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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

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***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.

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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.

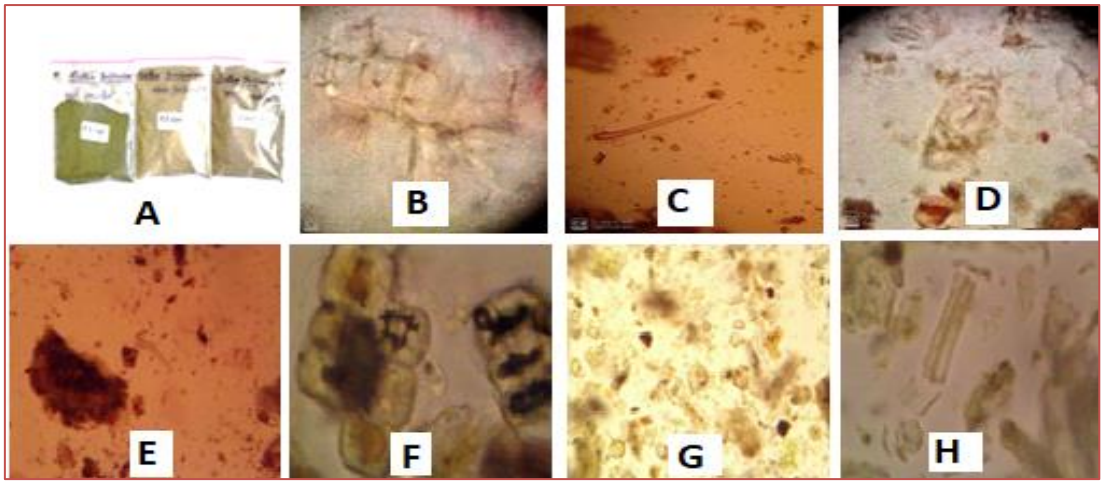

Figure 2: Images of powder microscopy

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.

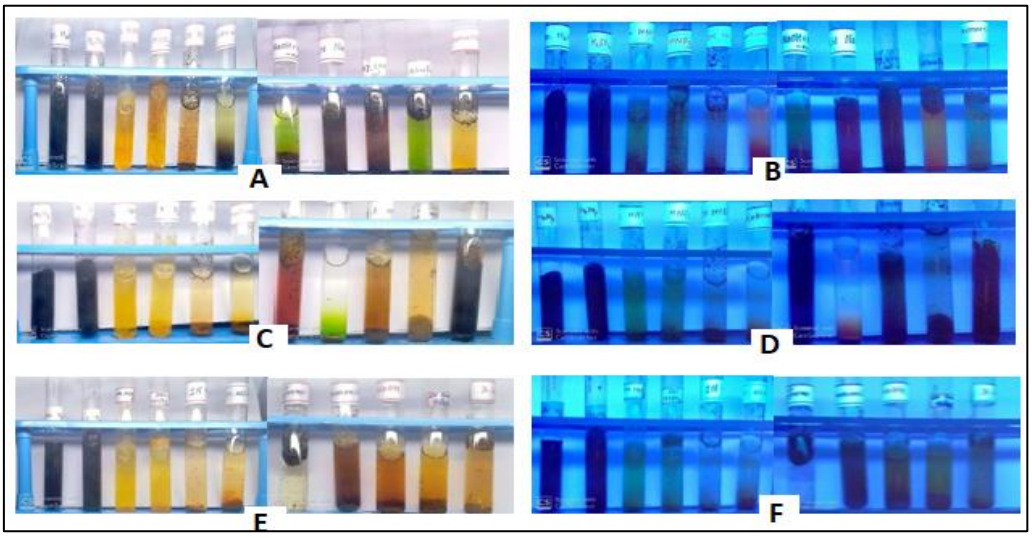

Figure 3: Images showing fluorescence colors

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.

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Research Article

Updates on Ethnomedicinal Uses and Biological Activities of *Genus Ruellia*

Jagtap T. D.[1], Shirsat, R. P.[2], Koche, D. K.*[1]

[1]*Department of Botany, Shri Shivaji College of Arts, Commerce and Science, Akola (MS) India 444001*
[2]*Department of Botany, Shri Dr. R. G. Rathod College of Arts and Science, Murtizapur Dist- Akola (MS) India 444107*

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ABSTRACT

Reullia is the genus of flowering plant comprising about 250 species, commonly called as wild pitunias. Some of the members of this genus are medicinally important and are being used traditionally to cure several ailments by tribals and local peoples. Present article deals with the discussion of various traditional uses and biological activities of members of genus *Reullia*, reported by several scientists. These plants showed diuretic, anti-diabetic, antipyretic, analgesic, antioxidant, gastroprotective, antimicrobial, antifertility, anti-inflammatory, antinoceptive, antiulcer, cytotoxic and anticancer properties. Several members of genus *Ruellia* have traditional medicinal values and most of them are explored for their biological properties. However, the bioactive molecules of these plants are yet to be investigated fully. Some of these plants could prove significant source of medicinal potential molecules as drug candidate.

Keywords: *Ruellia,* ethnomedicinal uses, biological activities.

INTRODUCTION

Since civilization, humans are using plants and plant products for their various needs includes routine healthcare. As plants possess healing properties, they are being used as traditional medicinal plants across the globe, especially by different tribes. Due to its unique phytogenographic and environmental conditions, Indian subcontinent supports the growth and development of over 20,000 flowering plants, of which about 7000 plants are reported to have medicinal potential and are being used by local medicine men in different native communities.

Now, it's a known fact that the properties of medicinal plants are due to their active secondary metabolites. The herbal era was started after the isolation of active compounds like digitoxin, quinine, cocain and codeine from different medicinal plants. The genus *Ruellia* belongs to family Acanthaceae (Acanthus family). The members of this genus are commonly known as wild petunias[1-2]. This genus consists of over 250 species, distributed in tropical and temperate regions of both the hemispheres including Indian subcontinent. *Ruellia* is represented by 10 species from India off which two were recorded from Maharashtra State [3-6]. Present review article is an update on the information related to folk medicinal uses, ethnobiology and phytochemical constituents from different members of genus *Ruellia* having medicinal potential.

MATERIAL AND METHODS

We conducted an online survey of literature in different online databases and professional websites with the key words related to our study. Initially we have searched for the ethnomedicinal uses of different members of *Ruellia* recorded by various ethno-botanists across the globe. Later we search for experimentally proven biological activities of various species of *Ruellia*. Then the data collected was interpreted in the light of recent researchers and compiled to prepare this review.

RESULTS AND DISCUSSION

Ethnomedicinal uses of members of Genus *Ruellia*

Ruellia is one of the most under rated medicinal plant genus of Acanthaceae. Some species of *Ruellia* are being used in traditional medicine preparations by different communities and also been part of Ayurveda and Ayush systems in India. The fresh leaves of the plant *Ruellia patula* is been use in earache[7]. One of the species, *R. tuberosa* has been extensively used as diuretic, anti-diabetic, antipyretic, analgesic, antioxidant[8], to treat gonorrhea, anti-hypertensive and gastroprotective[9-10]. Most of the plant species of *Ruellia* has been widely used as anti-diabetic, antipyretic, gastroprotective, antimicrobial, analgesic, anti-oxidant and anticancer against the epidermis of nasopharynx region[11]. *Ruellia asperula* is used in bronchitis, asthma, flu, fever and uterus inflammation[12]. The leaves of *R. prostrata* are being used in the treatment of chronic rheumatism, eczema, facial paralysis, cephalgia and hemiplegia; its leaf juice is an efficient remedy on colic infection in children[13]. *R. brittoniana* is being used for cardiovascular screening and also as antioxidant plant[14]. Choudhary[15] has documented the use of *R. patula* to cure bone fracture (stem decoction with cow milk),

**Author for Correspondence: kochedeepak77@gmail.com*

wound healer (leaf paste for external application) and antidote against snake bite (leaf chewing) from tribal belt of Rajsthan, India.

Biological activities of members of Genus *Reullia*

Antimicrobial activity

The chloroform, ethyl acetate, alcohol and aqueous extracts of the whole plant of *R. tuberosa* showed significant antibacterial properties. The aqueous extract exhibited less activity against fungal organisms[16]. The antibacterial activities of n-hexane, dichloromethane, ethyl acetate and methanol extracts of *R. tuberosa* were explored against Gram positive and Gram negative bacteria. The ethyl acetate and methanol fractions exhibited the highest rates of antibacterial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*[17].

Kader *et al*.[18] demonstrated the antimicrobial effect of leaf extract of *R. tuberosa* indicating methanolic extract was having highest antimicrobial potential. The methanol leaf extract showed significant antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Bacillus subtilis*, *Proteus mirablis* and antifungal activity against *Aspergillus sp*., *Mucor* sp., *Penicillium* sp. and *Fusarium* sp. Similar report was made by Senthilkumar *et al*. [19] indicating the potential antimicrobial activity of methanolic extract of *R. tuberosa*. The report of Than and Maw [20] also support above discussion.

Antioxidant activity

The antioxidant activity of different extracts of stem of *Ruellia tuberosa* were investigated by various in vitro methods like 2,2-diphenyl-1-picrylhydrazyl (DPPH), free radical-scavenging assays and the hydrogen peroxide induced luminol chemiluminescence assay. The results revealed that *R. tuberosa* possesses potent antioxidant activity[8]. These finding further supported by few other workers[21-22]; these reports indicate that leaf extracts of *R. tuberosa* has high antioxidant potential. Roopa *et al.* [23] studied the antioxidant potential of different organic extracts of *R. tuberosa* and stated that n-butanol extract has comparatively higher antioxidant activity. Krishna *et al.* [24] also presented similar report that extract of *R. tuberosa* having antioxidant property. Some other workers also reported the antioxidant potential of *R. tuberosa* [25].

Khachitpongpanit *et al.*[26] demonstrated that *R. tuberosa l*eave extract had high potential to scavenge DPPH and nitric oxide radicals. Safitri *et al.*[27-28] also given the experimental proof of anti-oxidant activity of hydroalcoholic and aqueous extract of *R. tuberosa*. Similar reports were made by Elgindi *et al.,* [29] on *R. brittoniana* and Kalaiselvi *et al.*[30] on *R. prostrata*. As per the report of Samy *et. al.*[31] from the five isolated compounds of *R. patula*, one compound showed high DPPH radical scavenging activities (with IC50 value of 14.3 ± 1.10 µM), while other four compounds exhibited a moderate activity (with an IC50 value of 37.5 ± 2.20, 31.9 ± 3.35, 31.7 ± 2.47 and 19.4 ± 2.59 µM, respectively). On the other hand, EtOAC fraction of *R. patula* displayed activity with IC50 25.5 ± 2.29 µg/ml compared with the standard trolox 16.7 ± 1.86. Wangia *et al.* [32] demonstrated that methanolic extract of *R. lineari-bractiolata* and *R. bignoniiflora*. He also reported the antioxidant activity of aqueous and organic extracts of Kenian *Ruellia prostrata* [33].

In 2017, Ahmad *et al.*[34] isolated and characterized as methoxylated flavonoid on the basis of spectral data including UV, IR, GC-MS, and NMR and also demonstrated that isolated compound have DPPH free radical scavenging activity. Tejaputri *et al.*[35] reported that the organic extracts of *Ruellia brittoniana* flowers has significant antioxidant activity where ethyl acetate extract seems to be more promising. Similarly, Piers *et al.*[36] showed that the ethanol extract of *R. angustiflora* consists of phenolics and flavonoids and possesses significant antioxidant activity.

Cytotoxicity and Anticancer activity

Active compounds isolated from *R. tuberosa* showed cytotoxicity in-vitro against KB cell line and HepG2 cell line [37]. Methanol extract of aerial part of *R. tuberosa* possessed cytotoxicity in H460 and MDAMB231 cancer cells, respectively [38]. Anticancer activity of only *R. tuberosa* is reported so far. Arun *et al*.[39] showed that methanol extract of aerial part of herb *R. tuberosa* possessed cytotoxicity. Its minimum inhibitory concentration (IC50) for methanol extract was found to be 3.5 and 1.9 µg/mL in H460 and MDAMB231 cancer cells, respectively. They have also isolated Tylocrebrine from *R. tuberosa* through bioassay directed column chromatography and elucidated its anticancer and anti-inflammatory potential. Similar report was also made by Nagarjuna *et al.* [40] indicating anticancer activity of R. *tuberosa* extract. Similarly Samy *et al.*[31] reported that methanolic extract, n-hexane and EtOAc fractions of *R. patula*, and MeOH extract, n-hexane and EtOAc fractions of *R. tuberosa* exhibited significant cytotoxic activity at a concentration of 100µM (µg/ml) against human lung cancer cell lines A459.

Anti-ulcer activity, Anti-noceptive and anti-inflammatory activity

Shrikumar and Parthasarthi [41] showed that ethyl acetate extract of *Ruellia tuberosa* has anti-ulcer property. As the economic cooperation and development guidelines, they have selected two doses 250 mg/kg (low dose) and 500 mg/kg (high dose) and Ranitidine as the standard drug (20 mg/kg). The ethyl acetate extract showed significant decrease in gastric volume, total acidity and free acidity. There was a significant ($p < 0.01$) increase in gastric pH only at high dose (500 mg/kg), when compared to control group. They further stated that the value of ulcer index decreased in a dose dependent manner, when compared to control group.

The ethanol extract of *R. tuberosa* was evaluated for its antinociceptive and anti-inflammatory properties in experimental mice and rat models. In the hot plate test, the group that received a dose of 300 mg/kg for mice showed maximum time needed for the response against thermal stimuli and maximum possible analgesic was similar to that of diclofenac sodium. The extract at 500

and 250 mg/kg doses showed significant reduction in acetic acid-induced writhing in mice, which was similar to diclofenac sodium. The extract also demonstrated significant inhibition in serotonin and egg albumin-induced hind paw edema in rats at the doses of 100, 200 and 300 mg/kg [42]. The anti-inflammatory properties exhibited by the extract were comparable to that of indomethacin at a dose of 5 mg/kg [42]. *R. brittoniana* and *R. tuberosa* were reported with significant anti-inflammatory potential [29,43].

Antispermatogenic activity and antifertility action

The aqueous extract of *R. prostrata* had a 40% antifertility action in female rats at a dose of 500 mg/kg, and the aqueous and petroleum ether extracts at a dose of 100 mg/kg had a 20% antifertility action [43]. Aqueous extract of tuberous roots of *Ruellia tuberosa* administered orally at the dose of 50, 100 and 150 mg/kg body weight for 21 days resulted in significantly decreased sperm count in male albino rats. The results suggested that the aqueous extract of *R. tuberosa* produces antispermatogenic effect in male albino rats [44].

Antidiabetic, antihyperlipidemic and hepatoprotective activity

As per the report of Rajan *et al.* [13] the methanol extract of *Ruellia tuberosa* leaves at a dose of 100 and 200 mg/kg of body weight was administered at single dose per day to diabetes-induced rats for a period of 14 days. They observed that the methanol extract of *R. tuberosa* leaves elicited significant reductions of blood glucose ($p < 0.05$), lipid parameters except HDL-C, serum enzymes and significantly increased HDL-C at the dose of 200 mg/kg when compared with the standard drug glibenclamide (5 g/kg). From this they concluded that methanol extract of *R. tuberosa* leaves possesses significant antidiabetic, antihyperlipidemic and hepatoprotective effects in alloxan-induced diabetic rats. Ullah *et al.* [21] also studied the hyperglycemic activity of different organic extracts of *R. tuberosa*. They reported that ethyl acetate fraction (100 mg/kg) showed the highest anti-diabetic activity with 34.31 ± 0.43%. The *in silico* anti-diabetic activity of aqueous extract of *R. tuberosa* was shown by Safitri *et al.* [27] and its *in vitro* proof was given by Roosdiana *et al.* [45]. The *in vitro* anti-diabetic potential of leaf extract of *R. prostrata* was confirmed through α-amylase and α-glucosidase inhibition methods [46].

Gastroprotective and analgestic activity

Aqueous extract of *R. tuberosa* roots showed a dose-dependent and robust gastroprotective activity in an alcohol induced gastric lesion model of rats. The extract also had mild erythropoietic and moderate analgesic activities and was well tolerated even with subchronic treatment [47]. Similar report was made by Roopa *et al*.[23] on aqueous extract of *R. tuberosa* showing gastroprotective and analgestic activity.

Other biological activities

In pharmacological investigation, extracts of *R. brittoniana* and *R. patula* were used for cardiovascular screening. In *in vivo* experiment, extracts of *R. brittonana* and *R. patula* showed a hypertensive activity in pentothal sodium anesthetized rats[48]. Salah *et al*.[49] demonstrated purgative effect of organic and aqueous extract of *R. praetermissa* and also reported that *R. praetermissa* has direct influence on the uterine physiology during gestation in rats; the plant extract appears to activate the myometrial cells membrane muscarinic receptors resulting in a uterotonic effect by a mode of action possibly via the cholinergic system. They further stated that the extract is possibly acting by facilitating the synthesis of endogenous estradiol which influences the stimulation of the growth of the uterine endometrium.

Methanol extract of *R. tuberosa* was investigated on uterus and gestation by using 350 mg/kg/day and was found to increase the number of implantation [13]. This study demonstrated that estrogenic effect of *R. tuberosa* extract may be due to flavonoid and sterol while cholinergic effect may be due to iridoid glycoside. Samy *et. al.,*[31] reported anti- leishmanial activity of n-hexane fraction of *R. tuberosa*.

CONCLUSION

The presented work is emphasizing on medicinal uses of different members of genus *Ruellia* and their different biological activities studied by various scientists. The discussion indicates that many members are still to be worked out for their biological activities. Secondly, the important aspect is isolation of active phytoconstituents from these members as probable agent to develop drug against specific ailments.

Conflict of Interest: The authors have no conflict of interest.

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COLLECTION AND IDENTIFICATION OF SOME WOOD DECAYING FUNGI FROM BULDHANA DISTRICT

Ms. Vrushali A. Ugale and Dr. Rasika N. Patil*

Department of Botany, Shri Shivaji College of Arts, Commerce and Science College, Akola, Maharashtra, India.

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***Corresponding Author**
Dr. Rasika N. Patil
Assistant Professor,
Department of Botany, Shri Shivaji College of Arts, Commerce and Science College, Akola, Maharashtra, India.

ABSTRACT

Fungi comprises about 80000 known species of microorganisms having great medicinal, environmental importance. Fungus is large group of eukaryotic heterotopic organisms which includes yeast, rust, mold as well as more familiar mushroom. There is a great diversity of fungi on our planet with hundreds of thousands have been describe and more than half still needing to be describe. Wood decaying fungi are not only a major element keeping forest ecosystem healthy, but they also play important role in social, economical and environmental pollution control. The basic role of wood degrading fungi in the global ecosystem is to recycle the carbon removed from the atmosphere via photosynthesis by autotrophic organisms.

KEYWORDS: Fungus, Soil Science, wood decaying, forest ecosystem, atmosphere, etc.

INTRODUCTION

Many fungi are free living in soil, water, others from parasitic, symbiotic relationship with plants or animals. Fungi is accurate in all aspects being both positive and negative roles for both nature and living beings. Some of the fungi that can be use as food like mushroom similarly yeast which is use in baking industries as well as beverages. Several fungi have medicinal properties as they can produce medicine like antibiotic ‘penicillin’ discovered from fungi *Penicillin notatum* by Alexander Fleming. While some fungi play a key role in Agriculture and forestry as mutualism or symbiosis. One of the best examples is mycorrhiza. The root of higher plants and fungus both are beneficial to each other. Plants makes foods and supplies to fungus while in return fungus supplies nutrients to plants and both of them benefited.

Lignocellulose is one of the most abundant renewable sources on earth. Saprotrophic fungi of Basidiomycetes plays an important role in recycling due to their capacity to convert complex polymeric carbohydrates component to compact plant cell wall lignicellulose into sugar and monomeric component. Factors that influenced decomposing activity of fungi during wood decayed are moisture content, oxygen concentration especially that of nitrogen. Dead wood has drastically declined from forest ecosystem because of human forest use activities. Loss of dead wood has come along with negative impact on wood inhabiting fungal communities, notable with decreasing in species richness in healthy manage forest. Dead wood is an important for carbon or nitrogen source in forest ecosystem and possibly soil is an important fungal species reservoir for wood and vice-versa.

Review of literature

A. Komonen *et al.* (2021), In this review they studied the colonization extinction dynamics of eight wood decaying fungi species in 16 old growth forest over a 20 year period. (1997-2017) Specialized wood decaying fungi can persist for decades in old growth forest fragments, if suitable dead wood is continually available.

Akpaja, *et al*. (2018) This study was carried out in order to determine the carbon/nitrogen (C/N) ratio that will give the highest mycelial extension and biomass of the mushroom *Daldinia concentrica*. A basal medium was prepared and varying ratios of carbon and nitrogen levels were prepared using glucose and yeast extract as carbon and nitrogen respectively. Carbon/ nitrogen ratio had a significant (p=0.05) effect on the vegetative growth of *Daldinia concentrica*.

Competition for iron via iron chealting compound has been recognized as an important antagonistic trait of many biological controlled agent (Neilands 1984, Leong 1986,Bossier 1988, Rane *et al.* 2005, Machuca *et. al* 2007) Wood decaying fungi like "*Trichoderma sp*" has been reported (Anke *et al.* 1991, Dutta *et al.* 2006) to produce iron chelating compound which may contribute to the biological control of wood decaying fungi.

Anna Pawlik *et al.* (Wood decaying fungi "*Cerrena sp*") *Cerrena unicolor* is wood degrading basidiomycetes with ecological and biological importance. It shows that this fungus grow in dark show a highest metabolic activity and decomposition of carbon source.(Bruce G. Marcot,) A Review of role of fungi in wood decaying of forest ecosystem :- states that fungi

are key players in health diversity and productivity of forest. ecosystem. This review covers various role and relationship of fungi in wood decaying in forest of Pacific Northwest region of the United States.

Daniel Eastwood. (2014) Evolution of fungal Wood Decay: - It consider that evolution of wood decay in the Agricomycetes and diversification of mechanism and nutritional modes from basic white rot ancestry. The evolution of fungal wood decay was an event of critical importance in maintain the planets "carbon cycle”

David lonsdale *et al*. (2007) Wood Decaying Fungi in forest: Conservation needs: wood decaying fungi are essential for functioning of forest ecosystem. Research has focused on the factors driving the species richness of wood decaying organism and is moving on to analyse effect of this species richness on ecosystem functioning.

Grant T Kirker (2018), Wood Decaying Fungi: states their importance on both economic and environmental scales. Wood decaying fungi have also uses in industrial process ranging from product development to waste breakdown. This studies also states that the role of wood decaying fungi to ecosystem in decomposition of woody material into soil.

Hanna Johannesson, (2000): Ecology of *Daldinia sp.* with Special Emphasis on *Daldinia Zoculata*. There are five distinct *Daldinia* species were identified from northern Europe: *D. concentrica, D. fissa, D. grandis, D. loculata and D. petriniae*. The last two mentioned have previously been referred to as *D. concentrica* in the literature.

These results suggest that *D. loculata* consists of a large, coherent Eurasian population of latent mycelia in unburned forests, established by ascospores dispersed from scattered burned forest sites. A tentative life cycle of D. *loculata* is presented.

Javier Ribera *et al*. (2020):- Influence of Soil Characteristics on Wood Bio deterioration by Brown Rot Fungi. Soil conditions can directly influence the inoculum potential of wood decay fungi, which is likely to be a major factor in the premature failure of utility poles across Europe. The objective of our study was to assess the influence of soil pH, humidity and iron on wood decay. For this purpose, we incubated Fe-impregnated wood specimens on artificial medium to evaluate the influence of the metal on the activity of brown rot fungi.

This study shows that the pH, humidity, iron content and selected wood preservatives greatly influence susceptibility of impregnated wood to brown rot fungi during ground contact.

Jackson Traas. (2020): This review states that three principal types of wood-degrading fungi: white-rot, brown-rot, and soft-rot. A basic role of wood-degrading fungi in forest ecosystems is to recycle the carbon stored by autotrophic organisms. Differences in the pathway through which each type of fungi degrades wood determines whether the carbon is released to the atmosphere as CO2, a greenhouse gas, or is recycled to the soil. Understanding the distribution and dominance of the different wood-decay fungi is pertinent to predicting their effect on the carbon cycle.

MATERIAL AND METHODS

Some species of wood decaying fungi growing on dead or living tree trunk from different agriculture farm sites of Buldhana district were collected. This was done during a month of January to March 2022.

All the wood decaying fungi were photographed at the sight using GPS map camera. The sample were collected and data was prepared having all detail information. This collected fungi were identified with the help of thoroughly research paper and classified with the help of Alexopolus and Mims key (1979).

IMPACTS OF WOOD DECAYING FUNGI ON ENVIRONMENT

Ecological Functions of Fungi

Fungi play a number of ecological roles in forest ecosystems that affect the health, diversity, productivity, and development of their biotic communities. Such roles include mycorrhizal associations with vascular plants, pathogens of commercial tree species, decomposers of coarse organic material, and food resources for wildlife.

Fungi as Decomposers

Fungi associated with down wood are saprobic, meaning that they derive nutrients from decaying organic materials. One such species in the Pacific Northwest is orange jelly (*Dacrymyces chrysospermus*) found on decaying logs Douglas (*Pseudotsuga meanzeisii*). Other unique fungi associated with down wood and wood decay in the Pacific Northwest are the birds nest fungus, *Nidula niveotomentosa* and the veined cup, *Disciotis venosa*. Fungi found in decaying wood, litter, and duff surve to recycle nutrients (Fogel and Hunt 1983),

particularly nitrogen and carbon as well as minerals, which can then be used by other organism. Such decomposition process also serve to physically and chemically break down soil organic matter and alter soil structure. In course down wood, wood fungi help mobilize nitrogen, phosphorus and potassium during the early decay stages (Harmon *et al.* 1994). Wood decomposition in German forest of European beech (Fagus sylvatica), in cool temperate and subalpine forests of Japan, Osono (2015) found that litter decomposition was more affected by the presence of specific fungal families than by the type of litter. Fungi of Basidiomycetes had higher rates of lignin breakdown than dead fungi of Xylariace.

In studying the role of fungi in decomposition. They also found that ascomycete fungi likely play a prominent role in wood decay, but stated that further testing is needed, and that better under-standing of the fungal roles in wood decay can help improve estimates of carbon sequestration of forests.

Fungi as Non timber

Many fungi—particularly aboveground fruiting mushrooms such as chanterelles, morels, matsutake, boletes, truffles, *Ganoderma* (reishi), and others—are sought as food sources, for medicinal use, and by recreational collectors in an expanding industry. (Amaranthus and Pilz 1996, Molina *et al.* 1993, Pilz *et al.* 1998, Schlosser and Blatner 1995). Kucuker and Baskent (2017)

Fungi as Food Resources for Wildlife

Fungi themselves are ingested by a wide variety of invertebrate and vertebrate wildlife (Fogel and Trappe 1978, Ingham and Molina 1991, Maser *et al.* 1978). Furniss and Carolin (1980) provided a number of examples of insect associations with fungi in forests of the Western United States, as follows. Bark beetles are associated with trees weakened or killed by root-rotting fungi such as Porioa root rot (Phellinus weirii), Annosus root rot (Fomesannosus), and shoestring rot (*Armillaria mellea* and *Phytophthora lateralis*). Ambrosia beetles in particular disperse, introduce, and feed on ambrosia fungi (Ambrosiella and Raffaelea) and can be highly fungi species-specific subterranean termites that comminute (chew) wood fiber are attracted to the wood-decaying fungus *Lenzites trabea*. Among invertebrates associated with yeasts are round headed beetles (*Dendroctonus sp*.), bark beetles, and carpenter ants (*Camponotus sp*.). Silver fir beetles (*Pseudohylesinus sericeus*) can be commonly associated with brown-stain fungi and root-rotting fungi, including *Armillaria mellea, Fomes annosus,* and *Phellinus weirii*.

Medicinal Uses

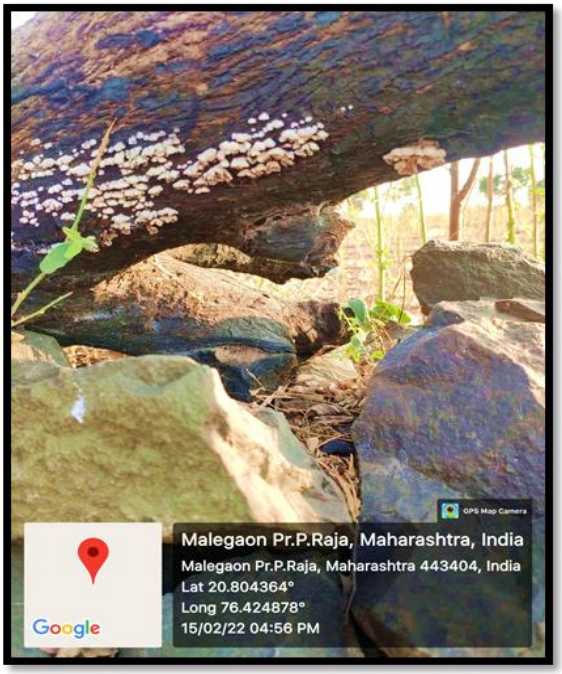
The common wood decaying fungi like *Trametes sp* produce peptide linked polysaccharides as an adjuvant with traditional chemotherapy to reduce rates of tumor growth and to reduce side effects of chemical treatment. (K. Smith 2018). Pathologists and land managers need to be concerned with effects of wood decay on the yield of goods and services. Interestingly, the effects of fungi may be positive and beneficial as well as potentially negative and costly.

OBSERVATIONS AND RESULTS

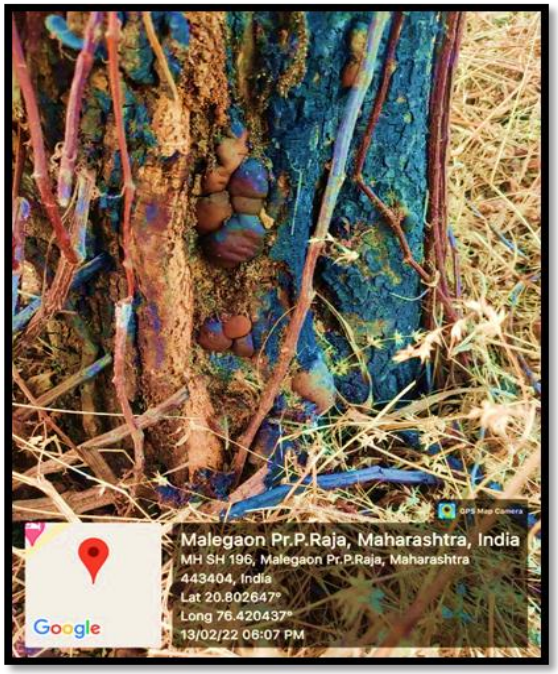
Common Name	Scientific Name	Family Name	Locality	Edibility	Morphology / Occurrence
Mossy maze Polypore	***Cerrena sp.***	Cerrenaceae	Rasulpur	Non-edible	Parasitic or saprobic forming overlapping clusters, most often on deciduous tree, stumps and logs.
Cramp balls or coal fungus	***Daldinia sp.***	Hypoxylaceae (Xylariaceae)	Malegaon	Nonedible	Fruiting bodies formed hard rounded dark brown balls that turns black with age, saprobic living on dead and decay wood. May types of insects and other small animals make their home inside the species of fungi.
Agrikon (bracket fungus)	***Fomitopsis sp.***	Fomitopsidaceae	Malegaon	Edible	Fruiting bodies grow in large conks on the trunks of trees, young fruiting bodies are soft, yellow – white soon hardening and becoming a chalky throughout, wood inhabiting parasitic fungus.
Reishi in Japan, Lingzhi in China	***Ganoderma sp.***	Ganodermataceae	Malegaon	Non-edible	Saprobic or parasitic growing alone on decaying hardwood logs, stumps. It is beautiful polypore having deep red cap has lacquered looking upper surface. Upper surface being shing as if varnished due to presence of amorphous waxy substance secreted by hyphae. Fruiting bodies of this genus are either sessile or stipitate.
Shaggy bracket	***Inonotus sp.***	Hymenochaetaceae	Malegaon	Non-edible	Occurs mainly on trunk of broad trees, saprobic in nature, having pale creamy brown colour. As fungus mature, it begins to dry out

					and in turn hardens.
Hexagonal pored polypore OR Dryad's saddle OR Pheasant's back	***Polyporus sp.***	Polyporaceae	Malegaon	Edible	Saprobic, solitary to grouped on fallen branched of deciduous trees. Many pores with small pits. Fungus can grow to be quite large and stick out as shelves from side of trees near base, fruiting bodies are durable.
Common spilt gill	***Schizopyllum sp.***	Schizophyllaceae	Malegaon	Edible	Most common, ubiquitous fungus well known as wood decay organism able to cause white rot. The mushrooms can remains dry for decades and then revived with moisture. They grow in shelf like arrangements, without stalks.
Gilled polypores OR Bracket fungus OR Turkey tail fungus OR many zone polypore	***Trametes sp.***	Polyporaceae	Malegaon	Non-edible	Multicolour gilled polypore or birch mazegill, fruiting bodies have gills instead of spores, produce small size semi-circular bracket on wood. Finely velvety cap surface, saprobic fungi, growing in clusters on logs, stump, downed branches. Thin, flexible, silky, hairy or pale straw colour with wide pores fused in clusters on side or top of fallen tree trunk. This is thin, leathery fungus. Grows on standing and fallen dead wood of deciduous trees, much more consistent in its general appearance. Fruiting bodies of fungi are thin in section. Typically yellowish orange in colour. It is most obvious in the winter month when deciduous tree are bare. This variable fungus grows mainly on dead hard wood including stumps and standing dead trees as well as fallen branches.

IMAGES OF WOOD DECAYING FUNGI

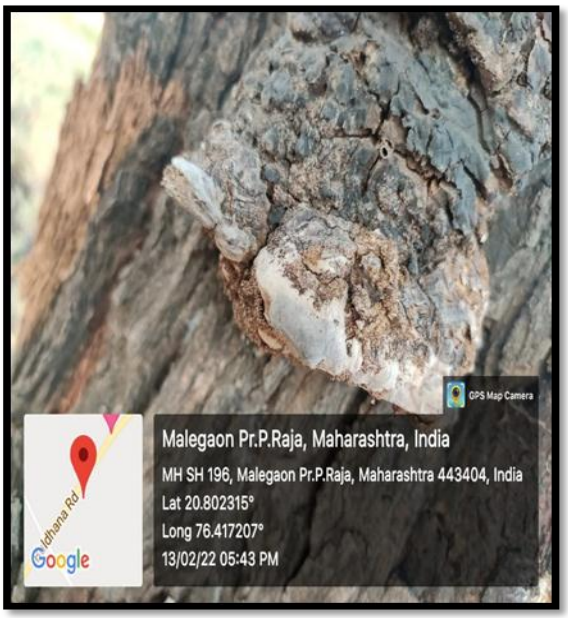


Cerrena sp.

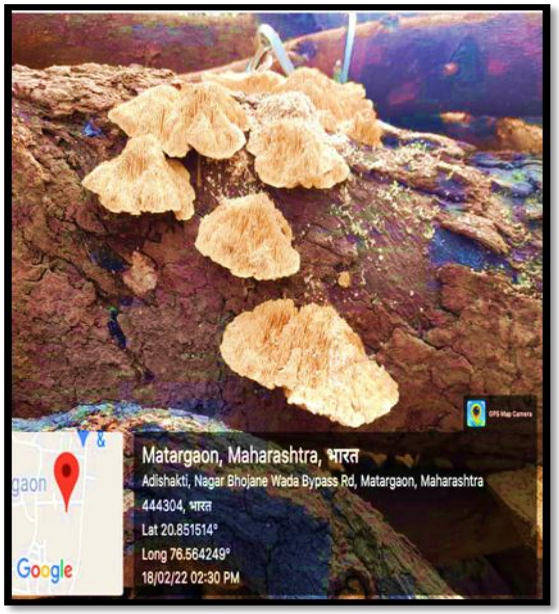


Daldinia sp.

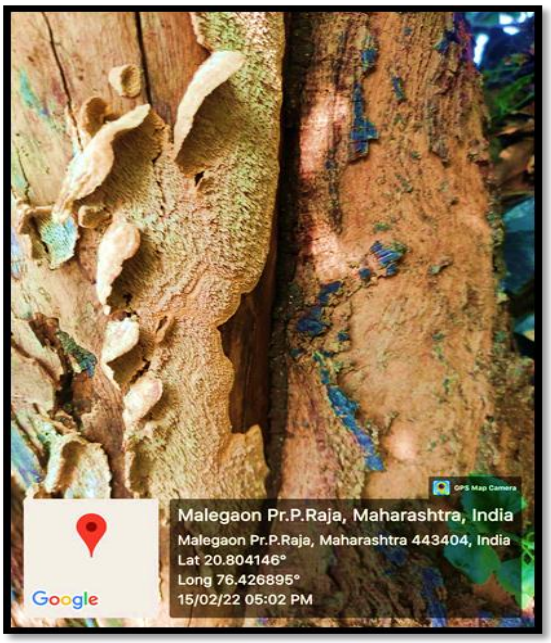
Fomitopsis sp.



Ganoderma sp.



Trametes sp. ***Inonotus sp.***



Polyporus sp. ***Schizopyllum sp***.

CONCLUSION

Presence of dead and decaying wood is a functional requirement not only for the animal wildlife, but also for trees. Process of decaying is different in various wood logs. Besides the microbes some invertebrates are also associated with decaying process.

Fungi is also responsible for wood decaying process but majority of wood decaying fungi are belonging from Division '**Basidiomycota**', due to their higher ability of breakdown of lignin

and cellulose as compared with others. It gives various applications and acknowledgement of their functions in wood decay process.

Decaying logs create difference in substrate, in turn different micro – sites allow species with different niche requirement to co-exist, thus influencing future stands composition. So more study are needed to quantify the amount of down woods.

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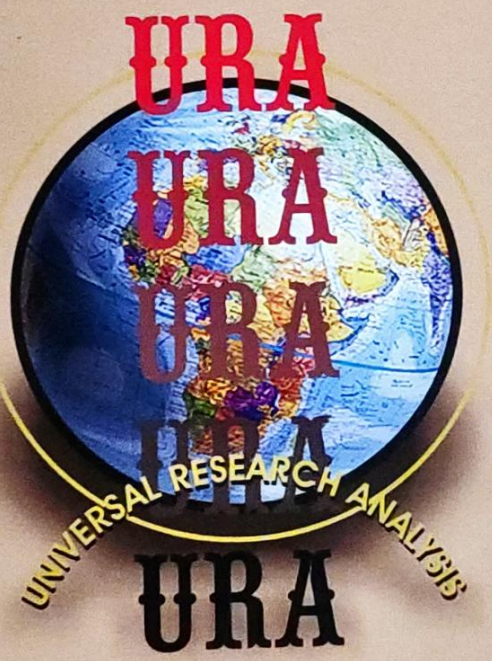

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INDEX

Sr. No	Title for Research Paper	Page No
1	Performance of Restructured Weather Based Crop Insurance in India **Dr. A. M. Raut, S. M. Shegokar**	1
2	Opportunities &Challenges A Dgital Payment In India **Dr. Balasaheb V. Maind**	14
3	Image of Women in Post-Independence English Novel : A Study of Selected Women Novelist **Vedant Prakash Deshmukh**	23
4	Smart Agricultural Robot for Spraying Pesticide with Image Processing based Disease Classification Technique **Prajakta M. Balgure, A. K. Tamboli**	28
5	The Geographical Study of the Main Causes of the River Floods in Maharashtra: Climate Change, Contraction of River, Sludge Accumulation **Rajendra D. Khurche**	39
6	Synthesis and gas Sensing Properties of Substituted Lithium Ferrites **S. A. Masti, V. S. Sawant**	48
7	Liberalization, Privatatization and Globalization : Opportunities and Challenges **Dr. Maroti T. Ghantewad**	55
8	भारतातील कुपोषण समस्या : एक अभ्यास **डॉ. यु. टी. गायकवाड**	62
9	मराठवाडयातील जिल्हानिहाय माशाचे उत्पादन व उत्पादन वाढ (२०००-१० ते २०१०-२०) **डॉ. एच. बी. राठोड, विठ्ठल गोविंद चव्हाण**	68
10	बीड जिल्ह्यातील शेतीच्या समस्या : एक भौगोलिक अभ्यास **जगन्नाथ चव्हाण**	72

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1

Performance of Restructured Weather Based Crop Insurance in India

Dr. A. M. Raut
Dept. of Commerce,
Shri Shivaji Arts, Commerce & Science College, Akot, Dist. Akola

S. M. Shegokar
Dept. of Commerce,
Shri Shivaji Arts, Commerce & Science College, Akot, Dist. Akola

Research Paper - Commerce

Introduction:

According to food and agriculture organisation of united nations (FAO), agriculture is deeply rooted in to the Indian economy contributing 23 percent in gross domestic product and generating 59 percent employments of the country's total workforce. Although, agriculture has been the backbone of Indian economy, it faced many risks like frequent droughts, irregular and unequal rainfalls, increase in global temperature, floods, hurricanes, lack or widespread of technology, market risk, price fluctuation of crop's production. Farmers face problems in agriculture farming like a variety of weather, pest, disease, input supply and market related risk and many more. Due to these problems the incomes of farmers become indeterminate every year. Uncertainty in farming income, farmers worry about their ability to repay debt, to meet overhead costs, their ability to meet essential living costs for their families. For reducing risks and problems in agriculture farming crop insurances help the farmers. It provides financial support to the farmers in the event of crop failure as well as help in maintaining flow of agricultural credit. Indian government provided various crop insurance schemes to cope with the different risks in agriculture sector. To provide cover to weather risk in agriculture farming, Weather-Based Crop Insurance Scheme (WBCIS) introduced by the government in the year 2007. It provides cover to theadverse conditions of weather parameters like rainfall including deficit rainfall, excess rainfall, unseasonal rainfall, rainy days, dry-spell, dry days, temperature high & low, frost, relative humidity, wind speed, hailstorm, cloud burst etc as

wolves it provides cover to all farmers including sharecroppers and tenant farmers growing notified crops in the notified areas. This scheme covered major food crops such as cereals, millets & pulses and oilseeds, commercial and horticulture crops. In 2016, Restructured Weather Based Crop Insurance Scheme (RWBCIS) is launched. 16,28,796 farmers were benefitted against 21, 63, 942 applications of farmers till 2019 by this scheme. The research study is to review and analyse performance of WBCIS and RWBCIS crop insurance scheme in India.

Need for the study:

Although India is largest producer country of pulses jute, rice, wheat, sugarcane, cotton and groundnuts fruits, vegetables etc., weather risks remain one of the major constraints limiting production and development of the agricultural sector. In adding to this major of portion of population are dependent on rain fed farming for their livelihood. So proposed research study aims at addressing issues as to how to extend the financial risk covered by the weather-based crop insurance. And yet, these weather risks are attributed to negative impact on agricultural sector, weather-based crop insurance has emerged as new weather risk management tool. So, study is proposed to review and analyse the weather-based crop insurance product helps to mitigate the risks in agriculture.

Objectives of the Study:

For the present study, following specific objectives have been framed.

1. To review the impact of weather-based crop insurance scheme.
2. To analyse performance of weather-based crop insurance scheme on agriculture.

Hypotheses of the Study:

1. The performance of RWBCIS is positive.
2. There is no difference in number of farmer's applications & number of farmers benefited against paid claims.

Research Methodology:

The study is based on secondary data of RWBCIS which published on the web portal of agriculture insurance of India. The time span of the data is from 2016 to 2020. For the presentation purpose, bar and line charts is used. To analyse data, percentage, data descriptors and Wilcoxon rank sum test are used.

Analysis of Data:

Table no. 1 Year and Season wise Number of Loanee Farmers Applications

Year	Season name	Number of Loanee Farmer Applications	Number of Non Loanee Farmer Applications
2016	Kharif	63676	8454
2017	Kharif	118779	5541
2018	Kharif	632283	14855
2019	Kharif	184198	83946
2020	Kharif	139000	86183

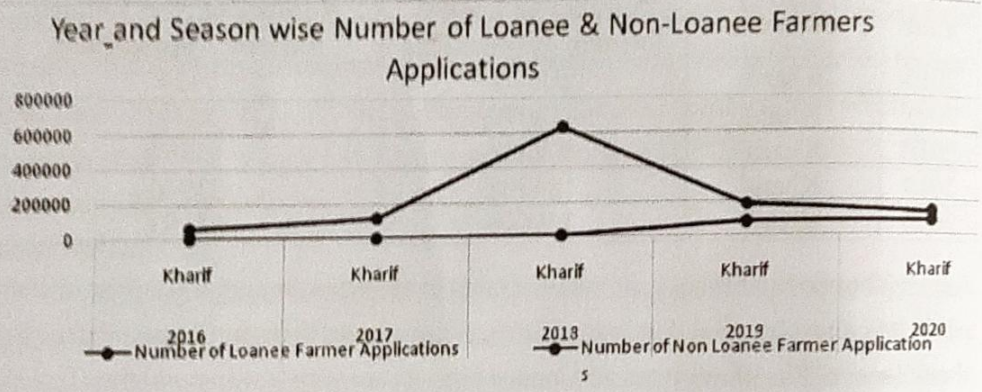
The above table no. 1 showed that number of loanee farmers are highest in kharif 2018. It is also observed that loanee farmers are greater than non-loanee farmers in kharif season. First three years non loanee farmers are very low insured than last two years of given period.

Table No. 2 Data Descriptors of Year and Season wise Number of Loanee and Non-Loanee Farmers Applications

Name of Technique	Mean	Median	Maximum	Mini mum	Std. Deviation	Skew ness	Kur tosis
Number of Loanee Farmer Applications	227587.2	139000	632283	63676	230334.0569	2.04	4.32
Number of Non Loanee Farmer Applications	39795.8	14855	86183	5541	41469.13231	0.58	-3.28

The above table no. 2 showed that descriptive statistics of the year wise and season wise number of loanee and non-loanee farmers applications. Mean and median of non- loanee farmers are lower than loanee farmers. Skewness value of Loanee farmers is above than one i.e., showing the greater asymmetrical distribution of data while the value of non-loanee farmers is below than one showing the approximately symmetrical distribution of data.

Chart no. 1 Year and Season wise Number of Loanee & Non-Loanee Farmers Applications



The above chart no. 1 pictured that upper curve belongs to the loanee farmers and lower curve belong to the non-loanee farmers showing number of farmers insured. The number of loanee farmers had greater in number to register themselves to WBCIS. In kharif 2016-2020 seasons, all farmers insured were below than average except season 2018.

Table no. 3 Year and Season wise Number of Loanee Farmers Applications&Number of Non Loanee Farmer Applications

Year	Season name	Number of Loanee Farmer Applications	Number of Non Loanee Farmer Applications
2016	Rabi	72009	3101
2017	Rabi	58927	13597
2018	Rabi	184288	119989
2019	Rabi	284986	165240
2020	Rabi	109842	53602

The above table no. 3 showed that number of loanee farmers applications are greater than number of non- loanee farmers applications. In 2017, loanee farmer applications were lowest in numbers. In the rabi season 2016, number of non- loanee farmer applications were below than half of in numbers of loanee farmer applications. The growth was showing in the non-loanee farmers types in applications but again it

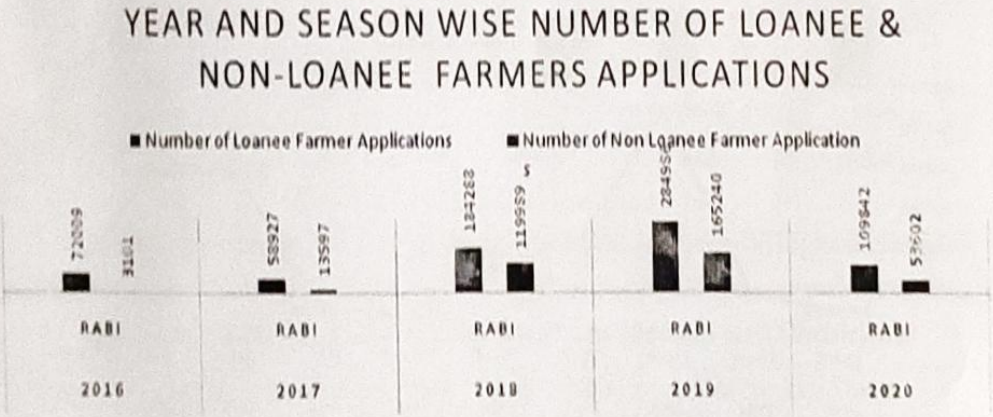
declined.

Table no. 4 Data Descriptors for Year and Season wise Number of Loanee Farmers Applications

Name of Technique	Mean	Median	Maximum	Minimum	Std. Deviation	Skewness	Kurtosis
Number of Loanee Farmer Applications	142010.4	109842	284986	58927	93631.286 14	1.0398063 63	0.0311903 16
Number of Non Loanee Farmer Applications	71105.8	53602	165240	3101	69801.706 22	0.5401679 2	1.8576529 2

The above table showed that averages for non- loanee farmers are lower than loanee farmer applications i.e., slightly higher than half of loanee farmers. The number of loanee farmer application are skewed than non-loanee farmers application.

Chart no. 2 Year and Season wise Number of Loanee& Non-Loanee Farmers Applications



The above chart no. 2 pictured that number of applications were wavy loanee farmers while non-loanee farmer applications had gradual positive slop towards right but it again in 2020 declined.

Table no. 5 Year wise and Season wise Area Insured

Year	Season name	Area Insured (Ha.)	Percentage changes
2016	Kharif	44516.68	...
2017	Kharif	86108.09	193.43
2018	Kharif	539732.4	1212.43
2019	Kharif	220334.1	494.95
2020	Kharif	147627.2	331.62
2016	Rabi	31907.34	71.68
2017	Rabi	43216.68	97.08
2018	Rabi	382265.6	858.70
2019	Rabi	381699	857.43
2020	Rabi	95938.55	215.51

The above table no.5 showed that year wise and season wise area insured in hectors. Percentage changes showed that in kharif seasons, growth found in area insured in 2017 & 2018 then growth declined in 2019 & 2020. In rabi seasons, growth found in area insured in first four years then it declined.

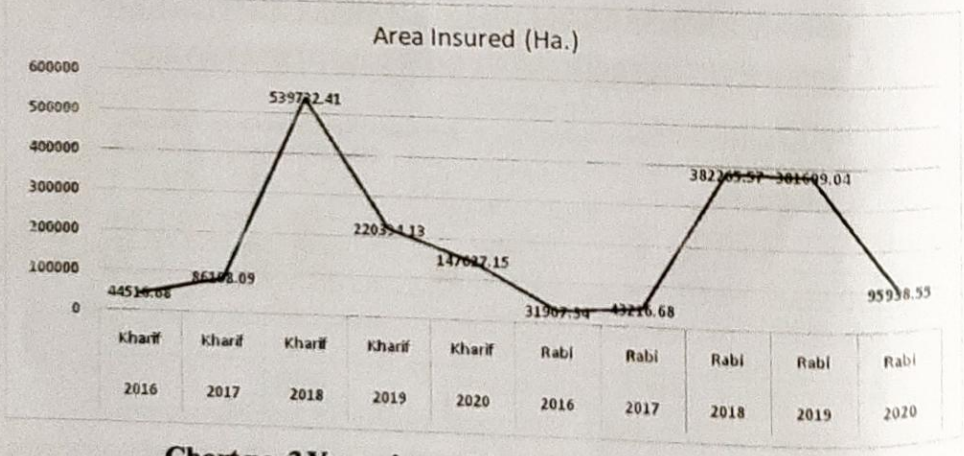


Chart no. 3 Year wise and Season wise Area Insured

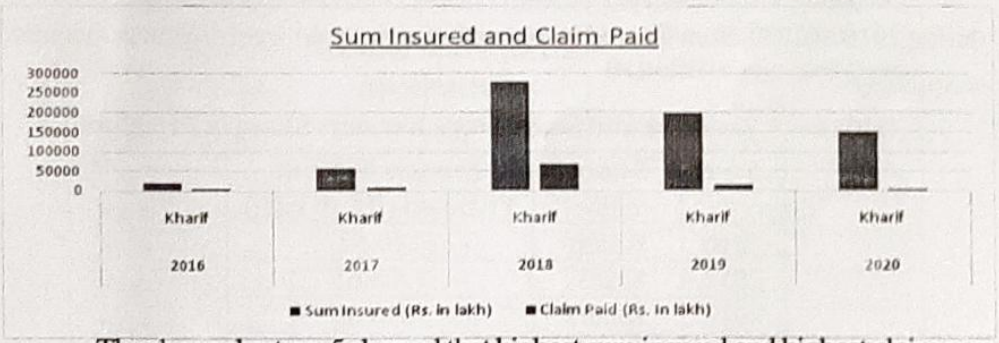
The above chart showed that kharif 2018 and Rabi 2018, 2019 had greater area insured than another year. Meanwhile kharif 2016, 2017, 2019, 2020 rabi 2016, 2017, 2020 had lower area insured in hectors.

Table no. 6 Year wise and Season wise Sum Insured and Claim Paid

Year	Season name	Sum Insured (Rs. in lakh)	Claim Paid (Rs. In lakh)	Percentage sum insured to claim paid
2016	Kharif	19632.27	6547.92	33.35%
2017	Kharif	57799.85	9144.98	15.82%
2018	Kharif	280366.5	68866.46	24.56%
2019	Kharif	200566.5	14481.82	7.22%
2020	Kharif	152165.5	2661.18	1.75%

The above table no. 6 tabulated that sum insured and claim paid to the farmers. Sum assured increased during first three years then it declined two years but diminished sum is not less than first two years. It showed the better coverage of crop insured. The claim paid data showed that only in 2018, claims paid to the farmers were in highest in rupees and lowest in 2020. Percentage sum insured to claim paid data showed that only 2016 kharif season had highest pay-out percentages.

Chart no. 5 Year wise and Season wise Sum Insured and Claim Paid



The above chart no. 5 showed that highest sum insured and highest claim pay-out in 2018. Sum insured in 2019 and 2020 is high but claim paid are not much accordingly.

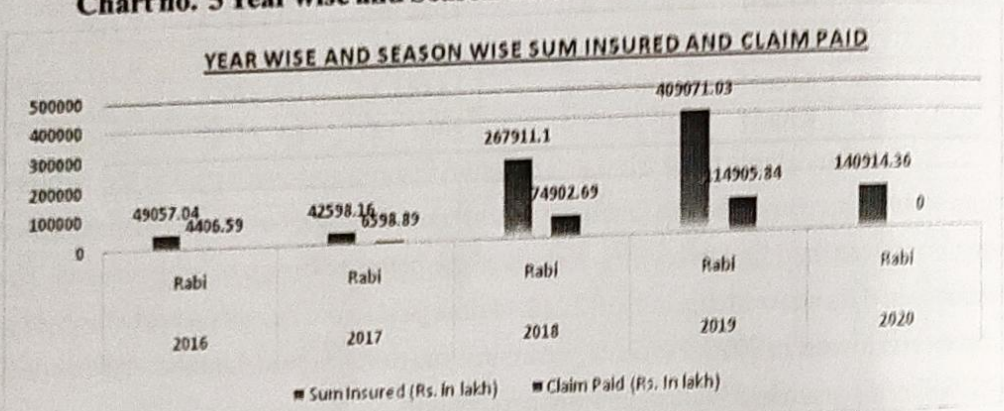
Table no. 7 Year wise and Season wise Sum Insured and Claim Paid

Year	Season name	Sum Insured (Rs. in lakh)	Claim Paid (Rs. In lakh)	Percentage sum insured to claim paid
2016	Rabi	49057.04	4406.59	8.98
2017	Rabi	42598.16	6598.89	15.49
2018	Rabi	267911.1	74902.69	27.96
2019	Rabi	409071	114905.84	28.09
2020	Rabi	140914.4	NA*	....

*NA= Not Available

The above table showed that Sum Insured and Claim Paidin 2019 higher than 2016 to 2018 period. Percentage sum insured to claim paid in 2019 is also high.

Chart no. 5 Year wise and Season wise Sum Insured and Claim Paid



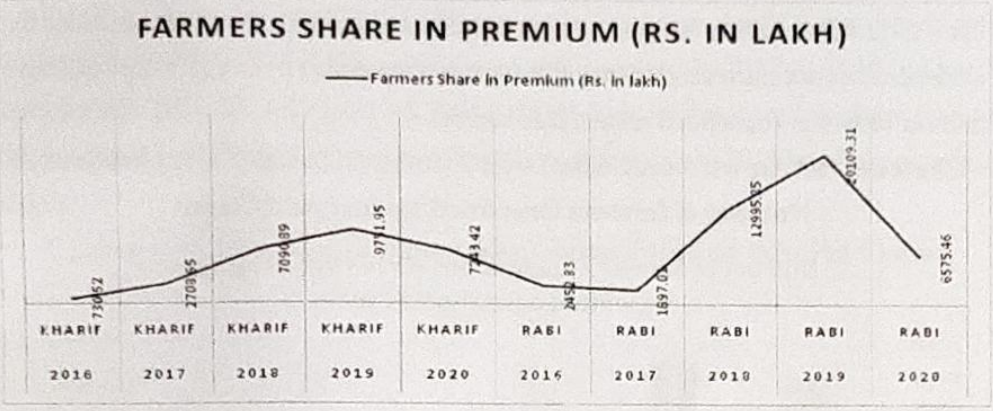
The above chart no. plotted that sum insured and claim paid in rabi seasons during 2016 to 2020. Sum insured increased but claim paid were not much increased accordingly.

Table no. 8 Year wise and Season wise Farmers Share in Premium

Year	Season name	Farmers Share in Premium (Rs. in lakh)
2016	Kharif	730.52
2017	Kharif	2708.65
2018	Kharif	7090.89
2019	Kharif	9751.95
2020	Kharif	7243.42
2016	Rabi	2452.83
2017	Rabi	1897.01
2018	Rabi	12995.85
2019	Rabi	20109.31
2020	Rabi	6575.46

The above table showed that year wise and season wise farmers share in premium. In kharif 2017, 2018, 2019 famers share premium increased then it reduced in kharif 2020. It was increased in rabi 2018, 2019 while 2017 and 2020 it showed decrease.

Chart no. 5 Year wise and Season wise Farmers Share in Premium



In the above chart no. 5 picturised that farmers share premium in rabi season was fast increased than kharif season. It was highest in rabi 2019 than given years.

Table no. 9 Year wise and Season wise Number of Farmer's Applications & Number of farmers Benefitted against paid Claims

Year	Season name	Number of Farmer's Applications	No. of farmers Benefitted against paid Claims
2016	Kharif	72130	65451
2017	Kharif	124320	113647
2018	Kharif	647138	643865
2019	Kharif	268144	91306
2020	Kharif	225183	19303
2016	Rabi	75110	45655
2017	Rabi	72524	62603
2018	Rabi	304277	281274
2019	Rabi	450226	351347
2020	Rabi	163444	NA

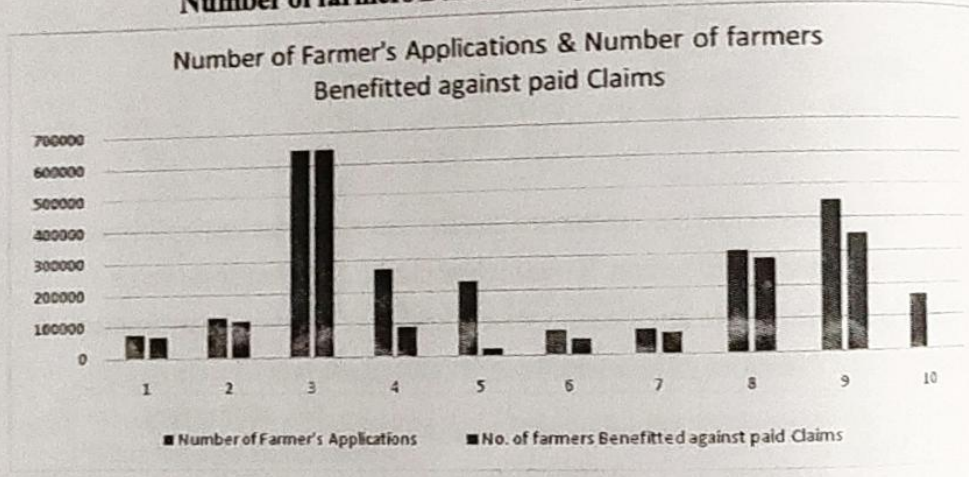
The above table showed that number of farmers applications increased in kharif 2017, 2018 and rabi 2018, 2019 but in other years it was decreased.

Wilicoxon Rank Sum Test

Significance Level	0.05
Z cri	1.65
Z cal	1.19
n	9

The value of Wilicoxon Rank Testfor two tailed test calculated "z" (1.19) is less than "z" (1.65) critical value. So,null hypothesis is not rejected. Here, we concluded that evidence does not show asignificant difference in the number of farmer's applications & number of farmers benefitted against paid claims.

Chart no. 10 Year wise and Season wise Number of Farmer's Applications & Number of farmers Benefitted against paid Claims



The above chart no. 10 showed that number of farmer's applications increased as well as number of farmers benefitted against paid claims also increased kharif 2019, 2020.

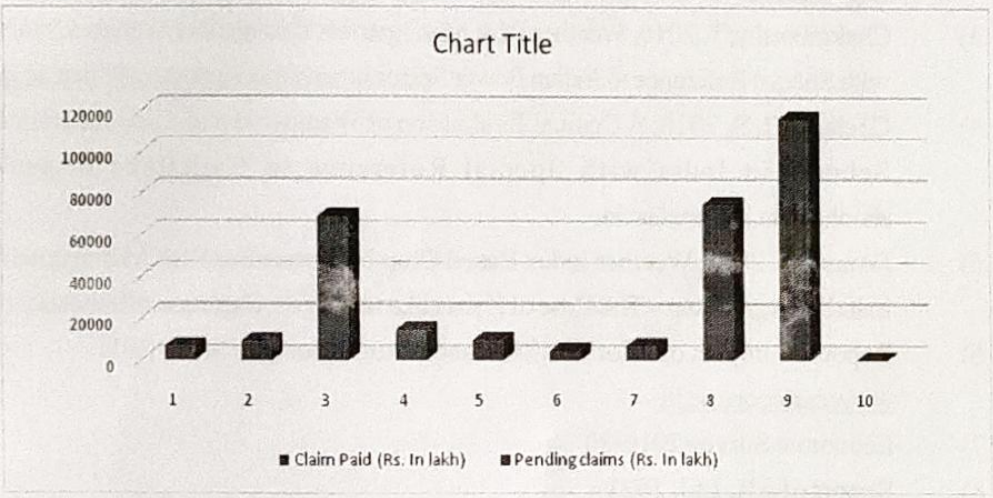
Table no. 10 Year wise and Season wise Claims Paid and Pending Claims

Year	Season name	Claim Paid (Rs. In lakh)	Pending claims (Rs. In lakh)
2016	Kharif	6547.92	0
2017	Kharif	9144.98	0
2018	Kharif	68866.46	155.71
2019	Kharif	14481.82	152.34
2020	Kharif	2661.18	6899.64
2016	Rabi	4406.59	0
2017	Rabi	6598.89	47.96
2018	Rabi	74902.69	4.67
2019	Rabi	114905.8	1532.23
2020	Rabi	NA*	NA*

NA=not available

The above table showed that claims paid and pending claims during kharif and rabi seasons 2016 to 2020. Claim paid amount increased in 2017 & 2018 in kharif season while 2019 & 2020 declined. Rabi seasons showed the growth in claim paid to the farmers. Kharif 2020 had huge pending claim while in rabi 2019 had huge pending claims.

Chart no. 8 Year wise and Season wise Claims Paid and Pending Claims



The above chart showed that kharif 2020 has shown more pendency of claims than any season and years.It showed that this scheme is have a positive performance.

Conclusions:

It was found from the analysis about performance of RWBCIS at all India level that, RWBCIS in terms of parameters like number of farmers covered, areas insured have registered positive growth. The Wilicoxon test results indicates that, null hypothesis, there is no significant difference in in the number of farmer's applications & number of farmers benefitted against paid claims, accepted. So here is concluded that over a period of time scheme's growth rate has increased and this shows the utilizing this risk management tool, can serve the farming community against production risk in agriculture.

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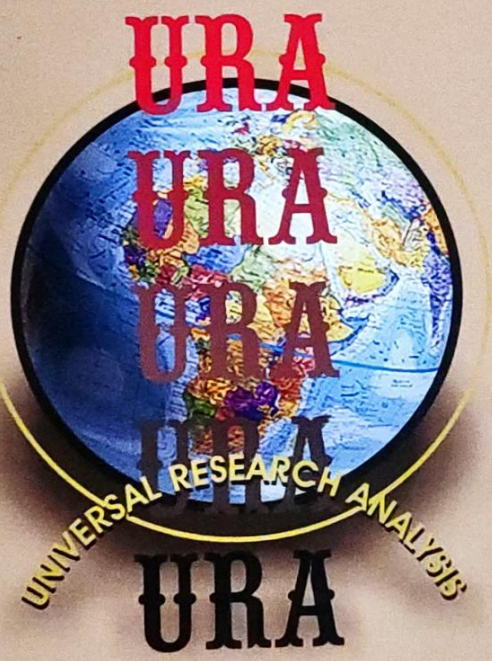

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INDEX

Sr. No	Title for Research Paper	Page No
1	Performance of Restructured Weather Based Crop Insurance in India **Dr. A. M. Raut, S. M. Shegokar**	1
2	Opportunities &Challenges A Dgital Payment In India **Dr. Balasaheb V. Maind**	14
3	Image of Women in Post-Independence English Novel : A Study of Selected Women Novelist **Vedant Prakash Deshmukh**	23
4	Smart Agricultural Robot for Spraying Pesticide with Image Processing based Disease Classification Technique **Prajakta M. Balgure, A. K. Tamboli**	28
5	The Geographical Study of the Main Causes of the River Floods in Maharashtra: Climate Change, Contraction of River, Sludge Accumulation **Rajendra D. Khurche**	39
6	Synthesis and gas Sensing Properties of Substituted Lithium Ferrites **S. A. Masti, V. S. Sawant**	48
7	Liberalization, Privatatization and Globalization : Opportunities and Challenges **Dr. Maroti T. Ghantewad**	55
8	भारतातील कुपोषण समस्या : एक अभ्यास **डॉ. यु. टी. गायकवाड**	62
9	मराठवाडयातील जिल्हानिहाय माशाचे उत्पादन व उत्पादन वाढ (२०००-१० ते २०१०-२०) **डॉ. एच. बी. राठोड, विठ्ठल गोविंद चव्हाण**	68
10	बीड जिल्ह्यातील शेतीच्या समस्या : एक भौगोलिक अभ्यास **जगन्नाथ चव्हाण**	72

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1

Performance of Restructured Weather Based Crop Insurance in India

Dr. A. M. Raut
Dept. of Commerce,
Shri Shivaji Arts, Commerce & Science College, Akot, Dist. Akola

S. M. Shegokar
Dept. of Commerce,
Shri Shivaji Arts, Commerce & Science College, Akot, Dist. Akola

Research Paper - Commerce

Introduction:

According to food and agriculture organisation of united nations (FAO), agriculture is deeply rooted in to the Indian economy contributing 23 percent in gross domestic product and generating 59 percent employments of the country's total workforce. Although, agriculture has been the backbone of Indian economy, it faced many risks like frequent droughts, irregular and unequal rainfalls, increase in global temperature, floods, hurricanes, lack or widespread of technology, market risk, price fluctuation of crop's production. Farmers face problems in agriculture farming like a variety of weather, pest, disease, input supply and market related risk and many more. Due to these problems the incomes of farmers become indeterminate every year. Uncertainty in farming income, farmers worry about their ability to repay debt, to meet overhead costs, their ability to meet essential living costs for their families. For reducing risks and problems in agriculture farming crop insurances help the farmers. It provides financial support to the farmers in the event of crop failure as well as help in maintaining flow of agricultural credit. Indian government provided various crop insurance schemes to cope with the different risks in agriculture sector. To provide cover to weather risk in agriculture farming, Weather-Based Crop Insurance Scheme (WBCIS) introduced by the government in the year 2007. It provides cover to theadverse conditions of weather parameters like rainfall including deficit rainfall, excess rainfall, unseasonal rainfall, rainy days, dry-spell, dry days, temperature high & low, frost, relative humidity, wind speed, hailstorm, cloud burst etc as

wolves it provides cover to all farmers including sharecroppers and tenant farmers growing notified crops in the notified areas. This scheme covered major food crops such as cereals, millets & pulses and oilseeds, commercial and horticulture crops. In 2016, Restructured Weather Based Crop Insurance Scheme (RWBCIS) is launched. 16,28,796 farmers were benefitted against 21, 63, 942 applications of farmers till 2019 by this scheme. The research study is to review and analyse performance of WBCIS and RWBCIS crop insurance scheme in India.

Need for the study:

Although India is largest producer country of pulses jute, rice, wheat, sugarcane, cotton and groundnuts fruits, vegetables etc., weather risks remain one of the major constraints limiting production and development of the agricultural sector. In adding to this major of portion of population are dependent on rain fed farming for their livelihood. So proposed research study aims at addressing issues as to how to extend the financial risk covered by the weather-based crop insurance. And yet, these weather risks are attributed to negative impact on agricultural sector, weather-based crop insurance has emerged as new weather risk management tool. So, study is proposed to review and analyse the weather-based crop insurance product helps to mitigate the risks in agriculture.

Objectives of the Study:

For the present study, following specific objectives have been framed.

1. To review the impact of weather-based crop insurance scheme.
2. To analyse performance of weather-based crop insurance scheme on agriculture.

Hypotheses of the Study:

1. The performance of RWBCIS is positive.
2. There is no difference in number of farmer's applications & number of farmers benefited against paid claims.

Research Methodology:

The study is based on secondary data of RWBCIS which published on the web portal of agriculture insurance of India. The time span of the data is from 2016 to 2020. For the presentation purpose, bar and line charts is used. To analyse data, percentage, data descriptors and Wilcoxon rank sum test are used.

Analysis of Data:

Table no. 1 Year and Season wise Number of Loanee Farmers Applications

Year	Season name	Number of Loanee Farmer Applications	Number of Non Loanee Farmer Applications
2016	Kharif	63676	8454
2017	Kharif	118779	5541
2018	Kharif	632283	14855
2019	Kharif	184198	83946
2020	Kharif	139000	86183

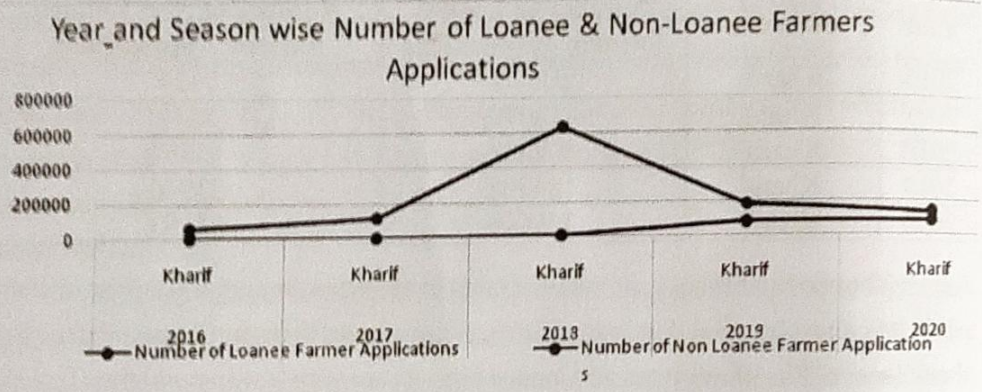
The above table no. 1 showed that number of loanee farmers are highest in kharif 2018. It is also observed that loanee farmers are greater than non-loanee farmers in kharif season. First three years non loanee farmers are very low insured than last two years of given period.

Table No. 2 Data Descriptors of Year and Season wise Number of Loanee and Non-Loanee Farmers Applications

Name of Technique	Mean	Median	Maximum	Mini mum	Std. Deviation	Skew ness	Kur tosis
Number of Loanee Farmer Applications	227587.2	139000	632283	63676	230334.0569	2.04	4.32
Number of Non Loanee Farmer Applications	39795.8	14855	86183	5541	41469.13231	0.58	-3.28

The above table no. 2 showed that descriptive statistics of the year wise and season wise number of loanee and non-loanee farmers applications. Mean and median of non- loanee farmers are lower than loanee farmers. Skewness value of Loanee farmers is above than one i.e., showing the greater asymmetrical distribution of data while the value of non-loanee farmers is below than one showing the approximately symmetrical distribution of data.

Chart no. 1 Year and Season wise Number of Loanee & Non-Loanee Farmers Applications



The above chart no. 1 pictured that upper curve belongs to the loanee farmers and lower curve belong to the non-loanee farmers showing number of farmers insured. The number of loanee farmers had greater in number to register themselves to WBCIS. In kharif 2016-2020 seasons, all farmers insured were below than average except season 2018.

Table no. 3 Year and Season wise Number of Loanee Farmers Applications&Number of Non Loanee Farmer Applications

Year	Season name	Number of Loanee Farmer Applications	Number of Non Loanee Farmer Applications
2016	Rabi	72009	3101
2017	Rabi	58927	13597
2018	Rabi	184288	119989
2019	Rabi	284986	165240
2020	Rabi	109842	53602

The above table no. 3 showed that number of loanee farmers applications are greater than number of non- loanee farmers applications. In 2017, loanee farmer applications were lowest in numbers. In the rabi season 2016, number of non- loanee farmer applications were below than half of in numbers of loanee farmer applications. The growth was showing in the non-loanee farmers types in applications but again it

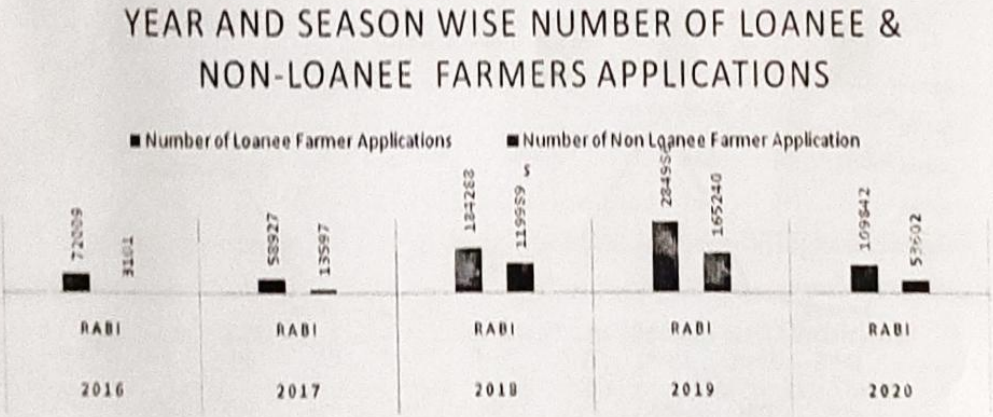
declined.

Table no. 4 Data Descriptors for Year and Season wise Number of Loanee Farmers Applications

Name of Technique	Mean	Median	Maximum	Minimum	Std. Deviation	Skewness	Kurtosis
Number of Loanee Farmer Applications	142010.4	109842	284986	58927	93631.286 14	1.0398063 63	0.0311903 16
Number of Non Loanee Farmer Applications	71105.8	53602	165240	3101	69801.706 22	0.5401679 2	1.8576529 2

The above table showed that averages for non- loanee farmers are lower than loanee farmer applications i.e., slightly higher than half of loanee farmers. The number of loanee farmer application are skewed than non-loanee farmers application.

Chart no. 2 Year and Season wise Number of Loanee& Non-Loanee Farmers Applications



The above chart no. 2 pictured that number of applications were wavy loanee farmers while non-loanee farmer applications had gradual positive slop towards right but it again in 2020 declined.

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2017	Rabi	43216.68	97.08
2018	Rabi	382265.6	858.70
2019	Rabi	381699	857.43
2020	Rabi	95938.55	215.51

The above table no.5 showed that year wise and season wise area insured in hectors. Percentage changes showed that in kharif seasons, growth found in area insured in 2017 & 2018 then growth declined in 2019 & 2020. In rabi seasons, growth found in area insured in first four years then it declined.

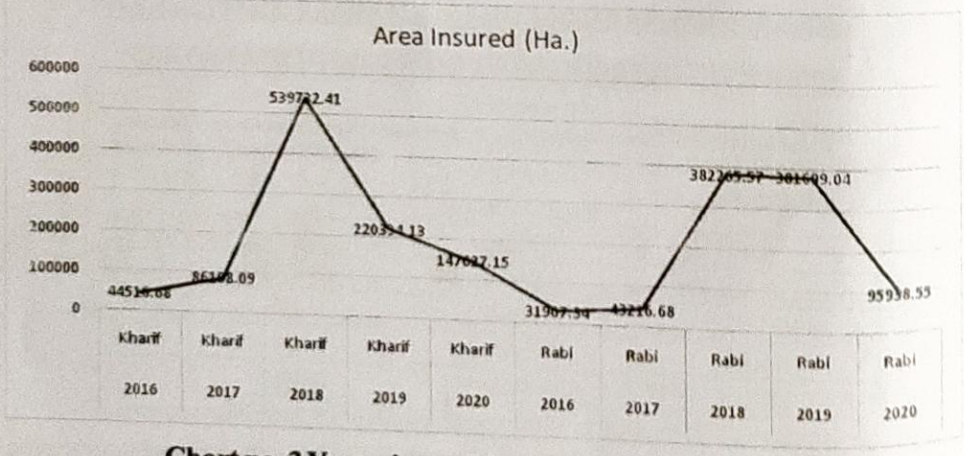


Chart no. 3 Year wise and Season wise Area Insured

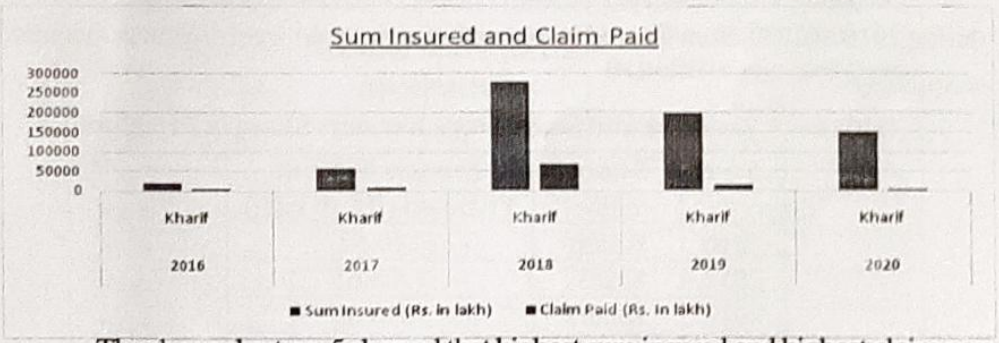
The above chart showed that kharif 2018 and Rabi 2018, 2019 had greater area insured than another year. Meanwhile kharif 2016, 2017, 2019, 2020 rabi 2016, 2017, 2020 had lower area insured in hectors.

Table no. 6 Year wise and Season wise Sum Insured and Claim Paid

Year	Season name	Sum Insured (Rs. in lakh)	Claim Paid (Rs. In lakh)	Percentage sum insured to claim paid
2016	Kharif	19632.27	6547.92	33.35%
2017	Kharif	57799.85	9144.98	15.82%
2018	Kharif	280366.5	68866.46	24.56%
2019	Kharif	200566.5	14481.82	7.22%
2020	Kharif	152165.5	2661.18	1.75%

The above table no. 6 tabulated that sum insured and claim paid to the farmers. Sum assured increased during first three years then it declined two years but diminished sum is not less than first two years. It showed the better coverage of crop insured. The claim paid data showed that only in 2018, claims paid to the farmers were in highest in rupees and lowest in 2020. Percentage sum insured to claim paid data showed that only 2016 kharif season had highest pay-out percentages.

Chart no. 5 Year wise and Season wise Sum Insured and Claim Paid



The above chart no. 5 showed that highest sum insured and highest claim pay-out in 2018. Sum insured in 2019 and 2020 is high but claim paid are not much accordingly.

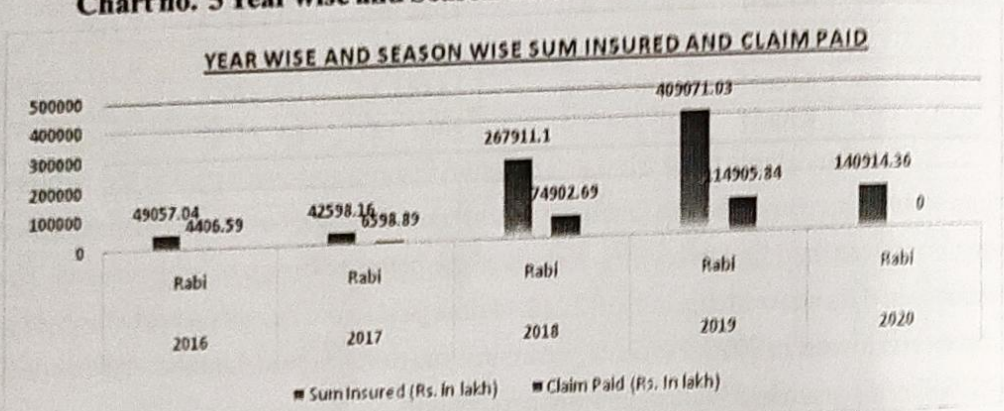
Table no. 7 Year wise and Season wise Sum Insured and Claim Paid

Year	Season name	Sum Insured (Rs. in lakh)	Claim Paid (Rs. In lakh)	Percentage sum insured to claim paid
2016	Rabi	49057.04	4406.59	8.98
2017	Rabi	42598.16	6598.89	15.49
2018	Rabi	267911.1	74902.69	27.96
2019	Rabi	409071	114905.84	28.09
2020	Rabi	140914.4	NA*	....

*NA= Not Available

The above table showed that Sum Insured and Claim Paidin 2019 higher than 2016 to 2018 period. Percentage sum insured to claim paid in 2019 is also high.

Chart no. 5 Year wise and Season wise Sum Insured and Claim Paid



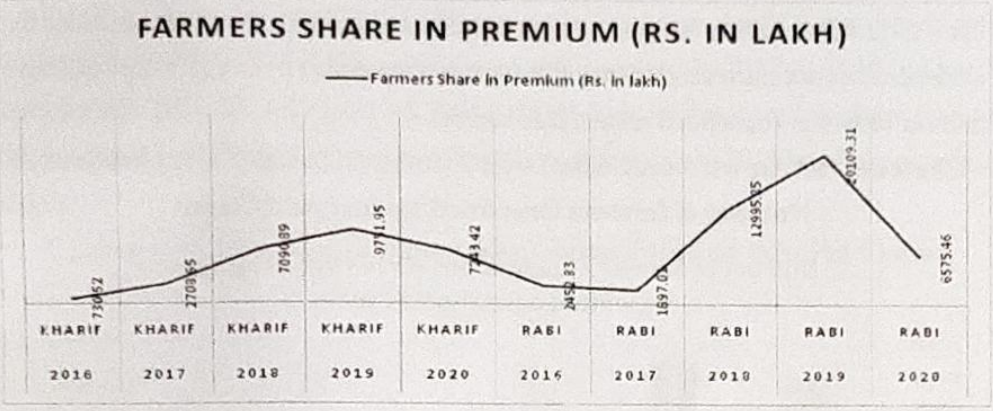
The above chart no. plotted that sum insured and claim paid in rabi seasons during 2016 to 2020. Sum insured increased but claim paid were not much increased accordingly.

Table no. 8 Year wise and Season wise Farmers Share in Premium

Year	Season name	Farmers Share in Premium (Rs. in lakh)
2016	Kharif	730.52
2017	Kharif	2708.65
2018	Kharif	7090.89
2019	Kharif	9751.95
2020	Kharif	7243.42
2016	Rabi	2452.83
2017	Rabi	1897.01
2018	Rabi	12995.85
2019	Rabi	20109.31
2020	Rabi	6575.46

The above table showed that year wise and season wise farmers share in premium. In kharif 2017, 2018, 2019 famers share premium increased then it reduced in kharif 2020. It was increased in rabi 2018, 2019 while 2017 and 2020 it showed decrease.

Chart no. 5 Year wise and Season wise Farmers Share in Premium



In the above chart no. 5 picturised that farmers share premium in rabi season was fast increased than kharif season. It was highest in rabi 2019 than given years.

Table no. 9 Year wise and Season wise Number of Farmer's Applications & Number of farmers Benefitted against paid Claims

Year	Season name	Number of Farmer's Applications	No. of farmers Benefitted against paid Claims
2016	Kharif	72130	65451
2017	Kharif	124320	113647
2018	Kharif	647138	643865
2019	Kharif	268144	91306
2020	Kharif	225183	19303
2016	Rabi	75110	45655
2017	Rabi	72524	62603
2018	Rabi	304277	281274
2019	Rabi	450226	351347
2020	Rabi	163444	NA

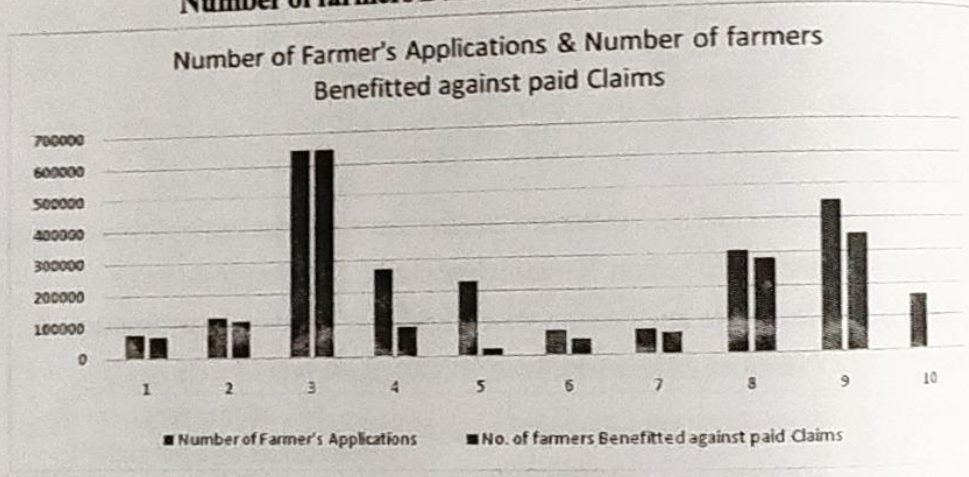
The above table showed that number of farmers applications increased in kharif 2017, 2018 and rabi 2018, 2019 but in other years it was decreased.

Wilicoxon Rank Sum Test

Significance Level	0.05
Z cri	1.65
Z cal	1.19
n	9

The value of Wilicoxon Rank Testfor two tailed test calculated "z" (1.19) is less than "z" (1.65) critical value. So,null hypothesis is not rejected. Here, we concluded that evidence does not show asignificant difference in the number of farmer's applications & number of farmers benefitted against paid claims.

Chart no. 10 Year wise and Season wise Number of Farmer's Applications & Number of farmers Benefitted against paid Claims



The above chart no. 10 showed that number of farmer's applications increased as well as number of farmers benefitted against paid claims also increased kharif 2019, 2020.

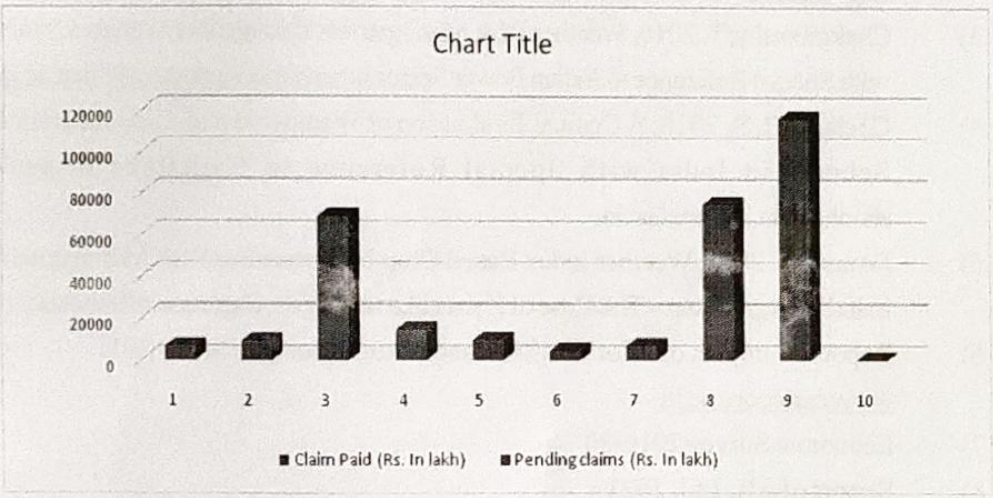
Table no. 10 Year wise and Season wise Claims Paid and Pending Claims

Year	Season name	Claim Paid (Rs. In lakh)	Pending claims (Rs. In lakh)
2016	Kharif	6547.92	0
2017	Kharif	9144.98	0
2018	Kharif	68866.46	155.71
2019	Kharif	14481.82	152.34
2020	Kharif	2661.18	6899.64
2016	Rabi	4406.59	0
2017	Rabi	6598.89	47.96
2018	Rabi	74902.69	4.67
2019	Rabi	114905.8	1532.23
2020	Rabi	NA*	NA*

NA=not available

The above table showed that claims paid and pending claims during kharif and rabi seasons 2016 to 2020. Claim paid amount increased in 2017 & 2018 in kharif season while 2019 & 2020 declined. Rabi seasons showed the growth in claim paid to the farmers. Kharif 2020 had huge pending claim while in rabi 2019 had huge pending claims.

Chart no. 8 Year wise and Season wise Claims Paid and Pending Claims



The above chart showed that kharif 2020 has shown more pendency of claims than any season and years.It showed that this scheme is have a positive performance.

Conclusions:

It was found from the analysis about performance of RWBCIS at all India level that, RWBCIS in terms of parameters like number of farmers covered, areas insured have registered positive growth. The Wilicoxon test results indicates that, null hypothesis, there is no significant difference in in the number of farmer's applications & number of farmers benefitted against paid claims, accepted. So here is concluded that over a period of time scheme's growth rate has increased and this shows the utilizing this risk management tool, can serve the farming community against production risk in agriculture.

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स्कूली शिक्षा में संगीत विषय की आदर्श संरचना (नई शिक्षा नीति के अनुसार)

ज्ञानेश्वर संजय कासार*
*शोधकर्ता, श्री शिवाजी कला, वाणिज्य आणि विज्ञान महाविद्यालय, अकोला, महाराष्ट्र
प्रोफेसर डॉ0 सोपान सी. वतारे**
**निर्देशक, श्री शिवाजी कला, वाणिज्य आणि विज्ञान महाविद्यालय, अकोला, महाराष्ट्र

सारांश : स्कूली शिक्षा में पारंपारिक विषयो की संरचना में संगीत एवं आदी ललित कला विषयों की महत्वपूर्णता को सभी विद्वानों ने अधोरेखित किया है। जमीनी स्तर पर हर स्कूली अपनी–अपनी सुविधा, क्षमता और चाहत के दम पर कला शिक्षा दे रही है। उनमे किसी में एकसमानता और एकवाक्यता नहीं है। परिणामस्वरूप, स्कूली शिक्षा में कला शिक्षा बहोत निराशाजनक स्थिती में है। महाविद्यालय स्तर पर दर्जात्मक, गुणात्मक, संख्यात्मक कला शिक्षा देने के लिये पहिले स्कूली कला शिक्षा के ढ़ाचे/संरचना में बदलाव करना पड़ेगा। इसके अनुरूप, नई शिक्षा नीति में कला शिक्षा पर विशेष ध्यान दिया गया है। इसके मार्गदर्शक सिद्धांतो को ध्यान में रखते हुए, भारत की स्कूली शिक्षा में संगीत, खेल एवं अन्य ललित कलाओ के आदर्श संरचना को विस्तारपूर्वक विवेचन किया है।

मुख्य शब्द : स्कूली संगीत शिक्षा, कला शिक्षा, नई शिक्षा नीति, यांत्रिक कलाए, कला–कौशल जांच, संख्यात्मक कला शिक्षा आदि।

परिचय : साहित्य, संस्कृति, भाषा, कला और विज्ञान ये शिक्षा के पांच आधारकोष हैं, जिनसे व्यक्ती का व्यक्तिगत विकास होता है। 'कोष' शब्द का प्रयोग 'ज्ञान के भण्डार' के अर्थ में किया जाता है। जीवन की समृद्धि और पूर्णता इन पाँच कोषो की शिक्षा से आती है। यद्यपि, इनमें से प्रत्येक कोष स्वतंत्र रूप से अध्ययनित ओर स्वायत्त है, यदि एक–दूसरे के साथ उनका संबंध 'संतुलन' के सिद्धांत पर आधारित होगा, तो ही व्यक्तित्व को पूर्ण रूप से विकसित कहा जा सकता है। साहित्य का उत्कृष्ट ज्ञान, सांस्कृतिक मूल्यों का ज्ञान, विज्ञान के माध्यम से अभिव्यक्त दृष्टि, कलात्मक समझ, भाषा की समृद्धि वाला व्यक्ति जब समाज में जाता है, तो वह उत्कृष्टता के स्तर पर पहुंच जाता है। इस समृद्धि की स्थिति में अनेक महान व्यक्तित्व उदाहरण के रूप में हमारी आखों के सामने आएगे। इसलिए, शिक्षा की शुरुआत इन सभी विषयों के बुनियादी ज्ञान से होनी चाहिए और कम उम्र में ही इन आवश्यक विषयों की ठोस नींव रखनी चाहिए। शिक्षा के प्राथमिक चरण से ही व्यक्ति इस कोष में विभिन्न विषयों का अध्ययन प्रारम्भ कर देता है। अध्ययन का यह प्रारंभिक चरण बहुत महत्वपूर्ण है।

दैनिक जीवन के लिए पारंपरिक विषयों की शिक्षा जितनी महत्वपूर्ण है, ललित कलाओं और विभिन्न खेलों की शिक्षा भी उतनी ही महत्वपूर्ण है। इस सारी शिक्षा के माध्यम से शरीर, बुद्धि, मन को सुदृढ़ बनाना तथा एक स्वस्थ, नैतिक एवं रचनात्मक समाज का निर्माण करना, यही उद्देश्य सभी शिक्षा शास्त्रियों ने प्रतिपादित किया है। इस संबंध में स्कूली शिक्षा बहुत महत्वपूण है। छात्र पहले १२ से १५ वर्षों में जो विषय सबसे अच्छी तरह सीखते हैं, वे उसे जीवन भर याद रहते हैं और उन्ही सिद्धांतों का हमेशा अभ्यास करते हैं। इसीलिए स्कूल स्तरपर पढ़ाए जाने वाले प्रत्येक विषय को उसके महत्व, उसके मूल स्वरूप, उसके मूल सिद्धांत के साथ प्रभावी ढग से पढ़ाया जाना चाहिए। समाज में पारंपरिक विषयों के प्रति काफी जागरूकता है। लेकिन, ललित कलाओं और खेलों के प्रति एक खास तरह की अज्ञानता समाज में बडे पैमाने पर देखी जाती है। आज के विज्ञान के युग में भी ललित कलाओं और खेलों की पढाई को लेकर स्कूली स्तर पर असमंजस की स्थिति है। समाज में जो विषय परम्परागत रूप से स्वीकृत हैं वही स्वीकृत हैं। यह बेहद दुर्भाग्यपूर्ण स्थिति है कि जो विषय खुशहाल शिक्षा का दायरा बढ़ाने के लिए हैं, वे एक–एक कदम पीछे हट रहे हैं। अभी भी ऐसे कई स्कूल हैं जो कलाओके विषयोको नहीं पढ़ाते। कुछ स्कूलों में बहुत आशिक स्थिति में, कुछ स्कूलों में अच्छी तरह से पढ़ाई जा रही है। इस समग्र स्थिति को देखते हुए छात्रों को अच्छी गुणवत्ता वाली कला शिक्षा प्रदान करना समय की माग है। इसके लिए स्कूल स्तर पर, शिक्षक स्तर पर, सरकारी स्तर पर पहल करना जरूरी है। कला शिक्षकों और कला प्रेमियों को भी एक साथ आकर सकारात्मक कदम उठाने की जरूरत है। स्कूली स्तर पर संगीत विषय का आदर्श स्वरूप क्या होना चाहिए? इस प्रश्न का समाधान इस लेखन के माध्यम से ढूंढने का प्रयास किया गया है।

स्कूली **स्तरपर ललित कला विषय** : व्यक्ति मूलतः सौन्दर्य प्रेमी होता है। वह दैनिक जीवन की हर घटना में सुंदरता तलाशता है। यह उनकी सौंदर्य दृष्टि ही थी जिसने कला का निर्माण किया। उनमें से कुछ कलाएँ उसके लिए प्रत्यक्ष रूप से उपयोगी हैं, वे भौतिक जगत में सुख का प्रमाण हैं। इसमे कलाकार किसी वस्तु में वास्तविकता को अभिव्यक्त करता है। दैनिक जीवन की सबसे आवश्यक आवश्यकताओं का आविष्कार बहुत ही सुदर ढग से किया गया है। ऐसी कला रचना के लिए कई तत्वो और सामग्रियों का अस्तित्व में होना आवश्यक है। इसकी गुणवत्ता अधिकतर इसी पर निर्भर करती है। इसीलिए इसे **'यांत्रिक कलाए'** कहा जाता है।

ललित कलाओं का संबंध सीधे मन से है, दृश्य या श्रवण माध्यम से आंतरिक मन के अदृश्य विचारों को परम सौंदर्य की अनुभूति कराना ललित कला की विशिष्ट विशेषता है। ललित कलाओ मे योग्यता एव समृद्धि अत्यत महत्वपूर्ण विशेषताएँ हैं।

1. ललित कला वह कला ह, जिसके माध्यम से भावना की अभिव्यक्ति के लिए रंग, रेखा, आकार, ध्वनि, लय, हावभाव के माध्यम से लयबद्ध सरचना बनाकर उच्चतम गुणवत्ता का आनंद पैदा किया जाता है।
2. समस्त ललित कलाओ में 'संगीत' को सर्वोत्तम कला मानी गयी है। इसका शिक्षा एक विशेष रूप से महत्वपूर्ण घटना है। परन्तु इसका सामान्य स्वरूप क्या होना चाहिए? इस बारे मे बहुत अज्ञानता है। कई बड़े शिक्षण संस्थानो मे इस पर गभीरता से विचार नहीं किया गया है।

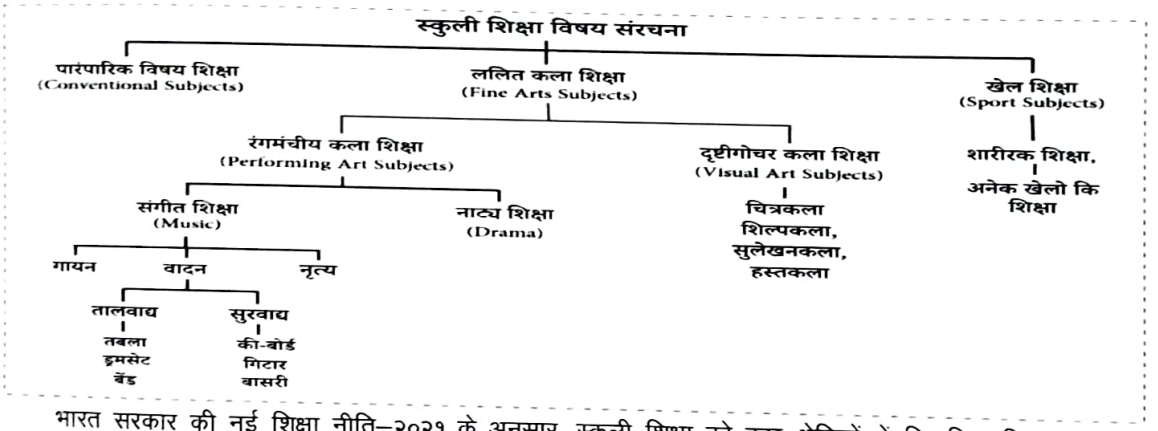
अतः अनेक विषयों की भीड़ में स्कूल स्तर पर ललित कला विषय का आदर्श स्वरूप निर्धारित करना बहुत कठिन है। यह विषय अधिकतर कला के प्रति प्रेम और स्कूल के प्रिंसिपल की दूरदर्शिता पर निर्भर करता है। स्कूलों में कला शिक्षा को अन्य स्कूलों के लिए एक आदर्श के रूप में देखा जाना चाहिए? या फिर सामान्य स्कूल की तरह पारंपरिक विषयों को ही प्राथमिकता दी जानी चाहिए? यह सब उनकी दृष्टि पर निर्भर करता है। मगर पहिले, स्कूल शिक्षा में विषयों की संरचना कैसी होनी चाहिए? इस पर एकवाक्यता होने पर ही आगे के विकास पर बात हो सकेगी। इस संबंध में, कला शिक्षा की प्रकृति और संरचना को और अधिक से आगे विस्तृत किया गया है।

स्कूली शिक्षा में विषयो को तीन मुख्य वर्गों में विभाजित किया जाना चाहिए–

1) पारंपरिक विषयों की शिक्षा(Conventional Subjects) : बौद्धिक क्षमता विकसित करने वाले विषय जैसे भाषा शिक्षा, गणित, विज्ञान, भूगोल, इतिहास।

2) ललित कला विषयों की शिक्षा(Fine Art Subjects): इस खंड मे दो प्रकार हैं। प्रदर्शन कला और दृश्य कला. संगीत, नाटक, नृत्य, चित्रकला, सुलेख, हस्तशिल्प जैसे भावनात्मक विकास विषय।

3) खेल विषयों की शिक्षा(Sport Subjects): शारीरिक शिक्षा, फुटबॉल, क्रिकेट, स्केटिंग, खोखो, कबड्डी, बास्केटबॉल ऐसे विषय हैं जो शारीरिक क्षमता को बढाते हैं।



भारत सरकार की नई शिक्षा नीति–२०२१ के अनुसार, स्कूली शिक्षा को कुछ श्रेणियों में विभाजित किया गया है। इसके मुताबिक आने वाले समय में स्कूली शिक्षा में भारी बदलाव देखने को मिलेंगे। ३ से १८ वर्ष की आयु के छात्रों के लिए स्कूली शिक्षा पाठ्यक्रम ५+३+३+४ के रूप में संरचित है।

१) बुनियादी स्तरः आयु ३ से ६ – आंगनवाड़ी/प्री–प्राइमरी स्कूल
आयु ६ से ८ – कक्षा १ और २

२) पुर्वाध्यायन स्तरः आयु ८ से ११ – कक्षा ३ से ५

३) पूर्व–माध्यमिक स्तरः आयु ११ से १४ – कक्षा ६ से ८

४) माध्यमिक स्तरः आयु १४ से १८ – कक्षा ६ से १२

इस अवधि में स्कूल स्तर पर पढाये जाने वाले सभी विषयों के पाठ्यक्रम का पुनर्निर्माण उपरोक्त संरचना के अनुसार किया जायेगा। स्कूलो की दृष्टि से पारंपरिक विषय शिक्षा को छोड़कर स्कूल में प्रथम वर्ष से १२ वीं वर्ष तक ललित कला एवं खेल अनुभाग में विभिन्न विषयों की शिक्षा का विभाजन भी ५३३४ के चार स्तरों में होना चाहिए।

१) बुनियादी स्तर (आंगनवाड़ी से कक्षा २ तक) : एक शोध के अनुसार, छह साल की उम्र तक बच्चों का दिमाग ८० प्रतिशत विकसित हो जाता है, इस उम्र में लचीला, खेल–आधारित, गतिविधि–आधारित, जिज्ञासा–आधारित सीखने की उम्मीद की जाती है। इस उम्र में, शब्दों की पहचान भाषा सीखने की शुरुआत है, सख्याओं की पहचान वस्तुओं की गिनती की शुरुआत है, रंगों और विभिन्न आकृतियों की पहचान, चित्रकला की शुरुआत है, संगीत शिक्षा की शुरुआत, विभिन्न प्रकार के बड़बड़ गीत, प्रार्थनाएँ, भजन, नृत्य, विभिन्न व्यायाम, घर और बाहर के खेल। शारीरिक सशक्तिकरण उनके शारीरिक, मानसिक, भावनात्मक और बौद्धिक विकास से शुरू होता है और उन्हें स्कूली शिक्षा के अगले स्तर के लिए उचित रूप से तैयार करता है।

संगीत, खेल मनुष्य की सहज प्रवृत्ति है। शिक्षा के इस प्रारंभिक चरण में खेल और ललित कलाएँ छात्रों के समग्र विकास में बहुत महत्वपूर्ण भूमिका निभाते हैं। यहा तक कि गणित और विज्ञान जैसे पारंपरिक विषयों में भी, शिक्षक छात्रों को कुछ कठिन अवधारणाओं को समझाने के लिए खेल, नृत्य, चित्र और गीतों का उपयोग करते हैं। खेल, कला की सहायता से अन्य विषयों के तत्वों को समझाते समय इन विषयों में भी प्रारंभिक शिक्षा देना जरूरी है। अन्य विषयों की तरह, गायन, नृत्य, अभिनय, खेल के लिए पुरे स्कूली समय में अलग–अलग तासिकाए होनी चाहिए। उन्हें छोटे–छोटे गीतों, मत्रों, नृत्यों, भजनों, उचित स्वरों में और वाद्ययत्रों के साथ प्रार्थनाओं के उच्चारण और नृत्य–नाटिका के माध्यम से, इसकी अभिव्यक्ति के अध्ययन के माध्यम से इन कलाओं से परिचित कराया जा सकता है। महीने मे एक या दो बार मंच प्रदर्शन जैसे छोटे प्रयासों के माध्यसे कला के प्रति रुचि और जिज्ञासा पैदा करने का प्रयास होना चाहिए।

१	**भाषा**	अंग्रेजी, हिंदी और क्षेत्रीय भाषाएँ
२	**मुख्य विषय**	गणित, विज्ञान, सामाजिक विज्ञान
३	**ललित कलाएँ**	गायन, नृत्य, नाटक, चित्रकला, हस्तशिल्प
४	**शारीरिक शिक्षा**	इनडोर–फील्ड खेल, योग

२) पूर्वाध्ययन स्तर (कक्षा ३ से ५ तक) : फाउंडेशन स्तरपर लिए गए विषयों के ज्ञान का इस स्तरपर अधिक विस्तृत तरीके से अध्ययन करना होता है। शिक्षण–अधिगम में यह एक महत्वपूर्ण कदम है क्योंकि छात्र पिछले स्तर पर स्कूल, शिक्षकों, सीखने के तरीकों से काफी परिचित और बसे हुए हैं। इस स्तर पर शिक्षकों को अधिक सतर्क रहना चाहिए। इस उम्र में जो सीख प्रभावी होगी वह जीवन भर यादगार रहेगी। इसके अलावा, इस उम्र में छात्र की क्षमताओं, प्राथमिकताओं, प्राकृतिक झुकाव पर ध्यान दिया जाने लगता है। भविष्य की शैक्षिक प्रगति की सीडी इसी उम्र से बनना शुरू हो जाती है। तदनुसार, अध्ययन शुरू होना चाहिए। जहां तक ललित कलाओं का सवाल है, विभिन्न उप–विषयों को शुरू करके 'विशेष–स्तर' पर एक विषय का चयन करना इस स्तर का प्रमुख लक्ष्य है। चुने हुए विषय का शास्त्र, परंपरा और तंत्र के पहलुओं को जानने कि शुरूवात यही से होनी चाहिए। इसके लिए अभिभावकों की सक्रिय भागीदारी के साथ शिक्षकों को **'कला–कौशल जांच'** (Art Aptitude Test) लेना चाहिए, जो छात्रों में जिज्ञासा–रुचि–क्षमता के बीच के अंतर को स्पष्ट रूप से बताता है। उपरांत, मुख्य कला–विषय का अध्ययन शुरू होना चाहिये। भले ही उप–कलाविषय इस स्तर पर तय हो, लेकिन मूल–विषय को सीखना भी आवश्यक है। अर्थात, शारीरिक और मानसिक क्षमता बढ़ने के अनुसार प्रत्येक विषय में गहन ज्ञान प्राप्त किया जा सकता है। संक्षेप में, तीनों मुल विषयों का एक साथ 'विशेष' स्तरपर कला अध्ययन इसी उम्र से शुरु करना चाहिए।

तालिका क्रमांक १

मुल–विषय(Main Subjects)	प्रति कक्षा / प्रति तासिका
शारीरिक शिक्षा–Physical Education	१ तासिका
रंगमंचीय कला–Performing Arts	१ तासिका
दृष्टिगोचर कला–Visual Arts	१ तासिका
कुल तासिकाए	**३ तासिकाए**

तालिका क्रमांक २

विशेष–विषय(Specialized Subjects)	प्रति कक्षा / प्रति तासिका
शारीरिक शिक्षा–Physical Education क्रिकेट, फुटबॉल, बास्केटबॉल, जिम्नस्टिक, बेटमिंटन, कॅरोम, चेस, रायफल, शूटिंग **(इनमें से कोई एक विषय)**	२ तासिकाए
रंगमंचीय कला–Performing Arts गायन, नृत्य, नाट्य सुरवाद्य – बासरी, कि–बोर्ड, व्हायोलीन तालवाद्य – तबला, ड्रम–सेट, बेंड **(इनमें से कोई एक विषय)**	२ तासिकाए
दृष्टिगोचर कला –Visual Arts चित्रकला, सुलेखन, शिल्पकला, हस्तकला **(इनमें से कोई एक विषय)**	२ तासिकाए
कुल तासिकाए	**६ तासिकाए**

तालिका क्रमांक १, में शारीरिक शिक्षा, रंगमंचीय कला, दृष्टिगोचर कला को पूरी कक्षा के लिए अनिवार्य किया जाना चाहिए। इसमें बच्चों को विषय की व्यापक शिक्षा मिलेगी, सभी विषयों को बारीकी से जानने और परखने का मौका मिलेगा। इसके अलावा, वह उपरोक्त प्रत्येक विषय में न्यूनतम कौशल और ज्ञान प्राप्त कर सकता है। **तालिका क्रमांक २ के अनुसार,** इस स्तर पर तीनों मूल विषयों के उप–विषयों को 'विशेष' स्तर पर सीखने के लिए उपलब्ध कराया जाना चाहिए। उपरोक्त तीनों विषयों की एक कक्षा को एक सप्ताह में कुल ६ तासिकाए मिलेंगी। यदि इसी प्रकार प्रत्येक कक्षा को प्रति सप्ताह ६ घंटे मिले तो कितनी गुणवत्ता का उत्पादन हो सकता है।

३) पूर्व–माध्यमिक स्तर (कक्षा ६ से ८) : पूर्व–अध्ययन स्तरपर चुने गए 'विशेष–विषय' के चयन से इस स्तर पर उस विषय की गहन तकनीक, सुंदरता, ज्ञान के अध्ययन को पर्याप्त समय और महत्व मिलेगा। इस स्तर पर प्रत्येक विषय की आवश्यक शारीरिक क्षमताओं–तकनीकों का अध्ययन करना चाहिए। इसके अलावा विषय के विभिन्न आवश्यक पहलुओं, जीवन मूल्यों, उससे निकलने वाले नैतिक मूल्यों का भी विशेष अध्ययन किया जाना चाहिए। इस स्तर पर विद्यार्थियों को समय–समय पर मंच उपलब्ध कराया जाना चाहिए। इसलिए, शिक्षक यह मूल्यांकन कर सकते हैं कि अर्जित ज्ञान ठीक से परिष्कृत है या नही। आत्मविश्वास और सहजता अध्ययन को निश्चित रूप से छात्रों को गहन अध्ययन के लिए प्रेरित करेगी। यह सर्वमान्य है कि १०० में से १०० छात्र कला के क्षेत्र में रुचि नही लेंगे, मगर जो जन्मसे ही अच्छे ज्ञान और कौशल के साथ पैदा हुए हैं, उन्हें स्कूल स्तरपरही कला के क्षेत्र में आगे बढ़ने के लिए सर्वोत्तम सुविधाएं मिलेगी। विद्यार्थी कला की प्रकृति के निकट सपर्क में आ सकेंगे। भविष्य की सभावनाए और सृजन के द्वार खुलेंगे और जीवन में कला के महत्व का अनुभव भी हो सकेगा। निःसंदेह ही आने वाले समय मे इसके दूरगामी सकारात्मक प्रभाव होंगे। कक्षा ३ से ५ तक जिस प्रकार विषयो का अध्ययन हुआ उसी को आगे बढाते हुए इस स्तरपर, मुल–विषय के ३ और विशेष–विषय के ६ तासिकाए मिलेंगे।

४) माध्यमिक स्तर (कक्षा ९ से १२) : कक्षा ९ में आने के बाद विषयो के चयन की महत्वपूर्ण प्रक्रिया बोर्ड स्तर पर पूरी करनी होती है। छात्र को अपनी योग्यता, क्षमता और भविष्य के करियर के अनुसार विषय का चयन करना होता है। लगभग प्रत्येक बोर्ड ने कला विषयों के पाठ्यक्रम की योजना इस वर्ष से बनाई है, जिसके अनुसार छात्र को प्रत्येक विषय–अनुभाग में से अपना पसंदीदा विषय चुनना होता है। नई शिक्षा नीति के अनुसार सभी विषयों को यथोचित रूप से विभाजित करने की सम्भावनाए दी गई है। तदनुसार, कला–विषयों के लिए भी एक अनुभाग बनाया गया है। कक्षा ८ तक जिन विषयो की अच्छी तैयारी हो, उन्हे इस स्तरपर 'मुख्य–विषय' के रूप में पढ़ा जाना चाहिए। बढ़ती उम्र के साथ इस स्तर की तकनीक की गहराई का और विस्तार होगा। कला विषयों का अधिक गहराई से अध्ययन किया जा सकता है।

तालिका क्रमांक ३

अनुभाग १	अनुभाग २	अनुभाग ३	अनुभाग ४
भाषा विषय	**मानव्यशास्त्र व सामाजिक शास्त्र**	**विज्ञान**	**गणित**
इंग्रजी (अनिवार्य)	भारतीय इतिहास	भौतिक विज्ञान	गणित व संख्याशास्त्र
हिंदी / संस्कृत	विश्व इतिहास	रसायन विज्ञान	अंतरराष्ट्रीय गणित
क्षेत्रीय भाषा / पाश्यात्य भाषा	भूगोल	जीव विज्ञान	
इनमें से कोई १	**इनमें से कोई १**	**इनमें से कोई १**	**इनमें से कोई १**

अनुभाग ५	अनुभाग ६	अनुभाग ७
कला शिक्षण	**स्वास्थ व शारीरिक शिक्षा**	**आवश्यक शिक्षा**
भारतीय संगीत (गायन, सुरवाद्य, तालवाद्य, नृत्य)	खाद्य विज्ञान (Food Science)	पर्यावरण
नाट्य	शारीरिक शिक्षा	व्यवसाय अध्ययन
संगणकीय कला (Digital Art)	योग	सूचना प्रौद्योगिकी
चित्रकला		
इनमें से कोई १	**इनमें से कोई १**	**इनमें से कोई १**

उपरोक्त तालिका के अनुसार कक्षा ६ से १२ तक अलग–अलग विषय विभाजन होना चाहिए। अनुभाग १–२–३–४ में 'पारंपारिक–विषय' शामिल हैं। १–१ अन्य विषय को 'मुख्य–विषय' के रूप में चुना जाना चाहिए। फिर अनुभाग ५–६–७ में से १–१ को 'मुख्य–विषय' के रूप में चुना जाना चाहिए। ऐसे कुल ८ विषयों का अध्ययन 'मुख्य विषय' के रूप में किया जाना चाहिए। **अनुभाग ५ में,** संगीत एक विकल्प है। संगीत शब्द का प्रयोग व्यापक अर्थ में किया जाता है। इसमें गायन की चार मुख्य कलाओं की उप–कलाएं, सुर–वाद्य, ताल–वाद्य और नृत्य अलग–अलग विकल्प के रूप में होंगे। प्रत्येक स्कूल को अपनी सुविधानुसार मुख्य–विषय का कम से कम एक उप–विषय पढ़ाने की सुविधा उपलब्ध करानी चाहिए।

निष्कर्ष : पारंपरिक विषय के साथ संगीत विषय के समानांतर अस्तित्व का प्रावधान कई वर्षों से प्रलंबित है। कई शैक्षणिक संस्थानों और स्कूलों में संगीत शिक्षा की अपनी प्रणाली है। कहीं कोई सहमति नहीं बन पाई। नई शिक्षा नीति के अनुसार स्कूली शिक्षा सभी संस्थानो में एक जैसी व्यवस्था स्थापित हो, जिससे कई वर्षों से बंद पड़ी संगीत शिक्षा को एक नइ गति मिलेगी और आने वाली पीढ़ी बचपन से ही हमारी संस्कृति, कला और उसकी विविधता से जुड़ सकेगी और इसके सकारात्मक दूरगामी प्रभाव समाज में देखने को मिलेंगे। स्कूली शिक्षा में संगीत के महत्व पर कई वर्षों से चर्चा होती रही है। सरकार को इस मामले में पहल करनो चाहिए। संपूर्ण भारत में लागू की गई 'नई शिक्षा नीति–२०२१' स्कूली शिक्षा पर विशेष ध्यान देने की एक बहुत ही प्रशंसनीय पहल है, इस दिशा में देश भर के सभी संस्थानों, स्कूलों को विशेष मार्गदर्शन मिलना चाहिए। नई शिक्षा नीति के अनुसार शिक्षा में **'कला'** क महत्व पर प्रकाश डाला गया है। उस महत्व को ध्यान में रखते हुए, इस शोध पत्र में आंगनवाड़ी से लेकर बारहवीं कक्षा तक की स्कूली शिक्षा में संगीत विषय की प्रकृति और संरचना पर प्रकाश डाला गया है। यदि ऐसी प्रभावी व्यवस्था विद्यालय स्तर पर लागू हो जाये, तो इसमें कोई संदेह नहीं कि उच्च संगीत शिक्षा में भी गुणात्मक एवं मात्रात्मक परिवर्तन आयेगा। उपरोक्त शोध स्कूली संगीत शिक्षा के संदर्भ में होने वाली महत्वपूर्ण बदलाव के लिये एक मार्गदर्शक, पथदर्शक शोध साबित होगा। जो स्कूली शिक्षा में आने वाली सुधारो को मार्गदर्शन करेगा। यह एक मौलिक शोध विधि का प्रकार है।

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20

मराठी गझल बादशाह : श्रीकृष्ण राऊत

प्रा.डॉ.संजय पोहरे
मराठी विभाग
श्री शिवाजी कला, वाणिज्य व विज्ञान महाविद्यालय, अकोला

सुरेश भटांनंतरच्या पहिल्या पिढीतील महत्त्वाचे गझलकार म्हणून श्रीकृष्ण राऊत यांचे नाव अग्रक्रमाने येते. मागील चाळीस वर्षांपासून मराठीतील नामवंत व दर्जेदार नियतकालीकातून श्रीकृष्ण राऊत सातत्याने गझल लेखन करीत आहेत. त्यांचा 'गुलाल' हा गझलसंग्रह 1989 मध्ये प्रकाशित झाला. या गझलसंग्रहातील केवळ पन्नास गझलांनी त्याना मराठी गझलविश्वात स्वत:ची एक स्वतंत्र ओळख निर्माण केली आहे. 2003 मध्ये 'गुलाल' या संग्रहाची दुसरी आवृत्ती नवीन गझलांसह 'गुलाल आणि इतर गझला' या नावाने प्रकाशित झाली. वयाच्या तेविसाव्या वर्षी पहिली गझल लिहिणाऱ्या राऊतांचे गझल लेखन वयाच्या पासष्टाव्या वर्षीदेखील अविरत सुरू आहे. त्यांच्या 'गुलाल' (1989), 'गुलाल आणि इतर गझला' (2003), 'कारुण्य माणसाला संतत्व दान देते' (2019) या संग्रहातील एकूण गझल संख्या 152 आहे. 1989 ते 2019 या 30 वर्षांच्या कालावधीत केवळ दोन गझलसंग्रह लिहून गझल निष्ठेचे उत्तम उदाहरण त्यांनी भटोत्तर गझलेसमोर ठेवले आहे. गझलेच्या संख्येपेक्षा गझलेतील काव्य (गझलियत) लाख मोलाची आहे. हाच वास्तुपाठ यातून निदर्शनास येतो.

श्रीकृष्ण राऊतांचा यांचा 'एकविसाव्या शतकाच्या उंबरठ्यावर जन्म घेणाऱ्या तान्ह्या मुला' हा मुक्तछंदीय कवितासंग्रह (2001) मध्ये प्रकाशित झाला. 'चारओळी तुझ्यासाठी' हा चारोळीसंग्रह (2003) मध्य. 'तुको बादशहा' हा अभंग संग्रह (2015) आणि 'चकव्यातून फिरतो मौनी सुधाकर कदम' यांच्यावर लिहिलेला सन्मानग्रंथ (2018) मध्ये प्रकाशित झाला. यासोबत 'राघू मैना' (1982), 'तू तिथे असाव' (2018) या चित्रपटांसाठी त्यांनी गीतलेखन केले आहे. आशा भोसले, सुरेश वाडकर, उषा मंगेशकर, भीमराव पांचाळे, राजेश उमाळे, दिनेश अर्जुना, हर्षवर्धन मानकर आदी नामवंत गायकांनी त्यांच्या गझल गायल्या आहेत. नागपूर येथील अखिल भारतीय साहित्य संमेलनातील 'सुरेश भट स्मृती गझल वाचन' सत्राचे अध्यक्षपद त्यांनी भुषविले आहे. 'मराठी गझल : तंत्रशुद्धता की तंत्रशरणता?' हा त्यांचा गाजलेला लेख विककिपिडियावर सुरेश भटांच्या 'बाराखडी' सोबत समाविष्ट करणात आला आहे. राऊतांना उत्कृष्ट लेखनासाठी अनेक पुरस्कार मिळाले आहेत. त्यामध्ये मराठी गझल लेखनासाठी बांधण जनप्रतिष्ठान, मुंबईचा 'जीवन गौरव पुरस्कार', वि.सा.संघाचा 'शरदचंद्र मुक्तिबोध स्मृती पुरस्कार', मसापचा 'कवी यशवंत पुरस्कार', 'भि.ग.रोहमारे ग्रामीण साहित्य पुरस्कार', 'संजिवनी खोजे स्मृती पुरस्कार', 'यशवंतराव चव्हाण साहित्य पुरस्कार', 'तुका म्हणे पुरस्कार', 'संत भगवान बाबा काव्य पुरस्कार', स्व. सूर्यकांतादेवी पोटे चॅरिटेबल ट्रस्ट अमरावतीचा राज्यस्तरीय 'साहित्यव्रती पुरस्कार' आदी पुरस्कारांनी त्यांना यथोचित गौरविण्यात आले आहे.

श्रीकृष्ण राऊतांच्या गझलेसंबंधी पु.ल.देशपांडे, कुसुमाग्रज, ना.घ.देशपांडे, मंगेश पाडगावकर, डॉ.अविनाश सांगोलेकर, डॉ.किशोर सानप यांनी त्यांच्या गझलेची प्रशंसा केली आहे. मंगेश पाडगावकर असे म्हणतात, "क्षुद्र स्वार्थाच्या, हपापाच्या पलीकडच्या उदात्त जगण्याचे खोल आकर्षण तुम्हाला आहे. ही सर्व तुमच्या या गझलांतील जमेची बाजू आहे." त्याचप्रमाणे 'राऊतांना गझलेची नस सापडली आहे', 'त्यांच्या गझला आशय संपन्न आहेत'. अशा एक ना अनेक प्रतिक्रिया समीक्षकांनी दिल्या आहेत. अशाच प्रकारे डॉ.मधुकर वाकाडे यांचे मत महत्त्वपूर्ण वाटते. "सुरेश भटांच्या तोडीचा मराठीत गझलकार आजतागायत निर्माण झाला नाही, असे माझे वैयक्तिक मत आहे, कारण त्यांनी ईश्काला चटावलेल्या गझलेला सामाजिकतेचं मध चाटवलं आणि गझलची प्रकृतीच बदलली. सामाजिक आशयाचा लळा आणि सामान्य माणसांच्या व्यथा वेदनांचा कळवळ असलेली गझल मला भावली आणि मराठी रसिकांच्या काळजाला भिडली. सुरेश भटांच्या नंतर सामाजिक जाणिवेतून गझल लिहिणाऱ्या मोजक्या गझलकारांपैकी श्रीकृष्ण राऊत हे एक सशक्त गझलकार आहेत आणि त्यांच्या कितीतरी गझलांचा मी चाहता आहे." सुरेश भटांच्या बाराखडीनंतर आकृतीबंधातील बदलत्या प्रवाहाचे शास्त्रबद्ध संयोजन श्रीकृष्ण राऊत यांनी केले आहे. त्यामुळे त्यांचो गझल लेखनासोबत गझल चळवळीचे कार्य दखलपात्र आहे. नवीन पिढीला गझलचे संस्कार त्यांच्या हातून होत आहेत, उदाहरण म्हणजे 'गझलाई' ही नवोदित गझलकारांना ममतेने प्रोत्साहित करणारी समीक्षा म्हणावी लागेल.

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श्रीकृष्ण राऊतांच्या गझलेला अनुभवसंपन्नतेचे वरदान लाभलेले आहे. एखाद्या सिद्धिप्राप्त वैराग्याच्या शब्दामध्ये असणारे वजन त्यांच्या गझलेच्या शब्दा-शब्दातून प्रत्ययास येते. त्यांचा प्रत्येक शेर वाचणाऱ्याला आपलेसे करून घेतो, तद्वतच सामान्यांना अनुत्तरीत वाटणाऱ्या प्रश्नांना एक सकारात्मक पर्याय देऊन जातो.

"येथली जमीनही नीट ना कळे तुला,
वाचतोस सारखा काय आसमंत तू."

राऊतांच्या गझलेचे वाचन वेळ, काळ बदलून केले असता त्यातून वेगवेगळ्या अर्थछटा अनुभवास येतात. त्या अनुभवातून वाचकांस अंतर्मुख होण्याचा आनंद मिळतो.

"सांजवेळी संगतीला एक नाही पाखरू,
तेरवीच्या पंगतीला खूप आली माणसे"

एका संवेदनशील व्यक्तिच्या मनाला जे-जे प्रश्न पडतात, ते सर्व प्रश्न राऊतांच्या गझलेचा विषय झालेले आहेत. कोणत्याही एका विशिष्ट आवर्तात त्यांच्या गझलेला बांधता येत नाही. एकाच गझलेमध्ये वेगवेगळे विषय येणे हे गझलेचे वैशिष्ट, राऊतांच्या गझलेविषयी तंतोतंत लागू पडणारे आहे. श्रीकृष्ण राऊतांच्या गझलेतील दु:ख एकाचवेळी वैयक्तिक आणि सामाजातील दु:खाचे प्रातिनिधीक प्रतीक म्हणून आलेले आहे. तुकारामांच्या अभंगातील दु:ख जसे एकाचवेळेस तुकोबांचे होते आणि त्याकाळातील सामाजिक जीवनाचेही होते त्याप्रमाणे अनुभवसदृश्यता या गझलेतून दिसून येते.

"आत्मकेंद्री फार झाले खानदानी आरसे
त्यात नाही स्पष्ट आता दु:ख माझे फारसे"

समाजातील सुख-दु:खाच्या अनुभवाला मांडताना जुन्या काळातील गावाचे चित्र डोळ्यासमोर उभे करण्याची शैली दिसून येते. आजच्या इतके जाती-धर्माचे वा माणुसकीला पारखे झालेली स्थिती पूर्वीही गावामध्ये नव्हती, तर लोकं कुणाच्याही सुख-दु:खात धावून जायचे त्याला मदत करायचे. त्याच्या घरातील कार्य आपल्या घरातील कार्य समजून घ्यावयाचे. याउलट आज दारांसमोर येणाऱ्याला पाणी मिळेल का? याची शाश्वती देता येत नाही. जातीचा, पदाचा व प्रतिष्ठेचा एवढा अहंकार पूर्वीही नव्हता. तो आज येत चाललेला आहे. साहेब, अंमलदार, खानदानी श्रीमंती आदींचा फार गर्व असण्याचे प्रतिबिंब 'आरसे' या प्रतिमेतून गझलकार सांगू पाहतात, आणि या ठिकाणी 'मी' हा सर्वसामान्य लोकांची भूमिका घेऊन येताना दिसतात. श्रीमंताच्या उत्सवाच्या सोहळ्यात जर ते मश्गुल असतली तर दीन-दलित, गरीब लोकांची दु:ख त्यांना कशी दिसणार? हा एक नैतिक प्रश्न त्यांना या गझलेच्या आधारे समाजाला विचारायचा आहे, असे वाटते. माणसाने समाजकेंद्री, समाजशील व्हावे अशी अपेक्षा व्यक्त केली आहे- "मला हा एकदा जेव्हा दिला आधार शब्दांनी, /बघा आकाश ताऱ्यांचे कसा मी तोलतो आता"

संत तुकोबांपासून केशवसुत, मर्ढेकर, नारायण सुर्वे, वामन निंबाळकर यांच्या पर्यंत शब्दांचे महत्त्व प्रसिद्ध आहे. केशवसुत म्हणता- 'आम्हाला वगळा गतप्रभ झणी होतील तारांगणे', कारण कवी, कलावंतानीच या चंद्र, सूर्य, ताऱ्यांना सौंदर्य बहाल केले आहे. सुरेश भटांनी तर म्हटले 'आकाश तारकांचे उचलून रात्र गेली.' या ठिकाणी राऊतांनीही म्हटलेले आहे की, शब्दांची दौलत, ताकद, श्रीमंती माझ्याकडे आहे तर मी तारकांचे आकाशही उचलू शकतो. 'तारका' ही प्रतिमा दु:खाची म्हणून येते. आभाळातील अगणित चांदण्या इतक्या दु:खांशी सामना करायला तयार आहे. वयाच्या सतराव्या वर्षापासून श्रीकृष्ण राऊत 'हायपरटॉफीक स्युडोमस्क्युलर डिस्ट्रफी' या नावाच्या आजाराशी लढत आहेत. पण त्याचा कोणताही बाऊ त्यांच्या वागण्या-बोलण्यात दिसून येत नाही.

"जसा तो बोलतो आहे तसा तो चालला नाही,
तुकारामास नव्हता रे कुणीही पाठचा भाऊ ..."

वरील 'शेर' संबंधी असे म्हणता येईल की, 'बोले तैसा चाले, त्याची वंदावी पाऊले' या अभंगाच्या मतीतार्थाने गझलकार म्हणतात, तुकारामांनी त्या काळात व्यक्त केलेली अपेक्षा आज ही लागू आहे. खोटे बोलने हाच जणू आज समाजाचा शिष्टाचार झाला आहे. चांगला माणूस,सज्जन माणूस, देव माणूस कोणाला म्हणावे तर बोलण्याला जागणारा असा कोणीही दिसत नाही. म्हणून तुकोबांना कोणी पाठचा भाऊ नाही तशी माणूसपणाची वृत्ती आज दुर्मिळ झाली आहे. आपल्या आदर्शांना आपण डोक्यावर घेवून त्यांचा उदोउदो करणार मात्र त्यांचे विचार डोक्यात घेणार नाही. हीच समस्या आजच्या समाजाची झालेली आहे. आम्हाला सर्व कळतं पण वळत मात्र नाही. ही माणुसकी समाजामध्ये नांदावी. तुकारामाना अपेक्षित समाज

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February 2023 Special Issue 07 Volume VI (B) SJIF Impact- 5.67

आदर्श समाज निर्माण व्हावा ही गझलकाराची मनोमन असलेली इच्छा या ठिकाणी व्यक्त करताना दिसतात. तुकारामांना पाठचा भाऊ कान्होंबा होता पण कर्जाची गहाण खते इंद्रायणीत बुडविण्याची वेळ आली तेव्हा मात्र त्याने आपल्या हिश्शाची गहान खते देण्यास नकार दिला. ती त्या काळातील कर्जमुकतीच होती. ही कळवळ्याची वृत्ती 'बुडत हे जन` अशी होती. हीच भूमिका राऊतांची या ठिकाणी दिसून येते- "चोरून रोज खातो उर्दूमधील लोणी / सायीवरी मराठी माझे इमान नाही."

गझल म्हटली तर उर्दू आणि उर्दू म्हटले की गझल त्यामुळे मराठीतील बऱ्याच महाभागांनी तिकडे मुक्त संचार करायचा आणि चोरीच्या मालावर इकडे मराठीमध्ये येवून गझल लिहायची म्हणजे उर्दूच्या भाषांत्तराची गझल आता पुढील काळात पाहायला मिळेल यात नवल वाटायला नको. सुरेश भटांनी मराठीचे महत्व जाणलेले होते. त्यांनी मराठी गझलेवर उर्दू भाषेला कलम केले नाही. आजही मराठी गझलेचे हितचिंतक म्हणविणारे उर्दू-हिंदी गझलांचे समीक्षण मराठीतून करताहेत. इथे मराठी गझलेची समीक्षा धड होत नाही आणि तिकडे उर्दू गझलेचे समीक्षण करण्याची आवश्यकताच काय? असा प्रश्न उभा होतो. त्यामुळे अशा वृत्ती असणाऱ्या व्यक्तिकडूनच उर्दूतील नजाकत मराठीपेक्षा कितीतरी पटीने जास्त आहे असे वाटायला लागते परंतु ही बाब विसरल्या जाते की, उर्दू भाषेच्या जन्मासाठी मराठी प्रांत आणि मराठी भाषेनेच तिला चैतन्य पुरविले आहे. तेव्हा मराठीमध्ये गझल लिहिण्यासाठी उर्दूचे ज्ञान असण्याची गरजच काय? अशा महाभागांची चलाखी जेव्हा कवींच्या लक्षात येते तेव्हा गझलकारांनी स्वताचे आत्मपरिक्षण करण्याची गरज आहे. ज्या भाषेत आपण लिहितो त्या भाषेशी इमान राखले तरच चांगली गझल निर्माण हाईल असा शहाणपणाचा सल्लाच कवी गझलकारांना या शेर च्या माध्यमातून देवू इच्छितात.

मराठी गझलेला सुरेश भटांच्या पुढे मार्गक्रमण करण्यासाठी अद्यावत उर्दूच्या नियमांचे ज्ञान असणे फार महत्वाचे आहे. गझलेचा गंध मराठी आहे की उर्दू आहे यापेक्षा त्यातील आशय - विषय किती जीवनाचे शाश्वत ज्ञान अवगत करणारा आहे. अंतर्मुख करणारा आहे, विचारप्रवण, आनंद देणारा आहे, हे फार महत्वाचे आहे,

"रे दु:ख माणसाचे अंतिम सत्य आहे,
बाकी मवाळ साऱ्या आहेत जाहिराती."

सत्याला सत्य म्हणून जाणावे आणि असत्याला असत्य म्हणून असे तत्वज्ञानच राऊतांच्या या शेरातून दिसते. जीवन दु:खमय आहे, हे आधी कळावं लागतं, मग तो राजा असो वा रंक त्याला दु:खाची जाणीव झाली तरच तो समानतेने वागेल. जीवनाचे तत्वज्ञान एखादी मोठी कादंबरी लिहून सांगता येणार नाही, ते या दोन ओळींच्या शेर मधून राऊतांनी सांगितले आहे. राम पंडित असे म्हणतात - "श्रीकृष्ण राऊत यांच्या 'गुलाल आणि इतर गझला` संग्रहातील एकोणसत्तर गजलांची अधिकृतता कोणताही रसिक प्रमाणित करेल या गजलांचा सौंदर्यानुभव, त्यातील अर्थपूर्ण अभिव्यक्ती व किंचित प्रतिकात्मक असूनही संप्रेषणीय होणाऱ्या कल्पना विचारात दडलेला आहे" ते त्यांच्या पुढील काही शेर च्या माध्यमातून पाहू-"सौभाग्य रेखणारे कुंकूच भासले जे, / कोण्यातरी मढ्याचा तोही गुलाल होता." / "मैत्री करून जमले बगळे सभोवताली, /टिपले हळूच त्यांनी माझ्या खिशात मासे." / "तसा न चंद्र राहिला, तशी न रात राहिली, /अजूनही तशीच तू तनामनात राहिली."

शेर हा एक स्वतंत्र अभिव्यक्ती असलेली स्वतंत्र कविता आहे, याचा पूर्ण आनंद राऊतांची गझल देते. संपूर्ण गझलेचा एक अंतस्थ धागा हे राऊतांचे वेगळेपण, त्यांच्या प्रत्येक गझलेमध्ये दिसून येते. त्यांनी गझलेच्या स्वतंत्रपणाला कोणताही बाध होत नाही वा कोणताही एक शेर वेगळा करून घेतला तर ती संपूर्ण अर्थ व्यक्त करणारी अभिव्यक्ती ठरते. हे खास वैशिष्ट राऊतांच्या गझलेचे सांगता येईल. त्यांच्या विषयी बोलताना डॉ. राम पंडित म्हणतात की, "शेरातील विषयांच्या वैविध्याने उर्दू रसिक वाचक/श्रोत्यांना रसोभंग जाणवत नसला तर तो प्रदीर्घ परंपरेचा परिणाम म्हणावा लागेल. मराठी काव्य रसिकांची अशा विषयांतरणाची आस्वादकवृत्ती अलिकडेच वाढीस लागली आहे. भटांच्या नंतर ज्या मोजक्या गजलकार कवींनी अशा विविध विषयांवरील शेरांच्या लक्षणीय गजला लिहिल्या, त्यात श्रीकृष्ण राऊत यांचे नाव अग्रक्रमाने निश्चितच घ्यावे लागेल." मराठी रसिकांनाही उर्दूच्या विशेषांप्रमाणे आनंद निर्मितीचा अनुभव निश्चितच राऊतांच्या गझलेतून मिळतो आहे. आणि त्यांच्या गझलेचे आणखी एक विशेष की, त्यांच्या गझलेला कोणत्याही विषयाचे वावडे नाही. दलित, ग्रामीण, आदिवासी, स्त्रीवादी अशा कोणत्याही आशय कक्षेमध्ये स्वत:ला न बांधता मुक्त चिंतन त्यांचे असते, त्यामुळे त्यांच्या गझलांमध्ये विषय वैविध्य जास्त प्रमाणात आहे. त्यासंदर्भात डॉ. राम पंडित असे म्हणतात की, "समकालीन गजलेस कोणताही विषय वर्ज्य नाही. त्यामुळे ती आशय व अभिव्यक्तीच्या दृष्टीने वर्तमान कवितेबरोबर प्रवास करीत आहे. मात्र छंद,रदीफ,काफिया इत्यादी कलात्मक अपरिहार्यतेमुळे व प्रतिभावान गजलकारांच्या कमतरतेमुळे तिचा प्रवास धीमा आहे. हाताच्या बोटांवर मोजता येतील एवजेच

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गजलकार भिडणारी गजल लिहिताहेत त्यात मी श्रीकृष्ण राऊत यांचा समावेश करेन.''गझल सम्राट सुरेश भटांनंतर मराठी गझल या काव्यप्रकारात विदर्भात कोणी बादशाहत निर्माण केली असेल तर ते गझल बादशहा श्रीकृष्ण राऊत आहेत.

"वाफ्यातले जुने हे बदलू जरा बियाणे
तेव्हा कुठे इथेही उगवेल पेरलेले"

वरील शेराविषयी प्रकाश धुळे असे म्हणतात- "इथं पेरलेल उगवत नाही (याचाच दुसरा अर्थ पेरलं तेच उगवत नाही असाही होऊ शकतो) म्हणून वाफ्यातलं जुनं बियाणं बदलण्याचा विचार कवी सुचवतो. पण पेरलेलं उगवत नसेल तर त्यासाठी फक्त बियाणंच कारणीभूत असू शकतं का? किंवा गाजराचं बियाणं पेरून जर कांदे उगवत असतील तर त्याला गाजराचं बियाणं कसं म्हणता येईल? ते कांद्याचं बियाणं होईल. ... आणि या दोन्ही स्थितीत दोष बियाण्यालाच कसा देता येईल? त्याआधी माती, पाणी, खते अशा अन्य गोष्टी बदलून बघण्याचा प्रयत्न व्हायला हवा. असं मला आजही वाटतं. मी सुचवलेला माती हा शब्द या अर्थानंच आलेला आहे. तो शब्द जर गजलच्या बहर/वजन मध्ये बसत नसेल तर कवीनं त्यासाठी अन्य पर्यायी शब्द शोधावा. त्यानी थेट बियाणं बदलण्याचा माडलेला विचार म्हणूनच मला चूकीचा वाटीतो. इथं मी कंसात दिलेला अर्थ कवीला अभिप्रेत नसेलही कदाचित, पण त्या अर्थाची शक्यता नाकारता येईल का? ... मी तरी नाकारणार नाही." गझलेचा वाच्यार्थ लक्षात घेऊन प्रकाश धुळे यांचा आक्षेप आहे, असे दिसून येते. भारतीय समाजातील एक सामाजिक विषमतावादी परंपरा आहे तर दुसरी सामाजिक समतावादी परंपरा आहे. आणि गझलकार निश्चितच सामाजिक समतावादी विचार प्रवृत्तीचे आहेत. त्यामुळे 'बीज' ही प्रतिमा मूलतत्ववादी विचाराचे निदर्शन करते. जुने विचार परंपरावादी असतात. त्यामुळे नवीन बियाणे, नवीन विचारांचे बियाणे रुजविण्याची आवश्यकता येथे गझलकार बोलून दाखवित आहेत. बदल म्हणजे परिवर्तन. शेतीचे रुपक घेवून हा नवीन वाफा ज्यामध्ये पिके घेतल्या जातात त्या मध्ये जुने परंपरावादी विचारांच्या बियाणां ऐवजी नवीन बियाणे पेरले तर तेच उगवणार हाच गझलकारांना अपेक्षित अर्थ त्यांच्या एकूण गझलेचा विचार करता दिसून येतो. "दोह्यात जीव नाही, गझलेत जान नाही /शायर जगात दुसरा माझ्या समान नाही"

मराठी गझलेविषयी दुजाभाव ठेवणाऱ्या महाभागांनी कायम मराठी गझलेची हेटाळणी केली आहे. आणि उर्दूची भ्रष्ट नक्कल म्हणून हिणवले आहे, व आपण लिहितो तेच कसं योग्य असे म्हणणाऱ्या प्रवृत्तीला उद्देशूंनच उपरोधिकपणे म्हटलेले आहे. आत्मप्रौढीने नव्हे. गझल ही वृत्तांतच लिहिली जाते. आणि राऊत यांची गझल वृत्तांशी एवढी एकरूप झाली आहे की कोणी ठरवूनही चूक शोधू शकत नाही. किंवा कोणताही शेर घ्या तो वृत्तांशी तेवढाच सच्चा दिसेल. हे करत असताना मात्र गझलीयतशी कोणतीही जडजोड ते करत नाहीत. हे त्यांचे खास वैशिष्टये आहे. राऊतांची गझल प्रत्येक पिढीच्या माणसाशी बोलते, बदलत्या काळावर भाष्य करताना रोजच्या धकाधकीच्या जीवनात आनंदाला पारखे झालेले यंत्रवत जीवन आयुष्यात निराशा घेऊन येते तेव्हा त्यातून मार्ग काढणारा दिलासा राऊत आपल्या निरीक्षणातून देवून जातात- "एक साधा मंत्र सांगू का सुखाचा / आण गजरा बायकोला छानपैकी"

एकाच वेळी अनेक अर्थ प्रसवण्याची ताकद राऊतांच्या गझलेत आहे, म्हणून ती प्रत्येकाला जवळची वाटते. आपलेच अनुभव मांडणारी वाटते. 'कारुण्य माणसाला संतत्व दान देते' या संग्रहात गझलेचा शीर्षक नाहीत, हे गझल अधिक तंत्रशुद्धतेकडे जाणारे वाटते. अनेक कवितांचा गुच्छ म्हणजे गझल, याला ते न्याय देणारे आहे. भ. बुद्ध, संत ज्ञानेश्वर, संत तुकाराम, म. फुले, डॉ. बाबासाहेब आंबेडकर या महापुरुषांच्या विचाराला आदर्श मानून श्रीकृष्ण राऊत समाजाकडे बघतात- "ज्ञानेश्वरास छळती, पीळतात जे तुक्याला / पाहून घ्या विठोबा अवतार निंदकाचे"

म.फुल्यांना अपेक्षित असलेले हक्क आणि अधिकार डॉ. बाबासाहेब आंबेडकरांनी मिळून दिलेत म्हणून आजची महिला स्वाभिमानाने जीवन जगत आहे. त्या विषयी गझलकार म्हणतात."अबलांच्या पाठीमागे कायदा उभा तू केला /शिवलेल्या ओठांवर मग हक्कांची आली गाणी"

इहवादी,लौकिक जीवनातील प्रेम, कौटुंबिक स्वास्थ्य, शेतकऱ्यांच्या आत्महत्या, स्त्री-सन्मान, आई-वडिलांच्या समस्या, व्यवहारातील फसवणुकी, प्रत्येकाला आपल्या जगण्यातील भाग वाटतो- "दु:खास धर्म नसतो, ना जात वेदनेला / हे मर्म जाणणारा सर्वज्ञा मानतो मी ।" / "सुखद:ख सांगण्याला उरली कुठे न जागा / शोधू तुला कुठे मी जग हे उदासवाने" /"बापास ठेव येथे, आई तुझ्याकडे ने / वृद्धपकाळ त्यांचा पोरात वाटलेला" / "आत्महत्या पाप आहे खूप झाले सांगणे / पोटभरल्या चोचल्यांचे खूप झाले सांगणे"

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अशा एक ना अनेक शेरांमध्ये गझलीयत विचारगर्भता ओतप्रोत भरलेली आहे. चिंतनशीलता हा जणू तिचा स्थायीभावच आहे. कारुण्याचे गझलेला दान देणारे विद्यापीठ श्रीकृष्ण राऊतांच्या माध्यमातून कार्यरत आहे. राऊतांच्या गझलेमध्ये सिद्धार्थ गौतम बुद्ध, यशोधरा, श्रीकृष्ण, राधा, मीरा, द्रोपदी, महात्मा फुले, डॉ.बाबासाहेब आंबेडकर, संत गाडगे बाबा, संत तुकोबा, संत ज्ञानेश्वर अशा अस्सल देशी प्रतिमा आणि प्रतीके येतात. त्यांची गझल सर्व समाज घटकांच्या सूक्ष्म निरीक्षणचाचे प्रतिनिधित्व करते. मानवी वृत्ती प्रवृत्तीवर बोलते, ती सामाजिक, राजकीय, उपदेशात्मक, संस्कारादी विषयांच्या अनुषंगाने आपल्याशी संवाद साधते. राऊतांच्या गझलेमध्ये स्त्री जाणीव, जागतिकीकरण, मिथक कथा, नेते, सावकार-शेतकरी, आई, सुखी जीवनाचे मंत्र, प्रेमविषयक जाणीव, नकलीपणा, माणसांचे होणारे अवमूल्यन, दु:ख, वेदना, वास्तव अशा सर्वांग विषयांवर ही गझल भाष्य करते. यासंदर्भात वसंत केशव पाटील असे म्हणतात की,- "सुरेश भटांनंतरच्या पिढीतील बिनीचे गझलकार म्हणून श्रीकृष्ण राऊत यांचे स्थान उल्लेखनीय आहे. हे निर्विवाद." सुरेश भटांनंतर बाराखडीच्या पुढचा प्रवास राऊतांच्या गझल चवदाखळीतून होत आहे.

संदर्भग्रंथ :

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प्रज्ञा दया पवार यांच्या साहित्याचे विवेचन

प्रा. डॉ. संजय एस. पोहरे
मराठी विभाग
श्री शिवाजी कला, वाणिज्य व विज्ञान महाविद्यालय, अकोला
मो. ९८२२२९६१२७ मेल : sspohare@gmail.com

प्रस्तावना :

प्रज्ञा दया पवार यांचे साहित्य स्त्रीवादी साहित्याची समीक्षा करणारे आणि त्यांच्याशी संवाद साधणारे साहित्य आहे. अनेक स्त्री लेखिकांनी स्त्रीवादी साहित्य लिहिले, स्त्रीयांवर होणाऱ्या रूढी–परंपरागत अन्याय–अत्याचार, हीनतेची जाणिव होऊन प्रत्येक स्त्री लेखिकेने आपले साहित्य समृद्ध केले आहे. परंतु प्रज्ञा दया पवार यांचे साहित्य भारतीय नव्हे तर आंतरराष्ट्रीय स्त्रीयांच्या चरित्राचे वाचन, चिंतन–मनन करून आलेले आहे. त्यामध्ये इसाडोरा डंकन, इनग्रिड बर्गमन, मरियम मकेबा, माय ॲंजेलो, तहमिना दुराणी, अशा स्त्रीया भेटतात. त्यामुळे प्रज्ञा दया पवारांचे साहित्य व्यापक मानसिक सजग बनवणारे साहित्य आहे असे म्हटल्यास वावगे ठरणार नाही. स्त्रीला तिच्या हक्क आणि कर्तव्याची योग्य जाणिव करून देते. स्त्रीवादी असणे म्हणजे पुरुषाच्या विरोधी असणे असे नव्हे तर पितृसत्ताक समाज व्यवस्थेचे मानसिक गुलामी नकारणे होय. आणि त्या ठिकाणी स्वातंत्र, समता, न्याय व बंधुता या मूल्यावर आधारित सामाजिक समता निर्माण करणारे विचार प्रस्तापित करणे होय.

प्रज्ञा दया पवार साहित्य निर्मितीमध्ये परंपरागत सांस्कृतिक मळवाटेने जाताना दिसत नाहीत तर थेट साहित्याला बहुधा वर्ज्य असलेल्या समकाळातील राजकीय प्रश्नांना जाऊन भिडतात. हे सर्व मांडत असताना मराठी भाषेचे तथाकथित नियम मोडून प्रचलित इंग्रजी शब्द–संज्ञेचा सन्हास वापर करताना दिसतात. त्यातूनही त्यांची भाषेविषयीची भूमिका ते स्पष्ट करतात– लोकभाषा ज्ञानभाषेत परावर्तीत करणं, विज्ञान आणि माहिती तंत्रज्ञानाने निर्माण होणाऱ्या स्थित्यंतरांना अचूक पकडता येण्याइतकं भाषेला सक्षम करणं आपल्याला जमलं आहे का? आनी–पानी करणाऱ्यामध्ये न्यूनगंड निर्माण करणारी मराठी आपण निर्माण करणार आहोत काय? असे प्रश्नही त्या उपस्थित करतात. एकूनच समाजाला मूलतत्ववादाची गुंगी देऊन अश्मिभूत करणाऱ्या राजकीय व्यूहनीतीला नव्वदोत्तरी लेखकाने सांस्कृतिक व्यूहनीतीच्या व्यापक भाषिक कृतीतून सशक्त पर्याय उभा करणं आता निकडीचं ठरणार आहे. आधुनिकवादासाठी नव्हे, तर संपूर्ण मानवी अस्तित्वासाठी. अशी साहित्य विषयक भूमिका आपल्या साहित्य लेखनाची घेऊन मराठी साहित्य विश्वात त्या आलेल्या दिसतात.

प्रज्ञा दया पवार ज्या दाटीवाटीत उभ्या आहेत तिथली धसमुसळी रेटारेटी अटळ आहे. ती रेटारेटी कधी पुरुषी आहे, कधी ब्राहमणी आहे, कधी वर्गीय आहे, कधी वर्चस्ववादी आहे, कधी भांडवलदारी व्यवस्थेची आहे. एकूणच कवी–लेखक म्हणून किंवा वैचारिक लेखन म्हणून त्यांच्या मनात एक व्दंव्द सळसळत असतं ते स्वकीयांबाबत असतं, पुरोगामी, डावे किंवा फुले–आंबेडकरी विचारांचीसुद्धा पताका खांद्यावर घेतलेल्या लोकांची फसगत कुठे होते यावर त्या भाष्य करतात. प्रज्ञा दया पवार या अनुभवातून गेल्यात अन् त्यावर बोलक्या देखील झाल्यात. याच ठिकाणी त्यांच्या लिहिण्यामागच्या प्रेरणाही त्या स्पष्ट करतात. कुठल्याही गटात, पंथात, मठात, कळपात राहायचे त्या नाकारतात आणि त्यांच्यावर येणारे बंधने त्या झुकारून लावतात. 'मला समजलेल्या फुले–आंबेडकरवादाच्या सम्यक भानाने लिहीत राहिल' अशी ठाम भूमिका घेतात. त्यांची कविता फक्त तात्विक नाही, केवळ वैचारिकही नाही, तर त्या वैचारिकतेला, तात्विकतेला मानवतावादाचा आणि जीवनानुभवाचा एक खोल, उत्कट, अस्सल, जीवंत स्पर्श आहे. माणसाच्या दु:खाला निकटतेने जाणणारी एक ओली सहृयता आहे. प्रज्ञा दया पवारांच्या कवितेचे केंद्रवर्ती आशयसूत्र केवळ दलित जाणिवेची कविता नाही तर या कवितेचा पैस त्याहीपलीकडे माणुसपणापर्यंत पसरलेला आहे. पुरुषप्रधान व्यवस्था आणि जातीव्यवस्था या व्यवस्था म्हणून एकच आहेत, याचे भान ही कविता देते. स्त्री–पुरुष संबंधावर निर्भीडपणे भाष्य करते. इथल्या कुटुंबव्यवस्थेने, लग्नसंस्थेने बाईला कसे पद्धतशीरपणे शोषण करून अन्यायग्रस्त ठेवले आहे. दुय्यमत्वाची एकही संधी या व्यवस्थेने सोडलेली नाही.

प्रज्ञा दया पवार यांनी सुरुवातीचे लेखन प्रज्ञा लोखंडे नावाने केले आहे. या मराठीतील कवयित्री आणि लेखिका आहेत. पाक्षिक 'परिवर्तनाचा वाटसरू' च्या त्या संपादक आहेत. शिवाय महाराष्ट्र राज्य साहित्य व संस्कृती मंडळ, डॉ.बाबासाहेब आंबेडकर चरित्र व साधने प्रकाशन समिती आणि मराठी संशोधन मंडळ या संस्थांच्या त्या

सदस्या आहेत. ख्यातनाम मराठी साहित्यिक दया पवार यांच्या त्या ज्येष्ठ कन्या आहेत. अलिकडेच प्रज्ञा दया पवार यांनी देशातील असहिष्णुता आणि तिरस्काराच्या वाढत्या वातावरणाचा निषेध म्हणून त्यांचे साहित्य पुरस्कार राज्य सरकारला परत केले.

प्रज्ञा दया पवार या ज्ञानसाधना महाविद्यालय, ठाणे येथे मराठी विभाग प्रमुख म्हणून कार्यरत आहेत. त्यांच्या प्रकाशित साहित्य कृतीमध्ये 'अंतस्थ' हा पहिला कविता संग्रह १९९३ ला मानसन्मान प्रकाशन पुणे यांनी प्रकाशित केला. त्या काव्यसंग्रहाची दुसरी आवृत्ती २००४ साली डिम्पल प्रकाशन, मुंबई यांनी काढली. त्यांचा दुसरा कविता संग्रह ' उत्कट जीवषेण्या धगीवर' हा २००२ साली लोकवाङ्मय गृह, मुंबई यांनी प्रकाशित केला. 'मी भिडवू पाहते समग्राशी डोळा' हा कविता संग्रह २००७ साली ग्रंथाली प्रकाशन, मुंबई यांनी काढला. 'आरपार लयीत प्राणांतिक' हा कविता संग्रह २००९ साली लोकवाङ्मयगृह, मुंबई यांनी काढला आणि दुसऱ्या वर्षी म्हणजे २०१० ला याच संग्रहाची दुसरी आवृत्ती प्रकाशित करावी लागली. 'दृश्यांचा ढोबळ समुद्र' हा कविता संग्रह २०१३ साली पॉप्युलर प्रकाशन, मुंबई यांनी प्रकाशित केला आहे. या पाच कविता संग्रहासह 'धदांत खैरलांजी' हे नाटक २००७ साली आणि 'केंद्र आणि परिघ' हा ललित लेख संग्रह २००४ साली डिम्पल प्रकाशन, मुंबई यांनी प्रकाशित केला आहे. 'टेहलटिकोरी' हा लेखसंग्रह २०१६ साली अक्षर प्रकाश्न मुंबईने प्रकाशित केला आहे. 'अर्वाचीन आरण' गद्यलेखन २०२० साली शब्द प्रकाशन, मुंबई यांनी प्रकाशित केला आहे.

वरील सर्व साहित्य कृतीसाठी त्यांना मातोश्री भीमाबाई आंबेडकर पुरस्कार, बिरसा मुंडा राष्ट्रीय साहित्य पुरस्कार, महाराष्ट्र फाऊंडेशन पुरस्कार, शांता शेळके पुरस्कार, महाराष्ट्र राज्याचे केशवसुत पुरस्कार, बालकवी पुरस्कार, इंदिरा संत विशेष पुरस्कार, ग.ल.ठोकळ विशेष पुरस्कार, बोधिवर्धन पुरस्कार, वनिता समाज गौरव पुरस्कार इत्यादी पुरस्कारांनी त्यांना सन्मानित केलेले आहे. त्याचप्रमाणे औरंगाबाद येथे आयोजित गुणिजन संमेलनाच्या अध्यक्षा (२०१२) पाटण (सातारा जिल्हा) येथे आयोजित विभागीय साहित्य संमेलनाचे अध्यक्षपद (२०१५), लातूर येथे आयोजित अस्मितादर्श साहित्य सूमेलनाचे अध्यक्षपद (२०१७), विरार , पालघर जिल्हा येथे आयोजित शिक्षक साहित्य संमेलनाचे अध्यक्षपद (२०२०), मॉस्को रशिया येथे झालेल्या वर्ल्ड बुक फेअरमध्ये निमंत्रितांच्या कविसंमेलनात सहभाग (२००९). या सर्व मानसन्मानातून व पुरस्कारातून त्यांच्या कार्याचा वा लेखनाचा अदमास घेतल्यास तो निश्चितच मराठी साहित्य विश्वासाठी गौरवाची व मोलाची भर टाकणरा ठरतो आहे. वंचित, कष्टकरी, सर्वहारा, बहुजन, दलित, भटकी, आदिवासी खऱ्या अर्थाने जीवतोड श्रमातून, घामातून संस्कृती निर्माण करतो आणि तोच चेहरा हा अस्सल भारतीय चेहरा असतो अशी परखड भूमिका प्रज्ञा दया पवार सातत्याने आपल्या साहित्यातून मांडत आलेल्या दिसतात. यासर्व घटकांचे साहित्यातील प्रतिबिंब अभ्यासणे पुढील साहित्य अभ्यासासाठी मोलाचा व मैलाचा दगड ठरू शकते.

प्रज्ञा दया पवार यांचे साहित्य हे स्त्रीवादी, दलित साहित्य क्षेत्रापुरते मर्यादित नसून एकूणच माणुसपणाच्या मूल्यांची जोपासना करणारे आहे. त्यांच्या साहित्यातून जातिअंताची चळवळ, स्त्री मुक्तीची चळवळ आणि सर्व परिवर्तनवादी चळवळीसाठी लागू असणारे रसायण आहे. त्यामुळे त्यांच्या समग्र साहित्याच्या अभ्यासाला महत्व प्राप्त होते. 'प्रज्ञा दया पवार यांच्या साहित्याचा विवेचक अभ्यास' करीत असताना हे संशोधन क्षेत्र एक विद्याशाखीय न राहता आंतरविद्याशाखीय होत असल्याचे दिसते.

दलित साहित्याच्या निर्मितीचा पुढील विकास टप्पा म्हणजे आंबेडकवादी साहित्य होय. शोषणाचा, गुलामीचा संदर्भ ज्या साहित्याला असेल आणि त्यातून मुक्तीची जाणीव आंबेडकरवादी प्रेरणेने झाली असेल असे जगातील कोणतेही साहित्य आंबेडकरवादी साहित्य होय. मिलिंद साहित्य सभा, अस्मितादर्श, सिंहगर्जना, समुचित या विचारपीठांतून आंबेडकरवादी साहित्य साकारत गेले. दलित समाजातील स्त्री लेखिकांना आणि कार्यकर्त्यांना एका बाजुला उच्चवर्णीय समाजातून येणाऱ्या काहीशा व्यक्तिवादी–स्त्रीमुक्तिवादी भूमिकेच्या सहकाऱ्यांना दलित–शोषित समाजातील स्त्रियांच्या जातीय दमन आणि शोषणाची दाहकता नव्याने सांगावी लागते. त्याचवेळी दलि समाजातील फुले–आंबेडकर यांच्या विचारांनी प्रेरित कार्यकर्त्यांच्या पुरुषसत्तावादी भूमिका आणि जाणिवा बदण्यासाठी सतत संघर्ष करावा लागतो. अशा गुंतागुंतीच्या वास्तवाचे विश्लेषण प्रज्ञा दया पवार यांच्या समग्र साहित्याच्या अभ्यासातून करता येईल.

प्रज्ञा दया पवार स्त्रीवादी दलित लेखिका म्हणून वावरत असताना ज्या वास्तवाला, अनुभवांना सामोरे जातात त्याचेच मर्मभेदक विश्लेषण त्या आपल्या साहित्यातून करतात. व्यक्तिगत जगण हे सुद्धा राजकीयच असते ही भूमिका स्त्रीमुक्तीवादी चळवळीने जगभरात प्रस्थपित केली. या भूमिकेतून भारतात स्त्रीमुक्ती, जाति अंताच्या चळवळी, आदिवासी अस्मितेच्या चळवळी आणि एकूणच डाव्या विचार प्रवाहाला मोठे बळ मिळाले. विविध

सामाजिक आणि राजकीय विश्लेषण पद्धतीचे आयाम बदलले या बदललेल्या वेचारिक प्रवाहाचे प्रतिनिधित्व आणि प्रवक्तेपण प्रज्ञा दया पवार करतात. तात्विक मांडणी म्हणजे तटस्थ, काहीसे भावना विरहित विश्लेषण हा संकेत ही धारणा स्त्रीमुक्तीवादी ततवचिंतनाने बदलली त्याचा प्रभावी साक्षात्कार प्रज्ञा दया पवार यांच्या लेखणीतून प्रतीत होतो. नव्वदोत्तर काळात त्यांनी घेतलेली स्त्रीवादी भूमिका ही निश्चितच एक विधायक विचार मांडणारी आहे. म्हणूनच मराठी साहित्य क्षेत्रामध्ये प्रज्ञा दया पवार यांच्या साहित्याचा समग्र अभ्यास महत्वाचा ठरतो.

प्रज्ञा दया पवार यांच्या समग्र साहित्याचा अभ्यास करताना त्यांच्या साहित्यातील महत्वाचा पैलू म्हणजे त्यांनी स्त्रीवादाच्या दृष्टिकोनातून केलेले लेखन हा होय. इंग्रजीतील फेड या संज्ञेला पर्यायी संज्ञा म्हणून मराठीत 'वाद' संकल्पनेचा उदय झालेला आहे. स्त्रीवादी साहित्याचा उगम हा अचानक झालेला नाही. मूलत: एकूणच जागतिक पातळीवर स्त्रियांच्या दमनस्थितीमुळे विचार करणाऱ्या अनेक स्त्रिया चिंतन करायला लागल्या स्त्री म्हणून स्त्रीला आलेले अनुभव आणि पुरुषप्रधान सांस्कृतिक परिप्रेक्ष्यामुळे स्त्रीच्या वाटयाला आलेले अनुभव, त्यामागील पुरुषसत्ताक समाज व्यवस्थेची मानसिकता नाकारण्याचे काम करणरा विचार म्हणजे स्त्रीवाद होय असे म्हणता येईल.

प्रज्ञा दया पवार यांची भारतीय साहित्यात आज स्वतंत्र स्त्रीवादी विचारधारा स्पष्टतेने जाणवू लागलेली आहे. वेदना, विद्रोह आणि नकार यातून फुले–आंबेडकर यांच्या प्रेरणेतून दलित साहित्याचा प्रवाह निर्माण झाला. त्यातही मराठी कवितेत दलित–स्त्रीवादी साहित्याने विचारांची व्यापकता वाढवली आहे. दलित स्त्रीची स्त्रीवादी भूमिका मराठी साहित्यात येणाऱ्या सवर्ण स्त्रीयांच्या स्त्रीवादापेक्षा भिन्न असलेली दिसून येते. हे महत्वाचे अनुभव विश्व प्रज्ञा दया पवार यांच्या साहित्यातून अभ्यासता येतील. दलित –वंचित स्त्रीची व्यथा, वेदना, तगमग त्यातून जन्माला आलेली व्यापक विद्रोहाची भावना प्रज्ञा दया पवार यांच्या साहित्यातून प्रखरशाने दिसून येते.

प्रस्तुत संशोधनामध्ये प्रज्ञा दया पवार यांच्या समग्र साहित्याचा विवेचक अभ्यास करण्यात येणार आहे. संपादक संजय पवार यांनी संपादित केलेल्या 'आभाळ पेलताना' आंबेडकरी कवयित्रींचा महत्वाचा दस्तावेज या ग्रंथामध्ये प्रज्ञा दया पवार यांच्या कविता व त्यांच्यावर भाष्य केलेले आहे. 'नव्वदोत्तर आंबेडकरी कवितेची मीमांसा' या वाड्.यीन समीक्षा ग्रंथामध्ये डॉ. अशोक रा. इंगळे यांनी प्रज्ञा दया पवार यांच्या नव्वदोतर कवितेचे समीक्षण केलेले दिसते. त्याचप्रमाणे 'मराठी वंचित साहित्य' या डॉ. सुनीलकूमार लवटे, अक्षर दालन प्रकाशन, कोल्हापूर यामध्ये प्रज्ञा दया पवार यांच्या कवितेचा समावेश आहे. 'पुरुष मला समजलेला' या अविनाश दुधे यांच्या संपादनाला प्रज्ञा दया पवार यांची प्रस्तावना लाभलेली आहे. दै. लोकसत्ता, दै. दिव्य मराठी, महाराष्ट्र टाइम्स्, परिवर्तनाचा वाटसरू आदि नियतकालिकातून त्यांच्यावर समीक्षण लिहिलेली आहेत. अनेक विद्यापीठाच्या अभ्यासक्रमामध्ये प्रज्ञा दया पवार यांच्या कविता अभ्यासक्रमामध्ये समाविष्ठ करण्यात आलेल्या आहेत. त्यामध्ये प्रामुख्याने एस.एन.डी.टी. विद्यापीठ, मुंबई , शिवाजी विद्यापीठ, कोल्हापूर आदी विद्यापीठामध्य त्यांच्या साहित्यावर अभ्यास होताना दिसतो.

प्रज्ञा दया पवार यांना स्त्रीवादी लेखन करताना लिंगभेदजन्य विषमतेबरोबरच जात वर्गवास्तव, त्याचबरोबर जागतिकीकरणातून येणारे कंगालीकरण, बाजार शरणता आणि व्याप्ती शिवायची बाकीची सर्व मानवी एकक दुय्यम ठरवत जाणेया बाबी महत्वाची भूमिका बजावत असतात. या भूमिकांचा श्धो घेणे, अर्थनिर्णयन करणे आणि त्यांच्या विरोधात हस्तक्षेप करणे हे कवी–लेखक म्हणून प्रज्ञा दया पवार चोख बजावतात.

नव्वदोत्तरी स्त्रीवादी साहित्याचे पुनरावलोकन करताना संशोधनक्षेत्रामध्ये प्रज्ञा दया पवार यांच्या समग्र साहित्याचा विवेचक अभ्यास हा विषय अद्यापपर्यंत संशोधनाचा विषय झालेला नाही त्यामुळे एक दलित कवी–लेखिका म्हणून प्रज्ञा दया पवार यांच्या बऱ्याचशा वैचारिक भूमिका प्रस्तुत प्रबंधाच्यया माध्यमातून स्पष्ट होतील.

मराठी साहित्यातील भाषांतरीत साहित्यात प्रज्ञा दया पवार यांच्या सद्य:कालीन परिस्थितीतील महत्व लक्षात घेऊन त्यांच्या मल्याळम, तमिळ, तेलगू, कन्नड, गुजराती, हिंदी, उर्दू, बंगाली रशियन आणि इंग्रजी या भाषांमधून अनुवाद करण्यात आला आहे. प्रज्ञा दया पवार यांच्या लेखनावर अभिप्राय नोंदविताना डॉ.माया पंडित म्हणतात– "प्रज्ञा दया पवार यांच्या कवितेने प्रतिकाराचे असे निखळ, नवे आणि लखलखीत आविष्कार आपल्याला दिले आहे. आपल्या कथा, कविता, नाटकांमधून एका नव्या आत्मभानाने मांडणारी दमदार लेखिका म्हणून प्रज्ञा पवार यांचा परिचय आहे."

प्रज्ञा दया पवार यांच्या लेखनामधून प्रकट होणाऱ्या आत्मभानाला नवे म्हणण्याचे कारण असे की, हे आत्मभान आधीच्या पिढयांमधल्या लेखिकांच्या आत्मभानापेक्षा निराळे आहे. हे अनेक भाष्यकारांच्या लेखनावरून प्रस्तुत संशोधनात मांडता येईल.

निष्कर्ष :

१. प्रज्ञा दया पवार आपल्या साहित्यातून समाजातील विषमतेवर निर्भिडपणे प्रहार करताना दिसतात.
२. प्रज्ञा दया पवार यांनी स्त्री–पुरुषांच्या जाणिवा परंपरागत असल्याचे मांडले आहे.
३. प्रज्ञा दया पवार साहित्यातून समकालीन राजकीय घडामोडीवर परखड भाष्य करतात.
४. प्रज्ञा दया पवार साहित्यातून समकालीन आर्थिक, सामाजिक परिस्थितीवर भाष्य केलेले आहे.
५. प्रज्ञा दया पवार यांनी समकालीन स्त्रीयांच्या व्यथा, वेदना प्रखरशाने मांडलेल्या आहेत.
६. प्रज्ञा दया पवार यांनी स्त्री–दु:खाला वैश्विक केले आहे.
७. प्रज्ञा दया पवार यांच्या साहित्यातून सामाजिक लोकशाहीचे मूल्य भान दिसून येते.
८. प्रज्ञा दया पवार यांची साहित्य लेखनाची भूमिका एका कार्यकर्त्याची दिसून येते.
९. प्रज्ञा दया पवार कोणत्याही एका साहित्य प्रकारात स्वत:ला गुंतून घेताना दिसत नाहीत.
१०. प्रज्ञा दया पवार यांच्या साहित्यातून समकालीन साहित्यिकांपेक्षा त्यांचे वेगळेपण दिसून येते.

नवे आकलन :

प्रज्ञा दया पवार यांच्या साहित्यावर विविधांगी प्रकारे लेखन झालेले आढळून येते. परंतु त्यांच्या समग्र साहित्याचा विवेचक अभ्यास संत गाडगे बाबा अमरावती विद्यापीठा अंतर्गत अद्यापपर्यंत अभ्यास झालेला आढळून येत नाही. त्यामुळे प्रस्तुत प्रस्तावित संशोधनामध्ये प्रज्ञा दया पवार यांच्या समग्र साहित्याचा विवेचक अभ्यास सविस्तरपणे केला जाईल.

प्रज्ञा दया पवार यांच्या साहित्याचे वेगळेपण म्हणजे आत्ता पर्यंत मोजक्या दलित/आंबेडकरी साहित्यिकांनी मांडलेला प्रखर नकार आणि विद्रोह त्यांच्या साहित्यात लेखिका निर्भिडपणे मांडताना दिसतात.

प्रज्ञा दया पवार पिळल्या गेलेल्या समूहातील स्त्रीयांची भूमिका वैचारिक पातळीवर उचलून धरतातच त्यासाठी फुले–आंबेडकरांचा विचार घेऊन अभ्यासात वा लेखनात समाधान मानत नाहीत तर चळवळीतल्या सर्व संघर्षात आपल्या साऱ्या लिफ्तारांसह सामील झालेल्या बहुजन–दलित–आदिवासी स्त्रियांच्याप्रती कृतज्ञता व्य करतात. स्त्रीवादाची मांडणी करताना परंपरागत स्त्रीवादाचा फोलपणा नकारतात आणि नव स्त्रीवादाची पायाभरणी करताना दिसतात.

मराठी विषयाच्या संशोधनामध्ये प्रामुख्याने महत्वाचा विषय येतो आणि तो म्हणजे भाषा. प्रज्ञा दया पवार यांच्या साहित्यातील भाषा विशेष व शैली यांचा उपरोक्त निर्देशित आराखडयानुसार त्यांच्या भाषेच्या व प्रस्तुत संशोधनासाठी लाभलेले मार्गदर्शक मूळात एक दलित–आंबेडकरी साहित्याचे अभ्यासक आहेत. त्यांच्या आचार्य पदवीचा विषय ''वामन निंबाळकर यांच्या समग्र साहित्याचा चिकित्सक अभ्यास'' यातून त्यांनी समग्र दलित साहित्याचा चिकित्सक अभ्यास केलेला आहे. त्याचप्रमाणे त्यांनी अनेक राष्ट्रीय व आंतरराष्ट्रीय नियतकालिकांमध्ये व चर्चासत्रांमध्ये सहभाग नोंदवून दलित–आंबेडकरी साहित्यावर संशोधन निबंध लेखन केलेले आहे. त्यामध्ये प्रस्तुत संशोधनाच्या अनुषंगाने काही प्रातिनिधिक संदर्भ प्रामुख्याने 'स्त्रीवादी स्त्री प्रतिमा', 'नव्वदोत्तरी मराठी कविता', '१९९० नंतरची मराठी कविता एक आकलन', 'मराठी कवितेतील सामाजिक भान', 'स्त्रीविश्व : स्त्रीभ्रूण हत्या कारण व परिणती', आदी विषयांच्या अनुषंगाने संशोधन केलेले आहे. त्यामुळे प्रस्तुत संशोधन विषयाचे मार्गदर्शक या विषयामध्ये कुशल तज्ज्ञ आहेत. त्यांच्या मार्गदर्शनाचा फायदा हे संशोधन करताना निश्चित होईल.

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पर्यावरणपुरक मवे चलन – क्रीप्टो करंसी

प्रा.डॉ. संजय तिडके
सहयोगी प्राध्यापक, वाणिज्य व व्यवस्थापन शाखाश्री शिवाजी कला,वाणिज्य व विज्ञान महाविद्यालय, अकोला

सारांश

जागतिक स्तरावर पयार्रवरण रक्षण हा अत्यंत महत्वाचा मुद्दा बनलेला आहे पर्यावरण रक्षणासाठी सर्व स्तरातून सर्वत्र प्रयत्न होत असतांनाचा कागदी चलन मोठयाप्रमाणावर सर्वत्र वापरले जात आहे. चलनासाठी लागणारा कागद तयार करण्यासाठी मोठया प्रमाणावर वृक्षतोड होउन पर्यावरणाची हानी होतांना दिसत आहे. अशा परिस्थितीत कागदी चलनाला पर्याय म्हणून क्रिप्टो करंसी ना जगभर वाढता वापर पर्यावरण रक्षणाक्ष्या दिशेने टाकले जाणारे एक पाउल आहे. भारत हा तरूणांना देश आहे. जगातील सर्वात जास्त तरूणांची संख्या भारतात आहे साहजिकच तरूणाईची म्हणजेच नव्या भारताची पसंद ही नविनच असणार आहे. भारतीय तरूणाईला क्रीप्टोकरंसी ने झपाटयाने आकर्षित केले आहे देशातील तरूणांचा एक मोठा वर्ग गुंतवणुकीसाठी क्रीप्टोकरंसींचा वापर करतानां दिसत आहे. तरूणांना आर्थिक बाजारपेठेत जाण्यासाठी क्रिप्टो करंसींचा एन्ट्री पाईंट म्हणून वापर करता येइल. क्रिप्टो करंसी बाजारातील भारतातील गेल्या काही वर्षातील वाढ ही जगात सर्वात जास्त असल्याने भविष्यात भारत ही क्रिप्टो करंसीची मोठी बाजारपेठ ठरेल यात शंकाच नाही.

प्रस्तावना

क्रिप्टो करंसी हे सामान्यता विकेंद्रित डिजीटल पैसा आहे जो इंटरनेटवर वापरण्यासाठी डिझाईन केलेला असून हे चलन २००८ मध्ये सुरूवात करण्यात आलेले बिटकॉईन हे पहिली क्रिप्टो करंसी होती आणि ती आतापर्यंतची सर्वात मोठी, सर्वात प्रभावशाली आणि सर्वमान्य अशी क्रिप्टो करंसी म्हणून मान्यता पावलेली आहे. नंतरच्या काळात बिटकॉईन आणि इथरियम सारख्या अनेक क्रिप्टोकरंसी सरकारी चलनाला पर्याय महणून विकसित झालेल्या आहेत. भारतामध्ये गेल्या दशकापासून क्रिप्टो करंसी च्या वापराला मोठया प्रमाणात सुरूवात झालेली असून ब्रोकर चुझर एजन्सी नुसार देशात शंभर दशलक्षहून जास्त भारतीय क्रिप्टोकरंसींचा वापर करतात. जगात ही संख्या सर्वाधिक आहे.

जगभरातील बाजारपेठामध्ये मंदी असल्याने त्याचा परिणाम क्रिप्टो बाजारात दिसून आला असून देशभरात वाढत्या क्रिप्टो करंसीच्या बाजारापंठेचे नियमन करण्यासाठी २०२२ मध्ये सरकाने नविन नियम केले आहेत. क्रिप्टो करंसी उत्पन्नावर व व्यववहारावर आता विशिष्ट दराने कर आकारला जाणार आहे. यानुसार क्रिप्टो करंसीपासून प्राप्त उत्पन्नावर ३० टक्के कर तर क्रिप्टो व्यवहारातून एक टक्का टीडीस कपात लागु करण्यात आली आहे. या क्षेत्रातील जानकारांच्या मते या करामुळे क्रिप्टोकरंसी च्या गुंतवणुकीवर परिणाम झाला असून ही गुंतवणुक कमी होत असून या क्षेत्रातील नव्या स्टार्टअप वर त्याचा विपरित परिणाम झाला आहे.

क्रिप्टोकरंसी व्यवहारातील वाढ

क्रिप्टो करंसी बाजारात २०२१ मध्ये १५ टक्के वाढ नोंदविली असून २०२० मध्ये भारतीय गुंतवणुकदारांनी २८.१० दशलक्ष डॉलर ची गुंतवणुक केली होती तर २०२१ मध्ये ती वाढून ४३८.१८ दशलक्ष डॉलर एवढी झाली आहे. २०२२ च्या शेवटच्या सहा कहिन्यात यामध्ये सुमारे १३९.९ दशलक्ष डॉलर एवढी गुंतवणुक झाली आहे. अशा परिस्थितीत जागतिक बाजारातील अस्थिरतेमुळे गुंतवणुकदार भीतीपोटी क्रिप्टो बाजारातून आपला पैसा काढून घेत असले तरी बाजार सावरला कि, त्यात परत पुर्वीप्रमाणेच तेजी येण्याची आशा आहे. क्रिप्टो करंजी बाबत भारतीय बाजारपेठ अजून तरी खरेदी आणि आभासी व्यवहारांसाठी आभासी केंद्र बनलेली नाही.

आव्हाने

क्रिप्टो करंसी ही विशेषता तरूणांचे चलन म्हणून जगातील अनेक प्रगत देशात स्विकारले गेलेले आहे भारतातील युवा वर्ग सुध्दा क्रिप्टो करंसी मध्ये गुंतवणुक करूण उत्पन्न मिळविण्यात आघाडीवर आहे.पंतप्रधान नरेंद्र मोदी यांनी

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अलीकडेच सिडनी संवादादरम्यान क्रिप्टो करंसी बाबत बोलतांना ही करंसी चुकीच्या लोकांच्या हातात पडू नये व तरूणाई वाया जाउ नये यासाठी सर्व लोकशाही देशांनी एकत्रितपणे काम केले पाहीजे असे विधान केले असून ते बरेच बोलके आहे. आधुनिक गुन्हेगारी कारवायामध्ये क्रिप्टोकरंसीचा वापर होत असल्याचे अनेक गुन्हयात दिसून आले आहे. क्रिप्टो करंसी बाबत सरकार अत्यंत संवेदनशील असून आर्थिक गुन्हेगारीला आळा घालण्यासाठी क्रिप्टो हे मनी लॉंड्रींगचे साधन होणार नाही याबाबत भारत सरकार काळजी घेत आहे.

ईतर परंपरागत गुंतवणुक पर्यायासोबतच देशातील तरूणांना क्रिप्टो करंसी हा गुंतवणुकीचा आकर्षक असा नवा पर्याय सापडला आहे. डिजीटल जगाचे हे नवे डिजीटल चलन म्हणून ते कोणत्याही देशाचे नसून जगाचे चलन बनले आहे. भारताला जागतिक बाजारपेठेत नेता म्हणून प्रस्थापीत करण्यासाठी

ब्लॉकचेन तंत्रज्ञानासाठी अधिक गुंतवणूक आवश्यक आहे. भारत सरकारच्या २०२२ च्या अर्थसंकल्पात डिजीटल चलनाबाबत केलेल्या घोषणांमुळे भविष्यात भारतातील डिजीटल चलनाची बाजारपेठ वाढण्याची आशा निर्माण झाली आहे.

निष्कर्ष

क्रिप्टो करंसी बाबत वरील विवेचनावरून असे म्हणत येईल कि, क्रिप्टो करंसी हे नव्या जगाचे नवे चलन असून जगभरातील युवकांची त्याला मिळत असलेली पसंती हे त्याचे द्योतक आहे. कागदी चलनाला पर्याय म्हणून क्रिप्टो करंसी कडे पाहील्यास पर्यावरण रक्षणात क्रिप्टो करंसी चे महत्व अतिशय जास्त आहे. भारतात क्रिप्टो करंसी एक संधी असली तरी अनेक मोठी आव्हाने सुध्दा समोर उभी आहेत. रिझर्व बॅंक ऑफ इंडियाचे गर्व्हनर शशिकांत दास यांनी क्रिप्टोकरंसी धोकादायक असल्याचे विधान केले आहे. असे असले तरी देशातील तरूणांचा मोठा वर्ग क्रिप्टो करंसी मध्ये गुंतवणूक करण्यासाठी पुढे सरसावला असल्याचे चित्र आहे.

संदर्भ

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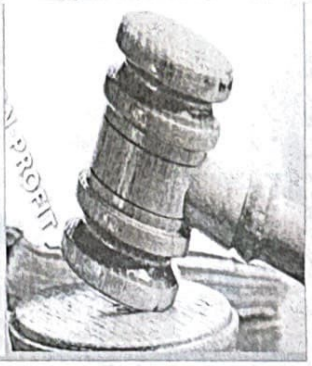

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20	भारतातील मत्स्य उत्पादनाचा अभ्यास प्रा. डॉ. मौलाना महेताब सय्यद	85
21	डॉ. जनार्दन वाघमारे हयांच्या 'मूठभर माती' या आत्मचरित्रातील शैक्षणिक जाणिवांचा अभ्यास डॉ. चंद्रशेखर सुधाकर देवघरे	89
22	नविन शैक्षणिक धोरण आणि संगीत : अंमलबजावणी आणि आव्हाणे डॉ. राहुल मल्हारी भोरे	94
23	छत्रपती शाहू महाराज यांच्या भाषणातील परिवर्तनवाद डॉ. अशोक जाधव	98
24	दुग्धजन्य व्यवसाय एक स्वयंरोजगार डॉ संजय ज तिडके , प्रा सुवर्णा दिनकर गोतरकर	102
25	असहकार आंदोलनामध्ये बुलढाणा जिल्ह्याचे योगदान प्रा.डॉ.अमोल रमेशराव बोरकर	106
26	उस्मानाबाद तालुक्यातील पिक प्रारुपाचा भौगोलिक अभ्यास डॉ.आसाराम दि.चव्हाण	109
27	घरकाम (मोलकरीण) करणा-या स्त्रीयांचा समाजशास्त्रीय अभ्यास प्राचार्य डॉ.कल्याण मोरे	113
28	बंजारा लोकगीतातील महिलांचे योगदान प्रा. डॉ. डी. एस. पवार	119
29	चंद्रपूर जिल्ह्यातील आदिवासी बालकांच्या कुपोषणा संबंधी आहारविषयक समस्या व त्यावरील उपाय डॉ. कीर्ती आ. वर्मा	122
30	भारतीय राजकीय तत्वज्ञान प्रा.डॉ.कऱ्हाळे विलास लिंबाजी	127
31	आदिवासी कवितेतील आत्मभान: एक आकलन प्रा. डॉ. एकनाथ वैजनाथ भिंगोले	129
32	चलेजाव आंदोलनात मातृभूमि वृत्तपत्राचे योगदान प्रा.डॉ.संतोष गोपाळकृष्ण कुळकर्णी	133
33	स्थानिक स्वराज्य संस्थानच्या राजकारणातील युवकांचा सहभाग एक चिकिसात्मक अभ्यास प्रा. ए.बी . राऊत	136
34	गव्हाणी अस्तित्वाचा झगडा प्रा.डॉ.कदम सुरेश व्यंकटराव	139
35	श्री चक्रधर स्वामी— आद्य समाजोद्धारक डॉ. महेंद्र झलके	143
36	डॉ. शंकर शेष के 'पोस्टेर' नाटक में रंगमंचिय अनुभूति डॉ. अनिल अ. पाखरे	147
37	मुस्लिम परिवेश को व्यक्त करने वालीनासिरा शर्मा का कहानी संसार। डॉ.विलास तुकाराम राठोड	151
38	Information Technology: its Need and Impact on Education Dr. Jyoti Gaikwad	154

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दुग्धजन्य व्यवसाय एक स्वयंरोजगार

डॉ संजय ज तिडके
श्री. शिवाजी महाविद्यालय अकोला
प्रा सुवर्णा दिनकर गोतरकर
संशोधक विद्यार्थी श्री. शिवाजी महाविद्यालय अकोला

सारांश : दुध हे एकमेव उत्पादन आहे जे एखादया व्यक्तीला लहानपणापासून ते वृध्दापकाळापर्यंत सतत सोबत करते. दुधाची उपलब्धता ही गायी, म्हशी, शेळया, मेंढया इत्यादी पासून होते. तर दुधापासून विविध पदार्थ तयार करण्यात येतात जसे की, दही, ताक, लोणी, तूप, श्रीखंड, पेढा इ.

प्रस्तावना : भारत हा कृषिप्रधान देश असून देशातील बरेच लोक हे शेती व शेतीपुरक व्यवसायावर अवलंबून आहेत. शेतीपुरक व्यवसायामध्ये दुग्ध व्यवसाय हा पुर्वीपसूनचे परंपरागत चालत आलेला महत्वाचा व्यवसाय आहे. जगात भारत देश हा दुधाच्या उत्पादनात आणि पशुधन संस्थेत प्रथम क्रमांकावर आहे. दरवर्षी दुधाला आणि दुग्धजन्य पदार्थ हया व्यवसायाला वृध्द होतांना दिसून येते. दुध हे आपल्या आहाराचा मुख्य घटक आहे. पुर्वीच्या काळापासून भारतीय संस्कृतीत दुधाला महत्व दिले जाते. दुध व दुधाचे पदार्थ हे सर्व पुजा, नैवेदय यात वापरले जाते. आहार शास्त्रात दुध व दुधाच्या पदार्थाला संपूर्ण आहार असे म्हणतात. दुध व दुधाचे पदार्थ शाकाहारी अन्नातील मुख्य घटक आहेत. दुधाक प्रथीनांचे प्रमाण जास्त असल्यामुळे शरीराची वाढ व रोग प्रतीकारक शक्ती वाढते. दुधामध्ये लॅक्टोन नावाची साखर कर्बोदके असतात. या साखरेमुळे दुधाला गोडी येते.

दुध एकमेव उत्पादन आहे जे एखादया व्यक्तीला संपूर्ण आयुष्यभर लहाणपणापासून ते वृध्दापकाळापर्यंत सतत सोबत करीत असते. दुध हे सर्वात परिपूर्ण अन्न आहे. त्यामध्ये मौल्यवान घटक, दुग्ध शर्करा, खनिजे, जिवनसत्वे, रंगद्रव्ये इत्यादी पदार्थ हे सर्व मानवी शरीरासाठी अनूकूल प्रमाणात असतात. प्राचीन तत्वज्ञानी दुधाला ''पांढरे खत'' असे म्हणत होते. दुध हे केवळ मौल्यवान अन्न उत्पादनच नाही तर एक महत्वाचा उपाय देखील आहे. कुपोषण, अशक्तपणा, यकृत, मुत्रपींड हृदय व रक्त वाहीन्यांचे विविध रोग आणि उच्च रक्तदाब या साठी हे उपयुक्त आहे. भारतात २६ नोव्हेंबर हा दिवस २०१४ सालापासून शेत क्रांतीचे जनक डॉ. वर्गीय कुरीयन यांचा जन्मदिन दुध दिन म्हणून साजरा केला जातो. हा दिवस साजरा करण्याचा उद्देश म्हणजे दुध आणि दुग्धजन्य पदार्थ बनविणाऱ्या उदयोजकांना प्रोत्साहन देणे हा आहे.

उदिष्टे :

१)दुध मागणीची पुर्तता कशा प्रकारे केल्या जाते हे अभ्यासणे
२) गायी, म्हशी, शेळया, मेंढया यांच्या विविध जातीचा अभ्यास करणे

संशोधन पध्दती :

प्रस्तूत पेपर हा पूर्णत: द्वितीयक सामग्रीवर आधारीत आहे. यासाठी मिळविलेले तथ्य / माहिती ही या संबंधीत पुस्तके, प्रबंध, प्रकाशित पेपर इत्यादीच्या सहायाने प्राप्त केली आहे.

दुधाळ जनावरे :

सामान्यपणे गाय, म्हैस, शेळी व मेंढीया पाळीव प्राण्याच्या दुधाचा वापर कमी अधिक प्रमाणात होत असतो. जगात सर्वात अधिक वापर गायीच्या दुधाचा होतो. म्हशीचे दुध देखील बऱ्याच प्रमाणात वापरण्यात येते. शेळीच्या दुधाचा उपयोग सर्वत्र होत असला तरी प्रामुख्याने भूमध्य समुद्राच्या भोवतालच्या प्रदेशात ते अधिक प्रमाणात वापरल्या जाते.

१) गाय : फायदेशिर दुग्ध व्यवसायासाठी विशिष्ट जातींच्या गायींची निवड करावी जसे की, जर्सी, गावरान, देवगी, गीर, थारपारकर, सिंधी, होल्सीन, फ्रीजीयन इ. त्यांच वय ३ ते ४ वर्षाच असाव, त्या दुसऱ्या त्या तिसऱ्या विवाच्या असाव्या लागतात. गायीच्या दुधात ३.९% स्निग्धांश, ३.२% प्रथीन, ४.८०% दुग्धशर्करा तर ८७.८% पाणी असते. पाण्याचे प्रमाण जास्त असल्यामुळे गायीचे दुध पातळ असते. म्हणून गाईचे दुध लहान मुलांकरीता जास्त गरजेचे असते.

२)म्हैस : दुग्ध व्यवसायासाठी म्हशी विशिष्ट जातीच्या वापराव्या लागतात. जसे की, दिल्ली, मुऱ्हा, जाफराबादी, पंढरपूरी इत्यादी. त्यांच वय ३ ते ४ वर्षाच असाव, त्या दुसऱ्या ते तिसऱ्या विवाच्या असाव्या. म्हशीच्या दुधात ८% स्निग्धांश, ३.२% प्रथीने, ४.०४% दुग्धशर्करा तर ८१.१% पाणी असते. गाईच्या दुधापेक्षा म्हशीने दुध घडत असते. साधारणत: एका म्हशीपासून दिवसाला १० लिटरा दुध मिळू शकते.

३)शेळी : शेतीला गरीबाची गाय म्हणतात शेळी पासून एका दिवसात १ ते १.५ लिटर दुध मिळू शकते. शेतीमध्ये विविध जाती आढळून येतात जसे की,

शेळीच्या दुधात ३.५% स्निग्धांश, ३.१% प्रथीने, ५.१% दुग्धशर्करा असतात तसेच ८८.९% पाणी असते. म्हणजे सर्व प्राण्यांच्या बाबतीत शेळीच्या दुधात पाण्याचे प्रमाणत जास्त असते.

४) मेंढी : मेंढीपासून दुधाची उपलब्धतता होत असून मेंढीचे दुध हे चवीने गोड असते. मेंढीच्या दुधात ६% स्निग्धांश, ५.४% प्रथीने, ४.९% दुग्धशर्करा असतात तर : पाणी असते पाण्याचे प्रमाण कमी असल्यामुळे मेंढीचे दुध घट्ट असते.

दुधात समाविष्ट असणारे घटक :

दुधात समाविष्ट असणारे विविध घटक हे मनुष्याचे आरोग्य उत्तम राखण्याकरीता त्याच बरोबर शरीराची योग्य प्रकारे वाढ होण्याकरीता फार उपयोगी पडते. दुधातील समाविष्ट घटक हे मनुष्याला शक्तीवर्धक, बृध्दीवर्धक बनविण्यास मोलाची भूमीका बजावतात. त्यामुळे अशा बहुगुणी घटकांच्या उपयोगा विषयी अभ्यास करणे आवश्यक आहे ते पुढील प्रमाणे

गाय, म्हैस, शेळी, मेंढी, यांच्या दुधातील प्रमुख पोषक घटक द्रव्ये/ १०० ग्रॅम

घटक	मात्रा	गाय	म्हैस	शेळी	मेंढी
पाणी	ग्रॅम	८७.८	८१.१	८८.९	८३.०
प्रथीने	ग्रॅम	३.२	४.५	३.१	५.४
स्निग्धांश	ग्रॅम	३.९	८.०	३.५	६.०
संतृप्त मेदाम्ल	ग्रॅम	२.४	४.२	३.८	२.३
एकल असतृत्प मेदाम्ल	ग्रॅम	१.१	१.७	०.८	१.५
बहुअसंतृत्प मेदाम्ल	ग्रॅम	०.१	०.२	०.१	०.३
कार्बोहायड्रेट (लॅक्टोज)	ग्रॅम	४.८	४.९	४.४	५.१
शर्करा (लॅक्टोज)	ग्रॅम	४.८	४.४	५.१	४.९
कोलेस्ट्रॉल	मिलिग्राम	१४	८	१०	११
कॅल्शीयम	मिलीग्राम	१२०	१००	१७०	१९५
उर्जा	किलो कॅलरी	६६	११०	६०	९५
	किलो जुल	२७५	४६३	२५३	३९६

दुधापासून बनविण्यात येणारे पदार्थ :

दुधापासून विविध पदार्थ बनविण्यात येतात ते पुढीलप्रमाणे :

१)दही : एका भांडयात गरम करून थंड झालेले दुध टाकून त्या भांडयात आधीचे दही किंवा लिंबूचा रस योग्य प्रमाणात मिश्रण केल्या जातो. त्यानंतर त्याला कमीत कमी १० तास तसेच ठेवण्यात येते. त्यापासून मिहणारे मिश्रण म्हणजे दही होय.

दही खाण्याचे फायदे :

प्रतिकार शक्ती वाढते. मधुमेह नियंत्रीत राहतो. पचनक्रिया सुधारते, जीवनसत्वांनी परिपूर्ण, आतडयांचे आरोग्य सुधारते, चेहरा त्वचा व केसांसाठी उपयुक्त इ.

२)लोणी : दुधापासून बनविण्यात येणारा स्निग्ध पदार्थ म्हणजे लोणी होय, लोणी हे दुधात विरजन लावून विशिष्ट कालावधीपर्यंत गोल, गोल फिरवून भांडयांच्या काठास आलेल्या पदार्थास वेगळे काढले जाते त्याला लोणी असे म्हणतात.

लोणी खाण्याचे फायदे : लोणी खाण्यामुळे पचनक्रिया सुधारते, वजन वाढते, डोळयांचे आरोग्य सुधारते, थायरॉईडचा त्रास होत नाही, हाडे मजबूत होतात.

३)तूप : तूप हे लोण्यापासून बनविण्यात येते. लोणी विशिष्ट वेळेपर्यंत तापवल्यानंतर त्याचे रूपांतर पातळ द्रावणात होतात ते द्रावण म्हणजे तूप होय.
तुप खाण्याचे फायदे : पचनक्रिया सुधारते, वनज वाढते, दुर्बलता कमी होते, डोळयांचे व त्वचेचे आरोग्य सुधारते, हाडे मजबूत होतात. इ.
४)श्रीखंड : हे दहयापासून बनविण्यात येते. घट्ट दही हे रेशमी कापडात कमीत कमी ८ ते १० तास ठेवण्यात येते. त्यानंतर तयार मिश्रणामध्ये प्रमाणानुसार साखर मिसळवून जायफळ, केसर, ईलायची इ टाकण्यात येते.
५) पनीर : पनीर बनविण्याकरीता दुधामध्ये सायट्रीक आम्ल किंवा सल्फर ॲसीडचे दोन ते चार थेंब टाकल्या जातात. त्याचे द्रावण तयार केल्या जाते. ते एका भांडयात पाच ते सात तास ठेवण्यात येते. त्यानंतर द्रावणातील पाणी काढल्या जाते. संपूर्ण पाणी काढल्यानंतर घट्ट द्रावण म्हणजे पनीर होय.
पनीर खाण्याचे फायदे : वजन कमी होण्यास मदत होते. पनीरमध्ये मुबलक प्रमाणात प्रथीने असल्याने मांसपेशी व हाडे मजबूत होतात. डायबेटीसला दुर ठेवण्यास पनीर उपयोगी पडते.

सारणी क्र. अ

एकूण वार्षिक विक्री वर्ष सप्टेंबर २०२२

अ.क्र.	उत्पादीत मालाचे नांव (दुध)	मासिक उत्पादन लिटर	वार्षिक उत्पादन लिटर	दर प्रती लिटर	एकूण वार्षिक विक्री किंमत
१	५ म्हशी प्रती दिवस ५० लिटर दुध ५० X ३६५	१५००	१८२५०	७२	१३,१४,०००
२	८ म्हशी प्रती दिवस ४० लिटर दुध ४० X ३६५	१२००	१४६००	६०	८,७६,०००
३	शेण विक्री	१० ट्रॉली	—	४०००	४००००
	एकूण विक्री				२२,३०,०००

सारणी क्र. ब

वार्षिक खर्च वर्ष २०२२

विवरण	राशी	राशी
१) डेप प्रती दिवस ३० किलो ३० X ३६५ = १०९५० X ३५ रू.	३८३२५०	
२) चुरी (२४ किलो प्रती दिवस) २४ X ३६५ = ८७६० X २२ रू.	१९२७२०	
३) कडबा कुटी (२० गाडी वार्षिक) प्रतीगाडी २०००	४००००	
४) हिरवा चारा	१००००	
५) वार्षिक विज बिल (दरमहा २१०० ग १२ महिने)	२५२००	
एकूण खर्च		६२८४७०

सारणी क्र. क
व्यवसायासाठी लागणारी यंत्र सामुग्री / उपकरणे
वर्ष २०२२

अ.क्र.	यंत्र/उपकरण	नग	किंमत	एकूण
१	फ्रिज	२	१५८९०	३१७८०
२	वेटगार्ड मशीन	१	१५००	१५००
३	टोपले	५	१२०	६००
४	टप	२	३५०	७००
५	जग	५	२५	१२५
६	दुधाची गुणवत्ता मोजणारे यंत्र	१	३००००	५००
७	बादल्या	५	१००	१०००
८	दुधाची कॅन	१०	१००	४०००
९	मापे	—	४०००	—
१०	भांडे व इतर उपकरणे	१	—	५०००
	एकूण खर्च			७५७०५

सारणी क्र. ड
मनुष्यबळ वर्ष २०२१—२२

अ.क्र.	प्रकार	संख्या	मासिक	वार्षिक वेतन
१	व्यवस्थापक	१	१५०००	१८००००
२	परिक्षक	१	१२०००	१४४०००
३	कारागीर	२	९०००	२१६०००
४	सफाई कामगार	२	४५००	१०८०००
	एकूण			६४८०००

वर्षिक नफयाचे आगणन
एकूण विक्री — एकूण खर्च
सारणी अ — (सारणी ब + क + ड)
२२,३०,००० — १३,५२,१७५
वार्षिक नफा ७ ८,७७,८२५
निष्कर्ष :

दुध आणि दुग्धजन्य पदार्थाची विक्री ही स्थायी स्वरूपातील दुकान किंवा फिरत्या किव्रेत्याकडून करण्यात येते असे दिसून येते. तसेच गायी, म्हशी, शेळया, मेंढया यांच्या विविध जाती दिसून येतात. नविन तंत्रज्ञानाचा विकास झाल्यामफहे हा व्यवसाय दिवसेंदिवस प्रगती करीत आहे.. योग्य ते प्रशिक्षण घेतल्यानंतर कोणतीही सज्ञा व्यक्ती दुग्धजन्य व्यवसाय उत्कृष्ट रितो करू शकते.

संदर्भग्रंथ सुची :

१)पोरगे डॉ. तानाजीराव (२०१८), दुग्ध व्यवसाय, दिलीपरान प्रकाशन पुणे
२)कर्वे, अरविंद (१९८५), दुध आणि दुधाचे पदार्थ, महाराष्ट्र राज्य साहित्य संस्कृती मंडळ, मुंबई
३)दक्षीणकर, ना.पु. (२०१४) दुग्ध व्यवसाय व्यवस्थापन, मंगेश प्रकाशन नागपूर
४)भोयर, डॉ. प्रदिप, दुध व दुग्धजन्य पदार्थ श्री. मंगेश प्रकाशन नागपूर
५)काटोळे, रविंद्र, दुग्धजन्य पदार्थ निर्मिती तंत्रज्ञान, गोडवा कृषी प्रकाशन
६)दुध, विकीपिडीया

A STUDY ON CONSUMER PERCEPTION TOWARDS DIGITAL WALLETS

Dr. Sanjay J. Tidke
Professor & Head, Department of Commerce
Shri Shivaji College of Arts, commerce & Science, Akola (MS)

ABSTRACT

The government of India takes various initiatives to promote digital transactions in the country. According to Newzoo Games Performance, Monitor India is the second largest country in the world that used smart mobile phones that is 659.00 million. India's 46.5 percent population used Smart Mobile phones regularly. E-Wallets in mobile phones are playing a vital role in the various types of digital transactions. Now a day become a regular practice for various types of e-payments by citizens due to the convenience of E-wallets. The present study is an attempt to evaluate and understand the consumer perception towards E payment through various mobile E-Wallets. A structural questionnaire was used to collect primary data.

Keywords: E-wallets, Digital Payments, Consumer Perceptions

I) Introduction

The Spread of digital technology and internet services has brought a massive transformation in the routine life of citizens. Information and Communication Technology plays a vital role and made a revolution in e-commerce and e-payment system. There is a rapid increase in the number of smart phone users in our country. According to Newzoo Games Performance Monitor, India is the second largest country in the world used 659.00 million smart mobile phones regularly. India's 46.5 percent population used Smart Mobile phones. It improves the growth ofe-commerce transactions with the help of various software application in smart phones. Digital Wallet is the most popular software system in a smart phone which is used equally to the physical wallet in which we carry money. E-wallets can be categorized into four parts: open wallets, semi-open wallets, closed wallets, and semi-closed wallets. A digital wallet is a software system that stores the user's details and passwords securely for payment across numerous websites. The bank account number of the user is linked to the digital wallet which allows the user to make purchases easily and quickly. The bank accounts of individual users are linked to their digital wallets. Digital wallets are not used only for online purchases but also for the authentication of the users. A digital wallet can store complete user information including credentials, transaction history, and personal details. They can be used in combination with other mobile payment systems.

Users can transfer their money through their bank accounts in digital wallets and carry out certain offline transactions as well. Despite the growth in the number of digital commerce applications, there are still certain issues faced by these e-commerce applications such as security issues, privacy issues, lack of knowledge, mobile illiteracy, and fraud. These issues are a major obstacle to further e-commerce business development. Hence it becomes very important for service providers to understand these issues from the consumer's perspective. According to the Reserve Bank of India, there are three types of E-wallets currently used in India

- **Open wallet**: Open digital wallet is used to purchase goods and services, including financial products like insurance and mutual funds. It can also be used to withdraw cash at ATMs or transfer funds at merchant locations and point-of-sale terminals where such cards are accepted.
- **Semi-closed**: Through semi-closed wallets, an individual can shop online, recharge their phone and pay bills. However, through these wallets, one cannot withdraw cash from an ATM. Through semi-closed wallets, one can purchase goods and services with listed merchants partnered with the wallet's company. Paytm, PayUMoney, and Oxygen are a few examples of semi-closed digital wallets.

- **Closed wallets**: Wallets issued to consumers for exclusive use are known as closed wallets. These can be used when transacting with these respective companies. A certain amount is locked with the company, in case you cancel or return the order. When a customer return or cancel an order, the merchant company credits your wallet account with the refund amount directly. Examples of closed digital wallets include BigBasket wallet, MakeMyTrip wallet, etc

The popular E-wallets are

1. Paytm
2. Phone Pe
3 Amazon pay
4 BHIM App
5. Freecharge
6 HDFCpayzapp
7. MobiKwik
8. Google Pay
9. Amazon Pay
10 Airtel Thanks App

II) Objectives of Study

- To study the awareness of youth towards the E-wallet in Akola city.
- To find out the preference for E-wallets among youngsters.
- To examine the perception towards the E-wallet.
- To identify the factors that affect consumer preference towards E-wallets.
- To suggest overcoming the problems of using an E-wallet.

III) Research Methodology

The present study is based on primary and secondary data sources. Primary data was collected from 50 respondents by using a structured questionnaire. Which has been created using Google Forms and distributed among social media users in Akola city of Maharashtra? The secondary data is collected from websites, research journals, newspapers, and magazines. For sampling random sampling method was used to collect the data from the respondents. The sample size is 50. And the data is analyzed and interpreted using Microsoft Excel.

IV) Data Interpretation and Analysis

Table 1 Demographic Profile of Responses (50)

	Categories	Count	Percentage
Age	18-25	14	28.00
	26-35	16	32.00
	36-45	11	22.00
	46-55	5	10.00
	56 and above	4	8.00
Gender	Male	32	64.00
	Female	18	36.00
Educational Qualification	Undergraduate	6	12.00
	Graduate	18	36.00
	Post Graduate	26	52.00
Annual Income	Less than 1 Lakh	5	10.00
	1Lakh to 2 Lakh	13	26.00
	2 Lakh to 3 Lakh	10	20.00
	3 Lakh to 4 Lakh	6	12.00
	4 Lakh to 5 Lakh	16	32.00
Profession	Service	21	42.00
	Business	14	28.00
	Professional	7	14.00
	Students	8	16.00

The above table explains that around 28% of the respondents are from the category of 18 to 25 years, and 32% of the respondents belong to the category of 26-35 years. Around 36% of the respondents are graduates and around 42% of them have been working in the service area. 32% of the respondents have an annual income in the range of 400000-500000

Table 2 Preference regarding the use of Digital Wallets for purchases

Products /services	No. of respondents Percentage	Percentage
Books	1	2.0
Movie Tickets	5	10.00
To pay bills	13	26.00
Travel Tickets	17	34.00
Clothes	4	8.00
Recharge Digital or DTH	1	2.00
To transfer money	2	4.00
Electronic products	1	2.00
Restaurants	6	12.00
Total	50	100

As per the above table, 34% majority of the respondents preferred to use Digital wallet payment to pay bills followed by travel tickets and so on.

Table 3 Factors influencing customers to go for Digital wallets

Factors Influencing opt for M-wallets	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Instant Payments	0	2(4%)	4 (8%)	29 (58%)	15(30%)
The reputation of the company	0	4(8%)	8(16%)	33(66%)	4(8%)
One stop shop	0	6(12%)	27(54%)	13(26%)	4(8%)
Seamless process	0	3(6%)	7(14%)	21(42%)	19(38%)
Instant Refunds	1(2%)	10(20%)	9(18%)	13(26%)	17(34%)
Rewards and offers	0	0	3(6%)	38(76%)	8(16%)
Safety and Security	0	2(4%)	15(30%)	25(50%)	8(16%)

From the above table, we understand that around 76% of the people agree that rewards and offers influence them to go for purchases, followed by 58% of the people who believe that digital wallets help to make instant payments.

Table 4 Factors abstaining customers to go for Digital wallets

Factors refraining the usage of M-wallets	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Prefer to use other cashless payment option	2(4%)	4(8%)	6(12%)	16(32%)	22(44%)
Concerned about the security of digital payments	1(2%)	5(10%)	7(14%)	11(22%)	26(52%)
No value in using digital payments	3(6%)	11(22%)	19(34%)	7(14%)	10(20%)
Glitches	6(12%)	10(20%)	5(10%)	9(18%)	20(40%)
Possibility of information theft during wireless transmission	2(4%)	4(8%)	3(6%)	16(32%)	25(50%)

From the above Table, it shows that 50% of the respondents strongly agree that they are concerned about the security of Digital payments and the possibility of information theft.

V) Findings

Based on the structured questionnaire that was administered to 50 respondents, the findings were as follows:

a) 34% of respondents prefer using digital wallets for paying bills followed by booking travel tickets and so on.
b) Instant payment, offers, and rewards One of the major reasons people opt for digital wallets. Nearby 76% of people opt for digital wallets because of the rewards attached tothe use of digital payments.
c) 44% of the respondents strongly agree that they are concerned about the security of Digital payments and leakage of information, which serves as one of the refraining factors for the use of digital wallets.
d) A great number (52%) of the respondents said that security is very important while purchasing products online.

VI) Conclusions

Thus, online purchases using digital wallets are increasing suddenly. The mindset of the customers has gradually moved from buying and selling on a cash basis to buying and selling by way of digital wallets. The majority of the respondents think that trust plays a vital role in the use of digital wallets. The use of digital wallets is in favorof the young generation as they feel it is more comfortable, structured, and convenient. It is analyzed from the survey that when a consumer makes a mind to purchase through digital wallets he or she is affected by multiple factors which influence his behavior out of which safety and security remain the major concern. The main crucial identified factors are time-saving, the offers and rewards, and convenience.
Mobile wallet payment is a sizable platform for new and upcoming technology which promotes financial institutions in India through mobile technology and also helps to increase their customers and users. The security issues that are tightened and reduced will automatically increase the adoption of a mobile wallet. Recently, everyone has had a smart phone but there is a need to create awareness and acceptance of mobile wallet services that are comfortable, structured, reliable, confidential, safe, and convenient without any effort.

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70	Women's Participation in Science and Technology **Dr. Trishala D. Elalkar**	**218**
71	Problems Faced by Women during Participation in Sports **Dr. Gajendra B. Raghuwanshi**	**221**
72	Status of Women through Ages in India **Dr. Shyam Dutonde**	**223**
73	Contribution of Women Artists in the Development of Indian Culture **Dr. Ajaykumar G. Solanke**	**226**
74	Emerging Women in the process of Developing Sufi Music **Dr. Niraj Lande**	**229**
75	Woman and Literature Sarojini Naidu **Prof. Shubhangi Baliram Barahate**	**232**
76	Nutrients Nourishing Women's Health And Wellness **Sarjerao R. Wagh**	**235**
77	Journey of Indian Literary Women **Dr.Nilima S. Tidke**	**238**
78	Journey of Indian Sportswomen **Dr.Sangita M. Khadse**	**240**
79	An Agenda For Empowerment : Appealing to Women Voters Through Party Manifestos **Ankita Sengupta**	**243**
80	Human Rights And Gender Equality For Women Empowerment **Dr.Vandana R. Khakre**	**247**
81	Nutrition - Energy Requirement For Physical Activity **Dr. Sunil Kumar**	**251**
82	Importance and Components of physical fitness **Professor Surendra Chauhan**	**255**
83	Relationship of Socio-Economic Status, Cast status, Education status & Sports Achievement Status through players Participation in Sports **Prof. Chandrashekhar Ingole**	**257**
84	Comparative study of anxiety level of tribal and non-tribal athletes **Assit. Prof. Atul Sharma**	**262**
85	Study of submitted project in Post Graduate teaching Department of Physical Education in Amravati University **Dr.Suraj Yeotikar**	**264**
86	Effect Of Yoga Practices And Physical Exercises On Health Related Fitness Of Adivasi School Students. **Assit. Prof. Pradeep Khedkar**	**267**
87	Soft Skills Needed inWomen Education for Employability **Dipak Vijay Jaiswal**	**269**
88	A Study Of Women Entrepreneur Challenges In India **Amrapali G. Hatkar**	**272**
89	Women and Higher Education **Lata Sandip Kolhe**	**276**
90	Problem And Perspective Of Women In The Indian Manufacturing Sector **Prof. Dr. Savita Nichit**	**279**
91	Effect Of Yoga Practices And Physical Exercises On Health Related Fitness Of Adivasi School Students **Assit. Prof. Pradeep Khedkar**	**283**

have made significant contributions. Historians with an interest in gender and science have researched the scientific endeavors and accomplishments of women.

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Problem And Perspective Of Women In The Indian Manufacturing Sector

Prof. Dr. Savita Nichit

Associate Professor, Department of Commerce & Management Shri Shivaji College of Arts, Commerce & Science Akola, Maharashtra

Abstract

Female workforce participation globally has been demonstrated to be a potent driver of the economic growth and development of Maharashtra and as well as India. To realize their full potential, the government of Maharashtra need to adopt targeted strategies to search out the barriers to women's workforce participation in all manufacturing sector. This research work enlightens the various types of female worker problems which is relatedto the manufacturing industry in Maharashtra as well as some possible solutions to the problem are also discussed.

Key Words: CSR CEDA, UNDP, Manufacturing sector,

Introduction

Every sector in India has its own importance and due share in both GDP and employment generation Like other sectors, India is not at all new to manufacturing. The manufacturing sector occupies a strategically important place in the Indian industry. Womenin India constitute a major portion of the population and therefore form a potential labour force which has remained untapped over the decades. Before making a discussion on the plight of women in the manufacturing sector, it becomes pertinent the thrown light on the overall statusof women in India.

Brief status of Indian women's participation in various sectors:

Healthcare: This is one of the best industries for female workers.At present, female presence is only 11%, **Technology and Core sector:** Research claimed that women now make up 28% of the IT workforce in India, **Oil and gas**:7%, **Automobile sector**: 10%**, Agriculture sector:** 60%**, Education sector:**42%.

When we moveto the **manufacturing sector**total of 8 million workers were employed in India's formal manufacturingindustries in 2019-20, 1.6million (19.7%) were women

In this analysis, we look at the gender gaps in manufacturing employment in the country using ASI data for 2019-20 the most recent round of the survey.

Even among this small share of women working in industries, there are wide regional and industry-wide variations.

Of the 1.6 million women workers across India, 0.68 million (43%) were working in the factories of Tamil Nadu alone. In fact, nearly three-fourths (72%) of all women working in industries were employed in the southern states of Tamil Nadu, Karnataka, Andhra Pradesh, and Kerala. In Addition to this skew in regional distribution, the gender gap in manufacturing employment varies widely across states. Manipur is the only state with a gender balance among those working in its manufacturing sector. The share of women workers in the state stood at 50.8% in (2019-20) Manipur followed by Kerala (45%), Karnataka(41.8%) and Tamil Nadu (40.4%)

Chhattisgarh had the most gender-skewed industrial workforce with women making up just 2.9% of those working in its manufacturing units. It was followed by Delhi with women comprising 4.7% and Jammu and Kashmir and West Bengal where women made up just 5.5 % of the total manufacturing each.

Among the first five most industrialised states, the picture is mixed with Maharashtra (12%), Uttar Pradesh (5.7%), and Gujarat (6.8%), having a large gender gap and Tamil Nadu and Andhra Pradesh faring much better. Women's share among industrial employees was less than 10% in 16 states and union territories.Despite being one of India's most economically progressive states, Maharashtra's status of women workers in the manufacturing sector is very poor.

OBJECTIVES OF THE STUDY:

To understand the role of women in the Indian manufacturing sector.

To know the problems of female workers in the Indian manufacturing sector.

To suggest some remedies for various types of problems.

RESEARCH METHODOLOGY:

This study is based on secondary data collected from books and National International Journals and Public and Private Publications available on websites.

Indian Manufacturing sector:

Before moving on to the problems of women workers in the manufacturing sector it is important to explore the current status of women's employment in someof the mostintentionally inclusive organisations in India, in this sector, The cross-section of data being presented here traces women's representation in white-collar roles from an entry-level to leadership level. Specifically in the manufacturing sector.

Women's representation in the manufacturing sector

Women's representation	Overall	Entry Level	Managerial level	SeniorManagerial level	Executive leadership level
2021	12%	13%	12%	12%	9%
2020	10%	11%	9%	7%	5%
2019	8%	10%	6%	3%	4%

(Source: Working Mother & Avtar Best companies of women in India study)

The data was presented between 2016 and 2021. This is also an indication of how the sector has responded to the covid-19 induced disruptions of the last two years. It is noted that women's representation continues to increase, moving up 4% between 2019 to 2021 from 8% to 12%.Thedata speaks for the entire universe of women in the sector we may conclude that the status is conduciveto designing inclusive paradigms' technical role in manufacturing. when a coupleincrease in aspiration amongst young women to enter and build careers in this sectorthe long-term impact would not only be an increased representation of women in this sector but also the innovativeimpacts of diversity in terms of production design and development.

PROBLEMS OF WOMEN IN MANUFACTURING SECTORS

According to the bank, working women in India are a minority. Women only make up one-third of India's manufacturing jobs. Today, the sector faces the lowest number of females since1960so why is the number of women in the industry declining despite the overall rise of manufacturing jobs in India? There are so many problems faced by female workers some major problems discuss here …

❖ Social norms and attitudes play an important role in shaping the career of women. Women can easily findjobs in education, nursing and secretory but in the manufacturing industries, there is always a prejudice favoured towards men. It is observed that the Indian Industrial sector always prefersmale employees.

❖ Women do not have the freedom or support to make decisions regarding their education, and career. This limits their ability to pursue independent choices and cater to the demands of their job.

❖ Literacy rate among the women withthe attainment of higher education, women are opting out of undesirable employment but appropriate jobs for educated women are not being created at the same rate. Thus, the increased gender gap in the manufacturing sector

❖ The deep-rooted blemish that manufacturing industries require more difficult physical labour and is reserved only for male keeps women away from entering the manufacturing industries however this stigma is been proven wrong inthe present scenario where technology is a major game changerwith advancement in technology, manufacturing is no more what it was defined in the 19th century. It has changed it's a dirty job reserved for the lower middle-class worker to a high-tech and innovative skilled man force.

❖ Andres(2017) noticed that the Indian economy since independence saw a major structural change with expanding service sector, a declining agriculture sector and a somewhat stagnant manufacturing sector. Structural changes can also be regarded as an important factor responsible for the low rate of participation in manufacturing industries

❖ Service sector has expanded to create a bulk of jobs which have attracted educated women. Not only this, the environment of the service sector has been more conducive and friendly as compared to manufacturing industries.

❖ Gender disparity in the pay scale

❖ Family Responsibility

❖ No Provision of flexible working hours

❖ Working in shifts

- ❖ Lack of mentorship
- ❖ Work-life conflict
- ❖ Long commute
- ❖ Lack of encouragement to acquire skills for this sector Lack of women in senior positions or leadership role
- ❖ Lack of challenging opportunities.
- ❖ There were challenges that female students who are interested in manufacturing sector jobs feel excluded from industrial opportunities.

While the above-mentioned factors are still true many manufacturing companies are taken steps to include and employ more women and increase their participation. According to CEDA totaljob available in the manufacturing sector in India is 27.3 million in 2020-21. the potential of reaping benefits by engaging with a diverse employee population could be immense, as the sector accounts for close to a quarter of the total jobs in the country.

The above analysis makesit quite clear that there isa wide gap between the male and female workforce in the manufacturing sector That's why female workers faced so many problems in these industries.

According to the CII and UNDP, a number of companies in the manufacturing sector have changed their business culture practices, to attract women and have been allocating their corporate social responsibility (CSR) funding for the inclusion of women'sInternational organisations such as the United Nations, World Bank, International Labour organisation have played a key role in supporting businesses and governments in countries like India to attain Sustainable Development Goal 5 – advancing gender equality and women's empowerment in order to fulfil their goal of 'leaving no one

CONCLUSION AND SUGGESTIONS

CONCLUSION:

- ➢ The above analysis makesit quite clear that there isa wide gap between the male and female workforce in the manufacturing sector That's why female workers faced so many problems in these industries.
- ➢ The study very clearly found wide inter-state and intra-state disparities in female labour participation in manufacturing industries.
- ➢ Manipur was found to be the highest employer of the women labour force in manufacturing industries while Chhattisgarh was the lowest employment
- ➢ Most industrialised states like Maharashtra and Gujarat also lagging ratio of the women workforce in the manufacturing sector also. It is very critical thinking.
- ➢ Gender stereotypes problem isa big issue in this sector. We must have a breakdown of it.

India tries to develop this sector with help ofinternational organisations no doubtbuteach person should contribute to encouraging female workers to work in the manufacturing sector.

SUGGESTIONS:

- ➢ This sector needs deep and inclusive research by the government and Global level.
- ➢ India tries to develop this sector with help ofinternational organisations no doubtbuteach person should contribute to encouraging female workers to work in the manufacturing sector.
- ➢ Provide vocational training forcollege-going student who is interested in this sector.
- ➢ Policymakers arrange gender equality programmes continuously.
- ➢ The Chamber of commerce, DIC offices, and MIDC offices arrange special training programmes for working women in the manufacturing sector.
- ➢ Policymakers promote women's leadership in the manufacturing sector and also encourage them to play a higher role in the manufacturing industry.

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" 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%

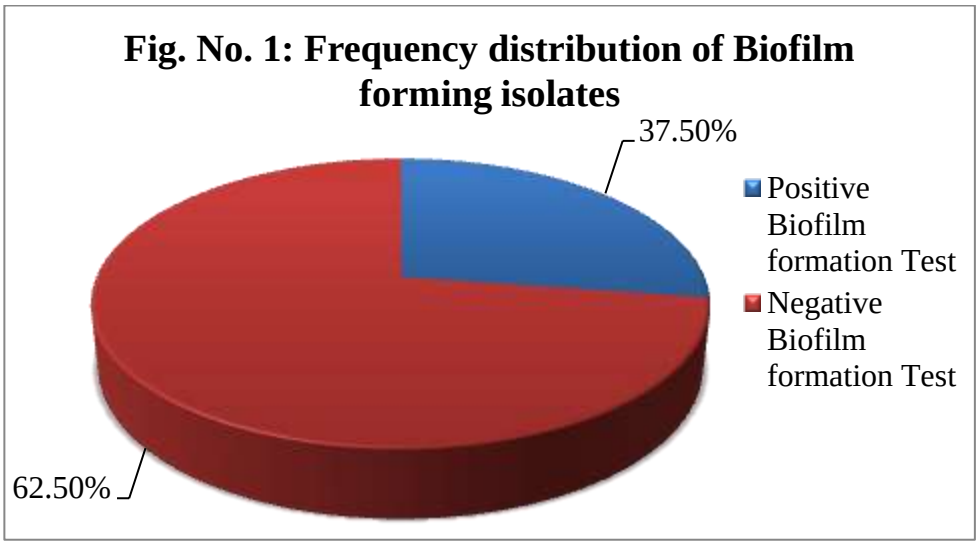
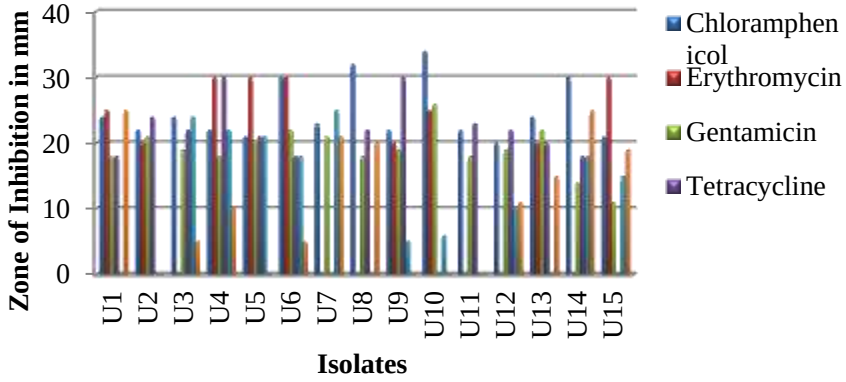


Table No. 4: Antibiotic Susceptibility Test against *E. coli* Isolates

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

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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

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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	- -

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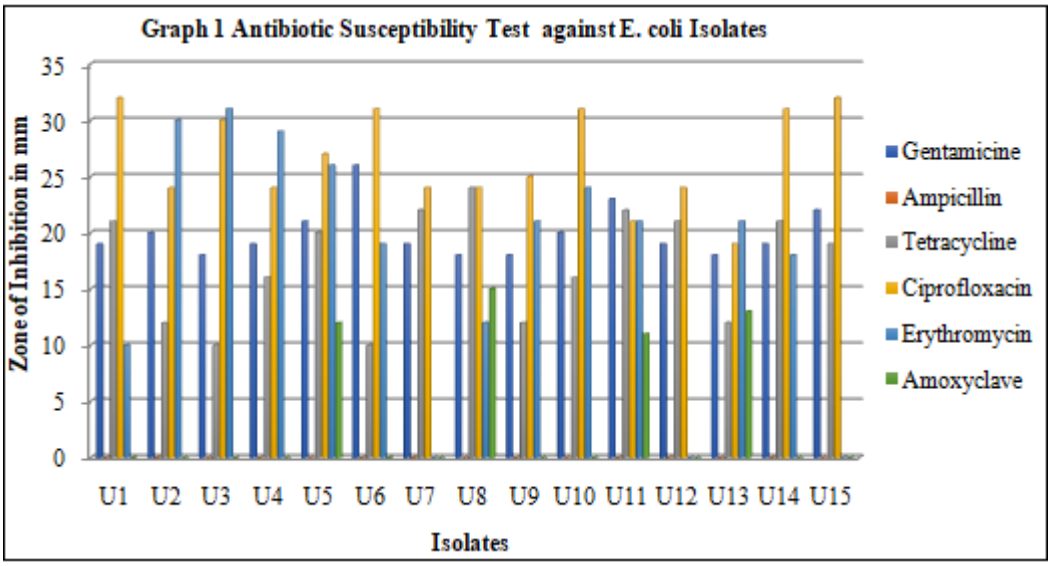
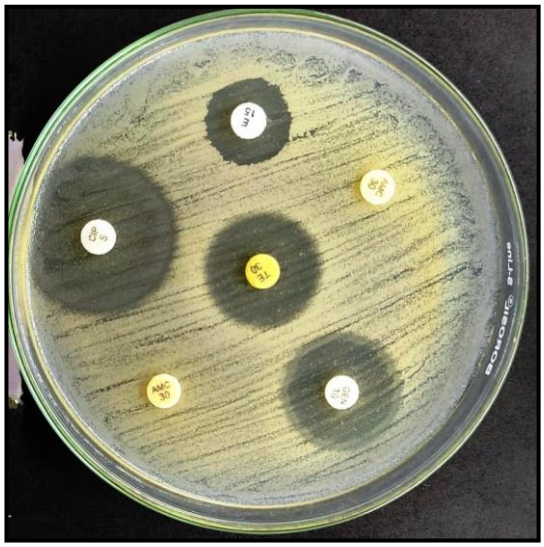
U5	21	- -	20	27	26	12
U6	26	- -	10	31	19	- -
U7	19	- -	22	24	- -	- -
U8	18	- -	24	24	12	15
U9	18	- -	12	25	21	- -
U10	20	- -	16	31	24	- -
U11	23	- -	22	21	21	11
U12	19	- -	21	24	- -	- -
U13	18	- -	12	**19**	21	13
U14	19	- -	21	31	18	- -
U15	22	- -	19	32	- -	- -

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

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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.

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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

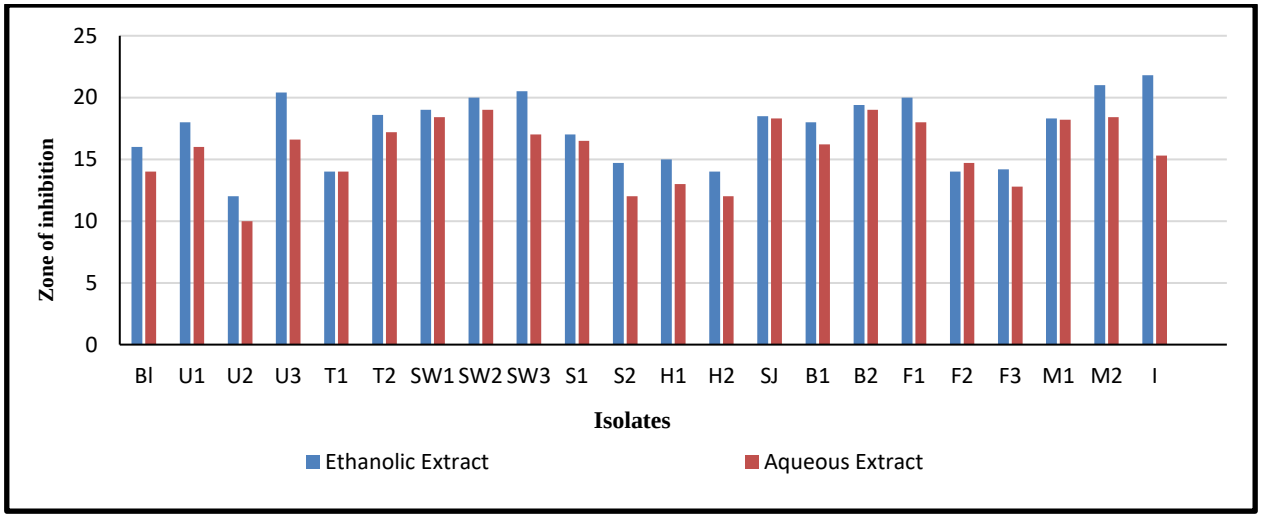

Figure 2: Inhibitory effect of Aqueous and Ethanolic extract of *Murraya koenigii leaves* on *E. coli* isolates

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

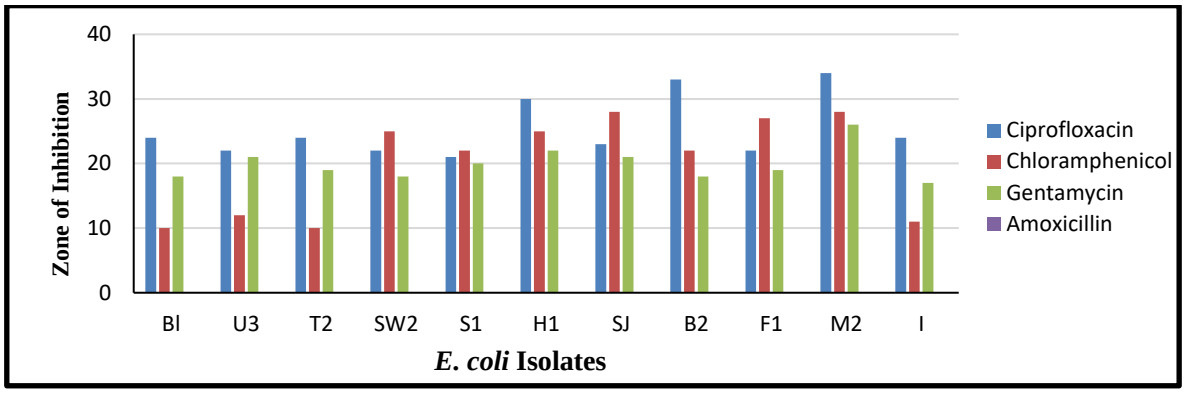

Figure 4: Sensitivity of *E. coli* isolates to Antibiotics

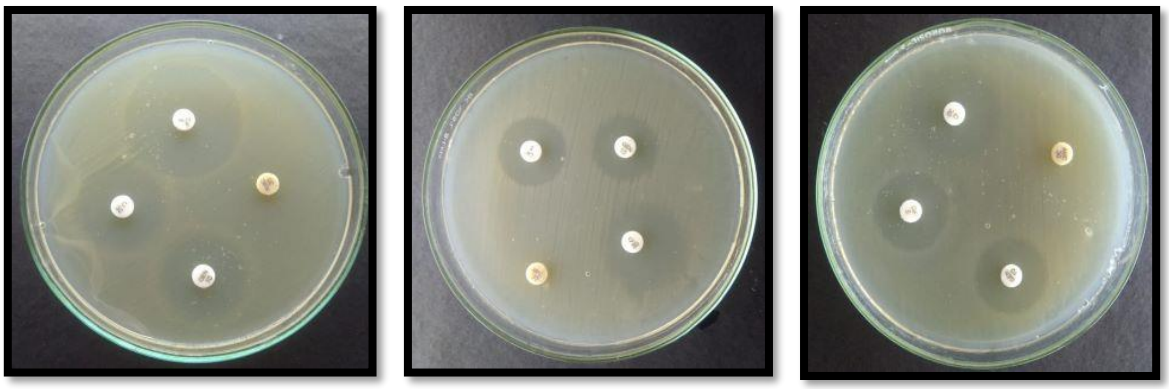

Figure 5: Spectrophotometric Analysis of Murraya koenigii plant leaves extract in different solvent

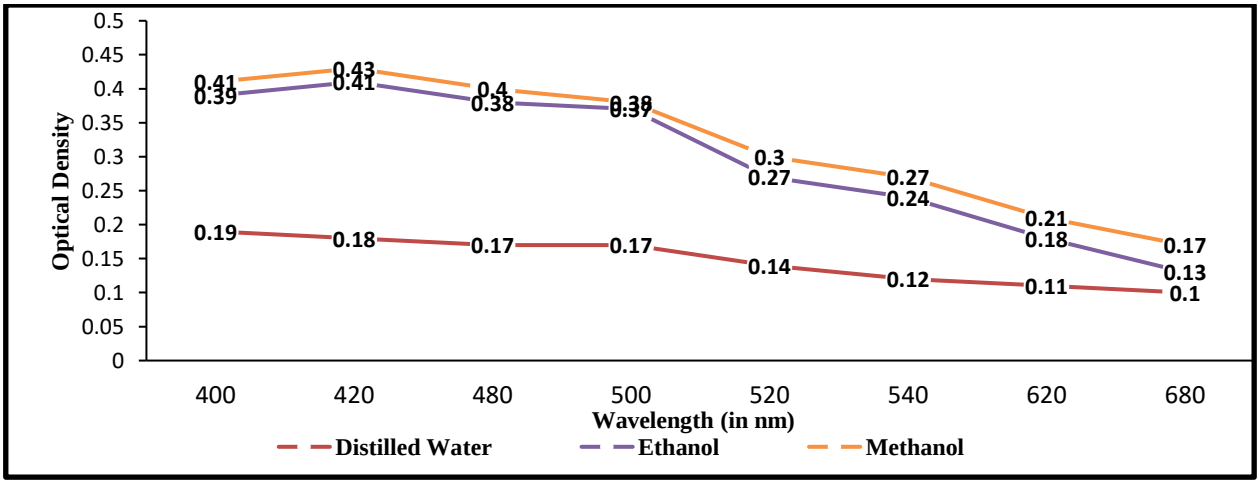

Table 3: Preliminary phytochemical analysis *Murraya koenigii* plant leaves extract

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.

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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.

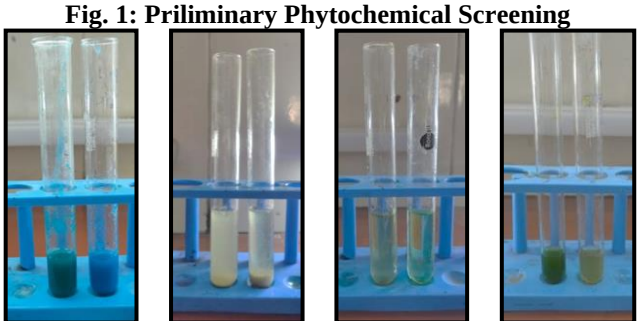
The preliminary sewage water treatment was observed with the help of the Multiple Tube Dilution Technique and based on Most Probable Number value which significantly decreased after the treatment of Water Hyacinth plant in the sewage water. The MPN value was around 2400 on the day 1 of the experiment 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

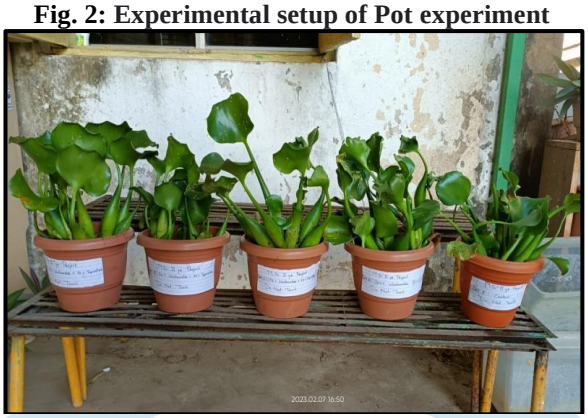
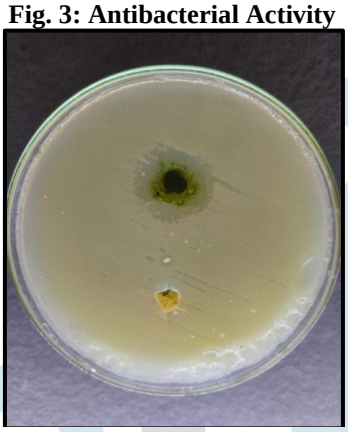


Fig. 3: Antibacterial Activity



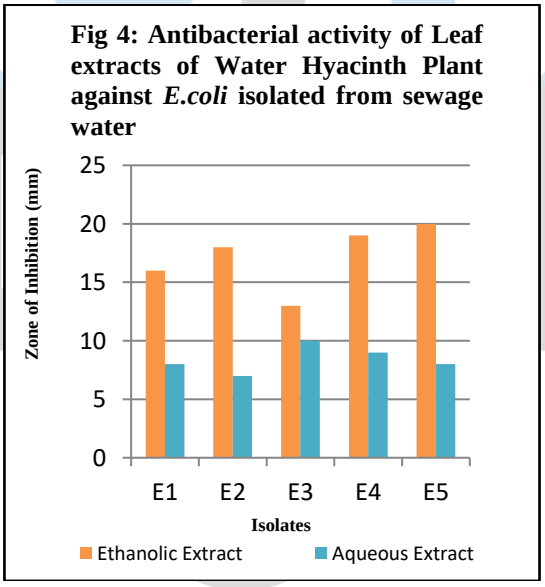


Fig 5 :The pH values of sewage sample before and after treatment with Water Hyacinth Plant

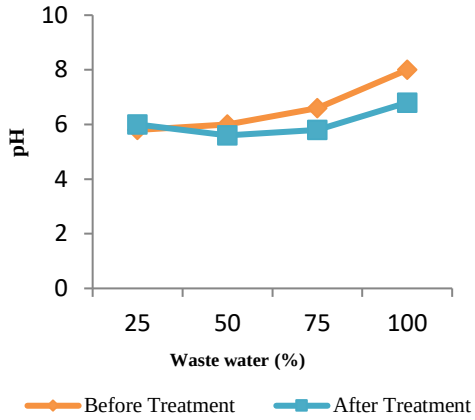


Fig 6: The Values of Total Dissolved Solids (TDS) for sewage water before and after treatment with Water Hyacinth Plant

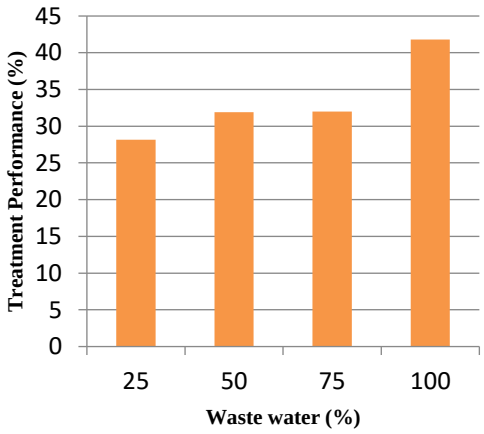


Fig 7: The Values of Dissolved Oxygen (DO) for sewage water before and after treatment with Water Hyacinth Plant

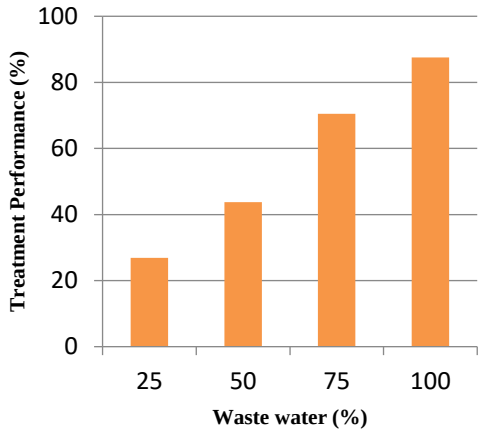
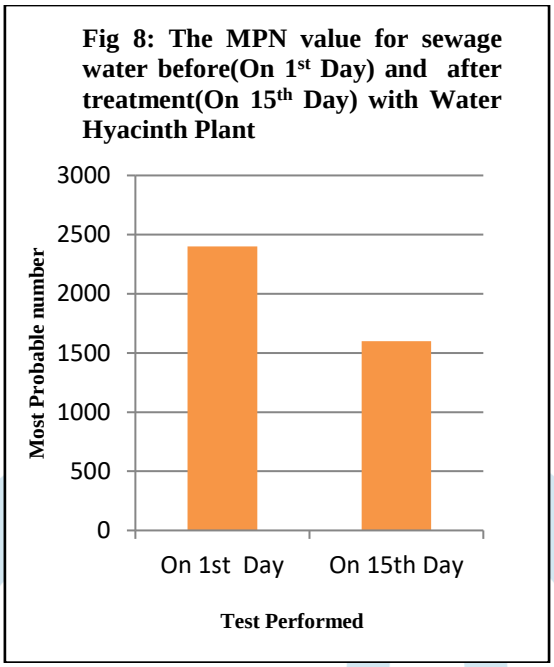


Fig 8: The MPN value for sewage water before(On 1st Day) and after treatment(On 15th Day) with Water Hyacinth Plant



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.

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"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

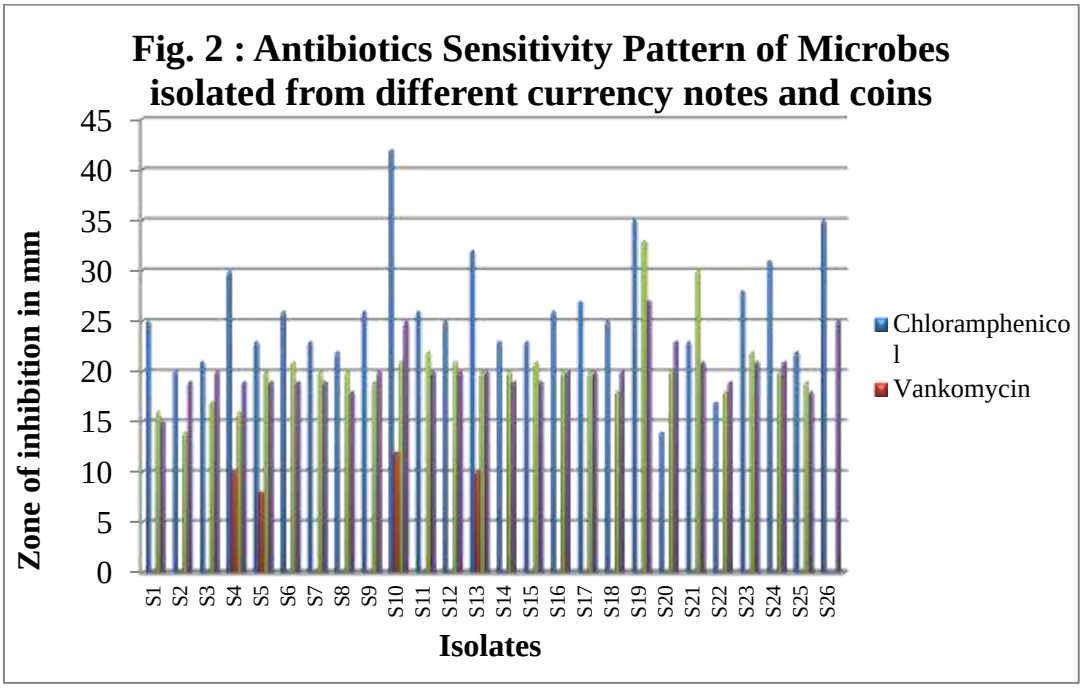
\Table No.2 : Gram Characters of Isolates obtained from different currency notes and coins

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.

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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

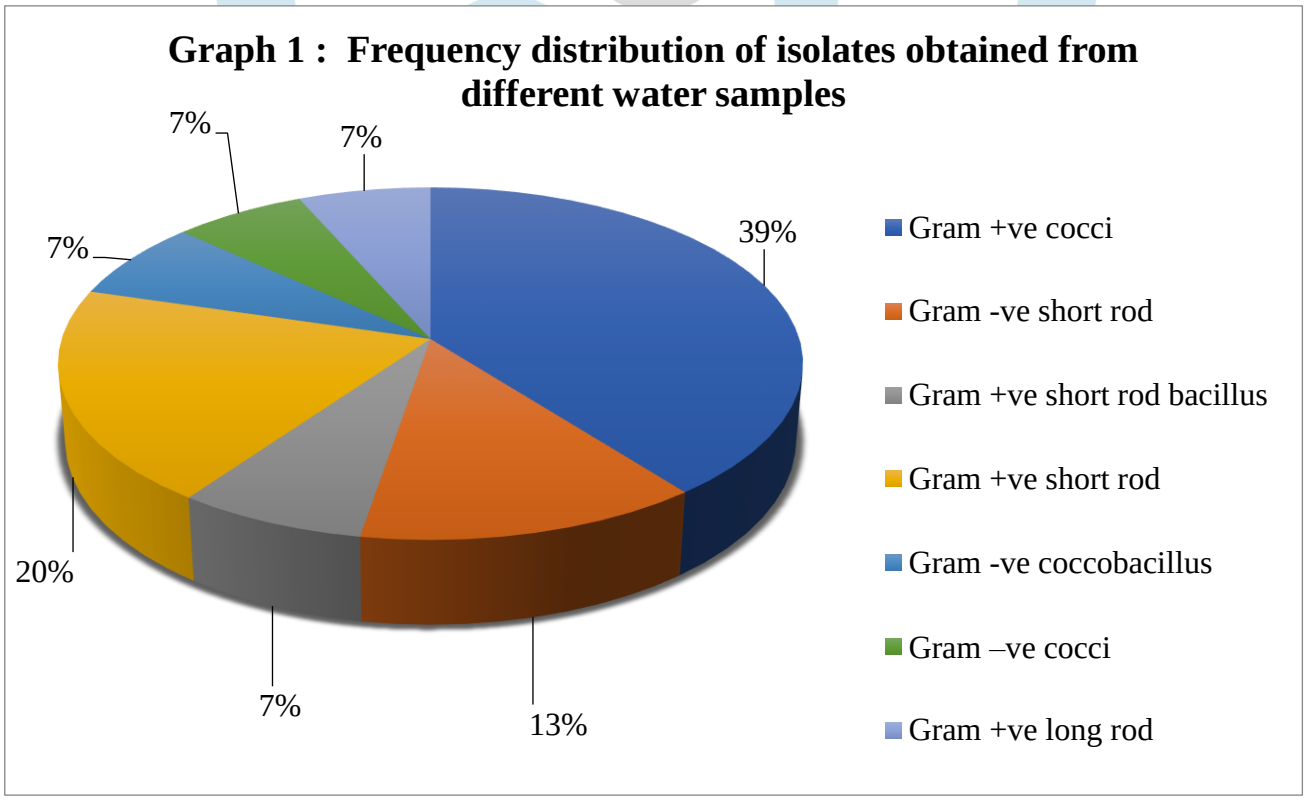

Table 2 :- Screening of Cleaning Agents

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.

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INDEX

No.	Title of the Paper — Authors' Name	Page No.
1	Challenges In Tribal Education: Difficulties And Development In Tribes — **Prof. Uttam R. Deulkar, Dr. Uday Manjre**	1
2	Role of Famer Producer companies with help of Innovative Business to increase farmer's income in India — **Mr.Rajesh M. Thoke , Dr.Vikhe A.A.**	6
3	Comparative Study Between Kabaddi And Basketball Players About Their Strength And Fitness — **Dr. Kamini M. Mamarde**	9
4	The Ornaments Depicted In The Craving Female Deities In The Temples Of Rayalaseema — **Dr.K.Chitti kalavathi**	12
5	Relationship Of Physical, Physiological And Athropometric Variable With 5km Running Performance Of Male Athletes — **Kumari sushma, Sharma Deepak**	18
6	Role of Human Resource Management on Indian Economy — **Yogeshwar Ramesh Jogi**	24
7	Situational factors related to anxiety and mood — **Prof. Dr. Sudhir Kahate**	27
8	Dr. Babasaheb Ambedkar's - Social, Political, Educationaland Economical Works — **Mr. Sachin S. Ramteke**	31
9	Effect Of Antarangyoga Sadhana On Human Body — **Miss. Shubhangi P. Rawale, Dr. Sunil Labale**	35
10	An Analytical Study of Elections in India: Political Review — **Amol Bhikaram Dhotre, Dr.Arun M. Shelke**	38
11	Startup India:A new Paradigm for Young Entrepreneur — **Ku.Jayaprabha Mahadeo Bhagat**	42
12	Cultural Shifts in the Post-2021 Society — **Samruddhi Gole, Dr. Kalyan More**	46
13	Political journalism in india: journalism and politics The history and current state — **Ms. Deepika S. Golatkar**	52
14	सामाजिक समस्याओ को उकेरती हिंदी फिल्में — **डॉ. राजेश**	55
15	बिहार के विकास में विधानसभा सदस्यों की भूमिका : २००५ से २०२० तक — **सद्दाम हुसैन डॉ. मो. जमशेद आलम**	59
16	डॉ. बाबासाहेब आंबेडकरांची धम्मक्रांती व अस्पृश्यता निर्मूलनासंबंधी विचार — **प्रा.डॉ. वामन ए. बोन्नागडे**	66
17	गोपाळ कृष्ण गोखले यांचे राजकीय व सामाजिक कार्य — **प्रा. डॉ. काशिनाथ शिवराव मानमोडे**	72
18	बचत गटाच्या माध्यमातून महिलांचे उभरते राजकीय नेतृत्व — **महेन्द्र देवरावजी भलमे**	76
19	वैदर्भीय ग्रामीण कादंबरी : एक वास्तव — **विजया विनायकराव वानखेडे**	79
20	राजकीय स्वातंत्र्य की सामाजिक स्वातंत्र्य यातील प्राधान्यक्रमामध्ये असलेल्या ब्रिटीशकालीन वैचारिक संघर्षाचे विश्लेषण — **डॉ. अशोक चाबर**	84
21	कोविड-19 महामारीमध्ये ग्रंथालय उपक्रम — **डॉ. सुखलाल राठोड**	88

22	भारतीय बँकिंग क्षेत्र – आव्हाने व संधी **डॉ. गजानन सोमकूंवर**	92
23	छत्रपती संभाजी महाराजांचे व्यापारविषयक धोरण : एक अभ्यास **प्रा.डॉ.साईनाथ शेटीवे**	97
24	भारतीय अर्थव्यवस्थेत डॉ.बाबासाहेब आंबेडकर यांचे योगदान **प्रा. निलेश अरुण दूर्गे**	101
25	महाराष्ट्र राज्याचा अर्थसंकल्प 2023 : कृषी विकासातून समृद्धीकडे **डॉ सुनिता कलाबे,**	105
26	शेरशहाच्या शासन व्यवस्थेचे मुल्यमापन **प्रा. डॉ. प्रमिला डी. भोयर**	110
27	ऑनलाइन व्यापार व त्याचे त्याचे परिणाम **प्रा. डॉ. जयंत पोरे**	114
28	कृषि पर्यटन में अपार संभावनाएं **डॉ. एम.आर. दातीर**	117
29	ग. दि. माडगूळकरांचा सिध्दहस्त लेखनीचा सौंदर्यात्मक : 'गीतबन' **प्रा. छत्रपाल श्रीपतराव लांबकाने**	122
30	प्रा. पुरूषोत्तम नागपुरे यांच्या साहित्याची प्रेरणा **सहा.प्रा.दीपक स.वानखडे**	126
31	कोविड-19 महामारीमध्ये ग्रंथालय उपक्रम **डॉ. राठोड सुखलाल शामराव**	130
32	कुसुमाग्रजांच्या कवितेचा अन्वयार्थ **प्रा. डॉ. विनोद नामदेव इंगळे**	134
33	ृषी उत्पन्न आणि ऊर्जा स्त्रोत डॉ.अर्चना शिवाजी वाघमारे,डॉ.राम प्र.ताटे	137
34	डॉ. बाबासाहेब आंबेडकर यांचाअस्पृश्यता विषयक विचार व कार्य **प्रा. मनोहर शामराव वागतकर**	139
35	महिलांसाठी कायदे व योजना आणि महिला सक्षमीकरण **प्रा.डॉ.आसाराम दि.चव्हाण**	145
36	वाशिम शहरातील घरकाम करणाऱ्या महिलांच्या शैक्षणिक व आरोग्य विषयक स्थितीचे अध्ययन **प्रा. डॉ. जयश्री पंजाबराव काळे**	149
37	मराठा- ऐक्येच्छु सभा : कृष्णराव केळूसकर **प्रा. मोहन बाबुराव चव्हाण**	152
38	Effectiveness of Activity Based Learning Methodology of pedagogy subject **Dr. Ranjana V. Tijare**	156
39	The Bank Merger in India & their Benefits **Purvesh Pramod Fating**	159
40	भारतीय शेती उत्पादन वाढी करिता सेंद्रिय शेती काळाची गरज **सहा.प्रा.विकास का.देशमुख**	163
41	महाराष्ट्रातील शालेय शिक्षणाचा शैक्षणिक स्तर खालावण्याचा कारणांची मिमांसा **प्रा. डॉ. बाळकृष्ण पू अडाळ**	167
42	Study of Zooplankton Diversity inSonala Dam, Sonala, Dist. Washim, (M.S.) **Dr. Ujwala P. Lande**	170
43	**Comparison Of Anxiety And Achievement Motivation Of Footballers Of Intercollegiate And University Team Prof. Chandrashekhar S. Ingole**	173

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Study of Zooplankton Diversity inSonala 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

Corresponding author : E mail landeujwala@gmail.com **Mobile No. : 9404092739**

Abstract:-

The present study was undertaken to studyZooplankton Diversity in Sonala dam, Sonala, Dist. Washim, Maharashtra. Sonala dam is an earthen dam, constructed by irrigation department of Maharashtra Govt. Zooplankton diversity was studied from this dam which is one of the most ecological parameters as these are the intermediate link between phytoplankton and fish. They play a significant role in transferring energy in aquatic ecosystem as primary consumers and can be used as indicators of tropic phase of a water body. The study area was divided in to five sampling stations to cover the whole dam. Monthly sample were collected by filtering fifty liter water sample through standard plankton net of bolting silk cloth No. 25 with 56µ mesh size and the concentrated sample were collected in 10 ml distilled water and were preserved in lugol solution and 4% formalin and observed . Population abundance and Percentage of zooplanktons was in the order of Rotifer • Cladocera • Copepoda • Ostracoda. Rotifers (27.90%), cladocera (16.76%), copepod (15.49%); ostracods (13.28%);

Key words :- Zooplankton, Sonala dam , Indicators, Ecosystem

Introduction : .

Zooplankton is the important component of aquatic fauna which serves as amajor component of aquatic food chain. It also maintains proper equilibriumbetween biotic and abiotic components of the aquatic ecosystem. The freshwater zooplankton is comprised of four major groups of invertebrate animals: Rotifers, Copepods, Cladocerans and Ostracoda occurring abundantly in all types of aquatic habitats and plays a vital role.Zooplankton diversity and their ecology greatly contribute to as understanding of the basic nature and general economy of aquatic habitats. Physico-chemical factors also regulate zooplanktonpopulation in water body. Various researchers carried out work to study the zooplanktons of different fresh water bodies. Jayabhaye (2010), studied zooplankton diversity of river Kayadhu, near Hingoli city Maharashtra. Tayade and Dabhade (2011) studied the rotifer community around Washim region and prepared a checklist of Rotifers in Washim region. Study of qualitative diversity of rotifer community of freshwater Katepurna reservoir, district Akola, Maharashtra, (India) was carried out by Pawar and Dabhade (2016). Zooplankton diversity reflects the water quality and they are the good indicators of changes taking place in the water resources. Kabra *et.al.* (2016), carried out a research work to analyze zooplanktons of Fresh water ecosystem in Washim town, Maharashatra, India. The Biodiversity of aquatic life conservation is an important task because day to day pollution is increasing and their direct effect is on aquatic life. In present days, the biodiversity is in danger due to pollution and human activities. Conservation of biodiversity is essential so it is compulsory to keep update knowledge of every aquatic species diversity. The density of planktons in water body determines stocking rate of fishes because they are the chief sources of the food of commercially important fishes as well as development in production of inland fishery sector. The presence and dominance of zooplankton species played a very significant role in the functioning of freshwater ecosystem.

Therefore, present investigation was undertaken to study zooplankton diversity of Sonala dam freshwater body in Washim District of Maharashtra, India with following aims and objectives-

1) Collection and preservation of Zooplankton from Sonala dam freshwater body.
2) Identification of Zooplankton by using standard methodology .
3) Study of diversity of zooplankton in Sonala dam water body.

Materials and Methods

The present study is a part of limnological survey undertaken inSonala dam, Sonala, Dist. Washim. Sonala Dam reservoir was constructed in the year 1981. Agricultural fields surround the reservoir. 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.

The selection of five sampling stations was made on the basis of human and other domestic activities. For biological analysis in water, 50 liter of water sample was filtered through standard plankton net of bolting silk cloth No.25 (56 mesh size). 125 ml was the final volume of the filtered sample which was transferred to another 125 ml plastic bottle and labeled mentioning the time, date and place of sampling. The samples were preserved by adding 2ml of 4% formalin. After 24 hours, the supernatant was carefully discarded and the final volume of concentrated sample was 50 ml. Preserved 50 ml water sample bottles were brought to the laboratory and examined under a Binocular microscope with different magnification. Quantitative analysis was done by Drop Count Method. Detailed taxonomic identification was carried out with Pennak (1989), Koradkar (1992) and Dhanpati (2000). Karl Pearson's formula was used to calculate correlation coefficient between some of the physico-chemical parameters and rotifers.

Result and Discussion :

Sonala Dam exhibited heavy bulk of rotifers all through the period of investigation. The observed zooplanktons belong to groups rotifers, cladocera, copepods and ostracoda. Rotifers (27.90%) dominated the zooplanktons population and were followed by cladocera (16.76%); copepod (15.49%); ostracods (13.28%); worms and larvae (11.52%) (Table-1). Abundance in zooplanktons was in the order of rotifers > cladocera > copepoda > ostracods and Station wise enumeration of total zooplanktons exhibited highest number of total zooplanktons at station I followed by station II, station IV, and station III however, at station V, the total zooplanktons were found to be the minimum. Rotifers were found to be maximum at station I and IV. Numerical abundance is shown in table 1. Zooplankton was observed maximum (55028 org/lit.) at station I and it was found minimum (47812 org/lit.) at station V (Table-1).Seasonal trend of zooplankton representing lower number in monsoon season. It might be due to rain water, causing diluting effects as suggested by Chapman et.al;(1985). On the other hand zooplankton might have consumed by fishes as reported by Dave et.al ;(1999). The increased turbidity in rainy season may be the cause for declining zooplankton population as suggested by Sharma and Sahai; (1988).

Conclusion:

The planktonic population varies qualitatively and quantitatively depending on the morphometry, source of water, its organic and inorganic content, climatic factors and with the season Zooplankton population belongs to four category exhibit more population of rotifers in the present investigation which is good food for the fishes therefore, the water body is advantageous for fish culture, Meshram, C.B. (2005). The presence of water insects, molluscs, macrophytes, provides food for migratory and residential birds. The pollution indicator phytoplankton and zooplankton were less in number at all the station confirms that the water is safe for drinking and also for healthy fish culture. The present status of water body is mesotrophic and nonpolluted hence; the water can be utilized for irrigation, drinking and fishery activities.

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Table :

Table1:Numerical abundance of zooplankton(org/l)at different stations of Sonala Da

Sr.No.	Zooplanktons	Stations					Total	%
		I	II	III	IV	V		
1	Rotifera	14801	13917	14654	15316	14138	72826	27.90
2	Cladocera	9646	9646	10383	7879	6185	43740	16.76
3	Copepoda	8026	9205	6480	9205	7511	40426	15.49
4	Ostracoda	8247	8395	6185	5913	5913	34653	13.28
	Total Zooplanktons	**55028**	**53607**	**51251**	**53335**	**47812**	**261034**	100

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SPIDER DIVERSITY AROUND SONALA DAM, SONALA, DIST. WASHIM, MAHARASHTRA

Ujwala P. Lande

Department of Zoology, Shri Shivaji College of Arts, Commerce & Science, Akola, (M.S.), India
*Corresponding Author: landeujwala@gmail.com

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ABSTRACT:
The paper reveals the study and identification of spiders found at Sonala dam, Washim and at its adjoining forest and agriculture fields. The survey conducted and recorded, noticed over all 28 mature male and female spiders, belonging to 10 families, and 24 species. Although, the spiders of different families were noticed, the most dominant family observed was Araneidae with 7 species. The vegetation and the climate present at Sonala dam and at its adjoining area ascertain the availability of recorded species of spiders.

Keywords :- Spiders, Climate, Araneidae, conservation.

INTRODUCTION :

Arachnids are a diverse group of invertebrate populations that exploit a wide range of spatial and temporal niches in virtually all biomes on the earth. Spiders are an important group of arthropods although poorly studied. Despite their rich abundance, ecological importance and ubiquitous occurrences, spiders are seldom included among organisms surveyed for extensive studies and conservation (Cole, 1994). Spiders play an indispensable role in the regulation of insect pests and other invertebrate populations in most ecosystems, as well play a vital role in sustaining the ecosystem (Russel-Smith, 1999). Spiders are widespread predators; they are of extensive economic importance to man due to their ability to suppress pest abundance in agro ecosystem. Spiders are very sensitive biological indicators and exhibit immense taxon and guild responses to environmental changes (Uetz, 1991). Spiders are widely used to assess the health of ecosystems, since they can be easily identified and are differentially responsive to natural and anthropogenic disturbances (Pearce and Venier, 2006). Spiders are discernible, amenable to capture by relatively economical, easily deployable and replicable techniques. The spider fauna of India is represented by 1520 spider species belonging to 377 genera and 60 families (Sebastian and Peter, 2009).

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 770, 12', 30" Longitude and latitude of 200, 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

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Godavari. Adan River in its way runs through the Maraldoh village, before draining in the dam.

SAMPLING :

Spiders were collected every month by adopting standard sampling techniques. Spiders were collected from tree trunks, ground, vegetation, under stones/crevices, grasslands and near water body etc. While collecting spiders care was taken to avoid collection of immature spiders and emphasis was given on collection of mature spiders. Also repetition was avoided during collection of sample. Spiders were sampled using many standard sampling techniques, each with its own limitations, such as active visual searching and hand picking, insect's nets, and beating, pitfall trap, sweeping, and stroking sticks. Collected specimens were preserved in 70% alcohol. At the initial level all the specimens were separated from other materials, labeled and identified according to Barrion and Litsinger (1995), Biswas and Biswas (1992), Davies and Zabka (1989), Gajbe (1987), Tikader (1962, 1970 ,1987) Platnick (1989, 2004).

MORPHOLOGY :

Spiders are commonly named according to web pattern, behavior of spiders and resemblance with other animals. Some of the common names are given in table 1.

RESULT AND DISCUSSION :

On examining the collection, it is quite fascinating and encouraging to document the varied types of spiders living around the Sonala dam. A total of 28 mature male and female spiders were recorded from the study area, belonging to 10 families and 24 species. The largest number of species belonging to family Araneidae, which is represented by 7 species followed by Salticidae representing 4 species, Gnaphosidae, Lycosidae, Oxyopidae, Uloporidae and Theridiiae were represented by 2 species each. The spiders were found to be thriving in different habitats. The spider families which mainly inhabited vegetation were Araneidae, Tetragnathidae, Oxyopidae and Philiodromidae. Hippasa, the member of Lycoidae family was found in funnel webs made over holes in the ground. Crab spiders belonging to Philodromidae were mainly found thriving on flowering plants. Tetragnathidae spiders were predominantly found on the reeds overhanging the water body. Spiders belonging to family Phosidae and Oxypidae were ground dwellers. The spider families predominantly found in agricultural field were Oxyopidae, Lycosidae, Salticidae, Araneidae and Gnaphosidae.

Environmental parameters, such as vegetation, topography and climate tend to influence spider distribution and diversity; as spiders are very sensitive to these parameters. Spiders are the most important invertebrate predators in many terrestrial ecosystems. Among the arthropods spiders play a significant role in ecosystem functioning throughout the habitat (Van Hook, 1971). Spiders seem well suited to discriminate habitat type and quality, since they play a significant role as diverse and abundant invertebrate predators in terrestrial ecosystem (Skrel, 1999). Despite their valuable ecological role in many ecosystems, spiders have not yet received due attention from conservation point of view. Negative public attitudes towards spiders might be one of the causes affecting attention (Kellert, 1986). A paucity of compiled information on spider conservation status and distribution may be a more important issue. This indirect approach of spider conservation indicates that the spider fauna is to be considered broadly in general conservation planning and habitat protection efforts as an important component of terrestrial ecosystems (Kishor Rithe, 2012). Substantial information in this respect will greatly determine the viability of this approach. Increased communication between conservation professionals and spider researchers may yield new co-operative approaches for assessing the

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usefulness of spiders in conservation tools. Hence it can be concluded that the area around Sonala dam is having rich biodiversity and should be essentially protected from anthropogenic encroachment. Spider can be used as an indicator of healthy ecosystem and hence our prime duty to protect the vegetation so as, to increase the production of different species.

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Table No. 1 : Spider Family Name and Common Name

Sr.No.	Family Name	Common Name
1.	Araneidae	Orbweavers
2.	Clubonidae	Sac Spiders
3.	Gnaphosidae	Ground Spiders
4.	Lycosidae	Wolf Spiders
5.	Oxyopidae	Lynx Spiders
6.	Philodromidae	Running Crab Spiders
7.	Salticidae	Jumping Spiders
8.	Theridiidae	Combfooted Spiders
9.	Tetragnathidae	Long jawed orb web weavers
10.	Uloboridae	Triangle weavers

Table No. 2 :- Total Species found in Study region

Sr.No.	Family	No. of Speies
1.	Araneidae	7
2.	Clubonidae	1
3.	Gnaphosidae	2
4.	Lycosidae	1
5.	Oxyopidae	2
6.	Philodromidae	2
7.	Salticidae	4
8.	Theridiidae	2
9.	Tetragnathidae	1
10.	Uloboridae	1

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Table No. 3 :- Spider fauna from study area

Family	**Species**
Araneidae	Araneus sp. (F)
	Araneus marmoreus (M)
	Argiope aemula (M)
	Neoscona sp. (M)
	Neoscona sp. (F)
	Zygiella sp. (F)
	Zelotes choubai (M)
Clubionoidae	Clubiona sp. (M)
Gnaphosidae	Gnaphosa paurinsis (F)
	Zelotes chandosiensis (F)
Lycosidae	Lycosa sp (F)
	Hippasa sp. (M)
Oxyopidae	Oxyopus sp. (M)
	Oxyopus sp. (F)
Philodromidae	Philodromus sp. (M)
Salticidae	Plexipus insulana (F)
	Plexipus paykulii (M)
	Plexipus paykulii (F)
	Plexipus sp.
Tetragnathidae	Tetragnathidae sp. (M)
Theridiidae	Leucage sp. M/F
	Leucage fastigata (M)
Uloboridae	Uloborus sp. (F)

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Extraction of natural fibers from some plant species found in Akola region

[1]Vaishali S. Patil, [2]Mahima S. Yadav

Department of Botany
Shri Shivaji College of Arts Commerce & Science Akola.

***Abstract*-Plants are the source of plant fibers. These plant-based fibers are used to create fabrics. Natural fibers are sustainable materials which are easily available in nature and have advantages like low-cost, lightweight, renewability, biodegradability, and high specific properties. Such fibers are derived from various parts of plants including leaves, stems (best fibers), fruits and seeds. Synthetic fibers are man-made fibers. The majority of them are petrochemicals because they are created using materials derived from petroleum. These fibers, which are used to create fabrics, can come from either natural or synthetic sources. Synthetic fibers do not absorb water or sweat melt and burn easily. On catching fire, it shrinks forming beads which stick to the skin. These fibers are non-biodegradable. Synthetic fibers are far less sustainable, consuming 342 million barrels of oil and releasing 8,000,000 tons of plastic into the ocean every year in the form of microplastics. It can take up to 200 years for synthetic fibers to biodegrade into the earth. They are an allergen to some. So, the increase in awareness of the damage caused by synthetic materials on the environment has led to the development of eco-friendly materials. In this study the natural fibers are extracted from those plants which are easily available and it has the potential to capture a good market share in the future.**

***Key words*-Natural fibers, extraction, plant parts use.**

INTRODUCTION:

Fiber crops are grown in fields that are used to make ropes, papers, cloth, etc. Plant fibers are also called natural fibers as they are obtained naturally and directly from the different sources of plants and their products. Among the plant species, the fiber yielding plants which are commonly usedby man holds the second position after the food plants in their economic importance. The ancient man started his nomadic life by using the plant material directly for covering and protecting his body, thatched leaves for shelters and huts; mats for household and other day-to-day activities. Gradually fast mobility and advancement in the lifestyle led him to search for lighter, more durable and sophisticated-looking materials for routine use. There began an era of developmentof different types of textiles, papers, basketries, woven cloths, mats, hats, ropes, and cordage material for various uses. The gradual depletion of forest resources of plant based material resulted in the loss of important diversity. The plant fibers havespecific qualities such as thermal insulation, resistance to water, and other desirabletraits to increase the constant supply of raw materials to plant fiber-based industriesa need was felt to explore and identify alternative materials. By identifying new fiber yielding species as well as novel uses of fiber through research and development, there would be decrees in pressure on a handful number of species used for fiber, besides supporting small scale industry and reinforcing fiber for waste fiber recycling the present enumeration is an effort taken in this direction (Gillah et al, 1998; Velasquez, 2001).

Survey of fiber yielding plants of Akola region has been left almost untouched. Akola is a district in Vidharbha region in the state of Maharashtra in central India.It is located at latitude 20-7 North longitude 77.07 the East. It is at an altitude of 925 ft (282m) above sea level. It has tropical savanna climate. Annual temperature ranges from high of 48^0 C (118 f) to a low of $10\ ^0$C (50 f).Natural fibersare good for the environment, comfortable to were, renewable, biodegradable, carbon neutral and can be used without depleting or damaging the environment. Whilst all land plants contain fibres they are usually too short or too weak to be used for anything other than paper-making, but there are well over 100 species suitable for growing in temperate climates that produce long and relatively strong fibres. They are of great insulators, good for sensitive skin trendy & fit in with the organicmovement. Synthetic fiber catch fire easily& dangerous to wear. They are by-products of petroleum, non biodegradable, creating long –term pollution. They can't easily recycle, hard to decompose & accumulate landfills more. Synthetic fibres can cause various bronchopulmonary diseases, such as asthma, extrinsic allergic alveolitis, chronic bronchitis with bronchiectasis, spontaneous pneumothorax, and chronic pneumonia. So, there is an urgent need to protect our environment by focusing on natural fibers.

MATERIAL AND METHOD:

Extensive survey of fiber yielding plants in Akola region was carried outfrom January to March 2022 and these plants were collected from different localities. More than 10 plants were collected in sterile polythene bags. Collectionwas made in different season. These plants were brought in laboratory and were identify by using Flora of Marathwada by Dr.V. N. Naik. Various plant parts suchas roots, leaves, fruits, seeds etc. were used for extraction of fibers. Plants such as*Gossypium hirsutum* (seed hairs), *Dracaena trifasciata (*leaves), *Dypsis lutescens* (leaves stalk), *Livistona chinensis* (leaves stalks), *Ceiba pentandra* (seed hairs), *Cocos nucifera (*mesocarp), *Agave Americana* (leaf), *Phoenix dactylifera* (stem) , *Livistona chinensis (*leaf), *Bambusa vulgaris*(stem), *Abelmoschus esculentus*(fruit), *Annona squamosa* (stem), *Ficus racemosa* (stem) , *Beaucarnea recurvate* (leaf), *Annona reticulata L.*(Stem) taken for extraction of plant fibers. Morphology of these plants was studied.

EXTRACTION OF PLANT FIBERS:

Hand scraping: In this fiber extraction method a knife or ceramic plate are used, by putting the parts of plant on a plate and scratch repeatedly by using the knife orceramic plate until the fiber is seen. After that scratch that plant part gently or slowly in order to prevent the fibers from damage. Finally, the extracted fiber willbe washed by water and dried in sunlight. Hand scraping of the plant part must be done in the first three days after harvesting. If left any longer, the plant part will become dry and the fibers will be difficult to extract. The gathered plant parts weresorted to remove any damaged, diseases or broken part of plants. Hand scraping method is the easiest and the shortest way of mechanically extraction of fiber,

RESULT AND DISCUSSION:

List of the plants used for extraction of fibers-

Sr. No.	Name of plants	Family	Part used forextraction of fiber
1	*Gossypium arboreum L.*	Malvaceae	Seed hairs
2	*Dracaena trifasciata(Prain) Mabb*	Asparagaceae	Hard (Leaves)
3	*Dypsis lutescens(H.Wendl.) Beentje & J.Dransf.*	Arecaceae	Hard(Leaves sheath)
4	*Livistona chinensis(Jacq.) R.Br. ex Mart.*	Arecaceae	Leaves rachis & Stem
5	*Ceiba pentandra (L.) Gaertn*	Malvaceae	Seed hairs
6	*Cocos nucifera L.*	Arecaceae	Fruit
7	*Agave americana L.*	Asparagaceae	Hard (Leaves)
8	*Phoenix dactylifera L*	Arecaceae	Leaves rachis
9	*Bambusa vulgaris Schrad. ex J.C.Wendl*	Poaceae	Bast (Stem)
1o	*Abelmoschus esculentus(L.) Moench*	Malvaceae	Fruit
11	*Annona squamosa L.*	Annonaceae	Bast (Stem)
12	*Ficus racemosa L.*	Moraceae	Bast (Stem)
13	*Beaucarnea recurvata Lem*	Asparagaceae	Hard (Leaves)
14	*Annona reticulata L.*	Annonaceae	Bast (Stem)

DISCUSSION:

Fibers derived from bio-based sources such as vegetables and animal originate termed as natural fibers. Some fibers (e.g., viscose rayon and cellulose acetate) are produced with chemical procedures from pulped wood or other sources (cotton, bamboo). Natural fibers being cost effective and abundantly available yield which have high potential in various industrial and commercial applications such as in the interior applications of the passenger cars, panels for partition and false ceiling, partition boards, roof tiles, coir fibers in packaging, furniture applications, as insulating materials in low energy houses, geo-textiles for soil protection and erosion control, enhancing barrier properties, composites etc. Due to research and developmental work in modification and treatment methods of natural fibers, utilization of natural fibers has observed a significant growth in various applications. The study addresses the potential applications of natural fibers in various commercial sectors for the development of environment-friendly products with an aim to replace synthetic fibers or inorganic fillers with cost-effective and efficient products.

In *Gossypium arboreum & Ceiba pentandra* fibers are obtain from seeds. In *Dracaena trifasciata, Dypsis lutescens, Livistona chinensis, Agave americana, Phoenix dactylifera, Livistona chinensis, Beaucarnea recurvata, fibres* are extracted from leaf while in *Cocos nucifera & Abelmoschus esculentus* it is extracted from fruit. In*Bambusa vulgaris, Annona squamosa, Annona reticulata & Ficus racemose* it is extracted from stem part.

Plant fibers are sclerenchyma elongated cells which occurs in different parts of plant, mainly in the stem and leaves. These are elongated cells with tapering ends and thick, usually heavilylignified cell walls.

Fibers are also associated with the xylem and phloem tissue of monocotyledonous and dicotyledonous plants stems and leaves. Sepration of fibers takes place by retting process, which involves bacteriaand fungi treatment. The cellulose, hemicellulose and lignin content in plant fibers vary depending on the plant species, origin quality and conditioner.

Natural fibers are an effective way of improving the quality of part regardingthe environment, economic and technical feasibility. However, to accomplish this goal there are certain issues that need to be tackled.

CONCLUSION:

Natural fibers are fully sustainable, renewable, and biodegradable. They have several advantages in comparison with man-made synthetic fibers and are widely used in the apparel sector and interior design. Unfortunately, they are flammable and not resistant to biodegradation. For this reason, their use is very often limited. Therefore, competitive products based on renewable resources needto be developed to have high quality, show excellent technical performance, and harm the environment less than current products based on petrochemical materials.Natural fibers are best option.

Natural fibers and the products designed around these materials possess many distinctive advantages such as cost-effective, low coefficient of friction, ease of availability, exhibit good thermal and dimensional stability, environmentally friendly, etc. Many of them are plentiful and readily available. These fibers can be used as a model for developing a national priority bio-product based on textile innovation, which can be facilitated through government support. It will be also beneficial to farmers, in order to increase

their economy. So, there must be the establishment of an information system for natural fibers, as well as collaboration with a variety of systems such as research and development institutions, companies,and universities, which can take efforts to increase the use of natural fibers in a sustainable circular economy.

Photo Plate 1

A) Gossypium hirsutum

B) Cotton fiber

C)Cocos nucifera

D) Coir fiber

E) *Dracaena trifasciata*

F) Leaf fiber

Photo Plate 2

A) Agave americana

***B)* Leaf Fiber**

C***) Ceiba pentandra***

D) Seed hairs fiber

E)Beaucarnea recurvata

F) Leaf fiber

Photo plate 3

A) Dypsis lutescens

B) Leaf sheath fiber

C) Annona squamosa

D) Stem fiber

E) *Phoenix dactylifera*

F) Leaf rachis fiber

Photo plate 4

A) Bambusa vulgaris

B) Stem fiber

C) ***Ficus racemosa***

D) Stem fiber

E) Annona raticulata

F) Stem fiber

Photo plate 5

A) Abelmoschis esculentus

B) Fruit fiber

C) Livistona chinensis

D)Leaf sheath fiber E) Leaf rachis fiber

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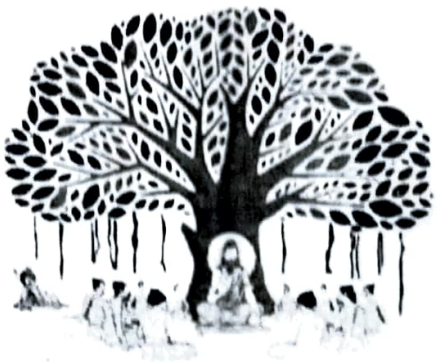

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सारांश :

संगीत एक ऐसी अमूर्त कला है जिसे सम्बद्ध कलाकार अपनी सतत् साधना से जीवंत करने का प्रयास करते है। कोई भी कला साधना के बिना पूर्ण रूप से सिद्ध नहीं होती है। साधना भारतीय शास्त्रीय संगीत की वह महत्व महत्वपूर्ण प्रभावी पद्धती है जो विभिन्न परिवर्तनों के बावजूद गुरुकुल परम्परा के सशक्त स्वरूप में आज भी सुरक्षित बनी हुई है। भारतीय संगीत की लम्बी परम्परा विभिन्न कालों मे गायन, वादन और नृत्य के क्षेत्र में अनेक कलाकारो ने अपनी अपनी कठिन साधना और उपासना द्वारा उसके विभिन्न स्वरूपों, शैलियों और पद्धतियों आदि को अपनी सोच समझ और सतत प्रयासों से निरन्तर परिमार्जित करने का प्रयास करते आये है। अपनी इन्ही विशिष्टताओं के रहते संगीत के क्षेत्र में वे अपनी अपनी विशिष्ट शैलियाँ स्थापित करने मे भी सफल हुए है।

प्रस्तावना

भारतीय दर्शन के अनुसार, शब्द ही ब्रम्हा है। और संगीत के माध्यम से साधक इसी नाद या ब्रम्हा की साधना करते इथे मोक्ष मार्ग को प्रशस्त करता है इसलिये संगीत - साधना को 'नाद-ब्रम्हा' की साधना कहा गया है. नादोपासना भी कहा जाता है, और संगीत - साधक को संगीत- उपासक। संगीत या साद की साधना तीन प्रकार से हो सकती है - गायन वादन और नर्तन

भारतीय संगीत और भारतीय सभ्यता का विकास साथ-साथ हुआ। संगीत ने साहित्य की भाँति अपनी सामग्री जनजीवन से ही जुटाई है। वैदिक काल मे सामगान से गांधर्व संगीत का विकास हुआ।

"गुरु गोविन्द दोनों खड़े करको लागूँ पाँय।

बलिहारी गुरु आपकी, गोविन्द दियो बताया"।

परंतु आजकाल संगीत शिक्षा की तीन-चार प्रणालिया भारत भर मे प्रचलित है।

क) गुरुशिष्य प्रणाली + 1RA Calcutta द्वारा संचालीत प्रणाली

ख) संगीत विद्यालयों में संगीत शिक्षा

ग) महाविद्यालयों में संगीत एक विषय के रूप में

घ) ट्युशन्स कर आजिविका चलाने वाले शिक्षको द्वारा संगीत शिक्षा

भारत में वैदिक काल में गुरुकुल शिक्षा पद्धती को प्रचार में होने के प्रमाण मिलते है। इस पद्धती मे विद्यार्थी गुरुकुल मे रहते हुए विद्या ग्रहण करते थे वे मूर्णतः गुरु के अधिनस्थ रहते थे और उनके अध्यन काल मे गुरु ही उनके अभिभावक हुआ करते थे शिष्य अपने गुरु के यहाँ रहते हुए पूर्ण समर्पण भाव से संगीत साधना करते थे। गुरु अपने शिष्यों को संगीत के तकनीकी पक्ष के साथ ही साथ संगीत की साधना के संस्कारों से भी संस्कारित करते थे।

निष्कर्ष :-

संगीत एक ऐसी अमूर्त कला है जीसे सम्बध्द कलाकार अपनी सतत् साधना से जीवंत करने का प्रयास करते हैं। कोई भी कला साधना के बिना पूर्ण रूप से सिद्ध नही होती। साधना भारतीय शास्त्रीय संगीत की वह महत्वपूर्ण प्रभावी पद्धती है जो विभिन्न परिवर्तनों के बावजूद गुरुकुल परम्परा मे आज भी सुरक्षित बनी हुई भारतीय संगीत की लम्बी परम्परा विभिन्न कालों मे गायन, वादन और नृत्य के क्षेत्र में अनेक कलाकारों ने अपनी अपनी कठिन साधना और उपासना द्वारा उनके विभिन्न स्वरूपो, शैलियों और पद्धतियों आदि को

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ELECTRONIC WASTE MANAGEMENT AND SUGGESTED REMEDIES TO CONTROL IT

Dr. Gajanan S. Wajire
Professor in Electronics,
Shri Shivaji College of Arts, Comm. & Science Akola (M.S.), India

Abstract:

The fundamental concept of electronic waste (or e-waste) describes that it includes all kind of discarded devices and/or gadgets related to electrical, electronic, computer or any other fields. Such types of used and scrapped electronics devices and gadgets which are intended for disposal, reuse, salvage or recycle are also considered e-waste. As per the latest survey, the global demand for electronic devices is on the rise and so is the number of used and discarded gadgets. Around 50 million tons of e-waste is generated every year, which is more than the weight of all of the commercial airplanes ever made. The United Nations report of 'World Economic Forum – 2021' arguments that at global level less than 20 % of e-waste is formally recycled, with 80% either ending up in landfill or being informally recycled. Most of it by hand in developing countries, exposing scrap workers to hazardous and carcinogenic substances such as mercury, lead and cadmium. Few last year's figures concluded that e-waste crossed about 48 MT in 2018 and in near future it is expected to double if any action is not taken against it. At world level, overall only 20 percent of its e-waste is recycled, which is eye opening. Casual processing of e-waste in developing countries may lead to adverse effects on environmental pollution as well as on living beings. In any way, everybody should involve in this campaign to save our earth from all kinds of pollution.

Due to major pandemics like COVID-19, almost whole world was locked down into the small houses. As a result, the importance of the new concept 'Work from home' has become a latest hash tag of the world. Ultimately, the need of all kinds of electronic gadgets and media is consistently growing, which is again insisting burden of e-waste in the world. Therefore, e-waste management plays an important role in the process of sustainable development for environmental issues.

Keywords: **E-waste, recycling, eco-friendly, digital cleaning, reuse, lead, tin, mercury, energy star, CSC, CRT.**

I. LEADING SOURCES OF E-WASTE:

There are many sources of e-waste from various sectors. The common products used for various data processing purposes are computers, monitors, scanners, speakers, keyboards, printers, mouse, memories & related storage devices. Different electronic devices used for entertainment and information purpose such as Televisions, Radios, DVD and CD players, MP3 players and so on includes the e-waste. Various equipment used for communication purpose like cell phones, landline phones, headphones, modems, fax, copier machines also contributes in e-waste sources. Number of household equipment's such as vacuum cleaners, mixers, grinders, microwave ovens, washing machines, induction tops, coolers, fans, fridges, air conditioners, wall clocks and so on increases the list of e-waste. Various audio-visual devices such as projectors, VCRs, stereo equipment, sound systems, camcorders, display monitors and so on becomes e-waste items with their life span. Many industrial and medical electromechanical equipment/devices can also be included in this list. Following chart shows major and leading sources of e-waste as shown in figure (1) below.

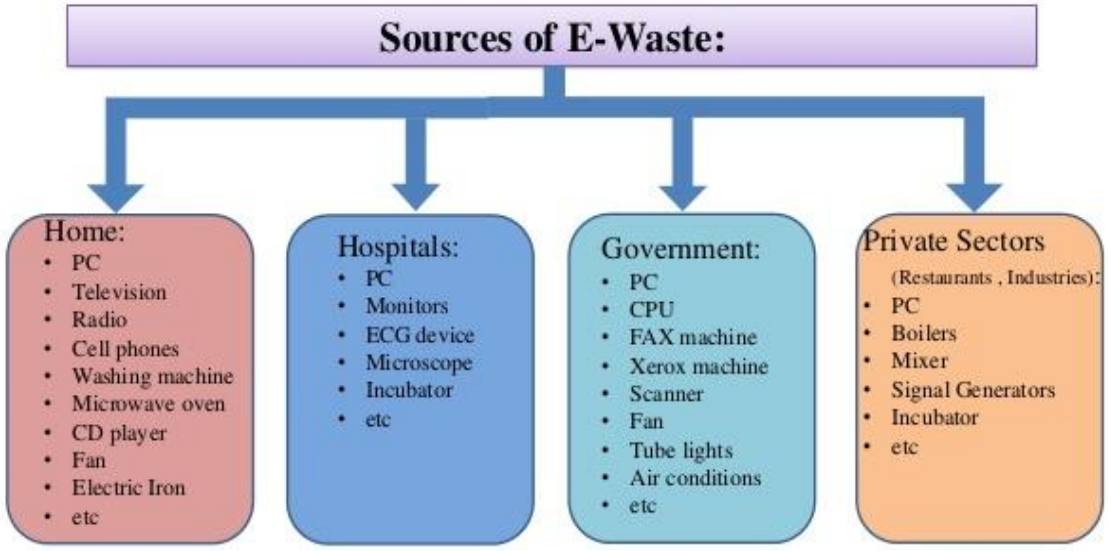

Figure (1): Major sources of e-waste

II. ENVIRONMENTAL EFFECTS OF E-WASTE:

E-waste contents various hazardous and toxic substances like Lead, Mercury, Sulphur, Cadmium, Beryllium, Chromium, Americium, and many other oxides. These substances from e-waste create environmental damage through emission. Toxic chemicals from e-waste can pollute the soil, crop and food sources. Also, these are non-biodegradable and causes air & soil pollution. E-waste dumping backyards and nearby places are polluted and causes health hazards to living beings too.

Regarding human beings, various harmful substances which can affect, are listed as:

Mercury**:** Found in fluorescent tubes causes effects in human include reduced fertility, slower growth rate, skin problems & respiratory problems. In animals, it may result death, reduced fertility and growth rate.

Sulphur**:** Found in lead-acid batteries. When released into the environment, it can create Sulphuric acid.

Tin/Lead**:** Found in solder, CRT monitor glass, lead-acid batteries can effect in life cycle disturbance of many animal kinds

Sulphur**:** Found in lead-acid batteries. causes effect includes liver damage, kidney damage, heart damage, eye and throat irritation.

Lead: Found in Solder, CRT monitor glass, lead-acid batteries causes effects include impaired cognitive function, behavioral disturbances, attention deficits, hyperactivity, problems of kidney & lower IQ.

DNA breaks**:** There is also evidence which can increase the likelihood of developing cancer, due to DNA chain breakings.

Cell damages**:** Elevated ROS (Reactive Oxygen Species) levels can cause damage to cell structures in living beings.

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Toxic elements present in the e-waste material can be classified as hazardous or non-hazardous and are tabulated as shown in following table (1).

Table (1) : Hazardous or non-hazardous elements

Hazardous elements	Non-hazardous elements
• Sulphur • Phosphorus • Cadmium • Beryllium • Chromium • Americium • Mercury • Lead • Tin etc..	• Copper • Germanium • Gold • Silver • Iron • Lithium • Nickel • Silicon • Zinc etc.

III. Utilization of e-waste materials:

As per technical specifications and standards, every e-waste product is having number of parts and components which remains in good as well as working conditions. With proper efforts, hard work and management skills, e-waste can also be well utilized in various ways as follows:

1) Gadgets and devices can be repair & reuse as possible before discarding.
2) Some gadgets and devices can be distributed to poor and/or needy people.
3) Some gadgets can be upgraded by the technology improvements.
4) E-waste can separate into reusable parts and components.
5) These parts can also be separated into metals, non-metals and glasses.
6) Many electronic components can be used as spare parts for repair purpose.
7) Various precious metals like Ag, Au, Fe, Cu, Al etc. can be recovered.
8) Raw materials like fiber, metal, glass or plastic can be recycled properly.
9) Many e-waste items can be preserved as historical or museum issues.
10) Resale & reuse of e-waste can also create jobs on some extent.

IV. Recommended methods for proper e-waste management:

To avoid any adverse effects on environment and living beings, following are few suggested and recommended methods for proper e-waste management.

1) Every producer & user should adapt scientific way of disposal.
2) Collect e-waste & send it to the authorized dealer, manufacturer or recycler.
3) All the e-waste can be send to CSC (Common Services Centers).
4) In India, total 350^{+} authorized CSC are available for such purpose.
5) 'Digital India' campaign should also adapt 'Digital Cleaning' concept.
6) At personnel level, utmost care should be taken to avoid any kind of pollution.
7) Recycling tasks should also be carried out in eco-friendly manners.
8) Producer should also get-back or by-back used or discarded e-waste products.
9) As per new e-waste policy, producers and distributers are abiding by their mandatory EPR (Extended Producer Responsibility) of e-waste management.

V. Some remedies to control e-waste:

In order to reduce e-waste on large extent, few suggestions are recommended in following bullet points. These suggestions are equally applicable and important to all those individuals engaged in this process.

1) Handle e-products very carefully without damage.
2) Try to buy 'Energy Star' rated standard products.
3) Learn to repair 'Basic troubleshooting' at home.
4) Repair or upgrade old electronic products by the experts.
5) Sale or donate your old electronic products or items.
6) Always 'Think twice' before buying new e-product.
7) Try to share e-products with friends or relatives as possible.
8) Try to rent heavy or costly e-products as can be possible.
9) Try to use 'Online data storage', 'Cloud services' or such facilities.
10) Reuse or recycle e-waste in more scientific ways.
11) Send e-waste to the nearest CSC or Dealers or Producers.
12) Create e-waste awareness among students, society and others.

VI. Conclusion:

All we should aware that 'Todays electronics or electrical gadgets are tomorrow's e-waste'. It is explicit that reuse and recycle of e-waste is more beneficial than modest disposal. The report advocates that costing of new devices and gadgets can be lowered with the help of recycling process. Everyone should be aware of e-waste and take steps to reduce the same. Now a day, e-waste management has developed as one of the fastest growing waste streams in the world. As per last few years figure, we are generating more than 50 Million Tons of e-waste every year and only about 20 % of this is recycled in proper way. As per recent survey at world ranking, India is at the 5^{th} top position in generation of e-waste, after China, USA, Japan and Germany.

In early days, due to COVID-19 pandemic, the need of all kinds of computer and electronics media is also consistently growing, which is again insisting the burden of e-waste in the world. Therefore, e-waste management plays a significant role in the process of sustainable development regarding environmental issues as well as human safety.

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Designing and Segmentation of Devanagari Script Based Captcha for Security of Web Based Applications

Anita B. Dube[1*], G. D. Ramteke[2] and R. J. Ramteke[2]

[1]Shri Shivaji College of Arts, Commerce and Science, Akola, MH, India
[2]Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon, MH, India

Abstract: *The paper aims to design Devanagari Script Based Captcha in Marathi. It also focuses on Segmentation of Captcha image. CAPTCHA is widely used as a security tool in web application. It is sometime referred as reverse Turing test as it is administered by machine and the target is user. In the state of Maharashtra all the official work is in Marathi. The CAPTCHA is used on website in mostly in English. The people from rural area are not comfortable with English CAPTHA. Hence this work is proposed. For designing this CAPTCHA, the dataset is created using Devanagari Marathi Numerals, Consonants and Vowels. The dataset of 1200 images are created and considered for this study. From this dataset the Captcha image of length 6 character is generated and distorted using some transformation like scaling and rotation. Also, noise is added to this image. Using bounding box method, the image in segmented into characters. The performance of this segmentation method is approximately 100%.*

Keywords: CAPTCHA, Devanagari script, Segmentation, Turing-Test

1. Introduction

In the era of digital world, we are using internet for all the activities. After COVID everything is available on net and all are becoming familiar with online services. To enjoy the benefits of online services one has to register herself/himself by filling online form. CAPTCHA (Completely Automated Public Turing Test to tell Computers and Humans Apart) is used as a security tool by all the websites to prevent it from malicious program called bots, Bots are the automated programs which run over the internet and consume web space as well as network traffic. In state of Maharashtra, a lot of people are from rural background. Now a day they are also using these online services if it is in their regional language. The Maharashtra state Govt. also uses Devanagari script as the language of communication. So, there is a need of Devanagari CAPTCHA which will be easy for these peoples who are not comfortable with English. For Developing Devanagari CAPTCHA, the steps required are Pre-processing, Segmentation, Feature extraction and Classification. Segmentation is the first most important and crucial phase from these. As the success of recognition phase depends on accuracy of segmentation. Hence the focus of this paper is basically on character segmentation of Devanagari CAPTCHA image.
Section-1 gives introduction and need for Devanagari Script based Captcha. Section 2 explains the related work on character segmentation. Section-3 explains the features of Devanagari Script. Phases of Devanagari Character Recognition System are givens in Section-4. Proposed method for Devanagari Script Based Captcha along with dataset preparation is given in Section-5. An algorithm is explainedin section-6. In Section-7, result and discussion is given.

2. Related Work

There are ample techniques for character segmentation. It is broadly classified in three types: Classical approach of segmentation, Recognition based approach of segmentation and holistic approach also referred as hybrid approach. The following table shows these types, criteria and techniques used for character segmentation [1].

Segmentation Approach	Depends on	Techniques used
Classical Approach	General properties of segment like height, width, separation from neighborhood characters	• Using white space and pitch • Projection Analysis • Connected component Analysis • Bounding Box Analysis
Recognition Based Approach	Semantic and syntactic correctness of character	• Hidden Markov Model • Non-Markov Approaches
Hybrid Approach	Opposite to classical approach where words are considered as the alphabets	• Dynamic Programming • Markov or hidden Markov chain

As the proposed work is for the printed character, the classical approach is used for this. For the purpose of character segmentation most prominent and common methods used in classical approach is projection analysis and Bounding box analysis. The study indicates the work done by different researchers for character segmentation. Ashwin R. Dobariya [2] worked on offline handwritten Gujarati text. Horizontal projection technique is used for line segmentation. After this vertical projection method is used for word as well as character segmentation. Pal and Sarkar [3] uses Component labelling method with combination of horizontal projection method. The result of character segmentation is 96.9%. The result decreases due to presence of touching and compound character. Vikas J. Dongare and Vijay H. Mankar[4,5] uses thinning operation on the image. Thinning is morphological operation used to perform on binary image. It removes some selected foreground pixel and reduces the image to single pixel thickness. The process seems like erosion or opening operation. Here the accuracy of character data is found to be 100% but accuracy deceases to 91% for numeric data. Ambadas B. Shinde et al. [6] uses different approach for character segmentation. First image is dilated which results in expanding the pixels. After this image is inverted and added in dilated image. Then image is converted to binary image and using bounding box method it separated the characters. It is observed that results are much better than horizontal projection method. Akshay J. Kant et al. [7] makes use of histogram to separate the characters. Firstly, horizontal histogram is used for removing the header line form the text. Then using vertical projection method threshold value is selected. Lastly by separating histograms the characters are separated. Accuracy of character segmentation is not so good due to the presence of joint characters.

3. Features of Devanagari Script

The origin of Devanagari script is from Brahmi script. This script is emerged from the Sinddham script which actually came from Gupta script. India is known for variety of cultures. India is multiscript and multilingual country with 18 constitutional languages and 10 different scripts. Devanagari script is used for languages such as Sanskrit, Hindi, Marathi and Nepali for written and oralcommunication.

The following are the features of Devanagari Script [8]

1. It can be written in left to write fashion in horizontal lines
2. It contains 13 independent vowels or ‘swar’ as well as 36 independent consonants

or 'vyanjana'.

3. Both vowels and consonants can be written as independent characters or can be modified by means of diacritics or matras

4. By combining consonants, their half form and modifier symbols large number of conjuncts are formed

5. The word is made up of three parts top, bottom and core part. The horizontal line also called header line or Shirolekha is used throughout the word. No such line is used in English word.

As in Devanagari there are consonants, vowels, numerals, vowel modifiers and Compound characters there are similar characters also. This all causes DOCR as a challenging task [9].

The top modifiers are place above this header line (Shirolekha) and lower modifiers are used below the core part.

अ (a)	आ (aa)	इ (e)	ई (i)
उ (u)	ऊ (oo)	ए (a)	ऐ (ae)
ओ (o)	औ (ao)	□□ (am)	□□(a:)
ऋ (ri)			

क (k)	ख (kha)	ग (g)	घ (gha)	ङ (nga)
च (ca)	छ (chha)	ज (ja)	झ (jha)	ञ (nya)
ट (ta)	ठ (thh)	ड (da)	ढ (dh)	ण (n)
त (t)	थ (tha)	द (d)	ध (dha)	न (na)
प (p)	फ (fa)	ब (b)	भ (bha)	म (ma)
य (y)	र (r)	ल (la)	व (v)	श (sha)
ष (shha)	स (sa)	ह (ha)	□□□ (ksh)	□□□ (tra)
□□□ (gya)				

Figure 1. Vowels and Consonants in Devanagari Marathi

4. Phases of Devanagari Character Recognition System

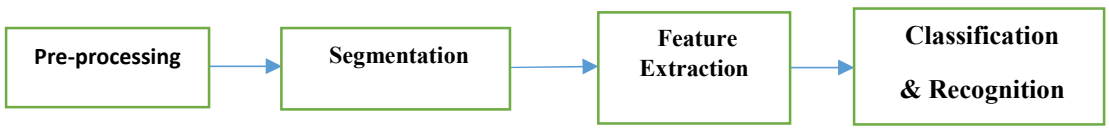


Figure 2. Phases of DCRS

4.1 Preprocessing Phase:

The main purpose of Preprocessing phase is noise reduction, Binarization, normalization, Noise Removal, skew detection and correction, slant removal.

Table 1. Preprocessing Techniques

Pre-processing Technique	Purpose	Method used

Binarization [10]	Converting grey scale image to binary image	Threshold Method
Noise Removal	To remove imperfection and impurities of data which in there due to scanning device or writing instrument	Median filter Wiener filter, Morphological operations, Gaussian filters [11]
Skew correction	Proper alignment of text document	Correlation, Projection Profile, Hough Transform [12]
Thinning	For boundary detection of an image	There are functions available in MATLAB

4.2 Image Segmentation:

The purpose of segmentation is to simplify the image which will be helpful for image analysis. Here image is divided into different parts having some similar attributes or properties. As an interest of this research in segmentation of Devanagari script, it is firstly divided into lines, then in words and finally in characters. For doing these Different types of segmentation techniques are available, one has to select the proper technique according to its need. Here the interest of this research in on segmentation of Devanagari characters. The following table shows the review of various segmentation methods.

Table 2. Levels of Segmentation

Level of Segmentation	Purpose	Techniques
Structural Layout	Separating text from image	Bounding Box Method[6]
Line Segmentation	Separating lines from paragraph	Projection Profile based Technique[13], Hough transform based technique[14], thinning based approach, Bounded Box Method
Word Segmentation	Separating words from lines	Global horizontal Projection method
Character Segmentation	Separating characters from words	Bounding Box Method, Projection profile method

4.3 Feature Extraction Phase:

This phase helps to extract the feature which is used to recognize the character. D. Tier et. al has explained various feature extraction methods. [15]

Table 3. Types of Features

Types of Features	Derived from	Features used	Methods Used
Structural Features	topological and geometric properties of a character	Horizontal and Vertical Line, End Points, No. of Crossing Points , Number of Curves, Number of Counters, Curves Opening Directions	Geometrical and topological features, Coding , Graphs and Trees
Statistical Features	statistical distribution of pixel	Area, Centroid, Bounding Box, MajorAxisLength, convex Hull , convexImage, FilledImage, FilledArea[16]	Zoning , Projection, histogram , Crossing and Distance, Moments, Profiling[17]

4.4 Classification and Recognition:

There are number of OCR system which uses pattern recognition methodologies. Some of these are like template matching, SVM, Neural Network, KNN etc. U Pal. et al. given a good survey on Devanagari character recognition [18].

5 Proposed Method for Devanagari Captcha Method

5.1 Dataset Preparation for Devanagari Captcha Method:

This work focuses only on printed Devanagari characters. For creating database Devanagari consonants, vowels and numerals are considered. For preparing the dataset ISM font is used. Each character has fixed size of 40X40 pixels.

The following are the steps of algorithm for dataset design of Devanagari Marathi characters.

Step 1: Type the required character in ISM DVOT Yogesh font
Step 2: Store the character as .jpeg image
Step 3: Perform required pre-processing on the character
Step 4: Repeat the above steps for the following dataset

1) NDS1: Dataset containing numeric data figure 1
2) VNDS2: Dataset containing vowels and numerals figure 2
3) CDS3: Dataset containing consonants only figure 3
4) CNDS4: Dataset containing consonants and numerals figure 4
5) VCNDS5: Dataset containing vowels, consonants and numerals figure 5
6) VCDS6: Dataset containing vowels and Consonants figure 6

All dataset images are as given below.

5.1.1 Numerals Dataset [NDS1]:

It contains numerals from 0 to 9. There are 10 numeral images of size 40 X 40 which are shown in the following figure.

Figure 2. NDS1

5.1.2 Vowels and Numerals Dataset [VNDS2]:

It contains vowels and numerals. Here only 4 vowels are considered to avoid complexity and maintain its usability.

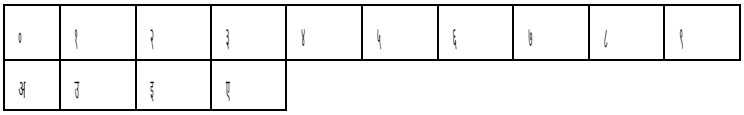


Figure 3. VNDS2

5.1.3 Consonants Dataset [CDS3]:

It contains 28 consonants. Though there are 33 consonants in Devanagari Marathi but

some of the characters are avoided. The middle bar characters like ग, णandशare not considered here. Also some other characters are not taken to keep tha CAPTCHA simple.

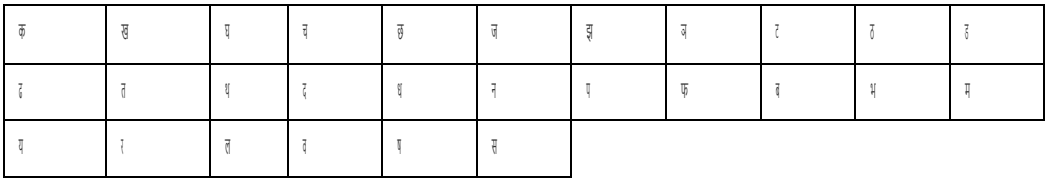


Figure 4. CDS3

5.1.4 Consonants and Numerals Dataset [CNDS4]:

It contains 28 consonants and 10 numerals:

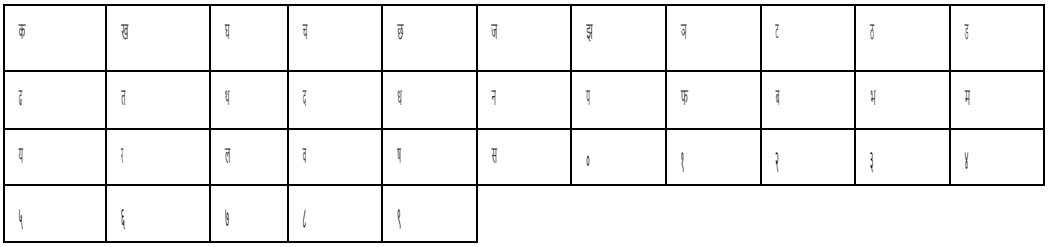


Figure 5. CNDS4

5.1.5 Vowels, Consonants and Numerals Dataset [VCNDS5]:

It contains 28 consonants, 10 numerals and 4 vowels.

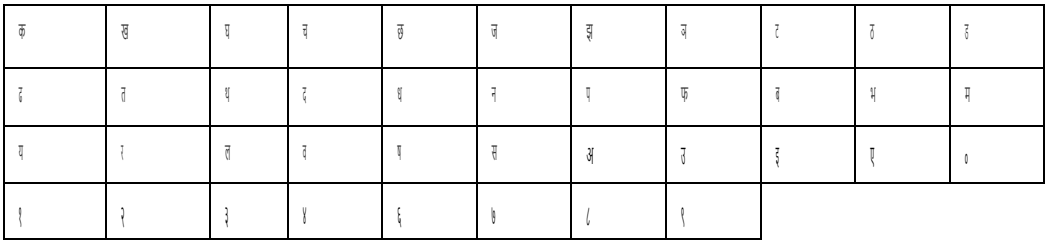


Figure 6. VCNDS5

5.1.6 Vowels and Consonants Dataset [VCDS6]:

It contains 28 consonants and 4 vowels.

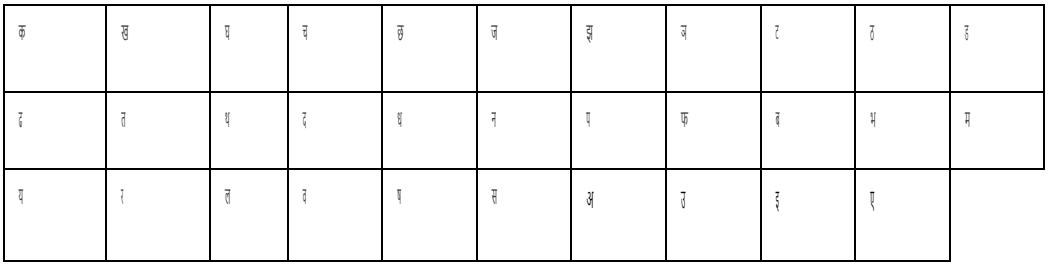


Figure 7. VCDS6

5.2 Algorithm for Devanagari Captcha Image Generation:

Step 1: Consider the above dataset for creating Devanagari Marathi text image.
Step 2: Fix the length of CAPTCHA image as 6 characters' long
Step 3: Select any 6 random numbers from the total number of images from that any one of these datasets
Step 4: Read images related to these 6 numbers so that random characters will be selected.
Step 5: Apply different transformations on each of these images separately, also add some noise to an image
Step 6: Combine all these transformed images into one to form CAPTCHA image.
Step 7: This will create the database containing 200 images for each of the mentioned dataset. All images are in .jpeg form. Dataset of about 1200 images are created which are considered for this study.

5.3 Implementation and Result of Proposed Algorithm

The above code is implemented in MATLAB R 2015a. The result of CAPTCHAimage is as follows:

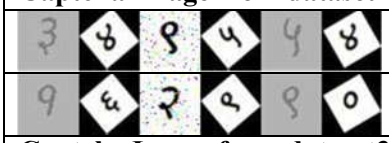
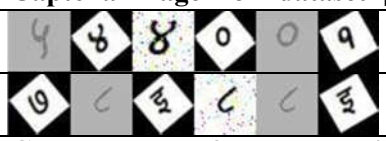
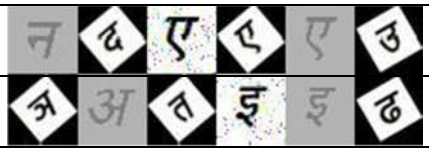
Captcha Image from dataset1[NDS1]	Captcha Image from dataset2[VNDS2]
	
Captcha Image from dataset3[CDS3]	**Captcha Image from dataset4[CNDS4]**
Captcha Image from dataset5 [CVNDS5]	**Captcha Image from dataset6[VCDS6]**
	

Figure 8 : Captcha Images for all 6 Datasets

6 Segmentation of Devanagari Script:

One of the most crucial steps in machine recognition of Devanagari script is document segmentation. In this process document is segmented on different levels. First level is Line segmentation in which lines are separated. There are various line segmentation techniques mentioned in the literature [19-21]. After line segmentation there comes word segmentation, where words are separated form lines and lastly character segmentation where individual characters are separated from the word.

Proposed Algorithm for Character Segmentation:

Step 1: Read the CAPTCHA image from any of the 6 databases
Step 2: Apply pre-processing techniques which includes grey scale conversion, binarization, resizing etc.
Step 3: Calculate the number of connected components using bwlabeln

Step 4: Using region prop function use bounding box for each connected component
Step 5: It gives unwanted bounding box also
Step 6: Extract each bounding box character using imcrop function
Step 7: To avoid unwanted bounding box check the size of each of this image, if it is less than 30 X 30 then don't consider that character
Step 8: Store resulting bounding box character in another folder using imwrite function

7. Result and Discussions:

Here 6 classes are created with different combinations of Devanagari Marathi consonants, vowels and numerals. Then Dataset for Captcha images are created from these 6 classes. Each Dataset contains 200 images, therefore total 1200 images are created and used for study. While creating the Captcha image by selecting characters from these classes some translation techniques are used like scaling, rotation and resizing. Some noise is also introduced in the image. The work is carried out in MATLAB.The algorithm is used to create Captcha image in Devanagari Marathi and character segmentation is performed on the same image. The result is as shown in figure 9.

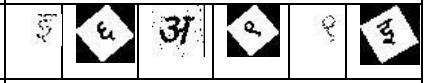
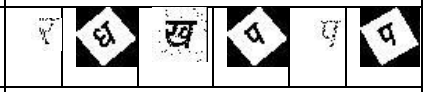
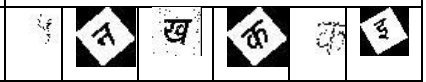
1. Captcha Image from dataset1[NDS1] with Bounding Box	Segmented Images
2. Captcha Image from dataset2[VNDS2] with Bounding Box	Segmented Images
	
3. Captcha Image from dataset3[CDS3] with Bounding Box	Segmented Images
	
4. Captcha Image from dataset4[CNDS4] with Bounding Box	Segmented Images
5. Captcha Image from dataset5[CVNDS5] with Bounding Box	Segmented Images
	
6. Captcha Image from dataset6[VCDS6] with Bounding Box	Segmented Images

Figure 9 : Segmentation of Captcha images from all 6 datasets

8. Conclusion:

To verify the performance of the proposed algorithm Captcha Images for all above datasets are created and tested. The same images are considered for the process of

character segmentation. All the images are segmented and stored separately using bounding Box method. Accuracy of the proposed system is found to be 100% with characters and numerals also.

Here end bar characters are neglected as it reduces the result because of end bar. So, the end bar characters like ा , ी and ी are intentionally avoided from the dataset. Also, to keep the dataset simple only selected vowels are considered.

From the results of previous work, it is observed that methods used for segmentation varies according to the application. For character segmentation the prominent methods used are projection profile and bounding box. From the study previous work, it becomes clear that bounding box method is good enough for character segmentation of CAPTCHA in Devanagari Marathi. So, Bounding Box method is applied with some pre-processing techniques to get better results. The success rate of the proposed algorithm is 100% with respect to numerals and characters which is good as compared to all the previous mentionedwork.

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INDEX

No.	Title of the Paper — Authors' Name	Page No.
1	Pandavlena: Revisiting the Past — **Prof Geetanjali Patil**	1
2	Theme of the Novel Huckleberry Finn – The Quest for Freedom — **Dr. Laxman Gajanan Kolte**	9
3	To Assess The Legislative Measures, Constitutional Rights And Remedies, Legal Obligations Against Environmental Pollution In Relation To Hospital Waste Management In Health Care System — **Dr.Diwakar Pradhan , Dr.Mayank Pradhan**	11
4	Problems of Agriculture Students in Vidarbha Region with Seeking Information — **Dr. Sandeep .A. Lande**	17
5	Eco-Printing Of Textiles Using Natural Dyes: A Global Sustainable Approach — **Sonali Y. Kharbade , Dr. Anjali Kaware**	23
6	An Analytical Study Of Marketing Of Selected Vegetables And Buyer Behaviour In Vegetable Markets Of Nagpur City — **Dr. Ajay Nanaji Saratkar**	29
7	Women's Contribution In World Of Sports: Development And Policies — **Dr. Jaikumar G. Kshirsagar**	39
8	Farmers Suicides in Maharashtra. — **Gaikwad Pratibha Shivaji**	42
9	Global Climate Change and Children health: Threats and Strategies for precautions — **Swapnil S. Arsad**	45
10	Digital Transition:Challenges and Opportunities — **Dr.Santosh Nivrutti Ghongade**	48
11	Evaluation Criterions of Entrepreneurship Training Institutes - An Empirical Study — **Venkataram Bhat , Dr. K. S. Sarala**	52
12	Gandhian Philosophy Of Politics — **Dr. Mini Pathak Dogra**	58
13	National Education Policy–2020: Issues and Challenges in Implementation — **Dr. Jasvir Singh**	62
14	Agriculture Act 2020: A Critical Review — **Shinde V.M**	66
15	स्त्री पुरूष लिंग समानतेचा समाजशास्त्रीय अभ्यास — प्राचार्य डॉ.कल्याण मोरे	68
16	वर्धा जिल्ह्यातील ग्रामीण लोकसंख्येचा स्थान निर्देशांक (Location Quotient) : भौगोलिक अध्ययन — प्रा. नारायण गोविंदराव सोनुले	73
17	युगसापेक्ष केशवसुत — प्रा.डॉ.सौ. शुभांगी डोरले – परांजपे	79

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Eco-Printing Of Textiles Using Natural Dyes: A Global Sustainable Approach

Sonali Y. Kharbade

Sant Gadgebaba Amravati university, Dist. Amravati ,Email: Sonalikharbade123@gmail.com 9960745795

Dr. Anjali Kaware

Professor and Head, Department of Home Science Shri Shivaji College of Arts, Commerce and Science, Akola

Abstract

Globalization has absolutely modified the style enterprise and its technique towards sustainability. Fast converting traits are majorly centered on artificial dyes and fabric. And those merchandise have failed constructing the bridge among sustainability and environment-pleasant designs. Therefore, this bankruptcy is aimed toward the technique towards layout improvement and improvement of sustainable green technique for display screen printing through the use of herbal dyes on fabric like silk and cotton. The bankruptcy is primarily based totally on sustainable layout technique which offers an awful lot provision for the use of herbal dyes for normal alternate in style. These outcomes have been evaluated through wearing out shadeation fastness exams for mild, wash, rubbing, and perspiration the use of preferred trying out techniques. Design technique used withinside the observe additionally has the capability for talent improvement packages for marketers and additionally contributes to rural improvement packages through developing sustainable growth.

Keywords: Dyes, fabric, technique, screen printing, Mordant, herbal, sustainable growth

Introduction

The use of herbal dyes has been in India for lots of years and is a part of India's cultural identity. In historic times, dyed textiles have been symbols of fame and, due to their cost, have been reserved most effective for the wealthiest classes. Dye re-assets have been in advance extracted from plants, animals, and minerals. Madder and indigo have been the primary dyes utilized in India due to the fact 2500 BC. With the intervention of artificial dyes, using herbal dyes for fabric dyeing has been decreased tremendously. Fast style needs low cost, simple, and reproducible dyeing or printing manner. Both the artificial dyes and herbal dyes play a key component for shade and ornamentation of fabric substances like silk and different fibers. Synthetic dyes are gambling critical and major position for coloring the bulk of silk substances, even as herbal dyes are being e-particularly used for growing unusual soothing sun sunglasses on silk yarns or fabric in small-scale region or rural region, that's progressively gaining recognition because of its non-toxicity and eco-friendly man or woman towards viable dangerous eco-toxicity standards of artificial dyes. Textile printing in India has been practiced over centuries. Screen printing the use of herbal dyes in India has helped in developing bridge among traditional printing strategies and mass manufacturing of textiles in an green way. In this bankruptcy herbal dyes along with madder, sappan wood, and indigo are used beneathneath optimized temperature, pH, and length for extraction. The cotton and silk substrates are organized for display screen printing through scouring the fabric. Screens are advanced primarily based totally at the styles received through traditional shibori dyeing strategies. During printing manner, madder, sappan wood, and indigo dye extract have been used to offer shadeation. More frequently it's miles assumed that shadeation will alternate relying on printing techniques and the substrate used. But in herbal dyes, this expectation is particularly excessive, and specifically in printing processes, the impact of mordant kind is of incredible significance for the colouration of the shadeation as printing is completely a one-of-a-kind technique in comparison with dyeing of textiles. As a sustainable technique towards display screen printing, mordants and binding marketers used on this bankruptcy are herbal. 20% alum is used with madder and sappan wood extraction as metamordanting agent. Tamarind kernel powder is used as thickening agent for madder and sappan wood. Cornstarch is used as thickening agent for indigo.

Fabrics

Most of the research to be had for dyeing with herbal dyes relate to woolen textiles, and such research on silk are nonetheless inadequate and that observe on cellulose or lignocellulose textiles is scant. Hence, there may be enough scope of task an included observe of the floor appearance, durability, dye intake, and display screen printing of silk and cotton with selective herbal dyes. Silk and cotton fabric had been taken into consideration for experimentation on this bankruptcy. As silk fabric are satisfactory to be had for industrial use, this sensitive filament fiber is widely known for its sheen, texture, water absorbency, dye affinity, thermal tolerances, and insulation homes; its dyeability is one of the high homes wished to research the display screen printing of shibori designs the use of herbal dyes.

Dyes and mordants

Commercially to be had herbal dyes like madder, sappanwood, and indigo are used for the experiments, which might be sourced from KMA Exports, Tindivanam, Tamil Nadu. Dye reassets used for this observe are without difficulty to be had, and the effluents aren't unsafe for the human fitness and riskless to the ecosystem. Myrobalan and alum have been used as metamordants even as making ready the printing paste of madder and sappanwood. Alum is used to deal with the fabric for its low environmental toxicity.

Reduction of indigo

According to discovery of European wooden vat discount recipe from medieval manuscripts, it changed into observed that a hitherto unknown bacterium, three Printing of Textiles Using Clostridium is a tidies, is answerable for indigo discount; this bacterium reduces the indigo debris to soluble leuco indigo. As consistent with the conventional indigo fermentation manner, vat automatically calls for the addition of crimson dye madder, which includes excessive attention of anthraquinones; those quinines notably boom the price of indigo discount through C. is a tidis. As quoted through J N Liles in his ee-e book The Art and Craft of Natural Dyeing, in 1794, Bancroft recommended that using glucose by myself will lessen the indigo and if discount did now no longer correctly occur, the addition of oxides of tin may be used. Hence, on this test in place of sodium dithionite, jaggery can be used together with sodium hydroxide to preserve the vat alkaline.

Reduction with jaggery and madder: indigo cake changed into powdered, and 10 g changed into taken in a vat; 1 l of water changed into stored over water tubtub at temperature of 60°C, to which 20 g of madder and jaggery changed into delivered. About four g of sodium hydroxide changed into then delivered to the answer, and the answer is maintained at pH 12 through including sodium hydroxide.

Dye extraction changed into executed at acidic and impartial medium for madder and sappanwood on the temperature of 70°C for 60 min, wherein 15 g of madder and 15 g of sappanwood have been used with separate vessels containing a hundred and fifty ml of water. When the extracted answer cools right all the way down to room temperature, 7.five g of alum is delivered as metamordanting agent for each madder and sappanwood dye extract. Additionally, 15 g of myrobalan changed into delivered to madder dye extract answer as mordanting agent. Then the extracted answer of madder and sappanwood changed into steeped for 12 h, which changed into later stirred and filtered.

Printing paste preparation

To make printing paste of indigo, a hundred ml water changed into taken in a beaker and 20 g of cornstarch is delivered and boiled, to which a hundred ml of fermented indigo answer changed into delivered and left for in addition fermentation for 12 h. To make printing paste of madder and sappanwood, 15 g of tamarind kernel seed powder changed into taken for every answer and combined with steady stirring the use of an electric powered blender.

Printing technique

The printing manner entails the printing pastes, fabric, and the display screen advanced the use of shibori designs. Fabric is laid on a waxed timber floor to make sure no motion of material even as printing. The print paste is guided via the display screen mesh or the open regions of the layout at the fabric through the use of a bendy rubber squeegee. A steady strain is maintained even as drawing the paste from one give up to any other and throughout every printing. The revealed fabric are then allowed to air-dry 24 h.

Washing and fixing

Printed fabric have been washed with simple water to cast off the cornstarch and tamarind seed kernel powder. Indigo samples have been washed with bloodless water accompanied through warm water with steady stirring. Printed samples of madder and sappanwood have been handled with dhawadi (Woodfordia floribunda) as postmordanting for solving the shadeation directly to the substrates. Fixation changed into carried out at 60°C for forty min accompanied through bloodless water rinse. Measurement of shadeation fastness homes Color fastness to washing of dyed samples changed into decided through launder-ometer according with approach prescribed in ISO 105-C02. Color fastness to rubbing changed into decided through crockmeter according with approach prescribed in AATCC crockmeter approach. Color fastness to mild of dyed cotton and silk fabric changed into assessed on IS 2454 1985. Light fastness of revealed material is encouraged through chemical and bodily state, attention of dye, nature of the fibers, and mordant kind . Color fastness to perspiration of dyed cotton and silk fabric have been decided through perspi-o-meter according with approach prescribed in ISO 105-E04:2013 check approach.

Review of Literature

Eco-innovation continues to be a young vicinity of research; but it has been an vicinity of growing situation for coverage makers, lecturers and practitioners. The intention of this paper is to offer a top level view of the present frame of literature on eco-innovations, and perceive the maximum applicable courses withinside the subject and the subjects of interest. We have carried out a evaluation of previous literature based on a Scopus seek and choosing the discipline "Social Sciences and Humanities". The seek gives us 384 articles. From their analysis, it may be located that there may be a clean growth withinside the relevance of this difficulty inside academia and numerous thematic developments rise up in eco-innovation research, with drivers of eco-innovation being the maximum popular. Our principal theoretical contribution is the development of a multilevel framework of eco-innovation drivers, with our literature evaluation having a selected awareness on systematizing the findings of the research inside this theme.

During the ultimate decades, consciousness associated with the want to optimize the environmental overall performance of merchandise has elevated and distinctive moves had been initiated from coverage makers, enterprise in addition to consumers. The end result of such moves may be visible amongst others in elevated environmental regulation, projects and voluntary agreements among corporations in addition to needs for product environmental certification and labelling (Wimmer, Züst, & Lee, 2004; Baumann, Boons, & Bragd, 2002; Wrisberg & Haes, 2002; Bras, 1997). Examples of various pro-environmental coverage measures which have been added at European or worldwide degree include; Extended Producer Responsibility (EPP), Integrated Product Policy (IPP), Integrated Pollution Prevention Control (IPPC), environmental certification thru the ISO 14000 collection or EMAS and more (Wrisberg & Haes, 2002).

Color characteristics of sappanwood with mordanting.

Fabrics	Mordants	CIE color coordinates			Description
		L*	a*	b*	
Cotton	Simultaneous mordanting (alum)	59.44	30.14	−9.60	Lighter, more red, and more blue
	Postmordant (*Woodfordia floribunda*)	60.88	27.30	−11.49	Lighter, more red, and more blue
Silk	Simultaneous mordanting (alum)	56.53	40.13	−17.91	Lighter, more red, and more blue
	Postmordant (*Woodfordia floribunda*)	60.09	37.45	−8.23	Lighter, more red, and more blue

Color characteristics of madder with mordanting.

Fabrics	Mordants	CIE color coordinates			Description
		L*	a*	b*	
Cotton	Simultaneous mordanting (alum)	61.21	13.84	19.14	Lighter, more red, and more yellow
	Postmordant (*Woodfordia floribunda*)	61.32	13.07	19.11	Lighter, more red, and more yellow
Silk	Simultaneous mordanting (alum)	67.69	13.53	11.29	Lighter, more red, and more yellow
	Postmordant (*Woodfordia floribunda*)	61.56	16.40	17.01	Lighter, more red, and more yellow

Color fastness for sappanwood.

Fabric	Mordants used	Fastness properties								
		Washing		Light	Perspiration				Rubbing	
					Alkaline		Acidic		Dry	Wet
		Change in color (cc)	Staining on cotton (cs)		cc	cs	cc	cs		
Cotton	Simultaneous mordanting (alum)	1/2	5	1	3/4	4	1/2	4	4/5	4
	Postmordant (*Woodfordia floribunda*)	1/2	5	1/2	3/4	4	1/2	4	4/5	4
Silk	Simultaneous mordanting (alum)	4	5	1/2	3/4	4	2	4/5	5	4/5
	Postmordant (*Woodfordia floribunda*)	3	5	1/2	3	4/5	2	4/5	5	4/5

Color fastness for indigo reduced with jaggery

Fabric	Reducing agents	Fastness properties								
		Washing		Light	Perspiration				Rubbing	
					Alkaline		Acidic		Dry	Wet
		Change in color (cc)	Staining on cotton (cs)		cc	cs	cc	cs		
Cotton	Jaggery	4/5	4/5	3	5	5	5	5	4	3
Silk	Jaggery	4	5	2/3	4/5	5	4/5	5	4/5	3

Process of marigold flowers dye to make printing paste

The craft of printing grabs a completely unique area in Indian civilization. It is assumed that method of printing from herbal dye were commenced for the reason that tenth century. Due to the carcinogenic impact of artificial dyes, the green-minded customers are lower back to herbal as those

are non-toxic, biodegradable and feature higher compatibility with the surroundings. Natural dyes incorporate the ones colorants that are extracted from any animal topics or vegetable topics with out the use of any chemical method. Natural dyes with few exceptions are non-sizeable however need to be used along with mordants. Mainly steel salt are used right here. Here species of a marigold flower call Tagetes erecta is selected. Petals are used to standardize the printing paste for cotton.

Material selection:

Marigold petals are dried in coloration and down to earth with powder that's used as a dye supply withinside the standardized printing paste.

Fabric Selection:

Any sort of herbal cloth may be used right here due to the fact it's far a herbal method. Marigold plant life dye may be connected to this cloth thru a popular printing recipe.

Preparation of compensating printing paste:

Some quantity of the petals of the flower are combined with a sure quantity of water. PH stage is needed at 7. After the elimination of water, the bathtub answer is strained with nylon cloth. The extracted answer is heated and combined with printing paste. The printing recipe is numerous for requiring the stop product. Dye paste, guar gum may be used as paste substances. The ratio and quantity of the substances range with the high-satisfactory of the stop product. It is stirred very cautiously to supply a uniform paste. Seven mordants are used to restore the printing paste in cloth. They are aluminum sulfate, ferrous sulfate, lead acetate, potassium dichromate, stannous chloride, zinc chloride and copper sulfate. The choice of mordant is numerous with the burden of the printing paste.

Printing is performed with a screening technique in pre scouring cloth. Finally, the cloth is dried and it's far steamed at 100°C. Steamed samples are given in bloodless rinse water to cast off superficial printing paste. The eco-revealed cloth is proven below:

Eco printing is recognized as a sustainable textiles application

Sustainability is the thrill phrase of economy, surroundings and society. Eco printing is a sustainable textiles software due to the fact right here herbal dye and herbal approaches are used. Environment-pleasant and coffee price primarily based totally aesthetic merchandise may be produced thru eco-printing which has massive social cost in assessment to marketplace competition. These programs can justify enterprise sustainability. Another aspect is method sustainability. From the eco-printing technique, we will reuse rinsed bloodless water as a flash of a bathroom on the plant. The aid is nature right here or cultivating flower. From this software, we will lessen our manufacturing price as eco fiber is to be had and clean to use.

Conclusion

In the current world global of rapid style, there's an elevated difficulty globally closer to using risky and carcinogenic artificial dyes like azo and benzidine; those dyes have irrevocable outcomes on nature and mankind. The developing attention approximately sustainability and environment-pleasant dyes has created an critical platform for younger researchers to restore and test with conventional method of fabric dyeing and printing. However, the fabric dyed from herbal dyes does want price addition to attain the favored marketplace acceptance; printing distinct motifs the use of herbal dyes can assist conquer the necessities of price addition for textiles. Natural dyes have usually been desired for its soothing colors. This bankruptcy changed into targeted at the utility of traditional shibori styles for display screen printing the use of herbal dyes. From the records of style, it's far regarded that the comeback of inexperienced garb is in excessive style. In addition, layout technique of fabric layout is likewise served as eco-direction on this bankruptcy. There is a massive scope to fabric printing the use of herbal dyes; new re-assets of herbal dyes and new traits in style packages can create a international area of interest marketplace for textiles and for herbal dyes. This studies may be an modern technique for fabric layout with display screen printing. The essential importance of this bankruptcy changed into to feature a price on fabric via way of means of enhancing the esthetic capabilities and business values of cloth. The utility of those strategies can function a brand new and entire technique to create modern cloth layout.

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RESEARCH ARTICLE

INDUCED PHYSICAL AND CHEMICAL MUTAGENIC STUDIES IN M1 GENERATION OF MUNGBEAN [*Vigna Radiata*(L.)WILCZEK]

***Deshmukh, A. G. and Koche, D. K.**

Department of Botany, Shri Shivaji College of Arts, Commerce and Science Akola (M.S.), India

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**Corresponding Author:*
Deshmukh, A. G.

ABSTRACT

The Mungbean [*Vigna radiata* (L.) Welczek] is one of the most important pulse grain crops of the Indian subcontinent having a high amount of protein. In the present study seeds of two varieties of mungbean were with gamma rays (100Gy, 200 Gy, 300Gy and 400Gy), EMS, and SA (0.1%, 0.2%, 0.3%, and 0.4%) respectively. In the M_1 generation, it was noted that physical mutagen gamma rays showed a comparatively higher percentage of germination than chemical mutagens EMS and SA. It also showed a higher rate of survival and plant fertility. The rate of germination in gamma-ray treated seeds AKM- 8802 ranged from 82 to 93.65%, and in the case of AKM-4 it was 87.30 to 88.88%, which was very close to respective controls. However, the trends observed that increase in the dose or concentration of mutagen there is a decrease in the rate of germination, rate of plant survival, and rate of plant fertility in all mutagens. These mutagens also showed a significant effect on the sterility of plants and thereby affecting fertility of the plants.

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INTRODUCTION

The Mungbean [*Vigna radiata* (L.) Welczek] is a member of the legume family Fabaceae whichis a widespread plant family andoccupies the third position as the largest family of flowering plants with approximately 650 genera and over 20,000 species (Doyle, 1944).Mungbean is an important pulse crop supplementing high plant protein in subtropical zones of globally. It is widely grown in the Indian subcontinent as a short-duration crop between two principal crops. Mungbean contains about 51% carbohydrate, 24 to 26% protein, 4% mineral, and 3% vitamins (Afzal *et al.,* 2008). Besides providing protein in the diet, Mungbean has the remarkable quality of helping the symbiotic root rhizobia to fix atmospheric nitrogen and hence enrich soil fertility(Anjum *et al.,* 2006). Worldwide efforts are being made to improve the qualitative and quantitative traits of this crop. However,it's narrowing genetic base is reportedly the major cause of concern for the breeding programs for Mungbean improvement as well as for crop production and productivity in the climate change scenario as a narrow genetic base also increase the vulnerability of this crop to various biotic and abiotic stress (Datta *et al*., 2012). Mutation induced by various physical and chemical mutagensis a way to create generic variability and creation of new varieties with improved character (Wongpiyasatid, 2000).Mutation breeding supplements conventional plant breeding as a source of increasing variability and could confirm specific improvement without significantly altering its acceptable phenotypes (Konzak *et al.,* 1996; Koche and Joshi-Saha, 2018).

Physical mutagens like gamma rays affect plant growth by altering the morphological, physiological, biochemical,and genetic features at the cellular level (Gunckel *et al.,* 1961) gamma rays and EMS can produce high ending new varieties (Khatri *et al.,* 2005; Jagadeesan and Ponniyamoorthy, 2023). Mutation breeding mainly depends upon the efficiency and effectiveness of mutagen. The required mutation depends on the option of an effective and efficient mutagenic agent (Solanki *et al.,* 1994). The current study is an attempt to induce the mutation in two mungbean cultivars, AKM-8802 and AKM-4 by gamma rays, EMS, and SA, and its M1 generation observations are presented in this article.

MATERIALS AND METHODS

Seed Material: The seeds of Mungbeanvarieties AKM-4 and AKM-8802 were obtained from Pulse Research Center, Dr. P. D. K. V. Akola (MS). Dry, uniform, and healthy seeds of Mungbean with a moisture content of 10 to 12% were used for experimental treatments.

Treatment Details: The experiment was conducted to determine the lethal dose (LD50) suitable dose of gamma rays and concentration of EMS, Sodium Azide, and duration of seed treatment. The dose of gamma rays decided after that were100 Gy, 200 Gy, 300 Gy and 400 Gy and that of EMS and sodium Azidewere 0.1% , 0.2%,0.3% and 0.4% were finally selected for the seed treatment, and duration fixed was for 4 hours. Selected seeds were soaked in distilled water for 10 hours and the wet seeds were treated with different concentrations of EMS and Sodium Azidefor 4 hours.

The untreated control was sown on either side of each plot. The seeds treated with different concentration of sodium Azide and EMS was washed thoroughly under tap water for 1 hour. The treated seeds from each treatment were used for raising M_1 generation in the field during 2021-22.

Experimental Site: The present investigation was carried out at the experimental field located at Mazod, Taluka and District Akola(M. S.). The soil type of the experimental field was slightly deep and calcareous with good drainage. The average minimum temperature was recorded as 18.65°C and the maximum as 34.63°C with an average annual rainfall of 671.09 mm (World Weather online, 2023).

RESULTS

After treatment by each mutagen with specific doses, the treated seeds of both mungbean cultivars were sown in the different plots of the experimental field. Later, the field and the growing crop in each plot were monitored closely for the rate of germination, rate of survival and rate of sterility, and fertility of plants.

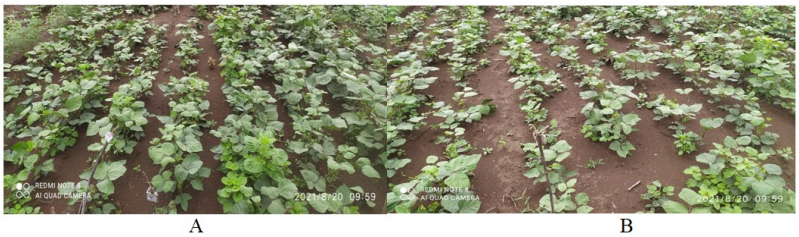
All the observations were noted and then the rate of germination, rate of survival, and rate of sterility in the mutagenized population was calculated. The results of AKM–8802 are presented in table 1 and that of the AKM-4 variety in table-2. The variety AKM 8802 showed 98% germination, 95% rate of survival, and 100% plant progeny. Gamma-ray-treated seeds showed germination in the range of 82 to 93.65%, the EMS-treated seeds showed germination ranging from 82.53 to 90.00 %, and SA- treated seeds showed germination rate in the range of 59.20 to 82.25%. The plant survival rate in gamma-ray irradiated progeny was between 85.33 to 98.00%, in EMS treated population it was from 54.00 to 77.19%, and in SA treated population it ranged from 70.50 to 75.65%. The fertility rate in M1 plants treated with gamma rays was between 93.80 to 100%, in EMS-treated plants it was between 87.40 to 91.70% and in SA-treated plants of AKM-8802 it ranged between 79.80 to 87.70% (Table-1). The variety AKM -4 showed 94.25% germination, 96.66% rate of survival and 100% plant progeny. Gamma-ray-treated seeds showed germination in the range of 87.30 to 88.88%, the EMS-treated seeds showed germination ranging from 80.95 to 85.71 % and SA- treated seeds showed germination rate in the range of 68.33 to 93.65%.

Table 1. Rate of seed germination, plant survival, sterility, and fertility in mutagenized M1 population of Mungbean variety AKM – 8802

Sr. No.	Treatment	Doses	Seeds Sown	Germination Rate (%)	Survival Rate (%)	Sterility Rate (%)	Fertility Rate (%)
1	Control	--	300	98.00	95.00	00	100
2	Gamma Rays	100 Gy	300	93.65	98.00	00	100
3		200 Gy	300	87.50	91.42	1.20	98.80
4		300 Gy	300	84.12	88.69	4.60	95.40
5		400 Gy	300	82.00	85.33	6.20	93.80
6	EMS	0.1 %	300	90.00	77.19	8.30	91.70
7		0.2 %	300	82.53	40.38	11.75	88.25
8		0.3 %	300	85.71	64.81	12.60	87.40
9		0.4 %	300	89.28	54.00	9.25	90.75
10	SA	0.1 %	300	82.25	75.65	12.30	87.70
11		0.2 %	300	78.33	72.50	16.25	83.75
12		0.3 %	300	65.50	68.62	17.66	82.34
13		0.4 %	300	59.20	70.50	20.20	79.80

Table 2. Rate of seed germination, plant survival, sterility, and fertility in mutagenized M1 population of Mungbean variety AKM – 4

Sr. No.	Treatment	Doses	Seeds Sown	Germination Rate (%)	Survival Rate (%)	Sterility Rate (%)	Fertility Rate (%)
1	Control	--	300	94.25	96.66	--	100
2	Gamma Rays	100 Gy	300	89.36	98.25	3.25	96.75
3		200 Gy	300	88.88	89.33	7.69	92.31
4		300 Gy	300	87.88	85.86	8.33	91.67
5		400 Gy	300	87.30	90.20	12.65	87.35
6	EMS	0.1 %	300	85.71	93.25	8.30	91.70
7		0.2 %	300	80.95	88.63	11.11	88.89
8		0.3 %	300	80.95	85.35	15.66	84.64
9		0.4 %	300	85.71	68.54	17.28	82.72
10	SA	0.1 %	300	93.65	68.55	09.65	90.35
11		0.2 %	300	80.15	63.25	16.33	83.67
12		0.3 %	300	72.66	52.36	18.22	81.78
13		0.4 %	300	68.33	46.85	21.21	78.79



A B

Fig. 1. Germination A. Control AKM- 8802 and B. 200 Gy gamma irradiated M_1 progeny

C D

Fig. 2. Germination C. Control AKM- 4 and D. 200 Gy gamma irradiated M_1 progeny

The plant survival rate in gamma-ray irradiated progeny was between 90.20 to 98.25%, in EMS treated population it was from 68.54 to 93.25%, and in SA treated population it ranged from 46.85 to 68.55%. The fertility rate in M_1 plants treated with gamma rays was between 87.35 to 96.75%, in EMS-treated plants it was between 82.72 to 91.70%, and in SA-treated plants of AKM-4 it ranged between 78.79 to 90.35% (Table-2).

DISCUSSION AND CONCLUSION

Our study results indicated that both physical and chemical mutagen has an impact on germination, growth, survival, and plant fertility. It was noted that in both varieties, the rate of germination decreases as there is an increase in the dose or concentration of chemical mutagen. Similarly, the rate of plant survival follows the same trend i.e. there is a decrease in the rate of survival as there is an increase in mutagen doses. Plant sterility in the treated population is also found to increase with an increase in mutagen doses. This also reciprocally affects the number of fertile plants in the treated population. Similar results are reported by various workers in different crop plants. Solanki and Sharma (1994) in lentils, Wongpiyasatid *et al*., (2000) and Sofia *et al*., (2019) in mungbean, Khatri *et al*., (2005) in *Brassica juncea*, Bogawar *et al*., (2017) and Aher and Koche (2023) in Cicer. Konzak *et al*., (2018) revealed that mutagens affect the growth and development of plants. From the study, it could be concluded that physical and chemical mutagens like gamma rays, EMS, and SA havea significant impact on plants' morphology, biochemistry, and genetics and thereby affect the rate of germination, survival, and fertility. These mutagens could be used to alter the genetic composition of mungbean for certain trait improvements.

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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

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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).*

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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).

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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).

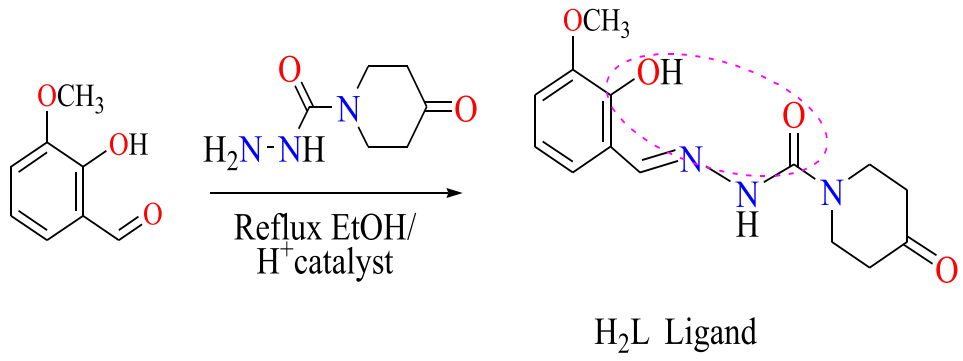
^{1H}NMR (DMSO-–d^6,500 MHz, δ ppm): 10.898(s,1H, OH, Phenolic.), 9.511 (s,1H,-C*H*=N- azomethine), 8.99 (s,1H,N*H*,amide), 6.934(d, J = 9.4 Hz, 1H,aryl-H), 7.122 (dd, J = 9.4 Hz, 1H,aryl-H), 7.303 (d, J = 9.05 Hz, 1H,aryl-H),3.839 (s, 3H, -OCH_3), and 3.358, 2.516(s, J = 4.21 Hz, 4H), 2.513,2.506 (s,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

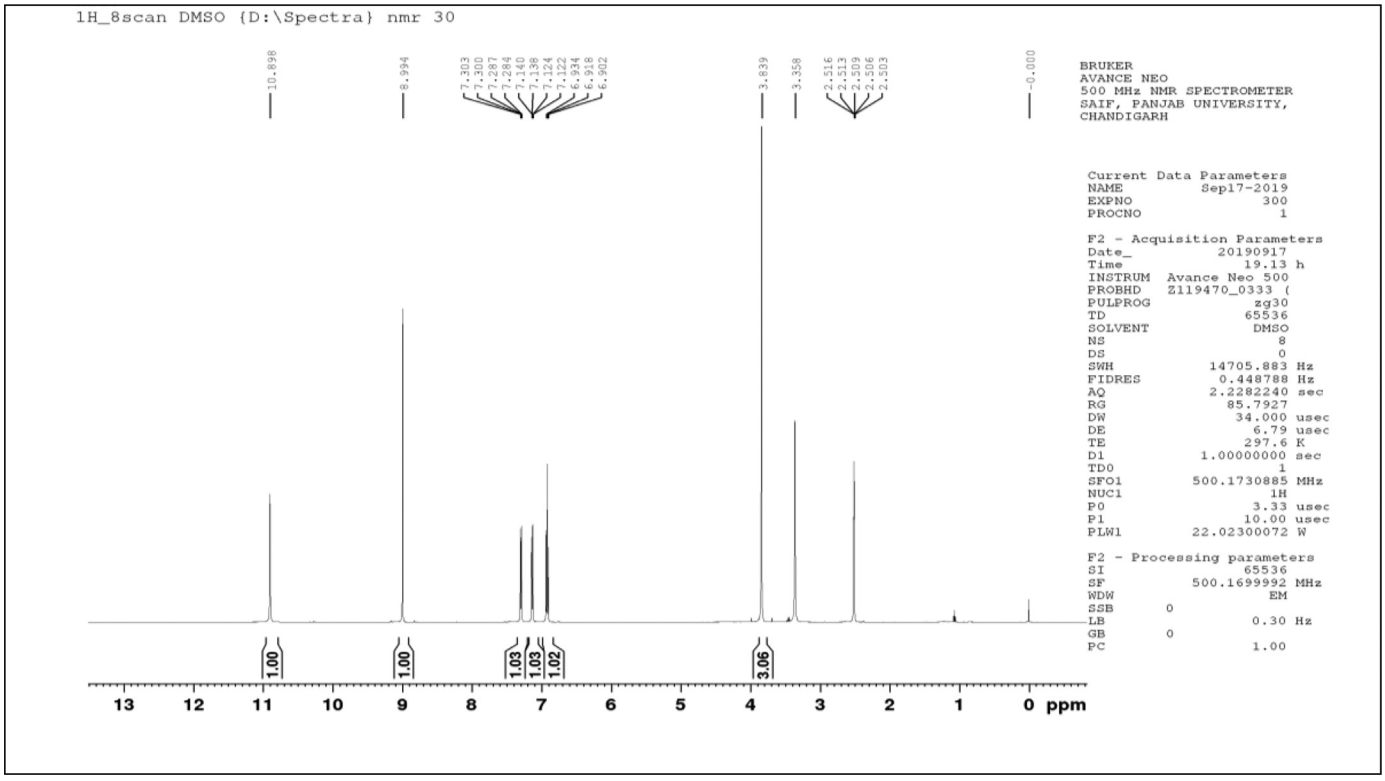


Fig. 1. ^{1H}NMR spectrum of hydrazone ligand (H_2L).

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

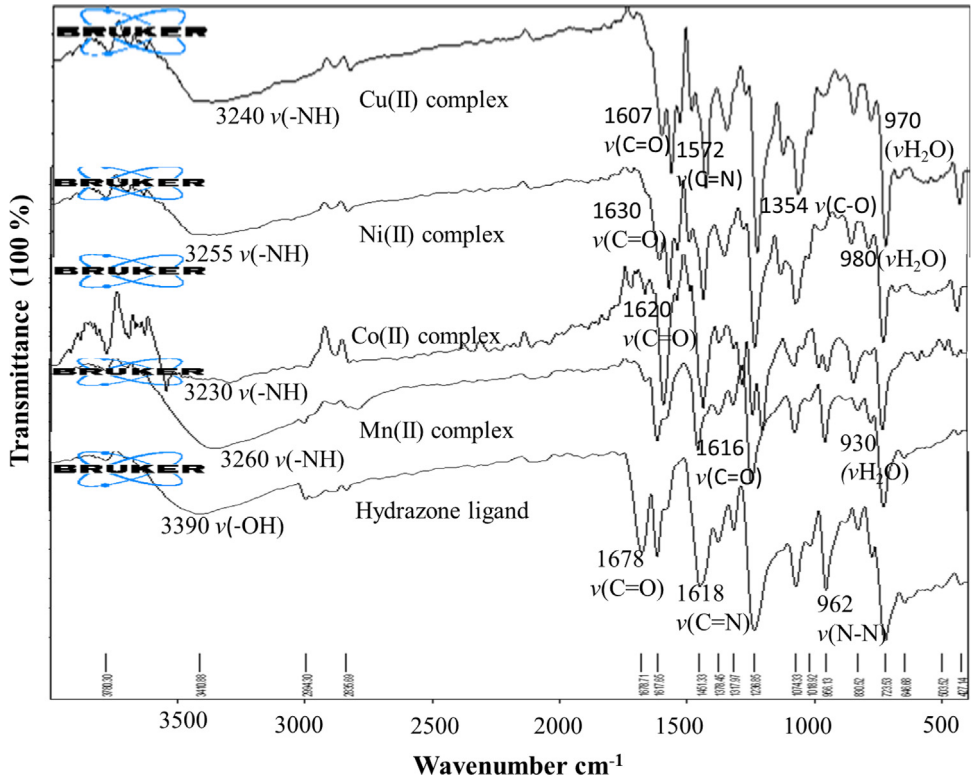


Fig. 2. FT-IR spectra of hydrazone ligand (H_2L) and its metal(II) complexes.

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-

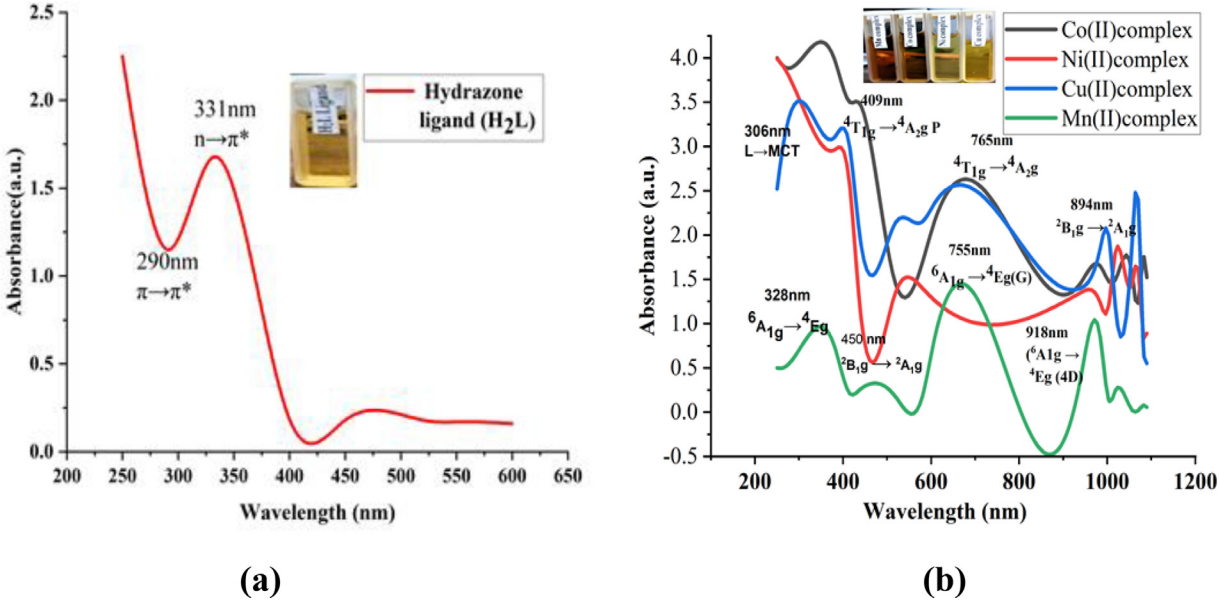


Fig. 3. (**a**) Electronic absorbance of hydrazone ligand (H_2L) and (**b**) Metal(II) complexes in DMSO (2 × 10^{-}4 mol dm^{-3}).

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

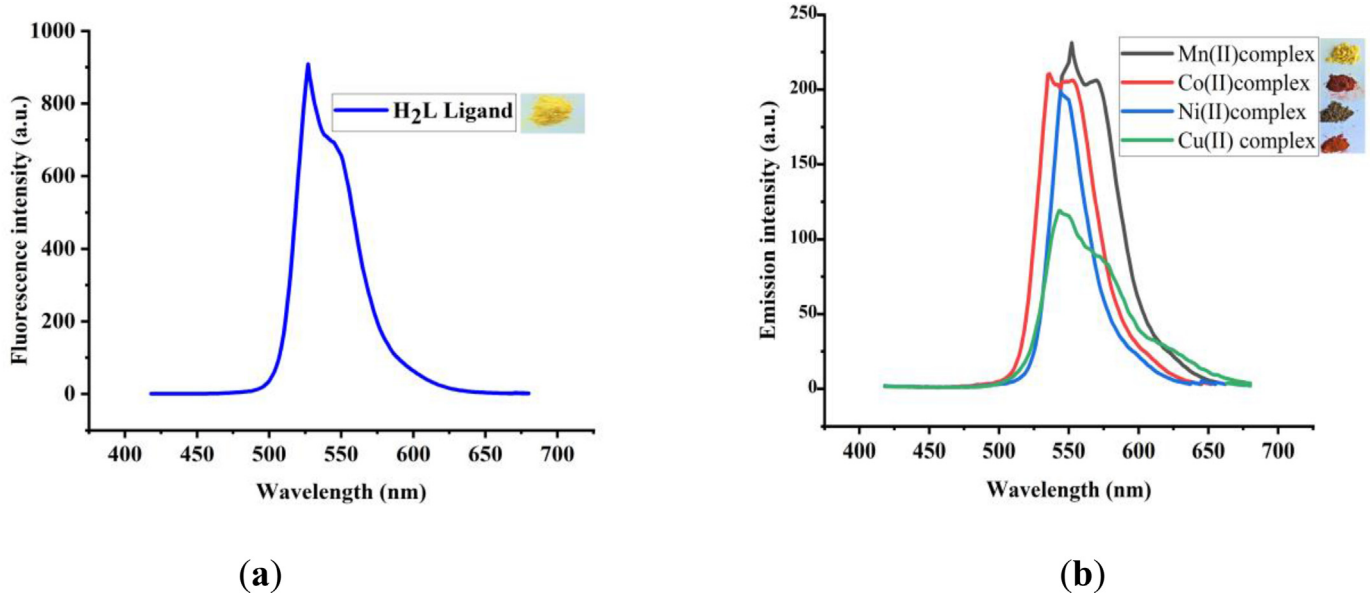


Fig. 4. Comparative fluorescence emission spectra of ligand (**a**) and (**b**) metal complexes.

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

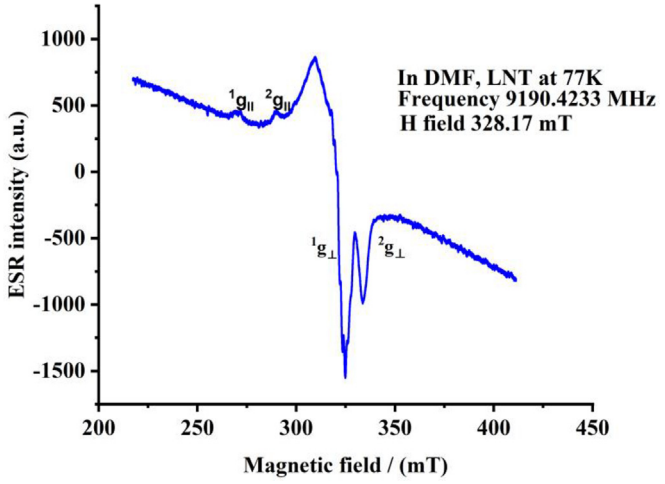


Fig. 5. ESR spectrum of Cu(II) complex.

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

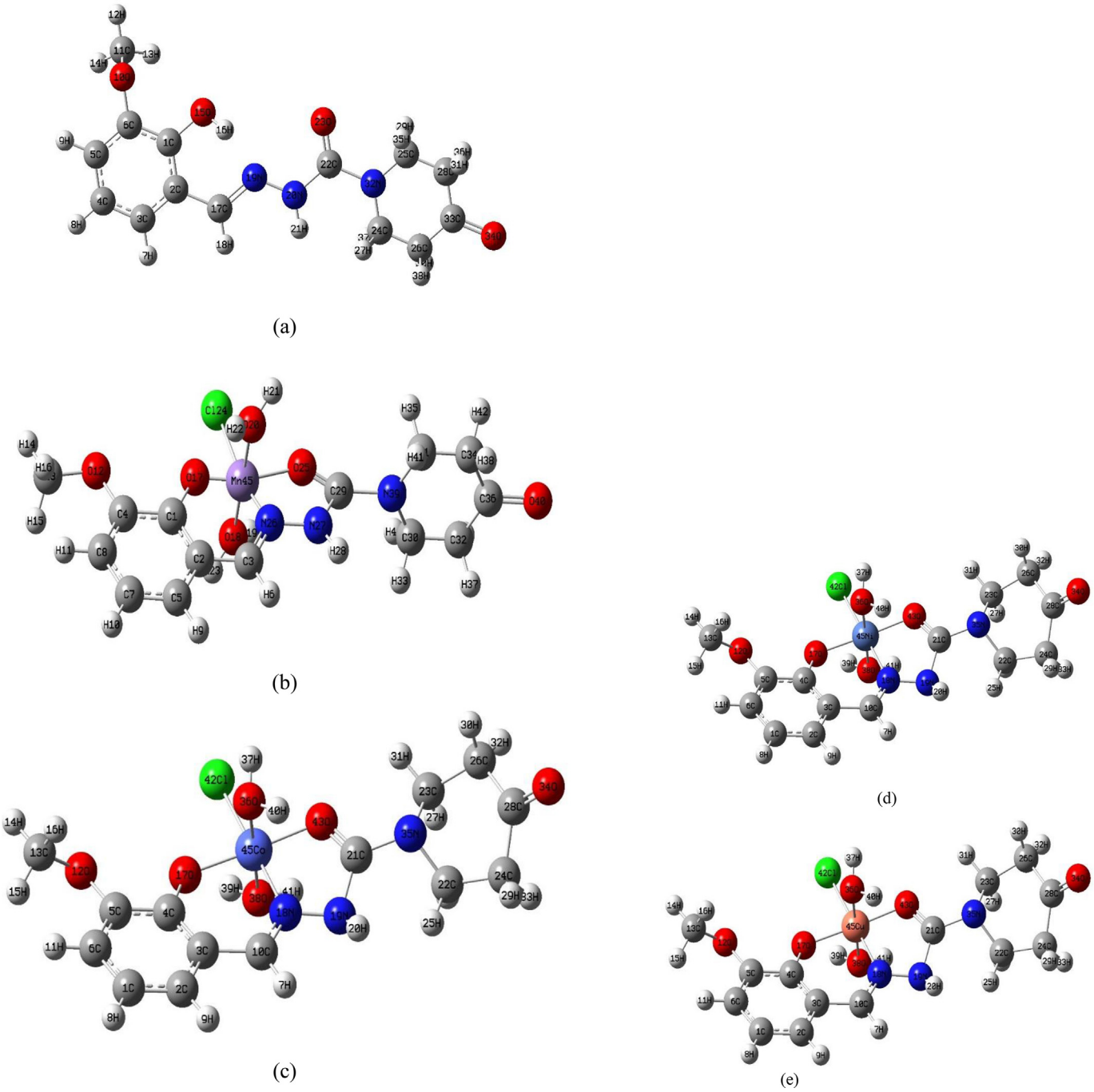


Fig. 6. Optimized molecular structure of (a) ligand, (b) Mn(II), (c) Co(II),(d) Ni(II), (e) Cu(II) complexes.

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						

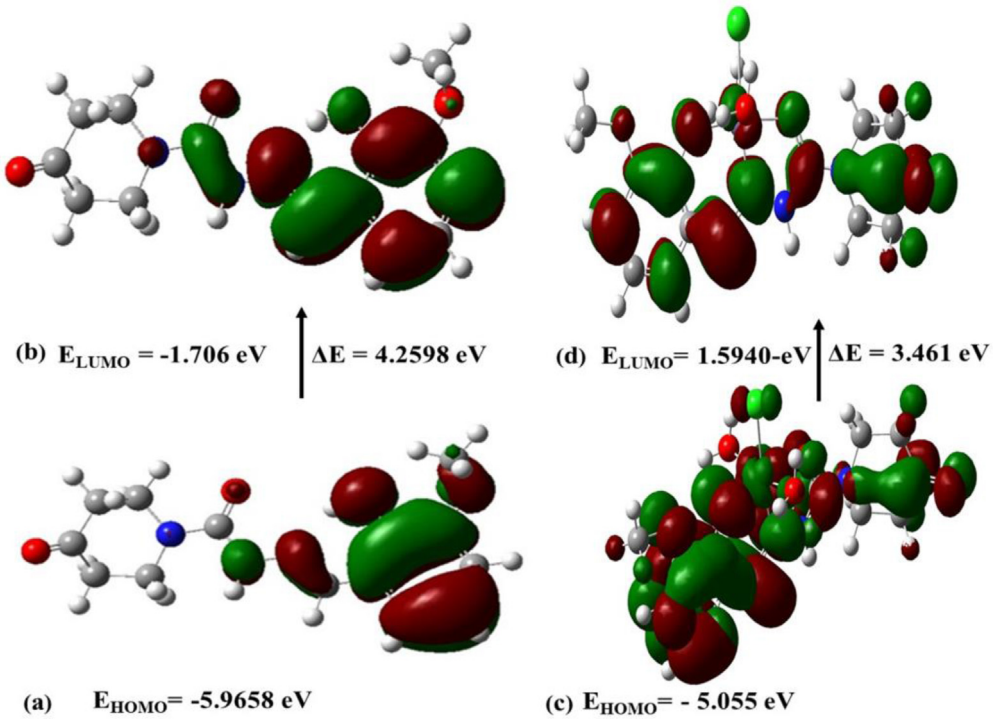


Fig. 7. Frontier molecular orbitals (a) HOMO, (b) LUMO of ligand (H_2L), and (c) HOMO and (d) LUMO of Mn(II) Complex.

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

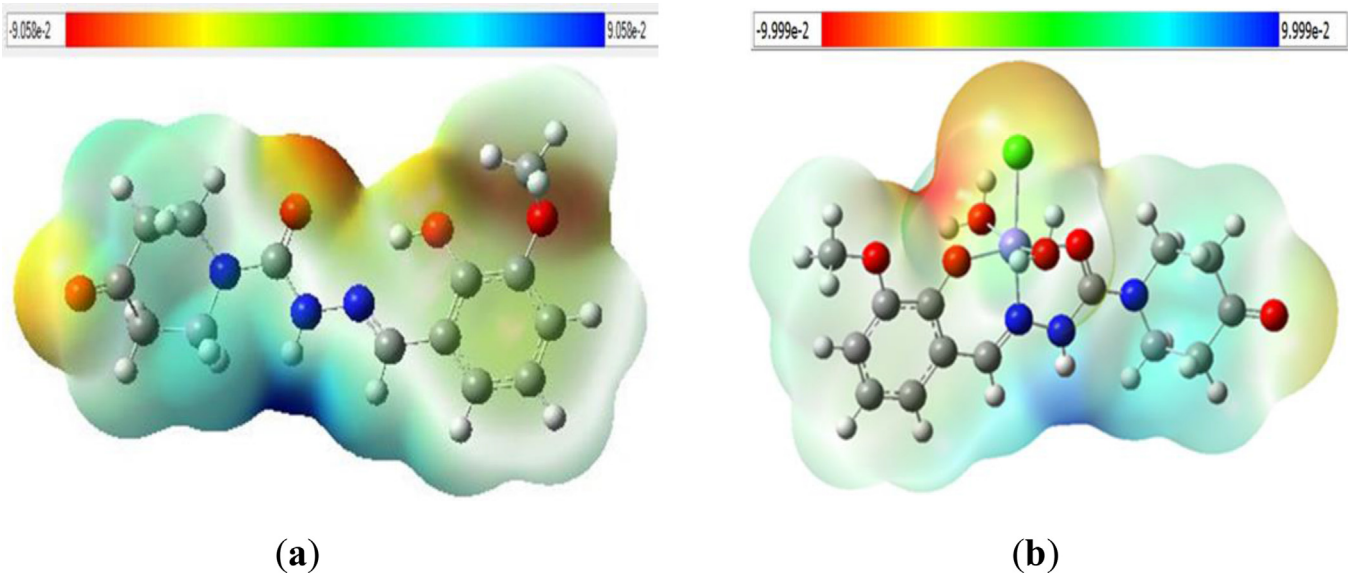


Fig. 8. Molecular electrostatic potential surface of (a) Ligand, and (b) Mn(II) complex.

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

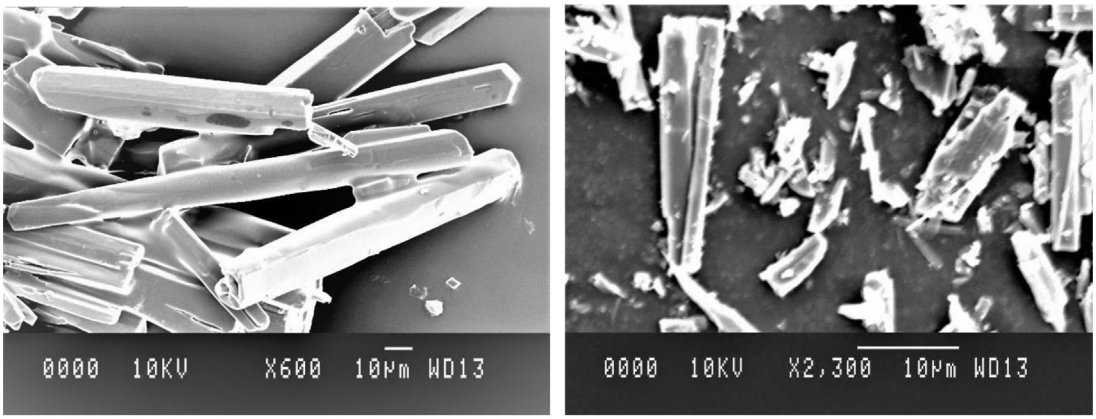


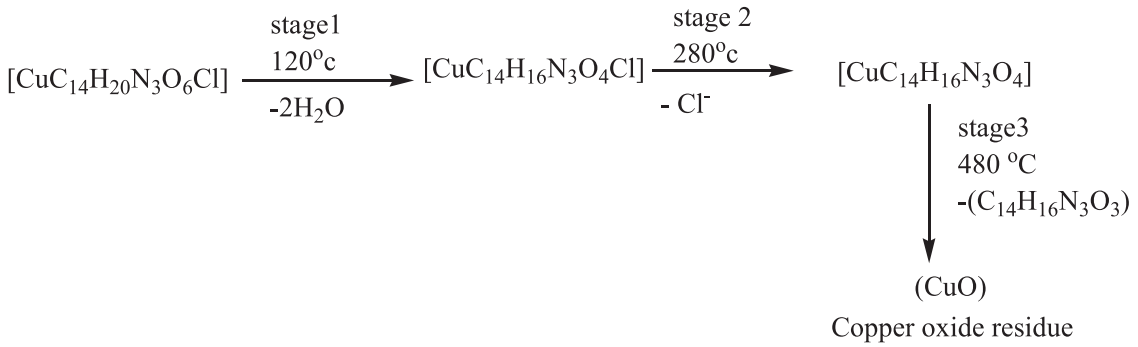
Fig. 9. SEM of (**a**) ligand (H_2L), and (**b**) Co(II) complex.

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.

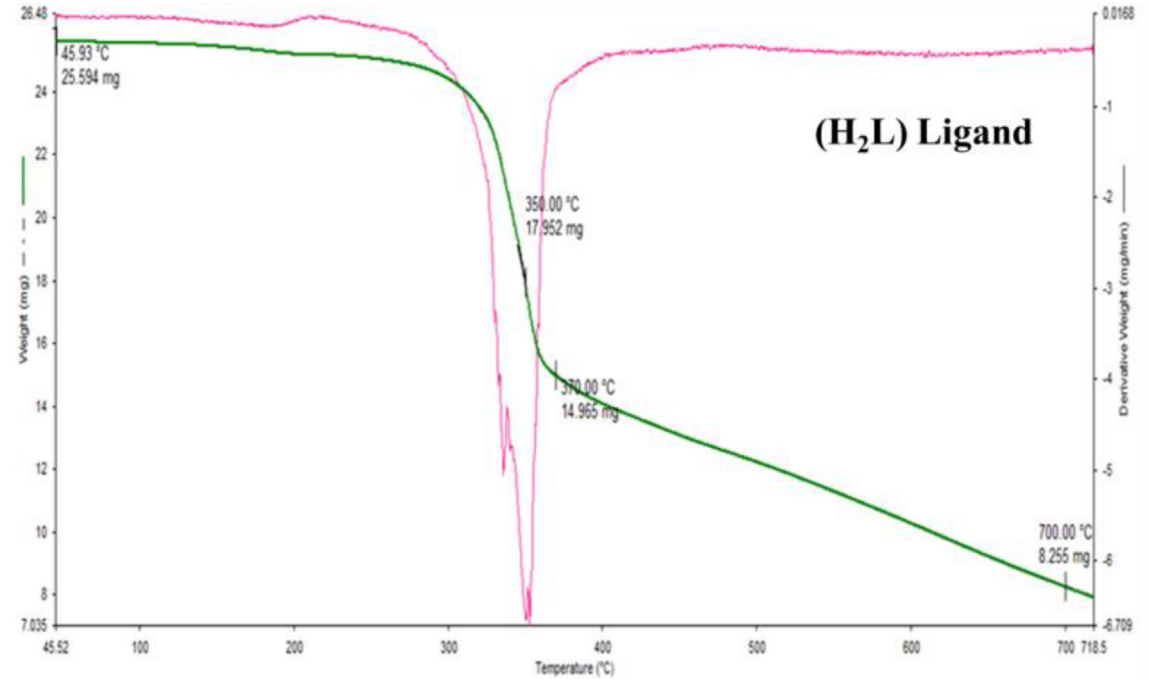
The thermograms of Mn(II), Co(II), Ni(II) and Cu(II) complexes showed decomposition in three steps and thermal decompostion of Cu(II) shown in (Scheme 2) as a representative case. The proposed stepwise thermal degradation pattern of all the complexes with respect to temperature and formation of respective 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)

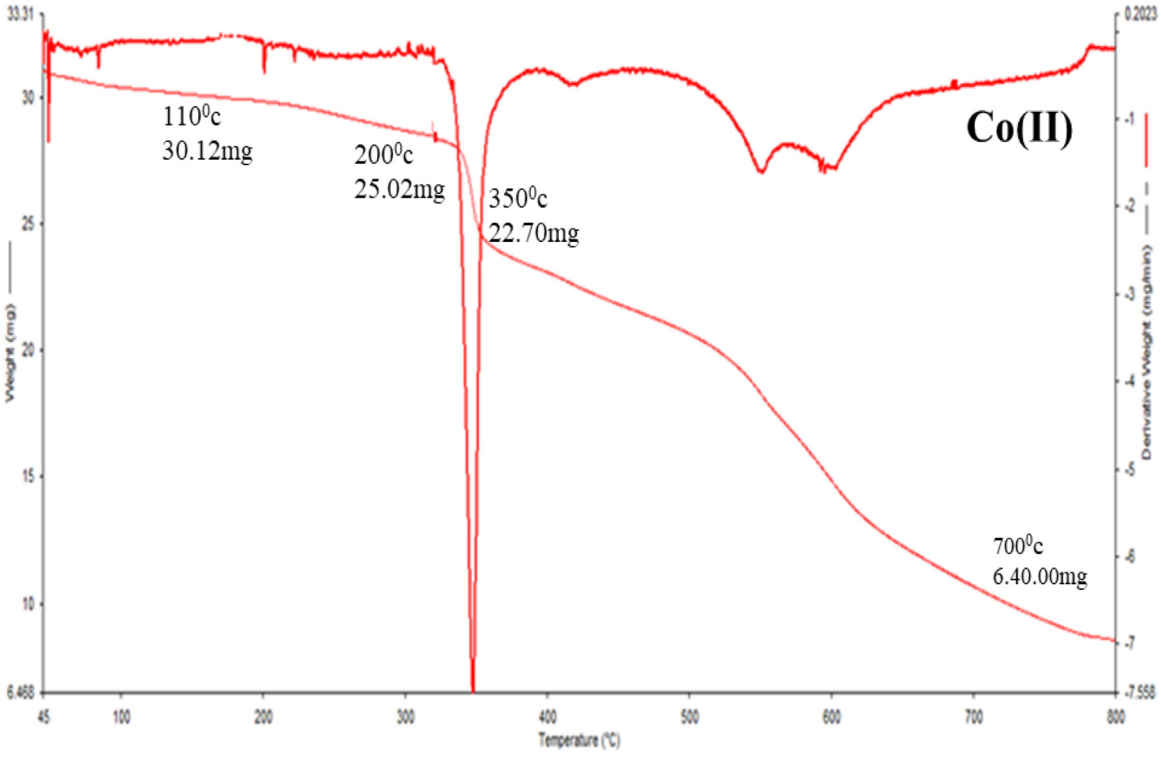
The kinetic and thermodynamic energy parameters associated with various decomposition steps in the thermal process are very important for the evaluation of the nature of complexes and also a quick technique for assigning the stability of the material substances. In the present investigation significant 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

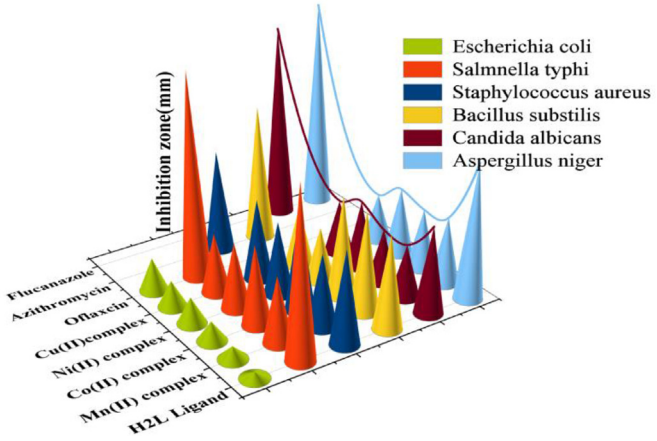


Fig. 11. Inhibition zone growth of microorganisms of tested compounds of ligand (H_2L) and its metal (II) complexes.

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.

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Supplementary materials

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

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A heterocyclic *N*'-(4-(diethylamino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazide Schiff base ligand and its metal complexes: Synthesis, structural characterization, thermal behavior, fluorescence properties, and biological activities

Gajanan Mahadu Dongare and Anand Shankarrao Aswar *

Department of Chemistry, Sant Gadge Baba Amravati University, Amravati-444602, Maharashtra State, India

** Corresponding author at: Department of Chemistry, Sant Gadge Baba Amravati University, Amravati-444602, Maharashtra State, India.*
e-mail: aswaranand@gmail.com (A. Aswar).

RESEARCH ARTICLE

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ABSTRACT

A new heterocyclic hydrazone Schiff base ligand, *N*'-(4-(diethylamino)-2-hydroxy benzylidene)-4-oxopiperidine-1-carbohydrazide, (H_2L) was derived by a condensation reaction of 4-oxopiperidine-1-carbohydrazide with 4-(diethylamino)-2-hydroxybenz-aldehyde. The ligand reacts with chloride salts of chromium(III), manganese(II), iron(III), cobalt(II), nickel(II), copper(II) and zinc(II) to form metal complexes of $[Cr(L)(Cl)(H_2O)_2]$, $[Mn(HL)(Cl)(H_2O)_2]$, $[Fe(L)(Cl)(H_2O)_2]$, $[Co(HL)(Cl)(H_2O)_2]$, $[Ni(HL)(Cl)(H_2O)_2]$, $[Cu(HL)(Cl)(H_2O)_2]$, $[Zn(L)(H_2O)]$, respectively. The structure of the hydrazone ligand was confirmed by elemental analysis and spectroscopic techniques, *viz*., FT-IR, ^{1}H NMR, ^{13}C NMR, and LC-MS spectroscopy. The newly synthesized ligand behaves as a tridentate *ONO* donor towards Cr, Mn, Fe, Co, Ni, Cu, and Zn metal ions. The spectral, magnetic moment, and thermal data indicate the octahedral geometry for all metal complexes except for Zn, which has tetrahedral geometry with 1:1 stoichiometry (M:L). ESR study revealed that π-bonding covalency is much stronger than the σ-bonding with axial distortion in the structure. The molar conductivity data suggested the nonelectrolytic nature of the complexes. The powder X-ray diffraction patterns suggest the nanocrystalline nature of the compounds. The SEM micrograph of the ligand significantly differs from its Ni(II) complex indicating coordination of Ni(II) ion to the ligand. The intense fluorescence emitted in the region of $\lambda_{Excitation}$ 521 to 524 nm due to the functional fluorophores of the ligand and its manganese (II), chromium(III), cobalt(II), and zinc(II) complexes. Various kinetic parameters such as E_a, ΔS, ΔH, and ΔG of various decomposition steps were calculated from TGA diagrams using Coats-Redfern method and the thermal stability order was found to be Cr < Fe < Co < Mn = Cu < Zn < Ni. The antibacterial and antifungal activities of the ligand and its divalent and trivalent metal complexes were performed against the various pathogens *viz*. *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus*, *Bacillus subtilis*, *Candida albicans*, and *Aspergillus niger* with reference to standard antibiotics *viz*. ofloxacin, azithromycin, and fluconazole. All metal complexes showed promising biological activity as compared with their parent ligand and may be used as a potential antimicrobial candidate in biological science.

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1. Introduction

The heterocyclic hydrazone Schiff base ligand plays a significant role in the coordination chemistry, as they easily form more stable complexes with most of the transition metal ions and found extensive applications in the various fields comprising organic synthesis, medicinal chemistry, non-linearity, and superb optical (*i.e*., absorbance and emission properties) to the supramolecular chemistry [1-4]. The hydrazone Schiff base containing the tridentate moiety of *ONO* active donor sites displayed a versatile class of ligands which have been studied for a long time as potential multifunctional properties due to their structural diversity, tautomerism, reaction conditions, and with good yield. The heterocyclic tridentate hydrazone contains the flexible *ONO* donor atoms in the carbonyl 'O' and the azomethine 'N', and phenolic 'O' active donor sites. Aroyl hydrazones are having to possess paramount importance due to their molecular modularity, structural flexibility, straightforward synthesis, and thermal stability have been explored as a reason for their diversified potential application [5,6].

The transition metal complexes derived from aroyl hydrazones exhibit very good enzymatic activity and are found very important in organometallic synthesis, analytical chemistry, and medicinal chemistry [6,7]. Furthermore, the tridentate moieties of the Schiff base of hydrazones and their complexes gained more recognition due to their broad-ranging biological properties, antinociceptive, and anti-inflammatory activities [8-10]. Hydrazone compounds containing the azo-methine group have shown a significant role in the medicinal

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field for the copper and iron chelators *in vivo* [11] and *in vitro* for iron overload treatment [12]. The hydrazone Schiff base ligands derived from salicylaldehyde derivatives are found as well-known as multidentate ligands and possess a broad level of antimicrobial efficiency [13-15].

Recently, the interest has grown up due to the single-step synthetic procedure for hydrazone Schiff base ligands with good yield in the crystalline state and more desirable donating property through the enolate/amide oxygen (nucleophile), azomethine nitrogen (nucleophile), and phenolate oxygen. Additionally, piperidone-based carbohydrazones are known to have strong coordinating properties and complexing ability toward transition-metal ions adopting several geometries, *e.g.*, bidentate, tridentate, or polydentate mode of linkage via *NO*, *ONO*, and N_2O_4. Transition metal complexes of Schiff base with carbohydrazide functionalities have of special research interest because of their roles in numerous physico-chemical and broad spectrum of biological properties, and functional fluorescence. Reviewing all above facts and in view of our continuing interest in the hydrazone of ligand, we designed and synthesized *N*'-(4-(diethylamino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazide ligand (H_2L) and its complexes of chromium (III), manganese(II), iron(III), cobalt(II), nickel(II), copper(II), and zinc(II) ions. The structure of the ligand and complexes were fully characterized by spectro/analytical techniques and magnetic moments. After complete spectro/analytical characterization, the ligand and its complexes were biologically screened *in vitro* for their antibacterial efficiency using the bacterial cocci of *Escherichia coli* (NCBI-0157), *Salmonella typhi* (NICM-2257), *Staphylococcus aureus* (NDCM-2257), *Bacillus subtilis* (NICM-2477) and fungal species of *Candida albicans* (MTCC-1637) and *Aspergillus niger* (NCIM-1005). In addition to this, thermo-kinetic data, fluorescence emission properties, and surface morphology of complexes have been reported for applications.

2. Experimental

2.1. Reagents and physical measurement methods

Metal chlorides were of AR grade (99%) and purchased from S.D. fine chemicals, India, 4-diethylamino salicyldehyde (99%) (Alpha Aesar, Great Britain), 1-carboethoxypiperid-4-one (99%) (Avra Synthesis, Hyderabad, India) were used without further purification. The solvents were doubly distilled before use. The elemental analysis (CHN) was carried out on a Carlo-Erba analyzer. The metal content of the complexes was analyzed by the gravimetric method after decomposing the organic moiety by a mixture of $HClO_4$, H_2SO_4, and HNO_3 (1:1.5:2.5) and then igniting metal oxide. The molar conductance measurements of a 1×10^{-3} M solution of metal complexes in DMSO at room temperature were carried out using a 180-Elico conductivity bridge. FT-IR spectra of ligand and its metal complexes were recorded on an Alpha-II compact Bruker Advance. IR spectrometer. The magnetic susceptibility of the complexes was measured at ambient temperature with a Sherwood MSB-MK-1 balance. The NMR (^1H, ^{13}C) spectra of hydrazone ligand were recorded on a Bruker Advance NMR spectrometer (500 MHz). The HR-Mass spectra of the hydrazone ligand was recorded using a micro-mass spectrophotometer. The absorption spectra have been recorded on a UV-Visible-1800 Shimadzu spectrophotometer in the wavelength range (λ) 250 to 1200 nm. The ESR spectrum of the Cu(II) complex was recorded at 77 K in LNT on a JEOL-ESR spectrophotometer using microwave frequency in the range of 8.750-9.650 GHz. Thermogravimetric analysis (TG/DTG) was carried out in N_2 atmosphere on a TGA-4000 Perkin-Elmer thermal analyzer in the temperature range of 40-800 °C, with a linear heating rate 20 °C/min with precision and accuracy of ±0.8 °C controlled by inbuilt Pyris software for TGA application of inbuilt electromagnetic compatibility (EMC) facilitated of stable weight calibration. The powder X-ray diffraction patterns of the compounds were recorded on a Miniflex (600) benchtop Rigaku X-ray diffractometer with a scanning range between 10-80°, the scan-axis 2θ/θ. The surface morphology of the hydrazone ligand and its complexes were recorded in 3D mode on JEOL-6390LV SEM(X100-X500) scanning electron microscope at 10 μM at 10 kV. The emission spectra were recorded in the wavelength region of 250-800 nm on a photoluminescence spectrophotometer (PL) Hitachi (F-7000) using a 150 W Xenon lamp. The progress of the reaction for the formation of the ligand was checked by using TLC (Merck's silica plates $60F_{254}$) and visualized by UV irradiation (254 nm).

2.2. Synthesis

2.2.1. Synthesis of N'-(4-(diethylamino)-2-hydroxy benzylidene)-4-oxopiperidine-1-carbohydrazide (H_2L)

The hydrazone Schiff base (H_2L) ligand was synthesized by a reaction of 4-oxopiperidine-1-carbohydrazide (0.315 g, 2.0 mmol) with 4-(diethylamino)-2-hydroxybenzaldehyde (0.3865 g, 2.0 mmol) in 20 mL ethanol with continuous stirring. The catalytic amount of sulfuric acid (1-2 drops) was added to the reaction mixture and refluxed for 3 hours in a water bath. After cooling to room temperature, a bright, spongy yellow product was separated out. The resulting product obtained was filtered, washed with dry ethanol, and finally recrystallized from DMSO, then dried over anhydrous $CaCl_2$ in a desiccator (Scheme 1).

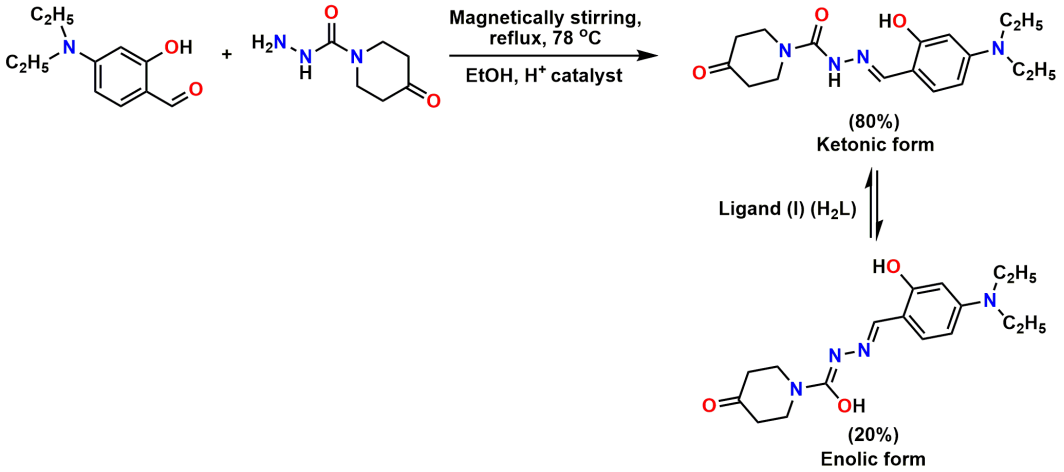
N'-(4-(Diethylamino)-2-hydroxybenzylidene)-4-oxopiperidine -1-carbohydrazide: Color: Yellow. Yield: 80 %. M.p.: 183-185 °C. FT-IR (KBr, ν, cm^{-1}): 3314 (OH, br, phenolic), 3261 (N-H, amide), 1670 (C=O, amide), 1626 (C=N, azomethine), 1300 (C-O, phenolic), 961 (N-N, azomethine). ^1H NMR (500 MHz, DMSO-d_6, δ, ppm): 11.48 (s, 1H, Ph-OH), 9.60 (s, 1H, -C*H*=N-), 8.60 (s, 1H, >NH), 7.41 (d, 1H, Ar-H), 6.55 (d, 1H, Ar-H), 6.11 (s, 1H, Ar-H), 3.49 (dd, 4H, -CH_2-C=O), 3.40 (q, *J* = 3.98 Hz, 4H, >N-CH_2-CH_3), 3.33 (dd, 4H, -CH_2-N), 1.05 (t, *J* = 6.90 Hz, 6H, >N-CH_2-CH_3). ^{13}C NMR (125 MHz, DMSO-d_6, δ, ppm): 12.30 (1C, CH_3), 12.42 (1C, -CH_3), 39.23 (1C, -CH_2, O=C-*C*H_2), 39.56 (1C, O=C-*C*H_2), 43.74 (1C, N-CH_2), 43.99 (1C, N-CH_2), 55.89 (2C, N-*C*H_2-), 95.79 (1C, Ar-C), 96.92 (1C, Ar-C), 103.93 (1C, Ar-C), 104.34 (1C, Ar-C), 106.27 (1C, Ar-C), 132.90 (1C, H*C*=N-), 160.48 (1C, C=O, >NHC=O), 162.00 (1C, Ar-*C*-OH), 180.01 (1C, C=O, H_2C(C=O)CH_2). HRMS (EI, *m/z*) calcd. for $C_{17}H_{24}N_4O_3$, 332.18; Found $[M]^{+1}$ = 333.34. Anal. calcd. for $C_{17}H_{24}N_4O_3$: C, 61.43; H, 7.28; N, 16.86. Found: C, 61.72; H, 7.50; N, 16.90%. UV/Vis (DMSO, λ_{max}, nm, ε): 245 (2.31), 331 (1.673), 432 (0.21).

2.2.2. Preparation of metal complexes

All metal complexes were synthesized by a conventional method. The H_2L ligand (0.6648 g, 2 mmol) and the respective metal chlorides (2 mmol) were dissolved separately in 25 mL of warm DMSO and dry ethanol, respectively. Both solutions were filtered and mixed in warm conditions with continuous stirring. The reaction mixture was then refluxed in an oil bath for about 4 hours and the pH of the reaction mixture was adjusted to *ca.* ~7.0 by adding ethanol: ammonia solution (7:3). The reaction mixture was cooled to room temperature. The colored solid products isolated were collected by filtration, washed with dry ethanol and petroleum ether, and finally dried in a desiccator over anhydrous calcium chloride. The analytical data of the compounds together with their proposed formula are given in Table 1.

Table 1. Analytical and physical data of the compounds.

Compounds	Molecular formula	Molecular weight (g/mol)	Elemental analysis (%) Found, (Calc.)					Molar conductance ($\Omega^{-1}cm^2mol^{-1}$)
			C	H	N	Cl	Metal	
H_2L	$C_{17}H_{24}N_4O_3$	332.40	61.72 (61.43)	7.50 (7.28)	16.90 (16.86)	-	-	0.0
$[Cr(L)(Cl)(H_2O)_2]$	$CrC_{17}H_{26}N_4O_5Cl$	453.86	45.00 (44.99)	6.00 (5.77)	12.50 (12.34)	7.90 (7.81)	12.80 (11.46)	18.20
$[Mn(HL)(Cl)(H_2O)_2]$	$MnC_{17}H_{27}N_4O_5Cl$	457.81	44.76 (44.60)	6.00 (5.94)	12.40 (12.24)	7.84 (7.74)	12.15 (12.00)	15.16
$[Fe(L)(Cl)(H_2O)_2)]$	$FeC_{17}H_{26}N_4O_5Cl$	457.71	44.76 (44.61)	5.85 (5.73)	12.45 (12.24)	7.80 (7.75)	12.30 (12.20)	26.15
$[Co(HL)(Cl)(H_2O)_2]$	$CoC_{17}H_{27}N_4O_5Cl$	461.80	44.30 (44.21)	6.10 (5.89)	12.40 (12.13)	7.75 (7.68)	12.84 (12.76)	17.80
$[Ni(HL)(Cl)(H_2O)_2]$	$NiC_{17}H_{27}N_4O_5Cl$	461.56	44.35 (44.24)	6.00 (5.90)	12.25 (12.14)	7.78 (7.68)	12.80 (12.72)	21.90
$[Cu(HL)(Cl)(H_2O)_2]$	$CuC_{17}H_{27}N_4O_5Cl$	466.42	44.90 (43.78)	6.90 (5.84)	12.15 (12.01)	7.75 (7.60)	13.80 (13.62)	8.15
$[Zn(L)(H_2O)]$	$ZnC_{17}H_{24}N_4O_4$	413.78	49.50 (49.35)	5.90 (5.85)	13.70 (13.54)	-	15.95 (15.80)	6.14



Scheme 1. Synthesis of the ligand and its ketonic-enolic forms.

3. Results and discussion

The reaction between 4-oxopiperidine-1-carbohydrazide and 4-(diethylamino)-2-hydroxybenzaldehyde in ethanol produced new hydrazone, *N*'-(4-(diethylamino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazide (H_2L) (Scheme 1). The formation of the ligand was further confirmed by spectro/analytical techniques, *viz*., FT-IR, ^{1}H NMR, ^{13}C NMR, and HR-MS. The reaction of this ligand with metal chlorides formed two types of complex with good yield $[Cr(L)(Cl)(H_2O)_2]$ (**1**), $[Fe(L)(Cl)(H_2O)_2)]$ (**2**), and $[Zn(L)(H_2O)]$ (**3**) in which the hydrazone ligand acts as a dibasic tridentate (in its enolic state) coordinated by *ONO* donor atoms, while in $[Mn(HL)(Cl)(H_2O)_2]$ (**4**), $[Co(HL)(Cl)(H_2O)_2]$ (**5**), $[Ni(HL)(Cl)(H_2O)_2)]$ (**6**) and $[Cu(HL)(Cl)(H_2O)_2]$ (**7**) hydrazone ligand acts as a monobasic-tridentate (in its ketonic form) coordinated by *ONO* donor atoms. All synthesized metal (II) and (III) complexes are colored powder, non-hygroscopic, and stable at room temperature. The complexes are insoluble in water and most of the common organic solvents, but sparingly soluble in DMF and DMSO. The analytical data obtained for the synthesized complexes confirmed that the complexes are mononuclear, and the ligand to metal ratio was found to be 1:1 (M:L) in all complexes. The molar conductivity of metal complexes in DMSO solution (1×10^{-3} M) at room temperature shows low values of 6.14-26.15 $\Omega^{-1}cm^2mol^{-1}$ indicating non-electrolytic nature and, moreover, indicated the chloride ion present within the coordination sphere.

3.1. Characterization of the ligand

The proton NMR spectrum of ligand shows a dd at δ 3.40 ppm due to (N-C*H*$_2$) protons and a singlet at δ 1.05 ppm for the methylenic protons at α- and β-positions of the $(CH_3CH_2)_2N<$ group. The heterocyclic ring shows two doublets at δ 3.33 ppm for four protons of the -C*H*$_2$- group at α-position and another two-doublet appeared at δ 3.49 ppm of four protons another of the -C*H*$_2$- group at β-position. One phenolic (O*H*) and another one azomethine proton (-*H*C=N-) showed downfield singlet appears at δ 11.48 and 9.60 ppm, respectively. Aryl protons were observed in their typical δ 6.11-7.41 ppm region. The ^{13}C NMR spectrum of the hydrazone ligand exhibits four signals at δ 39.23, 39.56, 43.74 and 43.99 ppm due to the four carbons of the heterocyclic ring. The signal observed at δ 180.01 ppm of the saturated carbonyl carbon of the heterocyclic ring located at low intensity whereas another signal at δ 160.48 ppm is due to amide carbonyl carbon. The azomethine carbon (-H*C*=N-) signal appeared at δ 132.90 ppm. The aryl carbons appear well within the expected region δ 95.79-106.27 ppm. The separate signals that appeared at δ 12.30 and 12.42 ppm are due to methyl carbon. 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.

3.2. Infrared spectra and bonding mode

In order to ascertain the bonding mode of the hydrazone ligand to the metal ion in the complexes, the infrared spectra of the metal complex were compared with that of its parent ligand. The selected IR bands for the ligand and its complexes together with their assignments are listed in Table 2. The IR spectra impart characteristic bands to identify various functional groups such as carbonyl (C=O), imino (=NH), (C=C), (C-C) bonds, crystal/lattice water, halide linkage, tautomerism, enolic, and phenolic group of vibrations in a heterocyclic ring system. The IR spectrum of the ligand shows a medium broad band at 3314 cm^{-1} due to the stretching frequency of the phenolic (OH) group and this band has been disappeared from the spectra of all complexes, indicating the formation of a coordination bond between the metal ion and the phenolic oxygen atom *via* deprotonation. It was further confirmed by the upward shifting of stretching frequencies (C–O) by the incre-

Table 2. IR spectral data (cm^{-1}) of the hydrazone ligand and its metal complexes.

Compounds	ν(OH) phen.	ν(NH) amide	ν (C=O)	ν(C=N) azomethine	ν(C-O) in phenyl	ν(C-O) in enol	ν(N-N)	Coord. ν(H_2O)	ν(M-O)	ν(M-N)
H_2L	3314	3261	1670	1626	1300	-	961	-	-	-
[Cr(L)(Cl)(H_2O)$_2$]	-	-	1620	1600	1310	1235	970	850	585	488
[Mn(HL)(Cl)(H_2O)$_2$]	-	3250	1625	1605	1341	-	958	838	553	440
[Fe(L)(Cl)(H_2O)$_2$)]	-	-	1651	1604	1349	1239	980	840	590	452
[Co(HL)(Cl)(H_2O)$_2$]	-	3255	1622	1600	1348	-	970	835	560	448
[Ni(HL)(Cl)(H_2O)$_2$]	-	3248	1630	1600	1312	-	964	820	570	460
[Cu(HL)(Cl)(H_2O)$_2$]	-	3235	1665	1598	1305	-	972	835	580	474
[Zn(L)(H_2O)]	-	-	-	1600	1317	1240	975	850	558	460

Table 3. Magnetic susceptibility and electronic absorbance data of metal complexes.

Metal complexes	$\mu_{effective}$ (B.M.)	Maximum absorption ν (cm^{-1})	Maximum absorption wavelength ν (nm)	Spectral transitions	Ligand fields			
					Dq (cm^{-1})	Interelectronic repulsion B (cm^{-1})	Racah parameter B_0 (cm^{-1})	Nephelauxetic ratio ($\beta = B/B_0$)
[Cr(L)(Cl)(H_2O)$_2$]	3.84	16529	605	$^4A_{2g} \rightarrow {}^4T_{2g}$	1653	976	918	0.74
		19321	518	$^4A_{2g} \rightarrow {}^4T_{1g}$(F)				
		26667	375	$^4A_{2g} \rightarrow {}^4T_{1g}$(P)				
[Mn(HL)(Cl)(H_2O)$_2$]	5.86	10417	960	$^6A_{1g} \rightarrow {}^4E_g({}^4D)$	1042	667	860	0.77
		11494	870	$^6A_{1g} \rightarrow {}^4E_g$(G)				
		20408	490	$^6A_{1g} \rightarrow {}^4T_2$(G)				
[Fe(L)(Cl)(H_2O)$_2$)]	5.90	10101	990	$^6A_{1g} \rightarrow {}^4T_{2g}$(G)	-	-	-	-
		13297	752	$^6A_{1g} \rightarrow {}^4T_{2g}$(G)				
		18868	530	$^6A_{1g} \rightarrow {}^4E_g$(D)				
[Co(HL)(Cl)(H_2O)$_2$]	4.62	9346	1070	$^4T_{1g} \rightarrow {}^4T_{2g}$	1168	704	971	0.73
		10787	927	$^4T_{1g} \rightarrow {}^4A_{2g}$				
		17575	569	$^4T_{1g} \rightarrow {}^4A_{2g}$(F)				
[Ni(HL)(Cl)(H_2O)$_2$]	2.80	10256	975	$^3A_{2g} \rightarrow {}^3T_{2g}$(F)	1026	794	1030	0.77
		11163	880	$^3A_{2g} \rightarrow {}^3T_{1g}$(F)				
		22173	451	$^3A_{2g} \rightarrow {}^3T_{1g}$(P)				
[Cu(HL)(Cl)(H_2O)$_2$]	1.71	11073	895	$^2B_1g \rightarrow {}^2A_1g(\nu_1)$	-	-	-	-
		15384	652	$^2B_1g \rightarrow {}^2B_2g(\nu_2)$				
		20408	490	(CT)				
[Zn(L)(H_2O)]	Dia.	27473	364	ILCT (n→π*)	-	-	-	-
		39216	255	ILCT (π→π*)				

ments of 5 to 49 cm^{-1} from 1300-1349 cm^{-1} in all complexes. The phenolic 'O' atom has been involved in the bond formation with metal(II) and metal(III) ions of the complexes. The ligand spectrum displayed a strong characteristic vibrational band at 1626 cm^{-1}, due to ν(-HC=N-, azomethine) and shifting of this band towards lowering frequency by 21-28 cm^{-1} from 1605-1598 cm^{-1} in the spectra of Mn(II), Co(II), Ni(II), and Cu(II) complexes indicates the coordination metal atom through azomethine nitrogen. This has been further strengthened by upward the shifting of ν(N–N) band from 958 to 972 cm^{-1} in the spectra of the metal complexes. The ligand shows band at 3261 cm^{-1} due to the stretching vibration of ν(N-H) group which appeared almost about at the same position as in the case of Mn(II), Co(II), Ni(II), and Cu(II) complexes indicating non-involvement in the coordination, which confirm the presence of ligand in its ketonic form. This is also further confirmed by the shifting of amide ν(C=O) to lowering frequency by 5-50 cm^{-1} from 1625-1665 cm^{-1} in these complexes, suggesting the coordination of carbonyl oxygen atom to metal ions as such without experiencing the enolization. However, these bands are completely absent in Cr(III), Fe(III), and Zn(II) complexes, which confirmed the *enol* formation act in accordance with the coordination linkages to the metal ion after deprotonation [16,17]. Furthermore, the existence of coordinated water molecules was confirmed by the presence of non-ligand bands 820-850 cm^{-1}, which was further supported by the thermal analysis. The coordination of ligand was further confirmed by the appearance of new weak intensity bands, non-ligand bands in the region of 553-590 and 440-488 cm^{-1} in the IR spectra of the complexes are assigned to frequencies of ν(M-O) and ν(M-N) stretching vibrations, respectively. Based on the above data, all metal complexes were identified as a mononuclear compound displayed on the basis of the characteristics of the vibrational band frequencies [18].

3.3. Room temperature magnetic susceptibility and electronic absorption spectral properties

The structural interpretation for the metal complexes was predicted from their magnetic moment and electronic absorption spectra measured at 300.15 K. The synthesized metal complexes were identified by their characteristic absorption of maxima as well as minima and the data are listed in Table 3.

The electronic spectrum of the Cr(III) complex shows three bands at 16529, 19231, and 26667 cm^{-1} which are assigned to the $^4A_{2g} \rightarrow {}^4T_{2g}$ (ν_1), $^4A_{2g} \rightarrow {}^4T_{1g}$ (F) (ν_2), and $^4A_{2g} \rightarrow {}^4T_{1g}$ (P) (ν_3) transitions, respectively, in accordance with octahedral geometry around chromium ion. The magnetic moment (μ) value is 3.84 B.M., which is indicative of the octahedral geometry. The ligand field parameters such as the crystal field splitting energy (Dq), the Racah parameter (B), the nephelauxetic ratio (β), and the ν_2/ν_1 were evaluated by using the König equation [19] and values are found to be 1653 cm^{-1}, 676 cm^{-1}, 0.74 and 1.16, respectively, which are also in agreement with the octahedral Cr(III) complexes. The value of interelectronic repulsion parameter B was found to be lower (676 cm^{-1}) than that of the free ion, confirming the presence of covalency in the metal-ligand bond.

The electronic spectrum of the Mn(II) complex exhibits three bands at 10417, 11494, and 20408 cm^{-1} attributed to $^6A_{1g} \rightarrow {}^4E_g({}^4D)$ (ν_1), $^6A_{1g} \rightarrow {}^4E_g$ (G) (ν_2), and $^6A_{1g} \rightarrow {}^4E_g$ (G) (ν_3) transitions, respectively, in an octahedral geometry. Additionally, the value of magnetic moment 5.86 B.M. is also supported to confirm an octahedral geometry around the Mn(II) ion.

The electronic spectrum of the Fe(III) complex showed three bands located at 10101, 13297, and 18868 cm^{-1} attributed to the $^6A_{1g} \rightarrow {}^4T_{1g}$ (G) (ν_1), $^6A_{1g} \rightarrow {}^4T_{2g}$ (D) (ν_2) and $^6A_{1g} \rightarrow {}^4E_g$ (D) (ν_3) transitions, respectively, in conformity with octahedral arrangements around the Fe(III) ion and the magnetic moment value is 5.90 B.M. which indicates the presence of the Fe(III) complex in octahedral geometry with d^5 high spin electronic configuration.

Table 4. Electron spin resonance spectral parameters of Cu(II) complex.

g_e	$g_{\|\|}$ (Avg.)	$g_\perp$ (Avg.)	g (Avg.)	$\Delta g = g_{\|\|}-g_\perp$	G	HSC×10^{-4} (cm^{-1})		HSC Avg.	$f = g_{\|\|}/A_{\|\|}$	Bonding parameters		Orbital reduction	
						$A_{\|\|}$	$A_\perp$			α^2	β^2	$K^2_{\|\|}$	$K^2_\perp$
2.0036	2.211	2.092	2.152	0.119	2.327	148	88	118	149.39	0.77	1.46	0.88	1.55

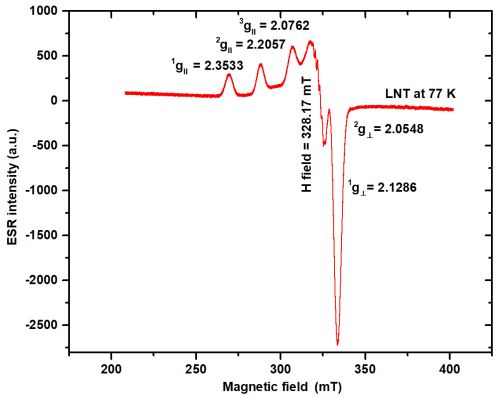


Figure 1. ESR spectrum of Cu(II) complex.

The electronic spectrum of the Co(II) complex exhibits three absorption bands at 9346, 10787, and 17575 cm^{-1}, which have been tentatively assigned to $^4T_{1g} \rightarrow {}^4T_{2g}$ (ν_1), $^4T_{1g} \rightarrow {}^4A_2$ (G) (ν_2), and $^4T_{1g} \rightarrow {}^4T_{1g}$ (F) (ν_3) transitions, respectively, which was in accordance with the octahedral geometry around the cobalt ion. The magnetic moment value 4.62 B.M. indicates octahedral geometry with high-spin arrangements around cobalt ion. The different ligand field parameters such as Dq, B, β, and ν_2/ν_1 have been evaluated and the values are found to be Dq = 1168 cm^{-1}, Racah parameter value (B) = 704 < 971 cm^{-1} (in free ion), β = 0.73 cm^{-1} and ν_2/ν_1 = 1.15. The lower B value of the complex than the free ion value suggests the presence of significant covalency in M-L bonding.

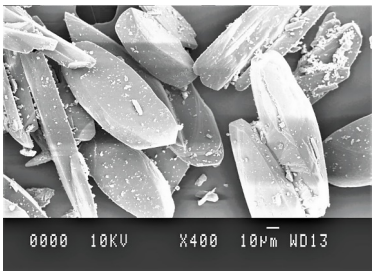
The absorption spectrum of the Ni(II) complex displayed three bands at 10256, 11163, and 22173 cm^{-1} due to $^3A_{2g} \rightarrow {}^3T_{2g}$ (F) (ν_1), $^3A_{2g} \rightarrow {}^3T_{1g}$ (F) (ν_2) and $^3A_{2g} \rightarrow {}^3T_{1g}$ (P) (ν_3) transitions, respectively, characteristic of an octahedral environment for Ni(II) complexes. The observed magnetic moment is 2.80 B.M., which is very close to the spin-only value for two unpaired electrons and is supported for octahedral geometry for the complex. The calculated values of various ligand field parameters were found to be Dq = 1026 cm^{-1}, B = 794 < 1030 cm^{-1} in free ions, and β = 0.77 cm^{-1} are applicable with to those of reported for octahedral complexes of Ni(II) [20]. The observed lower value of B than that of the free ion indicates an orbital overlap.

The absorption spectrum of the Cu(II) complex shows a broad absorption band at ~11073 cm^{-1} due to the $^2B_{1g} \rightarrow {}^2A_{1g}$ transition for distorted octahedral stereochemistry of Cu(II) complexes. The other weak absorption bands observed at 14663, and 20408 cm^{-1} correspond to $^2B_{1g} \rightarrow {}^2E_g$ and (L → M ion) charge transfer, transitions, respectively. The broadness of band occurs due to the presence of Jahn-Teller distortion, indicating distortion from octahedral geometry. The complex showed a magnetic moment of 1.71 B.M., which indicates the presence of one unpaired electron with the monomeric nature of the complex.

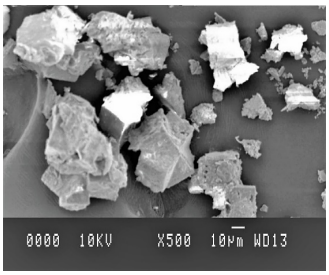
The electronic spectrum of the Zn(II) complex shows two bands at 27473 and 39216 cm^{-1}, which may reasonably be assigned to a charge transfer transition from the ligand to a metal ion. The ligand chromophores transition of π → π* and n → π* group in the UV region. The complex is found to be diamagnetic, as expected for the d^{10} system, which may suggest the tetrahedral geometry around the Zn(II) ion [21].

3.4. ESR study of [Cu(HL)(Cl)(H$_2$O)$_2$] complex

The ESR spectrum of the Cu(II)complex exhibits three prominent locations of ($g_{||}$) peaks at 2794, 2981, and 3161 G and another two $g_\perp$ peaks at 3336, and 3430 G and the spectrum is shown in Figure 1 and its data are summarized in Table 4. A well-resolved spectrum carrying the electron magnetic tensor components $g_{||}$ = 2.211 and $g_\perp$ = 2.092, which informs the presence of axial symmetry in the complex. The tensor values are shows a ($g_{||} > g_\perp$) and the further trend to appears in the order of ($g_{||} > g_\perp$) more than free electron magnetic tensor g_e = 2.0036 shows the configuration in a $d_x{}^2$-$d_y{}^2$ orbital in the ground state containing an unpaired electron. It was reported that the $g_{||}$ value is sensitive to the covalency nature of the ligand-metal bond ($g_{||}$ less than 2.3), which indicates that the covalency in the Cu-L bond. The deviation of tensor g_{ave} = 2.152 from the free electron tensor value g_e = 2.0036 accounted for the covalency in the metal-ligand bond. The geometric parameter was calculated by using Hathway's equation G = ($g_{||}$ - 2.0023)/($g_\perp$ - 2.0023) and found to be 2.327 value which was lower than 4.0 suggesting considerable exchange interaction with the metal center [22]. The tensor (A) displays the most significant tensor properties of magnetic interaction between the electron spin and neighboring nuclear spin, giving rise to the hyperfine structure in the spectrum. The hyperfine splitting constant (HSC) was calculated $A_{||}$ = 148 cm^{-1} and $A_\perp$ = 88 cm^{-1}, which suggesting that electron interaction within the only single copper nucleus confirmed distortion in the octahedral geometry around the Cu(II) ion center. The tensor component 'A' was calculated from the spectra by comparison of the spectral line width and the line shape. The calculated the tensor component ($A_{||}$ 148 cm^{-1} > $A_\perp$ 88 cm^{-1}) which predicted the distorted octahedral structure with axial symmetry through the copper-O bond and the copper-N bond. Inverse relation of the tensor components A‖ with g‖ indicates the conformity of the more delocalization of the electrons in the metal-ligand covalent bond. Comparing the increased values of A‖ with declining values of g‖, it clearly indicates more interaction of electrons with its nuclear spin. The ratio (f) = $g_{||}/A_{||}$ was found to be 149.39 and its $A_{avg.}$ = 118 which inferred the presence of distortion in the structure. The molecular orbital coefficient was calculated β^2 (1.46) > α^2 (0.77) which represents that π-bonding covalency is stronger than the σ-bonding with axial distortion in the structure. The contribution of the orbital reduction parameters ($K^2_\perp$ = 1.55) > ($K^2_{||}$ = 0.88) indicates the greater in-plane π-bonding than the out-of-plane π-bonding [23].



(a)



(b)

Figure 2. Scanning electron microscopic image of (a) H_2L and (b) Ni(II) complex using JEOL-6390L microscope.

3.5. SEM study

The scanning electron microscopic (SEM) image was captured to compare the surface morphology of the synthesized ligand and its Ni(II) complex as a representative case and is shown in Figures 2a and 2b. The different characteristic shapes and sizes of the ligand particles and its Ni(II) complex provide evidence of the metal complexation. The unit cell of the ligand appears as uniform platelets with slightly varying lateral dimensions to represent the cuboidal shape without any shadows and this was supported by the monoclinic crystal Bravais lattice from XRD studies. The high level of resolution at 500× SEM image of the Ni(II)complex, revealed that morphology appears as a cauliflower-like shape with upper grooves, non-uniform, irregular in shape with aggregation of molecules [24,25]. The magnified pictogram of ligand at ×400 and complex at ×500 level clearly informed differences in shape and size of the particle giving evidence of the formation of the metal complex.

3.6. X-ray diffraction analysis

The powder XRD pattern of H_2L ligand and its derived Mn(II), Ni(II), and Zn(II) metal complexes have been recorded by using the X-ray diffractometer with a target source of copper as an anode material, CuK_α = 1.540559 Å. The XRD diffractograms as representative cases to determine the Bravais lattice system, lattice framework, and volume of newly synthesized compounds [26,27]. The prominent peaks of the X-ray diffraction patterns have been indexed to find crystallite size, nature of compounds, peak intensities, relative intensities, interplanar spacing, and unit cell dimensions. Bragg's equation ($n\lambda = 2d\sin\theta$) was used for the evaluation of angle in 2θ and interplanar distances as *d*. The Miller indices were also reflected in a specified direction, which was supported by the crystal lattice parameters of *h*, *k*, and *l* values. The average particle size was calculated from Scherrer's equation (1918) $L = (K\times\lambda(nm))/(\beta(2\theta)\times\cos\theta)$; Scherer's constant ($K$ = 0.9), peak position in 2θ (deg.), and β parameters of full width at half maximum (FWHM). The ligand and divalent complexes of Mn(II), Ni(II), and Zn(II) were found to be 21.53, 37.030, 39.4341, and 34.89 nm, respectively, which inferring their nanocrystalline nature [28].

3.7. Thermogravimetric analysis

Thermogravimetric analysis is a tool to evaluate the thermal stability of complexes in terms of mass loss with respect to the variation of temperature and provide information about compositions, fragmentation patterns, and the presence of water of hydration as well as crystallization in the complexes. In the presence investigation, TG-DTG analysis of the H_2L ligand and its metal complexes was carried out under N_2 atmosphere in the temperature range of 40-800 °C with a linear heating rate 20 °C/min. Thermogravimetric analysis results are summarised in Table 5.

TG plot of ligand shows a one-step decomposition pattern and exhibits a broad endothermic peak (DTG_{max}), *ie,* T_{max} = 375 °C, ΔH = 196.3 kJ/mol with mass loss of 63.83% (Theor. 63.87%) due to the loss of one fragmented organic species ($-C_7H_{24}N_4O_3$). Further continuous heating up to 707 °C, the ligand undergoes complete decomposition and the thermogram becomes horizontal, which may possibly be due to the formation of the carbon residue 33.17%, (Theor. 36.13%).

The TG/DTG curve of the $[Cr(L)(Cl)(H_2O)_2]$ complex shows a broad peak (DTG_{max} = 130 °C) in the first decomposition step with a mass loss of 8.40% (Calc. 8.38%) corresponding to the elimination of two coordinated water molecules. In the second stage, a mass loss of 9.09% occurred (Calc. 8.49%) at ~250 °C (DTG_{max}) which corresponded to the removal of one mole of chloride ion. In the third stage of degradation, mass loss of the non-coordinated part of the ligand is observed at 62.08% (Calc. 62.04%) at ~450 °C and finally, the TG curve attains a horizontal level corresponding to the formation of stable metal oxide ($½Cr_2O_3$) [29,30].

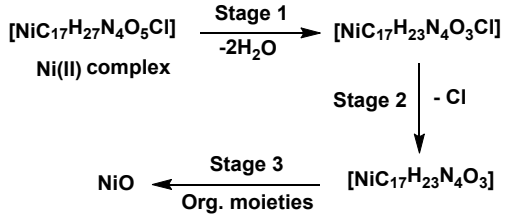
The TG/DTG curve of the $[Mn(HL)(Cl)(H_2O)_2]$ complex accounted for a mass loss of 8.00% (Calc. 7.86%) at ~110 °C (broad, DTG_{max}), due to the removal of coordinated water ($2H_2O$) molecules per mole of complex, whereas in the second decomposition step (DTG_{max}) at 249 °C complex shows a mass loss of 8.68% (Calc. 8.41%) corresponds to the loss of one chloride ion. The third decomposition step was observed around at ~390 °C with a mass loss of 75.57% (Calc. 74.00%) corresponding to the left of the maximum part of the coordinated ligand. At the end of the thermogram, it attains a horizontal plateau with residue left about 7.75% (Calc. 9.73%) as a stable metal oxide.

The thermogram of the $[Fe(L)(Cl)(H_2O)_2]$ complex exhibits mass loss ~7.86% (calc.7.86 %) at 100 °C broad (DTG_{max}) which is attributed to the loss of two coordinated water molecules from its coordination, while in 2nd step of decom-position at temperature 260 °C (DTG_{max}) with a mass loss 7.94% (Calc. 7.92%) corresponding to the elimination of one-mole chloride molecule. The 3rd stage of pyrolysis was observed at 360 °C with a mass loss of 64.24% (Calc. 64.22 %), which was attributed to the elimination of organic parts and was found at 20.01% (Calc. 20.00%) left as a $½Fe_2O_3$ residue.

The TG/DTG curve of the $[Co(HL)(Cl)(H_2O)_2]$ complex shows three steps decomposition in the temperature range of 45-750 °C. The first step of pyrolysis at 130 °C shows a mass loss of 5.98% (Calc. 7.77%) due to the loss of two coordinated molecules from its coordination sphere, whereas, in the second step, DTG_{max} at ~250 °C with a loss of mass of 7.82% (calc. 8.33%) corresponds to one molecule of chloride ion. With continued further heating, 3rd stage pyrolysis occurred within the temperature range between 320-600 °C with a maximum mass loss of 62.5% (Calc. 61.76%) corresponding to the organic parts of ligand. At the end of the thermal reaction, the formation of cobalt oxide was 23.70% (Calc. 22.14%).

Table 5. Stepwise thermal analysis data of the ligand and its metal(II/III) complexes.

Compounds	TG range (°C)	Derivative TG (°C)	Mass loss (%)		Fragmented species / Residue assignments
			Experimental	Theoretical	
H_2L	44-375	375	66.83	63.87	Removal of $C_7H_{24}N_4O_3$ species
	375-707	-	33.17	36.13	Organic residues
$[Cr(L)(Cl)(H_2O)_2]$	45-130	130	8.40	8.38	Removal 2×H_2O molecules
	130-252	249	9.10	9.09	Removal of Cl ion
	252-451	451	62.08	62.04	Removal of organic parts
	410-700	-	20.42	20.40	Residue of $1/2Cr_2O_3$
$[Mn(HL)(Cl)(H_2O)_2]$	45-110	110	8.00	7.86	Removal of coordinated 2×H_2O molecules
	110-255	249	8.68	8.41	Removal of one Cl ion
	255-380	379	75.57	74.00	Removal of organic parts
	380-700	-	7.75	9.73	Residue of MnO
$[Fe(L)(Cl)(H_2O)_2]$	45-110	100	7.86	7.86	Removal of coordinated 2×H_2O molecules
	110-390	260	7.94	7.92	Removal of Cl ion
	390-610	390	64.24	64.22	Removal of organic parts
	610-800	-	20.01	20.00	Residue of $1/2Fe_2O_3$
$[Co(HL)(Cl)(H_2O)_2]$	45-110	130	5.98	7.77	Removal of coordinated 2×H_2O molecules
	110-252	251	7.82	8.33	Removal of Cl ion
	252-320	320	62.50	61.76	Removal of organic parts
	320-807		23.70	22.14	Residue of CoO
$[Ni(HL)(Cl)(H_2O)_2]$	45-130	100	7.07	7.05	Removal of coordinated 2×H_2O molecules
	130-289	270	12.71	9.60	Removal of Cl ion
	289-450	390	64.43	64.25	Removal of organic parts
	450-753	-	15.78	19.10	Residue of NiO
$[Cu(HL)(Cl)(H_2O)_2]$	45-130	120	7.50	7.49	Removal of coordinated 2×H_2O molecules
	130-320	270	8.30	8.22	Removal of Cl ion
	320-630	330	64.20	63.99	Removal of organic parts
	630-776	-	20.00	19.95	Residue of CuO
$[Zn(L)(H_2O)]$	45-240	130	9.97	9.81	Removal of coordinated H_2O molecule
	240-650	650	69.01	69.00	Removal of organic parts
	650-750	-	21.02	20.81	Residue of ZnO



Scheme 2. Schematic representation of thermal degradation of Ni(II) complex.

The TG/DTG curve of the $[Ni(HL)(Cl)(H_2O)_2]$ complex showed three intense (DTG_{max}) endothermic peaks at 100, 270, and 390 °C exhibiting three-stage decomposition DTG_{max} at 100 °C with a loss of mass of 7.07% (Calc. 7.05%) with the removal of two coordinated molecules, in the 2nd step decomposition, at 270 °C with a mass loss 12.71 % (Calc. 9.60%) by the removal of fragments of one chloride ion. The 3rd degradation stage at 390 °C shows a maximum mass loss of 64.43% (Calc. 64.25%) of the organic parts of the ligand. The residue was left as NiO with 15.78% (Calc. 19.10%). The thermal degradation pattern for the Ni complex is presented in Scheme 2.

The TG curve of $[Cu(HL)(Cl)(H_2O)_2]$ complex shows a mass loss of 7.50% (Calc. 7.49%) at 120 °C, which accounted for the loss of two coordinated water molecules. The second step involves a mass loss of 8.30% (Calc. 8.22%) at DTG_{max} = 270 °C and this may attribute a loss of one chloride ion. In third decomposition step, involves a mass loss of 64.20% (Calc. 63.99%), at 330 °C which confirms the loss of organic parts of ligand, and finally, the thermogram became horizontal which possibly indicates the formation of stable copper oxide residue 20.00% (Calc. 19.95%).

The $[Zn(L)(H_2O)]$ complex displayed two-stage decomposition in which one small and another broad decomposition DTG_{max} at 130 °C for loss of one water coordinated/lattice water 9.97% (Calc. 9.81%) and the loss of organic moiety DTG_{max} at 650 °C was found (69.01% (Calc. 69.00%) in the temperature range of 400-650 °C. The formation of ZnO as the final residue was found to be 21.02%, nearly equal to the theoretical values (20.81%). The presence of water molecules was confirmed by the appearance of IR frequencies in the 820-850 cm^{-1} in the coordination, as well as the presence of chloride ions, by the Volhard estimation of these metal complexes [31,32].

We have attempted to predict the thermal stability of metal complexes on the basis of third-step decompositions and found to be Co < Cu < Mn < Fe ≅ Ni < Cr < Zn. All the physicochemical studies suggest the structure of three sets of complexes as proposed in Scheme 3.

3.8. Kinetic parameters of thermal decomposition (Coats-Redfern method)

The thermo-kinetic parameters activation energy (E_a), entropy (ΔS), enthalpy (ΔH), and free energy (ΔG) for the thermal decomposition reactions of the complexes were evaluated from the TG curves by using the Coats-Redfern relation, and values are reported in Table 6. The decomposition rate of compounds was depending upon the temperature and complexity of the structure [33]. The degree of thermal decomposition (α) calculated on TG curve by means of

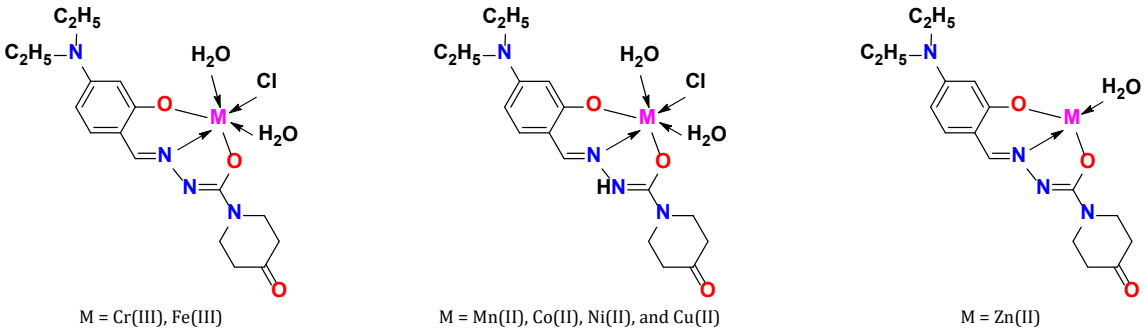
$$\alpha = \frac{Wi - Wt}{Wi - Wf} \quad (1)$$

whereas W_i, W_f, and W_t are the initial weight, final weight, and weight at a time, respectively. The activation energy (E_a) is calculated by Equation (2).

$$log\ \frac{[1-\alpha]^{1-n}}{[1-n]} = \frac{E_a}{2.303 \times R \times (T^2 \times S)} \quad (2)$$

Table 6. Calculated thermo-kinetic parameters for thermal degradation data for H_2L ligand and its di-and trivalent metal complexes (Coat-Redfern method).

Compound	Decomposition temperature (°C)	E_a (kJ/mole)	Z (s^{-1})	ΔS (J/mol/k)	ΔH (kJ/mole)	ΔG (kJ/mole)
H_2L	375	201.64	1.805×10^{2}	-16.50	196.3	207.0
$[Cr(L)(Cl)(H_2O)_2]$	130	10.87	2.01×10^{1}	-11.90	7.50	12.30
	250	23.09	2.11×10^{1}	-13.70	18.70	25.90
	450	140.94	2.34×10^{1}	-15.50	134.90	146.10
$[Mn(HL)(Cl)(H_2O)_2]$	110	18.80	2.01×10^{1}	-11.50	15.60	20.00
	380	186.32	2.05×10^{1}	-15.70	180.90	191.20
$[Fe(L)(Cl)(H_2O)_2]$	100	14.22	2.01×10^{1}	-11.30	11.10	15.30
	390	167.29	2.05×10^{1}	-15.90	161.80	172.30
	610	299.00	1.94×10^{1}	-18.70	307.00	290.70
$[Co(HL)(Cl)(H_2O)_2]$	130	20.81	2.01×10^{1}	-11.90	17.50	22.30
	250	107.69	2.04×10^{1}	-13.90	103.30	110.60
$[Ni(HL)(Cl)(H_2O)_2]$	100	18.61	2.01×10^{1}	-11.20	15.50	19.70
	270	115.91	2.04×10^{1}	-14.20	111.40	119.10
	390	712.15	2.21×10^{1}	-15.20	706.60	716.70
$[Cu(HL)(Cl)(H_2O)_2]$	120	12.40	2.01×10^{1}	-11.70	9.10	13.70
	270	91.46	2.03×10^{1}	-14.30	86.90	94.70
$[Zn(L)(H_2O)]$	130	23.09	2.01×10^{1}	-11.90	19.70	24.50
	650	74.11	2.02×10^{1}	-18.80	66.40	83.80



Scheme 3. Proposed structure of the metal complexes.

where 'α' denotes the degree of thermal decomposition and its conversion factors for mass losses, '*n*' denotes the order of reaction, Gas constant R = 8.314 (J/mol) and T^2S (K). The entropy of the thermal reaction was calculated by Equation (3),

$$\text{Entropy } (\Delta S) = 2.303\ R \times \log \frac{Z\times h}{K\times Tm} \quad (3)$$

where 'Z' denotes the frequency factor (s^{-1}); h is the Plank's constant (6.63×10^{-34} J.s); k denotes Boltzmann constant (1.3806×10^{-23} J/K); Tm was taken from the peak temperature in K. The enthalpy of reaction (ΔH) is indicating the amount of heat released or absorbed during the reaction and is calculated by Equation (4),

$$\Delta H = E_a\text{-}R\times T \quad (4)$$

Another important thermodynamic quantitative property, *i.e.,* free energy change of reaction (ΔG) of a system is calculated with this by Equation (5),

$$\Delta G = \Delta H - T\times\Delta S \quad (5)$$

where ΔH = Heat of reaction, T = Temperature (K), and ΔS = Entropy change. The values of the thermodynamic activation parameters for the ligand and its complexes revealed that the activation energy increased (E_a) 10.87 to 299 kJ/mol, suggesting that the high thermal stability of the compounds may be due to the covalency character of the M-L bond. The negative value of entropy of activation (ΔS) from -11.20 to -18.80 J/mol.K informed that the activated species have more structurally ordered than the dissociated ones and later was slower than the normal reaction rate. The negative values of entropy and the low-frequency factor (Z) were followed in the overall 1st, 2nd and 3rd step and finally resulted in stable metal oxide formation indicating slow decomposition, non-spontaneous nature and degree of structural 'complexity'. This was also supported by the positive value of the +ve (ΔG) values. The comparative order of parameters follows as $E_a < \Delta G \cong \Delta H$ which correlates with their thermal stability. The values of ΔH and the ΔG of the reaction were found in the range 7.50-706.60, and 13.70-207.00 kJ/mol, respectively, revealing that metal complexes showed more endothermic than exothermic as well as more thermally stable [34].

3.9. Fluorescence spectral study

The fluorescence emission spectra of H_2L and its complexes were recorded in the wavelength region of λ = 210-810 nm and the emission spectra are presented in Figure 3 and the data in Table 7. At the excitation state, the emitted band was measured in the emission slits having a width of 1.0 nm with the scan speed at a rate of 240 nm/min. The fluorescence emission intensity of the ligand and its $[Cr(L)(Cl)(H_2O)_2]$, $[Mn(HL)(Cl)(H_2O)_2]$, $[Co(HL)(Cl)(H_2O)_2]$ and $[Zn(L)(H_2O)_2]$ complexes were clearly indicated due to the active fluorophores group, *i.e.* an exchangeable azomethine proton (-C*H*=N-), functional (C=O) group in heterocyclic rings, the combined inhibition effects of photoinduced electron transfer (PET), static interaction by charge transfer from metal ion to fluorophore groups. The fluorescence emission band of the H_2L ligand and its metal complexes was observed with the varying wavelengths. The compounds have been induced from hyperchromic (blue shift) to bathochromic (red shift) which was resulting the intense fluorescent intensity (I_F) of 120, 109 a.u. at the wavelength $\lambda_{Excitation}$ 527, 524 nm of H_2L ligand and Mn complex, respectively.

Table 7. The fluorescence emission spectral data of the H_2L ligand and its divalent and trivalent metal complexes.

Compounds	Wavelength (nm)	Fluorescence emission intensity (a.u.)
H_2L	527	120.0
$[Mn(HL)(Cl)(H_2O)_2]$	524	109.0
$Cr(L)(Cl)(H_2O)_2]$	527	54.43
$[Co(HL)(Cl)(H_2O)_2]$	530	53.61
$[Zn(L)(H_2O)]$	544	22.74

Table 8. Antibacterial and antifungal assays of the H_2L and its divalent and trivalent metal complexes (mm.)

Compounds	Bacteria (Gram –ve)		Bacteria (Gram +ve)		Fungal species	
	E. coli (NCBI-0157)	*S. typhi* (NICM-2257)	*S. aureus* (NDCM-2257)	*B. subtilis* (NICM-2477)	*C. albicans* (MTCC-1637)	*A. niger* (NCIM-1005)
H_2L	08	09	10	10	11	09
$[Cr(L)(Cl)(H_2O)_2]$	10	10	11	12	12	10
$[Mn(HL)(Cl)(H_2O)_2]$	15	11	09	09	09	10
$[Fe(L)(Cl)(H_2O)_2]$	11	08	14	10	10	12
$[Co(HL)(Cl)(H_2O)_2]$	18	15	15	13	20	12
$[Ni(HL)(Cl)(H_2O)_2]$	16	16	14	19	15	15
$[Cu(HL)(Cl)(H_2O)_2]$	14	12	12	14	15	18
$[Zn(HL)(Cl)(H_2O)_2]$	19	20	14	17	25	13
Ofloxacin	30	30	-	-	-	-
Azithromycin	-	-	15	20	-	-
Fluconazole	-	-	-	-	28	30
DMSO	-	-	-	-	-	-

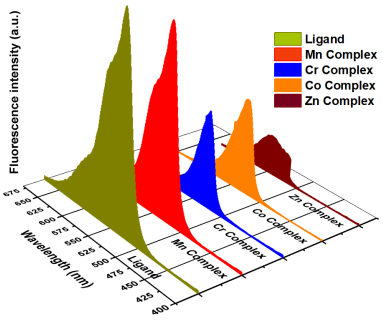


Figure 3. Comparative fluorescence emission spectra of the H_2L ligand with its metal(II) and metal(III) complexes.

The other three complexes of Cr, Co, and Zn also emitted significant fluorescent intensity (I_F) as 54.73, 53.61, and 22.74 a.u. at the wavelength of $\lambda_{Excitation}$ 527, 530, and 544 nm, respectively. On the basis of emission intensity of H_2L ligand was shown excellent fluorescent properties than to it's divalent and trivalent complexes and displayed the increasing order of Zn < Co < Cr < Mn < H_2L ligand [35,36]. The experi-mental emission data revealed that the hydrazone compound and its metal(II) and metal(III) complexes are good fluorescent components that may be used in photochemical applications and the detection of heavy metal ions in biological samples. The other Fe, Ni, and Cu complexes of this series were analyzed for fluorescence properties; however, they were referred to as nonfluorescent components due to negligible emission.

3.10. Evaluation of antimicrobial activities

The important aim was to the synthesis of *N*'-(4-(diethyl amino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazide ligand and it's metal complexes for testing *in vitro* antibiotic susceptibility for future biological applications. The antimicrobial activities were performed against selected bacterial (cocci) strains (Gram–ve): *Escherichia coli* (NCBI-0157), *Salmonella typhi* (NICM-2257); Gram +ve bacterial cocci: *Staphylococcus aureus* (NDCM-2257), *Bacillus subtilis* (NICM-2477) and fungal species of *Candida albicans* (MTCC-1637), *Aspergillus niger* (NCIM-1005) at a concentration of 1.0 mg/mL employing the disc-diffusion antibiotic culture-base test [37,38]. The culture-based microbiological assay was carried out in the diagnostic laboratory. The DMSO solvent was used as –ve control in the biological reaction. The potentiality of newly synthesized compounds was compared with the standard drugs *viz*. ofloxacin, azithromycin, and fluconazole regarded as a +ve control. The inhibition zone growth of microorganisms was studied after ~24 hours of the incubation period. The signify-cant result was found due to the presence of two ethyl groups in the bonding of nitrogen in the amino group, *i.e.* $(C_2H_5)_2$-N- in all the compounds which lead to decelerating the cluster growth of microorganisms [39]. The antibacterial and anti-fungal results data of the H_2L hydrazone ligand and its metal(II) and metal(III) complexes are summarized in Table 8. The inhibition zone data suggest pathogenic Gram +ve cocci bacteria, *i.e. Staphylococcus aureus* and *Bacillus subtilis* are found more sensitive than Gram -ve cocci bacteria *viz. Escherichia coli* and *Salmonella typhi*. Such group specificity may be due to an increase in lipophilicity upon complex formation. The coordination of metal ions increases activity upon coordination with the H_2L ligand was described on account of Tweedy's theory of chelation [40,41]. The partial sharing of the metal(II) and metal(III) ions with the ligand results the in the reduction of polarity which increases lipid solubility and leads to favor in entering into the normal cell of microorganisms [42,43]. Within the fungi, *Candida albicans* are moderately active compared to *Aspergillus niger*. The group of azomethine (C=N) acting in the exchanging of the proton to the metal complexes enhances the destroying capacity of the pathogenic microbial colonies of clusters and chain forms. It was found that the Cu complex played as a competent agent among all compounds inhibiting the growth of *A. niger* from the fungal species. The Co complex showed better activity than the Ni complex, which may be due to the varied morphological structures of the two fungi. In the antibacterial and antifungal studies of the H_2L ligand and its transition complexes showed a broad spectrum activity by the growing resistance to micro-

organisms and may be used as a potent antimicrobial agent in biological sciences [44-46].

4. Conclusions

The metal(II) and metal(III) complexes were synthesized from the reaction of the heterocyclic *ONO* donor *N*'-(4-(diethyl amino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazide ligand and with metal chlorides salts. The structural skeleton of the ligand was confirmed by spectroscopic and analytical methods. The newly synthesized mononuclear transition metal complexes are of three types *viz*. $[M(L)(Cl)(H_2O)_2]$ [M = Cr and Fe], $[M(HL)(Cl)(H_2O)_2]$ (M = Mn, Co, Ni, and Cu) and $[Zn(L)(H_2O)]$. The spectral, analytical, and thermal analysis data have confirmed the suitable geometry of all new complexes. The infrared spectra, absorption-emission spectra, ESR (Cu complex), and magnetic susceptibility data authenticcate that the bonding mode of the H_2L ligand through three donor *ONO* atoms with the metal ion the structure and assigned octahedral structure to each of $[Cr(L)(Cl)(H_2O)_2]$, $[Mn(HL)(Cl)(H_2O)_2]$, $[Fe(L)(Cl)(H_2O)_2]$, $[Co(HL)(Cl)(H_2O)_2]$, $[Ni(HL)(Cl)(H_2O)_2]$, $[Cu(HL)(Cl)(H_2O)_2]$, complexes whereas tetrahedral geometry to the $[Zn(L)(H_2O)]$ complex. On the basis of the ESR spectral data, the Cu(II) complex indicated more the π-bonding covalency than σ-bonding in the octahedral region. The powder XRD study has shown the nanocrystalline nature of the complexes. The kinetic data of thermal decomposition were evaluated from the Coats-Redfern relation, indicating that complexes show more ordered structures and are thermally stable at high temperature. The fluorescence emission spectral data of the four compounds demonstrated good fluorescent components and are recommended for use in photochemical applications. The hydrazone ligand and its metal(II) and (III) complexes show better potential activities in antibacterial screening against species of *Staphylococcus aureus*, *Salmonella typhi*, *Bacillus subtilis*, *Escherichia coli*, and fungal species of *Candida albicans* and *Aspergillus niger*. The zone of inhibition data suggests that all divalent and trivalent metal complexes are exhibiting more broad-spectrum activity than the free hydrazone Schiff base ligand, and are represented as potent antimicrobial agents for biological applications.

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Sample availability: Sample of the compounds are available from the author.

CRediT authorship contribution statement

Conceptualization: Anand Shankarrao Aswar; Methodology: Gajanan Mahadu Dongare; Software: Gajanan Mahadu Dongare; Validation: Anand Shankarrao Aswar; Formal Analysis: Gajanan Mahadu Dongare; Investigation: Gajanan Mahadu Dongare; Resources: Gajanan Mahadu Dongare; Data Curation: Anand Shankarrao Aswar; Writing - Original Draft: Gajanan Mahadu Dongare; Writing - Review and Editing: Gajanan Mahadu Dongare; Visualization: Gajanan Mahadu Dongare; Funding acquisition: Gajanan Mahadu Dongare; Supervision: Anand Shankarrao Aswar; Project Administration: Anand Shankarrao Aswar.

ORCID and Email

Gajanan Mahadu Dongare
infogmdongare@gmail.com
https://orcid.org/0000-0002-3986-9796
Anand Shankarrao Aswar
aswaranand@gmail.com
https://orcid.org/0000-0003-4368-496X

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CONTENTS OF MARATHI PART - I

अ.क्र.	लेख आणि लेखकाचे नाव	पृष्ठ क्र.
१	भारतीय राज्यघटनेची ठळक वैशिष्ट्ये **प्रा. समाधान नारायण दराडे**	१-५
२	वर्धा जिल्ह्यातील माध्यमिक शाळांमध्ये राबविण्यात येणाऱ्या पर्यावरणविषयक शैक्षणिक उपक्रमाचा चिकित्सक अभ्यास **डॉ. जी. व्ही. जैन**	६-११
३	जयप्रकाश नारायण यांचे सर्वोदयासंबंधी विचार **प्रा. डॉ. उमाकांत ज्ञानोबा वानखेडे**	१२-१५
४	आधुनिक अर्थव्यवस्थेसाठी अच्युत गोडबोले यांच्या आर्थिक विचारांची आवश्यकता एक अभ्यास **राधेशाम नंदकिशोर कुमठेकर** **गोरोबा तुकाराम खुरपे**	१६-२२
५	पत्रकारिता : माध्यमांचा जनसंवाद **डॉ. विशाखा संजय कांबळे**	२३-२८
६	महाराष्ट्रातील ओ.बी.सी चे राजकारण **कोंडीबा रमेश पडोळे** **प्राचार्य डॉ. पंजाब चव्हाण**	२९-३३
७	भारतीय अभिजात संगीतामध्ये पं. वि. ना. भातखंडे यांचे अतुलनीय योगदान **प्रा. हर्षवर्धन कृष्णराव मानकर** **प्रा. डॉ. कुणाल इंगळे**	३४-३९
८	आधुनिक काळात भारतीय पारंपारिक खेळातील समस्या **डॉ. प्रमिला हरीदास भुजाडे (गणवीर)**	४०-४४
९	जात आणि धर्माचे राजकीयकरण **गीता शंकर गाडेकर**	४५-४८
१०	प्रौढशिक्षण : सुलभ दृष्टीकोन तयार करणे **अशोक रामकृष्ण तवर** **प्रा. डॉ. जी. एस. कांबळे**	४९-५५
११	माध्यमिक विद्यालयीन विद्यार्थिनीकरिता आरोग्यविषयक जाणीवजागृती कार्यक्रमाचे विकसन व परिणामकारकता **डॉ. श्रीमती बी.के. पांडव (सरोज नवपुते)**	५६-५८

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७. भारतीय अभिजात संगीतामध्ये पं. वि. ना. भातखंडे यांचे अतुलनीय योगदान

प्रा. हर्षवर्धन कृष्णराव मानकर
संशोधन शोधार्थी, संगीत विभाग, मुंबई विद्यापीठ, मुंबई.
प्रा. डॉ. कुणाल इंगळे
मार्गदर्शक, संगीत विभाग प्रमुख, मुंबई विद्यापीठ, मुंबई.

प्रस्तावना

भारतीय अभिजात संगीताचे शिक्षण, घराण्यांमधून पूर्वापार चालत आलेल्या पारंपरिक गुरुकुल पद्धतीने दिल्या जात होते. घराण्यांतून दिले जाणारे हे संगीत हस्तगत करणे सर्वसामान्यांच्या आवाक्यातली बाब नव्हती. भारतात स्थापन झालेल्या संस्थागत शिक्षण पद्धतीतूनही संगीत शिकविल्या जाण्याची कोणतीच सोय अद्याप केल्या गेली नव्हती. त्यामुळे संगीत शिक्षणाच्या नावावर केवळ घराण्यांचेच वर्चस्व राहिले होते. संगीत शिक्षण म्हटले, तर घराण्यांविना दुसरा कोणताच इलाज उरलेला नव्हता. इतकेच काय, तर घराण्यांतील गायकांचे गाणे ऐकणेही बहुसंख्यकांसाठी जवळ जवळ दुर्लभच होते. अशा परिस्थितीत, भारतीय अभिजात संगीताची धारा सर्वसामान्यांसाठी उपलब्ध करून देण्याच्या दृष्टीने, तसेच संगीत कलेचे प्रत्यक्ष सादरीकरण व या कलेच्या तात्त्विक बाजूमध्ये असलेली विसंगती दूर करून, संगीताचा सर्वमान्य सैद्धांतिक पक्ष पुनर्प्रस्थापित करण्याच्या दृष्टीने अभूतपूर्व कामगिरी करण्याचे महान कार्य पंडित विष्णू नारायण भातखंडे यांनी केले.

पं. भातखंडेंचे पूर्ण नाव विष्णू नारायण भातखंडे उर्फ विष्णू शर्मा असे होते. त्यांचा जन्म १० ऑगस्ट १८६० साली झाला. संगीताप्रती ओढ त्यांना लहानपणापासूनच होती. त्यामुळे त्यांना संगीताचा छंद जडला होता. त्यांच्या वडिलांनीही त्यांच्या या छंदाचा कधी विरोध केला नाही. आपल्या या संगीत छंदाची जोपासना करता आल्यामुळेच त्यांना शालेय जीवनात गायनासंबंधीची अनेक पारितोषिके मिळविता आली. बासरी आणि सितार वादनातही प्रगती साध्य करता आली. सन १८८० साली ते मॅट्रिकची परीक्षा पास झालेत. त्यांच्या सांगीतिक वाटचालीच्या दृष्टीने, भावी आयुष्यात जे महान कार्य त्यांच्या हातून घडणार होते त्याला प्रेरक होईल अशी घटना, सन १८८४ च्या तेवढ्यात घडली. या काळात त्यांचा संपर्क मुंबई मधील 'गायनोत्तेजक मंडळी' नावाच्या संस्थेशी झाला. हे मंडळ मुंबईतील धनाढ्य अशा पारशी लोकांच्या पुढाकाराने चालविले जात असे. या मंडळाद्वारे घराणा परंपरेतील गायक- वादकांची मासिक वेतनावर नेमणूक केली जात असे. त्यामुळे आपल्या सांगीतिक जिज्ञासू प्रवृत्तीला वाट मोकळी करून देण्याच्या दृष्टीने हे मंडळ भातखंडेंना उपयुक्त वाटले. या दृष्टीने ते या संस्थेचे सदस्य झालेत. त्यावेळी दक्षिण हैदराबादच्या झैनुलाबुद्दीन खांचे शिष्य असलेले, श्री. रावजीबुवा बेलगावकर हे सुविख्यात धृपद गायक या मंडळात नोकरीला होते. रावजीबुवांच्या शिष्यत्वात राहून, भातखंडेंनी त्यांच्याकडून जवळ- जवळ तीनशे धृपद शिकून घेतले होते. पुढे सन १८८७ साली

नी वकिलीची परीक्षा उतीर्ण केली आणि जीवनव्यापनाचे साधन म्हणून यालाच पेशा स्वीकारून, वकिलीचा व्यवसाय त्यांनी रू केला. एकीकडे पेशा तर, दुसरीकडे संगीत कलेसंबंधीची आपली ओढ, अशी दुहेरी बाजू सांभाळून त्यांचे मार्गक्रमण सुरू ते पुढे या गायन उत्तेजक मंडळात असताना गायकांना प्रशिक्षण देण्याकरिता संगीतवर्ग देखील ते चालवीत असत. सन १८९५ ली रावजीबुवांचा मृत्यू झाला. पण ते थांबले नाहीत. त्यांच्या मृत्यूनंतर सारंगी वादक नझीर खां, त्यानंतर ग्वाल्हेर घराण्याचे गायक ग गणपतीबुवा भिलवडीकर, उस्ताद अली हुसैन खां व त्यांचे चुलते उस्ताद विलायत हुसैन खां अशी गायनोत्तेजक मंडळातील ळी नोकरीपेशा मंडळी, त्याच बरोबर त्यावेळी मुंबईत वास्तव्यास असलेले ख्याल गायक आशिक अली खां व त्यांचे वडील म्मद अली खां या सगळयांचे भातखंडेंनी शिष्यत्व स्वीकारून, त्यांच्या कडून कधी पैसे देऊन, कधी त्यांचा स्नेह संपादन करून, कधी आपला इरादा पटवून, त्याचे विविध ख्याल, तराणे, ठुमरी, होरी आदी शिकून घेतले होते. तर, या चिजांची नोंद देखील निर्मित केलेल्या स्वरलीपीत त्यांनी करून ठेवली होती. भातखंडेंचा स्वभाव मुळातच जिज्ञासू प्रवृत्तीचा असल्यामुळे, नोत्तेजक मंडळीत कोणत्याही कलाकाराचा कार्यक्रम अत्यंत गांभीर्याने ते श्रवण करीत असत. अशा कलाकारांशी सांगीतिक र्चा देखील करीत आणि आपल्या सांगीतिक ज्ञानात भर घालीत असत. या व्यतिरिक, संगीत विषयावरील उपलब्ध संस्कृत, हिंदी, ठी, गुजराती भाषेतील वाङ्मय वाचणेही त्यांनी आरंभिले होते. तर, त्यातून काही महत्त्वपूर्ण गोष्टी आढळून आल्यास त्यांची नोंद न ठेवण्याची सवयही त्यांनी स्वतःला लावून घेतली होती. या सगळ्या गोष्टींचा परिणाम असा झाला की, संगीत विषयाच्या र्भात त्यांचे स्वतःचे काही दृष्टिकोन निर्माण झाले. आपल्या या संगीतविषयक विचारांना ते गायनोत्तेजक मंडळातील विविध र्यक्रमांतून मांडू लागलेत. शिवाय विविध रागांची रूपे प्रदर्शित करण्यासाठी अनेक लक्षणगीतांची रचनाही त्यांनी या काळात ली होती. गायनोत्तेजक मंडळीतील नझीर खां हे त्यांच्या सांगीतिक विचारांशी सहमत असून, भातखंडेंनी रचलेली लक्षण गीतेही नी त्यांच्याकडून शिकून घेतली होती. या सर्व प्रपंचात ते संगीत कलेशी ते इतके एकरूप झाले की, सन १९१० साली संगीत ाराच्या दिशेने कार्य करण्याचा निर्णय घेऊन, वकिलीचा व्यवसाय सोडून दिला.

संगीत कलेसंबंधीच्या आपल्या आत्यंतिक आत्मीयतेमुळेच, भातखंडे संगीत कलेच्या भवितव्याच्या दृष्टीने फार विचार क लागले होते. संगीत वाङ्मयाच्या वाचनातून त्यांना नव्याने तीव्रतेने जाणवू लागलेले, संगीताचे पूर्वकाळातील वैभव, तत्कालीन माज व्यवस्थेत संगीत कलेबद्दल असलेला आदरभाव, तत्कालीन शिक्षण पद्धतीतर्गत संगीताच्या शिक्षणातील सर्वसमावेशकता, र, त्याच्या विपरीत सद्यःस्थितीत संगीत कलेवर असलेले मोजक्याच लोकांचे आधिपत्य, संगीत कला ही व्यसनी व व्यभिचारी कांच्या जीवन व्यापनाचे साधन म्हणून, समाजातील लोकांच्या मनात या कलेविषयी निर्माण झालेला तिरस्कारभाव, संगीताचा कवर्गही थोडा व त्यातही संगीताची जाण असणाऱ्यांची संख्या अत्यल्प, असे अनेक प्रश्न त्यांच्या मनात घर करू लागले होते. ची कारणमीमांसा शोधताना उत्तरादाखल जी बाब त्यांच्या लक्षात आली, ती ही की, जोपर्यंत सर्वसामान्यांत संगीत शिक्षणाचा भाव आहे, तोपर्यंत या समस्येचे समाधान होणे शक्य नाही. त्यामुळे सरते शेवटी त्यांनी संगीत कलेची ही स्थिती बदलण्याचा

निर्धार केला आणि संगीतोद्धाराचे ध्येय्य उराशी ठेवून, संगीत कलेला यथोचित दिशा प्राप्त करून देण्याच्या प्रेरणेने कार्य करण्यास प्रारंभ केला.

संगीत शिक्षणाच्या संदर्भात त्यांचे विचार आधुनिक आणि सर्वसमावेशकतेच्या तत्त्वाला अनुसरून होते. त्यांनी ज्या शिक्षण पद्धतीतून आतापर्यंतचे शिक्षण घेतले होते, ती संस्थागत शिक्षण पद्धती होती. या शिक्षण पद्धतीचे सर्वसमावेशकतेचे तत्व त्यांना संगीत शिक्षणासंबंधाने इष्ट वाटले. म्हणून संस्थागत शिक्षण पद्धती मधून संगीताचे शिक्षण दिले गेले पाहिजे, असे त्यांना मनोमन वाटू लागले होते. त्यामुळे, यादृष्टीने कार्य करण्यासाठीचे प्रयत्न त्यांनी आरंभिले. संस्थागत पद्धतीतून शिक्षण घेतांना, प्रयोगजीवी विषयांसंबंधात प्रायोगिक व सैद्धांतिक अशा दोन्हीही पक्षांच्या दृष्टीने अभ्यास करणे गरजेचे असल्याचे त्यांनी बघितले होते. संगीत ही सुद्धा प्रायोगिक कलाच, तेव्हा या कलेचे शिक्षण संस्थागत पद्धतीतून प्रत्यक्ष सुरू करण्याअगोदर संगीत कलेचा सुद्धा या दोन्ही पक्षाच्या दृष्टीने अभ्यासक्रम आखल्या जाउन, तो निश्चित करणे अगत्याचे आहे, याची त्यांना जाणीव झाली. कारण संगीत शिक्षणाच्या नावावर जे काही शिकविले जाते आहे त्याला, या कलेचा प्रत्यक्ष उपयोग व तिचा सैद्धांतिक पक्ष यात एकसूत्रता असणे आवश्यक आहे, याची त्यांना जाणीव होती. त्यादृष्टीने उपलब्ध असलेल्या संगीतासंबंधीच्या विविध ग्रंथांमधून, सद्यस्थितीत प्रस्तुत केल्या जाणाऱ्या गायन- वादन कलेला काही तात्त्विक आधार मिळतो आहे का?, हेही तपासणे आवश्यक होते. त्यामुळे संगीत कलेच्या या दोन्ही पक्षांच्या दृष्टीने सूक्ष्मरीतीने अध्ययन करण्याचे त्यांनी ठरविले. त्यादृष्टीने उत्तर हिंदुस्थानी संगीत पद्धतीमधील पूर्वीपासून ते सद्यस्थितीपर्यंत उपलब्ध असलेल्या जवळ जवळ सगळ्याच ग्रंथांचे गंभीर अध्ययन ते करू लागले. पण, ग्रंथगत वर्णन आणि मैफिलींमधून प्रस्तुंत केली जाणारी कला यात त्यांना दुरावा आढळून आला. त्यामुळे अपेक्षित असलेली माहिती कदाचित इतर ठिकाणी मिळू शकेल, या विचाराने सन १९०४ ते १९०९ सालापर्यंत भारतातील विविध भागांत दौरे केलेत. संगीत कलेची केंद्रे असलेल्या विविध ठिकाणांना भेटी दिल्यात. पण, सादरीकरणातून प्रस्तुत केली जाणारी कला आणि ग्रंथांतील त्यासंबंधीचे तात्त्विक वर्णन यात जमीन- असमानाचे अंतर आहे, याच निष्कर्षाप्रत त्यांना यावे लागले. दक्षिण भारतातही त्यांचा दौरा झाला होता. त्यांना यापूर्वी अज्ञात असलेले तेथील संगीत विषयक वाङ्मयही यावेळी प्राप्त करता आले. हे वाङ्मय पुढे स्वतः त्यांनी प्रकाशित केले होते. यावेळी दक्षिण हिंदुस्थानी व उत्तर हिंदुस्थानी अशा दोन वेगवेगळ्या संगीत पद्धती अस्तित्वात असल्याचेही त्यांना पहिल्यांदाच कळले आणि त्यांनीच ही माहिती सर्वप्रथम समोर आणली देखील. भारतीय संगीतातील रागकल्पना आणि तिच्यातील दरवेळी वेगवेगळा अविष्कार करण्याची क्षमता याची कारणमीमांसा शोधावी व रागसंकल्पनांचे स्वरूप निश्चित करून, त्यांचे साधार विशदीकरण देखील मांडावे, अशी त्यांची योजना होती. त्यादृष्टीने आतापर्यंत केलेले संशोधन, चिकित्सा आणि संगीत श्रवण यांच्या माध्यमातून त्यांनी आपल्या ध्येयाला मूर्त रूप दिले. हे मूर्तरूप म्हणजे सन १९०९ साली प्रकाशित झालेला त्यांचा 'हिंदुस्थानी संगीत पद्धती' या ग्रंथाचा पहिला खंड होता. त्यांच्या या ग्रंथाचे एकूण चार खंड प्रकाशित झाले. या खंडांत संगीताची उत्पत्ती, रागांचे दहा थाटांमधील वर्गीकरण, श्रुतीसंबंधीचे त्यांचे विचार, प्रत्येक रागांचा मिळाला तेवढा इतिहास, कालानुरूप त्यांत होत गेलेले परिवर्तन, त्यांचे हल्लीचे स्वरूप, त्यांचे आलाप, स्थायी व अंतरा त्याच बरोबर त्यांचे विस्तार व त्यांच्या चिजांची

ील मांडणी अशी सविस्तर माहिती व तेही त्या रागांचे वर्णन करणाऱ्या मूळच्या संस्कृत श्लोकासह दिल्या गेली आहे. पुढे ४ च्या सुमारास 'हिंदुस्थानी संगीत पद्धती' या ग्रंथाचा दुसरा आणि तिसरा खंड प्रसिद्ध झाला. चौथा खंड सन १९३२ ाशित झाला. संगीत कलेचा प्रायोगिक पक्ष व सैद्धांतिक पक्ष या दोन्ही दृष्टीने आधारभूत होईल असा पाठ्यक्रम निश्चित ा, असा पं. भातखंडे यांचा संगीत शिक्षणासंबंधी दृष्टिकोन होता. तो दृष्टिकोन या ग्रंथाच्या निर्मितीच्या निमित्ताने केल्या संशोधनात्मक कार्यातून त्यांना सिद्ध करता आला. आपल्या संगीत शिक्षणविषयक दृष्टिकोनातून आदर्श होईल, असा आतापर्यंतच्या सांगीतिक चिकित्सेच्या आधारे ते करू शकत होते. 'हिंदुस्थानी संगीत पद्धती' या ग्रंथाच्या प्रकाशनामुळे ांगीतिक कार्याची महती संगीतकला विश्वात पसरत गेली होती. त्यांची ही महती, त्याकाळातील संगीताचे विविध संगीतकार, गायक, वादकांसह, संगीतप्रेमी असलेल्या विविध संस्थानिकांपर्यंत सुद्धा पोहोचली. जसे- रामपूरचे नवाब, उत्तरप्रदेशच्या अकबरपूरचे राजा नवाब अली खान, अशा कलाप्रेमी असलेल्या विविध संस्थानिकांपर्यंत भातखंडेंच्या कार्याची महती पोहचू लागली होती. त्याच दरम्यान भातखंडेंच्या संगीत कार्याबद्दलची माहिती बडोदा संस्थानचे महाराजा ा गायकवाड यांच्याही कानावर पडली. याकाळात महाराजा आपल्या संस्थानातील सरकारी संगीत विद्यालयाच्या नेसंबंधी विवंचनेत होते. कारण, आतापर्यंत त्यांच्या संस्थानातील संगीत विद्यालयाच्या व्यवस्थापनेची जबाबदारी, गीस्से खां यांच्या देखरेखीत उत्तम रीतीने पार पडली होती. पण, त्यांच्या मृत्यूनंतर ही जबाबदारी पार पाडताना संगीत चांगल्या सल्लागारांची महाराजांना आवश्यकता भेडसावत होती, म्हणून महाराजांनी आपल्या विद्यालयाच्या नेकरिता भातखंडेंना आपल्याकडे बोलावून घेतले, आणि त्यांच्या सल्ल्यानुसार, सदर विद्यालयाच्या शिक्षण पद्धतीत घडवून आणल्या. दरम्यान, सयाजीरावांनी भातखंडे यांच्याशी संगीतविषयक अनेक बाबींवर चर्चा केल्यात. त्यांचे यक विचार समजून घेतलेत, विचारणा केली की, सद्यःस्थितीत भारतीय संगीताला काही तत्त्वप्रणाली आहे का, त्याकरिता ेल अशी स्वरलिपी व क्रमिक पुस्तके उपलब्ध आहेत का, पण, उत्तरादाखल भातखंडे यांनी सत्य परिस्थिती कथन करीत, ादक कलावंत आणि संगीतशास्त्र यांच्यात एकवाक्यता निर्माण झाल्याखेरीज, भारतीय शास्त्रीय संगीताला तात्त्विक प्रमाण ठीण आहे, असे आपले मत व्यक्त केले. महाराजांना ही बाब लक्षात आली, आणि हिंदुस्थानातील सर्व गायक व रांना एकत्र आणून त्यांच्यात, संबंधित बाबी संबंधी चर्चा घडवून आणून, संगीत विषयाला आवश्यक असे शास्त्ररूप देण्याची त्यांची कल्पना त्यांनी भातखंडेंच्या पुढे मांडली. भातखंड्यांनी ताबडतोब महाराजांना संमती दर्शविली. आणि सूचनेनुसार संगीत परिषदेची योजना तसेच त्यासाठीच्या कार्यक्रमाची आखणी केली. व बडोदा येथे अखिल भारतीय संगीत पहिले अधिवेशन सन १९१६ साली घडवून आणले. ज्यात, संगीत विषयक निबंध वाचन, चर्चा व गायनाचे कार्यक्रम रण्यात आले. या परिषदेत एक स्थायी स्वरूपाचे कार्यकारी मंडळ देखील स्थापन करण्यात आले असून, भातखंड्यांना त्या सरचिटणीस म्हणून योजल्या गेले होते. सदर परिषदेदरम्यान, 'उत्तर हिंदुस्थानातील संगीताचे ऐतिहासिक दृष्टिकोनातून ' या इंग्रजी भाषेतील विद्वत्तापूर्ण अशा निबंधाचे वाचनही भातखंडे यांनी केले होते. अशा संगीत परिषदेची पुढील

अधिवेशने, दिल्ली, बनारस तसेच लखनौ या ठिकाणी आयोजित करण्यात आली होती. सन १९१८ साली, दिल्ली येथील अधिवेशनात, शास्त्रीय संगीतातील राग नियमांबाबत, हजर असलेल्या गायकांमध्ये पहिल्यांदाच एकवाक्यता निर्माण झाली होती. या सगळ्या सर्वसंमत नियमांचा उल्लेख भातखंडेंनी आपल्या 'हिंदुस्थानी संगीत पद्धती' या ग्रंथाच्या चौथ्या खंडात केला. लखनौ येथील अखिल भारतीय संगीत परिषदेच्या पाचव्या अधिवेशनाच्या वेळी, संगीताची शिक्षण संस्था स्थापन करण्याचा निर्णय घेण्यात आला होता. पुढे चालून याच संस्थेचे नामकरण 'मॉरिस कॉलेज ऑफ हिंदुस्थानी म्युझिक' असे केल्या गेले. या कॉलेजमधील संगीतविषयक अभासक्रम व शिक्षण पद्धती याबाबतची तपशीलवार योजना देखील भातखंड्यांनीच तयार केली होती. सदर विद्यालयात शिक्षक म्हणून निष्णात गायक- वादकांची नेमणूक केल्या गेली. तर, संगीताचे उत्तम जाणकार व यशस्वी संगीत शिक्षक म्हणून ज्यांची ख्याती होती, असे भातखंडे यांचे शिष्य श्रीकृष्ण रातंजनकर यांची प्रिन्सिपॉल म्हणून नेमणूक करण्यात आली. ज्यांच्या उत्तम मार्गदर्शनाखाली पुढे अनेक शिक्षक तयार झालेत. सन १९१७ साली काही कारणावरून भातखंडेंचे गायनोत्तेजक मंडळीतील सदस्यांशी मतभेद निर्माण झाले होते, ज्यामुळे गायनोत्तेजक मंडळीशी त्यांचे संबंध संपलेत. पण, संगीत कलेच्या संबंधात शैक्षणिक दृष्टीने कार्य करण्याचे त्यांनी आपल्या मनाशी ठरविले होते. त्यामुळे त्यांनी आपल्या पारशी मित्रांच्या सहयोगाने स्थापन केलेल्या 'गुड लाईफ' या संस्थेच्या फ्लोरा फाउंटेन या ठिकाणच्या कार्यालयात 'श्री शारदा संगीत मंडळ' ही संस्था सुरू केली. अशाप्रकारे संस्थागत शिक्षण पद्धतीतून संगीत कलेच्या शिक्षणासाठी कार्य करण्याची आपली वाटचाल त्यांनी सुरूच ठेवली होती. या संस्थेतील अभ्यासक्रम, शिक्षण पद्धती सर्व त्यांनीच ठरविले होते. अल्पावधीतच ही संस्था फार लोकप्रिय देखील झाली होती. सन १९१७ दरम्यानच ग्वाल्हेरचे महाराजा शिंदे यांचेही भातखंडेंच्या संगीत शिक्षणासंबंधीच्या हालचालींकडे लक्ष वेधल्या गेले होते. महाराजांनी मुंबईत असताना भातखंड्यांच्या शिक्षण पद्धतीचे प्रत्यक्ष अवलोकन केले होते. त्यामुळे ग्वाल्हेरमध्ये सुद्धा भातखंडेंच्या या शिक्षण पद्धतीनुसार शिक्षण देणारे एक विद्यालय स्थापन व्हावे, अशी त्यांची इच्छा होती, जी महाराजांनी भातखंड्यांसमोर प्रकट केली. त्याला भातखंड्यांनीही आवर्जून संमती दर्शविली. ग्वाल्हेरला स्थापन झालेल्या 'माधव संगीत विद्यालय' नावाच्या विद्यालयाच्या संचालानाकरिता तेथील संगीताचा अभ्यासक्रम, शिक्षण पद्धती, त्याचे शास्त्र व प्रत्यक्ष गायन तसेच त्याच्यासाठीच्या परीक्षा इत्यादींसाठी व्यापक योजना भातखंडेंनीच तयार केली. आणि महाराजांच्या सल्ल्यानुसार त्यांच्या संस्थानातील गायकांची सदर विद्यालयासाठी शिक्षक म्हणून निवड करून, त्यांना आपल्या मुंबईतील वर्गात प्रशिक्षित केले. यासाठी लागलेला सगळा खर्च महाराजांनी केला होता. सदर विद्यालयाच्या शिक्षणक्रमाला अनुसरणाऱ्या पाठ्यपुस्तक निर्मितीची जबाबदारीही साहजिकच भातखंड्यांकडेच होती. ही जबाबदारी पूर्ण करण्याच्या अनुषंगानेच, आज संगीत अध्ययनासाठी आपणा सर्वांना उपयोगी ठरत असलेल्या, क्रमिक पुस्तक मालिकेचा जन्म संभव झाला. सन १९१७ ते १९३६ पर्यंत या क्रमिक पुस्तक मालिका सहा भागांमध्ये प्रसिद्ध होत गेल्या, ज्यातील प्रत्येकात संगीत विषयक तात्त्विक विवेचन, रागांचे वर्णन, स्वरलिपीच्या माध्यमातून त्या चिजांचे विशदीकरण तसेच स्वरविस्तार, रागांची वैशिष्ट्ये कथन करणारी लक्षणगीते व या सगळ्यांची दहा थाटात विभागणी एवढी सगळी माहिती सविस्तरपणे देण्यात आली आहे. या सहा मालिकेत एकूण १३०० पेक्षा जास्त गायकीतील

जांचा लक्षणगीतांसह समावेश केलेला आहे. शेवटी सन १९३६ सालीच १९ सप्टेंबरला भातखंडे यांचा देह शांत झाला आणि यूने त्यांना कवटाळून घेतले. आयुष्यभर त्यांनी केवळ संगीताचीच सेवा केली. संस्थागत शिक्षण पद्धतीच्या माध्यमातून संगीत क्षणाची वाट सर्वसामान्यांना उपलब्ध होण्यासाठी आवश्यक असलेला शिक्षणक्रम तयार करून, भावी पिढीला संगीत ध्ययनासाठी उपयुक्त होईल, अशा अनेक संगीतपर ग्रंथांची निर्मिती त्यांनी केली. संगीताचे वाचन आणि लिखाण करता यासाठी स्वरलिपी तयार केली, जी प्रामुख्याने आज उपयोगी आणली जाते. पूर्व काळापासून उपलब्ध असलेल्या जवळपास ाळयाच ग्रंथांचे त्यांनी गंभीर अध्ययन केले, आणि सर्वमान्य असे शास्त्र उपलब्ध करून, भावी पिढीतील संगीत अभ्यासक, ोधक, संगीत जिज्ञासू, कलावंत, विद्यार्थी अशा सर्वांवर थोर उपकार केले. त्यांच्या उपकारांना संगीत क्षेत्रातील मंडळी कधीच सरू शकणार नाहीत. ते भातखंडे यांचे सदासर्वदा ऋणी राहतील.

र्भसूची

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CONTENTS OF MARATHI P

	लेख व लेखकाचे नाव
संस्थांच्या निर्मितीमध्ये पं. विष्णू दिंगबर पलुस्करांचे योगदान	प्रा. हर्षवर्धन कृष्णराव मानकर प्रा. डॉ. कुणाल इंगळे
इ आणि राष्ट्रविकास	प्रा. वझरकर उदय मल्लिकार्जुन
रे बरवे यांच्या 'स्केच बुक' मधील लेखनाचा अन्वयार्थ	निखिल मा. राजवर्धन प्रा. डॉ. सुशीला सोलापूरे डॉ. शिरिष अंबेकर

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CONTENTS OF MARATHI PART - I

अनु क्र.	लेख व लेखकाचे नाव	पृष्ठ क्र.
२१	संगीत संस्थांच्या निर्मितीमध्ये पं. विष्णू दिंगबर पलुस्करांचे योगदान **प्रा. हर्षवर्धन कृष्णराव मानकर** **प्रा. डॉ. कुणाल इंगळे**	१११-११७
२२	खेळाडू आणि राष्ट्रविकास **प्रा. वझरकर उदय मल्लिकार्जुन**	११८-१२०
२३	प्रभाकर बरवे यांच्या 'स्केच बुक' मधील लेखनाचा अन्वयार्थ **निखिल मा. राजवर्धन** **प्रा. डॉ. सुशीला सोलापूरे** **डॉ. शिरिष अंबेकर**	१२१-१२६

OLUME - XI, ISSUE - II - MAY - OCTOBER - 2023
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२१. संगीत संस्थांच्या निर्मितीमध्ये पं. विष्णू दिंगबर पलुस्करांचे योगदान

प्रा. हर्षवर्धन कृष्णराव मानकर
संशोधन शोधार्थी, संगीत विभाग, मुंबई विद्यापीठ, मुंबई.
प्रा. डॉ. कुणाल इंगळे
मार्गदर्शक, संगीत विभाग प्रमुख, मंबई विद्यापीठ, मुंबई.

स्तावना

भारतीय संगीत हे एक अत्यंत प्राचीन असे संगीत आहे आणि या संगीताचा प्रवास गुरुकुलांमधून व त्यानंतर विविध ल्यांमधून व त्यानंतर विविध संस्थांमधून सुयोग्य रीतीने चालत राहिला आहे. पण, संस्थागत शिक्षण पद्धतीच्या प्रचार प्रसारामध्ये कोणत्या विद्वानांचे योगदान राहिले, हा सुद्धा एक अत्यंत महत्वपूर्ण पैलू आहे. त्यामुळे संगीत शिक्षणाच्या दृष्टीने शोधक प्रवृत्तीने चार करीत असताना, या विभूतींबद्दलची माहिती मिळविणेही तितकेच महत्त्वाचे ठरते. संस्थागत शिक्षण पद्धतीमधून संगीताचे क्षण मिळवून देण्यासाठी, विविध संगीत संस्थानांची निर्मिती करणाऱ्या विद्वानांसंबंधीची माहिती मिळविणेही तितकेच गरजेचे आहे.

संगीतकला ही गुरुकुलांच्या सानिध्यात राहून आपल्या मूळ रूपात जपल्या गेली. गुरुकुल शिक्षण पद्धतीमध्ये संगीतकलेला र्मिकतेचे आवरण असल्यामुळे, ती आपल्या शुद्ध रूपात जीवित राहिली होती. पण, हे जरी खरे असले तरी, त्याकाळात आलेल्या र्मिक अतिरेकीपणामुळे ती समाजाच्या खालच्या स्तरांतील लोकांपर्यंत पोहचू शकली नाही. पण, कोणतीच गोष्ट नेहमीकरिता राहत ही. मनुष्याला आवश्यक असलेल्या गोष्टींवर बदलत्या काळाचा आणि बदलत्या परिवेशाचा परिणाम होतोच. संगीत शिक्षणाच्या बतीतही हेच घडले. भारतावर जेव्हा विदेशी सत्ता स्थिरावू लागल्या तेव्हा मूळ भारतीय संस्कृतीवरही त्याचा परिणाम होत गेला. ातच जेव्हा इंग्रजांची सत्ता भारतावर स्थापन झाली, तेव्हा त्यांनी भारतात, त्यांच्या पाश्चात्त्य शैक्षणिक विचारांवर आधारित स्थागत शिक्षण पद्धती आणली. विविध शाळा, महाविद्यालये आणि विद्यापीठे भारतात स्थापन करून, ती रुजू केली. ही शैक्षणिक द्धती भारतात स्थापन करण्यामागे त्यांचे धोरण जरी मुत्सद्दीपणाचे असले तरी, या शिक्षण पद्धतीमुळे भारताला एक महत्त्वाचा फायदा ला, तो म्हणजे, या शिक्षण पद्धतीमध्ये सर्वसमावेशकता सामावलेली होती. समाजाच्या सर्वच स्तरांच्या लोकांना, हर प्रकारच्या क्षणाचा अधिकार या पद्धतीने बहाल केला होता. त्यामुळेच ही शिक्षण पद्धती भारतात आधुनिक शिक्षण पद्धती म्हणून स्वीकारल्या ली. पण, इंग्रजांनी स्थापित केलेल्या या विविध शाळा, महाविद्यालय व विद्यापीठांतून संगीत शिक्षणाची सोय सुरवातीच्या काळात ढती. तर, सामान्य विषयांचेच शिक्षण या पद्धतीतून दिल्या जात होते. पण या पद्धतींतर्गत असलेल्या सर्वसमावेशकतेच्या मूळ ाला केंद्रस्थानी ठेऊन, त्याच बरोबर घराणा पद्धतीतून अभिजात संगीताचे शिक्षण प्रत्येकाला शक्य नसल्याने, हे शिक्षण या स्थागत पद्धतीच्या माध्यमातून सर्वसामान्यांसाठी खुले करून देण्याच्या दृष्टीने पं. व्ही. डी. पलुस्कर या महान संगीत विभूतीने

ऐतिहासिक दृष्टीने अत्यंत महत्त्वपूर्ण भूमिका बजावली. तेव्हा या महान संगीतज्ञाच्या कार्याचा व व्यक्तिमत्वाचा आढावा प्रस्तुत लेखाद्वारे करण्यात येणार आहे.

पं. व्ही. डी. पलुस्कर

भारतीय अभिजात संगीतकलेला समाजजीवनात उन्नत स्थान प्राप्त करून देण्याच्या दृष्टीने, या कलेचे शिक्षण विस्तृत प्रमाणावर प्रसारित करण्यासाठी, कलावंतांना प्रतिष्ठा प्राप्त करून देण्यासाठी तसेच या कलेचे आस्वादन व साधना बहुसंख्य जनतेला सुकर करण्याच्या दृष्टीने महत्वपूर्ण भूमिका पार पडण्याचे काम पंडित विष्णू दिगंबर पलुस्कर यांनी केले. आपल्या उद्योगशीलतेने, संघटन चातुर्याने, कल्पकतेने व दूरदृष्टीने या कार्यात त्यांनी अपेक्षेपेक्षा अधिक यश संपादित केले. संगीताचे शिक्षण घेताना नानाविध अडचणींचा त्यांनी प्रत्यक्ष अनुभव घेतला होता. त्याकाळच्या महाजनांकडून संगीतकारांना मिळत असलेली अपमानास्पद वागणूकही त्यांनी तीव्रतेने अनुभवली होती. या अवस्थेला स्वतः गायक कलाकारही आपल्या वर्तणुकीमुळे काही अंशी जबाबदार होते, याची त्यांना जाणीव होती. संगीताच्या मैफिली या धनिकांच्या मर्जीवर अवलंबून असून, गायक कलाकारांना त्यांतून मिळणारे मानधनही स्वतःची आजीविका चालविण्यासही नाउमेद करणारे होते. म्हणजे, एकीकडे, संगीत विद्या प्राप्त करताना येणाऱ्या प्रचंड अडचणींचे अनुभव तर, दुसरीकडे ती विद्या साध्य झाल्यानंतर तिला विचारणारे अगदी थोडेच. अशा परिस्थितीत या कलेचा जिवंतपणा, तिचे तत्व व त्या कलेचे सामर्थ्य बहुसंख्येला पटवून देणे ही काळाची गरज बनली होती. यादृष्टीने पंडित विष्णू दिगंबर पलुस्करांनी केलेले कार्य अत्यंत महान आहे.

पंडित विष्णू दिगंबर पलुस्करांचा जन्म १८ ऑगस्ट १८७२ रोजी कुरुंदवाड या ठिकाणी झाला.[१] [देशपांडे वामन हरी, महाराष्ट्राचे संगीतातील कार्य, पृ. ८९.] त्यांचे वडील कीर्तनकार होते. त्यामुळे कीर्तनामधून होणाऱ्या गायनाचे संस्कार घरी व वडिलांसोबतच्या विविध ठिकाणच्या संचारात त्यांच्यावर घडणे स्वाभाविक होते. एका अपघातात त्यांच्या डोळ्यांना गंभीर इजा झाल्यामुळे त्यांची दृष्टी कमकुवत झाली. या कारणाने इंग्रजी विषयाचा पुढील शिक्षणाचा विचार त्यांना सोडावा लागला. संगीताकडे सुरुवातीपासूनच कल होता. शिवाय या कलेच्या साधनेत दृष्टीही फारशी गरजेची नाही, त्यामुळे संगीत विषयाच्या अभ्यासातच त्यांनी स्वतःला व्यस्त करावे, असे निश्चित केल्या गेले. पलुस्करांचा आवाज मुळातच गोड व मोहक असा होता. मिरजच्या संस्थानाधिपतींच्या प्रत्यक्ष मदतीने व प्रत्साहनाने, ग्वालियर घराण्याचे बाळकृष्णबुवा इचलकरंजीकर या प्रसिद्ध संगीतकाराकडे, सतत नऊ वर्षांपर्यंत त्यांना संगीताचे शिक्षण घेता येणे शक्य झाले. गुरुकडे त्यांच्या घरची कामे सुद्धा त्याकाळच्या गुरुशिष्य परंपरेतील रिवाजाप्रमाणे त्यांना करावी लागत असे. त्यामुळे कामाचा वेळ व गुरुकडून होत असलेल्या संगीत शिक्षणाचा वेळ वगळता, आपल्या दिनचर्येतील बहुतांश वेळेचा उपयोग, कंठसाधनेत व प्राप्त होत असलेल्या संगीत ज्ञानाच्या अध्ययनात त्यांनी केला. गुरुगृही शिक्षण घेताना एक गोष्ट त्यांना तीव्रतेने जाणवली की, आपल्या थोर अशा गुरुला एक गवई म्हणून जो योग्य मान दिला गेला पाहिजे, तो दिला जात नाही. पण, पलुस्करांनी मात्र गुरुची मर्जी संपादन करून निष्ठेने आपली संगीत साधना केली व गायनाच्या मैफिली करण्याइतपत

ली प्रगती साध्य केली. गुरुंकडून मिळालेल्या संगीताच्या ज्ञानाला प्रत्यक्ष सादरीकरणातून अभिव्यक्त करू शकण्याचा त्मविश्वास त्यांना आला.

संगीतकलेच्याच दृष्टीने आपल्या भवितव्याचा विचार करून ते महाराष्ट्राच्या बाहेर पडलेत व सन १८९६ पासून पुढील पाच र्यंत, बडोदा, राजकोट, ग्वाल्हेर, मथुरा व दिल्ली इत्यादी ठिकाणी भ्रमण केले. ज्या- ज्या ठिकाणी त्यांचा मुक्काम होत गेला, त्या- ठिकाणी आपल्या मैफिलींमधून आपली गानकला परिणामकारक रीतीने प्रस्तुत करून लोकांच्ची प्रशंसा मिळविली व एक उत्तम लाकार म्हणून प्रतिष्ठा प्राप्त केली.[२] [देशपांडे वामन हरी, महाराष्ट्राचे संगीतातील कार्य, पृ. ९०.] त्या काळात मैफिली या राजदरबार देवाणख्यान्यापुरत्याच मर्यादित होत्या. अशा परिस्थितीत राजकोटमधील मुक्कामात आपल्या गायनाचा जाहीर जलसा करून, त मैफिलींना प्रथमतःच त्यांनी सार्वजनिक स्वरूप दिले. तर, ग्वाल्हेर मधील मुक्कामात प्रभावीपणे आपले गायन सादर करून न रसिकांची पावती मिळविली. हिंदुस्थानी शास्त्रीय संगीताला अनुकूल अशा ब्रज भाषेचे अध्ययन त्यांनी मथुरेतील आपल्या ह महिन्याच्या मुक्कामात केले. तसेच, संगीतावरील संस्कृत वाङ्मयाचे परिशीलन व वक्तृत्वाच्या दृष्टीने हिंदी भाषेचे पाठही त्यांनी ले. याच दरम्यान, संगीत स्वरलिपी निर्माण करण्याचे प्रयत्न देखील त्यांनी सुरू केलेत. जालंदर येथे होत असलेल्या हरिवल्लभ त समारोहात आपल्या ग्वाल्हेर गायकीने उपस्थितांना मंत्रमुग्ध करून, एक श्रेष्ठ गायक म्हणून लौकिक संपादित केला. पंजाब तील मिळालेल्या या लोकप्रियतेची मदत त्यांना, भविष्यात त्यांच्या द्वारे अंगिकारल्या जाण्याऱ्या कार्याच्या दृष्टीने फार झाली. संगीतातील कलावंतांना अपेक्षेप्रमाणे जो मान मिळायला पाहिजे, तो दिला जात नाही, दुसऱ्या शब्दात सांगायचे झाले तर, च्या कलेची जेवढी दखल घेतली जाणे अपेक्षित आहे, तशी ती घेतली जात नाही, हा अनुभव एक गायक कलावंताच्या रूपाने र्वतच्या सांगीतिक प्रवासात त्यांना आला होता. त्यामुळे संगीताची तत्कालीन स्थिती व तिचे भविष्य याबद्दलची गहन चिंता काळात पंडितजींच्या मनात घर करू लागली होती.

संगीताच्या शिक्षणाचा अभाव असलेली बहुसंख्यक जनता एकीकडे, तर, दुसरीकडे कलावंतांची व्यसनाधीनता, लहरीपणा ीत शिक्षणातील कंजुषीपणा हे या परिस्थितीला कारणीभूत आहेत, हे पंडितजींनी हेरले होते. कलाकारांची लोकव्यवहाराशी ली फारकत त्यांना दिसून येत होती तर, असे कलाकार संगीताच्या शास्त्रीय पैलूंच्या चर्चेसंबंधीही उदासीन असल्याचे त्यांच्या र्शनास येत होते. संगीताचा रसिकवर्गही मर्यादित होता तर, अशा रसिकांकडून आपण मिळवत असलेल्या आनंदात इतरांना ागी करण्याची कोणतीच जाणीव होत नसल्याचे पंडितजींना निदर्शनास येत होते. अशा एकंदरीत परिस्थितीचे विचारचक्र त्यांच्या न फिरत होते व यातून संगीताची स्थिती कशी सुधारता येईल यादृष्टीने आपल्या भावी कार्यासंबंधीची योजना ते आखत होते. त संगीतकलेसंबंधी आस्था निर्माण व्हायला हवी, या कलेला तिचे पूर्वीचे मानाचे स्थान मिळायला हवे, संगीतकला ही भिमुख व्हायला हवी असे त्यांना मनोमन वाटत होते. म्हणून त्यादृष्टीने, कलावंतांनी आपले चारित्र्य निर्मल ठेवून औदार्याने संगीत ान देणे किती गरजेचे आहे, तर, संगीताचे शिक्षण देताना त्यासाठीच्या लेखन पद्धतीची आवश्यकता, तर, असे शिक्षण देण्यासाठी, क्रम आखला जाऊन, त्यासंबंधीच्या परीक्षा पद्धतीचा अवलंब, या सर्व संकल्पनांना मूर्तरूप देऊ शकणारा योग्य शिक्षक निर्माण

करण्याची आवश्यकता, त्याचबरोबर या कार्यात समाजातील धुरीणांकडून सहकार्य मिळविण्याची गरज, अशा विभिन्न दृष्टिकोनातून विचार करून, त्यानुरूप मार्गक्रमण करणे त्यांनी आरंभिले व तेही इतर कलाकारांच्या सहकार्याची अपेक्षा न करता. या सर्व उद्दिष्टांना साकार करण्याच्या दृष्टीने त्यांनी, लाहोर येथे ५ मे १९०१ या दिवशी 'राजा रामसिंह यांच्या हवेलीत जस्टीस पी.सी. चटर्जी यांच्या हस्ते'[३] ५१ [४] [देवधर बी. आर.,गायनाचार्य विष्णू दिगंबर पलुस्कर, पृ. ३१.] 'गांधर्व महाविद्यालय' या संगीत शिक्षण संस्थेची स्थापना स्वबळावर केली. सदर संस्थेचा कारभार लोकाश्रयावर चालण्याच्या दृष्टीने व संगीत शिक्षणाचे कार्य विस्तृत प्रमाणात व सुयोग्य रीतीने अमलात आणणे हा त्यांचा मुख्य हेतू होता. त्यादृष्टीने विद्यार्थ्यांकडून मिळणारी फी, दानदात्यांकडून लाभणाऱ्या देणग्या व स्वतःच्या कार्यक्रमांतून मिळणारे उत्पन्न यावरच विद्यालयाचा निर्वाह करण्याचा त्यांनी संकल्प केला. धनिकांचा अनुग्रह, हे नित्याची बाब नसल्याकारणाने, आणि विद्यार्थी संख्येवरच फीचे उत्पन्न अवलंबून असल्याने, आपल्या सांगीतिक कार्यक्रमांतून मिळत असलेल्या मानधनातूनच त्यांना संस्थेच्या जमाखर्चातील तूट भरून काढावी लागत असे.

विद्यालयातून जे शिक्षण दिले जाणे आहे, त्याचा आशय व क्रम ठरविण्याची महत्त्वाची गरज त्यांच्यापुढे होती. पण त्यासंबंधीच्या आवश्यक सांगीतिक वाङ्मयाची उपलब्धता, तसेच शिकविण्याचे संगीत लेखनपद्धतीत उतरवल्या जाणे, यादृष्टीने साहाय्यभूत ठरतील, अशी कोणतीच सामग्री उपलब्ध नसल्याने, यासंबंधीची तरतूद त्यांची त्यांनाच करावी लागली. त्याचे झाले असे की, यापूर्वीच ते 'राजस्थान मध्ये असतांना, तेथील एक बँड मास्टर, मि. जेम्स या व्यक्तीच्या प्रेरणेने त्यांनी स्वर लेखन प्रणालीवर अत्याधिक चिंतन केले होते. विशेष रूपाने त्यांनी हा विचार केला होता की, संगीत विद्यालय स्थापित केल्यानंतर दिवसाला एका तासाचा वेळ काढून, शिष्यांना शिकवायचे. पूर्वीची शिक्षण पद्धती यादृष्टीने उपयुक्त नव्हती. रागाचे नाव, त्या रागात उपयोगात येणारे स्वर, रागाचे आरोह- अवरोह, नियम आदी सगळे, शिष्यांना चांगल्या प्रकारे शिकवून झाल्यानंतर, जर, रागाची बंदिश शिकविल्या जाईल तर, विद्यार्थी अधिक चांगल्याप्रकारे शिकू शकतात.'[४] ४८ [४] [देवधर बी. आर.,गायनाचार्य विष्णू दिगंबर पलुस्कर, पृ.२७.] कारण की, असा अनुभव पंडितजींना ओंकारा मध्ये बाबा खेमचंद्राच्या दोन मुलांना शिकवितांना झाला होता. त्यावेळी, त्यांना हे सुद्धा वाटले की, बंदिशीची सरगम, बंदिशी सोबतच शिकविल्याने बंदिशीच्या कठीण जागा, जसे, मुरकी, खटका, मींड आदींना विद्यार्थी चटकन समझू शकतो.[५] ४९ [४] [देवधर बी. आर.,गायनाचार्य विष्णू दिगंबर पलुस्कर, पृ.२७.] 'यानंतर आपली नोटेशन पद्धती पक्की केल्यानंतर,काही पुस्तके ओंकारामध्ये लिहिलीत.'[६] ५० [४] [देवधर बी. आर.,गायनाचार्य विष्णू दिगंबर पलुस्कर, पृ.२७.] अशाप्रकारे त्यांनी अनुभवातून विद्यार्थ्यांना शिकविल्या जाण्याच्या दृष्टीने योजना केल्या. वेगवेगळ्या रागांमधील चिजा त्यांनी स्वतःच स्वरलिपीबद्ध केल्यात. कुलीन कुटुंबांतून आलेल्या विद्यार्थ्यांना खानदानी चिजांचे शृंगारिक स्वरूप मानवणार नाही, असा अंदाज घेऊन, भजन व भक्तिगीतांना रागदारीत चाली बांधल्या व अशा गीतांची स्वरलिपीसह क्रमिक पुस्तके देखील त्यांनी तयार केलीत. विद्यालयाच्या चोवीस वर्षांच्या कारकिर्दीत अशा पुस्तकांची संख्या साठच्या वर गेली होती. मैफिलीत उपयुक्त ठरतील अशा रागदारीतील चिजांचाही समावेश त्यांच्या सविस्तर गायकीसह या पुस्तकात पुढे केला गेला. अशा पुस्तकांच्या छपाईच्या दृष्टीने आणि प्रकाशनाच्या दृष्टीने विद्यालायाद्वारे एक छापखानाही त्यांनी सुरू केला होता.

संगीत विद्यालय चालविण्याच्या दृष्टीने दुसरी महत्त्वाची गरज पलुस्करांना जाणवली होती, ती म्हणजे अमलात आणावयाच्या शिक्षणक्रमानुसार, संगीताचे शिक्षण देऊ शकणाऱ्या संगीत शिक्षकांची उपलब्धता. यासंबंधी बाहेरच्या कलाकारांचा दृष्टीकोन त्यांच्या अपेक्षांशी जुळणारा नव्हता, हे ते समजून होते. त्यामुळे आपण शिकवीत असलेल्या विद्यार्थ्यांमधूनच असे शिक्षक निर्माण केले, तर अभिजात संगीताविषयीचा आपला दृष्टिकोन, त्याचा प्रचार-प्रसार व त्यानुरूप शिक्षण हे सगळे शक्य होईल, असे त्यांना उमगले. हीच कल्पना सत्यात उतरविण्याच्या दृष्टीने योजनाबद्ध पद्धतीने त्यांनी कार्य केले. आपल्या शिष्यांना 'उत्तम सांगीतिक शिकवण व शिस्त उपयुक्त ठरून, त्यामधून संगीताचा प्रचार- प्रसार व संगीत शिक्षणाच्या कार्यात वाहून घेणारे निष्ठावंत शिक्षक निर्माण केलेत. मिशनरी म्हणून काम करून, विद्यालयातून पंडितजींनी आपल्या देखरेखीखाली अशा कार्यात स्वतःला वाहून घेणाऱ्यांचा एक संघच तयार केला, ज्यातून अनेक यशस्वी संगीत शिक्षक म्हणून, काहींनी संघटक म्हणून, तर, काहींनी गायक म्हणून लौकिक संपादन केला. पुढारी गायक म्हणून कीर्ती मिळविणाऱ्या पंडितजींच्या शिष्यांपैकी, पंडित ओमकारनाथ ठाकूर, विनायकराव पटवर्धन, नारायणराव व्यास, शंकरराव व्यास, वामनराव पाध्ये, शंकरराव पाठक, बापूराव गोखले यांचा नामोल्लेख होतो. विद्यालयाचा लौकिक वाढत असताना, विद्यालयातून तयार झालेल्या शिक्षकांना इतर संगीत संस्थानांकडून मागणी व्हायला लागली. अशा संस्थांच्या पूर्ततेसाठी व आपल्या संस्थेच्या इतर शाखांच्या संचालनाच्या दृष्टीने, संगीतात दक्ष त्याचबरोबर तेथील कारभार व्यवस्थित व प्रगतीपर चालवतील अशा सहकाऱ्यांची त्यांनी योजना केली. डॉ. ॲनी बेझंट यांच्या मागणीवरून त्यांनी श्रीकृष्ण हर्लेकारांना बनारस हिंदू कॉलेजला पाठविले. अशाच रीतीने दुसरे संगीत शिक्षक पंडित व्ही. ए. कशाळकर यांना अलाहाबाद येथील कायस्थ पाठशाळा डिग्री कॉलेजमध्ये अध्यापक म्हणून पाठविले. याच कशाळकरांनी पुढे 'प्रयाग संगीत समिती' नावाची संस्था स्थापन केली व नावरूपास आणली. पलुस्करांचे आणखीन एक शिष्य पंडित नारायणराव खरे यांना गांधीजींच्या मागणीनुसार साबरमती आश्रमातील संगीत विभागाचे प्रमुख म्हणून पाठविले. खरेंनी आश्रमातील भजन व भक्तिगीतांत रागदारीचे संगीत अंतर्भूत केले. संगीताला लोकमान्यता मिळवून देण्याच्या दृष्टीनेच पंडितजींनी आपल्या विद्यालयातून दिल्या जाणाऱ्या अभ्यासक्रमाव्यतिरिक्त शिष्यांच्या अंगी निर्व्यसनीपणा, शिस्त, कष्टाळूपणा, स्वाभिमान आणि निष्ठा आदी मूल्यांचा आग्रह धरला होता. तर, अशा मूल्यांच्या जोपासनेतूनच आदर्श शिक्षक घडविलेत.

महाविद्यालयाच्या स्थापनेपासून आठ वर्षांच्या काळात लाहोरमधील गांधर्व महाविद्यालयाची खूप प्रगती झाली. सदर संस्थेला मिळत असलेले यश पाहून पंडितजींनी 'ईस. १९०८ साली दसऱ्याच्या शुभदिवशी जगदगुरु शंकराचार्यांच्या हस्ते मुंबई येथील गिरगाव मध्ये गांधर्व महाविद्यालयाचे उद्घाटन झाले.'[७] ५३ [४] [देवधर बी. आर.,गायनाचार्य विष्णू दिगंबर पलुस्कर, पृ.४६.] सदर महाविद्यालयातील विद्यार्थ्यांची वाढती संख्या आणि त्यामुळे वाढत असलेला व्याप, यामुळे त्यांनी गांधर्व महाविद्यालयाच्या या शाखेचे केंद्रात रूपांतर केले. सदर केंद्रातील विद्यार्थ्यांची संख्या पाचशेच्या घरात पोचली. यावेळी त्यांनी संगीत शिक्षणक्रमात इतरही काही इष्ट बदल घडवून आणलेत. स्त्रियांना संगीत शिक्षण निषिद्ध मानणाऱ्या परंपरेला तडा देत, स्त्रियांसाठी संगीताच्या शिक्षणाची दारे त्यांनी उघडलीत व याची सुरुवात त्यांनी आपली पत्नी व दोन पुतण्या अशा शिक्षिकांची योजना करून केली. विविध प्रकारच्या वाद्य

वादनाच्या शिक्षणाची व्यवस्थाही विद्यालयांतून केल्या गेली असून, त्यांच्या दुरुस्ती तसेच ती तयार करण्याकरिता सुद्धा विद्यालयात एक वेगळे दालन त्यांनी उभारले. त्यासाठी आपल्याच विद्यालयातील विद्यार्थ्यांना शिक्षण देऊन, त्यातूनच त्यांची Musical Instruments Supplying Company उदयास आली.[८] [देशपांडे वामन हरी, महाराष्ट्राचे संगीतातील कार्य, पृ.९४.] लाहोरमधील छापखाना व प्रकाशन विभाग मुंबईत आणून, संगीताशी संबंधित इतर पुस्तकांबरोबरच 'गांधर्व महाविद्यालय' या मराठी मासिकाचे प्रकाशन त्यांनी सुरू केले.

विद्यार्थ्यांना संगीतात पारंगत करण्याच्या दृष्टीने पंडितजींनी विद्यालयातील अभ्यासक्रम नऊ वर्षांचा निश्चित केला. ज्यांतर्गत प्रथम चार वर्षांचा अभ्यासक्रम 'संगीत प्रवेशिका' तर, पुढील पाच वर्षांच्या अभ्यासक्रमाला 'संगीत प्रवीण' असे नामकरण केल्या गेले. या शिक्षणक्रमातून उत्तीर्ण होणाऱ्या विद्यार्थ्यांना पदवी प्रदान करण्याची कल्पनाही पंडितजींना सुचली आणि त्यानुसार पहिला पदवीदान समारंभ १९११ साली मुंबईतील तत्कालीन गव्हर्नर लॉर्ड सीडनहॅम यांच्या हस्ते केला.[९] [देशपांडे वामन हरी, महाराष्ट्राचे संगीतातील कार्य, पृ.९४.] आपल्या विद्यालयात स्वतंत्र रीतीने संगीत परिषदा आयोजित करण्याची कल्पनाही त्यांना सुचली. अशी पहिली परिषद १९१८ साली त्यांनी आयोजित केली, ज्यात त्यांचे गुरु बाळकृष्णबुवा इचलकरंजीकर, रहिमत खां, विलायत हुसैन खां यांच्या सारखे कलाकार आमंत्रित केले गेले होते. त्यांच्या गायनाचे कार्यक्रमही त्यात केले गेले. पुढे आणखीन अशा चार परिषदांचे आयोजन पंडितजींनी केले होते.

गांधर्व महाविद्यालयाच्या मुंबईतील शाखेच्या कारकिर्दीतील सुरुवातीची काही वर्षे अत्यंत उत्कर्षाची ठरली होती. गांधर्व महाविद्यालयाच्या या केंद्राच्या कारभाराला व्यापक स्वरूप प्राप्त झाले होते. त्यामुळे सदर केंद्राच्या विस्तार पावणाऱ्या कारभाराला पुरेशी व साजेशी स्वतःच्या मालकीची अशी एक इमारत असावी, अशी पंडितजींची इच्छा होती. त्यादृष्टीने अपेक्षित धनराशी आपल्या गायनाच्या कार्यक्रमांतून, संगीत व्याख्यानांच्या कार्यक्रमांतून तर, मुख्यत्वे कर्जातून त्यांनी जुळविली आणि या संस्थेची स्वतःची प्रशस्त अशी इमारत आपल्या देखरेखीखाली मुंबईसारख्या शहरात उभी केली. पुढे चालून या इमारतीला लागूनच विद्यार्थी निवासस्थानही त्यांनी बांधले. विद्यालयासंबंधी सर्व जबाबदारी पंडितजींच्या एकट्याच्या खांद्यावर होती. त्यामुळे सदर इमारतीच्या कर्जाची परतफेड करण्याच्या दृष्टीने दूरदूरच्या ठिकाणी गायनाचे कार्यक्रम अथवा संगीतपर व्याख्यानांचे कार्यक्रम केलेत. पण, उतारवयात सदर कर्ज व त्याच्या व्याजाचे ओझे त्यांना जड होत गेले. अखेरीस १९२४ साली पंडितजींच्या गैरहजेरीत या इमारतीचा ताबा कर्जदात्यांनी घेतला आणि तिचा लिलावही करून टाकला. पंडितजींच्या अविरत अशा संगीत निष्ठेचा, संगीत शिक्षणातील कल्पकतेचा, संगीत शिक्षणविषयक महत्त्वाकांक्षेचा द्रव्याअभावी करून अंत झाला. गांधर्व महाविद्यालयाचा कारभार या कारणाने एकदम स्थगित झाल्याने, अनेक प्रयत्न करूनही त्याला पूर्वीचे स्वरूप प्राप्त होऊ शकले नाही. यामुळे पंडितजी इतके व्यथित झाले की, त्यांचे नंतरचे जीवन जवळजवळ विरक्तीच्या अवस्थेतच गेले. अशाच विरक्तीच्या अवस्थेत २१ ऑगस्ट १९३१ रोजी त्यांचा मृत्यू झाला[१०] [देशपांडे वामन हरी, महाराष्ट्राचे संगीतातील कार्य, पृ.९६.] आणि संगीत उद्धाराचा विडा उचलणाऱ्या या महान संगीत

विभूतीचा करुण अंत झाला. संगीत जगत या महान विभूतीच्या कार्याला कदापि विसरू शकणार नाही. भारतीय संगीत शिक्षणाच्या इतिहासात त्यांचे नाव सदैव राहील.

निष्कर्ष

सदर शोध लेखातून एवढाच निष्कर्ष काढता येईल कि, भारतीय संगीत जगतात पं. विष्णु दिगंबर पलुस्कर यांनी जे योगदान दिले ते अतुलनीय आहे. आणि त्यांनी जर संस्थागत शिक्षण पद्धतीत संगीत विषयाची सुरुवात केली नसती तर, संगीत शिक्षण हे सर्वसामान्यांपर्यंत पोहुचू शकले नसते. तथापि जे संगीत केवळ घराण्यांपुरते मर्यादित होते ते सर्वजनांना बहाल झाले नसते. ज्या कोण्या व्यक्तीलाही संगीतासंबंधीची थोडीही आस्था आहे अश्या सगळ्याच लोकांसाठी केलेली ही फार मोठी कामगिरी पं. पलुस्करांनी केली आहे. त्यांचे कार्य हे अत्यंत महत्वपूर्ण आणि अनमोल अश्या स्वरूपाचे आहे.

संदर्भ सूची

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ORIGINAL RESEARCH PAPER
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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.

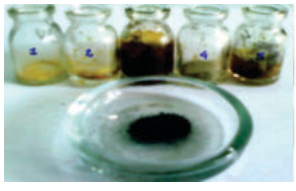
MATERIAL AND METHOD

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.

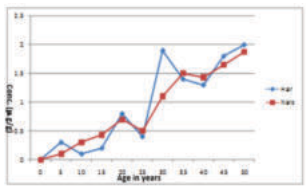
After drying of fingernails and hair samples, add few drops of concentrated nitric acid on the samples which is kept in vials .The procedure is used for the digestion of samples.



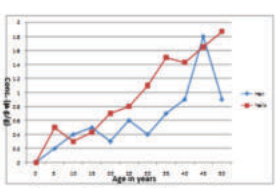
These ash samples now ready for atomic absorption spectro photometer analysis
(Yoshinaga J, Shibata Y, Morita M 1993).

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

Summary:-
Elevated zinc in hair is an unusual finding. Occupational or hobbyist exposure to zinc through paints, metalwork, or chemical use can cause elevation. Zinc may be present in detergents and bleaches. Exposure may be related to dermatitis because zinc is a common skin irritant in allergic eczema. Some forms of zinc (i.e., hexavalent) are highly toxic, but acute exposure to such compounds is rare. The high incidence of allergies among the people may in part be related to the presence of zinc in cement. Elevations of hair zinc have been reported only during the special metabolic needs of pregnancy, where the high values were present with evidence of zinc deficiency. Some Indian diets have lead-copper ratios in excess of those that produce hypercholesterolemia. Also, the mortality rate for child was correlated with the ratio of lead to copper in milk in the region. It was found that the abnormal ratio of the trace elements was due to the poor economic condition that was directly affected the diet of the people.

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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

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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)**.

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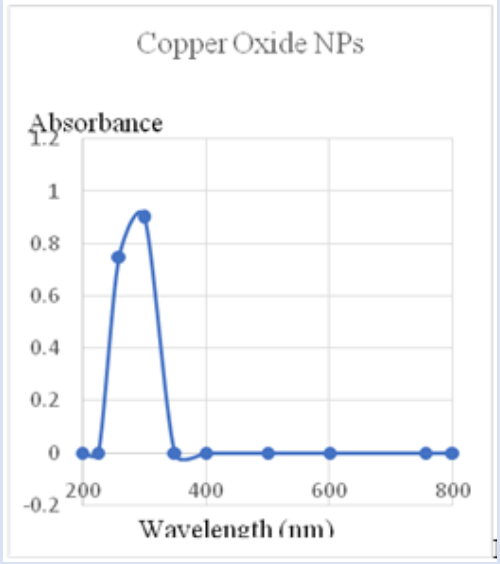

Figure 2: Uv-Vis's data of CuO NPs

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].

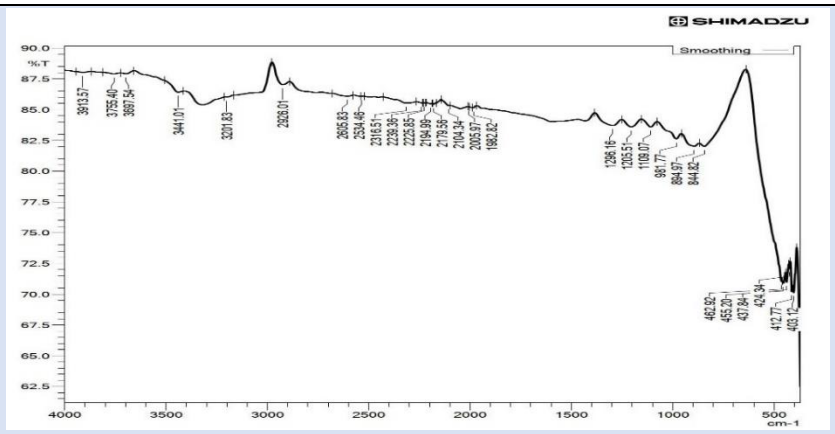

Figure 3: FTIR data of CuO NPs

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.

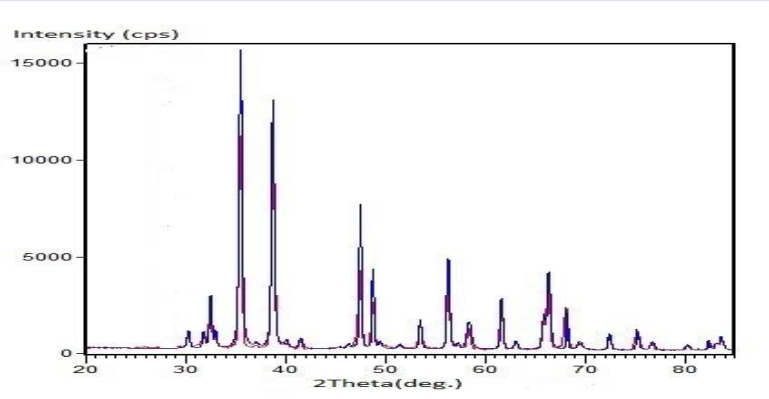

Figure 4: XRD data of CuO NPs

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.

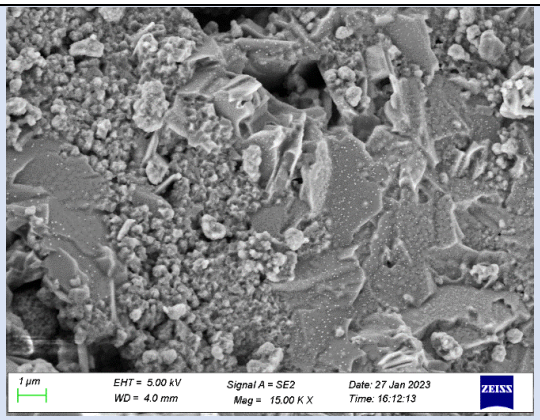

Figure 5: FESEM data of CuO NPs

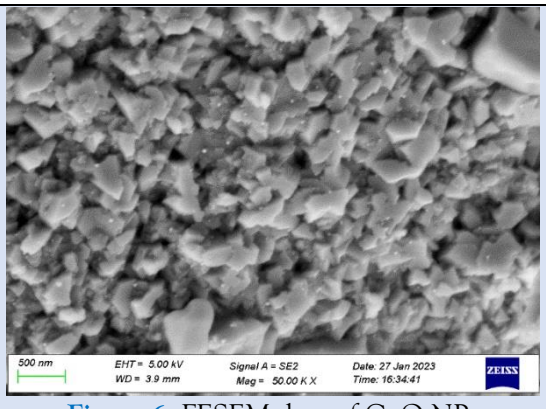

Figure 6: FESEM data of CuO NPs

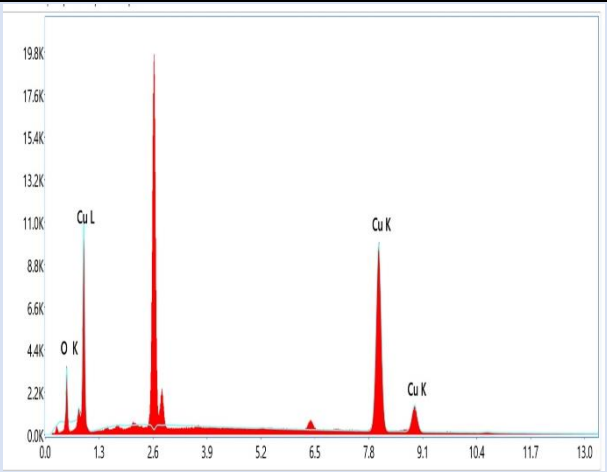

Figure 7: EDX data of CuO NPs

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

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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

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Conflicts of Interest

The authors declare no conflict of interest.

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Synthesis of Some New 1-Hepta-*O*-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-arylthiocarbamide) thiocarbamides

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

[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 We report the synthesis of a series of 1-hepta-*O*-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-aryl thiocarbamide) thiocarbamides. These were prepared by reacting 1-hepta-*O*-benzoyl-β-D-lactosyl-3-sulfanilamido thiocarbamide with various aryl isothiocyanates. The required 1-hepta-*O*-benzoyl-β-D-lactosyl-3- sulfanilamido thiocarbamide was prepared in good yield through the reaction of hepta-*O*-benzoyl-β-D-lactosyl isothiocyanate with sulfanilamide.

KEY WORDS: Aryl isothiocyanates, Lactosyl sulfanilamido thiocarbamide, Lactosylated thiocarbamides.

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INTRODUCTION

The consciousness of the significance of carbohydrates in living organisms and in medicine is rising due to the increasing understanding of their biological and pharmacological applications and their contribution in a huge range of physiological processes with diseases.[1-4] Carbohydrates are everywhere in nature as one of main groups of biomolecules. Although it has long been clear that sugars are both important foodstuff and structurally important compounds. An exciting development in carbohydrates since over the past 20 years has initiated to divulge that they are concerned in huge variety of very specific and sophisticated procedures. Similarly, there is a rising trend in carbohydrates derivative drugs[5] for therapeutic use.

Naturally, carbohydrates are broken down in the body to produce energy for various biological activities. It is well known that antibiotics have served mankind more than any other class of therapeutics. A number of medically important antibiotics, such as streptomycin, are carbohydrate derivatives.[6] Carbohydrate-based or-customized therapeutics are utilized widely in cardiovascular and hematological healing from provocative virus and anti-thrombolytic treatments to helping in wound healing.[7] Most of the carbohydrate-based drugs belong to the groups of antibiotics and cytostatics. Carbohydrate containing antibiotics, nucleosides, glycolipids, glycopeptides, glycoproteins, glycosaminoglycans, and glycosides of steroids which have been found to have therapeutic application.[8] A recent development in the laboratory synthesis of carbohydrates[9-13] makes it possible to produce complex, pure, and structurally defined carbohydrates for drug discovery and development. Several derivatives of thiocarbamides are used as pharmaceuticals, preservatives, rodenticides, and insecticides.[14-17] Thiocarbamides have valuable uses in organic synthesis and are used as intermediates in several organic synthetic reactions.[18] Bacterial resistance remains a significant threat and a leading cause of death worldwide, despite massive attempts to control infections. Sulfanilamide is a sulfonamide antibacterial drug. In an effort to develop biologically active antibacterial and antifungal agents, a novel substituted sulfanilamido thiocarbamides linked with carbohydrate units were synthesized through interaction of 1-hepta-*O*-benzoyl-β-D-lactosyl-3-sulfanilamido thiocarbamide with various aryl isothiocyanates. Therefore, their broad spectrum

*Corresponding author: Email: dipalimhaisne@rediffmail.com

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lactose unit), 711.73 (C=S stretch); ^{1}H NMR(CDCl$_3$,ppm):δ 8.04–7.18 (39H,*m*, aromatic protons), δ6.14–6.13(1H,*d*,NH), δ5.4–3.61 (14H, *m*, lactosyl ring protons), δ2.17(1H, *s*, NH) δ1.98 (2H, *s*, NH); Found C, 63.58; H, 4.41; N, 3.24; S,5.10. Calcd. for $C_{68}H_{57}O_{19}N_3S_2$:C, 63.60; H, 4.44; N, 3.27;S, 4.99%).

Synthesis of 1-hepta-O-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-phenyl thiocarbamide) thiocarbamide ***(5a)***

The 1-hepta-*O*-benzoyl-β-D-lactosyl-3-sulfanilamido thiocarbamide (0.0016 M, 2.1 g) in acetone (15 mL) was mixed solution of phenylisothiocyanate (0.0016 M, 0.22 g) in acetone (10 mL). This reaction mixture was refluxed for 8 h. This reaction was monitored by TLC. After completion of reaction, the reaction mixture was brought to the room temperature and solvent was distilled off to give a sticky residue. The sticky residue was triturated a several times with petroleum ether (60–80°C) and product was obtained as yellow solid **(5a)**. The crude product was recrystallized from ethanol (2.12 g, 91.38%), m.p. 162–164°C.

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

5a: IR (KBr,cm^{-1}): υ3354.21 (N-H stretch),3064.89 (aromatic C-H stretch), 2964.59 (aliphatic C-H stretch), 1728.22 (C=O stretch), 1315.45 (C-N stretch), 1271.09 (C-O stretch), 1155.36 (S=O stretch), 1097.50, 1070.49 and 1028.06 (Characteristic of lactose unit), 711.73 (C=S stretch); ^{1}H NMR (CDCl$_3$,ppm): δ 8.04–7.18 (44 H, m, aromatic protons), δ 6.40–6.39 (1H, *d*, NH), δ5.75–3.84 (14H, *m*, lactosyl ring protons), δ5.39 (1H, *s*, NH), δ2.17(1H, *s*, NH) δ1.31(H, *s*, NH) (Found: C, 63.44; H, 4.36; N, 3.92; S, 6.78. Calcd. for $C_{75}H_{62}O_{19}N_4S_3$: C, 63.47; H, 4.37; N, 3.95; S, 6.77%).

1-Hepta-O-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-o-tolyl thiocarbamide) thiocarbamide ***(5b)***

5b: IR (KBr, cm^{-1}): υ3352.28 (N-H stretch), 3064.89 (aromatic C-H stretch), 2964.59 (aliphatic C-H stretch), 1728.22 (C=O stretch), 1315.45 (C-N stretch), 1271.09 (C-O stretch), 1155.36 (S=O stretch), 1097.50, 1070.49 and 1028.06 (Characteristic of lactose unit), 711.73 (C=S stretch); ^{1}H NMR (CDCl$_3$,ppm):δ 8.02–7.18 (43H, *m*, aromatic protons), δ5.81–3.87 (14H, *m*, lactosyl ring protons), δ 6.40–6.39 (1H, *d*, NH), δ4.72(1H, *m*, NH), δ2.38 (1H, *s*, NH), δ1.65 (1H, *s*, NH), δ1.31 (3H, *s*, CH$_3$) (Found: C, 63.66; H, 4.45; N, 3.90; S, 6.73 Calcd. For $C_{76}H_{64}O_{19}N_4S_3$: C, 63.68; H, 4.47; N, 3.91; S, 6.70%).

1-Hepta-O-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-m-tolyl thiocarbamide) thiocarbamide ***(5c)***

5c: IR (KBr, cm^{-1}): υ3354.21(N-H stretch), 3064.89 (aromatic C-H stretch), 2964.59 (aliphatic C-H stretch), 1728.22 (C=O stretch), 1315.45 (C-N stretch), 1271.09 (C-O stretch), 1157.29 (S=O stretch), 1097.50, 1070.49 and 1028.06 (Characteristic of lactose unit), 711.73 (C=S stretch); ^{1}H NMR (CDCl$_3$, ppm):δ 8.02–7.18 (43H, *m*, aromatic protons), δ6.40–6.39 (1H, *d*, NH), δ5.75–3.84 (14H,*m*, lactosyl ring protons), δ4.94 (1H, *s*, NH), δ2.00 (1H, *s*, NH), δ1.66 (1H, *s*, NH), 1.31 (3H, *s*, CH$_3$). (Found: C, 63.64; H, 4.46; N, 3.87; S, 6.69Calcd. for $C_{76}H_{64}O_{19}N_4S_3$: C, 63.68; H, 4.47; N, 3.91; S, 6.70%).

1-Hepta-O-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-p-tolyl thiocarbamide) thiocarbamide ***(5d)***

5d: IR (KBr, cm^{-1}): υ3354.21(N-H stretch), 3064.89 (aromatic C-H stretch), 2968.45(aliphatic C-H stretch), 1728.22(C=O stretch), 1315.45 (C-N stretch), 1269.16 (C-O stretch), 1155.36 (S=O stretch), 1097.50, 1070.49 and 1028.06 (Characteristic of lactose unit), 711.73 (C=S stretch); ^{1}H NMR (CDCl$_3$,ppm)): δ 8.04–7.12 (43H, *m*, aromatic protons), δ6.40–6.39 (1H, *d*, NH), δ5.75–3.85 (14H, *m*, lactosyl ring protons), δ5.42 (1H, *s*, NH), δ2.34 (1H, *s*, NH), δ1.99 (1H, *s*, NH), 1.31 (3H, *s*, CH$_3$) (Found: C, 63.65; H, 4.44; N,3.88; S, 6.72. Calcd. $C_{76}H_{64}O_{19}N_4S_3$: C, 63.68; H, 4.47; N, 3.91; S, 6.70%).

1-Hepta-O-benzoyl-β-D-lactosyl-3-(1-sulfanilamido-3-p-chloro thiocarbamide) thiocarbamide ***(5e)***

5e: IR (KBr,cm^{-1}): υ3267.41 (N-H stretch), 3064.89 (aromatic C-H stretch), 2960.73 (aliphatic C-H stretch), 1726.29 (C=O stretch), 1315.45 (C-N stretch), 1271.09 (C-O stretch), 1155.36 (S=O stretch),1095.57,1070.49 and 1028.06 (Characteristic of lactose unit), 711.73 (C-S stretch); ^{1}H NMR (CDCl$_3$, ppm):δ 8.00–7.21 (43H, *m*, aromatic protons), δ6.40–6.39 (1H, *d*, NH) δ5.75–3.66 (14H, *m*, lactosyl ring protons), δ4.70 (1H, *s*, NH), δ1.63 (1H, *s*, NH), δ1.31 (1H, s, NH) (Found: C, 61.92; H, 4.17; N, 3.83; S, 6.63. Calcd. $C_{75}H_{61}O_{19}N_4S_3Cl$: C, 61.96; H, 4.20; N, 3.86; S, 6.61%).

CONCLUSION

Carbohydrate derivatives were synthesized and characterized for their structural clarification. Different analytical and spectral data support the structure. In the current investigation, the scheme implemented is simple, effective, and low-cost and also suitable for synthesizing significant molecules.

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DNA BARCODING – A WAY TOWARDS SUSTAINABLE DEVELOPMENT

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

[1]Asst. Professor, Department of Botany, Shri Shivaji College of Arts, Commerce & Science Akola

[2]Professor, Department of Botany, Shri Shivaji College of Arts,Commerce& Science Akola

ABSTRACT

This is the Review based study on DNA Barcoding. Wehave investigated Fabaceae Family using sequence data from the rbcl, matK, and ITS2, regions as DNA barcodes. Now a days DNA barcodes have provided a new biological tool for biologists to increase their understanding about species identification. Over the last decade three plant DNA barcode markers, rbcL, matK, and ITS2, have been developed, tested, and used to address basic questions in systematics, ecology, evolutionary biology and conservation, including community assembly, species interaction networks, taxonomic discovery, and assessing priority areas for environmental protection.DNA barcode sequences have the potential to improve investigations of the mechanisms underlying community assembly and functional trait evolution. Therefore, We analysed a species from Fabaceae family with the help of DNA Sequences by using rbcl as a DNA Barcode Marker. Therefore, we suggest that the DNA barcoding should be used as a tool a step towards Sustainable Development.

Keywords: *DNA Barcoding, Fabaceae, NCBI, Rbcl, Species Identification.*

Introduction:

Legumes (Fabaceae) make up the third-largest flowering family comprises 770 genera and over 19,500 species, which broken up into three widely accepted sub-families: the Caesalpinoideae, 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 legumes 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).

Recently, several DNA barcoding loci have been recommended to identify the plant species (Chen et al. 2010). DNA barcoding can be performed easily in any molecular biology laboratories and does not require plant morphological information. Many recent studies on DNA barcoding in plants focused on multiple loci, including nuclear (ITS) and plastid regions (psbA-trnH, rpoC1, matK and rbcL).

A reliable identification method at the species level is utmost importance. Mostly the plant species identification has been done with morphological traits. However, for the plant phenotypic characterization, a well-qualified botanical taxonomist or highly trained technicians need to be considered. Numerous molecular markers have been reported for plant species discrimination; the most used DNA markers were RFLP (Beckmann and Soller 1983), RAPD (Williams et al. 1998), AFLP (Vos et al. 1995), ISSRs (Zietkiewicz et al. 1994) and SSRs (Becker and Heun 1995).

Protocol:

DNA Barcoding using universal primers of RBCL.

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°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:

2X Phire 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 ^{o}C	-	30 sec	40 CYCLES
98 ^{o}C	-	5 sec	
58 ^{o}C	-	10 sec	
72 ^{o}C	-	15 sec	
72 ^{o}C	-	60 sec	
4 ^{o}C	-	∞	

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 37^{o}C for 15 minutes followed by enzyme inactivation at 85^{o}C 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

Following Data Obtained From Ncbi (National Centre For Biotechnology Information)

Plant Species No. 1

DEFINITION: *Acacia catechu* voucher PS0288MT06 ribulose-1,5-bisphosphatecarboxylase/oxygenase large subunit (rbcL) gene, partial cds;chloroplast.

ACCESSION No. GQ436355

ORIGIN

1 taaagcaagtgttggattcaaagctggtgttaaagattataaattgacttattatactcc
61 tgactatgaaaccaaggatagtgatatcttggcagcattccgagtaactcctcaacctgg
121 agttccgcctgaagaagcgggtgccgcggtagctgctgaatcttctactggtacatggac
181 aactgtgtggaccgatgggcttaccagtcttgatcgttacaaaggacgatgctaccacat
241 cgagcccgttgctggagaagaaagtcaatttattgcttatgtagcttatccccttagacct
301 ttttgaagaaggttctgttactaacatgtttacttcgattgtgggtaatgtatttgggtt
361 caaggccctgcgcgctctacgtctggaagatttgcgaatccctccttcttattctaaaac
421 tttccaaggtccgcctcacggcatccaagttgaaagagataaattgaacaagtacggccg
481 tcccctattgggatgtactattaaaccaaaattggggttatccgcgaagaattacggtag
541 agcggtttatgaatgtctccgtggtggacttgattttaccaaagatgatgagaatgtgaa
601 ttcccaaccatttatgcgttggagagaccgtttcttattttgtgccgaagcactttataa
661 agcacaggccgaaacaggtgaaatcaaagggcattacttgaat
//

Identification :

ORGANISM Senegaliacatechu Eukaryota; Viridiplantae; Streptophyta; Embryophyta; Tracheophyta;Spermatophyta; Magnoliopsida; eudicotyledons; Gunneridae;Pentapetalae; rosids; fabids; Fabales; Fabaceae; Caesalpinioideae;mimosoid clade; Acacieae; Senegalia.

Plant Species No. 2

Definition: *Acacia nilotica* voucher OM626 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) gene, partial cds; chloroplast.

ACCESSION JF265255

ORIGIN :

1 agtgttggattcaaagctggtgttaaagattataaattgacttattatactcctgactat

61 gaaaccaaagatagtgatatcttggcagcattccgagtaactcctcaacctggagttccg
121 cctgaagaagcaggtgccgcggtagctgctgaatcttctactggtacatggacaactgtg
181 tggaccgatgggcttaccagtcttgatcgttacaaaggacgatgctaccacatcgagccc
241 gttgctggagaagaaaatcaatatattgcttatgtagcttatcccttagacctttttgaa
301 gaaggttctgttactaacatgtttacttccattgtgggtaatgtatttgggttcaaggct
361 ctgcgcgctctacgtctggaggatttgcgaatccctccttcttattctaaaactttccaa
421 ggtccgcctcacggcatccaagttgagagagataaattgaacaagtacggccgtccccta
481 ttgggatgtactattaaaccaaaattggggttatccgctaagaattacggtagagcggtt
541 tatgaatgtctt
//

Identification :

ORGANISM: Vachellianilotica
Eukaryota;Viridiplantae;Streptophyta;Embryophyta;Tracheophyta;Spermatophyta;Magnoliopsida; eudicotyledons; Gunneridae;Pentapetalae; rosids; fabids; Fabales; Fabaceae; Caesalpinioideae;mimosoid clade; Acacieae; Vachellia.

Discussion

DNA barcoding with large number of individuals (species/accessions) has provided insights into relationships between species, which also has the ability to precisely estimate the intraspecific heterogeneity. In the present study we have obtained the Data from NCBI (National Centre For Biotechnology Information) records. Therefore, we believe that all of them were based on correctly identified plant species.

The main criterion for a standard DNA barcode is universality, in which the DNA barcode should be easily accessible from plants with a combination of primers (CBOL Plant Working Group et al. 2009). In our study, DNA barcode sequences were found to be easily amplified using polymerase chain reaction (PCR).

DNA Barcoding data is the basic information to trace evolutionary trend which will also help to formulate sustainable development of biodiversity.

Conclusion

DNA barcode sequences have the potential to address basic questions in systematics, ecology, evolutionary biology and conservation.

Hence, the present study can be explain the use of DNA Barcoding to develop sustainable environment.

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The Assessment of Phylogenetic Relationships in Fabaceae Family with Reference to Anatomical Characterization of Some Genera

Nikhil B. Choukhande[1] and P. P. Umale[2]
Assistant Professor, Department of Botany[1]
Professor, Department of Botany[2]
Shri Shivaji College of Arts, Commerce & Science, Akola, Maharashtra, India

Abstract: *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. In this study relationships are determined by anatomical similarities. Anatomy is tightly correlated, as cell and tissue structure has changed with respect to the evolution as novel functional mechanisms. So, it can provide valuable characteristics in phylogenetic analyses, but these are less frequently acquired today than in the past. Therefore, anatomical features used directly to generate a Phylogeny tree or cladistics or a cladogram. Finally, it is concluded that Anatomical characters of vegetative parts of flowering plants have been successfully employed to solve taxonomic problems and for the elucidation of phylogenetic relationships.*

Keywords: Anatomy, Cladogram, Fabaceae, Phylogeny, Tissue

I. INTRODUCTION

All life on Earth is part of a single phylogenetic tree, indicating common ancestry.

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).

A phylogeny is represented in a diagram known as a phylogenetic tree. The branches of the tree represent ancestral and/or descendant lineages. Relatedness among taxa in a phylogenetic tree is determined by descent from a recent common ancestor. Phylogeny and taxonomy are two systems for classifying organisms in systematic biology. While the goal of phylogeny is to reconstruct the evolutionary tree of life, taxonomy uses a hierarchical format to classify, name, and identify organisms (Gregory, T. R. 2008).

Plant anatomy is the study of the tissue and cell structure of plant organs. The term anatomy, as applied to plants, generally deals with structures that are observed under a high-powered light microscope or electron microscope. Anatomy is tightly correlated, as cell and tissue structure has changed with respect to the evolution of novel functional mechanisms (Cui, Y. *et al.,* (2022)

Anatomical characters of vegetative and floral parts of flowering plants have been successfully employed to solve taxonomic problems and for the elucidation of phylogenetic relationships. It was (Bureau, E. 1864) who for the first time used anatomical characters in plant classification for the delimitation of taxa of various levels, within the family Bignoniaceae.

After the discovery of Electron microscopy, it has brought revolution in all biological fields, and so also in the field of taxonomy. Plant micromorphological studies with the help of SEM and TEM aided by ultra microtome techniques, have proved a powerful tool in studying various anatomical aspects of taxonomic significance. However, till date only a few ultra structural characters have been exploited and applied in plant classification

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Therefore, it can provide valuable characteristics in phylogenetic analyses, but these are less frequently acquired today than in the past. Therefore, anatomical features used directly to generate a cladogram. (Michael G. Simpson, in Plant Systematics (Third Edition), 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 plants (Angiosperms),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 Anatomy 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.

II. 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. Acacia catechu (L.f.)Willd.
2. Canavalia gladiata (Sw.)DC.
3. Crotalaria junicea L.

Protocol for Anatomy

Suitable sections of plant material were first washed in clean water and then stained with 1% aqueous safranine. Keep sections in safranine for 5 minutes. A section was then placed on clean slide and few drops of aceto-butanol (1:3) were added to it and allowed to act for few seconds. Due to this a moisture is repelled instantaneously, a counter stain (light green) was added on the slide itself and section again washed with aceto-butanol (1:3) in order to remove extra stain. At this stage the material is dehydrated and can even be washed with absolute alcohol, the material then transferred to Xylol:Butyl Alcohol (1:1) grade for fraction of minute and finally transferred it into pure Xylol. The section was now ready for mounting (Wadoodkhan, Marathwada University Journal, 1980).

Anatomical Study of the Selected Plants

The selected plants after correct taxonomic identifications were proceed for anatomical characterization. Fresh material of each species was used for anatomical study. The transverse sections of stem were studied. The fresh stem materials were sectioned using fine razor and proceed for double staining of the sections. After that, the most suitable and stained sections were photographed using Carl Zeiss Binocular Microscope. The anatomical study of each section was done as per the standard method (Metcalfe and Chalk, 1979 and 1985; Fahn, 1990 and Rudall, 1994). Apart from the internal structure as seen in transverse sections of the material, trichome study was also done as trichomes are unique feature of some genus in fabaceae family.

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Observations

PLANT No. – 1

Acacia catechu (L.f.) Willd.

Morphological Characterization-

Habit: Small trees, 5-7 m tall; bark dark-brown; young parts with dense spreading hairs, often purplish.

Leaves: Leaves 10-15 cm long; rachis white-villous with glands between many of the pairs of pinnae and a large gland near the middle of the petiole; stipular spines hooked; pinnae 20-30 pairs, 3-5 cm long, subsessile. Leaflets 30-50 pairs, linear, 4-6 x 1 mm, sessile, subacute, often ciliate.

Flowers: Flowers sessile, in 1-4-nate axillary spikes 5-10 cm long; rachis white pubescent. Calyx campanulate, 1-1.5 mm long, hairy outside; teeth deltoid, ciliate. Corolla 4-5 mm long, dull white; lobes oblong, obtuse. Stamens much exserted.

Fruit: Pods stalked, 6-10 x 1.5 cm, flat, thin, brown, tapering at both ends, glabrous. Seeds 3-10, compressed, brown, polished.

Flowering and Fruiting Time: June to October.

Anatomical Characterization of Stem

In transverse section, stem shoes circular in outline. The present section shows secondary growth.

In transverse section stem shows following parts-

1. Epidermis – it is single layered, thick walled and parenchymatous in nature. The cells of epidermis are somewhat circulars in shape.
2. Hypodermis – it is collenchymatous in nature, it is 2-3 celled thick.
3. Cortex – Hypodermis is followed by cortical region, it consists of two layers i.e. outer cortex and inner cortex. Outer cortex is parenchymatous in nature while inner cortex is sclerenchymatous in nature. Both outer cortex and inner cortex is separated by Layer of Stone cells.
4. Endodermis and Pericycle is not seen.
5. Vascular tissue – secondary vascular tissue is observed, , the secondary tissues are also consisting presence of parenchymatous medullary rays, medullary rays transversing the secondary phloem and xylem tissues.
6. Xylem – large xylem cylinder is seen, it consists of large metaxylem vessels, xylem tracheids and xylem parenchyma.
7. Phloem – secondary phloem cylinder is observed above the xylem cylinder.
8. Pith- it small and pentangular in shape, it consists of parenchyma cells without intercellular cells.

PLANT No. –2

Canavalia gladiata (Sw.)DC.

Morphological Characterization-

Habit: Stout, glabrous, twining, annual herbs.

Leaves: Leaves 3-foliolate; petioles 10-15 cm long, striate, glabrous; stipule triangular, deciduous. Leaflets membranous, ovate-elliptic, 6-15 x 4-10 cm glabrous.

Flowers: Its flowering shoot is about 30 cm long and found at the leaf axils. Its purple flowers are sweetly-scented and notched at the tips.

Fruit: Its fruits are dry, dehiscent pods (legumes), linear-oblong, 6–15 by 1.5–3 cm, and contain many dark brown seeds.

Flowering and Fruiting Time: July to December.

Anatomical Characterizationof Stem

In transverse section, stem shoes circular in outline.The present section shows secondary growth.

In transverse section stem shows following parts-

1. Epidermis – it is single layered, thin walled and parenchymatous in nature. The cells of epidermis are somewhatcirculars to elliptical in shape.
2. Hypodermis – it is collenchymatous in nature, collenchyma is present in 3 - 4 layers.

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3. Cortex – Hypodermis is followed by cortical region, it consists of parenchymatous cells. The cortical region has 6-7 layers of compactly arranged parenchyamatous cells.
4. Endodermis – it is prominently observed in the present transverse section, it is single layered, and consists of elongated and thick-walled cells.
5. Pericycle – it is present in sclerenchymatous patches. These patches are interrupted by presence of parenchyma cells. The sclerenchymatous cells are compactly arranged.
6. Vascular tissue – in the present section secondary vascular tissues are observed, the secondary tissues are also consisting presence of parenchymatous medullary rays running from sclerenchymatous tissues to pith region. These medullary rays are 1-3 celled in thickness.
7. Xylem – secondary xylem cylinder consisting of xylem vessels and xylem tracheids and parenchyma cells. The xylem in primary vascular bundles are also seen prominently. The secondary phloem cylinder is present above the secondary xylen cylinder. The interesting characteristics of secondary phloem is, at some places the amount of secondary phloem produced by the vascular cambium is more. It results into presence of soft phloem tissue more in quantity supporting its twinning habitat.
8. Pith –it is the largest region present in the centre of stem. And it consists of parenchymatous cells.

PLANT No. – 3

Crotalaria junicea L.

Morphological Characterization

Habit: Erect, simple or branched, appressed hairy, annual herbs, 1-2 m tall; stems conspicuously striated.

Leaves: Leaves short-petioled, lanceolate-oblong to linear, 4-15x0.7-4 cm, acute at base, obtuse, mucronate; stipules linear, 1-2 mm long.

Flowers: Flowers 3-15 in lax racemes 3-20 cm long; pedicels 8-10 mm long, pubescent; bracts minute, linear-subulate; bracteoles linear. Calyx 2-2.5 cm long, clothed outside
with dense brown hairs; teeth long, linear. Corolla golden yellow, slightly exserted.

Fruit: Pods cylindric, 2-3x0.4-0.6 cm, brown-silky, 10-15 seeded. Seeds reniform, ash-grey, polished.

Flowering and Fruiting Time: August to November.

Anatomical Characterization of Stem

1. Stem is pentagular in outline, having five prominent angular outgrowths.
2. Presence of uniseriate trichomes.
3. Present transverse section showing secondary growth.
4. T.S. of stem is devided into following layers.

- Epidermis – Single layered, consisting thick walled cells, and some what circular in shape cells.
- Hypodermis – In angular growth region, it is Collenchymatous in nature. While in rest of the regions hypodermis is consisting Palisade tissue in 2-3 layers.
- Cortex – Hypodermal region is followed by cortex. Cortex consists of 3-4 layers of Parenchymatous cells.
- The inresting feature is presence of external vascular bundles in cortical regions. Which are conjoint, collateral and open and may be showing formation of secondary Vascular tissues.
- Vascular tissue – In the present material secodary vascular tissue are prominent seen. The secondary xylem on inner side of cambium and secondary Phloem on the outer side. The cylinder of secondary Xylem is seen interuppted by the presence of uniseriate medullary rays. At some places secondary xylem is consisting Metaxylem, Protoxylem, Tracheids and Xylem Parenchyma.
- Pith – pith is large situated in the centre. It consists of compactly arranged large parenchyma cells.

III. DISCUSSION

In the present study it is observed that the anatomical characters differ as per habit of the genus.

In *Acacia catechu* (L.f.) Willd. the Transverse section of Stem shows well developed secondary xylem cylinder and secondary phloem cylinder having medullary rays, While the pith region is small. In case of *Canavalia gladiata(Sw.) DC.* the habit is twining herb. Anatomically stem shows secondary growth by the formation of secondary cylinders of

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xylem and phloem. The pith is large. The quantity of phloem is more supporting twining habit of plant. The erect herbaceous plant *Crotalaria junicea L.*in anatomy of stem secondary growth is seen, The outline is pentangular, with uniseriate hairs. The large parenchymatous pith is present in the centre. The presence of additional external vascular bundles are interesting features in *Crotalaria juniceaL.*

IV. CONCLUSION

Anatomical characters of vegetative parts of flowering plants have been successfully employed to solve taxonomic problems and for the elucidation of phylogenetic relationships.

In the present study, three different genera having tree, herb and climber stem are studied anatomically, these characters are conserved as important evidence for evolution.

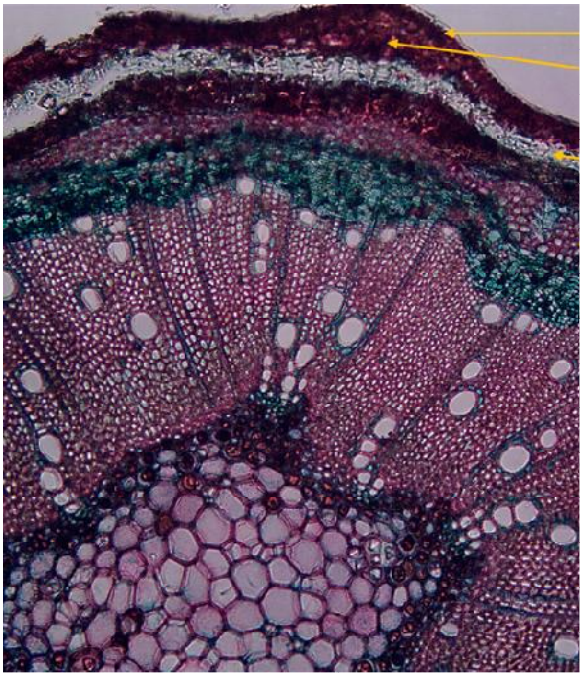
Some characteristics in all genera are found similar viz. single layered epidermis, presence of secondary vascular tissue and uniseriate medullary rays. But presence of less pith region in *Acacia catechu*as compare to other genera.

The sclerenchyma is present in cortical region, which is considered as primitive characters supporting tree habit. While formation of more secondary phloem is considered as advanced character in support of twining habit in *Canavalia gladiata.*

In the present study it is seen that the secondary xylem is more in Acacia catechu indicating it's woody nature and tree habit while in case of *Crotalaria junicea* the Scleroids are seen in pericycle region and supporting herbaceous nature. In *Canavalia gladiata* anatomical study showing anomalous secondary growth to explain the twining habit.

Finally, it is concluded that, The Anatomical characters has proved to be useful in tracing the evolutionary trends and for creation of interrelationship among the taxa. Woody *Acacia catechu* might be considered as primitive, while *Crotalaria junicea* and *Canavalia gladiata* are herbaceous but evolved.

PHOTO PLATE NO. – 1



T.S. stem-*Acacia catechu* (L.f.)Willd.-

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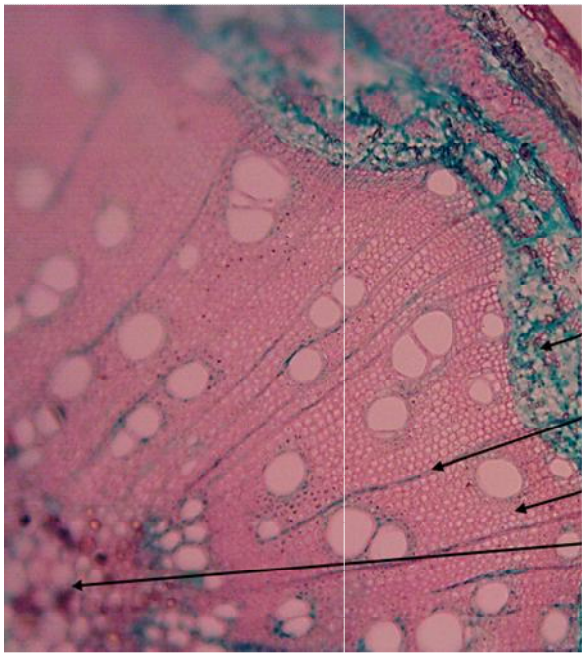
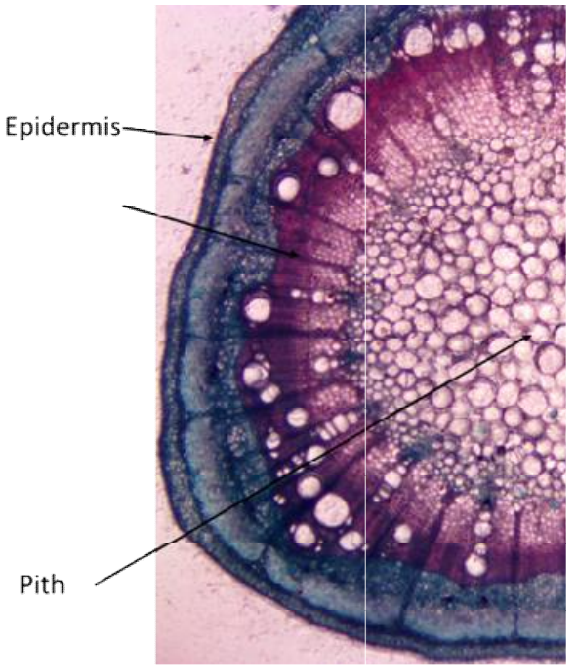


T.S. stem-*Acacia catechu* (L.f.)Willd.-

PHOTO PLATE NO. – 2



T.S. stem-*Canavalia gladiata (Sw.)DC.*

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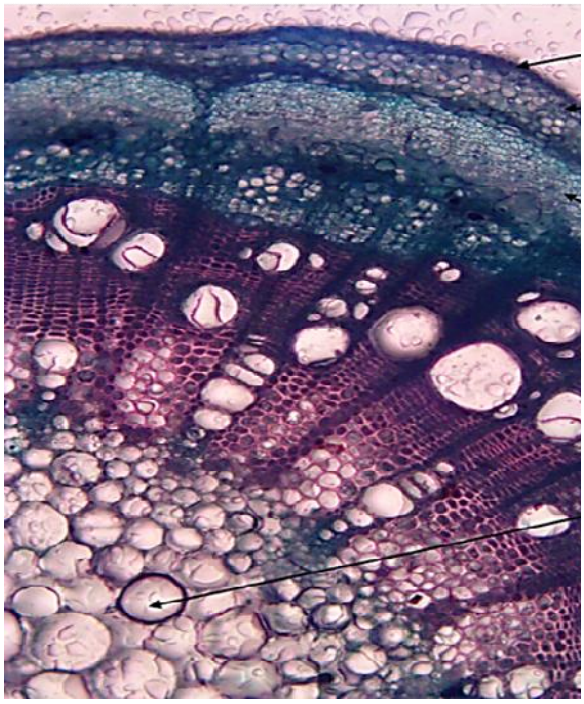
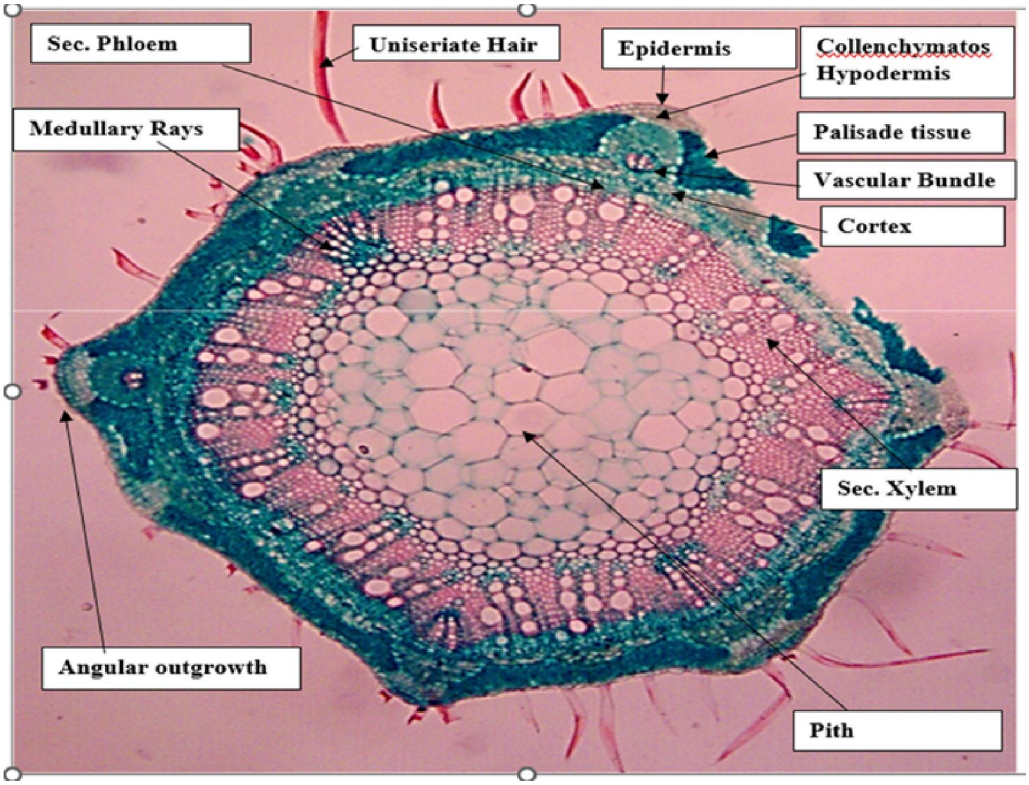


T.S. stem-*Canavalia gladiata (Sw.)DC.*

PHOTO PLATE NO. – 3



T.S. stem-*Crotalaria junicea L.*

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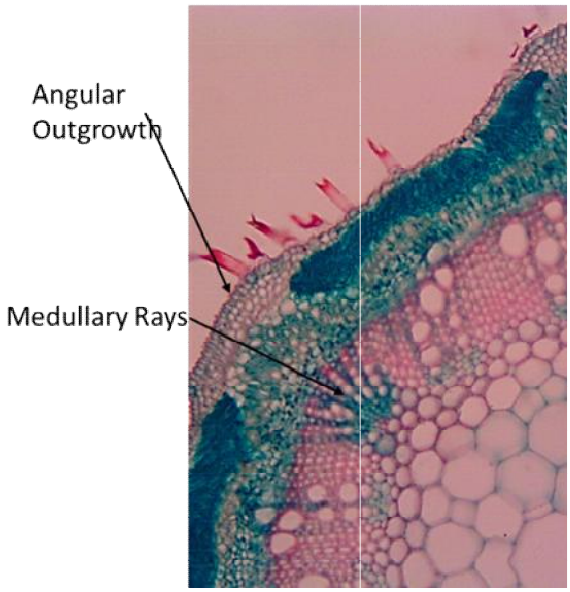

T.S. stem-*Crotalaria junicea L.*

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ROLE OF BIOMEDICAL ELECTRONIC DEVICES AND TECHNOLOGICAL UPGRADATIONS IN ELDERLY AND BEDRIDDEN PATIENTS

Author: **Dr. Niteen Shridhar Mohod**
Asst. Prof in Electronics
Shri Shivaji College of Arts, Commerce & Science, Akola, Maharashtra, India

Abstract:
As per the study, around 4% of every 2.5 million elderly people are bedridden. Due to sickness or old age, one who is confined to bed is termed as a bedridden patient. Caring for such a bedridden person is not an easy task. According to the survey carried out, 54 % of manual labor is needed to take care of bedridden patients throughout the world and there is no effective system available for shifting bedridden patients.
It has always been a very difficult and costly affair to move elderly and bedridden patients to the hospitals or the testing labs and that too, when the patient lives in a remote or interior place, it becomes even more tedious. There are various portable and affordable biomedical electronic devices built around microchips, like microcontrollers, available these days, like pulse oximeter, blood pressure and heart rate monitor, Glucose monitor, Real time stress detector and so on. [1]
Though medical doctors cannot entirely rely upon these portable devices in emergencies, considering the accuracy constraints, one can still definitely get an idea in advance about upcoming emergencies.

Keywords:
Bedridden, Biomedical electronic devices, microchip, pulse oximeter, Blood pressure and heart rate monitor, Glucose monitor, Stress detector

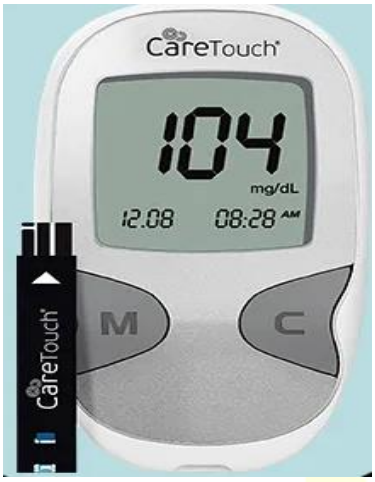
Introduction:
The objective of this paper is to clarify the role of biomedical electronic devices in a multi-level automated clinical interaction system which clears and integrates the analysis of environmental and biomedical data supporting the assessment of the quality of life of a bedridden patient. This will be done through biosensors applicable to disabled patients who are bedridden for long periods of time and need online monitoring also, to decide the line of medication. The system consists of a set of products that will help the biomedical data collection tasks of the patient and their potential and subsequent treatment for specialized medical assistance in person or at a distance.
Remote healthcare has categories like Telehealth and mobile health. Today, the patient can also be facilitated with online monitoring by doctors and near ones and the most important advantage of it is, even a non-specialized caregiver can also monitor and understand the emergency, which eventually reduces his psychological, physical and financial burden.

Conceptual Development:
Development of biomedical electronic devices started with the developments and upgradations in the technology, resulting in small size, high speed, efficient and accurate equipment which can even be handled by non technical people and, in the case of initial emergencies in elderly bedridden patients at home, a line of immediate medication can be decided. Devices like Microcontrollers, various processor ICs, Platforms like Arduino boards are playing a vital role in it. [2]

Common Biomedical Electronic Devices:

The unique application of Biomedical Electronic Devices is that the health related parameters can be monitored even by Non-Medical Professionals. Day by day, medical electronics are becoming a powerful tool, monitoring the parameters related to various diseases and assisting medical doctors in deciding the line of medication. This results in improving the awareness of a common person towards self health. [3]
The following discussion will clarify some popularly used biomedical electronic devices;

Blood Glucose Monitor:



It is a very handy gadget type medical electronic device used to calculate the glucose level in a diabetic patient. When a small drop of blood is placed on the chemical strip of the sensors, the chemical reaction takes place between blood and the chemical on the sensor strip and on passing of the current through, it immediately calculates and digitally displays the glucose in the blood using an LCD display. Here one has to go for pricking a finger with a lancet, which becomes painful for many and results in less frequent testing and consequently a poorer control of blood sugar levels. To combat the problem, many non-invasive techniques have been developed but the measurements are not as accurate as using a blood test.GlucoTrack, which is developed by Integrity Applications in Israel, measures sugar levels in blood through a combination of ultrasonic, electromagnetic and thermal waves. To provide readout, here the sensor is clipped on the ear. The device is indicated for adults with type 2 diabetes and is approved in Europe, where the company has started to commercialize the glucose monitor. [2]

Blood Pressure Monitor:

It is a biomedical device used to measure blood pressure instantly. It has a gauge and a monitor in a single unit and is even nice for elderly people with any degree of hearing loss. The cuff inflation provided is also automatic and thus even a non technical person can also handle it.

Portable Pulse Oximeter:

Most of us have been well acquainted with this portable pulse oximeter since Covid-19. On putting an index finger in a finger module, within no time it displays the percentage of oxygen in the blood and the heart rate of the patient. Though it is not approved by medical doctors in emergencies, still the caretaker can easily get a hint about the emergency. They are very portable and cheap.

IR Gun or Thermal Gun Scanner:

This IR thermometer also played a prominent role during Covid-19 as it was a Non Contact IR thermometer.
Contactless thermometers use advanced thermal imaging techniques to detect infrared rays emitted by an individual's body which indicates a person's body heat. The scanners are used to convert them into a readable temperature in ºF. The typical body temperature ranges between 97°F and 99°F.

Conclusion and future scope:

From the discussion above, it is very clear that with technological upgradations, biomedical electronic devices have become not only small sized, portable and cheap but are efficient enough to have a hint in well advance in case of emergencies in elderly, bedridden and even the patients who cannot move on their own.

As a future scope, all these parameters can be made online or even available live, which may require dedicated servers, but in that case, cost may be an issue.

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PORTABLE PULSE OXIMETER DESIGNING WITH ADDED FEATURES

Dr. Niteen Shridhar Mohod
Asst. Prof in Electronics
Shri Shivaji College of Arts, Commerce & Science, Akola, Maharashtra, India
mohodniteen@gmail.com

Abstract:

Pulse oximeter is mainly used to measure or monitor oxygen saturation in the blood (arteries) and the heart rate in BPM (Bits per Minute) of a person that too without going through the blood analysis. As witnessed during COVID-19 as how much important role the percentage oxygen in blood, heart rate and the body temperature plays and discarding them may even leads to the risk of death. The intention of this study is to develop the portable pulse oximeter. The design will be based on transmittance method and will use an Arduino Uno board, Red and IR Led, SpO2 sensor, LCD RG-1602A and associated circuitry. The design is simplified and portable with comparable accuracy and even the fault rectification is simple. Additional features like body temperature and making the parameters online available is also possible with the said pulse oximeter by adding IC LM 35 and GSM module.

Keywords:

Pulse Oximeter (PO), Oxygen saturation, Blood analysis, Transmittance, SpO2 sensor, GSM module.

INTRODUCTION:

Percentage oxygen in the blood, heart rate and the body temperature are the prominent parameters related to human health. The blood plays vital role in carrying the oxygen to the entire body. Lack of or excess of oxygen causes disruption to the body's working systems. [1] The heart mainly pumps the blood throughout the body and in case it doesn't function properly the person gets uncomfortable. Checking heart rate through the arteries is one of the methods to know the heart rate in BPM [Beats per Minute]. [2] Normal heart rate in case of adults ranges between 60 to 100 BPM. [3] While the percentage oxygen in the blood in a healthy human is between 97% to 99%.Oxygenated hemoglobin allows more red light to pass while absorbs IR light on the contrary deoxygenated hemoglobin allows more IR light to pass while absorbs Red light and this is the principle used in transmittance method.[4]

Pulse oximeter is an instrument used for the purpose which analyzes arteries (beats on fingers) and can also help in monitoring the heart rate. Thus without doing any blood test the analysis of percentage oxygen in the blood and the heart rate can be done using pulse oximeter.[5]

Many pulse oximeters designed before were not portable and hence an attempt is made by an author to design pulse oximeter which will not only be a portable but also have comparable accuracy with the pulse oximeters used in emergencies.

MATERIAL AND METHODS:

i] ***Component and Devices***

The designing of this pulse oximeter comprises of Red and IR LEDs, Photo detector, Instrumentation amplifier, Open loop comparator, Arduino Uno board with IC 328P,LCD RG-1602A, IC LM 35, GSM Module and the system Reset.

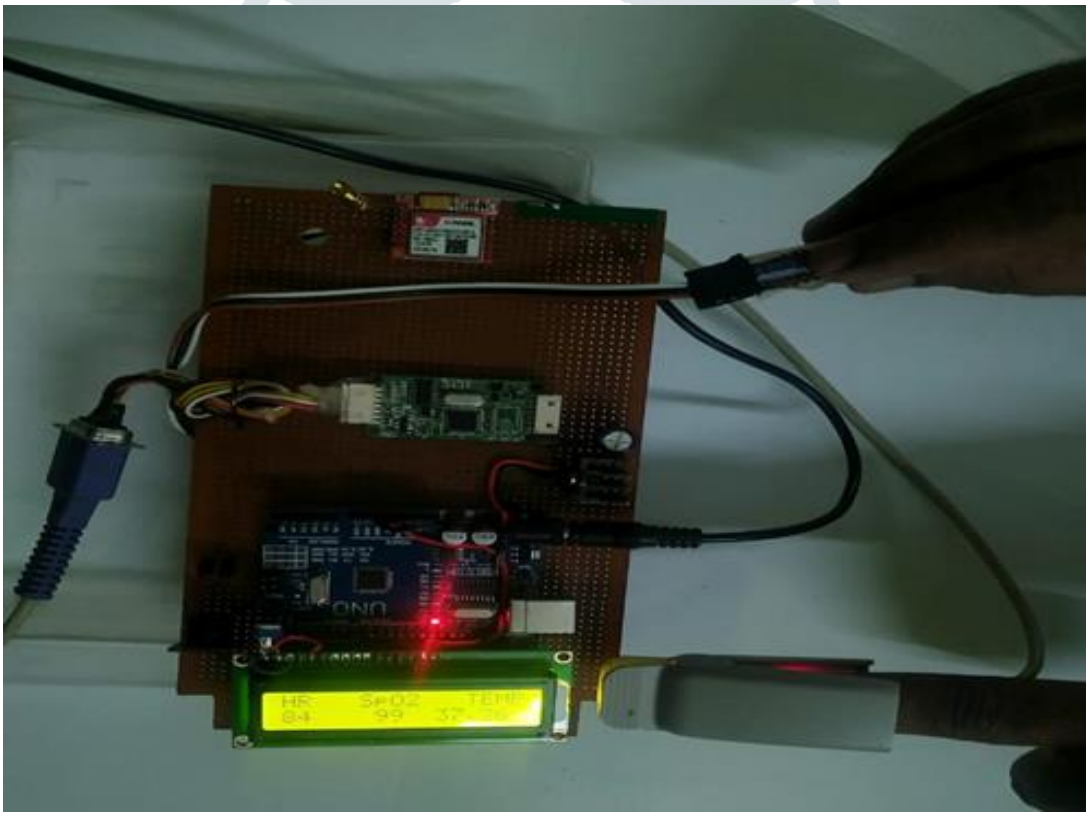
ii] ***Methodology adopted***

Hereunder these study 5 different age groups were selected and their % oxygen saturation, heart rate and the body temperature were measured and compared with the standard pulse oximeter Biomedics HR5000 used in the hospital and their graphical analysis is also done. For every age group around 5 samples were taken.

iii] ***Additional features incorporated***

Mostly the pulse oximeters are meant to measure percentage oxygen saturation in the blood and the heart rate but since COVID-19 knowing the body temperature has also proven its importance and hence measuring it and having all these three parameters online available through GSM module with delay not more than 10 seconds were the features incorporated.

DESIGNED CIRCUIT:



Designed Pulse Oximeter

TESTING OF DESIGNED PULSE OXIMETER:

Designed pulse oximeter was tested with 5 age groups and the readings were compared with the standard pulse oximeter and digital thermometer and found them almost close.

A] Age Group: Zero to 14 Years (Children):

SN	Subject's Age in Years	Subject's Gender (M/F)	Hospital's Pulse Oximeter Readings % Oxygen Sat.	Hospital's Pulse Oximeter Readings Heart Rate in bpm	Hospital's Pulse Oximeter Readings Temp in °C	Designed Pulse Oximeter Readings % Oxygen Sat.	Designed Pulse Oximeter Readings Heart Rate in bpm	Designed Pulse Oximeter Readings Temp in °C
1	04	M	98	105	37.20	98	106	37.26
2	12	F	98	83	38.15	98	82	38.23
3	14	F	99	96	36.70	98	96	36.77
4	05	F	98	102	37.59	98	102	37.74
5	04	M	98	125	36.75	98	125	36.77

B] Age Group: 14 to 24 Years (Early Working Age):

	Subject's		Hospital's Pulse Oximeter Readings			Designed Pulse Oximeter Readings		
SN	Age in Years	Gender (M/F)	% Oxygen Sat.	Heart Rate in bpm	Temp in °C	% Oxygen Sat.	Heart Rate in bpm	Temp in °C
1	19	F	99	94	38.15	99	93	38.23
2	16	F	99	84	36.70	99	84	36.77
3	17	F	99	105	37.53	100	105	37.74
4	15	F	98	84	38.21	98	84	38.23
5	21	M	99	67	37.18	100	66	37.26

C] Age Group: 25 to 54 Years (Prime Working Age):

	Subject's		Hospital's Pulse Oximeter Readings			Designed Pulse Oximeter Readings		
SN	Age in Years	Gender (M/F)	% Oxygen Sat.	Heart Rate in bpm	Temp in °C	% Oxygen Sat.	Heart Rate in bpm	Temp in °C
1	25	F	94	91	37.29	95	91	37.26
2	43	F	99	88	38.46	99	88	38.77
3	53	M	98	80	36.45	98	81	36.77
4	47	M	97	106	37.19	97	106	37.26
5	39	M	99	97	38.72	99	96	38.77

D] Age Group: 55 to 64 Years (Mature Working Age):

	Subject's		Hospital's Pulse Oximeter Readings			Designed Pulse Oximeter Readings		
SN	Age in Years	Gender (M/F)	% Oxygen Sat.	Heart Rate in bpm	Temp in °C	% Oxygen Sat.	Heart Rate in bpm	Temp in °C
1	M	62	97	71	38.19	97	72	38.23
2	F	59	97	84	37.55	97	84	37.74
3	M	63	98	87	36.59	98	86	36.77
4	M	56	99	66	37.17	99	65	37.26
5	M	64	98	84	36.37	97	84	36.77

E] Age Group: 65 Years and above (Elderly)

	Subject's		Hospital's Pulse Oximeter Readings			Designed Pulse Oximeter Readings		
SN	Age in Years	Gender (M/F)	% Oxygen Sat.	Heart Rate in bpm	Temp in °C	% Oxygen Sat.	Heart Rate in bpm	Temp in °C
1	F	74	99	108	36.59	99	108	36.77
2	M	76	97	106	37.17	98	106	37.26
3	F	73	99	87	37.70	99	87	37.74
4	F	65	97	67	37.69	96	67	37.74
5	M	67	98	63	37.23	98	63	37.26

RESULT AND CONCLUSION:

Readings obtained through the designed pulse oximeter for the five varied age groups related to three different health related parameters were found very close to the standard pulse oximeter and the digital thermometer used in the emergencies and the accuracy attain was more than 99%.Also the designed PO is much cheaper and the cost can even be reduced if the production is done on mass scale.

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Distribution and diversity of hemiptera fauna of Katepurna Wildlife Sanctuary, Akola district, Maharashtra, India

Priyanka M Ramteke
Assistant Professor, Shri Shivaji Art, Commerce and Science College Akola, Maharashtra, India

Abstract
Diversity of bug at different parts of Katepurna region was studied from 1 February2021 to 1 december 2021. Katepurna Sanctuary is situated in the district of Akola, which comes under the Vidarbha region. (Maharashtra). The study yielded the identification of 8species belonging to 5 families of the order Hemiptera and all these species are reported first time from this sanctuary.

Keywords: Katepurna Wildlife Sanctuary, hemiptera

Introduction

Akola town of the Vidharbha State of Maharashtra. Situated at latitude 20.7^0 North and longitudinal 77.07 ^{0}East.It is an altitude of 925ft(287m) to 1036.745ft(316m) above sea level. Akola has tropical savanna climate Annual temperature range from a high of 47.6^0c to a low 2.2^0c. Annual rain fall averages 800mm. Katepurna Sanctuary is situated in the district of Akola, which comes under the Vidarbha region. The sanctuary occupies a large part of catchment area of the Katepurna reservoir. Due to the presence of large amount of water, birds get attracted towards the place. The period between October to June is the ideal time for visiting the place. Flora- The place is very rich in vegetation cover and mainly comprises of southern tropical deciduous forests. There are more than 115 species of plants & trees like Bahada, Aola, Tendu, Dhawada, Salai, Moha, Teude and many more. Fauna- The sanctuary is a home to a wide array of animals like Black buck, Hyena, Wolf, Nilgai, Leopard, Jungle cat, Hare, Wild boar, Monkey etc. The chief attraction of the sanctuary is the Barking deer and the Four-horned Antelope. One can also see various species of birds like Peafowl, eagles, woodpecker etc. Katepurna Wildlife Sanctuary is spread over 73.69 sq. km. It covers a great part of the catchment area of the Katepurna reservoir. It is well known for for-horned antelope and barking deer.

Hemipteran insects that are usually called as 'true bugs'are of great economic importance as most of them are pests of various commercial crops. The members of the group show hemimetabolous type of metamorphosis as the nymphal stages having great resemblance in structure with that of adult (Ghosh and Biswas 1995). A detailed account of Hemiptera fauna of central India had been done by Distant (1904*a* and *b*). Later on brief account of this order were described by Ghosh and Biswas, 1995, Ramakrishna *et al.* 2006, Chandra 2008 and 2009 respectively.

Material and Methods

The major freshwater source is Katepurna River situated at Mahan, near Barshi Takali. The region has a large area under crop cultivation. Bugs were collected from various localities of Katepurna region by hand picking, net trap and light tarp methods. The specimens were shorted out and bugs were pinned and dried and identified with the help of literature and manuals as well as different websites from the internet.

Result

Table 1: A total of 8 bug individuals were recorded belonging to 8 species Within 8 genera falling under 5 families.

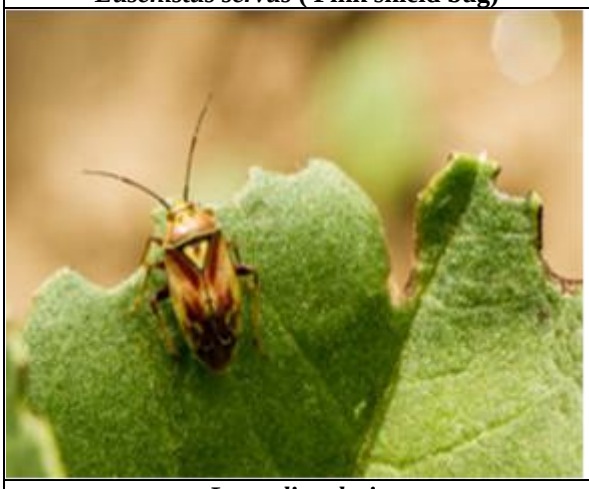
Sr. No.	Name of the species	Family	Genus
1.	*Chrysocoris patricius* (Green jewel bug)	Scutelleridae	*Chrysocoris*
2.	*Palomena prasina* (Green shield bug)	Pentatomidae	*Palomena*
3.	*Euschistus servus* (Pink shield bug)	Pentatomidae	*Euschistus*
4.	*Dysdercus cingulatus* (Red cotton bug)	Pyrrhocoridae	*Dysdercus*
5.	*Lygus lineolaris*	Miridae	*Lygus*
6.	*Diabrotica undecimpunctata* (Ladybug)	Coccinellidae	*Diabrotica*
7.	*Harmonia axyridis* (lady bug)	Latreille	*Harmonia*
8..	*nezara viridula* (green vegetable bug)	Pentatomidae	*Nezara*

***Chrysocoris patricius* (Green jewel bug)**

***Palomena prasina* (Green shield bug)**

***Euschistus servus* (Pink shield bug)**

***Dysdercus cingulatus* (Red cotton bug)**



Lygus lineolaris

Diabrotica undecimpunctata (Lady bug)

***Harmonia axyridis* (lady bug)**

***nezara viridula* (green vegetable bug)**

Fig 1: Images of some Bug of protected areas of Katepurna wildlife Sanctuary of Akola (M.S.)

Discussion

Bugs mainly occur as a pest on various plants. A total of 8 bug individuals were recorded belonging to 8 species Within 8 genera falling under 5 families falling under order Hemiptera. All of them are reported first time from records Katepurna wild life Sanctuary. Family Pentatomidae and Pyrrhocoridae respectively show the maximum diversity among all the families. *Chrysocoris patricius* (Green jewel bug) belong to family Scutelleridae recorded near their host plant namely *Mangifera indica* (Mango). Pentatomidae family represents three species of bug *Palomena prasina* (Green shield bug), Euschistus servus (Pink shield bug) and Nezara viridula (green vegetable bug) These bugs feed on fruit and stems of a wide variety of plants. Hosts include native species, weeds, garden flowers, vegetables, maize, fruit crops and macadamia nuts. Pyrrhocoridae family represents bug Dysdercus cingulatus (Red cotton bug) Found on cotton (Gossypium), D. cingulatus feeds on a number of other crop plants including okra (Abelmoschus esculentus), muskmallow (Abelmoschus moschatus), hibiscus, white jute (Corchorus capsularis), citrus and maize (Zea mays). It also attacks trees including silk cotton tree (Bombax ceiba), kapok (Ceiba pentandra), teak (Tectona grandis) and the portia tree (Thespesia populnea).

The species Lygus lineolaris, Diabrotica undecimpunctata(Lady bug) and *Harmonia axyridis* (lady bug) represented the family Miridae, Coccinellidae and Latreille respectively.These three families appeared to be scarce representing single species.

Lygus lineolarisgrown crop plants, but favors cotton. While Garlic flowers attract pollinators and beneficialinsects like ladybugs. Besides this garlic repels pests and insects like flies and mosquitoes.

Conclusion

Insects like Bug provide useful services to mankind and the environment in a number of ways. They keep pest insects in check, pollinate crops we rely on as food, and act as sanitation experts, cleaning up waste so that the world doesn't become overrun with dung. Professional entomologists contribute to the betterment of humankind by detecting the role of insects like Bug in the spread of disease and discovering ways of protecting food and fiber crops, and livestock from being damaged. They study the way beneficial insects contribute to the well being of humans, animals, and plants.

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Preliminary study on diversity of coleopteran fauna from Katepurna region, district Akola, Maharashtra, India

Priyanka M Ramteke
Assistant Professor, Shri Shivaji Art, Commerce and Science College Akola, Maharashtra, India

Abstract
The present investigation on the coleopteran diversity in and around Katepurna region, District Akola, Maharashtra, India was conducted from October 2021 to December 2021. The beetles were collected from diverse areas of Katepurna region as crop land, water bodies and grassland terrain. A total of 12 beetle individuals were recorded belonging to 12 species Within 12 genera falling under 9 families.

Keywords: coleopteran, beetle, Insecta, Katepurna, Akola

Introduction
Coleopteran (Linnaeus, 1758) is an exceedingly diverse order of class Insecta. They are distributed worldwide and are adapted for every possible habitat on our planet (except marine and polar regions). Habitat and food specificity make them ecologically and economically significant as indicator species and pests respectively2. The World record of identified species is 3,50,0003 where as 17,431 species have been reported from India.
The beetle diversity is enormous; they display a great deal of ecological importance. Some of them are specialized feeder of animal and plant debris5, while some are not. Many of species are destructive; by feeding on vital plant parts like flowers, fruits and seeds, which ultimately damage our economy. Numbers of the predatory species are biological control agents of agricultural pests' beetles of the family Coccinellidae (lady bugs) feeds on insect pest like aphids that damages crops. They also play a crucial role in the ecosystem as a pray of several Pisces, Aves Mammals. The present study helps in understanding the diversity of beetles from Katepurna.

Materials and Methods
Study area
The total geographical area of Akola district is 5417 sq.km. The global location of the District extends between north latitudes 20°16' and 21°17' and east longitudes 76°38' and 77°38'. The major freshwater source is Katepurna River situated at Mahan, near Barshi Takali. The region has a large area under crop cultivation. The beetles were collected from diverse areas of Katepurna region as crop land, water bodies and grassland terrain. Light traps method was used for insect collection, majority of insect collected at evening hand picking were also applied. Filed visit was undertaken every collected and preserved as per the standard procedure, and specimens were identified with the help identification literature and manuals7-9 as well as different websites from the internet.

Result

Fig 1: A total of 12 beetle individuals were recorded belonging to 12 species Within 12 genera falling under 9 families.

Sr. No.	Name of the species	Family	Genus
1.	*Mylabris variabilis* (Blister beetle)	Meloidae	*Mylabris*
2.	*Attagenus Unicolor* (Black carpet beetle)	Dermestidae	*Attagenus*
3.	*Typocerus Sparsus* (Black and yellow long horn beetle)	Cerambycidae	*Typocerus*
4.	*Carabus nemoralis* (Ground beetle)	Carabidae	*Carabus*
5.	*Cassida Circumdata* (Mottled tortoise beetle)	Chrysomelidae	*Cassida*
6.	*Coccinella Septempunctata* (Seven spotted lady beetle)	Coccinellidae	*Coccinella*
7.	*Epicauta Vittata* (Striped blister beetle)	Meloidae	*Epicauta*
8.	*Lyctoxylon dentatum* (Powderpost beetle)	Bostrichidae	*Lyctoxylon*
9.	*Batocera rufomaculata* (Long horned beetle)	Cerambycidae	*Batocera*
10.	*Chauliognathus lugubris* (Yellow neck soldier beetle)	Cantharidae	*Chauliognathus*

11.	*Megapenthes caprella* (Winter click beetle)	Elateridae	*Megapenthes*
12.	*odagrica fuscicornis* (Flea beetle)	Chrysomelidae	*Podagrica*

Mylabris variabilis (Blister beetle)

Attagenus Unicolor (Black carpet beetle)

Typocerus Sparsus (Black and yellow long horn beetle)

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Chauliognathus lugubris (Yellow neck soldier beetle)

Megapenthes caprella (Winter click beetle)

Podagrica fuscicornis (Flea beetle)

Fig 1

Discussion

12 specimens collected, 12 species of beetles were identified. The checklist of beetles is given in Table I. In present study diversity of beetles of 9 different families were recorded. A preliminary study was conducted on beetles of Katepurna Wildlife Sanctuary. The region has a large area under crop cultivation. The beetles were collected from diverse areas of Katepurna region as crop land, water bodies and grassland terrain.

The notable species accumulated in the Crop land habitats of Katepurna were *Mylabris variabilis* (Blister beetle) and *Epicauta Vittata* (Striped blister beetle) belongs to Family Meloidae on their respective host plants namely *Solanum tuberosum* (potato) & *Solanum lycopersicum* (tomato).

The Dermestidae represented a few species of beetle which include *Attagenus Unicolor*(Black carpet beetle) observed as a pest Feed on barley, peanuts, bran, maize and also on household items including wool articles, some synthetic fibres, cereal products, damaging carpets.

Cerambycidae family represents two species of beetle *Typocerus Sparsus* (Black and yellow long horn beetle) and *Batocera rufomaculata* (Long horned beetle). It feed on Ficus carica, papaya, mangifera indica (mango) and shorea robusta.

The Carabidae represented a few species of beetle which include Carabus nemoralis(Ground beetle) observed as a pest Feed on eggs and larvae of root maggots, aphids, caterpillars, beetle larvae and weed seeds.

Chrysomelidae family represents two species of beetle Cassida Circumdata (Mottled tortoise beetle) and Podagrica fuscicornis (Flea beetle). It feed on Feed upon sweet potato plants, other crops including cabbage, corn & strawberry.

The Coccinellidae represented a few species of beetle which include Coccinella Septempunctata (Seven spotted lady beetle) Found on crops including potatoes, legumes, sweet corn, alfalfa, wheat, sorghum, etc.

The species Lyctoxylon dentatum (Powderpost beetle), Chauliognathus lugubris (Yellow neck soldier beetle) and Megapenthes caprella (Winter click beetle) represented the family Bostrichidae, Cantharidae and Elateridae respectively. These three families appeared to be scarce representing single species.

The species Lyctoxylon dentatum (Powderpost beetle) lives in dead branches & limbs of trees, barns and sheds. Attack on wood products manufactured from hardwood trees such as oak, ash, walnut, hickory, poplar or cherry.

Chauliognathus lugubris (Yellow neck soldier beetle) found on flowers such as sunflowers, goldenrod, coneflowers. Feed on eggs or larvae of another insects.

Megapenthes caprella (Winter click beetle) found on Wide variety of crops including beans, beets, clovers, corn, cotton, grasses, wheat, oat, potato & sweet potato.

Conclusion

Beetles are of value to humans in many ways. They are prominent decomposers, especially in forests. As predators, they reduce populations of problem insects, especially caterpillars. Ladybird beetles are widely known to be important predators of aphids, and can be purchased commercially for this purpose.

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Induced physical and chemical mutagenic studies in M_1 generation of Chickpea (*Cicer arietinum* L.)

***S. R. Aher[1] and D. K. Koche[2]**
Assistant Professor, Department of Botany, M.S.P. Arts, Science and K.P.T. Commerce College, Manora Dist. Washim (M.S.), India.
Professor, Department of Botany, Shri Shivaji Arts, Commerce and Science College Akola (M.S.), India.
Corresponding Author Email: shivdasaher92@gmail.com (Mobile. No.: 8605355240)

ABSTRACT:
The seeds of chickpea (*Cicer arietinum* L.) varieties -Vishal and JAKI-9218 were treated with mutagens EMS, Sodium azide (SA), and Gamma-rays. M_1 generation was raised and studied with respect to different morphological parameters such as germination percentage, plant survival percentage at maturity, plant sterility percentage, and fertility percentage. Germination Percentage was found lesser in both populations treated with chemical mutagens as compared to physical mutagen gamma radiation and control. High sterility is recorded in M_1 plants of both Chickpea varieties treated with EMS and Sodium azide. However, the plant germination, survival and fertility percentage were highest in the gamma-ray-treated M1 population of both varieties. An increasing trend with an increase in mutagenic concentrations/doses is recorded for the percentage of sterility while germination percentage and plant survival percentage at maturity revealed a decreasing trend with increasing mutagenic concentrations/doses.

KEYWORDS: Chickpea, EMS, Gamma Rays, Germination, mutagens, M_1 generation.

INTRODUCTION:
Chickpea botanically described as *Cicer arietinum* L. belongs to the family Fabaceae. It is popularly grown for its edible mature seeds. It is a cheap plant protein, carbohydrates, and minerals source in the human diet, especially in the Indian arena (Jukanti *et.al.*, 2012). This crop plant also plays a key role in the enrichment of soil fertility by fixing atmospheric nitrogen through symbiotic nitrogen fixation. It's a popular grain among people, but the average yield of chickpeas reported in India is far below its potential (Choudhary *et al*., 2013).

Induced mutation breeding has become an established tool in plant breeding to supplement existing germplasm and improve cultivars in certain traits. Mutagenesis has been widely used as a potent method of enhancing variability for crop improvement. This is a highly effective method in enhancing natural genetic resources and have been used in developing improved cultivars of crops (Gaul *et al*., 1972; Lee *et al*., 2002; Jagadeesan and Punniyamoorthy, 2023).

Therefore, it was planned to initiate the work of induced mutation breeding in Chickpea. The present paper deals with the details of the effects of physical mutagen gamma rays and chemical mutagens EMS and SA on different parameters of the M_1 generation of Chickpea varieties Vishal and JAKI. Variety Jaki has its specialized role in the high productivity of the chickpea crop throughout the state while Vishal is an old Desi variety bearing a large pod size. The parameters considered in this work are the percentage of germination, percentage of survival, percentage of sterility, and percentage of fertile mutants.

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MATERIAL AND METHODS:

Seed Material: The seeds of Chickpea cultivars such as JAKI- 9218 and VISHAL were obtained from Pulse Research Station, Dr. P. D. K. V. Akola (MS). Germplasm of Chickpea was irradiated with Gamma Rays (Co-60) and treated with EMS and Sodium Azide in laboratory conditions. The gamma irradiation facility was made available from the Central Instrumentation Facility, Rashtra Sant Tukdoji Maharaj Nagpur University, Nagpur. For the present study, Dry, uniform, and healthy seeds of Chickpeas (Var. Vishal and Jaki- 9218 with a moisture content of 10 to 12% were selected and about 320 seeds of each cultivar and for each dose of mutagen were selected and treated with gamma radiations (100 Gy, 200 Gy, 300 Gy, and 400 Gy) EMS and Sodium Azide (0.1% 0.2% 0.3%).

Treatment Details:

The experiment was conducted to determine the lethal dose for the suitable concentration of EMS, Sodium Azide and duration of seed treatment. The dose of gamma rays 100 Gy, 200 Gy, 300 Gy and 400 Gy, EMS, and sodium Azide 0.1%, 0.2%, and 0.3% were finally selected for the seed treatment and the duration fixed was for 4 hours. Selected seeds were soaked in distilled water for 10 hours and the wet seeds were treated with different concentrations of EMS and Sodium Azide (0.1%, 0.2%, and 0.3%) for 4 hours. The untreated control was sown on either side of each plot.

The seeds treated with different concentrations of Sodium Azide and EMS was washed thoroughly under tap water for 1 hour. The treated seeds from each treatment were used for raising M_1 generation in the field.

Table 1. Mutagens and Doses used:

Sr. No.	Mutagens	Dosages			
1.	Gamma rays	100 Gy	200 Gy	300 Gy	400 Gy
2.	Sodium Azide (S.A.)	0.1%	0.2%	0.3%	
3.	EMS	0.1%	0.2%	0.3%	

Experimental Site:

The present investigation was carried out in an experimental field located at Jaipur, Taluka Sengaon District Hingoli (M.S.). The soil type of the experimental field was medium-deep to deep black soil with good drainage. The average annual minimum temperature recorded was 18°C and that of maximum was 31°C during winter with average rainfall of 596.5 mm. (Source: World Weather Online).

The M_1 generation was thoroughly studied for the following parameters.

1. **Percentage of germination.**
   The germination percentage is recorded directly at the field from the number of seeds germinated, 7 to 14 days after seen sowing. The number of germinated plants is recorded from each treatment/dose of mutagen and for control.
2. **Percentage of survival.**
   The plant's survival rate is recorded at the complete maturity level. Generally, at the time of flowering and pod setting. The number is denoted in the form of percentage.
3. **Percentage of sterile and fertile mutants.**
   From the raised progeny from each treatment, few plants were found completely sterile at the time of flowering and pod setting. The number of sterile plants is noted and their percentage values are calculated. The sterile plant flowers were observed, and pollens are tested under the microscope on a slide by adding a few drops of 1.5% acetocarmine. Fully stained pollen grains were considered as fertile while empty, partially stained ones were considered sterile. The remaining plants were counted as fertile and their percentage was

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calculated for each dose.

RESULTS AND DISCUSSION:

The results of the morphological parameters recorded in M_1 population of gamma rays, EMS and SA treated progenies of variety Vishal and variety JAKI are given in table 2 and table 3 respectively. This includes seed germination %, Plant survival, and percentage of sterile and fertile plants in given populations.

Table 2. Effect of mutagens on different M_1 parameters in chickpea variety Vishal.

Treatment	Concentration (%)/Dose	Seed Sown	Seed germinated	Seed germination %	Plants survived	Plant survival %	Plant sterile	Plant sterility %	Plants fertile	Plant fertility %
Control	--	320	318	99.37	318	100	00	00	318	100
Gamma rays	100 Gy	320	316	98.75	310	98.10	02	0.64	308	99.35
	200 Gy	320	306	95.62	289	94.44	03	1.03	297	99.00
	300 Gy	320	313	97.81	308	98.40	01	0.32	307	99.67
	400 Gy	320	306	95.62	285	93.13	06	2.10	279	97.89
Sodium Azide (S.A.)	0.1 %	320	208	65.00	186	89.42	27	14.51	159	69.35
	0.2 %	320	184	57.50	152	82.60	42	21.05	110	72.36
	0.3 %	320	100	31.25	64	64.00	38	59.37	26	40.62
E.M.S.	0.1 %	320	205	64.06	166	80.97	12	0.07	154	92.77
	0.2 %	320	151	47.18	105	69.53	18	17.14	87	82.85
	0.3 %	320	101	31.56	57	56.43	13	22.80	44	77.19

Table 3. Effect of mutagens on different M_1 parameters in chickpea variety Jaki.

Treatment	Concentration (%)/Dose	Seed Sow	Seed germinated	Seed germination %	Plants survived	Plant survival %	Plant sterile	Plant sterility %	Plants fertile	Plant fertility %
Control	--	320	318	99.37	319	99.68	00	0.00	319	100
Gamma rays	100 Gy	320	319	99.68	318	99.68	02	0.62	316	98.70
	200 Gy	320	314	98.12	309	98.40	04	1.29	305	98.70
	300 Gy	320	309	96.56	304	98.38	07	2.30	297	97.69
	400 Gy	320	308	96.25	295	95.77	05	1.69	290	98.30
Sodium Azide (S.A.)	0.1 %	320	313	97.81	225	71.88	15	6.66	210	93.33
	0.2 %	320	258	80.62	177	68.60	22	12.42	155	87.57
	0.3 %	320	230	71.87	154	66.95	21	13.63	123	79.87
E.M.S.	0.1 %	320	293	91.56	230	78.49	12	5.21	218	94.78
	0.2 %	320	251	78.43	195	77.68	27	13.84	168	86.15
	0.3 %	320	203	63.43	155	76.38	32	20.64	123	79.35

Percentage of germination:

The germination rate of treated seeds is found to be lesser than the control in each

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dose of treatment of all mutagens used (table-2 and 3). Among treated 100 Gy dose of gamma radiations showed the highest percentage of germination for both varieties. In general gamma-ray treated, seeds showed higher germination rates followed by SA-treated seeds and EMS-treated seeds respectively. Further in each case, the rate of percentage of germination in each mutagen treatment was found to decrease with an increase in dose or concentration of mutagen (table-2 and 3). Figures 1 and 2 are representative photographs of control and treated plots of chickpea varieties Vijay and JAKI. In both of the selected varieties the process of germination in EMS treated seeds is found to be very slow, it took more 6-8 days extra for germination than control seeds in the field. But after germination the growth rate in same mutant plants found to rapid and it recovers the gap of long duration.

Figure 1. Germination in control seeds plots of both selected varieties.

Figure 2. Germination in gamma ray (100Gy) plots of variety JAKI.

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Percentage of survival:

After germination, all the germinated plants do not survive till maturity. There might be different reasons for their deaths like microbial infections, morpho-physiological abnormalities, injury etc. In controls of both varieties, the survival was 100%. In both varieties, gamma irradiation 100Gy showed the highest survival among all. The survival rate of gamma treated population was noted as 97.89 to 99.35 in variety Vishal and 97.69 to 98.70 in JAKI. Further SA and EMS-treated populations showed lesser survival as compared to gamma ray treated populations (Table-2 and 3).

Percentage of sterile mutants:

The highest percentage of sterility was recorded in the progeny of EMS-treated seeds in both varieties. In variety JAKI its percentage ranges from 5.21 to 20.64%, while that of SA treated seeds was ranging from 6.66 to 13.63% and of gamma-treated seeds progeny was ranging from 0.62 to 2.30% (Table-2 and 3). In case of variety Vijay similar trend was observed. In sterile mutants generally petals are found to be absent and so that the flower bud directly enclosed by calyx. Because of absence of petals the anthers can directly see by outside of flower buds. (Figure 3)

Percentage of fertile mutants:

When the percentage of fertile plant types calculated in M1 generation of variety Vijay, gamma radiation treated progeny showed the highest percentage ranging from 97.89 to 99.35% followed by that of SA (40.62 to 72.36%) and EMS (72.19 to 92.77) (table-2) and a similar trend was observed in Variety JAKI. Figure 3 shows a sterile M1 plant type variety Vishal treated with EMS and Figure 4 represents a gamma radiation (300Gy) treated normal fertile plant type of the same variety. Fig. 5 and Fig. 6 represents Control normal fertile plant type of variety Vishal and variety Jaki respectively. Fertile plant types bears a good viable pollens.

Figure.3. Sterile mutant from 0.1% EMS-treated seeds of variety Vishal.

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Figure. 4. Normal fertile plant type from Gamma 300 treatment variety- Vishal.

Figure. 5. Normal fertile plant type from Control variety- Vishal.

Figure. 6. Normal fertile plant type from Control variety- Jaki.

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CONCLUSIONS:

The mutagen directly affects various plant traits directly or indirectly. As our results indicate that their gamma rays showed the highest germination percentage, high survival rate, and higher plant fertility in both varieties of chickpea. Similar studies were reported by Swaminathan *et al*., (1962) in Barley, Avan *et al*., (1980) in rice, Wongpiyasatid *et al*., (2000) in mungbean, Wani *et al*., (2009) in Chickpea, Mahamune and Kothekar (2012) in *Phaseolus* sp., Bogawar *et al*., (2017) in Chickpea varieties, Sofia *et al*., (2019) in Mungbean varieties and Kondapalli and Lavanya (2021) in Chickpea varieties.

From the study, it could be concluded that the mutagenic doses affect the germination, survival and plant fertility percentage. In general, the treated progeny has low rate of germination, low survival higher sterility in chickpeas. Further, as we increase the dose or concentration of mutagen, it increases its effect and further lowers the rate of germination, survival, and fertility.

The lowers in the rate of germination, survival, and fertility it might be because of the random chromosomal aberrations in the treated seeds of mutants. As we increase the concentration of doses there may more chromosomal breakage and can cause more mutations that can disturb or loss the functions within the genome of plant.

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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.

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