diagnostic assay platform. Applied and Environmental Microbiology.2017; 83 (4): e0244916.
[2] Gupta et al., 2010 R. K. Gupta, Z. Arany, P. Seale, R. J. Mepani, L. Ye, H. M. Conroe, Y. A. Roby, H. Kulaga, R. R. Reed, B. M. Spiegelman
[3] Gould D. Causes, prevention and treatment of Escherichia coli infections. Nursing Standard.2010; 24 (31): 50–6.
[4] Madappa T. Escherichia coli infections. (accessed 29 January 2015).2014. Nicholas D Maynard, Robert C Mason, David J Bihari, Mark N Smithies, R Neil Dalton Chest 108 (6), 1648 - 1654, 1995
[5] Nicholas D Maynard, Robert C Mason, David J Bihari, Mark N Smithies, R Neil DaltonChest 108 (6), 1648 - 1654, 1995
[6] A surveillance study 1996
[7] John Bycroft, Rizwan Hamid, Helen Bywater, Prasad Patki, Michael Craggs, Julian Shah Neurourology and urodynamics 23 (3), 252 - 256, 2004
[8] RJA Buirma, AM Horrevorts, JHT WagenvoortScand J Infect Dis 78 (Suppl), 35 - 44, 1991

Licensed Under Creative Commons Attribution CC BY

International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Evaluation of Antimicrobial Efficacy of *Murraya Koenigii* Plant Leaf Extract Against *E. coli* Isolated from Different Sources

Fokmare Samruddhi S[1], Zodpe S.N[2]

[1]Student, P.G. Department of Microbiology, Shri Shivaji College of Arts, Commerce and Science, Akola – 444003 (M.S.), India.
[2]Assistant Professor, P.G. Department of Microbiology, Shri Shivaji College of Arts, Commerce and Science, Akola – 444003 (M.S.), India.

Abstract

The current study was carried out to evaluate the anti-microbial efficacy of the leaf extract *Murraya koenigii* plant against *E. coli* isolated from clinical and various other sources like water, soil, skin, floor, juice, basin, incubator and mobile phone. The anti-microbial test showed that the ethanolic extract was more potent than aqueous extract of *Murraya koenigii* leaves against *E. coli*. The sensitivity of the bacterial isolates from each sample having lowest potential against the extract was examined against four different antibiotics. It was observed that all isolate showed complete resistance to Amoxicillin and were sensitive to Ciprofloxacin, Chloramphenicol and Gentamycin. Qualitative analysis of active compounds in extract of *Murraya koenigii* leaves was done using different chemical reagents. The result showed the presence of phenols, flavonoids, terpenoids, tannins and quinones. The Total Antioxidant Capacity was calculated to be 40.42%. UV-VIS spectrophotometric analysis of extract of *Murraya koenigii* leaves in different solvents like distilled water, ethanol and methanol was done. The analysis exhibited peaks at wavelength 420 and 500 nm for methanol and 500nm for distilled water and ethanol.

Keywords: *Murraya koenigii*, *E. coli*, Antimicrobial Activity

1. Introduction

Traditional medicine is still recognized as the preferred primary health care system in many communities, with over 60% of the world's population and about 80% in developing countries depending directly on medicinal plants for their medical purposes. (Tugume P. *et. al.* 2019). One of which is *Murraya koenigii* plant. The Curry Tree (*Murraya koenigii*) is tropical to the subtropical small tree in the family *Rutaceae*, which is native to India. It is reported to have anti-oxidant, anti-diabetic, anti-carcinogenic, anti-dysenteric, stimulant, hypoglycemic and antimicrobial activities (Ningappa *et. al.*2008). The extract of curry leaves shows very significant antibacterial activity against many broad ranges of bacteria mainly *E. coli.*

Escherichia coli is Gram-negative, facultative anaerobic and rod-shaped bacterium of the genus *Escherichia*. Pathogenic *E. coli* contamination of the environment may occur through manure and other animal wastes, wastewaters from slaughterhouses and effluent from wastewater treatment plants *(Balière et. al.* 2015). Most pathogenic *E. coli* are transmitted by fecal-oral route from food materials, water, animals, and environment. Depending on the pathotype and the system, *E. coli* infection may cause a range of

syndromes including watery, mucoid, or bloody diarrhea; abdominal cramps; urinary tract infection syndromes; and meningitis. Also, syndromes have been reported as food poisoning outbreak, travel-related illness, or animal or contaminated environment contact-related diseases.

In the past few years, antibiotics helped saving a significant number of lives and reduced the illness of several million people across the world (Jones *et. al.* 2007). However, the emergence and rapid spread of extended-spectrum cephalosporin and carbapenem resistance in *Enterobacteriaceae* is becoming a global health challenge. In addition, antibiotic-resistant *E. coli* are also increasing and becoming a major threat for global human health. The increasing resistance to cephalosporin, especially the parallel rise in the frequency of multidrug-resistant *E. coli*, constitutes an increasing concern for the treatment of *E. coli* disease (Wu D *et al.*2021).

To find alternative medicine medicinal plants frequently used as raw materials for extraction of active ingredients which used in the synthesis of different drugs, or use to complement or neutralize drag's negative effects (synergic medicine), also medical plants can prevent the appearance of some diseases, this will help to reduce the use of the chemical remedies which will be used when the disease is already present i.e., reduce the side effect of synthetic treatment.

Phytochemically curry leaves are rich source of organic compounds with different chemical composition such as alkaloids, flavonoids carbohydrates, sterol and volatile oil (Shaikh *et. al.* 2020). The presences of important phytochemicals make the plant useful for treating different ailments and have a potential of providing useful drugs of human use. Antioxidants are the substance that when present in low concentrations compared to those of an oxidisable substrate significantly delays or prevents oxidation of that substance (Praveen *et. al.* 2007). Antioxidant-based drug formulations are used for the prevention and treatment of complex diseases like atherosclerosis, stroke, diabetes, Alzheimer's disease and cancer (Khalaf *et. al.* 2008).

This study aims to detect the antimicrobial activity of the leaves of plant *Murraya koenigii* via assessing its phytochemical constituents and antioxidant activity against enteropathogenic *E. coli.*

2. Materials and Methods

Collection of samples

For this study 30 samples from various sources were taken for the isolation of *E. coli.* Clinical samples such as blood and urine were collected from Mapari Pathology Laboratory, Akola. Soil samples were collected from Rhizospheric area of Rose, Hibiscus and Mango plants in a cleaned polythene bag. Sewage water samples from local drains of Akola city, domestic water samples from residential area and various juice samples from local vendors of Akola City were collected. Other samples like skin, floor, basin and mobile were collected using sterile cotton swabs. The swabs were rotated and rubbed against sampled surface several times and then kept in sterile test tubes until inoculation.

Isolation and Identification

Each of the collected samples without much delay was inoculated onto EMB (Eosin Methylene Blue) agar plates and incubated at 37°C for 24 hours. The colonies which produced metallic green sheen with dark centered colonies were selected and were sub-cultured to assess the uniformity of colony appearance. Further identification of the bacteria was done based on colony characteristics observed on the EMB Agar plate, morphological characteristics by Gram's staining, sugar fermentation test, and a series of biochemical tests.

Extract Preparation

Murraya koenigii leaves were collected locally from Akola city of Maharashtra, India. The curry leaves were washed thoroughly and dried under shadow at room temperature for 5 days or until constant weight. Then the dried leaves were ground to fine powder in a mixer grinder.

1) Aqueous Extract:

The curry leaf powder of about 20gm in 100ml of double distilled water and kept at room temperature for 2 days. The extract was filtered through Whatman No. 1 filter paper followed by muslin cloth.

2) Ethanolic Extract:

The powdered curry leaf was mixed with 70% ethanol for 24 to 48 hours. It was then filtered using Whatman No. 1 filter paper. The extract was concentrated further in a water bath at 40°C by heating and evaporating the solvent.

Antimicrobial Activity

Antibacterial activity using plant extract was evaluated by Agar Well Diffusion Method on Nutrient Agar. Each isolate of *E. coli* was uniformly swabbed onto the individual plates using sterile cotton swabs. Wells were made by using sterile borer. A micropipette was used to pour the extract solution into each well on all plates. After incubation at 30o C for 24 hours the zone of inhibition was measured in millimeters.

Antibiotic Susceptibility Test

Antibiotic susceptibility test was carried out using agar disc diffusion method on Nutrient Agar. Each strain of *E. coli* was uniformly swabbed onto the individual plates using sterile cotton swabs. After the inoculation, different antibiotic discs were placed on the medium using sterile forceps. The antibiotics used in the study include Ciprofloxacin (5µg/disc), Chloramphenicol (30µg/disc), Amoxicillin (30µg/disc), and Gentamicin (10µg/disc). The plates were incubated at 30o C for 24 hours. After incubation, clear zone of inhibition was measured and results were noted.

Spectrophotometric analysis of *Murraya koenigii* leaf extract

The extract was centrifuged at 3000rpm for 10min and filtered through Whatman No.1 filter paper. The sample is diluted to 1:10 with the different solvent. The extract was scanned at wave length ranging from 400 to 680 nm using UV-VIS Spectrophotometer and the characteristic peaks were detected.

Phytochemical Screening

Qualitative phytochemical analysis of the curry leaf extracts was carried out to detect the presence of phytochemicals by following the procedures stated below:

1. Test for phenol

2ml of *Murraya koenigii* extract was taken in a test tube and few drops of 1% ferric chloride were added in it. Presence of phenol was confirmed by the appearance of green/blue/ bluish green/ brown/ brownish red color (Sophiyamole L *et. al.* 2017).

2. Test for flavonoids

2 ml of Murraya koenigii leaf extract solution was taken in a test tube and 3 ml of diluted ammonia was added to the solution and then 1 ml concentrated sulphuric acid was added into the solution. The tube was observed for appearance of yellow color indicating the presence of flavonoids.

3. Test for terpenoids

3ml Murraya koenigii leaf extract dissolved in 1ml of chloroform in a test tube and 1ml of concentrated sulphuric acid was added in the test tube. An intense red- brown indicates the presence of terpenoids (Sophiyamole L *et. al.* 2017).

4. Test for tannins

About 0.5g of dried powder of Murraya koenigii plant sample was boiled in 4ml of water in a test tube and then filtered. Few drops of 0.1% Ferric chloride were added to observe brownish green or blue-black coloration indicating the presence of tannin (Sophiyamole L *et. al.* 2017).

5. Test for Quinone

A few drops of concentrated hydrochloric acid were added to 1ml of extract. A yellowish-brown color was observed for the presence of quinone.

Antioxidant Activity

Total antioxidant activity of curry leaf extract was determined spectrophotometrically by phospho-molybdenum assay. Phosphomolybdenum reagent solution was prepared by mixing 0.46g sodium phosphate, 78.4mg ammonium molybdate and 3.367ml sulphuric acid for 100ml in water. The reaction mixture containing1 ml of curry leaf extract (1mg/ml) and 3ml of phosphomolybdenum reagent was incubated at 95oC for 90mins. Absorbance was read at 695nm against reagent blank in a UV-VIS Spectrophotometer. The antioxidant capacity was estimate using the following formula: % Inhibition = $\frac{\text{Abs.of control}-\text{Abs.of sample}}{\text{Abs.of control}} \times 100$

3. Results And Discussion

During the current research work total 30 samples were analyzed including clinical samples such as blood and urine samples where as other samples were collected from different sources such as tap water, sewage water, soil, skin, pineapple juice, sugarcane juice, basin, floor, mobile, incubator and shoes. From total 30 samples, 23 samples were isolated as Gram negative coccobacilli. On the basis of cultural, morphological and biochemical characteristics, the isolates obtained were tentatively confirmed as *Escherichia coli*. In the study, M. Kavitha (2017) reported the antimicrobial efficiency of *Murraya koenigii* against bacteria such as *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. Similar reports were given by Pagu *et.al.* (2020). They isolated *Escherichia coli* from urine sample of UTI patients for observing the antimicrobial effect of aqueous extract of *Murraya koenigii* leaves.

In the current investigation, Aqueous and Ethanolic extract of leaves of *Murraya koenigii* plant were prepared to detect its antimicrobial activity against *E. coli*. The ethanolic extract obtained from *M. koenigii* were less viscous in nature and brownish in color. The Antimicrobial Activity of aqueous and ethanolic extract of *Murraya koenigii* leaves was evaluated by Agar Well Diffusion Method on Nutrient Agar. It was observed that ethanolic extract of leaves of *Murraya koenigii* was more effective than the aqueous extract (Table 1; Figure 1)

Ramamurthy and Prasanth (2018) reported similar findings of *Murraya koenigii* plant extracts demonstrating greater antibacterial activity against *Escherichia coli.* Sethi *et. al.* (2012) found the highest antibacterial activity against *Escherichia* (29mm) with methanolic extract of Leaf and Bark of *Murraya.* According to the study done by Arun Thanavel *et.al.* (2017) *Murraya koenigii*'s wintertime acetone extract had more actively than other extract against *E. coli* (16mm), *K.pneumoniae* (17mm), *S.typhi* (16mm) and *P.mirabilis* (15mm).

The isolates from each sample having highest potential as antimicrobial was selected for the antibiotic susceptibility testing. It was noticed that all the isolates showed complete resistance to Amoxicillin and were sensitive to Ciprofloxacin, Chloramphenicol, and Gentamycin. The M2 (mobile) isolate was found to be the most susceptible to the antibiotics used forming a zone of clearance of 34 mm for Ciprofloxacin, 28 mm for Chloramphenicol and 26 mm for Gentamycin. The least sensitive isolate for Ciprofloxacin was

S1 (soil) forming 21 mm zone of inhibition. The least zone of 10 mm was recorded for Chloramphenicol against the isolates obtained from Bl (blood) and T2 (tap water). For Gentamycin 17 mm zone was obtained against *E. coli* obtained from incubator (Table 2; Figure 3).

According to the research done by Arun Thangavel *et.al.* (2017) it was revealed that Ciprofloxacin had a high level of inhibitory effect against *E. coli* found in urine samples from UTI patients. Also, Olerumi *et.al.* (2011) in his study observed that the Ciprofloxacin and Oflaxin could inhibit the growth of gram-negative bacteria. The results of Nehia Hussein *et. al.* (2017) showed that *E. coli* resistance to Erythromycin, Ciprofloxacin, Cefotaxime, Tobramycin, Doxycycline, and Clindamycin are 100%, 97%, 94%, 100%, 89% and 93% respectively, while both chloramphenicol and gentamicin were inhibited 22.33 mm and 18.66 mm respectively.

The qualitative UV-VIS spectrum profile of extract of *Murraya koenigii* in different solvents like distilled water, ethanol and methanol were studied at different wavelength ranging from 400 to 680 nm due to sharpness of peaks and proper baseline. The profile showed the peaks at 420 and 500 nm with absorption of 0.43 and 0.38 respectively for methanol; 0.41 and 0.37 respectively for ethanol, while for distilled water the profile showed peak at 500 nm with absorption of 0.17 (Figure 5). The result is in accordance with Pagu *et.al.* (2020) who scanned at wave length ranging from 200 to 1100 nm exhibited four peaks 751.55, 954.65, 1,008.20 and 1,053.00. Similar study was done by K. Kalaichelvi *et.al.* using *Micrococca mercuralis* petroleum ether extract at selected wavelength from 200 nm to 700 nm due to sharpness of peak and proper baseline. The profile showed the peaks at 214, 446 and 472 nm with the absorption of 0.599, 0.655, and 0.550 respectively.

The preliminary phytochemical screening of *Murraya koenigii* plant was carried out in current research to check the presence of phytochemicals in the plant. It was seen that all the phytochemical constituents such as phenols, flavonoids, terpenoids, tannins and quinones were present in the *Murraya koenigii* leaf extract (Table 3). Similar results for the presence of phytochemicals like flavonoids, phenols, tannins, terpenoids and various other like alkaloids, carbohydrates amino acids and proteins in the Murraya koenigii. L aqueous extracts was reported by Pagu *et.al.* (2020). Also, Rashmi and Naveen (2016) reported the presence of phytochemical constituents viz. alkaloid, carbohydrate, phenols, tannins and terpenoids in the *Murraya koenigii* L aqueous extract.

Total antioxidant capacity was determined by phosphomolybdenum assay. The total antioxidant capacity of aqueous extract of *Murraya koenigii* was determined to be 40.42%. Another study done by Rajesh *et.al.* (2017) revealed that the total antioxidant activity of acetone extract of *M. koenigii* old leaves was found to be 151.58%, and for young leaves in petroleum ether, the value was 72.23%. Pagu *et. al.* (2020) also the evaluated the antioxidant activity via phosphomolybdenum assay; the total antioxidant capacity was found to be 27.29 AAE/100 g of crude aqueous leaf extract.

Table 1: Antimicrobial Activity of *Murraya koenigii* against *E. coli* isolated from different sources

Isolates	**Aqueous Extract**	**Ethanolic Extract**
	Zone of Inhibition (in mm)	
Blood (Bl)	14.0	16.0
Urine 1 (U1)	16.0	18.0
Urine 2 (U2)	10.0	12.0
Urine 3 (U3)	16.6	20.4

Tap water 1 (TW1)	14.0	14.0
Tap water 2 (TW2)	17.2	18.6
Sewage Water 1 (SW1)	18.4	19.0
Sewage Water 2 (SW2)	19.0	20.0
Sewage Water 3 (SW3)	17.0	20.5
Soil 1 (S1)	16.5	17.0
Soil 2 (S2)	12.0	14.7
Hand1 (H1)	13.0	15.0
Hand 2 (H2)	12.0	14.0
Sugarcane Juice (SJ)	18.3	18.5
Basin 1 (B1)	16.2	18.0
Basin 2 (B2)	19.0	19.4
Floor 1 (F3)	18.0	20.0
Floor 2 (F2)	14.7	14.0
Floor 3 (F3)	12.8	14.2
Mobile 1 (M2)	18.2	18.3
Mobile 2 (M2)	18.4	21.0
Incubator (I)	15.3	21.8

Figure 1: Antimicrobial Activity of leaf extract of *Murraya koenigii* plant against *E. coli* isolated from different sources

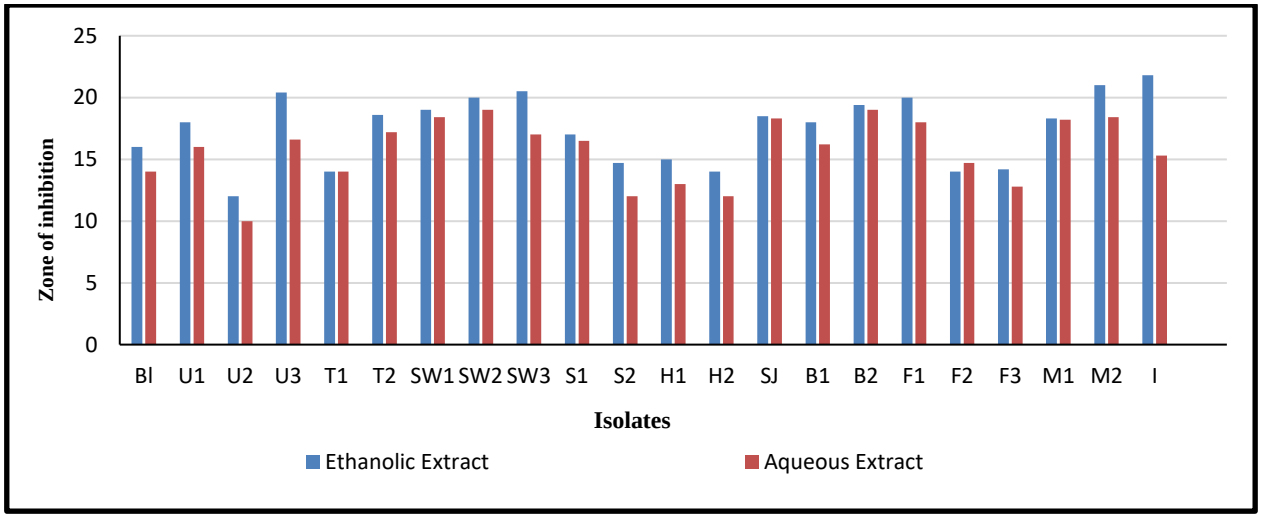


Figure 2: Inhibitory effect of Aqueous and Ethanolic extract of *Murraya koenigii leaves* on *E. coli* isolates



Table 2: Antibiotic Susceptibility Test against *E. coli* isolates

Isolates	Ciprofloxacin	Chloramphenicol	Amoxicillin	Gentamycin
	Zone of Inhibition (in mm)			
Bl	24	10	-	18
U3	22	12	-	21
T_2	24	10	-	19
SW_2	22	25	-	18
S_1	21	22	-	20
H_1	30	25	-	22
SJ	23	28	-	21
B_2	33	22	-	18
F_1	22	27	-	19
M_2	34	28	-	26
I	24	11	-	17

Figure 3: Antibiotic Susceptibility Test against *E. coli* isolates

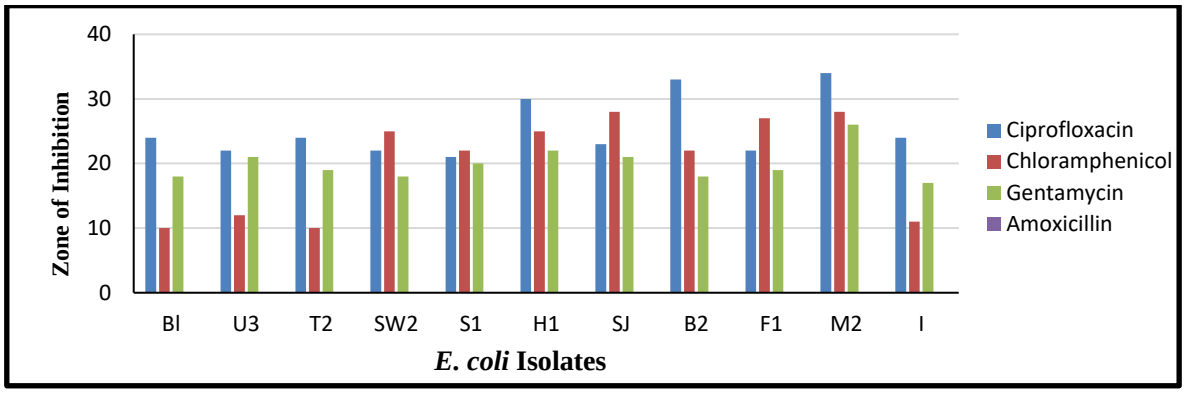


Figure 4: Sensitivity of *E. coli* isolates to Antibiotics

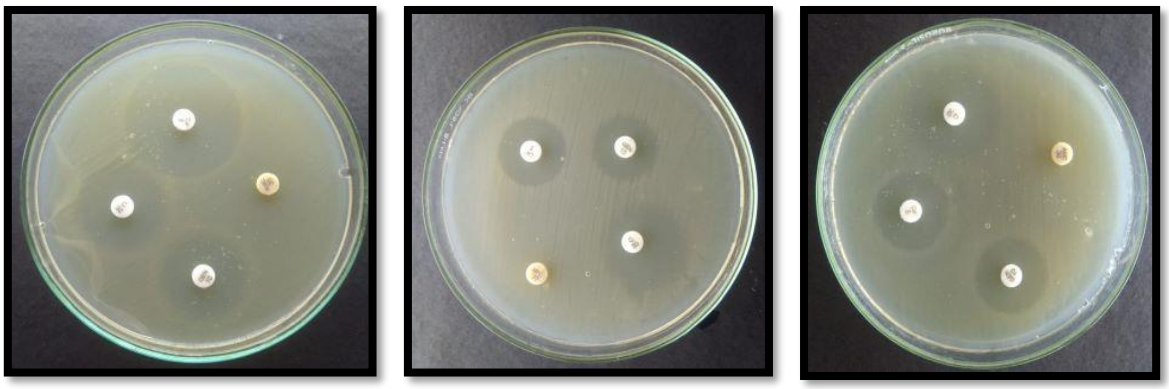


Figure 5: Spectrophotometric Analysis of Murraya koenigii plant leaves extract in different solvent

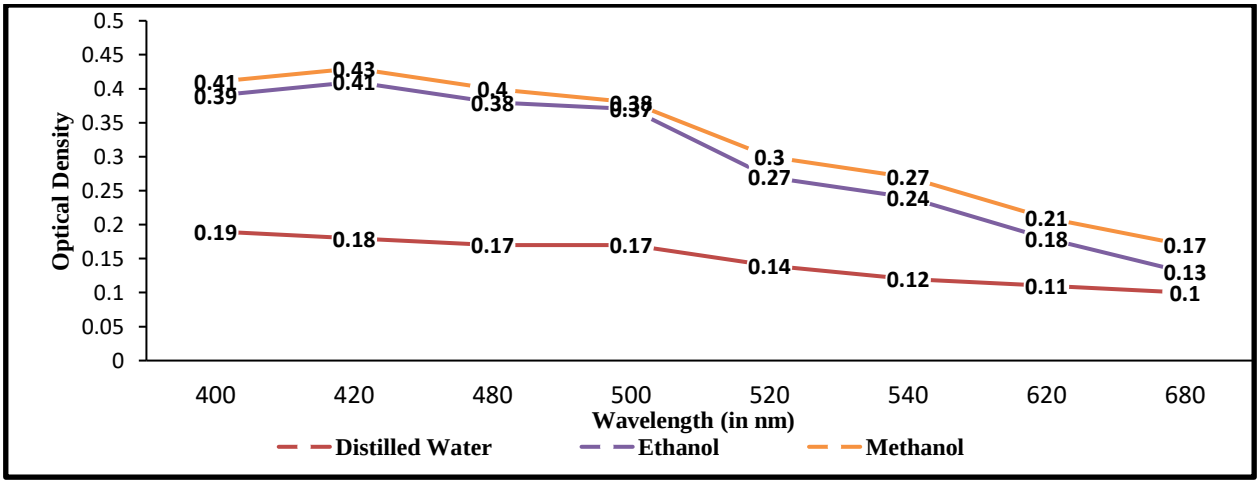


Table 3: Preliminary phytochemical analysis *Murraya koenigii* plant leaves extract

Phytochemicals	Color Change	Leaf Extract
Phenols	Brown	+
Flavonoids	Yellow	+
Terpenoids	Red-brown	+
Tannins	Brownish green	+
Quinones	Yellowish brown	+

4. Conclusion

The current research is related to the antibacterial activity of *Murraya koenigii* against *E. coli* obtained from clinical and various other sources. *Murraya koenigii* is a source of several bioactive compounds including phenols, flavonoids, terpenoids, tannins and quinones, which could be responsible for the inhibition of enteropathogenic *E. coli*. Thus, *Murraya koenigii* plant can be used as an effective antimicrobial agent in new drugs against *E. coli* and also could be used as raw material in water purification. However, further study needs to include bioavailability, efficiency enhancement in clinical investigation and in water purification.

5. References

1. Baliere, C., Rinc_e, A., Blanco, J., Dahbi, G., Harel, J., Vogeleer, P., Giard, J.-C., Mariani-Kurkdjian, P. et al. (2015) Prevalence and characterization of Shiga toxin-producing and enteropathogenic *Escherichia coli* in shellfish harvesting areas and their watersheds. Front Microbiol 6,1356.
2. Jones RN, Sader HS, Fritsche TR, Pottumarthy S. Comparisons of parenteral broad-spectrum cephalosporins tested against bacterial isolates from pediatric patients: report from the SENTRY antimicrobial surveillance program (1998-2004). Diagn Microbiol Infect Dis. (2007) 57:109–16. doi: 10.1016/j.diagmicrobio.2006.06.011
3. Kalaichelvi K, Dhivya SM. Screening of phytoconstituents, UV-VIS Spectrum and FTIR analysis of *Micrococca mercurialis* (L.) Benth. International Journal of Herbal Medicine, 2017; 5(6): 40-44.
4. Khalaf NA, Shakya AK, Al-Othman A, El-Agbar Z and Farah H: Antioxidant activity of some common plants. Turk J Biol 2008; 32: 51-5.
5. M. Kavitha Antibacterial and antioxidant activity of leaf organic extracts of local cultivars of Murraya koenigii (L.) Spreng from Tamil Nādu Bioscience Biotechnology Research Communications 10(2): 359-364 (2017).
6. M. Veera Pagu, K. R. Jeya and S. Vennila, Evaluation of phytochemicals, antioxidant potential and invitro antibacterial efficiency of *Murraya koenigii* leaves against uropathogenic *E.coli*, 2020, ISO 9001:2015 Certified Journal, Volume 10, Issue 1, 1185-1195.
7. Nehia Hussein, Noor A. Hanon. The antimicrobial Activity of some medical plants extracts used against some types of bacteria that causes urinary tract infection, Al-Mustansiriyah Journal of Science, 2017; DOI: http://doi.org/10.23851/mjs.v28i3.177
8. Ningappa MB, Dinesha R, Srinivas L: Antioxidant and free radical scavenging activities of polyphenol-enriched curry leaf (*Murraya koenigii* L.) extracts. Food Chemistry 2008; 106, 720–728.
9. Praveen K and Awang B: Antioxidant activity, total phenolic and flavonoid content of *morinda citrifolia* fruit extracts from various extraction processes. JESTEC 2007; 2: 70-80.
10. Rajesh ST, Sharmistha B, Shuchi K. Assessment of antioxidant activity of leaves of *Murraya koenigii* extracts and its comparative efficacy analysis in different solvents. J. Pharm. Sci. Res, 2017; 9: 288–291.
11. Ramamurthy V, Prasanth AS. Phytochemical screening and antibacterial activity of Murraya koenigii. World Journal of Pharmaceutical Research, 2018; 7(5): 1830-1837.
12. Rashmi JB, Naveen G. Phytochemical analysis and antibacterial activity of different leaf extracts of Murraya koenigii. International Journal of Biochemistry and Biomolecules, 2016; 2(2): 1-5.

13. Shaikh H, Shaikh S, Priya R. A review on Indian traditional herb *Murraya koenigii* its nutritive & medicinal properties in human health management. World Journal of Pharmaceutical Research, 2020; 9(6): 850-863.
14. Sonia Sethi, Shrikant, Gupta B Lal. Antimicrobial Activity of Medicinal Plants on Urinary Tract Pathogens International Journal of Pharmacy and Pharmaceutical Sciences Vol 4, Issue 2, 2012.
15. Sophiyamole L, Dr Reshma J k, Sakhi Prabhachandh R, Nimmi Babychan. Phytochemical analysis of *Murraya koenigii* in urban and coastal area, 2017 Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org.
16. Tugume P, Nyakoojo C. Ethno-pharmacological survey of herbal remedies used in the treatment of paediatric diseases in Buhunga parish, Rukungiri District, Uganda. BMC Complementary and Alternative Medicine, 2019; 19(1): 353.
17. Wu D, Ding Y, Yao K, Gao W and Wang Y (2021) Antimicrobial Resistance Analysis of Clinical Escherichia coli Isolates in Neonatal Ward. Front. Pediatr. 9: 670470.doi: 10.3389/fped.2021.670470

To Evaluate the Potential of Water Hyacinth plant (*Eichhornia crassipes*) in Waste Water Treatment

Madghe Shraddha M. and Zodpe S. N.

PG Department of Microbiology, Shri Shivaji College of Arts, Commerce and Science,
Akola – 444003 (M.S.), India.

***Abstract*—Water Hyacinth is a major freshwater weed in most of the frost-free regions of the world and is generally regarded as the most troublesome aquatic plant. In the present study, the flora present on the roots of Water Hyacinth is isolated and identified. The preliminary phytochemical screening of leaf extract (Ethanol and Aqueous) was studied, and it was observed that the presence of alkaloids, flavonoids, proteins as phytochemicals was found in both extracts; beside these, ethanolic extract also showed the presence of phenols. Water Hyacinth is used in waste water treatment due to its capacity of absorbing nutrients. This study was conducted to find out the potential of Water Hyacinth plant in the treatment of sewage water via the pot culture experiment. It was noticed during the investigation that the Water Hyacinth plant shown the favorable changes in every parameter, including pH, TDS, DO and MPN. Therefore, it can be concluded that Water Hyacinth plant is effective in treating waste water.**

***Keywords*— Phytochemical, Water Hyacinth (*Eichhornia crassipes*), Waste Water.**

I. INTRODUCTION

The Water Hyacinth (*Eichhornia crassipes* (Mart.) Solms) is an aquatic flowering plant that belongs to the *Pontedericeae* family. Water Hyacinth is a vascular fast growing floating aquatic plant which is commonly found in tropical and subtropical regions of the world with well-developed fibrous root system and large biomass (Gao and Bo, 2004). The roots of Water Hyacinth release some labile organic compounds that supports the growth of heterotrophic bacteria (Silvester and Musgrave, 1991). The knowledge about the bacteria present in the roots of Water Hyacinth can greatly help in management of the water bodies infested with Water Hyacinth and optimization of treatment designs based on Water Hyacinth (Jaiswal S. and Singhal P.K., 2011). Plants and hydrophytes (as Water Hyacinth) have increasingly been shown to provide rich source of natural bioactive compounds with antimicrobial, antitumoral, antiviral and antioxidant activities (Hamid H.H. *et al.,* 2013).

The use of plant extracts and phytochemicals, both with known antimicrobial properties, can be of great significance in therapeutic treatments (Sanaa *et al.,* 2012). Many studies have shown that the devastating aquatic weed may be useful for developing alternative compounds to treat infectious diseases caused by bacterial pathogens (Hamid H.H. *et al.,* 2013). Because of the high nutrient absorption potential of Water Hyacinth, it has already been tried for treatment of large variety of wastewaters (Moorhead *et al.,* 1988; Orth and Sapkota, 1988; Tripathi and Shukla, 1991; Casabianca- Chassany *et al.,* 1991; Jebanesan, 1997; Quazzani *et al.,* 1995; Dhote, 2017). Such systems using Water Hyacinths or other aquatic plants have been appropriately named as living machines (Todd J and Todd N., 1994). Water Hyacinth has been used in aquatic systems worldwide for waste water purification, it has tremendous capacity of absorbing nutrients and other substances from water and hence brings the pollution load down (Khare A. and Lal E.P., 2017).

The present study was conducted to isolate and identify the bacteria from roots of Water Hyacinth (*Eichhornia crassipes*), also an attempt was made to find the potential of Water Hyacinth plant in the treatment of sewage water. The aim of the study was to detect the phytochemical constituents of some Water Hyacinth extracts (Aqueous and Ethanol), also investigation of the antimicrobial activities of the plant extracts.

II. MATERIAL AND METHODS

Collection of Samples

The present study was performed on the actively growing Water Hyacinth plants collected from stagnant water pond. This pond is situated near Akot fail area in Akola. The domestic waste from neighboring residential are drained into the pond. The pond has dense stand of Water Hyacinth plants that covers nearly 60% of its surface area. The plant was collected in the sterile polythene bags. The bags were sealed immediately at the site and brought to the laboratory.

Isolation of bacteria from the Roots of Water Hyacinth

The roots of the plant were washed with sterile distilled water and 5-gram root pieces were thoroughly macerated. The homogenized mixture was diluted up to 50 ml with sterile distilled water and shaken vigorously. One ml of that homogenate was taken and diluted appropriately by serial dilution technique. The diluted samples were plated on the TGYEA medium. The whole process was completed in under aseptic condition. The plates were incubated at 37 ± 1°C for 24 to 48 hr. The segregated colonies were picked up and purified by sub-culturing on nutrient agar plates and maintained on agar slants (Jaiswal S. and Singhal P.K., 2011).

Identification of isolated bacteria by Conventional Methods

The bacteria isolated from roots of Water Hyacinth plants were subjected to cultural and morphological characterization. Other characteristics were determined by various biochemical tests such as Indole test, Methyl Red test, Voges Proskauer test, Citrate test,

sugar fermentation and various enzyme test such as catalase, amylase, oxidase, urease, gelatinase. The growth of bacterial isolate was also observed on Eosin Methylene Blue (EMB) agar, Mannitol Salt Agar (MSA), Bismuth Sulphite Agar (BSA).

Preparation of Leaf Extract of Water Hyacinth plant

The Water Hyacinth plant was washed thoroughly with the deionized water before left to air dry. The dried leaves were subsequently pulverized in a laboratory blender to obtain fine powder.

- Aqueous Extract

The powdered leaves were extracted with distilled water. 50 g each were immersed in 250 ml of water and allowed to macerate for 24 hr; the suspension was shaken on electric shaker for the first 6 hr. The suspensions were filtered, and the filtrates were evaporated by rotary evaporator. The extracts were weighed and stored in airtight containers (Ibrahim *et al.*, 2012).

- Ethanolic Extract

A known weight of the air-dried grinded sample (10g) was successively extracted with organic solvent i.e., ethanol. Filtration of extract and evaporation of solvent by rotary evaporator (at 40 to 45°C) was done (Jin *et al.*, 2003).

Phytochemical Screening

Eichhornia crassipes leaves extract (Aqueous and Ethanolic) were subjected to preliminary phytochemical screening for the detection of various plant constituents such as alkaloids, flavonoids, phenols, tannins, saponins, anthocyanins and proteins (Thamaraiselvi and Jayantni, 2012).

Antibacterial Activity of Leaf Extract of Water Hyacinth Plants

Antibacterial activity using plant extract was evaluated by Agar Well Diffusion Method on Nutrient Agar. *E. coli* was uniformly swabbed onto the individual plates using sterile cotton swabs. A micropipette was used to pour the plant extract solution into well which was made with the help of sterile borer. After incubation at 37°C for 24 hours, the zone of inhibition was measured in millimeters.

Sewage Treatment Potential of Water Hyacinth Plants by Pot Culture Experiment

Approximately 30-40 plants of young Water Hyacinth were taken from Akot Fail area in Akola, washed thoroughly in running tap water to avoid any surface contamination, blotted with clean blotting paper for any surface moisture avoiding damage to root and leaf apices. The sewage water was collected from Railway Station area, Akola. The plants were transferred to plastic pots having capacity of 5 liters containing waste water in different concentrations. Before transferring the plants into pots, an initial analysis of some parameters like pH, Total dissolved solids and Dissolved oxygen was done (Dar S.H. *et al.*, 2011).

- Set A: 25% Wastewater + 75% Tap water
- Set B: 50% Wastewater + 50 % Tap water
- Set C: 25% Wastewater + 75 % Tap water
- Set D: 100% Wastewater
- Set E: Control (Tap water without dilution)

Most probable number (MPN) of sewage water was measured on the day 1 and again on day 15 for the pot experiment. Results of most probable number (MPN) test was compared between day 1 and day 15, for checking the MPN value, whether it is decreased or same. Similarly, analysis of parameters like dissolved oxygen, total dissolved solids and pH were also checked for day 1 and day 15 and results were compared.

III. Results and Discussion

Four isolates were obtained from the roots of growing water hyacinth plants from which two were Gram-positive (I_1 and I_4) and two were Gram-negative isolates (I_2 and I_3). Out of these, one of the Gram-positive isolates (I_1) was cocci and other isolate (I_4) was rod shaped where as both Gram-negative isolates (I_2 and I_3) were rod shaped. The growth of different isolates on various selective media were also studied along with Cultural, Morphological and Biochemical characterization. So, considering the results obtained by Cultural, Morphological and Biochemical characterization, the obtained isolates i.e., I_1, I_2, I_3 and I_4 were tentatively confirmed as *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Salmonella typhi* and *Bacillus subtilis*, respectively. Jaiswal S. and Singhal P.K. (2011), also reported regarding the isolation of flora from roots of water hyacinth and during their study, total 30 isolates were obtained, from which 25 were Gram-negative rods such as *Vibrio vulnificus*, *Aeromonas hydrophila*, etc., three were Gram-positive rods like *Bacillus alvei* and two were Gram-positive cocci.

During the current study, the preliminary phytochemical screening of leaf extracts of Water Hyacinth plant i.e., Ethanolic and Aqueous, were studied (Table 1 and Fig. 1). It was observed that the presence of alkaloids, flavonoids, proteins as phytochemicals was found in both extracts; beside these, ethanolic extract also showed the presence of phenols. Lalith and Jayanthi (2012a) reported the presence of alkaloids, flavonoids, phenols, sterols, terpenoids, proteins and absence of anthocyanins, saponins and tannins in ethanol extract of dry Water Hyacinth which is similar to our results. The findings of phytochemical analysis of ethanolic extract by the Haggag *et al.*, (2016) and Kayathri *et al.*, (2015) were found to be similar as our findings in some phytochemicals such as phenols, proteins, and tannins while some phytochemicals such as alkaloids and flavonoids showed opposite results when compared to our findings.

Antibacterial activity of some extracts of water hyacinth against *Escherichia coli* isolated from sewage sample were summarized in Fig. 3 and Fig 4. It was observed that the ethanolic extract had antibacterial activity against all isolates, with highest zone of inhibition of 20 mm and the lowest zone of inhibition of 13 mm. Aqueous extract showed very weak antibacterial activity with lowest zone of inhibition of 7 mm and the highest zone of inhibition is of 10 mm given by the E_3 isolate which have given lowest activity of ethanolic extract. Rios and Recio (2005) reported that aqueous extracts was less potent than ethanol extract; this may be due to the solvent and/or the method of extraction, so the antimicrobials in aqueous extracts less than other extracts. The result by Saraf K. R. and Barate D.L. (2018) of the antimicrobial activity of aqueous extract against E. coli showing 21 mm inhibition zone which is not

in the accordance with our results of antimicrobial activity of aqueous extract showing zone of inhibition of 10 mm. Haggag *et al.*, (2017) revealed less antimicrobial activity compared to our results. The *E. coli* showed highest zone of inhibition against ethanolic extract i.e., 20 mm compared to the results of Haggag *et al.*, (2017) was found to be less than that of our results against ethanolic extract, it showed zone of inhibition of 8.3 mm.

Phytoremediation is a new area of biotechnology that takes advantage of fact that certain species of plants and fungi flourish by accumulating waste materials present in the water (Dar S. H. *et al.*, 2011). Water Hyacinth found to be a potential phytoremediation plant for greywater treatment, providing consistent quality of treated water (Prasad R. *et al.*, 2022). The present work utilizes the Water Hyacinth plant to evaluate the remediation of various wastewater pollutants. An attempt was made to study the phytoremediation efficiency of Water Hyacinth plant. To evaluate the efficacy of plant, pot experiment was performed for 15 days i.e., all the parameters were observed on first and last day of the experiment. The plant was grown in the pots containing different concentrations of sewage water. Four semagats were made with the different concentrations of sewage water and one set of control was also made (Fig.2). This set up of the pot experiment is similar to the experimental set up by Dar S. H. *et al.*, (2011). Parameters such as pH, total dissolved solids and the dissolved oxygen were checked before treatment (on the day 1) and after treatment (on day 15).

The pH is the measurement of all the intensity of acidity or alkalinity and measure the concentration of hydrogen ion in water. In our study, the pH values before (day 1) and after treatment (day 15) with Water Hyacinth plants were measured. It is found that the pH value reduced to 6.8 from 8.0. The highest activity was shown by the 100% wastewater set while the lowest activity was shown by the 25% waste water set. The pH values are compared in the Fig 5. Similar results were obtained by Dar S. H. *et al.*, (2011) during their study they found that pH level decreased to 7.2 from 7.8. Also, they reported that Water Hyacinth plant can be used in areas where the acidity of soil is very high.

Total Dissolved Solids are often used to express the degree of contamination or number of impurities in water and wastewater. The total dissolved solid (TDS) reduction by Water Hyacinth was good in almost all concentrations showing highest reduction of 41.81% in 100% waste water set and lowest reduction of 28.15 % in 25% waste water set (Fig 6). Dar S. H. *et al.*, (2011) found the similar results as ours. They found that 61% decrease in 25% waste water and highest in 100% waste water set i.e., of 66%. Khare A. and Lal E.P., (2017) reported that TDS and turbidity value decreased significantly in all the three treatments Also, they reported that total dissolved solid reduction by Water Hyacinth is almost similar in all three treatments for both the years of study. The similar findings had also been reported by Dipu *et al.*, (2010); Shah *et al.*, (2010); Groudev *et al.*, (2001) and Wirojanagud *et al.*, (2002).

The photosynthetic activities in plants increase the Dissolved oxygen in water, thus creating aerobic conditions in the system (Yadav *et al.*, 2011; Bastviken S., 2006). In our study, the dissolved oxygen value increased significantly in all the treatments with highest increase of 87.5% in 100% waste water and lowest increase was of 26.92% in 25% waste water (Fig 7). Khare A. and Lal E.P. (2017) reported that dissolved oxygen increase by test plant was maximum in T2 treatment (537.73%) in year 2010-11 and 501% in 2011-12. Similar findings were observed by Dar S. H. *et al.*, (2011) that Water Hyacinth increased the dissolved oxygen level in all waste water samples, it showed an increase from 0 to 100 % in 75 and 100% waste water around 2.5 mg/L in both. Thus, reported that the DO level is increased by the Water Hyacinth.

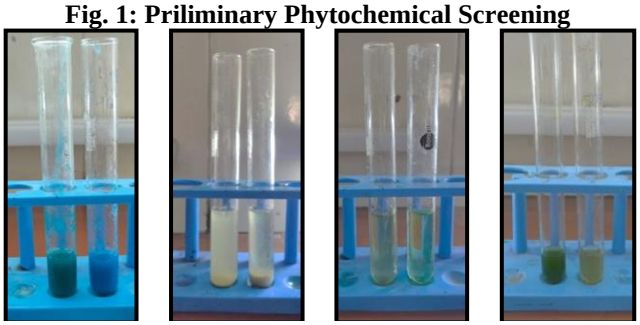
The preliminary sewage water treatment was observed with the help of the Multiple Tube Dilution Technique and based on Most Probable Number value which significantly decreased after the treatment of Water Hyacinth plant in the sewage water. The MPN value was around 2400 on the day 1 of the experiment and was reduced to the 1600 when measured on day 15. Based on the data obtained, we may recommend the use of Water Hyacinth plant in sewage water treatment (Fig 8).

Table 1: Preliminary Phytochemical Screening of leaf extracts of Water Hyacinth Plant.

Sr. No	***Phytochemicals Analyzed***	***Aqueous Extract***	***Ethanolic Extract***
1	Alkaloids	+ve	+ve
2	Anthocyanins	-ve	-ve
3	Flavonoids	+ve	+ve
4	Phenols	-ve	+ve
5	Proteins	+ve	+ve
6	Saponins	-ve	-ve
7	Tannins	-ve	-ve

Key: +ve = positive test; -ve = negative tests

Fig. 1: Priliminary Phytochemical Screening



Proteins Alkaloids Tannins Phenols

Fig. 2: Experimental setup of Pot experiment

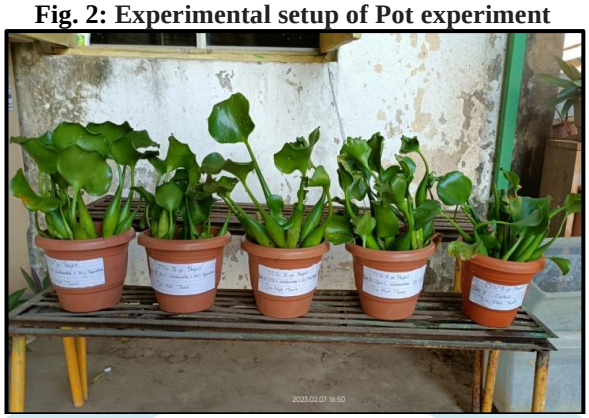
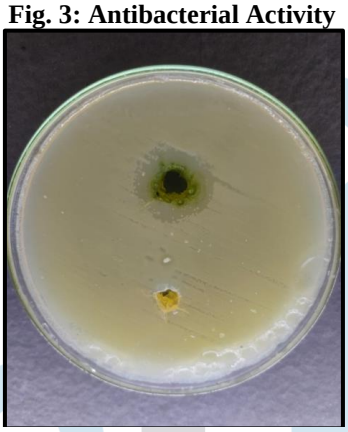


Fig. 3: Antibacterial Activity



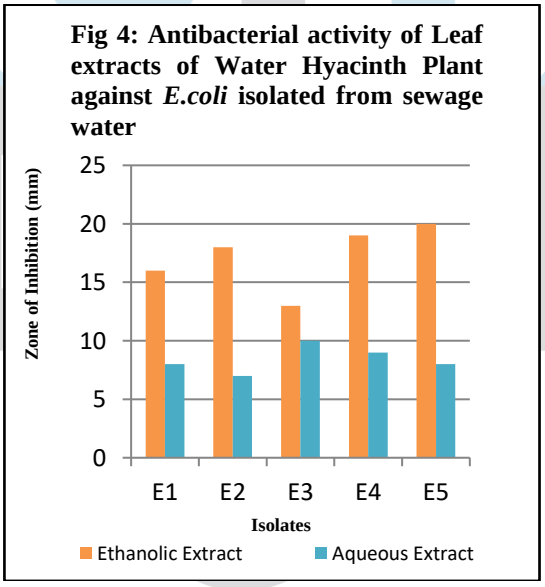


Fig 5 :The pH values of sewage sample before and after treatment with Water Hyacinth Plant

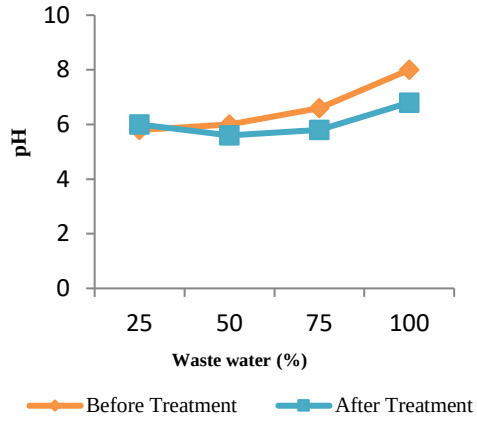


Fig 6: The Values of Total Dissolved Solids (TDS) for sewage water before and after treatment with Water Hyacinth Plant

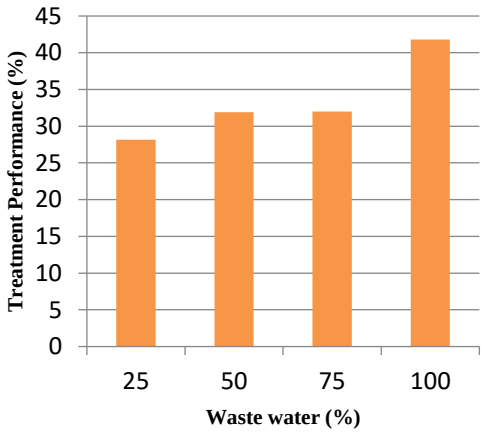


Fig 7: The Values of Dissolved Oxygen (DO) for sewage water before and after treatment with Water Hyacinth Plant

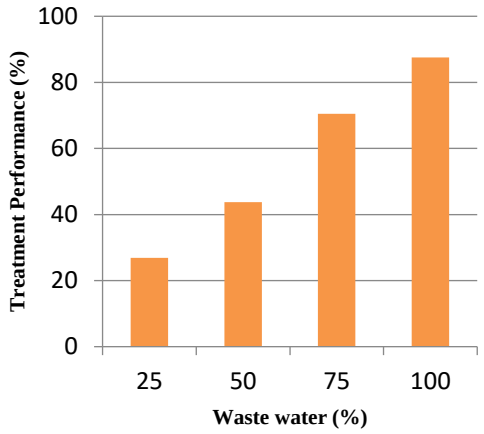
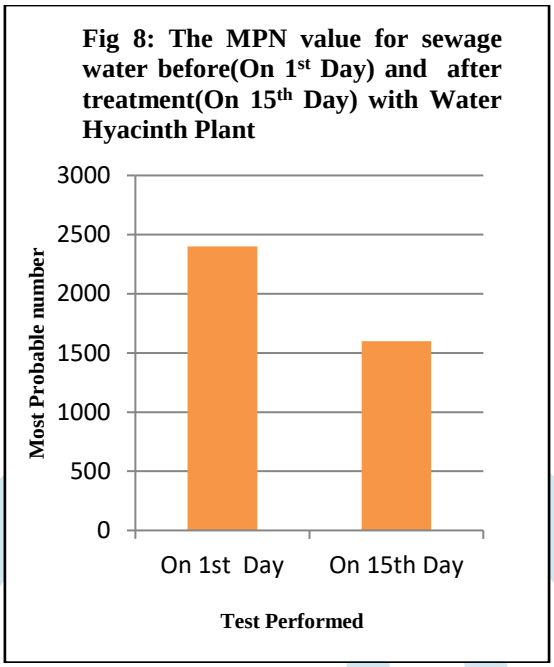


Fig 8: The MPN value for sewage water before(On 1st Day) and after treatment(On 15th Day) with Water Hyacinth Plant



IV. CONCLUSION

The ethanolic extract of Water Hyacinth exhibited antimicrobial activity against the isolates obtained from waste water. In case of waste water, Water Hyacinth plant is quite effective in purifying it. The Water Hyacinth plant showed significant changes in pH, Dissolved Oxygen, Total Dissolved Solids and MPN. The plant can be used for sewage treatment as it is easily available, low in cost, eco-friendly. Research is still needed to fully understand the role of water hyacinth, particularly in regards to any effects it may have on other living things and its capacity to absorb harmful substances from our environment.

REFERENCES

[1] Bastviken S. (2006). Nitrogen removal in treatment wetlands-Factors influencing spatial and temporal variations. *Linkopingstudies in Science and technology. Linkoping*

[2] Dar, S.H., Kumawat, D.M., Singh, N., and Wani, K.A., 2011, Sewage treatment potential of water hyacinth (*Eichhornia crassipes*)., *Res. J. Environ. Sci*., 5(4), 377-385.

[3] De Casabianca-Chassany ML and Goma G. Treatment of paper industry effluents with *Eichhornia crassipes*: First result (Tartas factory, Landes). *Competes Rendus De. Academic Des Science Serie III Sciences* De la vie. 312(11); 1991: pp. 579-585.

[4] Dhote S. Role of macrophytes in improving water quality of an aquatic ecosystem. *J. Appl. Sci. Environ. Manage*. 11(4); 2007:133-135.

[5] Dipu, S., Anju, A., Kumar, V. and Thanga, SalomGnana (2010). Phytoremediation of dairy effluent by constructed wetland technology using wetland macrophytes. *Global Journal of Environmental Research*, 4(2): 90-100.

[6] Gao L and Bo L, The study of a specious invasive plant water hyacinth (*Eichhornia crassipes*); Achievements and challenges. Acta. Photogeological Sinica, 28(6): 735-752, (2004)

[7] Groudev, S.N., M.V. Nicolova, I.I Spasova, K. Komnitsas and I. Paspaliaris, (2001). Treatment of acid mine drainage from a uranium deposited by means of a natural wetland. Paper presented at the ISEB phytoremediation conference, Leipzig Germany, pp: 146-148.

[8] Haggag, M. W., Abou El Ella, S. M., & Abouziena, H. F. (2017). Phytochemical Analysis, Antifungal, Antimicrobial Activities and Application of *Eichhornia crassipes* Against Some Plant Pathogens. *Planta Daninha*, 35(017159560)

[9] Hamid, H. H., Ghaima', K. K., & Najem, A. M. (2019). Photochemical, antioxidant and antibacterial activities of some extracts of water hyacinth (*Eichhornia crassipes*) leaves. *International Journal of Science and Research*, 8(9), 173-179.

[10] Ibrahim H, Oyi RA, Eninmidu JO and Bright NT, Antimicrobial activity of the water extracts of the leaves and fruits of *Carissa edulis* Vahi (*ApocyanaceaeI*). *Journal of medical plants research*, 4(11):1028-1032, (2012).

[11] Jaiswal, S., & Singhal, P. K. (2013). Isolation and biochemical characterization of bacteria present in roots of water hyacinth (*Eichhornia crassipes* (Mart) Solm.) in Robertson Lake Jabalpur. *International Journal of Science and Technology*, 3(3), 108-113.

[12] Jebanesan A. Biological treatment of dairy waste by *Eichhornia crassipes* Solms. *Environ*. And *Eco*., 15(3); 1997: 521-523.

[13] Jin ZH, Zhuong yy, dni, SG and Li TL, Isolation, and identification of extracts of *Eichhornia crassipes* and their allelopathic effects on algae. *Ball Environ*. *Contam. Toxicos*, 71(5):1048-1052, (2003).

[14] Kayathri B., Kanimozhi K. & Panneerelvam A. (2015). Preliminary phytochemical analysis and in vitro investigation of antimicrobial activity of *Eichhornia crassipes* (mart.) Solms. Against poultry pathogens. CIBTech *Journal of Microbiology* ISSN: 2319-3867 (Online) Vol. 4 (1),9-27.

[15] Khare, A., & Lal, E. P. (2013). Waste Water Purification Potential of *Eichhornia crassipes* (Water Hyacinth). *International Journal of Advanced Biotechnology and Research*, 4(1), 110-116.
[16] Lalitha TP and Jayanthi P, Preliminary studies on phytochemical and antimicrobial activity of solvent extracts of *Eichhornia crassipes* (Mart.) Solms. *Asian Journal of Plant Science and Research*, 2(2):115-122, (2012a).
[17] Moorhead KK, Reddy KR and Graetz DA. Nitrogen transport in a water hyacinth - based water treatment system. *J. of Environ. Qual*., 17 (1) ;1988: 138-142.
[18] Orth HM and Sapkota DP. Upgrading a facultative pond by implanting water hyacinth. *Wat. Res*.,22 (12); 1988: 1503 – 1511.
[19] Prasad R., Sharma D., Yadav K.D. and Ibrahim H. (2022). Preliminary study on greywater treatment using water hyacinth. *Applied Water Science*,11,88. Doi: 10.1007/s13201-021-01476-7.
[20] Quazzani N, Bouhoum K, Mandi L, Bouarab L, Habbari K, Rafiq R, Picot B, Bontoux J and Senwartzbrod J. Waste water treatment by stabilization pond marralesh experiment. *Wat. Sc. Tech*., 31(12); 1995: 75-80.
[21] Rios JL and Recio MC, Medicinal plants and antimicrobial activity. *Journal of Ethnopharmacology*, 100:80-84, (2005).
[22] Sanaa M, Shananab M and Emad AS, Biological activates and anticorrosion efficiency of water hyacinth (*Eichhornia crassipes*). *Journal of Medicinal Plants Research*, 6(23):3950-3462, (2012).
[23] Saraf, S., & Barate, D. (2018). Antimicrobial activity of *Eichhornia crassipes* against MDR clinical pathogens. *Journal of Applied Pharmaceutical Science*, 8(04), 077-082.
[24] Shah. Rouf Ahmad, Kumawat, D.M., Singh, N., and Khursheeed Ahmad Wani (2010) Water hyacinth (*Eichhornia crassipes*) as a remediation tool for dye-effluent pollution. *I.J.S.N., VOL. 1*(2), 2010: 172-178.
[25] Silvester WB and Musgrave DR. Free living diazotrophs. In: Biology and biochemistry of nitrogen fixation. (Eds.: Dilworth M.J. and A.R. Glenn). Elsevier New York. 1991: 162 - 186.
[26] Thamaraiselvi PL and Jayantni P, Preliminary studies on phytochemicals and antimicrobial activity of solvent extracts of *Eichhornia crassipes* (Mart.) Solms. *Asian Journal of Plant Science and Research*, 2(2):115- 122, (2012).
[27] Todd J and Todd Nancy Jack. From ecocities to living machines: Principle of ecological design. Berkeley: North Atlantic Books. *J. of Environ. Eng.* ASCE, 107 (EE5) 1994.
[28] Tripathi BD and Shukla SC. Biological treatment of waste water by selected aquatic plants, *Environ. Pollut*., 69(1); 1991: 69-78.
[29] Wirojanagud, W., N. Supachaisakorn and A. Boonpoke, (2002). Removal of organic matter contaminated pulp and paper industrial wastewater by soil. *17th WCSS, Thailand*, pp. 14-21.
[30] Yadav, S. B., Jadhav, A. S., Chonde, S. G. and Raut, P. D. (2011) Performance evaluation of surface flow constructed wetland system by using *Eichhornia crassipes* for wastewater treatment in an institutional complex. *Universal Journal of Environmental Research and Technology*, 1(4): 435-441.

International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol.10 No.4 Mar – Apr 2023

"Assessment of Bacterial Contamination from Paper Currency and Study of it's Antibiogram Pattern"

Pagrut S.R [1] , S. N.Zodpe[2]
Department of Microbiology Shri Shivaji College of Arts, Commerce and Science, Akola
***Corresponding Author* - Pagrut S.R**
Email- shyampagrut22@gmail.com

Abstract:
Money, whether in the form of coins or paper notes is perhaps the most widely handled article by people everyday throughout the world. Money is used as a medium for exchange for goods and services, settlement of debts and for deferred payments in economic activities. Currency notes represent a universal medium for the transmission of bacteria in the environment and among humans. There is a possibility that currency notes might act as environmental vehicles for the transmission of pathogenic organisms. The present investigation was carried out on Five hundred, two hundred, one hundred, fifty, twenty, ten and coins. Indian paper currency notes of all the denominations obtained from different occupational groups in Akola City, Maharashtra, India. The present study revealed the extent and the level of microbial contamination of Indian paper currency. 86.4% of currencies were contaminated with pathogenic organisms. 26 isolates from the collected Indian paper currency yielded 6 different types of bacterial species. Assessment revealed active participation of the following organisms as *Escherichia coli, Bacillus spp, Klebsiella spp, Staphylococcus aureus, Micrococci and Pseudomonas spp*. Rs.10, Rs.20 had more contamination, other denominations like Rs.200, Rs.100, Rs. 50 had moderate contamination and less contamination with Rs.500. The study suggested that Indian paper currency notes are highly contaminated with pathogenic microorganisms and this contamination may play a significant role in transmission of infectious diseases. Hence, great care must be taken while handling money during the preparation and handling of food to avoid cross contamination

Keywords : Indian Currency, Notes, Coins, Contamination

Introduction :-

Globally, money is one of the items most frequently passed from hand to hand. During its passing, money can get contaminated and may thus play a role in the transmission of microorganisms to other people.

Microorganisms are known to spread via air. water, food etc. an important mechanism of the spread of pathogens by formites. Paper currency is widely exchanged for goods and services in countries worldwide (Felgo and Nkansah 2010; Alwakeel and Naseer. 2011). It is used for every type of commerce. Accumulated data obtained over the last 20 years on the microbial status and survival of pathogen on coins and currency notes indicate that this could represent a potential cause of sporadic cases of food borne illness. The paper/polymer currency notes and coins may harbor various deadly pathogenic microorganisms. Currency in the form of notes represent a universal medium for the transmission of bacteria in the environment and among humans. There is a possibility that currency notes might act as environmental vehicles for the transmission of potential pathogenic microorganisms (Prasai *et al.,* 2009).

Research has shown that currency paper provides a large surface area as a breeding ground for pathogenic microorganisms. Pathogenic microorganisms can survive on Money which represents an often overlooked reservoir for enteric diseases (Michaels, 2002). But recent studies from different parts of the world have revealed that currency; either as coins or papers have high rates of microbial contamination which cause disease. The pathogenic or potentially pathogenic bacteria found on these currency notes may cause a wide variety of diseases from food poisoning, skin infections, respiratory and gastrointestinal infection to life threatening diseases such as meningitis

and septicemia. In other way, contamination of currency notes can also be traced to dust, soil, water, micro flora of the body of handlers (Awe *et al* .,2010).

MATERIAL AND METHODS :

Samples Collection of Currency and Coins :-

Total 60 Samples were collected during the current study. Samples were collected from Bank, Shopkeeper, Bus Conductor, ATM, Chat Center, Fruit seller and Home collection. All the samples were collected by wearing hand gloves. Samples were collected in zip lock polythene bag.

To Isolates and Identify Bacterial Pathogens from Coin and Currency notes :-

For bacteria, cotton swab moistened with sterile, physiological saline was used to swab both sides of the currency notes. The swab was inoculated on Nutrient agar as well as various selective media were used such as Mannitol Salt Agar, EMB agar and Pseudomonas Isolation Agar from the Nutrient broth, a loop of broth was streaked on to the Nutrient agar and incubated at 37°C fro 24 hrs, for isolated colonies. After 24 hrs isolated colonies were observed.

Identification of Isolates

Further the Isolates were processed for confirmation by morphological study. On the basis of staining procedure morphology of isolates were observed. The confirmation of isolate was done by Biochemical characterization in which Sugar fermentation test and IMViC test was done. On the basis of Cultural, Morphological and Biochemical characterization the isolates were tentatively confirmed (Bergey's manual of Determinative Bacteriology, 1939)

To study the Antibiogram Pattern of obtained Isolates by Agar well diffusion method (Ryan, K. J. *et al.,* 1970) :-

Antibiotic susceptibility test for selected 26 isolates was conducted based on the Kirby, Baur Disc Diffusion Method. Antibiotics used were Erythromycene, Chloromphenycol, Gentamycene, Tetracyclene, Amphicillin and Vancomycene. Antibiotic disc were placed on Mueller Hinton Agar. The plates were incubated at 37°C for 24 hrs. The plates were observed for Zone of inhibition after 24 hrs. The zone of inhibition is recorded in mm.

RESULTS AND DISCUSSION :

Table NPo.1 : Collection of different paper currency notes & coins under different physical condition.

S.N	Sources of currency	₹10	₹20	₹50	₹100	₹200	₹500
1	Bank counter	-	-	-	-	2	2
2	Grocery Shop	5	3	2	2	1	1
3	Bus conductor	5	5	5	4	2	-
4	ATM machine	-	-	-	3	1	1
5	Chat centre	5	3	2	1	-	-
6	Hospital	4	2	2	3	2	2
7	Fruit seller	2	2	2	1	1	1
8	Home collection	5	5	5	2	2	1
S.N	**Sources of coins**	**Ps 20**	**Ps 50**	**₹1**	**₹ 2**	**₹5**	**₹10**
1	Home collection	5	2	3	3	2	2
2	Grocery Shop	-	-	3	3	2	2
3	Bus conductor	-	-	4	2	2	2
5	fruit seller	-	-	4	4	3	2

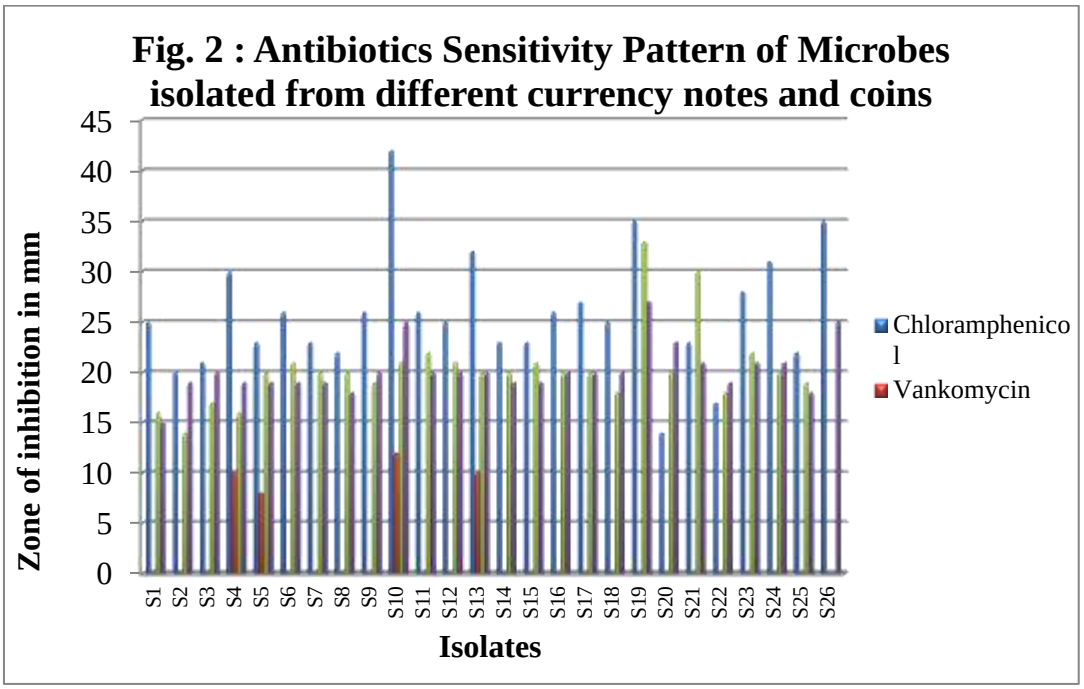
\Table No.2 : Gram Characters of Isolates obtained from different currency notes and coins

Currency and coins	Sources
	Hospital
₹ 10	Gram + ve cocci
₹ 50	Gram – ve bacilli
₹ 100	Gram – ve cocci
₹ 200	Gram + ve bacilli
Currency and coins	**Grocery Shop**

₹ 1	Gram + ve cocci
₹ 2	Gram + ve bacilli
₹ 5	Gram – ve cocci
₹ 10	Gram + ve cocci/ Gram – ve rods
₹ 20	Gram + ve bacilli
₹ 50	Gram + ve cocci
₹ 100	Gram + ve cocci
₹ 200	Gram – ve cocci
Currency and coins	**ATM machine**
₹ 100	Gram +ve cocci
₹ 200	Gram +ve bacilli
₹ 500	Gram +ve bacilli

Table No.3 : Antibiotics Sensitivity Pattern of Microbes isolated from of different currency notes and coins.

Isolates	Zone of Inhibition in mm			
	Chloramphenicol	Vankomycin	Erythromycin	Gentamycine
S1	25	R	16	15
S2	20	R	14	19
S3	21	R	17	20
S4	30	10	16	19
S5	23	8	20	19
S6	26	R	21	19
S7	23	R	20	19
S8	22	R	20	18
S9	26	R	19	20
S10	42	12	21	25
S11	26	R	22	20
S12	25	R	21	20
S13	32	10	20	20
S14	23	R	20	19
S15	23	R	21	19
S16	26	R	20	20
S17	27	R	20	20
S18	25	R	18	20
S19	35	R	33	27
S20	14	R	20	23
S21	23	R	30	21
S22	17	R	18	19
S23	28	R	22	21
S24	31	R	20	21
S25	22	R	19	18
S26	35	R	R	25



The various currency notes and coins were based on their physical condition as level of contamination could also be related to the physical condition of the currency. Collection of different paper currency note and coins were done under different physical condition. The samples were collected from different sources, such as Bank, Grocery shop, Bus conductor, ATM, Chat Center, Hospital, Fruit Seller and Home collection. The samples collected were paper notes and coins of Ps. 20, 50 and Rs. 1, 5, 10, 20, 50, 100, 200 and 500 (Table No. 1).

Similar study was conducted by Anitha*et al.,* (2020). They revealed the distribution of isolates from the various currencies from the various community sources. A total 65 samples collected from 26 source and all the 65 samples of four denominations had microbial contamination. A total of 11 different genera of bacteria and 6 different genera of fungi were isolated from collecting samples of Indian currency notes. A total number of 93 bacterial strains and 79 fungal strains were isolated. The paper currency notes are graded using condition, appearance and degree of dirtiness as new, moderate and old as shown in Table 1. The present study revealed the extent and the level of microbial contamination of Indian paper currency. 86.4% of currencies were contaminated with pathogenic organisms. 121 isolates from the collected Indian paper currency yielded 6 different types of bacterial species.

On the basis of morphological characteristics the various gram characters were observed for the isolate obtained from currency notes and coins such as Gram negative cocci, Gram positive cocci, Gram positive bacilli and Gram negative rods. (Table No. 2). A total of 11 different genera of bacteria were identified. Identification showed the active participation of these species in descending order as, *Klebsiella spp, Bacillus spp, Escherichia coli, Pseudomonas spp, Micrococci* and *Staphylococcus aureus*. The frequency of occurrence of *Klebsiella spp* was the highest in the present study which indicates the presence of faecal contamination via cross-contamination with raw products or poor personal hygiene.

Various morphological, cultural and biochemical characteristics was observed. On the basis of all result tentatively confirmed isolates were identified as *S. aureus, E. coli, P. aeruginosa, Stroptococcus spp.* Our results are in accordance with Pradeep *et al.,* (2012). They carried out Biochemical characterization for Butcher, Municipal Corporation, Food sellers, Hospital and Bank samples was showed, Bacteria isolated from bank, butcher, Municipal Corporation, hospital and food seller sample are pathogenic. Based staining and upon biochemical the morphology, gram characterization, the microorganisms found may be *Staphylococcus aureus, Klebsiella pneumoniae, E.coli* and *Pseudomonas aeruginosa.*

The antibiotic sensitivity pattern of microbes isolated from different currency notes and coins showed in Table 3 and Fig. 2. The maximum sensitivity pattern was seen against Chloramphenicol in all isolates. Among them S10 showed maximum zone of inhibition (42 mm) and S20 showed minimum zone of inhibition (14 mm). All the isolates shows resistance against Vancomycine except some isolates like S4, S5, S10, S13 showed minimum zone of inhibition. All isolates showed good sensitivity against Erythromycin with highest zone of inhibition by S21 (30 mm) and lowest zone of inhibition by S2 (14mm). In case of Gentamycine also isolates give good sensitivity, but the isolate S10 and S 26 showed maximum zone (25 mm) whereas S1 showed minimum zone of inhibition 15 mm.

Similar study was conducted by Sucilathangam*et al.,* (2016). Antibiotic susceptibility was determined by the agar diffusion technique on Mueller- Hinton agar (Kirby-Bauer NCCLS modified disc diffusion technique) using 9 antibiotic discs including Ampicillin (10µg), Amikacin (30µg), Gentamicin (10µg), Cotrimoxazole (25µg), Cefotaxime (30µg), Ceftazidime (30µg), Ceftriaxone (30µg), Ciprofloxacin (5µg) and Erythromycin (5µg). Resistance pattern of all pathoge4nic Gram negative bacilli and Gram positive organisms were observved by them. Only one isolate of *Staphylococcus aureus* was MRSA and all the gram negative bacilli were resistant to Amiicillin. 11 strains of *E coli* and 49 strains of *Klebsiella* were resistant to Ampicillin. These two bacteria were found to be quite sensitive to Amikacin, Gentamicinand Ciprofloxacin. *Klebsiella* were more resistant to different cephalosporin groups whereas *E. coli* was less resistant. *Pseudomonas* was quite sensitive to Amikacin, Gentamicin, Ciprolfloxacin and cephalosporins.

References

1. Ahmed, S Parveen, S Nasreen, T., & Feroza, B.(2010) Elecation of the Microbial Contamination of Bangladesh Paper Currency Notes in Circulation. *Adcance in Biological Research*, **4**(5), 266-271
2. Al-Ghamdi, A. K., Abdelmalek, S. M. A., Bamaga, M. S., Azhar, E., Wakid, M. H., & Alsaied, Z. (2011). Bacterial contamination of Saudi" one" Riyal paper notes. *Southeast Asian Journal of Tropical Medicine & Public Health*, **42**(3), 711-716.
3. Alwakeel SS and Naseer AL. (2011) Bacterial and fungal contamination of Saudi Arabian paper currency and cell phones. *Asian Journal of biological sciences.***4**(7) : 556-562
4. Ayandele AA and Adeniyi SA. 2011. Prevalence and antimicrobial resistance pattern of micro organisms isolated from Naira notes in Ogbomoso North, Nigeria. *Journal of Research in Biology*, **8**:587-593.
5. Barro, N., Bello, A. R., Savadogo, A., Ouattara, C. A. T., & Iiboudo, A. J. (2006). Hygienic status assessment of dish washing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso). *African Journal of Biotechnology*, ***5***(11).
6. Bergey, D. H., Breed, R. S., Murray, E. G. D., & Hitchens, A. P. (1939). Manual of determinative bacteriology. *Manual of determinative bacteriology. Fifth Edn.*
7. Bernholz, P. (2015). Monetary regimes and inflation: History, economic and political relationships. In *Monetary Regimes and Inflation*. Edward Elgar Publishing.
8. Bhat, N., Bhat, S., Asawa, K., & Agarwal, A. (2010). An assessment of oral health risk associated with handling of currency notes. *Int J Dent Clin*, **2**(3), 14-6.
9. Dehghani, M., Dehghani, V., & Estakhr, J. (2011). Survey of microbial contamination of Iranian currency papers. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, **2**(3), 242-8.
10. Felgo P and Nkansah M. 2010. Bacterial load on Ghanaian currency notes. *African Journal of Microbiology*, **4**(22):2375-2380.

To Evaluate the Antibacterial Efficacy of Different Cleaning Agents in Water Treatment

Kurmi Vidur P[1], Zodpe S.N[2]

PG Department of Microbiology, Shri Shivaji College of Arts, Commerce and Science Akola – 444003 (M.S), India

Abstract: Water is essential for the life, but many people lack the accessibility to clean and healthy drinking water and die as a consequence of water-borne infections, Microorganism-mediated water pollution is considered as one of the great concerns to the aquatic environment across the globe. The effluent of fecal matter, hospitals, industry, and cattle farms increase the bacterial load in a water body. Coliform groups of bacteria have long been typically applied as an indicator organism of microbial contamination of the water and historically led to the public health security perception. Among the coliform, *Escherichia coli* is the indicator of fecal contamination. The multiple tube fermentation technique has been applied as a conventional way to detect coliform in water samples through the fermentation of lactose sugar with production of acid and gas. The potability of water has been measured by the absence or presence of coliform bacteria within the permissible limit referencing the most probable number index value (MPN/100 ml). As fecal pollution indicators, fecal *streptococci* and *Clostridium perfringens* are widely used as an alternative to coliform bacteria. Screened cleaning agents during the study Alum, Bleaching powder, Jeevan drop, Jamun wood. Physicochemical and bio-chemical aspects of the water have been investigated to assess the quality of water. The variations of the physicochemical properties of water samples directly influence the biotic communities and primary productivity of the water bodies at different areas.

Keywords: Coliform bacteria, Microbial pollution, Fecal contamination, E. coli, Fecal streptococci, MPN, Water pollution, Cleaning agents.

Introduction:

Water is of fundamental importance for life on earth (APEC water, 2016). It is well known fact that fresh water is an important necessity for our health (Elimelech, 2006). Water borne diseases are easily spread because the drinking water system are not suitable for associated microflora and human use. There are a number of different infectious agents detrimental to human health that grow in contaminated/unsanitary water which can cause a number of waterborne illnesses; such as Cholera, Hepatitis, Typhoid, and Diarrhea (Vestergard, 2016). Other contaminants are man-made by-products of Industry and Agriculture, including heavy metals like mercury, copper, chromium, lead, and hazardous chemicals, dyes and compounds like insecticides and fertilizers. Improper storing or disposing of household chemicals such as paints, synthetic detergents, solvents, oils, medicines, disinfectants, pool chemicals, pesticides, batteries, gasoline and diesel fuel can lead to ground water contamination (Kass *et.al*., 2005; Anwar 2003). According to UN report 2003 (UN WWAP 2003) every day 2 million tons of sewage, Industrial and Agricultural waste are discharged into the world's water.

Jamun wood is a good water cleaning agent. Traditionally the jambul fruits, leaves, seeds, and bark are all used in ayurvedic medicine. The bark contains tannins and carbohydrates, accounting for its long-term use as an astringent to combat ailments like dysentery (R. Namasivayam, 2008). Alum (aluminum potassium sulfate) the crystallized double sulfates with the formula KAl(SO4).12H2O are generally odorless, colorless crystalline solids that turn white in air, which is used in food preservation and antiseptic for many preparation process such as pickling and fermentation and water purification as a flocculants (Bestoon, 2012). Bleaching powder or Calcium hypochlorite,70% (or 65%) available chlorine is the description frequently given to a commercial product widely used as a sanitiser for swimming pools and for purifying water supplies. Jeevan drop water disinfectant. Sodium hypochlorite (NaOCl) is a compound that can be effectively used for water purification. It is used on large scale for surface purification, bleaching, odor, removal and water disinfection. The present work is carried out in the line of above workers as only a few studies have been done so far on the use of cleaning agents in decontaminating potable water in India.

Materials and methods:

Total Fifteen water samples were collected from Rivers, Ponds, Lakes and Industrial areas, of Akola city and other cities. The sample waters collected were analyzed (in triplicates) according to the standard protocols and tests prescribed to check the associated micro flora with the water sample.

Multiple Tube Fermentation Technique (MPN: most probable number): This test determines total number of coliforms present in the water sample by checking acid and gas production by coliforms in multiple tubes of Mac Conkeys broth.

Presumptive Test: This method is similar to MPN but the medium used is lauryl tryptose broth suitable for detection of fecal coliforms.

Confirmed Test: This test confirms the presence of fecal coliforms by two ways, one by observing acid and gas production in brillian green lactose bile broth (BGLB) and presence of typical colonies (giving metallic sheen) on Eosin methylene blue (EMB) agar.

Completed Test: This test involves biochemical characterization of typical colonies on EMB. Apart from this biochemical characterization and growth on specific media was checked of the other isolates obtained from the water sample. (Andrew D., *et.al*., 1917).

Water Cleaning agents or hard-surface cleaners are substances use as a Bleaching powder, Jeevan drop, Alum, Jamun wood (usually liquids, powders, sprays, or granules) used to remove dirt, including dust, stains, foul odors, and clutter on surfaces and

killing of microorganisms. Purpose of cleaning agents include health, beauty, removing offensive odor, and avoiding the spread of dirt and contaminants to oneself and others. Some cleaning agents can kill bacteria. To check the antimicrobial efficacy of cleaning agent, various water cleaning agent were screened such as Bleaching powder, Jeevan drop, Alum, Jamun wood the cleaning agent is added into the water and the contact time was 24-48 hrs. After contact period, further the water sample were tested for presence of coliform and MPN analysis.

Results and discussion:

Table No. 1: Collection of water sample from different water sources and study of its physiochemical characteristics.

Sr No.	Water sample collection	Collection site	Isolates obtained	Water colour	pH
1	Sample 1	Morna River	Gram +ve cocci	Yellowish	6.5-7.0
2	Sample 2	Babulgaon Pond	Gram -ve short rod	Greenish	7
3	Sample 3	Pankaj Pipe Industries MIDC Akola	Gram +ve cocci	Transparent	6.8
4	Sample 4	Rathi Pedewala Akola	Gram +ve short rod bacillus	Clear	7.2
5	Sample 5	Home Muncipal Water Supply	Gram +ve cocci	Transparent	6.0.-.6.5
6	Sample 6	Mahabeej Pond	Gram +ve cocci	Greenish	7.2
7	Sample 7	Gujarati Sweets	Gram -ve coccobacillus	Clear	7.1
8	Sample 8	Shakti Tyres MIDC Akola	Gram +ve cocci	Blackish	6.2
9	Sample 9	Ner Dhamna Purna Barrage Akola	Gram -ve short rod	Yellowish	6.0
10	Sample 10	Ajani Village River	Gram +ve short rod	Yellowish	6.7
11	Sample 11	Rahit Nimbi Village River	Gram -ve cocci	Muddy	6.3
12	Sample 12	Pinjar Village River	Gram +ve short rod	Yellowish	6.8
13	Sample 13	Bhandegaon Village River	Gram +ve cocci	Muddy	6.9
14	Sample 14	Adan Bori Village River	Gram +ve short rod	Muddy	6.3
15	Sample 15	Jamwadi Lake Jamwadi Dist. Yavatmal	Gram +ve long rod	Clear	6.1

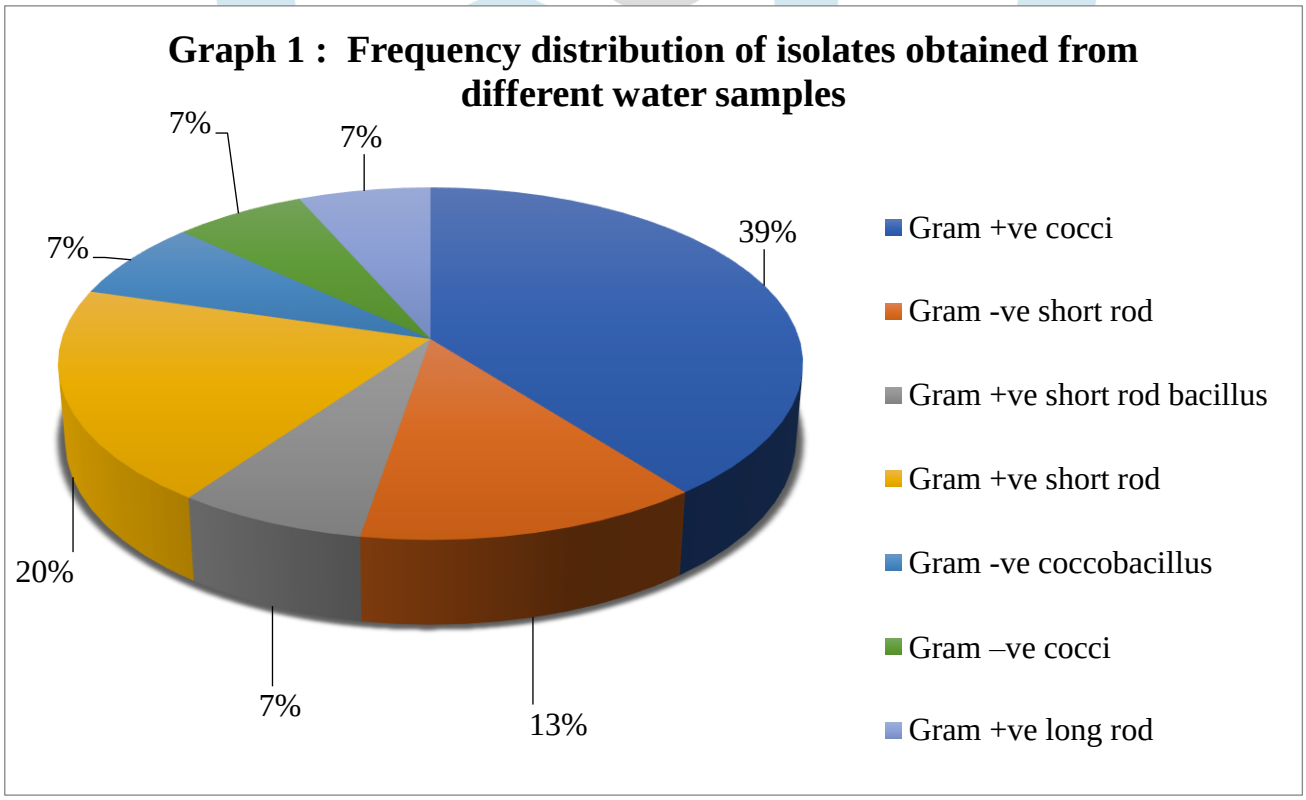


Table 2 :- Screening of Cleaning Agents

Sr. No.	Cleaning Agent	Medicinal Properties
1	Alum	➢ Helps to purify water ➢ Reduce wrinkles ➢ Treats canker sores
2	Bleaching powder	➢ It is used as disinfectant for water to make it free of germs. ➢ It is used for bleaching cotton, linen in textile industries, for bleaching washed clothes in laundry. ➢ It is used as oxidizing agent in many chemical industries.

3	Jeevan Drop	➢ It is used as water disinfectant. ➢ It is used as odor removal. ➢ It is used on large scale for surface purification
4	Jamun Wood	➢ It is used as a water purifier. ➢ It reduces body fat. ➢ It controls blood sugar and purify blood.

Discussion:

Water is an important solvent that without it, a human being cannot survive for a matter of a few days. There are a number of different infectious agents detrimental to human health that grow in contaminated/unsanitary water which can cause a number of waterborne illnesses; such as Cholera, Hepatitis, Typhoid, and Diarrhoea.

During the current research work the water sample were collected from different sources such as River, Pond, Industrial areas, Lake, Hotels and from different locations of Akola and Yavatmal districts. The collected water sample were further processed for isolation of organisms. During the study the organisms were isolated on different media such as Nutrient agar, Mac Conkey agar (Table 1).

According to Armstrong, *et al*., (2007) focused on the importance water is a universal solvent it dissolves salts, inorganic and organic compounds and gases that take part in metabolic reactions, maintain the macromolecular framework, stabilize plasma membrane, thermoregulation, transport nutrients, and maintain homeostasis and body volume/weight. Botkin, D. B and Keller E. A. (2005), observed Direct discharge of domestic wastes leaching from poorly maintained septic tanks and improper management of farm wastes are suspected as the major sours of waterborne diseases.

On the basis of Morphological characteristics the most frequently encountered isolates obtained were Gram positive cocci from Sample No. 1, 3, 5, 6, 8 and 13 followed by Gram positive Short rods from Sample No. 10, 12 and 14 followed by Gram negative short rod from Sample No. 2, 9 whereas other least obtained isolates were Gram positive short rod bacillus from Sample No. 4. Rest of other samples shows morphology of bacteria such coccobacilli, Gram negative cocci and Gram positive long rods respectively (Table1).

Jung *et al.,* (2004) noticed microbial contamination detection in water resources: Interest of current optical methods, trends and needs in the context of climate change. Presence of bacteria is predominantly in all sorts of environment of human involvement, majority of them are human as well as animal pathogen. Smith *et al.,* (2008) observed Sediment can be a reservoir for coliform bacteria released into streams. The study revealed that there is more *Staphylococcus aureus* in Ekoro than other while that from Arubu had more *P. aeruginosa* than others. *S. aureus* was the most predominant bacterial isolates encountered. Pathogenic bacteria are known to elaborate various extracellular products that may contribute to their virulence in host. Some of the extracellular products include enzymes and toxins.

On the basis of pie chart (Graph No. 1) on frequency distribution of isolates obtained from different water samples shows the frequency of isolates among the total 15 isolates obtained from 15 samples, 5 samples were Gram +ve cocci showing frequency of 33 % whereas 26% isolates were Gram –ve short rods and least obtained were 7% showing variation in morphology. So from the pie chart it was noticed that diversified group of microorganisms were present in water sample responsible for causing health issues in human being. So much study should focused on use of different cleaning agents in purifying the water.

The bacterial loads including, total bacteria, Gram positive *Staphylococci* and Gram negative bacteria were determined in water and bioaerosol samples collected during three different stages (sewage inlet, aeration tank and final effluent) of STP located in JNU campus. Sewage carries a huge burden of potential pathogens mainly enteric bacteria. (Toze, 1997) observed originating from different types of waste sources such as domestic, hospital, and industrial discharges etc. (Amine, 2013).

Physiochemical analysis of collected water sample was carried out. We checked for the colour of water sample and pH. pH of water sample was in between 6.5 to 7.2 whereas, the water colour differs from Clear, Transparent to Yellowish, Blackish, Greenish and somewhat Muddy appearance (Table 3).

Shukla *et al.,* (2013), also suggested Physical parameters like Temperature, Odor, Taste and Colour was agreeable in Process and Municipal water. The pH range of drinking water should far between 6.5 to 7.5 and municipal water pH observed 7 to 7.5. So it complied with the acceptance criteria of pH range and it was found to be healthy for human use. For Potable water, Dissolved carbon dioxide and Dissolved oxygen were found to be 6.4 and 33. TDS of water sample showed range below 1500 ppm and it complied with the given criteria of Indian standard. Minerals like Calcium, Magnesium, Chloride, Sulphate, Barium, and Copper are essential for body. Tests of these minerals were performed on potable water sample.

During the current investigation the water samples were assessed for presence of coliform organism by using Presumptive, Completed test and Confirmed test (Table 4).

Shahezad A. (2013), observed Water-borne diseases have been a potential threat in causing fulminating infections and diseases. The studies done by Parihar *et al.,* (2012) involved the physico-chemical and microbiological analysis of the ground water samples in Gwalior city. Shahejad A. (2013) focused on chloride and CO_2 content and DO determination in the samples collected from railway stations of Amravati, Akola, Bhusawal, Nashik, Kasara and Mumbai. Sapkota *et al.,* (2012) checked the microbiological quality of the drinking water of Dehradun city. While the present work involved microbiological analysis by MPN and the tests to determine and confirm the presence of fecal coliforms and biochemical identification of the isolates obtained.

During the confirmatory test all the samples were assessed for acid and gas production test. Almost all the isolates obtained from different samples shows acid production + ve whereas, most of the isolates showed negative result for gas production. Compare to acid production, only five isolates shows gas production whereas rest of other isolates shows negative results. Further we processed for MPN analysis of water sample. Almost all the fifteen samples showed acid and gas production + ve for 10 ml less for 1 ml and moderate at 0.1 ml indicating highest range of MPN value for collected water sample (Table 5).

Amin *et al.*, (2012) observed water is indispensible for life. The study results shows that 90 % (10/11) of mineral water supplied in 20 litre cans which are purchased by people at cost ranging from Rs. 35 to 45, are unsatisfactory for drinking. Among the 7 samples of Corporation supplied water collected from different places of Chennai, 71 % (5/7) were unsatisfactory for drinking. We included 2 well water samples in the study to know the bacteriological status and both were found to be unsatisfactory. Though the sample size is small, the results highlight the poor quality of drinking water available to the population of Chennai.

Water cleaning agents or hard-surface cleaners are substances use as a Bleaching powder, Jeevan drop, Alum, Jamun wood (usually liquids, powders, sprays, or granules) used to remove dirt, including dust, stains, odor, and clutter on surfaces and killing of microorganisms. Purpose of cleaning agents include health, beauty, removing offensive odor, and avoiding the spread of dirt and contaminants to oneself and others. Some cleaning agents can kill bacteria. Different cleaning agents were screened on the basis of their medicinal properties in purifying the water samples. The cleaning agents were screened where Alum, Bleaching powder, Jeevan drop, Jamun wood (Table 6).

Alum (aluminum sulfate) is a nontoxic liquid that is commonly used in water treatment plants to clearify drinking water.

It is a strong oxidizing agent. It is used as a disinfectant which is used for disinfecting water to make potable water.

Jeevan drop water disinfectant. Sodium hypochlorite (NaOCl) is a compound that can be effectively used for water purification. It is used on large scale for surface purification, bleaching, odor removal and water disinfection.

The wood of the Jamun is strong and water-resistant and used as water cleaning agent.

Related findings about the use of Jamun wood, Bleaching powder, Alum, Jeevan drop as cleaning agent was not recommended but related products are used to purify the water as cleaning agent. Gala-Gorchev (1996) and Melvin *et al.*, (1967) focused on the use of common strong oxidant in the form of chlorine and its compounds, viz. chloramine or chlorine oxide are used in disinfection technique.

According to Punayani *et al.*, (2006), Iodine and Chlorine are good oxidizing agent. It is effective against many varieties of pathogenic organisms including spores, cysts, viruses, etc. in a short time.

Now the collected water samples were treated with selected cleaning agents. The contact time period for the cleaning agents in water sample was near about 24 to 48 hours. After treatment with different cleaning agents water sample were reassessed for coliform test and MPN test (Table 7).

The cleaning agent such as Jamun wood and Alum shows acid and gas production, whereas, cleaning agent such as Bleaching powder and Jeevan drop show high antibacterial activity by reducing the acid and gas production (Table 8 and 9).

For MPN value in relation to Alum and Jamun wood, shows acid and gas was greatly reduced to much extent. After contact with Bleaching powder and Jeevan drop MPN result for acid and gas production was greatly reduced as compared to prior treatment (Table 8 and 10).

Comparative analysis of MPN values were assessed before and after addition of different cleaning agents and it was noticed that MPN value was highest for the collected water sample. Highest MPN value was recorded for samples followed by 900 MPN for sample 9 whereas least value 34 was recorded for sample 13. After addition of cleaning agents MPN was surprisingly reduced to greater extent. Almost all the screened cleaning agents shows antibacterial activity in controlling the microflora from water. Even though all the cleaning agents used were traditional agents, so we can recommend them for water purification agent. So, after the completion of research work we recommend the use of different cleaning agents such as Alum, Jeevan drop, Bleaching powder, Jamun wood for water purification and may proved to be ecofriendly, economical, easy for application and non hazardous in near future.

References:

1. Ali, S. S., Anwar, Z., & Khattak, J. Z. K. (2012). Microbial analysis of drinking water and water distribution system in new urban Peshawar. *Current Research Journal of Biological Sciences*, **4**(6), 731-737.
2. Amadi, L. O. (2020). A review of antimicrobial properties of alum and sundry applications. *Acta Scientific Microbiology*, **3**(4), 109-117.
3. Amine, A. E. K. (2013). Extended spectrum beta-lactamase producing bacteria in waste water alexandria, Egypt. *International journal of bioscience, biochemistry and bioinformatics*, **3**(6), 605.
4. Andreozzi, R., Caprio, V., Insola, A., & Marotta, R. (1999). Advanced oxidation processes (AOP) for water purification and recovery. *Catalysis today*, **53**(1), 51-59.
5. Armstrong, L. E., Buyckx, M., Campbell, S., & Fulgoni, V. (2007). Scientific consensus statement regarding the importance of hydration and total water intake for health and disease. *J. Am. Coll. Nutr*, **26**(5).
6. Bibby, D. M., and Milestone, N. B. (1984). The decomposition of high grade bleaching powder (calcium hypochlorite). *Journal of Chemical Technology and Biotechnology. Chemical Technology*, **34**(8), 423-430.
7. Bnyan, I. A., Alta'ee, A. H., and Kadhum, N. H. (2014). Antibacterial activity of aluminum potassium sulfate and *Syzygium aromaticum* extract against pathogenic microorganisms. *J Nat Sci Res*, **4**(15), 137-141.
8. Botkin, D. B., & Keller, E. A. (2005). Water supply use and management In. *Environmental Science 5th ed. John Willey & sons*, 406-415.
9. Boyce, J. M. (2016). Modern technologies for improving cleaning and disinfection of environmental surfaces in hospitals. *Antimicrobial Resistance and Infection Control*, **5**(1), 1-10.
10. Chauhan, S., Gupta, K. C., Singh, J., and Morar, G. (2015). Purification of drinking water with the application of natural extracts. *Journal of Global Biosciences*, **4**(1), 1861-1866.
11. Cooper, R. (2018). Water, sanitation and hygiene services in Pakistan.
12. Food and Agriculture Organization of the United Nations, Hunger, A. A., Aid, A., International Federation of Red Cross and Red Crescent Societies, World Vision International, and Agencia Española de Cooperación Internacional. (2016). *Free Prior*

and Informed Consent: An Indigenous Peoples' Right and a Good Practice for Local Communities: Manual for Project Practitioners. Food and Agriculture Organization of the United Nations.

13. Jung, A. V., Le Cann, P., Roig, B., Thomas, O., Baurès, E., & Thomas, M. F. (2014). Microbial contamination detection in water resources: interest of current optical methods, trends and needs in the context of climate change. *International Journal of Environmental Research and Public Health*, **11**(4), 4292-4310.
14. Kanakoudis, V., and Tsitsifli, S. (2017). Potable water security assessment—A review on monitoring, modelling and optimization techniques, applied to water distribution networks. *Desalin. Water Treat*, **99**, 18-26.
15. Kass, A., Gavrieli, I., Yechieli, Y., Vengosh, A., and Starinsky, A. (2005). The impact of freshwater and wastewater irrigation on the chemistry of shallow groundwater: a case study from the Israeli Coastal Aquifer. *Journal of Hydrology*, **300**(1-4), 314-331.
16. Khalifa, M., and Bidaisee, S. (2018). The importance of clean water. *Sch J Appl Sci Res*, **1**(7), 17-20.
17. Ligor, M., and Buszewski, B. (2006). An Investigation of the Formation of Taste and Odour Contaminants in Surface Water Using the Headspace SPME-GC/MS Method. *Polish Journal of Environmental Studies*, **15**(3).
18. Parihar, S. S., Ajit, K., Ajay, K., Gupta, R. N., Manoj, P., Archana, S., & Pandey, A. C. (2012). Physico-chemical and Microbiological analysis of underground water in and around Gwalior city, MP, India. *Research Journal of Recent Sciences*
19. Popkin, B. M., D'Anci, K. E., and Rosenberg, I. H. (2010). Water, hydration, and health. *Nutrition reviews*, **68**(8), 439-458.
20. Rajendra, S., Rubin, D., & Abhishek, M. (2012). Microbiological quality of potable water in Dehradun city.
21. Rutala, W. A., and Weber, D. J. (2008). Guideline for disinfection and sterilization in healthcare facilities, **2008**.
22. Rutala, W. A., and Weber, D. J. (2013). Disinfectants used for environmental disinfection and new room decontamination technology. *American journal of infection control*, **41**(5), S36-S41.
23. Sabharwal, J. (2015). Health issues and environmental impact of cleaning agents. *International Journal of Novel Research in Life Sciences*, **2**(2), 31-38.
24. Shahezad, A. (2013). Evalution of drining water quality of railway sations from Amravati to Mumbai. *Int. J. Res. Sci. Tech*, **2**, 505-507.
25. Shannon, M. A., Bohn, P. W., Elimelech, M., Georgiadis, J. G., Marinas, B. J., and Mayes, A. M. (2008). Science and technology for water purification in the coming decades. *Nature*, **452**(7185), 301-310.
26. Sharma, S., & Bhattacharya, A. J. A. W. S. (2017). Drinking water contamination and treatment techniques. *Applied water science*, **7**(3), 1043-1067.
27. Shrikant Baslingappa, S., Nayan Singh J, T., Meghatai M, P., and Parag M, H. (2012). Jamun (Syzygiumcumini (L.)): a review of its food and medicinal uses. *Food and Nutrition Sciences*, **2012**..
28. Singh, H., Singh, D., Singh, S. K., & Shukla, D. N. (2017). Assessment of river water quality and ecological diversity through multivariate statistical techniques, and earth observation dataset of rivers Ghaghara and Gandak, India. *International Journal of River Basin Management*, **15**(3), 347-360.
29. Singh, S., Singh, A. K., Saroj, P. L., and Mishra, S. (2019). Research status for technological development of jamun (*Syzygium cumini*) in India: A review. *Indian Journal ofAgricultural Sciences*, **89**(12), 1991-1998.
30. Smith, J., Edwards, J., Hilger, H., & Steck, T. R. (2008). Sediment can be a reservoir for coliform bacteria released into streams. *The Journal of general and applied microbiology*, **54**(3), 173-179.
31. Toze, R. S. G. (1997). Microbial pathogens in wastewater: literature review for urban water systems multi-divisional research program.
32. Tsitsifli, S., and Kanakoudis, V. (2018, July). Disinfection impacts to drinking water safety—A review. In *Proceedings* (Vol. **2**, No. 11). MDPI.
33. Werber, J. R., Osuji, C. O., and Elimelech, M. (2016). Materials for next-generation desalination and water purification membranes. *Nature Reviews Materials*, **1**(5), 1-15.

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781

Screening of Biosurfactant Producers from Bacillus subtilis and Study of its Antimicrobial Potential against Clinical Isolates

Shivani A. Bhagat, Swati N. Zodpe
1 M.Sc. Student, Department of Microbiology,Shri Shivaji College, Akola
2 Assistant Professor and Head, Department of Microbiology, Shri Shivaji College, Akola

Submitted: 15-04-2024 Accepted: 25-04-2024

ABSTRACT
The Current study was carried out to check the antimicrobial potential of produced biosurfactant against clinical isolates. Total 10 samples were collected during the study and further processed for isolation and identification. The predominant organisms were B.subtilis, P.aeruginosa, S.aureus and Micrococcus. The study was continued with the B.subtilis. The Biosurfactant was produced from B.subtilis. Biosurfactants production ability was confirmed with different screening methods such as Phenol Sulphuric Acid Method,Haemolysis Method and different Analytical methods such as Oil Spreading Test, Emulsification Index. The most predominant clinical isolates was P.aeruginosa, E.coli, K.pneumonia, S.aureus and S.typhi. The antimicrobial activityof produced biosurfactant checked against clinical isolates..
Keywords: Biosurfactant,Bacillus subtilis, Clinical isolates, Antimicrobial activity.

I. INTRODUCTION

Most of these microorganisms are bioactive and survive at the top few inches of the agriculturalsoils (Foster JW et al.,2010). Microbial degradation process aids the elimination of spilledoil from the environment after critical removal of large amounts of the oil by various physical and chemical methods (Ijah and Okang, 1993). This is possible because microorganisms have enzyme systems to degrade and utilize diesel oil as a source of carbon and energy (Ijah and Antai, 1988; Ezeji et al., 2005; Antai and Mgbomo, 1993).

The term "biosurfactants''refers to a class of modern surfactants that are derivedfrommicroorganisms and are equally diverse in terms of structure and function. They are attracting more attent;on due to their biodegradability and environmentally favourable qualities.(Shekhar et al., 2015). Biosurfactant producing microorganisms universally inhabit fresh water, soil, sediment, and sludge (Perfumo et al.,2010).Bacteria strain such as Bacillus, that can survive in harsh environments for a long time, are generally known as biosurfactants producers (Mulligan CN 2005).

II. MATERIAL AND METHODS

Collection of samples :
The soil sample was used for this study were collected from various Automobile garrages in Akola region.

Isolation and identification of bacteria from oil contaminated sample :

The sample were enrich using inoculating in sterile mineral salt medium. 1 ml of sample was inoculated in 100 ml of mineral salt medium. The medium was inoculated for 24 hours and were selected based on the colony morphology on the nutrient agar and selected microbes were gram scoloed. The selected isolates were screened for the production of biosurfactants and using the following screening methods (Nayarisseri A et al., 2018).

Screening and Production of Biosurfactant by using isolated microorganisms :

Bacteria were cultivated aerobically in a 500 ml Erlenmeyer flask with 100 ml mineral salt medium.Flasks containing sterilised mineral salt medium were inoculated with a loopful of bacterial culture is kept in a shaker at 200 rpm and 30°C for 7 days.After 7 days of incubation, each flask's culture broth was centrifuged for 15 minutes at 6000 rpm and 4°C, and the supernant was filtered through 0.45m pore size filter paper (Millipore).The drop collapse essay, oil spending assay, emulsification assay, BATH assay and surface tension assay were all performed using this cell – free culture broth (Nayarisseri A et al., 2018).

Phenol Sulphuric Acid Method :

In phenol Sulphuric acid method 1 ml of 5% phenol was added to the supernant and to this

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781

added 5 ml of concentrated Sulphuric acid drop by drop the colour changes from yellow to orange indicates the biosurfactant production (Kappeli and Finnetry, 1980).

Haemolytic activity :

The blood agar plates containing 5% v/v blood were used to seed the desired isolate, which was incubated at 37°C for 48 hours.Then, the plates were examined to form the clear zone around bacteria colonies, and the size of the clear zone was measured(Dhasayan Aet al., 2015).

Oil Spreading Test :

10 ul of crude oil is added to the surface of 40 ml of distilled water in a petridishto form a thin oil layer.Then, 10 ul of culture or culture supernant are gently placed on the centre of the oil layer. If biosurfactant is present in the supernant, the oil is displaced and a clearing zone is formed (Morikawaet al., 2000).

Emulsification test (E24) :

Several colonies of pure culture were suspended in test tubes containing 2 mL of mineral salt medium after 48 h of incubation, 2 mL hydrocarbon (oil) was added to each tube.Then, the mixture was vortexed at high speed for 1 min and allowed to stand for 24 h. The emulsion index (E24) is the height of the emulsion layer (cm) divided by total height (cm), multiplied by 100 (Bodouret al., 2004).

Collection of Clinical Isolates :

The clinical samples was used for this study were collected from Government Medical College, Akola.

Isolation and Identification of Clinical Isolates :

The collected samples were inoculated on various selective media. All the plates were incubated at 37°C for 24 hrs.After incubation different cultural were identified on the basis of Cultural, Morphological and Biochemical Characterisation.

Antibiotics Sensitivity Test :

Antibiotic susceptibility tests were carried out by disc diffusion method (Bauer WA etal., 1966).Disc fusion method was used for the evaluation of antibiotic resistance by culturing the isolates on the Mueller-Hinton agar medium. After incubating the plates for 18-24 hours at 37 °C, the diameter of the growth inhibition zone was investigated.

Antimicrobial activity of produced biosurfactant against clinical isolates :

The antibacterial activity of crude biosurfactant was tested using the agar well diffusion method.The crude biosurfactant was tested on S.typhi, Aspergillusniger,S.aureus and E.coli along with control was used as 5% ciprofloxacin. The plates were incubated for 24 hours at 37°C. The presence of a clear zone suggests that the crude biosurfactant has antibacterial action (S.O. Adebajo et al., 2020).

III. RESULT AND DISCUSSION

Table No.1:- Frequency Distribution of Bacteria found in soil sample

Sr. No.	Name of organisms	No. Of isolate (out of 22)	Percentage (%)
1	B.subtilis	10	45.4
2	P.aeruginosa	6	27
3	S.aureus	4	18
4	Micrococcus	2	4

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781

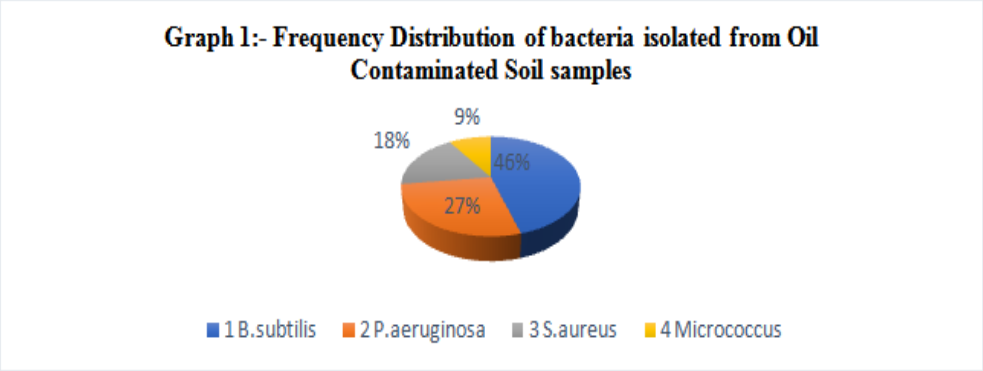


Table No.2 :- Conformation of Biosurfactant producer organism on the basis of different tests Phenol Sulphuric Acid Method, Haemolysis Method and Oil Spread Test

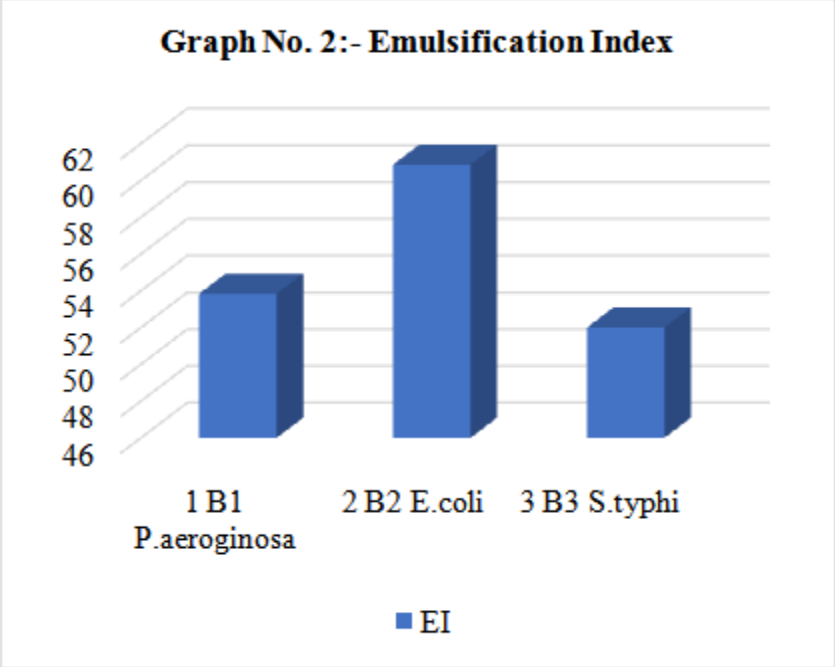
Sr.No.	Isolate	Phenol Sulphuric Acid Method	Haemolysis Method	Oil Spreading Test
1	B1	+	-	+
2	B2	+	+	+
3	B3	+	-	-
4	B4	+	+	+
5	B5	+	+	+
6	B6	+	-	-
7	B7	+	-	+
8	B8	+	-	-
9	B9	+	+	+
10	B10	+	+	+

Key :- +ve – Positive , -ve – Negative

Table No.3:- Emulsification Index

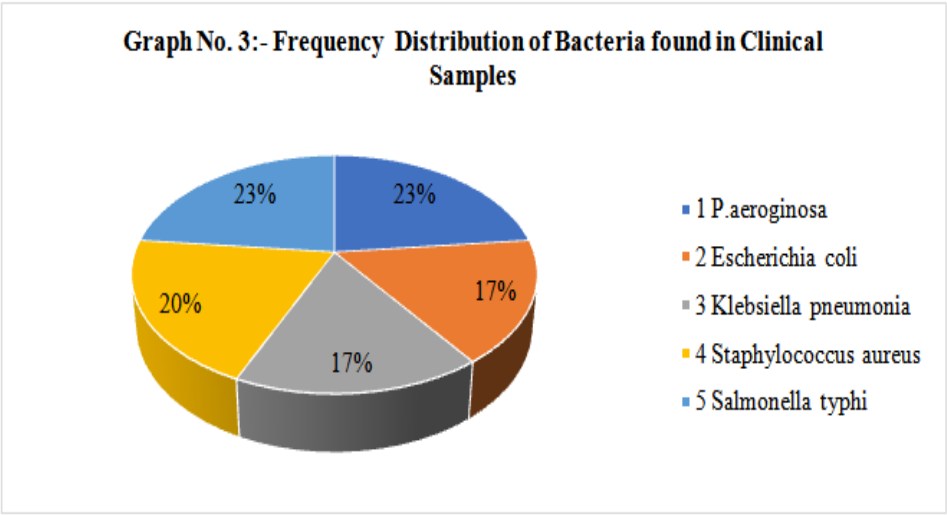
Sr.No	Isolate	Organisms	EI
1	B1	P.aeroginosa	53.84
2	B2	E.coli	60.8
3	B3	S.typhi	52

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781



TableNo.4:- Frequency Distribution of Bacteria found in Clinical Samples

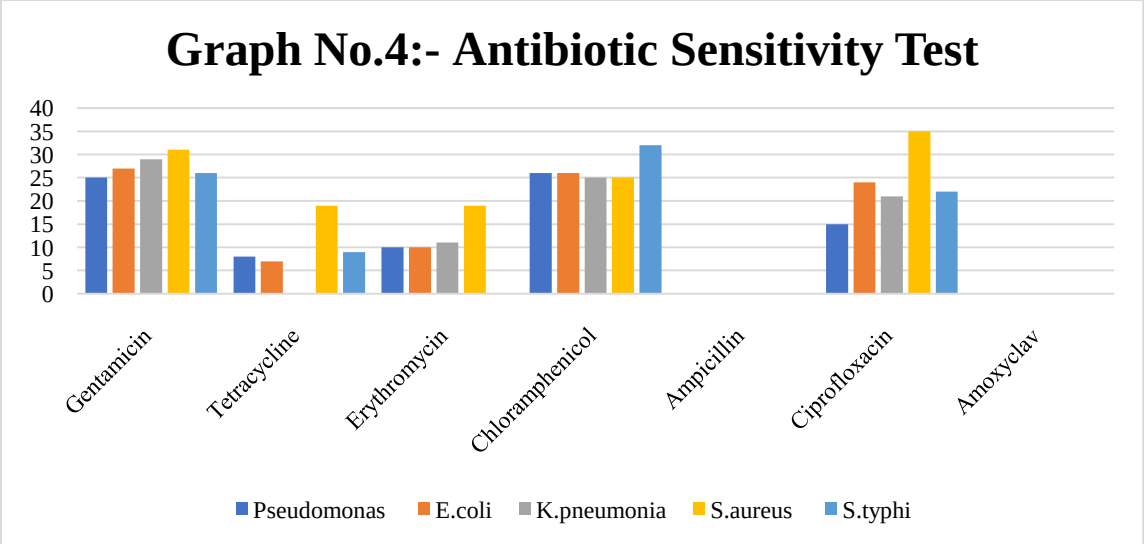
Sr.No.	Name of Organisms	No. Of Isolates (Out of 30)	Percentage (%)
1	P.aeroginosa	7	23.33
2	Escherichia coli	5	16.66
3	Klebsiella pneumonia	5	16.66
4	Staphylococcus aureus	6	20.00
5	Salmonella typhi	7	23.33



International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781

Table No. 5:-Antibiotic Sensitivity/Resistance test

Sr.No	Antibiotic	Name Clinical isolates (Zone in mm)									
		P.aeroginosa		E.coli		K.pneumoniae		S.aureus		S.typhi	
1	Gentamicin	25	S	27	S	29	S	31	S	26	S
2	Tetracycline	8	R	7	R	-	R	19	I	9	R
3	Erythromycin	10	I	10	I	11	R	19	R	-	R
4	Chloramphenicol	26	S	26	S	25	S	25	S	32	S
5	Ampicillin	-	R	-	R	-	R	-	R	-	R
6	Ciprofloxacin	15	S	24	S	21	I	35	S	22	I
7	Amoxyclav	-	R	-	R	-	R	-	R	-	R





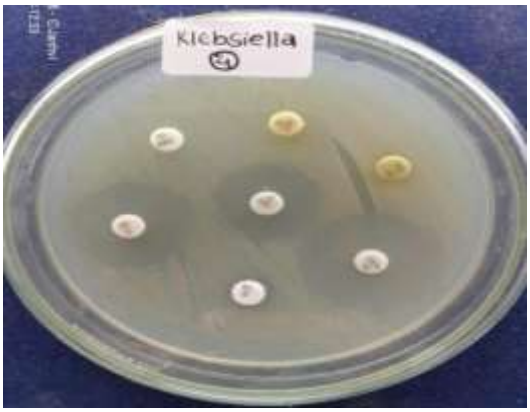
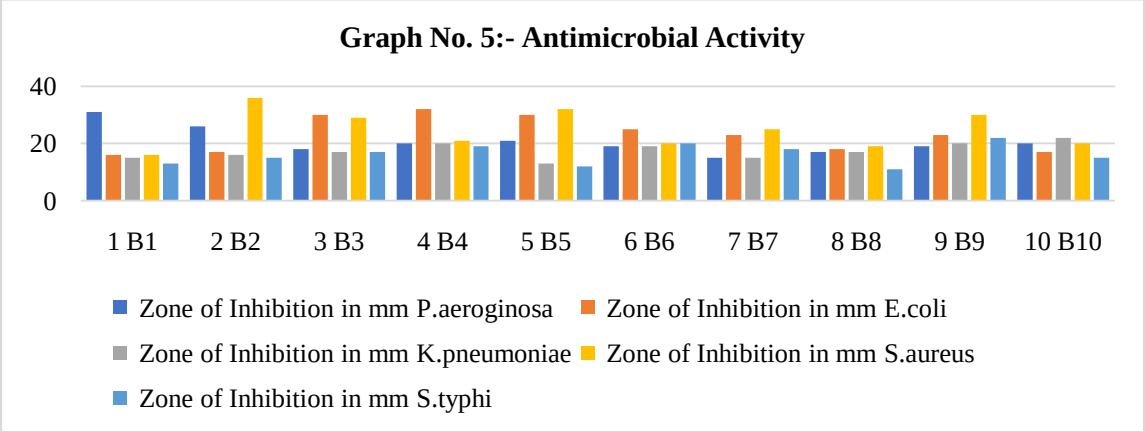


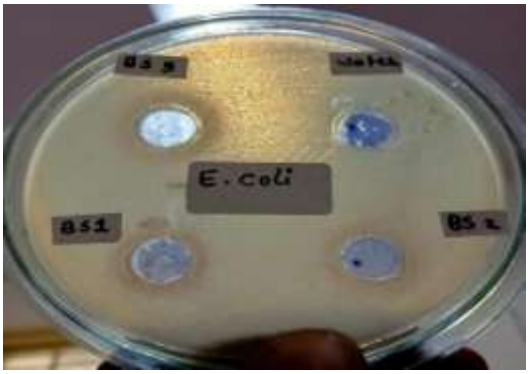
Table No.6:- Antimicrobial Activity of produced Biosurfactant from Bacillussubtilisand its activity against Clinical isolates

Sr.no	Isolate	Zone of Inhibition in mm				
		P.aeruginosa	E.coli	K.pneumonia	S.aureus	S.typhi
1	B1	31	16	15	16	13
2	B2	26	17	16	36	15

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781

3	B3	18	30	17	29	17
4	B4	20	32	20	21	19
5	B5	21	30	13	32	12
6	B6	19	25	19	20	20
7	B7	15	23	15	25	18
8	B8	17	18	17	19	11
9	B9	19	23	20	30	22
10	B10	20	17	22	20	15







IV. DISCUSSION :

A total 10 oil contaminated soil samples were collected from different automobile garages, Akola city .In that soil samples different types of bacteria obtained (Table No.1). Frequency distribution of isolated oil contaminated soil samples was taken B.subtilis is found in 10 samples (45.40%), P.aeruginosais found in 6 samples (27.00%), S.aureuswas found in 4 samples (18.00%) and Micrococcus found in 1 sample (4.00%) (Table No.2). The oil contaminated soil samples were further subjected for isolation and identification. For Conformation of the isolates B.subtilis further study was carried out with Biochemical Test are carried out. The all the test confirmed the isolates B.subtilis.

The Bacillus subtilis screened for the biosurfactant production ability. To confirmed the ability of isolate for biosurfactant production, different screening methods used were Phenol Sulphuric Acid Method and Haemolysis Method. Where, as different Analytical methods used were Oil Spread Method and Emulsification Index. The biosurfactant production ability was checked for 10 isolates, it was noticed that 7 isolates shows the positive result for phenol sulphuric acid method ,5

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 2 Mar-Apr 2024, pp: 1737-1744 www.ijprajournal.com ISSN: 2249-7781

isolates shows positive result for Blood Haemolysis Method which were considered as the biosurfactant confirmatory test and 7 isolates shows positive test for Oil Spread Test (Table No.3). This result is accordance with the result of Yousself et al., (2004) reported that the oil displacement technique is more suitable than the drop collapse method in detecting low levels of biosurfactant production.Total 3 isolates were tested for emulsification index.The emulsification index for the biosurfactant produced from E.coli the isolate B2 shows strong emulsification index of 60.86. The emulsification index for biosurfactant produced from Pseudomonas aeruginosa the isolates B1 shows 53.84 emulsification index. The emulsification index for biosurfactant produced from S.typhi the isolates B3 shows 52 emulsification index (Table No.4 and Graph No.2). This result is accordance with Patowary et al., (2017) reported that the biosurfactant maximum emulsification activities 100% for crude oil, followed diesel, kerosene and engine oil.

A total 15 clinical samples were collected from Government Medical College, Akola. Isolation and identification of bacteria and were tentatively confirmed on the basis of Bergey's Manual of Determinative Bacteriology (Table No.5).

Frequency distribution of clinical isolates studied and it was noticed that P.aeruginosa was found in 7 samples(23.33%), Escherichia coli is found in 5 samples (16.66%), Klebsiellapneumonia is found in 5 (16.66%), Staphylococcusaureus is found in 6 samples (20%) and Salmonellatyphi is found in 7 samples (22.33%) (Table No.6 and Graph 3).

The detail study of Morphological and Cultural characteristics of each clinical isolates. These isolates were obtained from GMC, Akola and different isolates such as P.aeruginosa , S.typhi, S.aureus, K.pneumonia and E.coli were obtained.

Antibiotic Sensitivity / Resistance pattern was studied against clinical. During the course of study it was notice that Gentamicin , Ciprofloxacin and Chloramphenicol shows sensitivity to all the isolates. Where as E.coli is resistance for Tetracycline, Klebsiella is resistance to Erythromycin. Most surprising result was obtained in case of Amoxyclav and Ampicillin which shows no zone of inhibition (Table No.7and Graph 4). Our result is in accordance with the result of Coates et al., (2011) and Gudina et al., (2016) reported the Antibiotic therapies is the main choice for treatment of most human bacterial infections.

Antimicrobial activity of produced biosurfactant from isolates was checked and it was noticed that all the biosurfactant produced from oil contaminated soil shows excellent antibacterial activity to controlling the clinical isolates showing zone of inhibition ranging from 8mm - 39mm (Table No.8 and Graph5).Where as very least activity was shown by biosurfactant produced from isolate against E.coli.Pseudomonas aeruginosa is having strong antibacterial activity against clinical isolates.Our result is correlates with Patowary et al., (2017) reported that B.subtilis, S.aureus , K. Pneumonia and E.coli were susceptible to the purified biosurfactant where it showed antibacterial properties that inhibited both Gram +ve and Gram -ve strains.

V. CONCLUSION

Biosurfactant producer are present in oil contaminated soil also. Biosurfactant produced from Bacillus subtilis isolated from soil shows best activity in controlling the isolates from clinical microflora. For commercial production of biosurfactants optimization study with respect to oil contaminated soil flora at biological and engineering level is needed. Optimization study for those of biosurfactant should be carried out. New genera among the biosurfactant producer by using various clinical samples should be investigated.

REFERENCES

[1]. Antai SP, Mgbomo E (1993). Pattern of Degradation of Bonny light crude oil by Bacillus Spp. and Pseudomonas Spp isolated from oil spilled site W.A.J. Biol. Appl. Chem. 38(1-4):16-20.

[2]. Bauer WA, Kirby WMM, Sherris JC, Truck M. Antibiotic susceptibility by standardized single disc Method. Amer J Clin Path. 1966; 45(4):493-496

[3]. Bodour A A, Guerrero-Barajas C, Jiorle B V., Malcomson M E, Paull AK, Somogyi A, Trinh L N, Bates R B and Maier R M. (2004):Structure and Characterization of Flavolipids, a Novel Class of Biosurfactants Produced by Flavobacterium sp. Strain MTN11. AppEnvironMicrobial. 70:114-120

[4]. Coates A R, Halls G and Hu Y. (2011): Novel classes of antibiotics or more of the sameBritish Journal of Pharmacology 163:1

[5]. Dhasayan A, Selvin J. Kiran S. Biosurfactant production from marine

bacteria associated with sponge Callyspongiadiffusa. 3 Biotech 2015:5(4):443-54. doi: 10.1007/s13205-014-0242-9

[6]. Ezeji EU, Anyanwu BN, Onyeze GOC, Ibekwe VI (2005). Studies on theutilization of Petroleum Hydrocarbon by Micro Organism isolated fromoil Contaminated Soi.l. Int. J. Nat. Appl. Sci. 1(2): 122-128.

[7]. Foster JW, Woodruff HB (2010) Antibiotic substances produced by bacteria. Ann N Y Acad Sci 1213:11

[8]. Gudina EJ, Rocha V, Teixeira JA, Rodrigues LR (2016) Antimicrobial and anti-adhesive activities of cell-bound biosurfactant from Pseudomonasaeruginosa PA1. RSC Adv 6(67):62986–62995.

[9]. Ijah UJJ, Antai SP (1988). Degradation and Mineralization of crude oil by bacteria. Niger. J. Biotechnol. 5: 79-86.

[10]. Ijah UJJ, Okang CN (1993). Petroleum Degrading capabilities of bacteria isolated from soil, W.A.J. Biol. Appl. Chem. 38(1-4): 9-15.

[11]. Kappeli, O., Finnerty, W. R. (1980). Characteristics hexadecane partition by the growth medium of Acenetobacterspp. Biotechnol.Bioeng., **22**. 495-503.

[12]. Mulligan, C.N., 2005. Environmental applications for biosurfactants. Environ. Pollut. 2005;133(2):183-98. doi: 10.1016/I.envpol.2004.06.009.(pubMed: 15519450).

[13]. Morikawa M, Hirata Y, Imanaka T. BiochimBiophysActa**2000**; 1488(3):211-218.

[14]. Nayarisseri A, Singh P, Singh SK. Screening, isolation and characterization of biosurfactant producing Bacillus subtilis strain ANSKLAN03. Bioinformation. 2018 Jun 30;14(6):304-314. Doi: 10.6026/97602630014304. PMID: 30237676; PMCID: PMC6137570.

[15]. Patowary K, Patowary R, Kalita M C and Deka S. (2017): Characterization of biosurfactant produced during degradation of hydrocarbons using crude oil as sole source of carbon. Frontiers in microbiology 8. 193-206.

[16]. Perfumo A, Smyth TJP, Marchant R, Banat IM (2010) Production androles of biosurfactants and bioemulsifiers in accessing hydrophobicsubstrates. In: Timmis KN (ed) Handbook of hydrocarbon and lipidmicrobiology. Springer, Berlin Heidelberg, pp 1502–1510

[17]. Shekhar, S., Sundaramanickam, A. and Balasubramanian, T. (2015) Biosurfactant producing microbes and their potential applications: a review. Crit Rev Environ Sci Technol 45, 11522-1554.

[18]. Youssef NH, Duncan KE, Nagle DP, Savage KN, Knapp R.M. and McInerney, M.J. (2004) Comparison of methods to detect biosurfactant production by diverse microorganisms. Microbiol Methods 56:339–347

IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

"Assessment of Antimicrobial Potency of A.indica Against Target Bacteria and Formulation of Neem Based Floor Cleaner as a Disinfectant"

Rathod M. G[1], S. N. Zodpe [2]

Department of Microbiology Shri Shivaji College of Arts, Commerce and Science, Akola.

Abstract

The current study was carried out to check the efficacy of A.indica against microflora. Total 52 samples from floor, wash besins of college department and sewage samples were also collected during the study and further processed for isolation and identification. The predominant organisms were *S.aureus, E.coli, P.aeruginosa, S.typhi.* The activity of A.indica Neem was checked in different organic solvents such as acetone, ethanol, aqueous similarly during the study neem based floor cleaner was also formulated. The physical parameter as well as antimicrobial activity of formulated floor cleaner was also checked. Excellent result in terms of zone of inhibition was observed, indicating neem plant have strong antibacterial activity in controlling microflora.

Keywords- A.indica, *S.aureus, S.typhi, P.aeruginosa, E.coli*, floor cleaner.

INTRODUCTION

Plants have been a source of herbal remedies through-out the history of mankind. Various medicinal plants have been used for years in daily life to treat diseases all over the world (Nimri et al., 1999; Saxena, 1997). Azadirachta indica A. Juss (syn. Meliaazadirachta) is well known in India and its neighboring countries. It is popularly known as Indian neem (margosa tree) or Indian lilac. It is an evergreen tree, cultivated in various parts of the Indian subcontinent. Every part of the tree has been used as traditional medicine for household remedy against various human ailments. Azadirachta Indica (A. Indica) belongs to the family Meliaceae, commonly known as neem. It is used in traditional medicine as a source of many therapeutic agents. A. Neem is fast-growing tree, generally 15–20 m tall (sometimes up to 40 m tall), with a crown diameter up to 20 m. Neem is evergreen but can shed most of its leaves under dry conditions.

MATERIALS AND METHODS

Selection of plant

The plant neem (Azadirachta indica) was selected for study. Its leaves were collected from local area.

Leaf extract

The completely shade dried material was coarsely powdered. The powder is then aseptically kept in air tight container at the moisture free place.

Ethanol, Acetone, Aqueous extract.

5gm of dried leaf powder were taken in a separate container.

50ml of ethanol in one container and 50 ml of acetone in another container was added and kept for 24 hours with periodic shaking then filter the suspension using Whatmann filter paper no1.

The filtrate was then evaporated on a water bath. After evaporation add 2ml of DMSO solution (dimethyl sulphoxide) and the filtrate was collected in air tight container.

Phytochemical analysis (As described as odebiyiet al.,1978)

The coarse powder was soaked in 10 ml of distilled water after 1hourhe suspension were filtered using Whatmann filter paper no 1 then filtered was used for the phytochemical analysis**.**

Test for carbohydrates

1ml of Molisch's reagent was added to 2 ml of neem extract after which a few drops of concentrated sulphuric acid was added. A purple colouration depicts the presence of carbohydrates.

Test for Tannins

2 ml of 5% ferric chloride was added 1 ml of neem extract. A greenish black colouration depict that tannins are present.

Test for Saponins

2 ml distilled water was added 2ml neem extract and shaken for 15 minutes. Foam formation indicates that saponins are present.

Test for Flavonoids

5ml of dilute NH3 solution was added into 1ml of neem extract prior to the addition of concentrate sulphuric acid. A yellow colouration depicts that flavonoid are present**.**

Test for Terpenoids

2 ml chloroform and concentrated H2SO4 was added to 0.5 ml of neem extract. A red brown ring formation at the interface depict that terpenoids are present.

Test for Phenol

2 ml distilled water and a few drops of 10% ferric chloride was added to 1ml of neem extract. A green colouration depicts that phenol are present.

For Acids

Sodium bicarbonate solution was added to 1ml on neem extract. Formation of effervescence depict the presence of acids.

Test for glycosidase

3 ml of chloroform and 10% NH3 solution was added to 2 ml neem extract. A pink colouration depicts that glycosidase are present

Test for Alkaloids

2 ml concentration HCL was added 2ml neem extract before a few drops of Mayer's reagent were added. A greenish colouration depict that alkaloids are present.

Collection of samples

Sewage sample was collected from slum area nearby to Shri Shivaji College of Arts Commerce and Science, Akola. Few samples were collected from the wash basins of labs and floor of different washrooms, as well as infected urine samples from different laboratory.

Isolation and identification from different sources

The collected samples inoculated on nutrient agar by using swabbing technique and then incubate for 24hours in incubator at 37℃. Identification of the isolates was done on the basis of cultural, morphological and biochemical characters on the basis of Bergey's manual of determinant bacteriology**.**

Antimicrobial activity

The organisms were inoculated in Nutrient Broth and incubated at 37℃ for 3-4 hours and these was used for inoculum. Antimicrobial activity was checked by agar well diffusion method on Muller Hinton Agar. A sterile cotton swab was inserted into the bacterial suspension and then rotated and compressed against the wall of the test tube so as to express the excess fluid. Evenly spread the swab so the uniform layer is formed on the agar.Now with the help of cork borer four well of 6mm are bored and the wells are filled with the plant extract i.e (Ethanol, Acetone and Water).And the fourth well is poured with distilled water as a control. By using micropipette the plants extracts are put in wells. Then the petri plates were incubated in incubator for 24 hours at 37℃. Zone of inhibition is form. Zone of inhibition is measured in mm.

Formulation of floor cleaner

The floor cleaner was prepared by using different component such Sodium Bicarbonate, Sodium Hydroxide, EDTA etc. Add all these ingredients in a beaker one by one in beaker and place it at room temperature. Lastly the development of colour was checked. Prepared floor cleaner was spread on lab platforms to check its cleaning activity. Similarly, floor cleaner was also inoculate on nutrient agar to check the presence of any contaminant in it. Same Procedure was repeated 4 to 5 times. Visual examination of floor

cleaner was done by checking colour odour and consistency. Antimicrobial activity of floor cleaner was checked against isolates obtained.

Results and discussion.

As per the observation the antimicrobial activity of different extract of neem leaf showed more zone of inhibition against *S.aureus*, *E.coli* and while *S.typhi* and *P.aureginosa* are less susceptible to neem extract.(table1; fig1)

Table 1 : Antimicrobial Activity of Different Extract of Neem (in mm)

Sr no	Name of the organism	Ethanol	Acetone	Aqueous
1	*S.aureus*	20.0	21.2	20.1
2	*P.*aureginosa	17.6	19.4	17.5
3	*E.coli*	18.2	17.2	12.5
4	*S.typhi*	18.0	20.0	15.5

Table 2: Formulation of Floor Cleaner in Laboratory

Sr no	Ingredients	Weight %
1	Water	100ml
	EDTA	0.5
3	Sodium bicarbonate	3
4	Sodium hydroxy	1
5	Acid slurry	6
6	Perfume	0.5
7	Neem oil	0.3
8	Sodium dodecyl sulphate	0.3
9	Colour	2
10	Benzalkonium chloride	0.2
11	SLES	10
12	Sodium hypochlorite	0.5
13	pH strip	1-2

14	Neem extract	2
15	Salt /NaCl	1-2

Table 3: Antimicrobial activity of prepared floor cleaner. (in mm)

Name of organisms	**Distill water**	**Floor cleaner1**	**Floor cleaner2**
S aureus	R	19.1	20.2
P aeruginosa	R	17.2	19.3
E coli	R	18.0	22.1
S typhi	R	24.0	15.1

In this study leaf extract of A. Indica, exhibits antimicrobial effects against the target pathogens, *Staphylococcus aureus, Pseudomonas aeruginosa, and E.coli ,S.typhi*. It is a simple and inexpensive method for the better sanitization with no toxic effects.

Conclusion

The current investigation concluded that:

The aqueous extract of neem plant leaves in acetone extract have shown strong antimicrobial properties and has higher inhibition rate. The prepared floor cleaner shows strong antibacterial activity in controlling the lab floor and platform microflora. Further studies are needed including toxicity evaluation and purification of active antibacterial constituents from A.indica extracts looking towards a pharmaceutical use. The neem plant contains different phytochemicals and had beneficial effect in controlling the pathogenic microflora and thus can be used in therapeutic formulation in near future.

References

Ali,A. (1993). Textbook of Pharmacognosy, Publication and Information Directorate, New Delhi, India.

Almas K (1999). The antimicrobial effects of extracts Azadirachta indica (Neem) and Salvadora persica (Arak) chewing sticks. Indian J Dent Res 10:23-26.

Bandyopadhyay U, Biswas K, Chatterjee R, Bandyopadhyay D, Chattopadhyay I, Ganguly CK, Chakraborty T, Bhattacharya K, Banerjee RK (2002). Gastroprotective effect of neem (Azadirachta indica) bark extract: possible involvement of H+-K+-ATPase inhibition and scavenging of hydroxyl radical. Life Sci 71:2845-2865

Baswa M, Rath CC, Dash SK, Mishra RK (2001). Antibacterial activity of Karanj (Pngamia pinnata) and neem (Azadirachta indica) seed oil: a preliminary report. Microbios 105:183-189

Bhomick BN, Choudhary BK (1982). Antifungal activity of leaf extracts of medicine plants on Alternaria alternata. Indian Botanical Reporter 1:164-165

Chopra RN, Nayar SL, Chopra IC (1956). Glossary of Indian Medicinal plants. Council of Scientific and Industrial Research, New Delhi

Fujiwara T, Takeka TO, Gihara Y, Shimizu M, Nomura T, Tomuta Y (1982). Studies on the structure of Polysaccharidesfrom the bark of Medica Azardichta. Chemical Pharmaceu Bull 30:4025-4030.

International Research Journal
IJNRD
Research Through Innovation

ISSN 2319 - 359X

AN INTERNATIONAL MULTIDISCIPLINARY
HALF YEARLY RESEARCH JOURNAL

IDEAL

Volume - XII Issue - II March - August - 2024

HINDI PART - I

Peer Reviewed Referred and
UGC Listed Journal No. 47026

Single Blind Review/Double Blind Review

ज्ञान-विज्ञान विमुक्तये

IMPACT FACTOR / INDEXING
2023 - 7.537
www.sjifactor.com

❖ EDITOR ❖

Assit. Prof. Vinay Shankarrao Hatole
M.Sc (Math's), M.B.A. (Mkt), M.B.A (H.R),
M.Drama (Acting), M.Drama (Prod & Dirt), M.Ed.

❖ PUBLISHED BY ❖

Ajanta Prakashan
Aurangabad. (M.S.)

CONTENTS OF HINDI PART - I

अ.क्र.	लेख और लेखक के नाम	पृष्ठ क्र.
२५	बाल साहित्य एवं बाल कहानियों का बाल विकास में उपयोगिता **प्रो. डॉ. प्रवीण देशमुख** **किशोर राघोबाजी डोंगरे**	११९-१२१
२६	भारतीय संस्कृति में संगीत की भूमिका **प्रा. डॉ. वनिता तु. भोपत (केतकर)**	१२२-१२४
२७	विदर्भ स्थित गोर बंजारा जनजाति के लोकसंगीत की वर्तमान स्थिति का अभ्यास **वैभव प्रभाकर डगवार** **प्रा. डॉ. साधना शिलेदार**	१२५-१३०
२८	शारीरिक शिक्षा, स्वास्थ्य एवं योग **Pro. Vaishali Kashinath Sonone**	१३१-१३५
२९	वर्तमान संगीत के रुझान **डॉ. कु. प्रिती बी. इंगळे (वाकपांजर)**	१३६-१४०
३०	वर्तमान युग मे अनुवाद की आवश्यकता **प्रो. डॉ. संगीता जगताप**	१४१-१४७
३१	उत्तर हिंदुस्तानी शास्त्रीय संगीत के विज्ञान और कला में परिवर्तन **डॉ. भागवत लहुबुवा ढोले**	१४८-१५१
३२	जीवन में संगीत का महत्त्व **डॉ. वृषाली र. देशमुख**	१५२-१५६
३३	पंडीत भातखंडे के दस थाटो की लोकप्रियता : एक अध्ययन **प्रा. विशाल विजय कोरडे**	१५७-१६१
३४	भारतीय संगीत शिक्षा के नये आयाम **मिलन सु. गडवे**	१६२-१६४
३५	समकालीन साहित्य में किसान विमर्श **डॉ. अनिल अ. पाखरे**	१६५-१६८

VOLUME - XII, ISSUE - II - MARCH - AUGUST - 2024
IDEAL - ISSN - 2319 - 359X - IMPACT FACTOR - 7.537 (www.sjifactor.com) **CC - 5**

२६. भारतीय संस्कृति में संगीत की भूमिका

प्रा. डॉ. वनिता तु. भोपत (केतकर)
संगीत विभाग, श्री शिवाजी कला, वाणिज्य व विज्ञान महाविद्यालय, अकोला ।

सारांश

संगीत भारतीय सभ्यता, संस्कृति व इतिहास का प्राण है। भारत की संपूर्ण जीवन, यात्रा में संगीत ने हर स्थिती मे यहां के मानव को नया लक्ष्य दिया है। प्रकृति की चमत्कारिक क्रियाओं- प्रतिक्रियाओं से लेकर सत्य व सांत्वना की खोज के समस्त मार्ग संगीत की छाया से ही निकाले है। भारत के सामवेद में प्रस्तुत संगीत प्रमाणोंसे लेकर संस्कृति के समूह व लोकगायन तक सभी कुछ संगीत से जुडे है ।

प्रस्तावना

वर्तमान समय में दैनिक जीवन तथा चारों और केवल वातावरण पर दृष्टि डालने से संगीत की संवादात्मक शक्ति के दर्शन होते है। मंदिरों, देवालयों, गुरुद्वारों आदि में सुबह-शाम कीर्तन, भजन, चौपाई या गुरुओं की, वाणियों को गाकर भक्त अपने इष्ट के साथ संवाद स्थापित करते है। संगीत मानव व समाजके नैतिक उत्थान के लिए आवश्यक है। संगीत अपने आप में एक सबल संवादात्मक माध्यम है। और एक दुसरे से भावनात्मक सम्बन्ध बनाने में सहयोग प्रदान करती है ।

संगीत के कलात्मक तत्व स्वर, ताल ध्वन्यात्मक प्रवाह एवं लयकी गति मानता प्रकृति के कण-कण में व्याप्त है। इसीलिए प्रत्येक प्राकृतिक गतिविधी में विद्यमान ध्वन्यात्मक तत्व ही संगीत के उत्प्रेरक बनकर प्रकृती और संगीत का अटूट सम्बन्ध स्थापित कर देते है और तब ऐसा लगता है कि संगीत अपने ध्वन्यात्मक प्रवाह से प्राकृतिक चित्रण करने में पूर्णत: सक्षम है। ऐतिहासिक तथ्यों पर दृष्टिपात करने से ज्ञात होता है कि संगीत भौतिक दृष्टि से मनोरंजन का साधन बनाकर सौन्दर्य शास्त्रीय धरातल पर और आत्मिक उत्कर्ष के लिए साधना का माध्यम बनकर आध्यात्मिक धरातल पर मानव के लिए निरन्तर सभ्यता व संस्कृती का पोषक बनकर उभरा है। एकान्तिक साधना से लेकर मन्दिरों व देवालयों में आराधना का स्रोत बनने के साथ- साथ राजदरबारों की शोभा बनकर प्रवाहीत होने वाली संगीत कला के आधार भूत कलात्मक तत्वों ने अपनी संवेदनात्मक शक्ति से भिन्न- भिन्न गेय विधाओं का रूप लेकर कालक्रम में अपनी प्रयोजनीयता को सिद्ध किया है ।

भारतीय संगीत व इसकी उत्कृष्टता के बारे में विभिन्न विद्वानोंने अपने मत प्रस्तुत किये है ।

नारद संहिता में कहा गया।

नाहं वसामि वैकुण्ठे, योगिनामं हृदये नच ।
यदा भक्ता यत्र गायन्ति तत्र तिष्ठति नारदा ।

यति संगीत ही इश्वर प्राप्तिका सर्वोत्तम साधना है।

- नारद संहिता

DOI PREFIX 10.22183
JOURNAL DOI 10.22183/RN
SIF 7.399

RESEARCH NEBULA
An International Refereed, Peer Reviewed & Indexed Quarterly Journal in Arts, Commerce, Education & Social Sciences

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA
ISSN 2277-8071

CLASSICAL MUSICAL PRINCIPLE IN THUMRI

ORCID Connecting Research and Researchers

https://orcid.org/0009-0001-1799-9848

https://orcid.org/0009-0002-1770-7208

NETRA MANKAR
Research Scholar, Assistant Professor, Department of Music,
Shri Shivaji College of Arts Commerce and Science, Akola.
aarushsolav044@gmail.com

DR. S. V. KADU
Research Supervisor, Department of Music,
Shri Shivaji College of Arts, Commerce and Science, Akola.
shirishkadu@gmail.com

Received: 26.08.2023 Reviewed :28.08.2023 Accepted: 01.09.2023

ABSTRACT

This research paper delves into the intricate exploration of Shrimati Shobha Gurtu's unique singing style through a systematic and organized approach. Research, viewed as an ongoing intellectual process, aims to continuously unveil new insights while addressing deficiencies in existing knowledge. Central to this pursuit is the selection and application of appropriate research methods, with a focus on analytical and descriptive techniques. The study extends beyond mere analysis of Gurtu's musicality, delving into the sociological significance of her contributions to classical music. It is evident that her artistic endeavours have not only preserved cultural heritage but also left a profound impact on future generations of music scholars. Through an examination of various scholarly perspectives, this research endeavors to provide a comprehensive understanding of Gurtu's musical legacy. In line with contemporary methodologies, a diverse range of information technologies including books, audio-visual materials, and online resources have been utilized to enrich the research process. By employing a multifaceted approach, this research paper offers valuable insights into the characteristic singing style of Shobha Gurtu, contributing to the broader discourse on classical music scholarship.

KEYWORDS: *Singing style,classical music, Research methods, Sociological significance*

'ठुमरीतील शास्त्रीय सांगीतिक तत्व मिमांसा

प्रस्तावना :-

संशोधन ही कधीच न संपणारी प्रक्रिया आहे. संशोधन हा सतत नव्याचा शोध घेण्याचा एक व्यवस्थित व संघटित असा प्रयत्न आहे व ही एक बौद्धिक प्रक्रिया आहे. ज्यातून जुन्या ज्ञानातील उणिवा दूर करून ज्ञानात सतत नवीन भर घातल्या जाते. कुठल्याही संशोधनाचा आधार त्याची संशोधन पद्धती असते. प्रत्यक्षपणे विविध चाचण्या व परीक्षणाची गरज असते. प्रस्तुत शोधनिबंधामध्ये शोभा गुर्टू यांच्या वैशिष्ट्यपूर्ण गायकीच्या शैलीचा अभ्यास करण्यासाठी प्रामुख्याने विश्लेषण आणि वर्णनात्मक संशोधन पद्धतीचा वापर केलेला आहे. तसेच एखाद्या कलावंताचा अभ्यास हा इतरांना कसा विविध पद्धतीने भावतो याचे समालोचन करूनच करावा लागेल.श्रीमती शोभा गुर्टू यांच्या उपशास्त्रीय संगीताचा विषय अभ्यासाला निवडताना प्रामुख्याने सांगावे लागेल की, त्यांनी संस्कृती व साहित्याचे जतन केलेले आहे. समाजशास्त्रीय दृष्टिकोनातून उपशास्त्रीय संगीतात त्यांचे फार मोठे योगदान आहे. त्यांच्या या योगदानाचा पुढील पिढीतील संगीत अभ्यासकांना निश्चितच फायदा होईल. म्हणून श्रीमती शोभा गुरु टूयांच्या उपशास्त्रीय संगीता बाबत संदर्भातील निरनिराळ्या अभ्यासकांची विश्लेषणात्मक दृष्टी परिशिलन करून संदर्भीय विषयाच्या माहितीचा गोषवारा शोधला आहे.आवश्यकतेनुसार पुस्तके,ऑडियो, Video, YouTube, Google सारख्या माहिती तंत्रज्ञानाचा देखील संशोधनासाठी उपयोग केल्या गेला आहे. अशा प्रकारे विविध संशोधन पद्धतीचा उपयोग प्रस्तुत शोधनिबंधामध्ये केलेला आहे.

उपशास्त्रीय संगीत म्हणजे काय :-

DOI PREFIX 10.22183
JOURNAL DOI 10.22183/RN
SIF 7.399

RESEARCH NEBULA
An International Refereed, Peer Reviewed & Indexed Quarterly
Journal in Arts, Commerce, Education & Social Sciences

INTERNATIONAL STANDARD SERIAL NUMBER INDIA
ISSN 2277-8071

कला ही अखंड अभिव्यक्ती आहे. प्रत्येक कलेच्या मुळाशी मानवी भावनांचा उगम असतो. ज्या की व्यक्त करण्यासाठी तो तळमळत असतो. संगीत ही एक अनोखी विधा आहे. ज्यामुळे प्रत्येकदा आनंदा अनुभूती येते. शारंग देवकृत 'संगीत रत्नाकर' या ग्रंथात संगीताची व्याख्या 'गीतम्, वाद्यम् नृत्यम् त्रयम् संगीत मुच्यते' अशी केली असून याचा अर्थ गायन वादन व नृत्य या तिघांच्या मधुर संगमाला संगीत असे म्हणतात. अशी केली आहे भारतीय शास्त्रीय संगीतात जाती गायन, प्रबंध गायन, ध्रुपद गायनापासून ख्याल गायकीपर्यंत गायन शैलींचा प्रवास झाला. आज भारतीय संगीतात मुख्य संगीता सोबत ख्याल गायकीचेच मूळ घेऊन उपशास्त्रीय संगीताचा जन्म झाला. आज त्यातीलच ठुमरी, कजरी, दादरा, टप्पा, गझल, होरी इत्यादी गायनशैली प्रचलित व लोकप्रिय आहे. उपशास्त्रीय संगीत म्हणजे स्वरांच्या सहाय्याने केलेली सुबक नक्षी, स्वर, ताल आणि शब्द यांचा सुंदर असा मेळ. उपशास्त्रीय संगीत प्रकारात स्वरांसोबत शब्द व अर्थ यांना सांभाळणे ही गायक कलाकाराची जबाबदारी असून ती पेलण्यासाठी पोषक विचारांची व रीयाजाची जोड लागते. शास्त्रीय संगीतातील बंदीशी व उपशास्त्रीय संगीतातील बंदीशी किंवा गीत प्रकार उदाहरणार्थ ठुमरी,दादरा, चैती, होरी, गझल, झुला वगैरे या दोन्हींमध्ये निश्चितच फरक आहे. या दोन्ही गायकीचे मूळ हे स्वर असले तरीही उपशास्त्रीय संगीताला शास्त्रीय संगीता सारखी नियम व शास्त्रीय बंधनांची चौकट नसते. भारतीय संगीतात अधिक तर उपशास्त्रीय संगीतात शब्दांना एक प्रकारे आधारच आहे संगीताच्या परंपरेत स्वराला अधिक प्राधान्य आहे. स्वरांची योग्य तालीम जर गाठीशी असेल तर उपशास्त्रीय संगीत गाण्याला चालना मिळते.

शोभा गुर्टू यांचे ठुमरी साठी योगदान:-

ठुमरी ही भारतीय संगीतातील आधुनिक शैली आहे. जी मुख्यतः श्रृंगाररसाने ओतप्रोत आहे. ठुमरीच्या उत्पत्ती विषयी की ठुमरीचा जन्म केव्हा, कसा आणि कुणाद्वारे झाला यासंबंधी निश्चित काही सांगू शकत नाही. ठुमरीचे 'बोलबाटकी ठुमरी' आणि 'बोल बनाव की ठुमरी असे दोन भाग पडतात.

बोलबांट की ठुमरी या प्रकाराला बंदिश की ठुमरी असेही म्हटल्या जाते. बोलबाटकी ठुमरीत संगीताचे प्राबल्य असते. तर यालाच बंदीशीची ठुमरी म्हणतात. आणि बोलबनाव म्हणजे आलापाबरोबर बोल घेऊन ठुमरी गायकीची बडत करणे तिला शब्दांद्वारे स्वरांकित करणे. सजवणे आणि म्हणूनच अभिनयाचा आधार न घेता स्वर काकू आणि शब्दांत द्वारे ती अलंकृत करणे भावांचा अभिव्यत्तम हा मात्र उद्देश राहिला. त्यामुळेच ती राजरोसपणे मैफिलीत गायल्या जाऊ लागली. आणि बनारसी ठोंबरी म्हणून ओळखल्या जाणारी ही बोल बनावाची ठुमरी राग प्रधान गंभीर प्रकृतीची होय ज्यामध्ये ठुमरीच्या भावानुरूप, काव्यानुरूप त्याच्या भावाला साजेशा सुंदर हरकती, मुर्की, खटका, छोटा छोटा स्वर समूह, कमी मात्रांच्या सपाटताना घेऊन तिच्यात रंग भरल्या जातो. तीच बोल बनावची ठुमरी. वास्तविक बंदीशीच्या ठुमरीचे पुनरुज्जीवन करण्याचे श्रेय शोभाताईंना जाते. शोभाताई या बंदिशीची ठुमरी गायच्या ज्यामध्ये ठुमरीचे पारंपारिक रूप समोर येते. बोलबाट आणि बोलबनावाची ठुमरी गाणे ही खूप अवघड होते. कारण यासाठी शास्त्रीय संगीताच्या सखोल अभ्यासाची आवश्यकता असते. आणि या भारतीय शास्त्रीय संगीताची तालीम शोभाताईंना लहानपणापासूनच मिळाल्यामुळे ख्याल गायनाचा त्यांचा अभ्यास दांडगा असल्याने ठुमरी गाताना त्याचा त्याच प्रवाहात सहजपणे जवळपासच्या रागांच्या लकीरी त्यात मिसळून जायच्या. यात मुद्दाम असे घडवलेले काहीही नसून ठुमरीच्या सादरीकरणात त्याची भरपूर मदत होऊन विविधता वाढली. व त्यामुळे त्यांचे ठुमरी गायन समृद्ध बनत गेले. राग गायनाच्या अभ्यासाचा दुसरा परिणाम म्हणजे त्यांच्या स्वतः रचलेल्या ठुमरी दादऱ्यात अनेक रचना अशा रागांवर आधारित आहेत की जे राग ठुमरी साठी नेहमी वापरत नाहीत.

शोभाताई ह्या पूरब पंजाबी ख्याली अंगाच्या अशा सर्व ठुमऱ्या एकदम सहजपणे सादर करीत असत. पूरब आणि बनारस अंगामध्ये पंजाबी अंगाच्या मूर्क्या, हरकती यांचे सौंदर्यपूर्ण मिश्रण करून वादक आणि रचनाकारांच्या अनेक रचना त्यांनी सफाईदारपणे सादर केल्या. व आपली अशी वेगळी ठुमरी शैली निर्माण केली. ठुमरीच्या

DOI PREFIX 10.22183
JOURNAL DOI 10.22183/RN
SIF 7.399

RESEARCH NEBULA
An International Refereed, Peer Reviewed & Indexed Quarterly
Journal in Arts, Commerce, Education & Social Sciences

ISSN 2277-8071

आकृतीबंधात नाजूक कलाकुसर, स्वरांचे बारीक नक्षीकाम, व सर्व अभिव्यक्तीतला सैयतपन उठावदार असूनही भडकपणाचा अभाव हे शोभाताईंचे खास वैशिष्ट्य दिसते.

या गुणवैशिष्ट्यांमुळे ठुमरी गायकीला एक नवीन वळण मिळत आहे. ख्याल गायन व गझल गायन यांच्याहून स्वतंत्र असे परिणाम ठेवणारी ठुमरी गायकी या नवीन प्रवाहाने पुढे जात आहे.

शोभाताईंची पकड असणारे गीत प्रकार :-

शोभाताई ह्या सर्वच प्रकारच्या ठुमऱ्या अगदी सहजपणे गात असत. पूरब आणि बनारस अंगामध्ये पंजाबी अंगाचे सौंदर्यपूर्ण मिश्रण करून त्यांनी अनेक रचना सादर केल्या. 'सैया निकस गये मैना लढी थी' ही ठुमरी त्याचे एक उत्कृष्ट उदाहरण आहे. शब्दांचे अर्थवाही पण मजाकतीचे उच्चारण नेटकेपणाने केलेली,राग मिश्रणे, शब्दातील दर्द, पुकार आणि गायनातील एकूणच प्रगल्भता ही त्यांची गानवैशिष्ट्ये. काहीशा मर्दानी जाड आवाजामुळे हे भावदर्शन उथळ न वाटता संयमित होई. त्यांच्या या अदाकारीमुळे प्रेक्षकांशी संवाद साधण्याची किमया त्यांच्याजवळ होती. ठुमरी सोबतच दादरा, चैति, कजरी, झुला, होरी, बारमासा,मांड इत्यादी गीतप्रकारांमध्ये त्यांना नैपुण्य प्राप्त होते. तसेच गझल व भजन हे गीतप्रकारही त्या अत्यंत भावपूर्ण रीतीने सादर करीत असत.

निष्कर्ष :-

ठुमरीतील मिंड, खटका, मुर्की, छोट्या ताना ,लयकारी , तालाचे वजन इत्यादि बाबी शास्त्रीय संगीतातील सांगीतिक तत्व सिद्ध करतात व ठुमरी हा प्रकार उपशास्त्रीय संगीतातील फक्त मनोरंजनाचे साधन नसून यामध्ये मानवी जिवनाचे तत्व भावभवनांच्या माध्यमातून सिद्ध होते आणि हीच सर्व गुण वैशिषटहे शोभाताईंच्या गायकी मध्ये दिसून येते

संदर्भ ग्रंथ :

1. भारतीय संगीत के प्रमुख स्तंभ - रविंद्रनाथ बहोरे
2. ठुमरी एक गान विधा - चित्र मोडक
3. सफर ठुमरी गायकी का - अंजली पोहनकर
4. ठुमरी दादरा कल और आज - प्रवीण जरेट