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SRC-QUEST Volume 4 | December 2024

SRC-QUEST

Volume 4 | December 2024

Showcasing the latest faculty research in arts, science and commerce.

Seethalakshmi Ramaswami College

Tiruchirappalli, Tamil Nadu, India

Accredited with A+ by NAAC (4th Cycle)

SEETHALAKSHMI RAMASWAMI COLLEGE

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SRC - QUEST

Volume 4 | December 2024

Editor - in - Chief

Dr. S. Santhi

Showcasing the latest faculty research in Arts, Science and Commerce.

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The light that guides us all..
To them we owe all our achievements

Our Revered Founder

Padmabhushan Sri N.Ramaswami Ayyar
Srimathi Alamelu Seethalakshmi Ammal

Titles Conferred on our Founder

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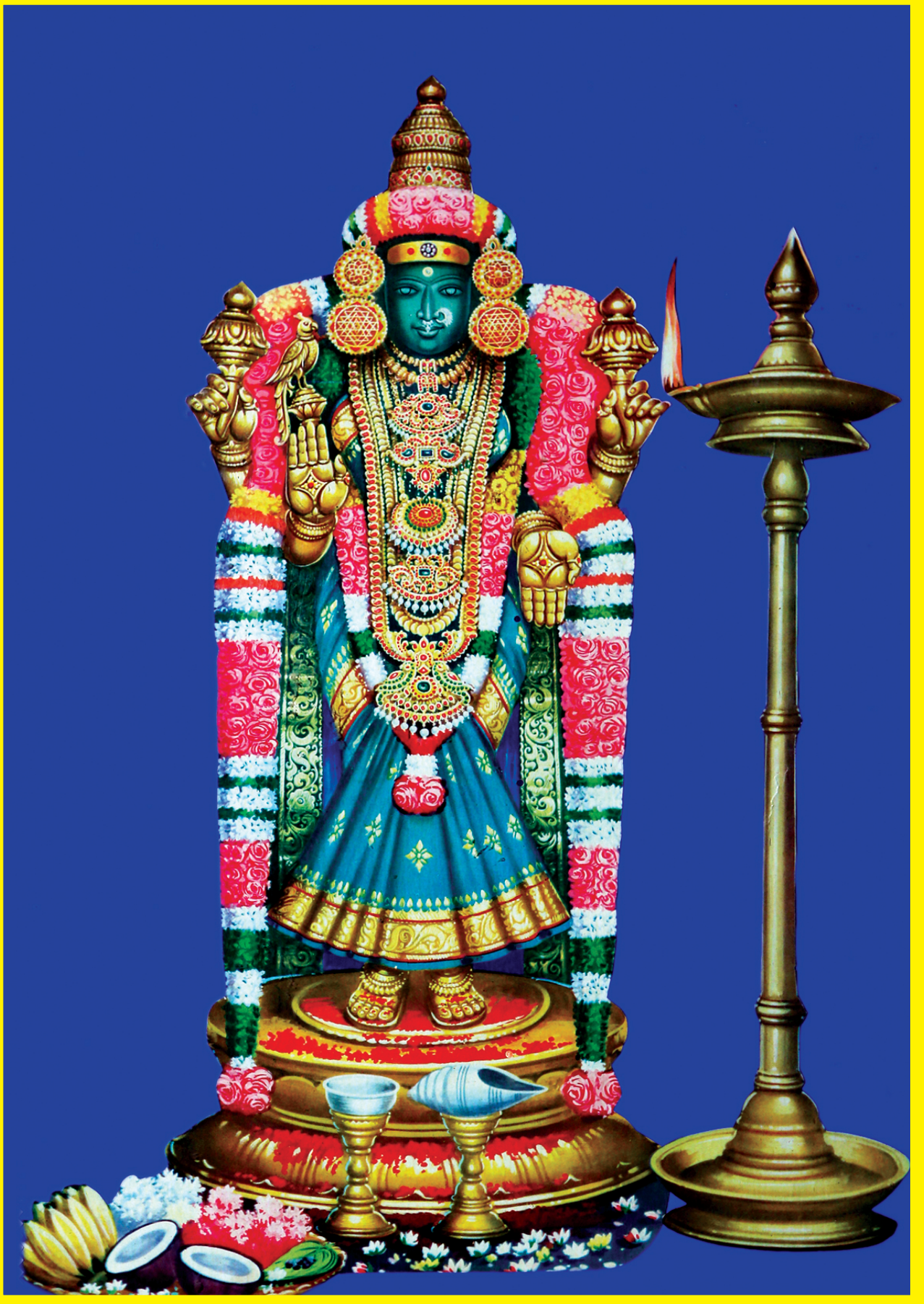

Smt. Vasantha Panchapakesan

Co-ordinator

Padmabhushan Sri. N. Ramaswami Ayyar Educational Complex

(1943 – 2020)

An epitome of kindness and our source of inspiration.

May she continue to guide us from her heavenly abode

R. Panchapakesan, B.Sc., B.L.,
MANAGING TRUSTEE & SECRETARY

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Seethalakshmi Ramaswami College
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Message

Seethalakshmi Ramaswami College, a higher education institution of repute, having made more than 70 years of astute contribution to women's empowerment through education, has a hallmark tradition of engaging in research and contributing to innovation.

The students, scholars and faculty – the primary stakeholders in the institution are encouraged to contribute through research. Faculty's constant engagement in research is reflected in their publication.

SRC - Quest is one such initiative to present faculty's research contributions to the academia. This in-house annual journal of SRC, is multi-disciplinary in nature, as it includes scholarly contributions from all disciplines.

The emerging and new areas of study in the various disciplines are explored with keenly, to make impactful findings, which are directly beneficial for scholars and students in their disciplines, to take the ideas forward and make fruitful contribution not only to their domains but also to the nation.

I congratulate the faculty who have contributed to this edition of *SRC – Quest*and the journal team, who have successfully brought out this volume,thus adding to the research outcome of the institution.

Best wishes to succeed in all your endeavours.

MESSAGE FROM PRINCIPAL

Dr. M.V. Alli
Principal
Seethalakshmi Ramaswami College
Tiruchirappalli - 2

It is with profound pleasure and enthusiasm that we present the fourth edition of our in-house journal *SRC-QUEST*, a vibrant reflection of the spirit, dedication, and achievements that define Seethalakshmi Ramaswami College, Tiruchirappalli. This publication is more than just a collection of research and review articles; it is a celebration of our intellectual diversity, our commitment to learning, and the unique attributes that make the environment of our institution dynamic.

In this edition I am sure, you will find new research findings, innovative areas of scientific enquiry, recent insights and reflect the research caliber of our faculty. Each contribution has showcased their curiosity, critical thinking, and dedication that we strive to cultivate in our institution. Our journal represents a space where ideas flourish, perspectives broaden and innovation is celebrated.

Our institution remains committed to fostering an environment that values academic rigor, creative freedom and social responsibility. Publication of this edition will be instrumental in keeping researchers informed about the latest developments in their field, supporting the integrity of research through reproducibility and replicability and influencing the direction of future research endeavors.

I would like to extend my heartfelt gratitude to the Editor-in-Chief, Editorial Team, Authors, Reviewers and Technical Team who were involved in the production and publication of this journal. Your hard work has brought this publication to life, creating a platform for information and ideas that enrich the research community.

I invite each reader to appreciate the content of this journal and to celebrate the collective creativity and knowledge it represents.

Dr. M.V. Alli

ACKNOWLEDGEMENT

"First and foremost, I offer my fervent supplications at the revered lotus feet of the omnipotent Goddess Akilandeswari, imploring divine providence and sagacious guidance to illuminate our Odyssey towards the attainment of our lofty objectives.

I extend my deepest gratitude to our venerable founder, whose visionary leadership and unwavering commitment have served as a beacon of inspiration, charting our course and fostering a milieu conducive to excellence, thereby catalyzing our metamorphosis into a paradigm of success.

My copious namaskarams to our esteemed Madam Coordinator, whose invaluable blessings havenurtured our growth, facilitated our progress, and provided an impetus for our ascent.

I sincerely offer my namaskarams and fathomless gratitude to our Managing Trustee, whose indefatigable efforts, unrelenting dedication, and unwavering resolve have culminated in the triumphant publication of this magnum opus.

I place on record my profuse thanks to our Executive Director for his rich guidance in the process of publication of this volume.

I acknowledge with profound appreciation the indefatigable endeavors of our Director Academics, who has left no stone unturned, surmounted seemingly insurmountable obstacles, and offered sage counsel to ensure the unalloyed success and efficacious implementation of this endeavor.

I thankfully acknowledge the perspicacious guidance and encouragement proffered by our Secretary, which has been instrumental in facilitating the seamless publication of this volume, navigating complex logistical challenges, and traversing uncharted territories.

My thanks are due to our Principal, Dr. M.V.Alli, whose unstinted support and consummate cooperation have inspired us to strive for excellence.

I express my sincere thanks to the discerning reviewers and contributors, whose meticulous efforts, astute observations, and sage recommendations have been pivotal in making this publication a resounding success.

My deep sense of gratitude and thanks are due to the members of the Board and Technical Committee, whose timely counsel, valuable suggestions, and cooperative spirit have been essential in making this publication a reality, navigating complex challenges, and overcoming seemingly insurmountable hurdles.

I extend my sincere thanks to Mr.Gani Mohamed for his opportune assistance, which has proven to be a catalyst for our success.

Lastly, I extend my heartfelt appreciation to all individuals who have contributed their expertise, time, energy, and passion to bring this volume to fruition, transforming a vision into a tangible reality.

Dr. S. Santhi
Associate Professor of Chemistry
Editor-in-chief-SRC-Quest

FOREWORD MESSAGE FROM THE BOARD OF EDITORS

Seethalakshmi Ramaswami College, a paragon of academic excellence, owes its genesis to the visionary zeal of our founder, Padmabhushan Shri. N. Ramawami Ayyar, who pioneered the empowerment of women through holistic education, thereby sowing the seeds of intellectual and personal growth. This philanthropic stalwart, ahead of his time, recognized the transformative potential of women's education and took the helm, establishing a beacon of learning in the 1950s, long before it became a mainstream imperative.

The baton of excellence was subsequently passed to his illustrious progeny, Sri. R. Panchapakesan, who built upon his father's legacy with unwavering dedication, unrelenting passion, and a steadfast commitment to academic distinction. Alongside his erudite wife, Madam Coordinator Smt. Vasantha Panchapakesan, he navigated the institution through uncharted waters, harmoniously blending traditional values with innovative pedagogy, and catapulting the college to unprecedented heights. This noble pursuit continues unabated, spearheaded by their sons, Sri. Ramani Panchapakesan, Executive Director, and Dr. Kannan Panchapakesan, Director – Academics, who remain resolute in their quest for scholarly excellence.

SRC-QUEST, the college's flagship journal, was inaugurated in 2021 as a testament to academic rigour, intellectual curiosity, and a multidisciplinary approach to knowledge dissemination. This esteemed publication strives to showcase cutting-edge research, fostering practical applications, innovative solutions, and paradigmatic shifts in complex, real-world problems. The inaugural volume, dedicated to our founder's 125th birth anniversary in July 2021, marked a watershed moment, while the second and third volumes consolidated this momentum. The fourth volume now boasts 27 erudite research articles from faculty members across Arts, Science, Commerce, and Management disciplines, underscoring the institution's unwavering commitment to academic integrity, excellence, and the pursuit of knowledge.

The editorial and technical committees of this peer-reviewed journal extend their deepest gratitude to the college authorities for their unwavering support, sagacious guidance, and unstinting encouragement. We also acknowledge the invaluable contributions of our faculty members, whose dynamic scholarship has enriched this volume, and whose intellectual ferment continues to propel the institution forward. It is our distinct privilege to facilitate the dissemination of knowledge through these exemplary research articles, thereby fostering a community of scholars and paving the way for future breakthroughs.

BOARD OF EDITORS

SRC - QUEST

SHOWCASING THE LATEST FACULTY RESEARCH IN ARTS, SCIENCE AND COMMERCE

Volume 4 October 2024

CONTENTS

EXTRACTION, ISOLATION AND CHARACTERIZATION OF BIOACTIVE COMPOUNDS IN *LEPIDAGATHIS CRISTATA* (WILD), ACANTHACEAE

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Abstract

Medicinal plants are rich in bioactive components that are utilized to treat various human ailments. Phytochemical constituents are responsible for the medicinal activity of plant species. Phytochemical screening is an important step in identifying bioactive compounds present in particular medicinal plants. Hence the present research focused on screening of phytochemicals in *Lepidagathis cristata* by preliminary biochemical test, TLC, HPLC and GC-MS analysis. The results of the phytochemical analysis of the plant extract revealed the presence of reducing sugar, saponins, terpenoids, alkaloids, phenolics, tannins and flavonoids. The TLC result showed that the presence of gallic acid , caffeic acid, quercetin, rutin and ferulic acid . The HPLC analysis revealed the presence of phytochemicals namely oleic acid, 3-(octadecyloxy) propyl ester, heptadecane, 9-hexyl , octadecane, 3-ethyl-5-(2-ethylbutyl) and heptadecane, 9-hexyl and ethyl iso-allocholate. GC-MS also confirmed the presence of phytoconstituents, such as heptadecane, 9-hexyl-(C23H48), octadecane, 3-ethyl-5-(2-ethylbutyl), oleic acid, 3-(octadecyloxyl)propyl ester, docosanoic acid, 1,2,3- propanetriyl ester, ethyl iso-allocholate and stigmasterol. This study also enhances the traditional usage of *L. cristata* for its bioactive compounds. These phytoconstituents needs further pharmacological investigation in order to develop new drugs for the treatment of specific diseases and this plant seemed a potent medicinal agent and could be used as a therapeutic drug in future.

Keywords: *Lepidagathis cristata*, preliminary biochemical test, TLC, HPLC, GC-MS analysis, Oleic acid, 3-(octadecyloxyl)propyl ester

Introduction

Medicinal plants are the richest resource of drugs of traditional system of medicine, modern medicine, pharmaceutical intermediates and chemical entities for synthetic drugs [1]. The herbal medicines serve the health needs of about 80% of the world's population, especially for millions of people in the vast rural areas of developing countries; more than 65% of the global population uses medicinal plants as a primary health care modality [2].

Plants are used as food, medicine, flavor, cosmetic, fumigant, insect deterrent and ornamental [3].

India is one of the world's 12 biodiversity centers with the presence of over 45,000 different plant species. Of these, about 15,000 to 20,000 plants have immense medicinal value. Everyday new inspiring information is being added to folklore medicine for the development of drugs [4].

Plants are the reservoirs of potentially useful chemical compounds which could serve as newer leads and clues for modern drug design. The most important of these bioactive constituents of plants are alkaloids, tannins, flavonoids and phenolic compounds [5]. Correlation between the phytoconstituents and the bioactivity of plant is desirable to know for the synthesis of compounds with specific activities to treat various health ailments and chronic diseases as well. For example, vincristine (an antitumor drug), digoxin (heart regulators) and ephedrine (a bronchodilator used to decrease respiratory congestion) were all originally discovered through research on plants [6]. The medicinal plants are useful for healing as well as for curing of human diseases because of the presence of phytochemical constituents [7]. Phytochemicals are primary and secondary compounds. Chlorophyll, proteins and common sugars are included in primary constituents and secondary compounds have terpenoids, alkaloids and phenolic compounds [8].

There is growing awareness in correlating the phytochemical constituents of a medicinal plant with its pharmacological activity [9,10,11]. Screening of active compounds from plants has led to the invention of new medicinal drugs which have efficient protection and treatment roles against various diseases, including cancer [12] and Alzheimer's disease [13].

The present study was carried out for screening of qualitative and quantitative phytochemical analysis of *Lepidagathis cristata* Willd. *Lepidagathis* genus belongs to the family Acanthaceae represented by 100 species, widely distributed in tropical and subtropical regions of Asia and Africa [14]. *Lepidagathis cristata* is an important medicinal herb distributed widely in peninsular India.

L. cristata has been widely used as folklore medicine, it is used to cure fever, the aqueous extract of leaves mixed with *Ocimum* juice in 10:1 ratio and the tuberous flower ash mixed with coconut oil is applied externally on inflamed area. The leaf extract is used especially for malarial fever. It is also used for ring worm, burn, wounds, skin and itchy infections [15,16,17]. Used as bitter tonic for fever, pneumonia, flu, mouth infections [18], eczema, psoriasis and other skin infections [19]. The ash of whole herb is applied externally

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on chronic wounds of pet animals [20]. Fumigation of this medicinal herb is used to treat epilepsy [21]. The roots of the herb are used in stomachic and dyspepsia. The inflorescence ash is used for itchy affections of skin and burns [22]. Leaf juice with copper sulphate is given during snakebite for gaining consciousness [23].

Materials and Methods

Lepidagathis cristata Willd. is a medicinal herb, belongs to the family Acanthaceae commonly known as *Nakkapidi*, *Lankapindi* (Yanadi tribal), *Mullabanthi* (Telugu), *Karappan poondu* (Tamil), *Karappanundu* (Malayalam) and *Otdhompo* (Santhal tribe) [24]. Usually, it appears in dry places and waste lands. It is a perennial herb, branches numerous from highly reduced main stem; Leaves- sessile, 3.0 - 6.0 × 0.5 - 1.0 cm, linear-lanceolate, pubescent, acute at both ends, margin entire to serrulate; Flowers- in globose heads, crowded at the base of the stem; bracts elliptic, spinesent; bracteolate. Calyx- lobes 5, hairy; corolla- white with brown or purple spots; stamens 4, didynamous, anther two celled and exerted; style slender; stigma simple, fruit capsule, oblong and Seeds 2 (Figure 1). Flowering seasons is January-March [25].

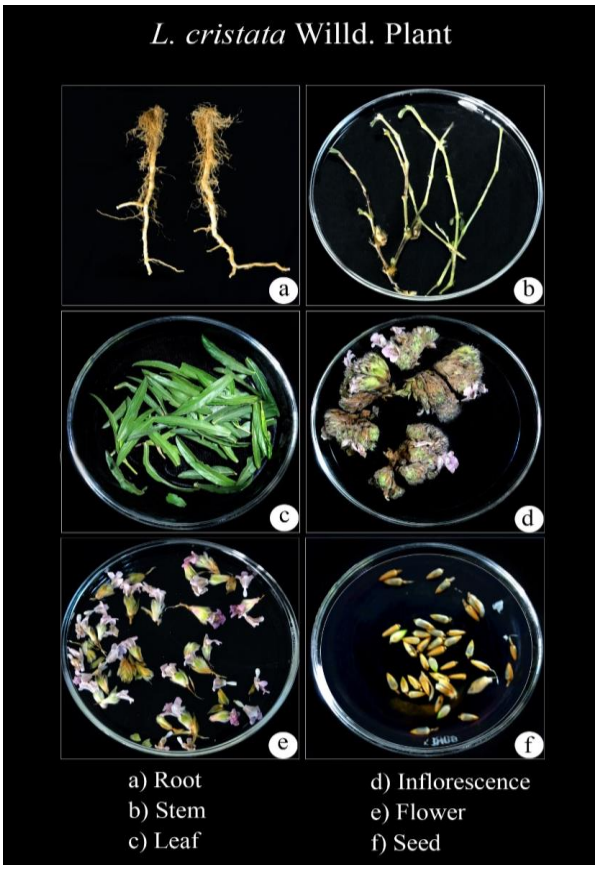

Figure 1.

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Source of Plant Material

The plants of *L. cristata* were collected from a naturalized population in Sobanapuram, foot of Pachhaimalai Hills, Tiruchirappalli District. The plant material was washed under running tap water, air dried in shade and then homogenized to fine powder and stored in sterile air tight bottles for the experimental use.

Phytochemical Analysis of *L. Cristata*

a) Preliminary phytochemical tests for qualitative chemical examination

The ethanolic extract of *L. cristata* was subjected to qualitative tests for the identification of phytochemical constituents is referred as test solution. The preliminary phytochemical screening has been performed by Brindha *et al*. [26] method. Ten grams of the dried powdered plant material in 150 ml of ethanol for six hours is extracted using Soxhlet apparatus. The extract was concentrated and used for preliminary phytochemical screening (Table 1).

Table1: Preliminary Phytochemical Test - Observation & Inference

Test	Observation	Inference
Test solution + 2 ml of Fehling's reagent + 3 ml of H_2O	Red-orange colour formed	Presence of reducing sugar
Test solution +H_2O and shake	Foamy lather formed	Presence of saponins
Test solution+ Piece of tin + 3 drops of thionyl chloride	Violet or Purple colour developed	Presence of triterpenoid
Test solution taken with 2N HCl. Aqueous layer formed and to which one or few drops of Mayer's reagent (5 g of potassium iodide and 1.4 g of mercuric chloride dissolved in 100 ml of distilled water)	White precipitate or turbidity formed	Presence of alkaloids

Test solution in alcohol+ one drop of neutral ferric chloride (5%) solution	Intense blue colour developed	Presence of phenolic compounds
2 ml of test solution + H_2O and lead acetate few crystals	White precipitate developed	Presence of tannins
Test solution in alcohol + a bit of magnesium and one or two drops of conc. HCl and heat	Red or orange red colour formed	Presence of flavonoids

b) Isolation of phytochemicals from *L. cristata* by TLC

Glass plates (4 cm ×12 cm) were cleaned with acetone to remove the dirt, grease marks and fingerprints. Thirty grams of silica gel was mixed with 60 ml distilled water and made into slurry. The slurry was coated on the glass plates to a 0.25 cm thickness and dried in a dust free chamber for 10-15 minutes. Then TLC plates were heated for an hour at 110 ^{o}C in an oven [27]. Chromatograms were developed in a saturated chamber. After the chromatogram was developed, the plates were dried, visualized and photographed under UV light at 254 and 365 nm in KEMI make UV cabinet.

c) High Performance Liquid Chromatography (HPLC) analysis

The HPLC analysis of root, leaf and inflorescence of *Lepidagathis cristata* samples was conducted using a mobile phase methanol: water (80: 20), column 250 × 4.6 mm, 5 µm at a flow rate 1.0 ml/ minute, injection volume 20 µl with a given time of 50 minutes (Shimadzu, model 2010 CHT, Software LC solution). Standard curve of double distilled water (ddH_2O), gallic acid, caffeic acid, rutin, quercetin, ferullic acid and the test samples were compared and the respective compounds present in *L. cristata* plant were detected by HP-LC analysis [28].

d) Gas chromatography and Mass Spectroscopy (GC-MS) analysis

The powered sample (20 g) was soaked and dissolved in 75 ml of ethanol for 24 hr. Then the filtrates were collected and evaporated under liquid nitrogen. The GC-MS analysis was carried out using a Clarus 500 Perkin-Elmer (Auto system XL) Gas Chromatography equipped and coupled to a Mass detector Turbo mass gold-Perkin-Elmer Turbomass 5.1

spectrometer with an Elite-1 (100% Dimethyl Polysiloxane), 30 m × 0.25 mm ID × 1 µm df capillary column. The instrument was set to an initial temperature of 110 ^{o}C, and maintained at this temperature for 2 min. At the end of this period, the oven temperature was raised up to 280 ^{o}C, at the rate of an increase of 5 ^{o}C/min, and maintained for 9 min. Injection port temperature was ensured as 250 ^{o}C and Helium flow rate as 1 ml/min. The ionization voltage was 70 eV. The samples were injected in split mode as 10:1. Mass spectral scan range was at 25-400 mhz. [29]. The chemical constituents were identified by GC-MS. The fragmentation patterns of mass spectra were compared with those stored in the spectrometer database using National Institute of Standards and Technology-Mass Spectral database (NIST-MS).

Results

Medicinal plants are of great importance to health due to the presence of phytoconstituents. There is growing awareness in correlating the phytochemical constituents of a medicinal plant with its pharmacological activity. The present research focused on screening of phytochemicals in *Lepidagathis cristata* by preliminary biochemical test, TLC, HPLC and GC-MS analysis. The results of the phytochemical analysis of the plant extract revealed the presence of reducing sugar, saponins, terpenoids alkaloids, phenolics, tannins and flavonoids (Table 2).

Table 2: Results of the phytochemical constituent test of *L. cristata* extract

Phytochemical	**Result**
Reducing sugar	+
Saponins	+
Terpenoids	+
Alkaloids	+
Phenolics	+
Tannins	+
Flavonoids	+

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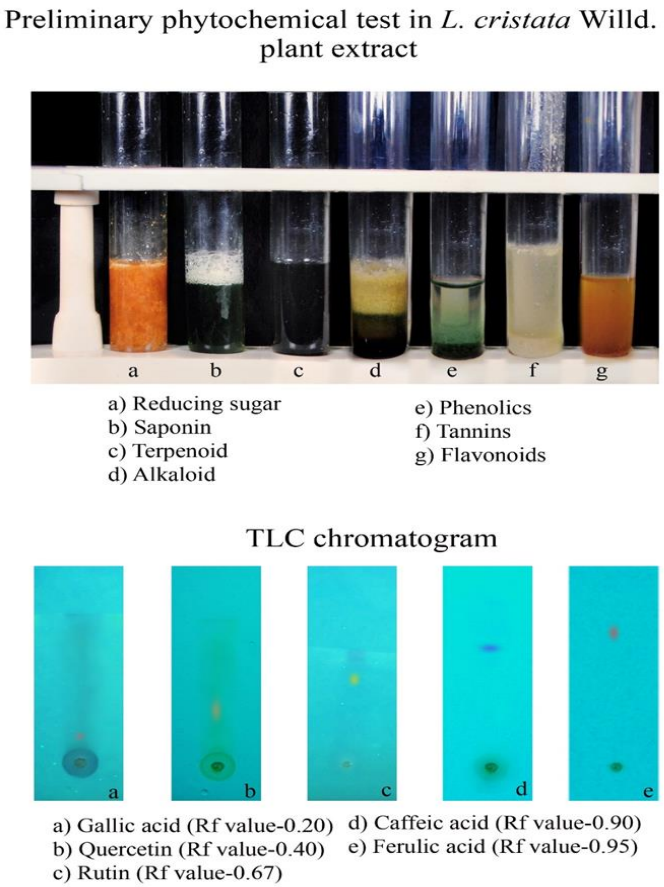


Figure 2.

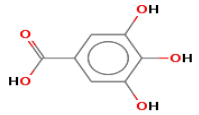
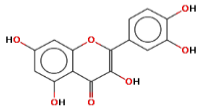
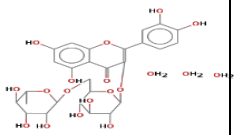
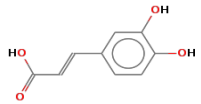
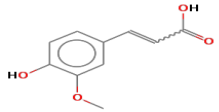
Thin layer chromatography (TLC) was used for the detection of phytochemicals from the plant extract of *L. cristata* the separated compounds and their Rf values were depicted in Figure 2 and Table-3.

Table 3: Thin layer chromatography results of ethanolic extract of *L. cristata*

Band No.	Name of the compound	Colour of the band	Rf value
1	Gallic acid	Brownish blue	0.20
2	Quercetin	Orange	0.40
3	Rutin	Dark yellow	0.67
4	Caffeic acid	Blue	0.90
5	Ferulic acid	Dark brown	0.95

The TLC results indicated that root and leaves showed higher concentration of gallic acid 4.80 µg/gm and 0.11 µg/gm respectively. It was also shown that caffeic acid, quercetin, rutin and ferulic acid were found in root, leaves and inflorescence. The name of the phytocompound and its chemical name, molecular formula, molecular weight, structure, compound nature and its biological activities are given in the Table-4 below:

Table 4: Bioactive compounds identified in *L. cristata* by HPLC analysis

S. No.	Name of the compound	Chemical name	Molecular formula	Molecular wt. g/mol	Structure	Compound nature	Biological activity
1	Gallic acid	Benzoic acid, 3,4,5-trihydroxy-	C7H6O5	170.1195		Phenolic acid	Anti-inflammatory, antimutagenic, anticancer, antioxidant and antimicrobial
2	Quercetin	Quercetin sophoretin	C15H10O7	302.2357		bioflavonoid	Anti- cancer, antioxidant, anti inflammatory, Hepatoprotective activity and antiviral
3	Rutin	Rutoside quercetin-3-nutinoside	C27H36O19	664.5633		bioflavonoid	Anti-Alzheimer, antiarthritic, antidiabetic, antiulcer, antiasthmatic & anticancer
4	Caffeic acid	Hydroxycinnamic acid	C9H8O4	180.15742		Polyphenol	Anticancer, antidiabetic, anti-inflammatory, antimicrobial and antioxidant
5	Ferulic acid	2-Propenoic acid, 3- (4-hydroxy-3-methoxyphenyl) -	C10H10O4	194.184		phenols	Anti-diabetic and anti-Ageing antioxidant, anti-inflammatory, antimicrobial, antiallergic, anticarcinogenic and prevent photodamage of skin.

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The HPLC analysis revealed the presence of phytochemicals namely Oleic acid, 3-(octadecyloxy) propyl ester, Heptadecane, 9-Hexyl , Octadecane, 3-Ethyl 5-(2-Ethylbutyl) and Heptadecane, 9-Hexyl and Ethyl iso-allocholate. The identification of phytochemicals was confirmed with the respective reference samples.

GC-MS also confirmed the presence of phytoconstituents, such as Heptadecane, 9-hexyl-(C23H48), Octadecane, 3-ethyl-5-(2-ethylbutyl) (C26H54), Oleic acid, 3-(octadecyloxyl)propyl ester (C39H76O3), Docosanoic acid, 1,2,3- propanetriyl ester(C69H134O6), Ethyl iso-allocholate (C26H44O5) and Stigmasterol (C29H48O). The molecular structures of these compounds were predicted through Mass spectrum analysis (Figure 3 and Table 5).

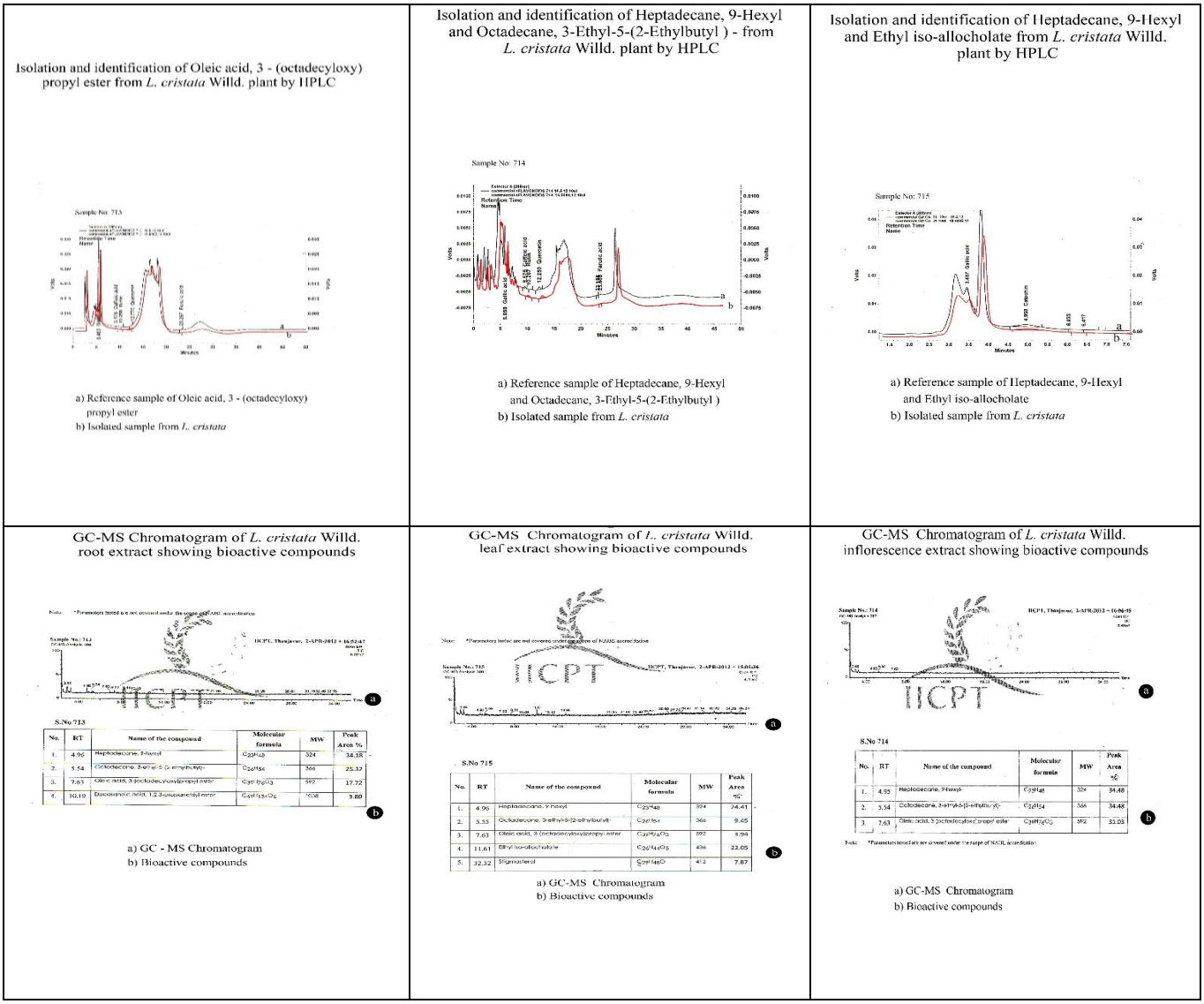

Figure 3

Table 5: The molecular structures of the Compounds

S. No	Name of the Compound	Molecular Formula	Molecular Weight	Retention Time (RT)			Peak area %		
				Root	Leaf	Inflore scence	Root	Leaf	Inflore scence
1	Heptadecane, 9-hexyl-	C23H48	324	4.96	4.96	4.95	34.18	24.41	34.48
2	Octadecane, 3-ethyl-5-(2-ethylbutyl)	C26H54	366	5.54	5.55	5.54	25.32	9.45	34.48
3	Oleic acid, 3-(octadecyloxyl) propyl ester	C39H76O3	592	7.63	7.63	7.63	17.72	3.94	31.03
4	Docosanoic acid, 1,2,3-propanetriyl ester	C69H134O6	1058	10.1	__	_	3.8	-	-
5	Ethyl iso-allocholate	C26H44O5	436	-	11.61	-	-	22.05	-
6	Stigmasterol	C29H48O	412	-	32.32	-	-	7.87	-

Discussion

Phytochemical screening was carried out to assess the chemical composition of root, leaf and inflorescence extracts of *L. cristata* by preliminary phytochemical test and found that reducing sugar, saponins, terpenoids, alkaloids, phenolics, tannins and flavonoids were present. Similar results were obtained in various Acanthaceae plants, *Acanthus montanus* [30], *Papulosis imbricate* [31], Asystatia *travancorica* [32] and *Odontonema strictum* [33].

The TLC results indicated that the presence of high concentration of gallic acid in *L. cristata* the same results was reported by Kalitha Parveen *et al*., [34] in *Blepharis maderaspatensis* . Rashmi Ranade *et al.,* [35] documented that the leaf and stem extracts of *Barleria prionitis* contains high gallic acid (211.70 µg/g) and caffeic acid (37.74 µg/g). Gallic acid is the type of simple phenol compound found commonly present in plant tissues. It

possesses astringent activity [36], antibacterial, anti-fungal, antiviral, anti- inflammatory, antioxidant, anticancer and anti-diabetic activities [37]. The other compounds quercetin, rutin, caffeic acid and ferulic acid isolated from TLC studies.

The HPLC analysis revealed the presence of four phytochemicals namely Oleic acid, 3-(octadecyloxy) propyl ester, Heptadecane, 9-Hexyl, Octadecane, 3- Ethyl-5-(2-Ethylbutyl) and Ethyl iso-allocholate. The identification of phytochemicals was confirmed with the respective reference samples. Gallic acid is phenylpropanoid, chemically 3, 4, 5-Trichydroxybenxoic acid isolated from *Eruca sativa* [38]. Quercetin constitutes phenolic compound derived from flavones isolated from *Acacia lencophloea* [39], caffeic acid isolated from *Ammi majus* seed [40] possess many biological activities including antimicrobial activities, such biologically active compounds were also isolated from *L. cristata*.

In GC-MS analysis, major phytochemical compounds with high peak area (%) was present in the root, leaf and inflorescence of *L. cristata* which contains Heptadecane, 9-hexyl- (34.48%), Octadecane, 3-ethyl-5-(2-ethylbutyl) (34.48%), Oleic acid, 3-(octadecyloxyl) propyl ester (31.03 %), Ethyl iso-allocholate (22.05 %) and Stigmasterol (7.87%). The molecular structures were predicted through mass spectrum analysis. The phenolic compounds were reported in *L. scariosa* [41] and found to be most efficient therapeutic substances used as medicinal agents for analgesic, antispasmodic, and antimicrobial properties [42, 43]. Wound healing properties [44] and antioxidant properties, anti-inflammatory, anti-androgenic and anticancer activity [45]. Raghavendra *et al.*, [46] concluded that the inflorescence extract of *Pleocaulus sessilis* exhibited high antibacterial activity than leaf and stem extracts. Sawadogo *et al.*, [47] reported that among the six species of acanthaceae plants (*Blepharis lineariifolia*, *Dicliptera verticillata*, *Dyschoriste perrotteii*, *Lepidagathis anobrya* and *Nelsonia canescens*) *L. anobrya* has high phenol and flavonoid and also it possesses the best antioxidant activity. In this study five compounds were identified in the root, leaf and inflorescence extracts of *L. cristata* and these compounds may be helpful for drug development.

Conclusion

Nature is a unique source of structures of high phytochemical diversity, many of them possessing interesting biological activities and medicinal properties. An intensive search of new phytochemical is required for the development of noval pharmacological therapeutics. This study also enhances the traditional usage of *L. cristata* for its bioactive compounds. These phytoconstituents needs further pharmacological investigation in order to develop new drugs for the treatment of specific diseases.

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2-(1H-INDOL-3-YL)-N-((1R,4R)-1,7,7-TRIMETHYLBICYCLO[2.2.1] HEPTAN-2-YLIDENE) ETHANAMINE : A STUDY ON QUANTUM MOLECULAR DESCRIPTORS

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Abstract

Density functional theory is the most promising approach to predict the electronic structure of matter. It provides a variety of molecular properties such as molecular structure, vibrational frequency, atomization energy, ionization potential, electric and magnetic properties, reaction paths etc. Hence the research work has been planned to compute optimized molecular structure and quantum molecular descriptors of the Schiff base 2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1] heptan-2-ylidene) ethanamine by carrying out HOMO-LUMO analysis obtained by DFT/B3LYP with 6-31+G(d) basis set.

Keywords :Imines, Schiff Bases, DFT, Quantum descriptors, HOMO – LUMO energy

1. Introduction

Schiff bases are a huge category of compounds differentiated by the presence of a double bond connecting the carbon and nitrogen atoms, giving them their adaptability, which are produced by many ways as they can combine with different alkyl or aryl substituents. Schiff bases demonstrate a wide spectrum of biological activities, such as antibacterial, antifungal, antimalarial, anti-inflammatory, antiproliferative, antiviral, and antipyretic.

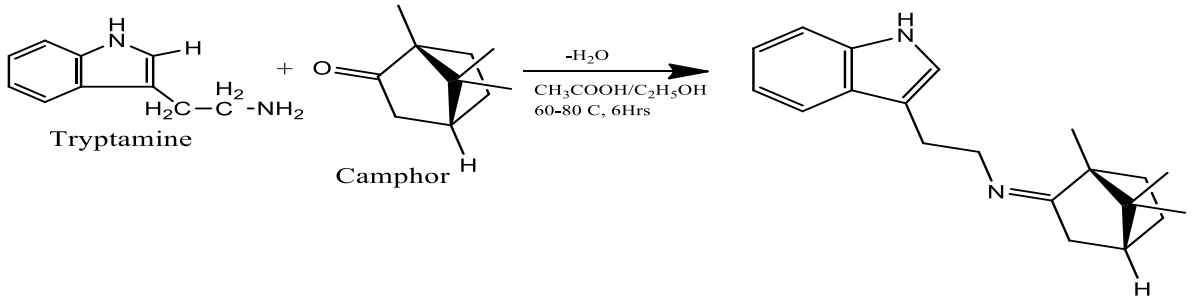
They are employed as dyes, pigments, catalysts, reagents for synthesizing organic compounds and stabilizers for polymers.On the other hand, coordination compounds with heterocyclic Schiff base ligand has attracted much attention of the chemist in current years to find applications as potential drugs due to the presence of multifunctional groups. They also serve as a back bone for the synthesis of various heterocyclic compounds.The present study is

aimed to compute quantum molecular descriptors for the compound 2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1] heptan-2-ylidene) ethanamine using HOMO – LUMO energy gap obtained from DFT calculations.

2.Experimental Methods

Synthesis of the Schiff Base

2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene) ethanamine (TC) was prepared by the condensation of tryptamine (1.6g) with an equivalent amount of camphor in acetic acid - alcohol mixture at room temperature (Scheme). The whole mixture was kept under reflux for 5 hours. The solid obtained was filtered and dried over anhydrous $CaCl_2$ in a vacuum desiccator. Recrystallisation was performed using ethanol as solvent[2].



2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)ethanamine (TC)

3. Results & Discussion

3.1 Characterisation of the Schiff base

The synthesized compound is characterized by physical, analytical, UV- Visible, FTIR and H^1NMR spectroscopic techniques.

Table 1: Physical and analytical data of Schiff base

Name of the Schiff base	Colour	Melting point (°C)	Yield (%)	Elemental analysis (Calc / Exp) in %		
				N	C	H
TC	Light yellow	219	65	9.5 (9.3)	81.6 (81.5)	8.8(8.7)

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3.2 Spectral Characterisation of Schiff base

UV-Visible spectra

Electronic spectra of the Schiff base were recorded in DMSO in the range of 200-800nm at room temperature.The compound exhibits bands at 274nm and 575nm due to**π-π*** and**n-π*** transitions respectively[2] (table 2, fig.2).

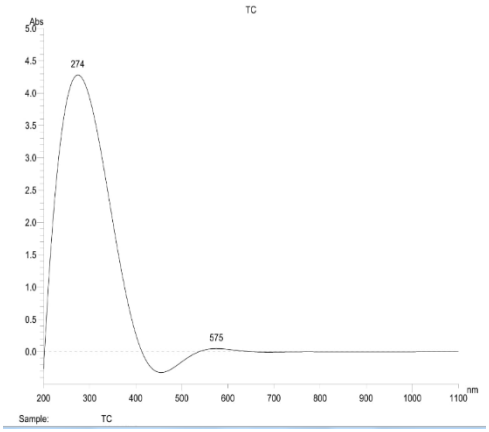

Figure 2. UV-Visible spectrum of Schiff base

Table 2. UV-Visible spectral data

Name of the Schiff base	**π- π***	**n- π***
	λ max(nm)	**λ max(nm)**
TC	274	575

FTIR spectra

In FTIR spectra the appearance of azomethine -CH=N- band at 1625cm^{-1} and absence of characteristic peaks due to the carbonyl group of aldehydes and ketones at 1700 cm^{-1} confirms the formation of Schiff base[3-6]. Absorption band in the region 3253 cm^{-1} may be ascribed to N-H stretching vibrations of indole group. The band at 1442 cm^{-1} is due to $\nu_{C=C}$ stretching

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vibrations of aromatic rings.The broad peaks in the region 1000-1100 cm^{-1} may be attributed to C-N stretching vibrations of primary amines. The peak observed in the region 1408cm^{-1} can be assigned to C-C stretching vibrations of aromatic ring.The bending vibrations of various groups are found in the region 400-960 cm^{-1}. The presence of bicyclic ring and aromatic ring moieties can be deciphered from the bending vibrational modes in the range 550-800 cm^{-1}(table 3, fig.3).

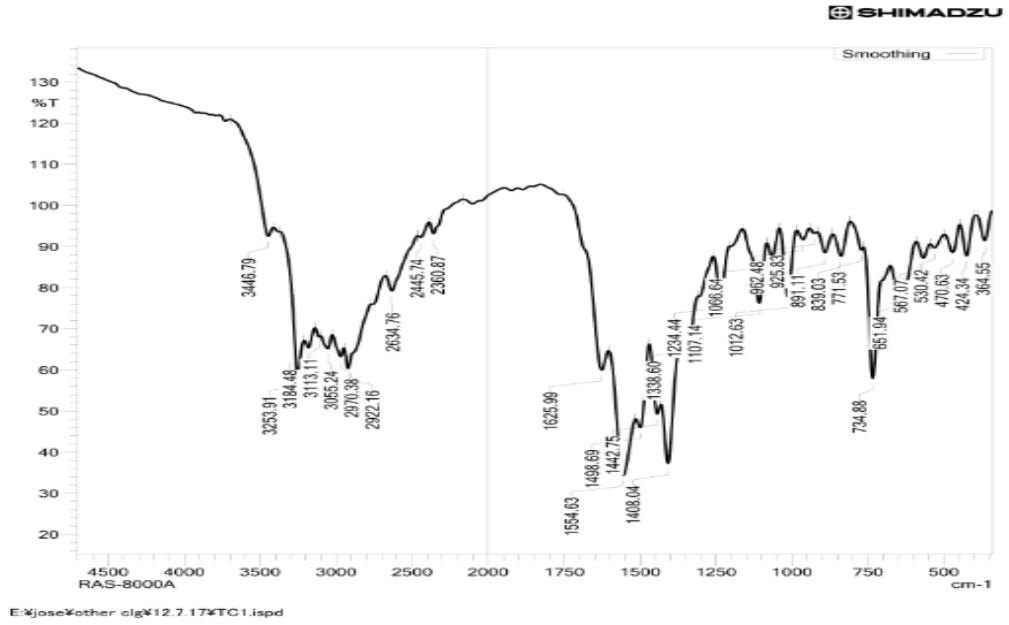

Figure 3. FTIR spectrum of Schiff base

Table 3. FTIR spectral data

ν_{OH} (cm^{-1})	ν_{NH} (cm^{-1})	ν_{C-H} (cm^{-1})	$\nu_{CH=N/}$ $\nu_{C=N}$ (cm^{-1})	$\nu_{C=C}$ (cm^{-1})	ν_{c-c} (cm^{-1})	ν_{C-NH} (cm^{-1})	ν_{C-O} (cm^{-1})	**Bending vibrations**	
								δ_{C-C} δ_{C-H} δ_{C-N} δ_{C-OH} (cm^{-1})	$\delta_I/\delta_{Cl}/\delta_{OH}$($cm^{-1}$)
3446	3253, 2922	2634, 2360	1625	1442,	1408	1336		734, 652	567

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H^1 NMR spectra

The peaks observed at 7.55-6.9ppm are due to aromatic ring protons.The protons of the bicyclic ring moiety in the compound derived from camphor are evidenced by the appearance of multiplet in the region 0.8-2.9 ppm. A singlet peak observed at 11.012 ppm may be attributed to N-H proton of tryptamine moiety (table 4).

Table 4. H^1NMR spectral data

δ_{N-H} of tryptamine (ppm)	$\delta_{CH=N}$ (ppm)	δ_{CH} aromatic (ppm)	δ_{CH} in aliphatic (ppm)	H_2O protons (ppm)
11.012 (s)	-	7.55-6.9(m)	2.9 (s), 2.5-1.78(m)	6.054

3.3 Structure of the Schiff base

The structure of the Schiff base is shown in fig.1.

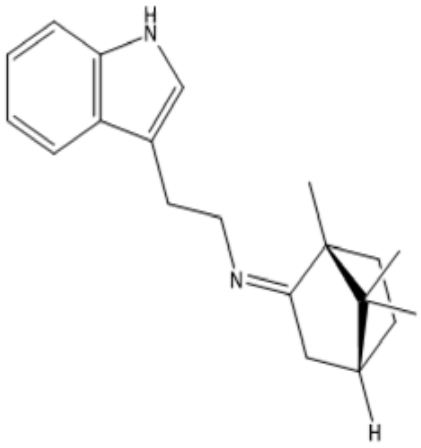

Figure 1. Structure of 2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1] heptan-2-ylidene)ethanamine

3.4 Computational Study

Density functional theory is the most constructive approach to compute the electronic structure of matters. It has become an effective tool to predict the molecular properties such as molecular structure, vibrational frequencies, atomization energies, ionization energy, reaction paths, electric and magnetic properties[7].

The HOMO represents the ability to donate electron while LUMO exhibits the ability to accept an electron. HOMO-LUMO orbitals are also called frontier orbitals as they lie at the outermost boundaries of the electrons in a molecule. These orbitals play a key role in quantum chemistry as well as in the electric and optical properties. HOMO- LUMO energy gap illustrates the chemical reactivity and kinetic stability of the molecules. Small gaps lead to mobile pi electrons since it is easy for the electron to jump to a higher energy level. The greater the mobility of pi electrons, the greater the distribution of energy throughout the molecule, thereby stabilizing a system. A molecule with the least HOMO, LUMO gap signifies low kinetic stability, high chemical activity and are termed as a soft molecule. A molecule with a large frontier orbital gap is associated with less reactivity, high stability and is termed as a hard molecule.

The HOMO-LUMO energy gap is an analytical parameter to evaluate the electrical transport properties of molecules. The quantum molecular descriptors of a molecule such as chemical potential(μ), electron affinity (A), electronegativity (χ), ionization potential (I), softness(s), hardness (η) and electrophilicity index(Ψ) can be calculated from HOMO and LUMO energy values using the Koopman's theorem for closed shell molecules[8].

The present study is focused to predict the reactivity of the Schiff base by employing DFT method. The DFT computation was performed using Gauss view 09W program package. The optimized structure parameter of the Schiff base was calculated using the

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restricted closed shell model, Becke's three parameter hybrid exchange functional with Lee – Yang – Parr correlation functional (DFT/B3LYP). The basis set 6-31+G (d,p) augmented by d polarization functions on heavy atoms and p polarisation functions on hydrogen atoms as well as diffuse functions for both hydrogen and heavy atoms are found to be more appropriate for the present study. Images have been visualised with the help of Gauss view 5.0 program.

The behaviour of an atom or molecule is characterised by certain parameters called global and local descriptors. The Chemical reactivity of any molecule is predicted by such data[199]. Hence it is aimed to calculate the quantum molecular descriptors of the molecule such as ionization potential, electron affinity, chemical hardness, softness, electronegativity, chemical potential and electrophilicity using the energy values of HOMO and LUMO. All the calculated values are presented in tables5a & 5b.

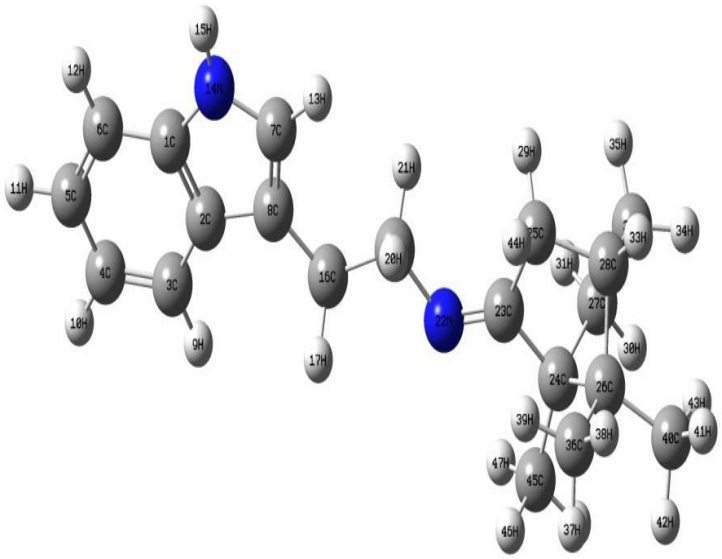

Figure 4. Optimised structure of 2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)ethanamine [TC]

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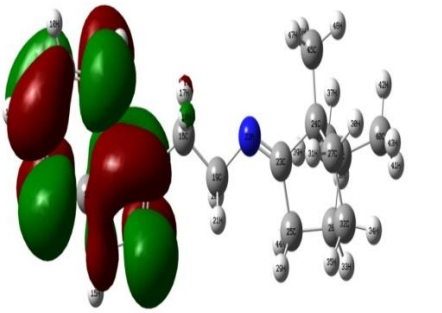
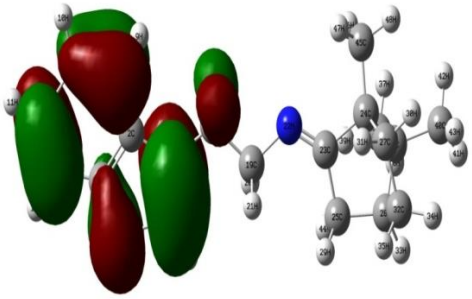
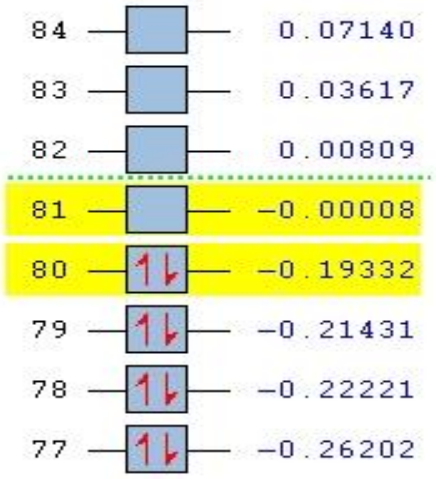


LUMO



HOMO



	Energy
HOMO	- 0.19332
	-
LUMO	- 0.00008
Energy gap	0.19324

Figure 5. HOMO and LUMO energy gap of 2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)ethanamine [TC]

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Table 5a: Global Reactivity Descriptors

Descriptor	Values in a.u.
EHOMO Ionisationpotential I(-)	0.193
ELUMO ElectronAffinity A(-)	0.000
EHOMO -ELUMO	0.193
EHOMO +ELUMO	0.193
(I -A)/2 η	0.096
(I +A)/2 μ	0.096

Table 5b. Global Reactivity Descriptors

Descriptor	Values in e.v.
EHOMO I(-)	5.260
ELUMO A(-)	0.0021
EHOMO - ELUMO	5.258
EHOMO + ELUMO	5.262
(I - A)/2 η Chemical hardness	2.629
(I + A)/2 μ Chemical Potential	2.631
1/η ξ Chemical softness	0.380
μ2	6.923
2η	5.258
E, Ψ= μ2/2η Electrophilicity	1.316

Table 6.Optimized geometrical parameters of 2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)ethanamine

Name	Definition	Values in Angstroms	Name2	Definition2	Values in Degrees	Name3	Definition3	Values in Degrees2
R1	R(1,2)	1.4458	A1	A(2,1,6)	120.4036	D1	D(6,1,2,3)	-0.0121
R2	R(1,6)	1.3803	A2	A(2,1,14)	107.0339	D2	D(6,1,2,8)	179.9938
R3	R(1,14)	1.4577	A3	A(6,1,14)	132.5625	D3	D(14,1,2,3)	179.9905
R4	R(1,15)	1.5005	A4	A(1,2,3)	120.4093	D4	D(14,1,2,8)	-0.0036
R5	R(2,3)	1.3803	A5	A(1,2,8)	107.0347	D5	D(2,1,6,5)	0.012
R6	R(2,8)	1.4575	A6	A(3,2,8)	132.5559	D6	D(2,1,6,12)	-179.9879
R7	R(3,4)	1.4049	A7	A(2,3,4)	118.452	D7	D(14,1,6,5)	-179.9914
R8	R(3,9)	1.0989	A8	A(2,3,9)	121.2714	D8	D(14,1,6,12)	0.0086
R9	R(4,5)	1.39	A9	A(4,3,9)	120.2766	D9	D(2,1,14,7)	0.0018
R10	R(4,10)	1.1003	A10	A(3,4,5)	121.1386	D10	D(2,1,14,15)	-179.9985
R11	R(5,6)	1.4049	A11	A(3,4,10)	119.1113	D11	D(6,1,14,7)	-179.9951
R12	R(5,11)	1.1002	A12	A(5,4,10)	119.7501	D12	D(6,1,14,15)	0.0046
R13	R(6,12)	1.0989	A13	A(4,5,6)	121.1411	D13	D(1,2,3,4)	0.006
R14	R(7,8)	1.4077	A14	A(4,5,11)	119.7526	D14	D(1,2,3,9)	-179.991
R15	R(7,13)	1.0896	A15	A(6,5,11)	119.1063	D15	D(8,2,3,4)	179.9984
R16	R(7,14)	1.4072	A16	A(1,6,5)	118.4553	D16	D(8,2,3,9)	0.0013
R17	R(8,16)	1.54	A17	A(1,6,12)	121.2745	D17	D(1,2,8,7)	0.0041
R18	R(14,15)	1	A18	A(5,6,12)	120.2702	D18	D(1,2,8,16)	-179.9881
R19	R(16,17)	1.07	A19	A(8,7,13)	125.205	D19	D(3,2,8,7)	-179.989
R20	R(16,18)	1.07	A20	A(8,7,14)	109.5728	D20	D(3,2,8,16)	0.0188
R21	R(16,19)	1.54	A21	A(13,7,14)	125.2222	D21	D(2,3,4,5)	-0.0004
R22	R(19,20)	1.07	A22	A(2,8,7)	108.1756	D22	D(2,3,4,10)	179.9989
R23	R(19,21)	1.07	A23	A(2,8,16)	124.7422	D23	D(9,3,4,5)	179.9967
R24	R(19,22)	1.54	A24	A(7,8,16)	127.0822	D24	D(9,3,4,10)	-0.004
R25	R(22,23)	1.47	A25	A(1,14,7)	108.183	D25	D(3,4,5,6)	0.0006

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R26	R(23,24)	1.5417	A26	A(1,14,15)	72.5671	D26	D(3,4,5,11)	179.9918
R27	R(23,25)	1.5407	A27	A(8,16,17)	109.4712	D27	D(10,4,5,6)	-179.9987
R28	R(24,26)	1.5506	A28	A(8,16,18)	109.4712	D28	D(10,4,5,11)	-0.0076
R29	R(24,27)	1.5416	A29	A(8,16,19)	109.4712	D29	D(4,5,6,1)	-0.0065
R30	R(24,45)	1.54	A30	A(17,16,18)	109.4713	D30	D(4,5,6,12)	179.9934
R31	R(25,28)	1.5417	A31	A(17,16,19)	109.4712	D31	D(11,5,6,1)	-179.9977
R32	R(25,29)	1.07	A32	A(18,16,19)	109.4712	D32	D(11,5,6,12)	0.0022
R33	R(25,44)	1.07	A33	A(16,19,20)	109.4712	D33	D(13,7,8,2)	179.9969
R34	R(26,28)	1.5506	A34	A(16,19,21)	109.4712	D34	D(13,7,8,16)	-0.0112
R35	R(26,36)	1.54	A35	A(16,19,22)	109.4712	D35	D(14,7,8,2)	-0.003
R36	R(26,40)	1.54	A36	A(20,19,21)	109.4712	D36	D(14,7,8,16)	179.9889
R37	R(27,30)	1.1159	A37	A(20,19,22)	109.4713	D37	D(8,7,14,1)	0.0008
R38	R(27,31)	1.115	A38	A(21,19,22)	109.4712	D38	D(13,7,14,1)	-179.9992
R39	R(27,32)	1.5408	A39	A(19,22,23)	109.4712	D39	D(2,8,16,17)	-60.0068
R40	R(28,32)	1.5416	A40	A(22,23,24)	111.4874	D40	D(2,8,16,18)	59.9932
R41	R(28,33)	1.1056	A41	A(22,23,25)	111.6707	D41	D(2,8,16,19)	179.9932
R42	R(32,34)	1.1159	A42	A(24,23,25)	103.7638	D42	D(7,8,16,17)	120.0025
R43	R(32,35)	1.115	A43	A(23,24,26)	101.2544	D43	D(7,8,16,18)	-119.9974
R44	R(36,37)	1.07	A44	A(23,24,27)	107.1925	D44	D(7,8,16,19)	0.0025
R45	R(36,38)	1.07	A45	A(23,24,45)	114.6028	D45	D(8,16,19,20)	59.9989
R46	R(36,39)	1.07	A46	A(26,24,27)	101.252	D46	D(8,16,19,21)	-60.0011
R47	R(40,41)	1.07	A47	A(26,24,45)	116.2518	D47	D(8,16,19,22)	179.9989
R48	R(40,42)	1.07	A48	A(27,24,45)	114.6054	D48	D(17,16,19,20)	-60.0011
R49	R(40,43)	1.07	A49	A(23,25,28)	103.7629	D49	D(17,16,19,21)	179.9989
R50	R(45,46)	1.07	A50	A(23,25,29)	110.5597	D50	D(17,16,19,22)	59.9989
R51	R(45,47)	1.07	A51	A(23,25,44)	110.5597	D51	D(18,16,19,20)	179.9989
R52	R(45,48)	1.07	A52	A(28,25,29)	110.5597	D52	D(18,16,19,21)	59.9989
			A53	A(28,25,44)	110.5597	D53	D(18,16,19,22)	-60.0011
			A54	A(29,25,44)	110.6515	D54	D(16,19,22,23)	-179.9999

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			A55	A(24,26,28)	94.3374	D55	D(20,19,22,23)	-59.9999
			A56	A(24,26,36)	113.0015	D56	D(21,19,22,23)	60.0001
			A57	A(24,26,40)	113.004	D57	D(19,22,23,24)	130.4032
			A58	A(28,26,36)	112.9999	D58	D(19,22,23,25)	-114.0302
			A59	A(28,26,40)	113.0013	D59	D(22,23,24,26)	155.3814
			A60	A(36,26,40)	109.8319	D60	D(22,23,24,27)	49.7275
			A61	A(24,27,30)	110.5438	D61	D(22,23,24,45)	-78.6644
			A62	A(24,27,31)	111.4898	D62	D(25,23,24,26)	35.049
			A63	A(24,27,32)	103.7662	D63	D(25,23,24,27)	-70.6049
			A64	A(30,27,31)	108.3597	D64	D(25,23,24,45)	161.0033
			A65	A(30,27,32)	110.9975	D65	D(22,23,25,28)	-120.1975
			A66	A(31,27,32)	111.6708	D66	D(22,23,25,29)	-1.6407
			A67	A(25,28,26)	101.2515	D67	D(22,23,25,44)	121.2458
			A68	A(25,28,32)	107.1935	D68	D(24,23,25,28)	0.0106
			A69	A(25,28,33)	114.5989	D69	D(24,23,25,29)	118.5673
			A70	A(26,28,32)	101.2561	D70	D(24,23,25,44)	-118.5461
			A71	A(26,28,33)	116.2461	D71	D(23,24,26,28)	-55.1459
			A72	A(32,28,33)	114.6129	D72	D(23,24,26,36)	62.1054
			A73	A(27,32,28)	103.7606	D73	D(23,24,26,40)	-172.3996
			A74	A(27,32,34)	110.9994	D74	D(27,24,26,28)	55.1503
			A75	A(27,32,35)	111.6649	D75	D(27,24,26,36)	172.4017
			A76	A(28,32,34)	110.5432	D76	D(27,24,26,40)	-62.1033
			A77	A(28,32,35)	111.4972	D77	D(45,24,26,28)	-179.9971
			A78	A(34,32,35)	108.3623	D78	D(45,24,26,36)	-62.7457
			A79	A(26,36,37)	109.4712	D79	D(45,24,26,40)	62.7493
			A80	A(26,36,38)	109.4712	D80	D(23,24,27,30)	-170.345
			A81	A(26,36,39)	109.4712	D81	D(23,24,27,31)	-49.7445
			A82	A(37,36,38)	109.4713	D82	D(23,24,27,32)	70.5905
			A83	A(37,36,39)	109.4712	D83	D(26,24,27,30)	83.9994

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			A84	A(38,36,39)	109.4712	D84	D(26,24,27,31)	-155.4001
			A85	A(26,40,41)	109.4712	D85	D(26,24,27,32)	-35.0651
			A86	A(26,40,42)	109.4712	D86	D(45,24,27,30)	-41.9546
			A87	A(26,40,43)	109.4712	D87	D(45,24,27,31)	78.6459
			A88	A(41,40,42)	109.4713	D88	D(45,24,27,32)	-161.0191
			A89	A(41,40,43)	109.4712	D89	D(23,24,45,46)	-40.3402
			A90	A(42,40,43)	109.4712	D90	D(23,24,45,47)	79.6598
			A91	A(24,45,46)	109.4712	D91	D(23,24,45,48)	-160.3402
			A92	A(24,45,47)	109.4712	D92	D(26,24,45,46)	77.3807
			A93	A(24,45,48)	109.4712	D93	D(26,24,45,47)	-162.6193
			A94	A(46,45,47)	109.4713	D94	D(26,24,45,48)	-42.6193
			A95	A(46,45,48)	109.4712	D95	D(27,24,45,46)	-164.8995
			A96	A(47,45,48)	109.4712	D96	D(27,24,45,47)	-44.8995
						D97	D(27,24,45,48)	75.1005
						D98	D(23,25,28,26)	-35.0663
						D99	D(23,25,28,32)	70.5912
						D100	D(23,25,28,33)	-161.0091
						D101	D(29,25,28,26)	-153.623
						D102	D(29,25,28,32)	-47.9655
						D103	D(29,25,28,33)	80.4342
						D104	D(44,25,28,26)	83.4904
						D105	D(44,25,28,32)	-170.8521
						D106	D(44,25,28,33)	-42.4524
						D107	D(24,26,28,25)	55.1526
						D108	D(24,26,28,32)	-55.145
						D109	D(24,26,28,33)	179.9933
						D110	D(36,26,28,25)	-62.1
						D111	D(36,26,28,32)	-172.3977
						D112	D(36,26,28,33)	62.7406

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						D113	D(40,26,28,25)	172.4085
						D114	D(40,26,28,32)	62.1108
						D115	D(40,26,28,33)	-62.7509
						D116	D(24,26,36,37)	104.7036
						D117	D(24,26,36,38)	-135.2964
						D118	D(24,26,36,39)	-15.2964
						D119	D(28,26,36,37)	-149.6649
						D120	D(28,26,36,38)	-29.6649
						D121	D(28,26,36,39)	90.3351
						D122	D(40,26,36,37)	-22.4831
						D123	D(40,26,36,38)	97.5169
						D124	D(40,26,36,39)	-142.4831
						D125	D(24,26,40,41)	-150.2164
						D126	D(24,26,40,42)	-30.2164
						D127	D(24,26,40,43)	89.7836
						D128	D(28,26,40,41)	104.15
						D129	D(28,26,40,42)	-135.85
						D130	D(28,26,40,43)	-15.85
						D131	D(36,26,40,41)	-23.0311
						D132	D(36,26,40,42)	96.9689
						D133	D(36,26,40,43)	-143.0311
						D134	D(24,27,32,28)	0.0101
						D135	D(24,27,32,34)	118.76
						D136	D(24,27,32,35)	-120.2047
						D137	D(30,27,32,28)	-118.7429
						D138	D(30,27,32,34)	0.0071
						D139	D(30,27,32,35)	121.0424
						D140	D(31,27,32,28)	120.2225
						D141	D(31,27,32,34)	-121.0276

						D142	D(31,27,32,35)	0.0077
						D143	D(25,28,32,27)	-70.6056
						D144	D(25,28,32,34)	170.331
						D145	D(25,28,32,35)	49.7228
						D146	D(26,28,32,27)	35.0487
						D147	D(26,28,32,34)	-84.0147
						D148	D(26,28,32,35)	155.3771
						D149	D(33,28,32,27)	161.0028
						D150	D(33,28,32,34)	41.9394
						D151	D(33,28,32,35)	-78.6688

4. Conclusion

The Schiff base compound(2-(1H-indol-3-yl)-N-((1R,4R)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)ethanamine) was prepared by the condensation of tryptamine and camphor. It was characterized by analytical data and spectral techniques. The quantum molecular descriptors of the Schiff base compound have been computed using HOMO-LUMO energy gap obtained from DFT calculations. Further the optimized molecular structure images of frontier orbitals and optimized geometrical parameters have been reported.

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COBALT (II) SCHIFF BASE COMPLEX: SYNTHESIS, SPECTRAL CHARACTERIZATION AND ANTIMICROBIAL INVESTIGATION

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Abstract

Cobalt complex with the Schiff base 2-((4-nitrophenylimino)methyl-6-ethoxy)phenol have been synthesized and investigated by conductivity measurements, IR, electronic, H^1 NMR, fluorescence, cyclic voltammetry and EI mass spectral studies. The spectral data of the complex have revealed bidentate coordinating nature of the Schiff base. The Schiff base and the complex have been screened for gram-positive bacterium *corynebacterium diphtheria*, gram-negative bacterium *E.coli* and fungi*cryptococcus neoformans* bythe agar well diffusion method. The complex showed enhanced antimicrobial activities compared to free Schiff base towards all pathogens.

1. Introduction

Schiff base complexes have been interest for chemist because of easy synthesis and wide range of pharmacological effects in the field of antimicrobial [1-4], anticancer [5, 6], antitumour[7], urease inhibitory[8], antituberculosis [9], anti-inflammatory [10], anticonvulsant[11], antiproliferative [12] and analgesic [13] activities. The azomethine groups commonly known as Schiff bases are synthesized from condensation of active carbonyl compounds and primary amines. They have the ability to form complexes with different transition metal ions[14].Cobalt is an essential micro nutrient in the body used for the cell function and also for the production of antibacterial and antiviral compounds that prevent infections[15]. Therefore, the synthesis of Schiff base ligand that chelate cobalt for antimicrobial therapies has shown momentous promise. The present work makes an effort to find out pharmaceutical applications of Schiff base complex containing cobalt. Here we reportthe synthesis, characterization and antimicrobial activities of thecobalt(II) complex of Schiff base ligand(EN) from 3-ethoxy salicylaldehyde and 4-nitroaniline.

2. Experimental Section

2.1 Reagents

3-ethoxy salicylaldehyde (SIGMA ALDRICH), 4-nitroaniline (LOBA CHEMIE), cobalt(II) acetate tetrahydrate (AR), Ether (MERCK, LR), Dimethyl sulfoxide (DMSO) (MERCK), N,N-dimethylformide (DMF) (MERCK), Silica gel (SIGMA ALDRICH) 200-

425 mesh. Commercially available rectified spirit was dried over anhydrous quicklime for 24 hours, filtered and distilled before use. (Boiling point-78^{o}C).

2.2. Methods

Melting point of the ligand and its complex were determined by using the Elico melting point apparatus. The electrical conductivity of complex was measured in 10^{-3}M solution of dimethyl formamide using Elico Conductivity Bridge. Infrared spectral measurements were made for the free ligand and its complex using Perkin Elmer IR RXI spectrometer (4000 cm^{-1} to 400 cm^{-1}). The electronic spectra of the complex in UV-visible region was recorded using Shimadzu UV Spectrophotometer (UV-1800). The proton NMR spectra was taken for the ligand using the instrument, Bruker 400 MHz FT – PMR spectrometer. Fluorescence spectra were carried out on Jasco Spectrofluorometer(FP-8200). EI mass spectra were recorded on GC-Mass Spectrometer – Joel GCMS GC – Mate II. Electrochemical measurements were performed at room temperature in an air tight three electrode cell by using glassy carbon electrode with 0.025 cm^2 surface area as a working electrode, a platinum wire served as the counter electrode and a Ag/AgCl in a saturated KCl solution as reference electrode.

2.3 Synthesis

2.3.1 Synthesis of 2-((4-nitrophenylimino)methyl-6-ethoxy)phenol

To a hot ethanolic solution of 4-nitroaniline (0.69g, 0.01 mol) an ethanolic solution of3-ethoxy salicylaldehyde (0.83g, 0.005mol) was added. The reaction mixture was refluxed for 3 hours. The dark red colouredsolid mass was formed on evaporation of solvent at room temperature. The solid mass was washed several times with ether and recrystallized from ethanol. The purity of the ligand was checked by melting point and TLC. (Yield- 94%, melting point- 124^{o}C).

2.3.2 Synthesis of cobalt(II) complex

To a hot ethanolic solution of Schiff base **(**1.144 g, 0.002 mol)in minimum quantity of dimethyl formamide, an ethanolic solution of the cobalt(II) acetate tetrahydrate (0.234g, 0.002 mol) was added. The reaction mixture was refluxed for 6 hours on a water bath. Yellowish orange precipitate was obtained on evaporation of solvent at room temperature. The precipitate formed was collected by suction filtration, washed thoroughly with ether and dried. The yellowish orange precipitate obtained was soluble in DMF and DMSO. (Yield – 88%, melting point – 140^{o}C).

3. Antimicrobial Activities

Petri plates containing 20 ml nutrient agar medium were seeded with 24 hr culture of bacterial strains were adjusted to 0.5 OD value according to McFarland standard, (*E.coli*-443 and *Corynebacterium diphtheriae*)Wells were cut and concentration of sample EN and cobalt complex (100 µl) was added. The plates were then incubated at 37°C for 24 hours[16,17]. The antibacterial activity was assayed by measuring the diameter of the inhibition zone formed around the wells. oxytetracycline was used as a positive control.

Petri plates containing 20ml potato dextrose agar medium was seeded with 72 hr culture of fungal strain *(Cryptococcus neoformans)* wells were cut and different concentration of sample EN and cobalt complex (100 µl) was added. The plates were then incubated at 28°C for 72 hours [18]. The anti-fungal activity was assayed by measuring the diameter of the inhibition zone formed around the wells. Ketoconazole was used as a positive control. The values were calculated using Graph Pad Prism 6.0 software.

4. Results and Discussion

4.1 Molar conductance and metal percentage

The molar conductance of the complex in 10^{-3} M DMF solution is found to be 20 x 10^{-3} $ohm^{-1}cm^2mol^{-1}$ showing its non-electrolytic nature [25]. This obtained value implies that no anions are present outside the coordination sphere. The stoichiometry of the complex was determined by estimating the amount of cobalt by pyrolytic method**(Table 1)**.

Table 1. Metal analysis and physical characteristics of the complex and the ligand

S.No	Compound	Molecular formula	Yield (%)	Colour	Melting point ^0C	Molar conductance $\times10^{-3}$ ohm^{-1} cm^2mol^{-1}	% Metal	
							Calculated	Observed
1	Schiff base(EN)	$C_{15}H_{14}O_4N_2$	94	Dark red	124	-	-	-
2	[Co(EN-H)$_2$.2H$_2$O]	$C_{30}H_{30}O_{10}N_4Co$	88	Yellowish orange	140	20	8.86	9.56

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4.1 IR spectra

The Schiff base displays a sharp band at 1585 cm^{-1} due to azomethine ν(-CH=N-) mode[19]. A broad band centered at 3424 cm^{-1} is characteristic of hydrogen bonded phenolic ν(O-H) stretching vibration[20]. The band assignable to the azomethine undergoes a shift to higher frequency 1628cm^{-1} indicating coordination of azomethine nitrogen with Co(II) ion in the complex. This is further supported by the appearance of new band observed at 430 cm^{-1} due to ν(M-N)[21]. The coordination through hydroxyl oxygen after deprotonation is revealed by the disappearence of the broad band at 3424 cm^{-1} and appearance of a new band at 3428 cm^{-1} in the complex is due to coordinated water molecules. The coordination of ν(O-H) mode is further confirmed by the appearance of a new band at 556cm^{-1} due to ν(M-O)[22] in the complex.

4.2 Electronic spectra

The electronic spectrum of the ligand shows the bands at 421 nm (23752 cm^{-1}) is due to intraligand charge transfer transition.The electronic spectrum of the Co(II) complex shows a band at 398 nm (24038 cm^{-1}) due tothe $^4T_{1g}(F) \rightarrow {}^4T_{1g}(P)$ transition, indicate octahedral geometry[23].

4.3 H^1 NMR spectrum

The proton magnetic resonance spectrum of the Schiff basewas taken in DMSO-$d_6$solvent**(Figure 1)**. The ^{1}H NMR ofEN exhibits peak at δ9.02 ppm (s, 1H) suggesting the appearance of -CH=N proton[24]. The peak at δ12.42 ppm (s, 1H) and peak in the range δ 6.9 - 8.34 ppm (m, 7H) indicate hydroxyl and aromatic protons. The peaks in the region δ 1.34 - 1.39 ppm (t, 3H) are assigned to -CH_3 group of ethoxy substituent on the benzene ring while peaks in the region δ4.06 - 4.13 ppm (q, 2H) are attributed to -CH_2 protons of the ethoxy substituent.

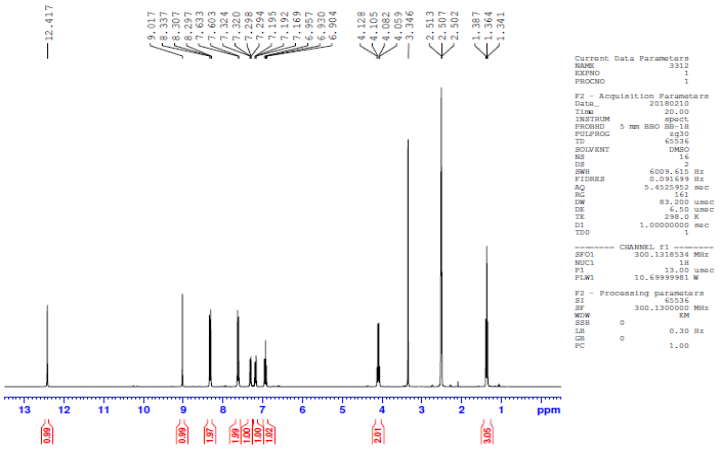

Figure 1. NMR spectrum of 2-((4-nitrophenylimino)methyl-6-ethoxy)phenol

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4.4 EI mass spectrum

The Schiff base exhibits a molecular ion peak at 286. The mass spectral data of Schiff base is consistent with the formulation: $C_{15}H_{14}O_4N_2$ of molecular weight 286.10 (calculated 286). The base peak at 271 is due to $C_{14}H_{11}O_4N_2$ fragments. The EI mass spectra of the Schiff base**(Figure 2)** and its Co(II) complex**(Figure 3)** are used to compare their stoichiometry and confirms the probable formulations of the metal : Ligand ratio to be 1 : 2 in the complex. The molecular ion peak at 664.82 supports the formula assigned to the complex as $C_{30}H_{30}O_{10}N_4Co$ and confirms the octahedral geometry.

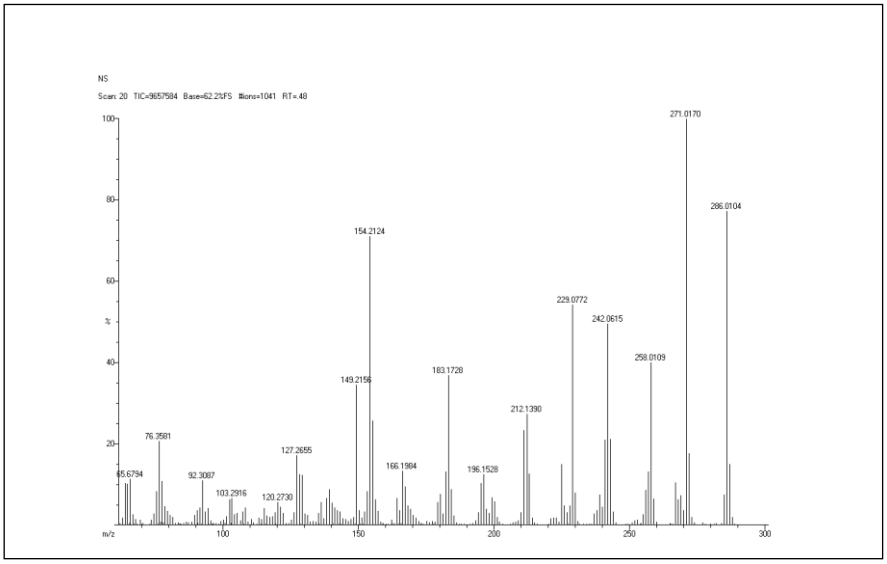

Figure 2. EI mass spectrum of 2-((4-nitrophenylimino)methyl-6-ethoxy)phenol

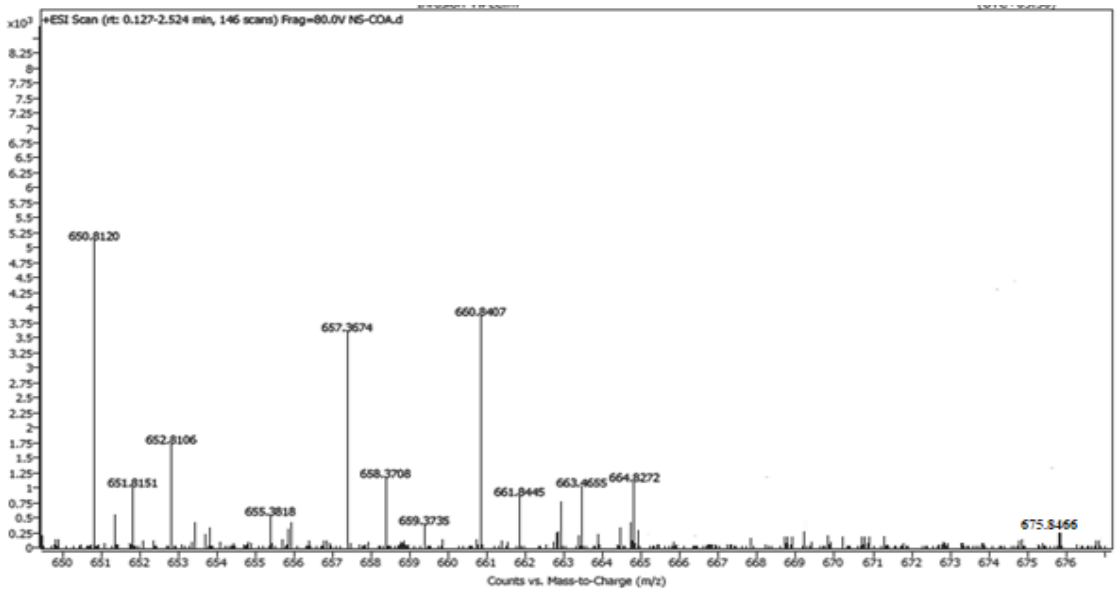

Figure 3. EI mass spectrum of [Co(EN -H)$_2$.2H$_2$O]

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4.6 Fluorescence spectra

The ligand exhibits a fluorescence emission at 501**(Figure 4)**, with corresponding intensity at 20. The emission wavelength of Co(II) complex is 804 **(Figure 5)**with the corresponding intensity of 418.The emission intensity of the complex is different from that of Schiff base. Significant differences in the emission maximum of ligand and its complex establish the coordination of the metal ion to the ligand.

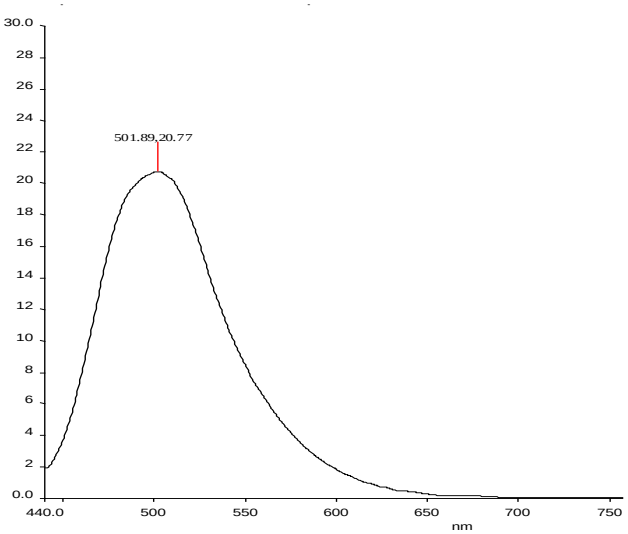

Figure 4. Fluorescence spectrum of 2-((4-nitrophenylimino)methyl-6-ethoxy)phenol

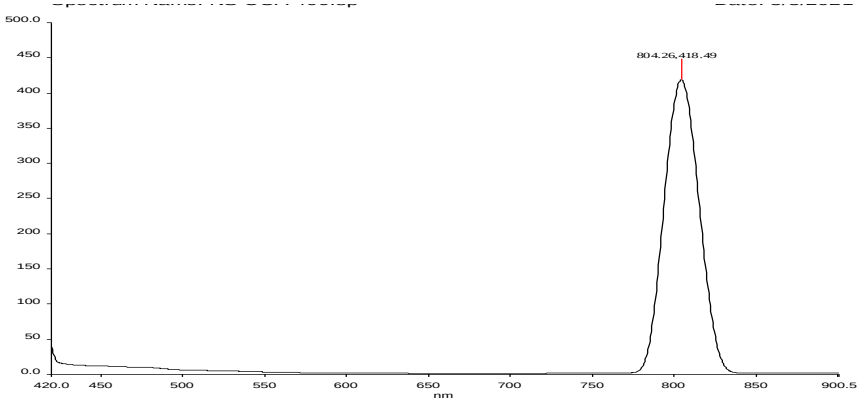

Figure 5. Fluorescence spectrum of [Co(EN-H)$_2$.2H$_2$O]

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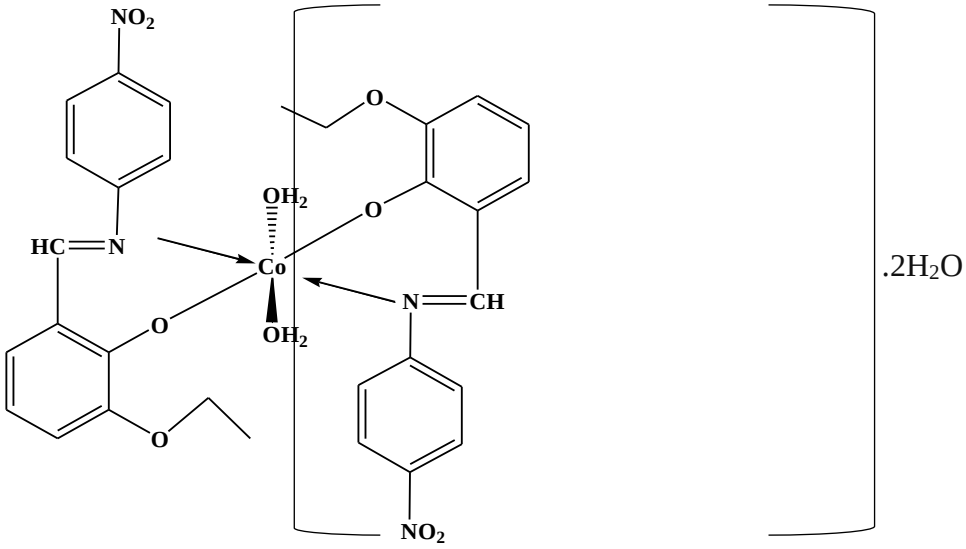
Based on these evidences, the following structure has been proposed for the complex



Structure of [Co(EN-H)$_2$.2H$_2$O]

4.7 Electrochemical behaviour

The cyclic voltammogram of Co(II) complex doesn't show any characteristic potential indicating that in the complex, ligand stabilizes the metal in +2 oxidation state.

4.8 Antimicrobial activities

The Schiff base and the complex have been screened for gram positive bacterium Corynebacterium diphtheria, gram negative bacterium E.coli and fungus Cryptococcus neoformans by agar well diffusion method and the results obtained are formulated in **Table-2** and **Figure 6 &7.**

Table 2 .Antimicrobial activities against all pathogens

S. No	**Name of the test organism**	**Zone of inhibition (mm) Mean±SD**		
		EN	[Co(EN-H)$_2$.2H$_2$O]	**PC**
1.	Corynebacterium diphtheriae	11.5±0.7	15.25±0.4	17.75±1.06
2.	E.coli	12.75±1.06	19.75±1.06	17.5±0.7
3.	Cryptococcus neoformans	14.5±0.7	24±1.4	25.25±0.4

From the experimental Table 2, it has been observed that the Schiff base and its complex shows significant activity against all pathogens. The Co(II) complex exhibit higher antimicrobial activities than the free Schiff base[25]. The Co(II) complex has remarkable

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antimicrobial activities against all pathogens. The antibacterial activity of $[Co(EN\text{-}H)_2.2H_2O]$ is higher compared to the standard oxytetracycline against ***E.coli.*** and antifungal activity is closed to the standard ketoconazole against cryptococcus neoformans.

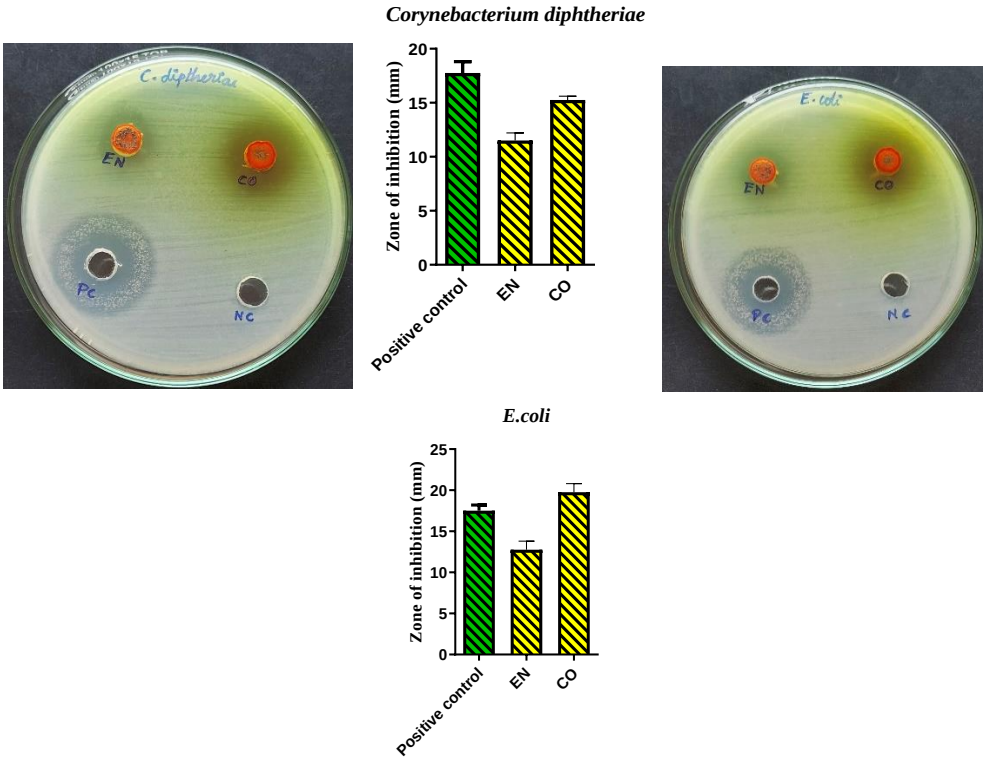

Figure 6.Antibacterial activity of EN and Co complex against *Corynebacterium diphtheria* and*E.coli.*

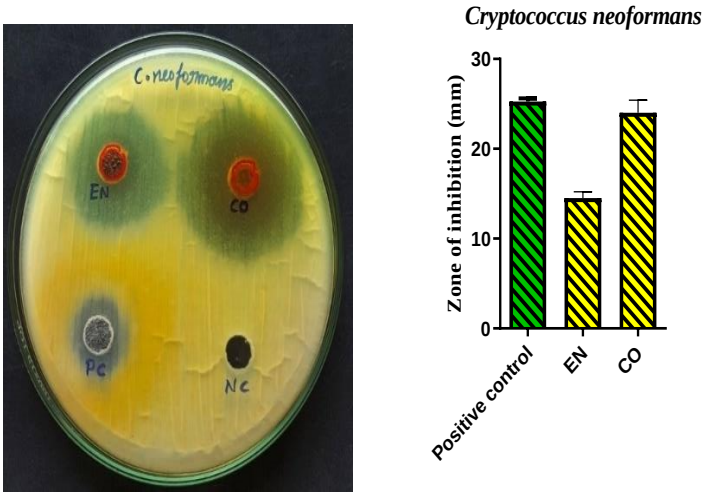

Figure 7. Antifungal activity of EN and Co complex against *Cryptococcus neoformans*

Conclusion

The Schiff base 2-((4-nitrophenylimino)methyl-6-ethoxy)phenol has been synthesized from 3-ethoxy salicylaldehyde and 4-nitroaniline. It has been complexed with cobalt(II) acetate tetrahydrate. The spectral data of the complex have revealed bidentate coordinating nature of the Schiff base through nitrogen atom of azomethine group and oxygen atom of phenoxide ion. The cyclic voltammogram of Co(II) complex indicates that in the complex, ligand stabilizes the metal in +2 oxidation state. Fluorescence intensity is maximum for $[Co(EN\text{-}H)_2.2H_2O]$ complex however, this complex is favourable to be used in fluorescence switches and sensors. The antibacterial activity of Co complex is more compared to the standard Oxytetracycline against ***E.coli.*** Thus $[Co(EN\text{-}H)_2.2H_2O]$ complex plays a crucial role in pharmaceutical usage.

Acknowledgements

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SYNTHESIS, CHARACTERISATION AND ANTIMICROBIAL STUDIES OF SCHIFF BASE DERIVED FROM 4-METHOXY-3-HYDROXYBENZALDEHYDE AND 4-METHOXY ANILINE AND ITS METAL COMPLEXES

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Abstract

Synthesis and characterisation of three new Schiff base complexes of Co(II), Ni(II) and Cu(II) with vanilliden-p-anisidine (VNA) are described. The complexes have been characterised by analytical methods, conductivity measurements, magnetic susceptibility, thermal studies, infrared, electronic and EPR spectral studies. The high affinity for the chelation of the Schiff bases towards the transition metal ions is utilized in preparingtheir solid complexes. IR spectra show that (VNA) is coordinated to the metal ions in a bidentate manner through azomethine-N and phenolic-Oatom.Based on the results obtained, octahedral geometry assigned to Co(II) and Cu(II), whereas Ni(II) complex has been assignedtetrahedral geometry. The thermal behaviour of metal complexes reveals that the hydrated complexes lose water molecules of hydration in the first step, followed by decomposition of ligand molecule in the subsequent steps. The antimicrobial results indicate that the metal complexes have better activity compared to Schiff base ligand.

Keywords: Schiff base, metal complex, IR spectra, antimicrobial studies.

1. Introduction

Schiff base was first reported by Hugo Schiff, a German Chemist in 1864 [1]. Schiff bases can beprepared by condensing carbonyl compound and amine in different conditions and indifferent solvents with the elimination of water molecules.In recent years, the researchers have fascinated enormous attention toward Schiff bases (azomethine linkage) and their metal complexes owing to numerous applications in pharmacology such as antiviral, antifungal, antimicrobial, antimalarial, antituberculosis, anticancer, anti-HIV, catalytic application in oxidation of organic compounds and nanotechnology[2]. Coordination compounds are formed between a metal atom and a molecule withone or more unshared pairs of electrons by coordinate bonds. These compounds are alsotermed as ‘ligands’.Coordination compounds are one of the fascinating areas of chemistry; numerous interesting and important properties of these complexes were investigated. The field of bioinorganic Chemistry is

concerned with coordination compounds [3]. Many bioactive compounds like haemoglobin, myoglobin, chlorophyll, metalloporphyrins and cytochromes are metal complexes. Schiff bases and their transition metal complexes continue to be interested even after over a hundred years of study. Introduction of metal complexes play an essential role in agriculture, pharmaceutical and industrial chemistry [4-8].

4-Methoxy-3-hydroxy benzaldehyde (isovanillin) can be used as a precursor in the chemical total synthesis of morphine. It is a phenolic aldehyde, an organic compound and isomer of vanillin. It is a selective inhibitor of aldehyde oxidase.4-Methoxy aniline (p-anisidine) is used as a reagent for the detection of oxidation products such as aldehydes and ketones in fats and oils.

Crystal structure, hydrogen bonding, Hirshfeld surface analysis and inhibition efficiency of a Schiff base 2-methoxy-6-(naphthalene-2-yliminomethyl)-phenol has been already reported from our laboratory [9]. As the continuation of our study of transition metal complexes here we report a novel Schiff base (E)-2-methoxy-5-(((4-methoxyphenyl)imino)methyl)phenoland its three metal complexes (Co(II), Ni(II) and Cu(II)). Hence in the present study, we report the synthesis, spectral analysis and antimicrobial properties of the newly synthesised compounds.

2. Experimental

2.1 Materials

All chemicals used were of analytical reagent grade (AR) and of the highest purity available. $CoCl_2.6H_2O$, $NiCl_2.4H_2O$, $CuCl_2.2H_2O$, isovanillin,4-methoxy aniline, benzene, and Ethanolhave been purchased from Merck and used as such.

2.2 Physical measurements

Infrared spectra were recorded using KBr disks on a FT-IR Perkin-Elmer spectrophotometer in the range 4000-400cm^{-1}. Molar conductances were measured in DMF ($1x10^{-3}$ M) using Elico conductivity bridge and dip type conductivity cell. Electronic spectra of the complexes were recorded in DMF on a Perkin-Elmer spectrophotomer. ^1H NMR spectrum of the ligand was recorded in DMSO with a Bruker 400MHz using TMS as internal standard. Magnetic susceptibility measurements were carried out on solid compounds using Gouy balance at room temperature. Melting points of the ligand and its metal complexes were determined by open capillary method using vanaspathi bath and are uncorrected. TGA

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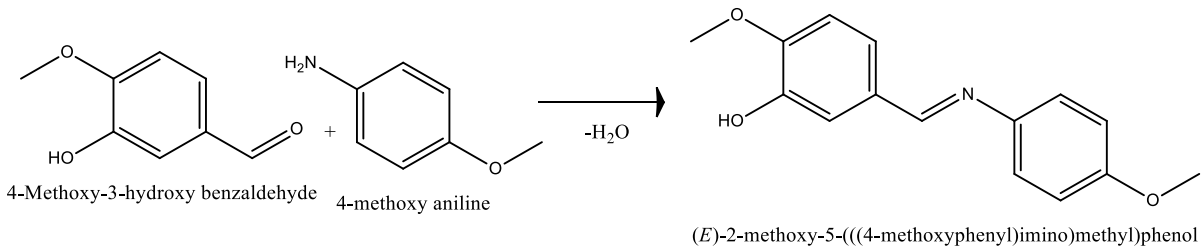
curves of the complexes were recorded on a Perkin Elmer analyser, (Diamond (TGA/DTA) heating rate of 10℃/min.from 40-740℃. The EPR study was carried out in Bruker EMX Plus model at Liquid Nitrogen Temperature (LNT). In vitro antibacterial and antifungal activities were studied at Kovai Medical College of Pharmaceutical sciences, Coimbatore.

2.3Preparation of ligand

The ligand was synthesised by refluxing 0.05mol of the 4-methoxyanilineand 0.05mol of isovanillinin ethanol for about 2 hours. The Schiff base which is separated on concentration and cooling, was washed with benzene and recrystallized from ethanol and dried in vacuum over anhydrous calcium chloride.

The ligand was brownish pale black crystalline solid (Scheme 1), soluble in DMF and DMSO but insoluble in ethanol, chloroform, benzene and ether. The melting point the Schiff base was found to be 126°C.



Scheme 1: Synthesis of Schiff base

2.4 Preparation of Co(II), Ni(II) and Cu(II) complexes

Ethanolic solution of 0.05mol of metal salt (chlorides of cobalt, nickel and copper) was added to an ethanolic-DMF mixture solution containing 0.1 mol of the ligand (molar ratio [M:L: 1:2]) [10]. The reaction mixture was kept under reflux for about six hours. The product obtained was washed several times with hot benzene and then with ether, to get a crystalline solid. The product was again washed several times with hot benzene to remove the excess ligand. The complex was dried in vacuum over anhydrous calcium chloride.The yield ranged from 60% to 72%. The dried complexes were subjected to spectroscopic analysis.

$$MCl_2xH_2O + 2HL \xrightarrow[\text{Ethanol-DMF}]{\Delta} ML_2\ xH_2O$$

Where M= Co(II), Ni(II) & Cu(II).

3. Results and discussion

The synthetic route for preparation of the Schiff base ligand is represented in Scheme–1.In general, the complexes were obtained by heating under reflux of respective metal salts with ligand, in 1:2 molar ratio. Complexes 1–3 gave a sharp melting point indicating the isolationof fairly pure complexes.The stoichiometry of the complex was determined by estimating the amount of metal ion by standard methods.

3.1 Characterisation of ligand (HL)

The ligand (E)-2-methoxy-5-(((4-methoxyphenyl)imino)methyl)phenol **(HL)** is characterised based on elemental analysis (Table 1), IR, ^{1}H NMR, ^{13}C NMR and mass spectral studies. The results obtained are in good agreement with those calculated for the suggested formula. The melting point of the ligand is very sharp and its purity being checked by TLC. The ligand is insoluble in aqueous and most of the organic solvents and soluble only in DMSO, DMF, hexane and dioxan.

3.1.1 Vibrational spectrum

The proposed assignments of the various internal modes of vibrations are furnished in Table 2.The IR spectrum (Figure 1) of the band consists of broad band in the region of 3471cm^{-1} assigned to the hydroxyl group. The presence of azomethine group [11] in the spectrum is noticed by new band at 1633cm^{-1} of the Schiff base. The phenolic(C-O) stretching is observed at 1213cm^{-1}.The infrared spectral data of the ligand is in consistent with the formation of the Schiff base ligand.

3.1.2 Electronic Spectrum

The electronic spectrum of the ligand (Figure 5A) was recorded in DMSO and is listed in Table 2. The electronic spectrum of the ligand shows two bands at 297 nm and 350 nm. may be due to n$\rightarrow\pi^*$ and $\pi \rightarrow \pi^*$transitions respectively.

3.1.3 NMR spectrum

The ^{1}H-NMR spectra of the Schiff base ligand (Figure 6a) has a signal at δ=7.98 ppm (s)[11] and it is attributed to azomethine proton (-CH=N-). The ^{1}H-NMR of the ligand exhibit signals at δ=4 ppm (s,3H,OCH_3). The signal for the aromatic proton (-OH) appears at δ=9.9ppm(m, 6H). The number of protons calculated exactly matches with proposed molecular formula.

3.1.4. Mass spectrum

The electron impact mass spectrum of the free ligand (HL) (Figure 7), confirms the proposed formula by showing a peak at *m/z*=257(12%) corresponding to the ligand moiety. The parent ion peak (257) is in good agreement with the suggested molecular formula. This spectrum confirms the formation of Schiff base ligand.

3.2 Characterization Of the Metal complexes

3.2.1 Vibrational spectra

The tentative assignments of the important IR spectral bands for the Schiff base ligand as well as its complexes viz Co(II), Ni(II) and Cu(II) are listed in Table 2. The Schiff base ligand was compared with the spectra of the complexes. In Co(II) complex [12] the coordinated water molecules are indicated by the appearance of a broad band at 3433cm^{-1}.The FT-IR spectrum of ligand exhibits a strong band of the azomethine (C=N) at 1633 cm^{-1}[115]. This band is shifted to the 1649cm^{-1} in cobalt, which further confirms the coordination of the ligand through azomethine nitrogen. A similar shift at 1602cm^{-1} in nickel and 1647 cm^{-1} in copper complex further supports the chelation of ligand to metal azomethine linkage.

However, after complexation of metal to nitrogen ν(M -N) [13-15] via a new band at the far – IR regions of 452cm^{-1} for cobalt, 477cm^{-1} for nickel and 466cm^{-1} for copper. In the far-IR region another new bands around 589cm^{-1}, 550cm^{-1} and 507cm^{-1} for cobalt, nickel and copper complex respectively and are assigned toν(M-O). These show the effect of complexation via azomethine nitrogen and phenolic oxygen. These overall data suggest that after complexation the azomethine-N and phenolic oxygen shifted to lower or higher frequencies in all the complexes as compared to that of ligand.

3.2.2 Molar conductance data

The electrical conductivity of all the complexes were studied at the room temperature by dissolving it in DMF (concentration of 10^{-3}M). In all cases the conductivity value observed is less than 20. The values of electrical conductivities are listed in Table 1. The value of electrical conductivity of the complexes follows the order Co(II)< Ni(II) < Cu(II) which may be due to the variation of ionic size of the cation. The molar conductance values are too low to account for any dissociation of the complexes in DMF, indicating non-electrolytic nature [16].

3.2.3Electronic spectra and magnetic moment data

The cobalt complex in DMF solvent in 1×10^{-5} mol/cm^3 showed that it has an octahedral feature. Co complex (Figure 5b) displays four absorption bands at 367nm (27,248 cm^{-1}), 444nm (22,523 cm^{-1}), 584nm (17,123 cm^{-1}) and 881nm (11,351 cm^{-1}) ascribed to L→M charge transfer, $^4T_{1g}$ (F)→$^4T_{2g}$(P), $^4T_{1g}$ (F)→$^4A_{2g}$(F) and $^4T_{2g}$ (F)→$^4T_{1g}$(F) transitions respectively[17]. The magnetic moment value of cobalt at room temperature is 4.69 B.M. The above electronic spectral data and magnetic moment value strongly support the existence of high spin octahedral geometry around cobalt[18].The diffuse reflectance spectrum of nickel complex (Figure 5c) displays two absorption maxima at 622nm (16,077 cm^{-1}) and 1272nm (7,862 cm^{-1}) corresponding to $^3T_1$(F)→$^3T_1$(P) and $^3T_1$ →$^3A_2$ transitions respectively [17]. The nickel complex has the room temperature magnetic moment value of 3.46 B.M., which is in the normal range observed for tetrahedral Ni(II)complex [18]. The μ_{eff} value of the copper complex is 1.80 B.M. indicating an octahedral environment around copper [19]. The electronic spectrum of complex (Figure 5d) has only one band at 611nm (16,367cm^{-1}). It may be assigned to the $^2E_{1g}$→$^2T_{1g}$ transition confirming the octahedral geometry in the copper complex [20].

3.2.4 Thermal Analysis

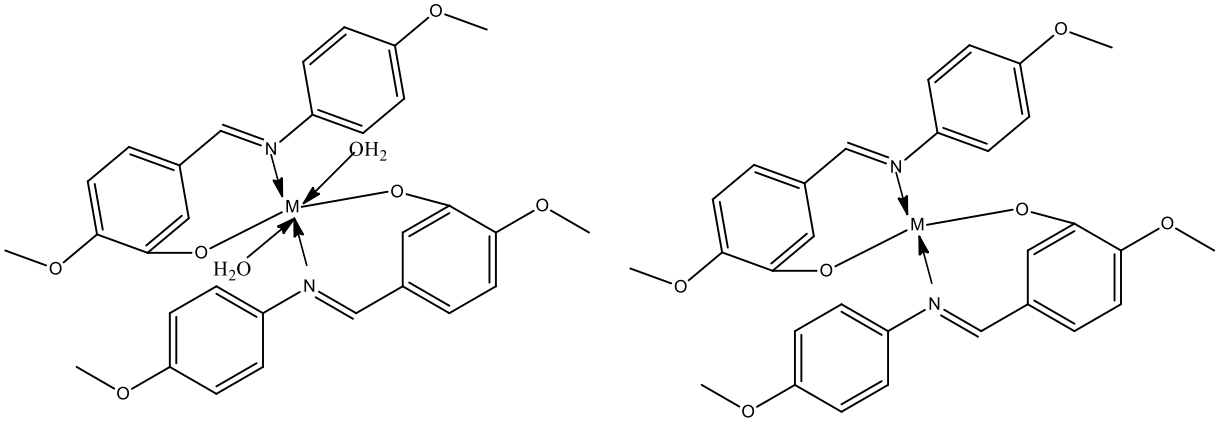
Thermal analysis techniques are usually employed for determining the thermal stability and composition of complexes. Thermal behaviours (TGA–DTA) of the ligand and its metal complexes have been performed in the temperature range from 40 to 740^{0}C under N_2 atmosphere with a heating rate of 10°C min^{-1}(Figure 8a, 8b & 8c). The mass losses (experimental and calculated) as a function of temperature of the Co(II) complex 1 decompose mainly in three steps. The first step appeared within the temperature range 115-190ºC was due to the elimination of coordinated water molecules [21]. The second step within the temperature range 220-310ºC was associated with an endothermic. This peak was due to the partial decomposition of the ligand. The final decomposition step appeared above 450ºC corresponding to the complete thermal decomposition of the complex and the loss of their organic portion resulting in the formation of CoO as final products.The Ni(II) complex exhibits thermal stability up to 250ºC, which confirms that this complex is free from any types of water molecules. The second step within the temperature range 300-350ºC was associated with an endothermic. This peak was due to the partial decomposition of the ligand. The final decomposition step appeared above 390ºC corresponding to the complete thermal

decomposition of the complex and the loss of their organic portion resulting in the formation of CuO as final products.

The Copper (II) complex decompose in three steps. The first step appeared within the temperature range 130–190ºC was due to the elimination of coordinated water molecules. The second step within the temperature range 200–280ºC was associated with an endothermic. This peak was due to the partial decomposition of the ligand. The final decomposition step appeared above 300 and upto 490ºC corresponding to the complete thermal decomposition of the complex and the loss of their organic portion resulting in the formation of CuO as final products.

3.2.5 EPR spectrum of copper complex

The room temperature EPR spectrum of complex exhibits an isotropic signal, without any hyperfine splitting, with g_{iso} = 2.067. The X–band EPR spectrum of the complex in DMSO at liquid nitrogen temperature is shown in the Figure 9. In frozen state four peaks are observed at low field region. The complex exhibits the $g_{\parallel}$ value of 2.23 and $g_{\perp}$ value of 2.15. These values indicate that the ground state of copper ion is predominantly $d_{x^2-y^2}$. From the g values of copper complex a high spin octahedral geometry is proposed for the complex[21].The metal complexes (Co(II), Ni(II) and Cu(II)) of the ligand have been structurally characterised by analytical, various spectral and thermal analysis. The metal ligand stoichiometry in all these complexes is 1:2. The Schiff bases coordinate to metal ions through azomethine nitrogen and phenolic oxygen after deprotonation, forming a stable structure.From all the above spectral evidences the proposed structure of the complexes are shown below.



Where M= Co(II) & Cu(II)
Octahedral geometry

Where M= Ni(II)
Tetrahedral geometry

Scheme 2: Structure of the metal complexes

4. Antimicrobial activity

The reactivity of the synthetic products towards the biological systems is an important feature of the current research. The compounds synthesised have been evaluated for their antibacterial and antifungal action by using disc diffusion technique [22]. *Staphylococcus aureus,Bascillus subtilis, E. coli, Pseudomonas aeruginosa, Klebsiella sp., Candida albicans and Aspergillus niger* have been used as the test organisms. DMSO is used as negative control and Ciprofloxacin is used as positive standard for antibacterial and Nystatin for antifungal activities. Results have been recorded in the form of inhibition zones (diameters, mm) and activity is shown in Table 3. It has been observed that all the compounds show a remarkable biological activity against different types of gram positive and gram negative bacteria and against fungi species.

4.1 Antibacterial activity

The antibacterial activity of the ligand and complexes (**1-4**) has been tested and their zone of inhibition values are furnished in Table 3 and a comparative account of all the compounds are represented in the Figure10. The sensitivity of bacterial species towards ligand HLis moderate to significant. All the metal complexes of the ligand HL show a progressive increase in the antibacterial activity against the twogram positive and one gram negative bacterial species. But the activity decreases for a cobalt and nickel complexes against *E.coli*. The maximum zone of inhibition value (25 mm) is shown by the copper complex. In most of the complexes the activity increases upon chelation (Figure 11).

4.2 Antifungal activity

The newly prepared Schiff base and its complexes show a weak to significant fungal activity against the two fungal species *A.niger* and *Candida albicans.* The maximum sensitivity values are observed for the cobalt complex *A.niger* and the minimum sensitivity value is shown by all the complexes against both the fungal species *Candida albicans*. The impact of complexation shows significant changes for all the complexes and a similar trend has been noted for the three sets of complexes (Figures 11).

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Table 1: Physical characteristics and analytical data of the Schiff base and its Metal(II) complexes

S. No.	Schiff base/ Metal complexes	Molecular formula	Colour	Yield %	M.Pt. °C	μ_{eff} (BM) at RT	Λ_m $\Omega^{-1}cm^2$ mol^{-1}	Elemental analysis Calcd.(Obs.)in (%)			
								C	H	N	M
I	HL	$C_{15}H_{15}NO_3$	Pale black	74	126	-	-	70.02 (69.07)	5.88 (4.38)	5.44 (4.53)	-
1	$[Co(L)_2.(H_2O)_2]$	$CoC_{30}H_{30}N_2O_8$	Brown	60	173	4.69	10.5	59.51 (57.96)	4.99 (4.28)	4.63 (4.39)	9.73 (9.59)
2	$[Ni(L)_2]$	$NiC_{30}H_{26}N_2O_6$	green	66	196	3.46	15.7	63.29 (62.78)	4.60 (4.27)	4.92 (4.35)	10.13 (9.27)
3	$[Cu(L)_{2.}(H_2O)_2]$	$CuC_{30}H_{30}N_2O_8$	Dark brown	70	259	1.80	14.6	62.76 (60.99)	4.56 (3.97)	4.88 (4.78)	11.07 (10.17)

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Table 2: Spectral Data Of The Ligand and its Complexes

Compound	IR Spectral band (cm^{-1})	Assignments	Electronic Spectral data (nm)	Assignments	Geometry
HL	3471 (b) 1633 1213	υ (-O-H) υ (-HC=N-) υ(-C-O)	297 350	n→π* π→π*	-
$[Co(L)_2 (H_2O)_2]$	3433 (b) 1649 (s) 1228 (s) 452 589	υ (O-H/H_2O) υ (-CH=N-) υ (-C-O) υ (M-N) υ (M-O)	367 444 584 881	L→M CT $^4T_{1g}(F) \rightarrow {}^4T_{2g}(P)$ $^4T_{1g}$ (F) → $^4A_{2g}$ (F) $^4T_{2g}(F) \rightarrow {}^4T_{1g}(F)$	Octahedral
$[Ni(L)_2 (H_2O)_2]$	3416 1602 (s) 1229 (s) 477 550	υ (O-H/H_2O) υ (-CH=N-) υ (-C-O) υ (M-N) υ (M-O)	622 1272	$^3T_1$ (F)→$^3T_1$(P) $^3T_1 \rightarrow {}^3A_2$	Tetrahedral
$[Cu(L)_2(H_2O)_2]$	3399 (b) 1647 (s) 1226 (s) 466 507	υ (O-H/H_2O) υ (-CH=N-) υ (-C-O) υ (M-N) υ (M-O)	611	$^2E_{1g} \rightarrow {}^2T_{1g}$	Octahedral

s=strong **b=broad**

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Table 3: Antimicrobial activity of Schiff base and its metal complexes

S. No.	Schiff base/ Metal complexes	Zone of inhibition in mm					
		Gram positivebacteria		Gram negative bacteria		Fungi	
		Staphylococcus aureus (NCIM2079)	*Bacillus subtilis (NCIM 2063)*	*Eschericsia coli (NCIM 2065)*	*Klebsiella sp. (NCIM 2098)*	*Aspergillus niger (NCIM 105)*	*Candida albicans (NCIM 3102)*
1	HL	18	22	20	19	20	13
2	$[Co(L)_{2.}(H_2O)_2]$	16	18	16	20	22	15
3	$[Ni(L)_2]$	20	18	20	16	18	15
4	$[Cu(L)_{2.}(H_2O)_2]$	22	23	25	18	20	15

Standard – Ciprofloxacin 5µg/disc; Nystatin 100 units / disc for fungi **Solvent–DMSO**

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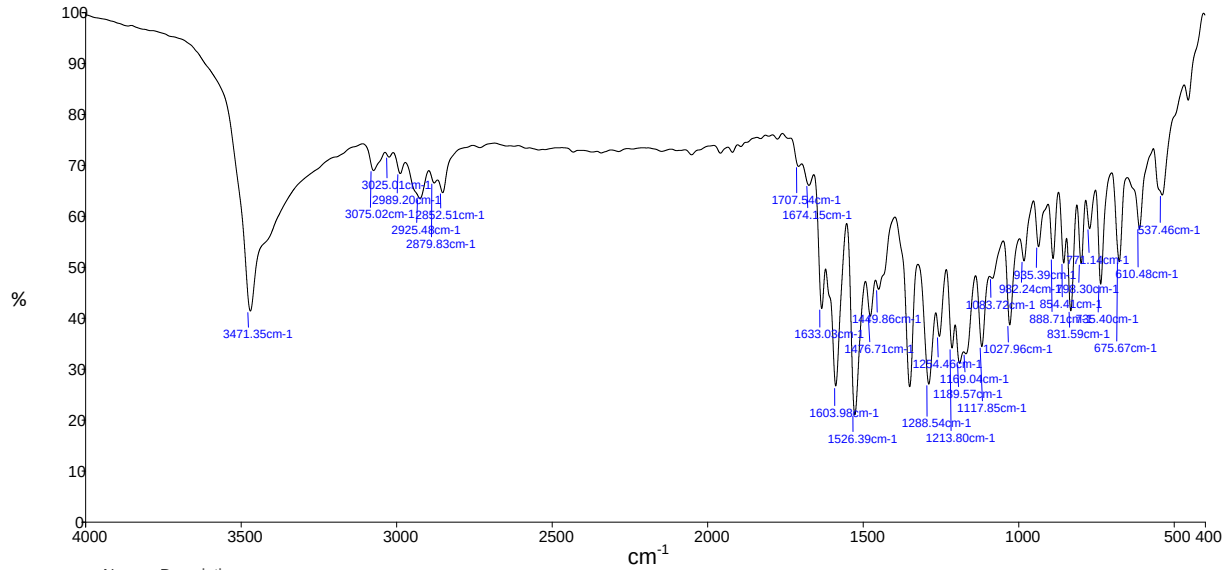

Figure 1. IR spectrum of the Schiff base ligand

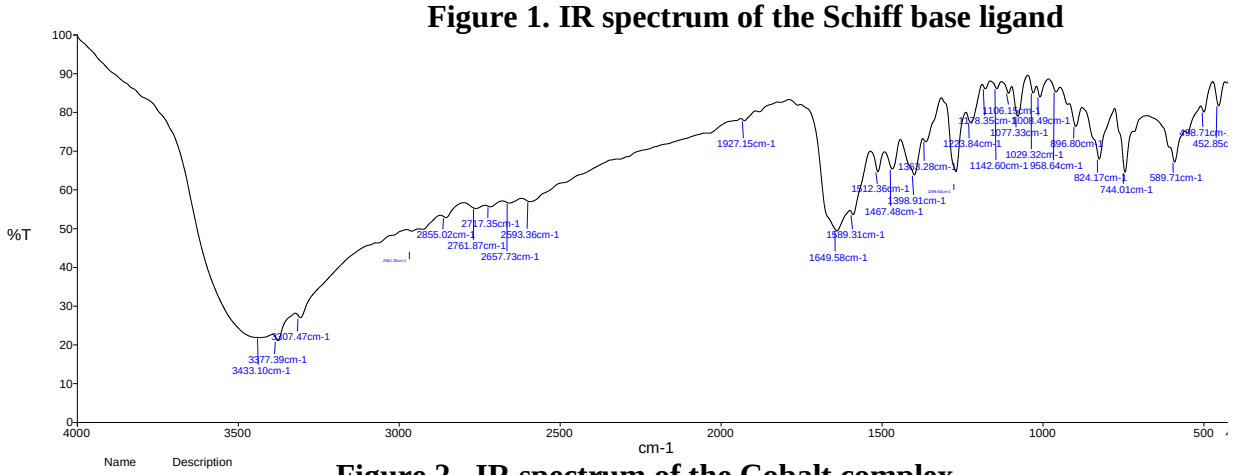

Figure 2. IR spectrum of the Cobalt complex

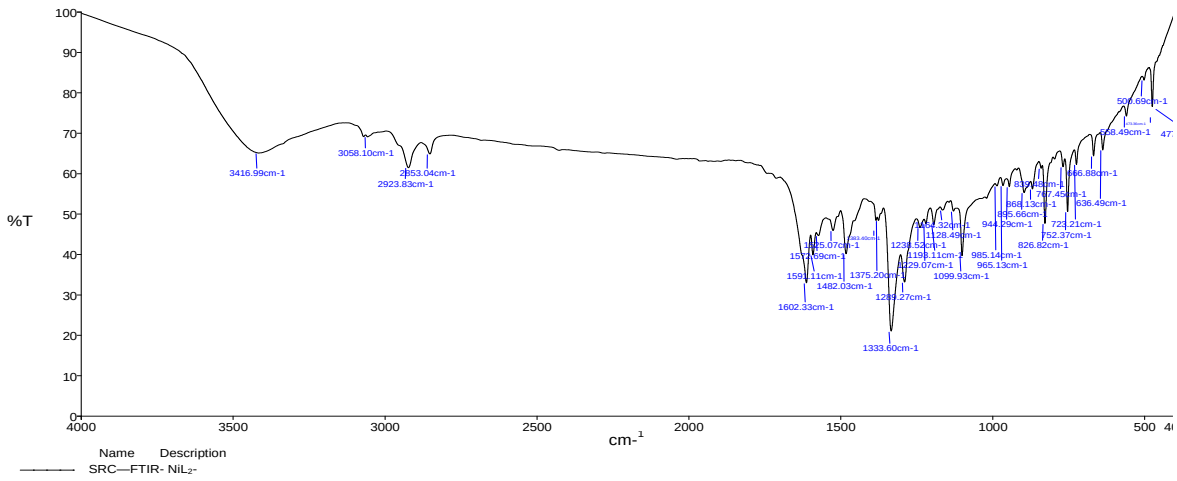

Figure 3. IR spectrum of the Nickel complex

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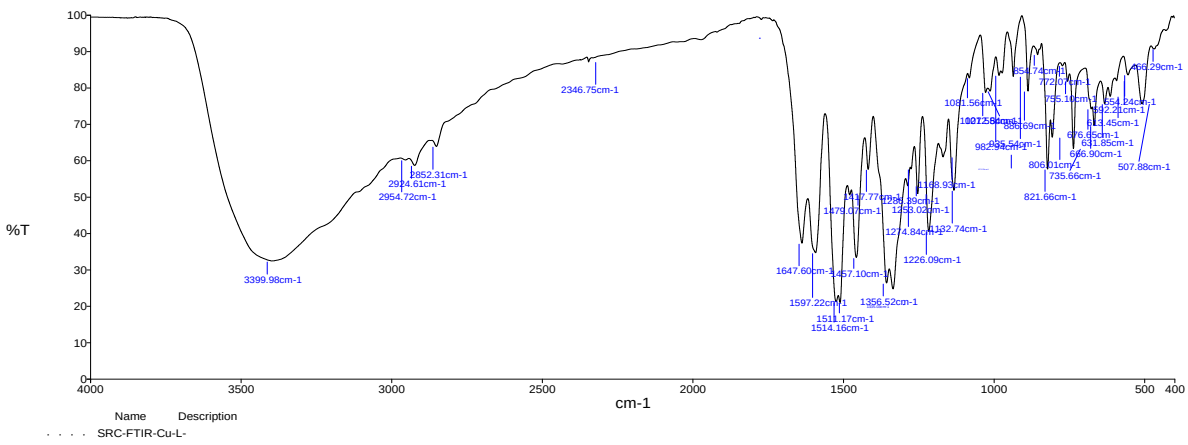

Figure 4. IR spectrum of the Copper complex

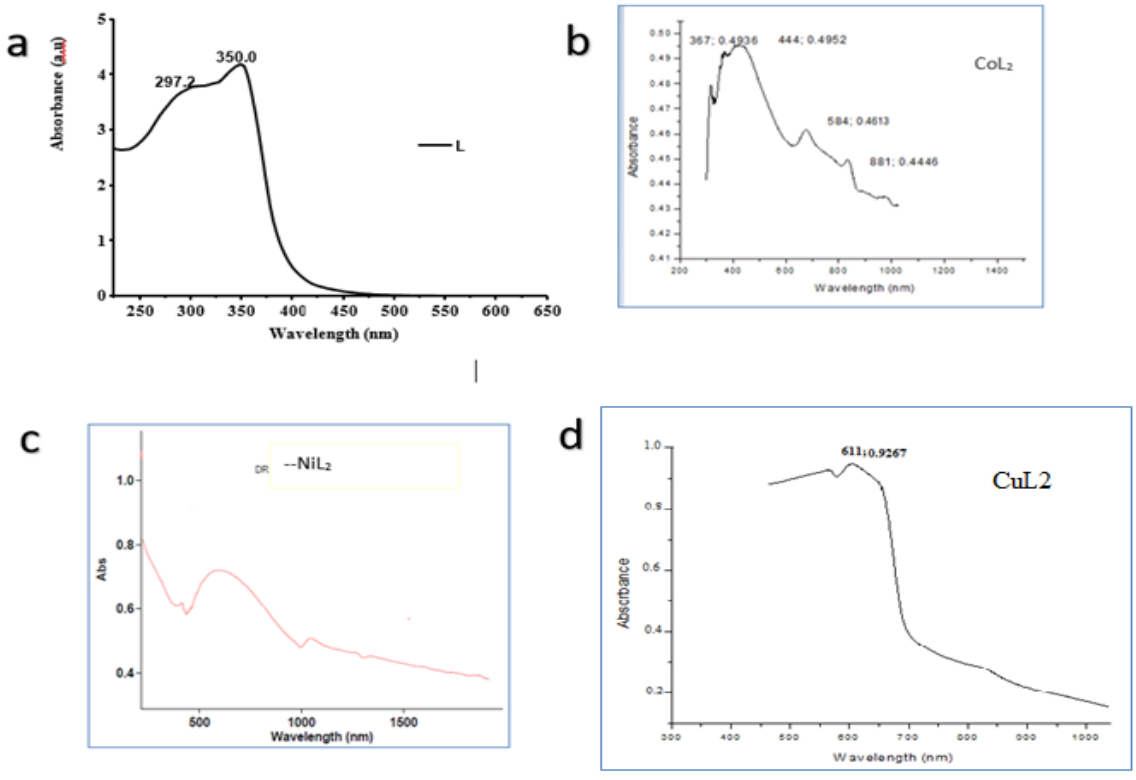

Figure 5a,5b,5c,5d Electronic spectra of the Schiff base ligand, Cobalt, Nickel and Copper complexes

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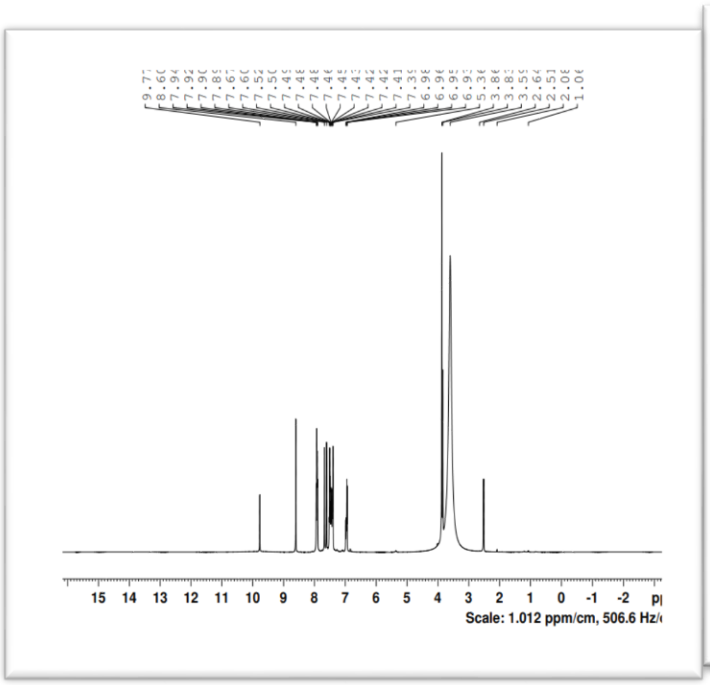

Figure 6a. ^{1}H-NMR spectrum of the Schiff base ligand

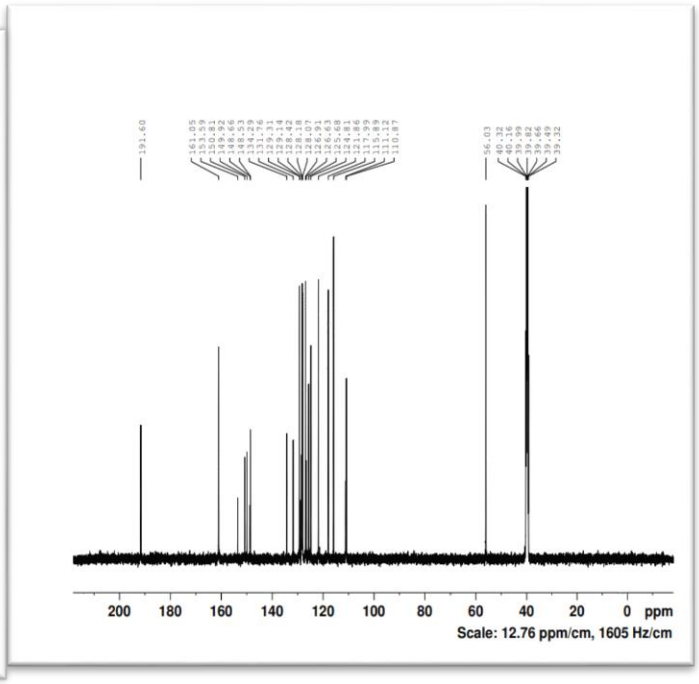

Figure 6b. ^{13}C-NMR spectrum of the Schiff base ligand

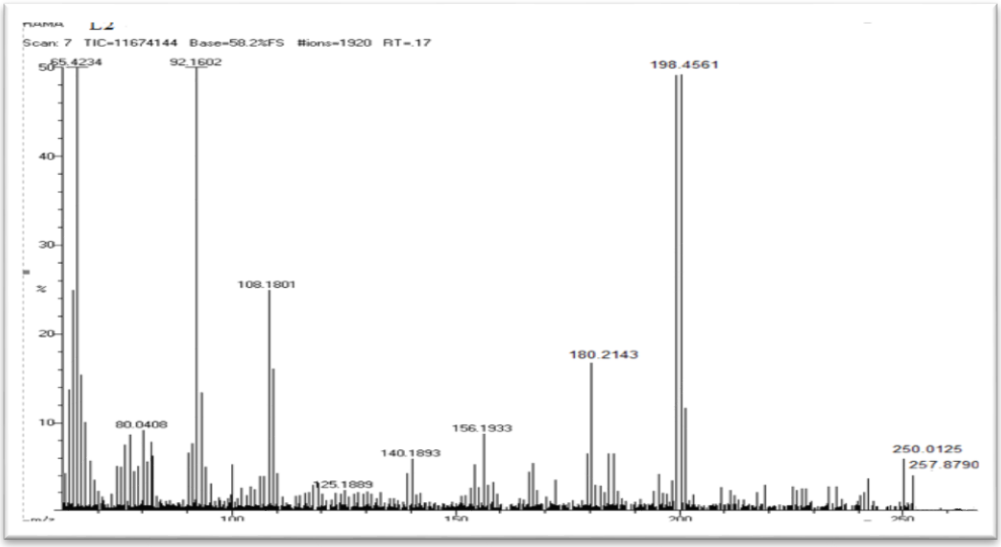

Figure 7. Mass spectrum of the Schiff base ligand

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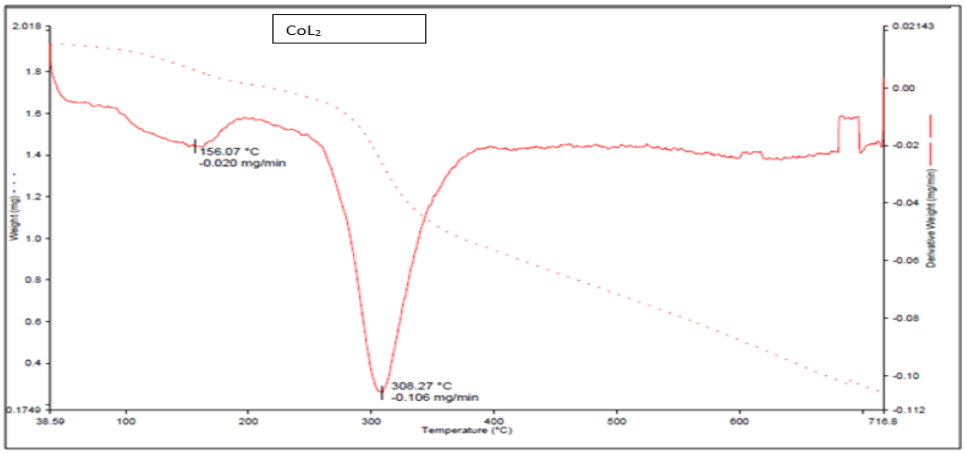

Figure 8a. Thermogram of the Cobalt complex

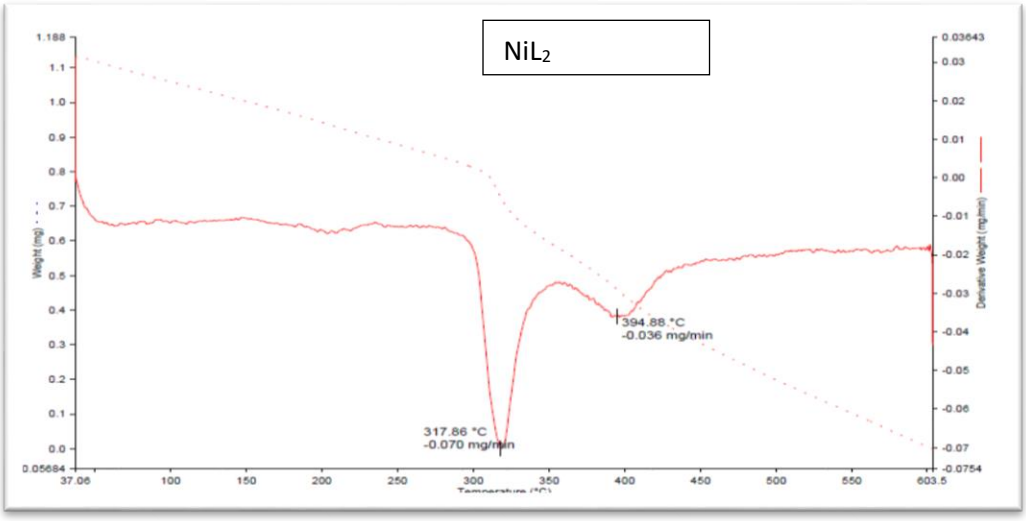

Figure 8b. Thermogram of the Nickel complex

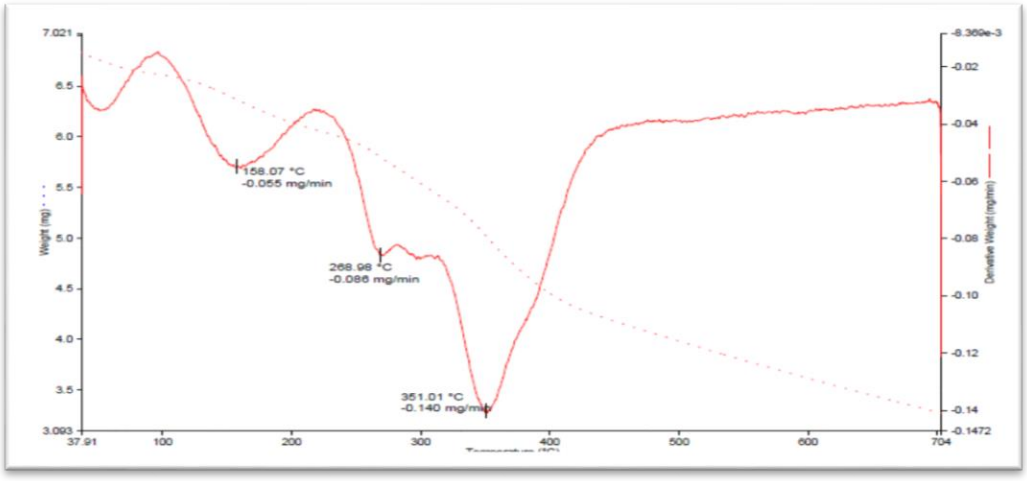

Figure 8c. Thermogram of the Copper complex

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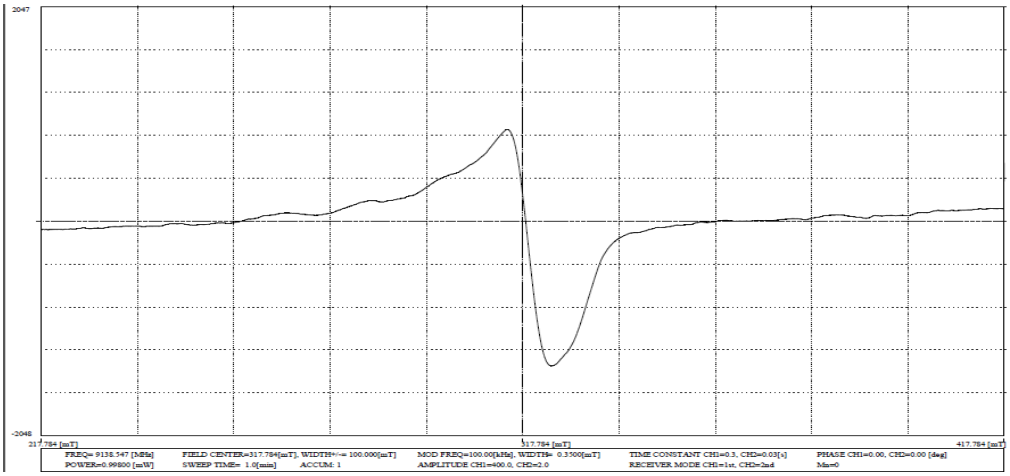

Figure 9. EPR spectrum of the Copper complex

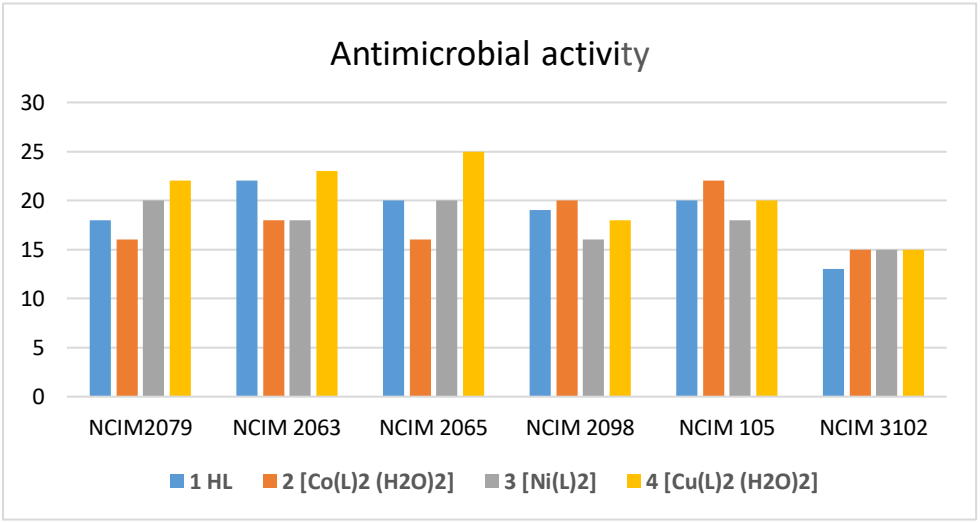

Figure 10. Antimicrobial activity of the Schiff base and its complexes

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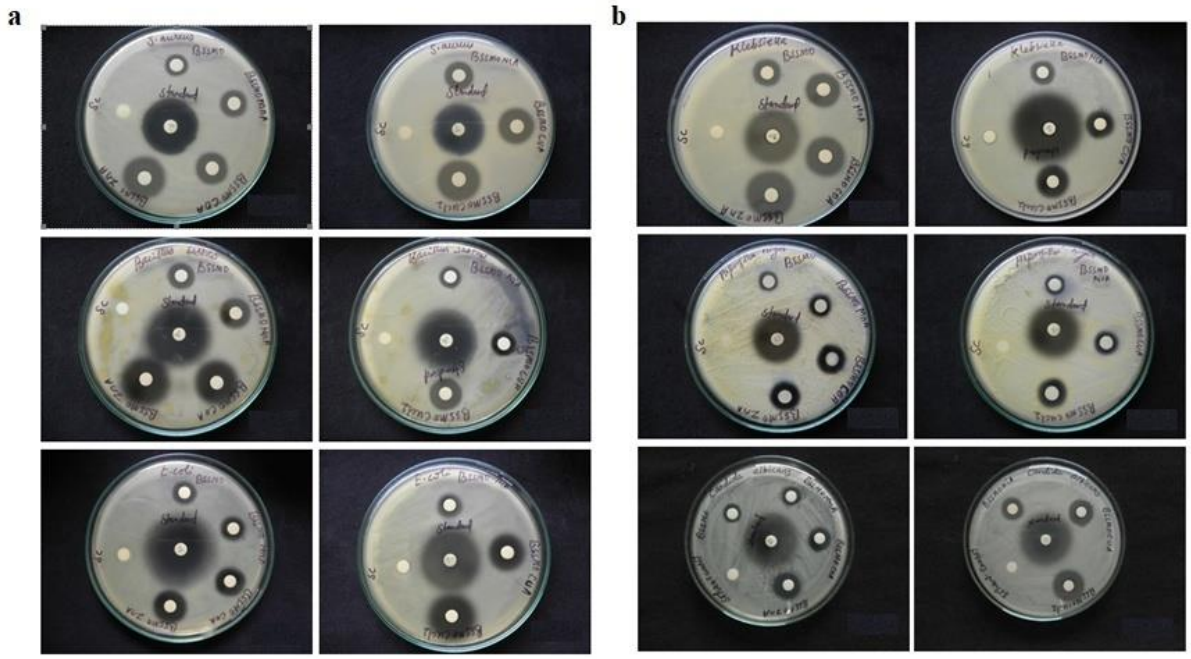

Figure 11a. *Invitro* antibacterial screening of Schiff base HL and its metalcomplexes against *Staphylococcus aureus, Bacillus subtilis* and *Eschericsia coli*

Figure 11b. *In vitro* antibacterial screening of Schiff base HL and its metalcomplexes against *Klebsiella sp.* and *in vitro* antifungal screening against*Aspergillus niger* and *Candida albicans.*

IV Conclusion

A total of three new series of Co(II), Ni(II), and Cu(II) Schiff base complexes have been synthesized and characterized.From the analytical data and the physical studies the ligand has been shown to act as a bidentate manner and coordination through the azomethine nitrogen and phenolic oxygen.The metal:ligand stoichiometry in all these complexes is 1:2. The thermal decomposition provided information concerning the presence of coordinatedwater molecules in cobalt and copper, whereas nickel has no water molecule coordinated in its structure. The final product of decomposition was stable metallic oxide. The complexes decompose in three or two steps and display complex thermal behaviour.Octahedral geometry is assigned to cobalt and copper complex. Tetrahedral geometry is noticed in nickel complex. The geometry of the complexes are confirmed by absorption spectra and magnetic moment data. In general metal complexes possess antibacterial and antifungal activity against the selected species of bacteria and fungi more than the free Schiff base ligand.

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A STUDY ON THE IMPACT OF NONPERFORMING ASSETS ON THE NET PROFITS OF PUBLIC AND PRIVATE SECTOR BANKS IN INDIA

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Abstract

Nonperforming assetsare the major issues for the banks today which are increasing and it affects the profitability of the commercial banks. Nonperforming assets (NPA) have a high cost for the banks as these assets do not earn any profit. The problem of NPA is not only affecting the banks but the entire economy of a country. The present study is concerned with analysing the NPAof Public and Private sector banks.The standard ratios relating to NPA are computed and assessed for a period of six years from 2014-15 to 2019-20. The study finds the impact of the Net NPA on the Net profit of the bank groups during the study period.The study concludes that the NPA affect the profitability of banks.

Keywords: Non Performing Assets (NPA), Public sector Banks, Private sector Banks, Net Profit, Net Assets.

Introduction

Indian banks acts as the connecting network of every Indian people and commercial institution. The banks operate not only for commercial gains but also for the development of society by providing a whole range of interrelated services. Therefore there arises a necessity to evaluate the performance of the banks not only of quantitative criteria like profit percentages but also qualitatively by assessing the relative operational efficiency of each unit of banking system which get reflected on the profit of banks. Among the factors affecting profitability Non-Performing assets (NPA) is the major one.

NPA – An Outlook

NPA is defined as a credit facility in respect of which the interest and or instalment of principal has remained unpaid past due for a specified period of time. NPA also known as non-productive asset constitute an integral part of bank's operation. A bank gives out money upfront and earns income overtime on the promise of a borrower to repay. When loans are not repaid, the bank loses both its income stream as well as its capital. The level of nonperforming loans are recognised as an indicator for assessing banks credit risk, asset quality and efficiency in allocation of resources to productive sectors.

Types of NPA

Gross NPA

It is the sum total of all loan assets as classified by Reserve Bank of India. It reflects the total quality of the loans lent by banks. It comprises of the non-standard assets like sub-standard assets, doubtful assets and loss assets. Gross NPA= Gross NPA/Gross Advances.

Net NPA

It is the Gross NPA after deducting provisions. As the NPA became burden for banks, provisions are created as per RBI guidelines. Net NPA=Gross NPA- Provisions/Net Advances.

Causes of NPA

The major causes of NPA in banking sector may be inefficient credit management system, wilful defaults, business cycles, industrial sickness, delayed legal salvations, pandemic or natural calamities etc. NPA is considered as a double edge weapon as the banks cannot survive without lending loans and on account lending the risk of nonperforming assets are higher . The money get blocked and the eraning capacity of the banks also start to decrease . Increase in NPA affects the profitability of banks and also their existence.

Literature Review

Kaveri (2001), studied on the NonPerforming assets of various Indian Commercial banks and based on the study suggested various strategies to reduce the extent of NPA in banks.

Prashanth k Reddy (2002) in his study focuses on comparative study on Non-Performing Assets in India in the Global context.

Meenakshi Rajeev and Mahesh H.P. (2010), in their study concluded that accounting norms have been modified substantially and mechanisms are in place for reduction of bad debts.

Bhavani Prasad and Veera . D (2011), studied NPAs in Indian Banking sector and concluded that PSBs accounted for 78% of total NPAs and this is due to falling revenues from traditional sources.

Jaynal Ud-din Ahmed (2011), in his study concluded that the earning capacity and profitability of banks has been adversely affected by the high level of NPAs and the reduction of NPAs in banks is posing the biggest challenges in the Indian economy.

Siraj.K.K ,Sundarsanan Pillai P., (2012), in their research study concluded that NPA still remains a major threat and the incremental component explained through additions to NPA poses a great question mark on efficiency of credit risk management of banks in India.

Veerakumar,K. (2012), in his research study concluded that the bank management may speed up recovery of good loans and bad loans through various modes to decelerated growth

of NPAs from the present level and also to prevent re-emergence of NPAs over the minimum level.

Ganesan. D &R.Santhanakrishnan (2013), in their research paper have made an attempt to examine the non-performing assets of State Bank of India over the past 10 years beginning from financial year 2002 to the financial year 2012. The researchers in this paper aimed to study the sources of deployment of funds for the chosen bank. They examined the gross and the net NPA of the bank and investigated the impact of NPA on the profitability of the bank. They have suggested measures to improve NPA effectively in banks.

Ravindra N. Sontakkel 1., Chandan Tiwari 2 (2013), the paper underlines the in depth study of the conceptual framework of Non Performing Asset commonly known as NPA in banking. It further discusses the NPA trend in the scheduled commercial banks in India for the preceding period of five years i.e. (2008 – 2012). Finally it covers the measures to be undertaken to reduce the menace of NPA in banks.

Syed Ibrahim M. Dr.,1 Rangasamy Thangavelu2 Dr.(2014), this paper focuses on the the concept of NPAs, components of loan assets the commercial banks in India with especial reference to the public sector, private sector and the foreign bank. The study is diagnostic and exploratory in nature and makes use of secondary data. The study finds and concludes that the commercial banks have significantly improved their working performance in the areas of NPAs.

Research Gap

NPA is always a threat to the banking sector and extensive research is carried out on the topic. This study focuses to study the NPA of all Public and Private sector banks during the period 2014-15 to 2019-20 before the covid period and it may extended to study the impact of NPA after covid period.

Statement of Problem

Non-performing Assets (NPA) is the key indicator to assess the health and wealth of Indian banking industry. It has emerged since over a long period as an alarming threat to the Indian banking industry. Managing bad loans and keeping them at the lowest level has become the important concern for the banks. The Gross NPA of Indian banks in March 2013 was 3.3 percent, in March 2014 it was 3.7 percent whereas in March 2015 it has risen up to 4.4 percent and it is expected to rise further. This leads to high operating cost and in turn affects the profitability of the banking sector. The public sector bank though excelled in financial performance than private sector, its nonperforming asset is rising high than the private sector. The private sector have minimised their nonperforming assets by strengthening

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their credit appraisal over the years. Hence the paper focuses on studying the impact of nonperforming assets on the Net Profit of Public and Private sector banks.

Objectives

The following are the objectives of the study:

1) To compare the non-performing assets of Public and Private sector banks.
2) To assess the impact of Net NPA on Net Profits of Public and Private sector banks.

Scope of the Study

The study focuses on the NPA ratios of Public and Private sector banks for a period of six years from 2014-15 to 2019-20.

Methodology

This is an analytical study based on the secondary data collected from the RBI publications, Annual Reports of banks, published materials in Newspapers, Magazines, Books and Websites. From the data NPA ratios are computed and compared for Public and Private sector banks.

Limitations

The following are the main limitations of the study:

i) The study focuses only on the ratios of Nonperforming assets.
ii) The study is based on secondary data as published in various publications of RBI and other reports.
iii) The study is confined only to a period of six years.

Assessment of NPAand Net Profits ofPublic and Private Sector Banks

Non-performing assets have a great impact on bank's operation.The increase in the profitability of a bank is always preceded by the composition of assets and liability. The level of non-performing assets is recognised as a critical indicator for assessing bank's efficiency, viability and solvency. Hence the following ratios are computed to assess the impact of NPA on profitability of banks.

i) Ratio of Gross NPA to Gross Advances
ii) Ratio of Net NPA to Net Advances
iii) Ratio of Gross NPA to Total Assets
iv) Ratio of Net NPA to Total Assets

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These ratios are calculated and presented for each financial parameter and descriptive statistics such as Mean, Standard Deviation (SD) and Covariance(CV) are used to assess the financial position of the two bank groups for six years (20014-15 to 2019-20).

The table stating the ratio of Gross NPA to Gross Advances indicates that the ratios are more conducive in Private bank group with the variability being minimum of 1.24%. The mean ratio of Public sector bank group is highest with 10.408% where the mean NPA is found much lesser to the extent of 4.075%. in Private sector Banks.

Table 1: Ratio of Gross NPA to Gross Advances

Year	Public Sector Banks	Private Sector Banks
2014-15	**5.0**	**2.1**
2015-16	**9.3**	**2.8**
2016-17	**11.7**	**4.1**
2017-18	**14.6**	**4.7**
2018-19	**11.6**	**5.3**
2019-20	**10.25**	**5.45**
Mean	**10.408**	**4.075**
SD	**2.92**	**1.24**
CV	**28.05**	**30.43**

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

An insight into the ratios of Public sector reveals that in 2017-18 there is a highest of 14.6% Gross NPA ratio. With regard to Private sector the proportion ofNPA shows a gradual increase throughout six years.

The table stated below reveals the ratio of Net NPA to Net Advances of the major two bank groups the Public and Private sector. The mean of 5.35% the highest is found in Public sector bank. The ratios are more consistent in Private bank group.

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Table 2: Ratio of Net NPA to Net Advances

Year		Public sector banks	Private sector banks
2014-15		2.9	0.9
2015-16		5.7	1.4
2016-17		6.9	2.2
2017-18		8.0	2.4
2018-19		4.8	2.0
2019-20		3.8	1.6
Mean		5.35	1.75
SD		1.74	0.51
CV		32.52	6.58

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

On considering the Public sector throughout all these six years the net NPA is higher than Private sector group. The least of 0.9% is found in 2014-15 in Private sector group and the highest mean of 8% is found in 2017-18 in Public sector group.

The ratios during the period of six years for two bank group indicate the higher consistency in Public bank group (CV 26.60%) whereas Private sector shows higher variability of 55.55%. The mean ratio of Public and Private sector shows very least with 1.76% and 1.75% respectively.

Table3: Ratio of Gross NPA to Total Assets

Year	Public sector banks	Private sector banks
2014-15	3.2	1.3
2015-16	5.9	1.8
2016-17	7.0	2.6
2017-18	8.9	3.0
2018-19	7.3	3.5
2019-20	7.4	6.7
Mean	6.617	3.15
SD	1.76	1.75
CV	26.60	55.55

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

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The Gross NPA to Total assets is found highest in Public sector banks throughout six years. Higher ratio of 8.9% is found in 2017-18 in Public sector and 6.7% in Private sector in the year 2019-20. The Private sector shows a gradual increase in Gross NPA ratio during six years.

It can be inferred from the table of Net NPA to Total Assets ratio that they show higher consistency in Public sector bank group. The higher mean of 3.167% is seen in Public sector bank group.

Table 4: Ratio of Net NPA to Total Assets

Year	Public sector banks	Private sector banks
2014-15	**1.8**	**0.5**
2015-16	**3.5**	**0.8**
2016-17	**3.9**	**1.3**
2017-18	**4.5**	**1.5**
2018-19	**2.8**	**1.3**
2019-20	**2.5**	**1.8**
Mean	**3.167**	**1.2**
SD	**0.90**	**0.43**
CV	**28.42**	**35.83**

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

The ratios of two bank group reveal that Net NPA is found higher of 4.5% in 2017-18 in Public bank group and 1.8% in 2019-20 in Private bank group. Private group shows a gradual increase of Net NPA to Total Assets throughout six year period.

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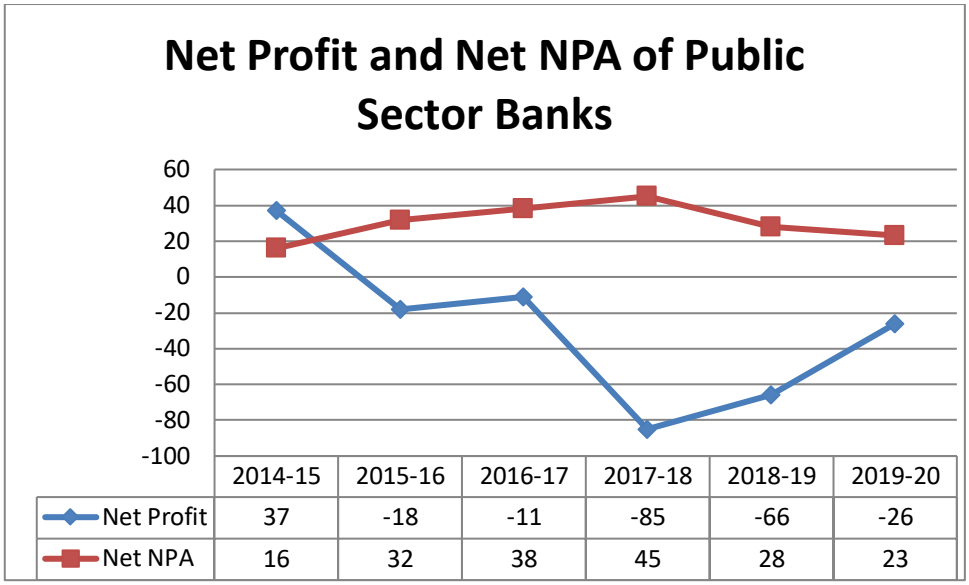

Figure 1.

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

The above figure reveals that the Net Profit is highest in 2014-15 then it started to decline reaching the least in 2017-18. The banks earn losses throughout five years from 2015-16 onwards. The Net NPA show a mixed linear trend from highest of 45 crores in 2017-18 but in the later years it started to decline.

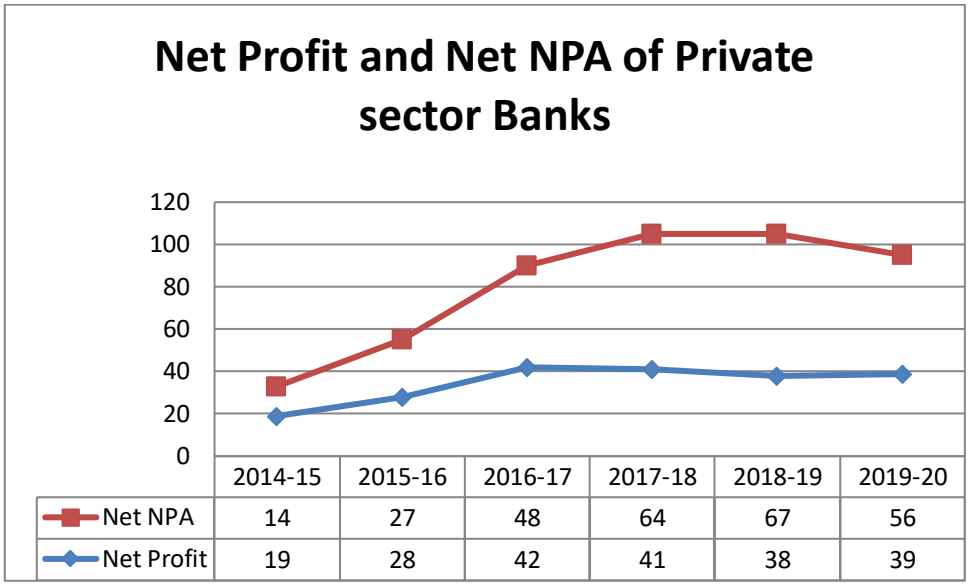

Figure 2.

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

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From the above figure it is evident that the Net Profit of Private banks is found higher with nearly of 42 crore rupees in 2016-17 and the least of 14 crore rupees is found in the year 2014-15. The Net NPA of the banks is soaring high throughout five years from 2014-15 to 2018-19 but it declined in 2019-20.

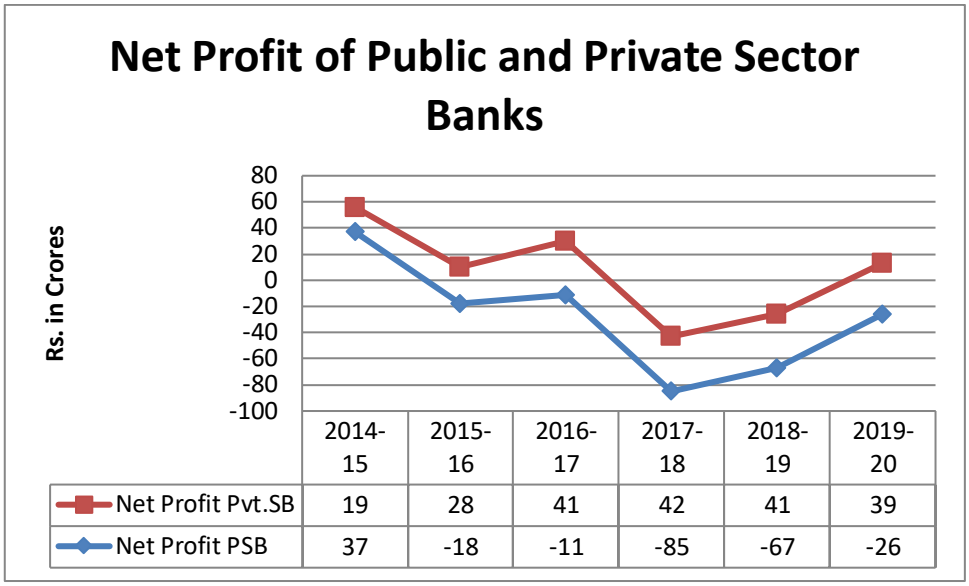

Figure 3.

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

The above figure indicates that the trend of the Net Profits of both the sector are in parallel to one another. The Net Profits of Public sector is lower than the Public sector throughout six years.

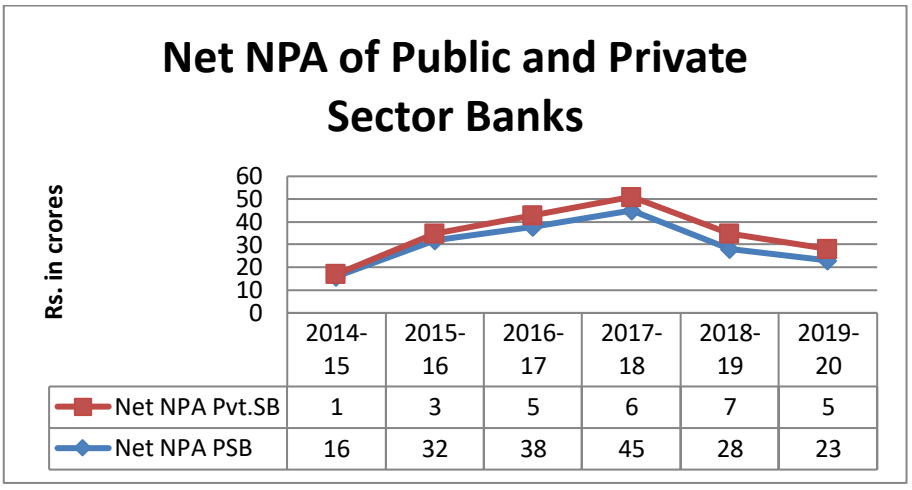

Figure 4.

Source: Data computed and compiled from the various issues of statistical tables relating to banks in India (RBI).

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The given figure reveals that the Net NPA of Private banks are higher than the Public sector banks throughout six years.

Findings

The following are the findings while assessing the impact of nonperforming assets on the Net Profits of banks:

1) The Public sector banks show profit only in the year 2014-15 and it incurs a loss throughout five years and it became difficult for the banks to earn profit in the forthcoming years. The Gross NPA ratios are higher in the Public sector banks than the Private sector. However the Net NPA to Net Advances ratios show higher level of mean in the Private sector bank group.
2) The Non-performing assets of Private sector are higher than the Public sector throughout six years and the Net Profits of the Private Banks are higher. It reveals that the Private bank though having higher NPA it earns profits from the loan lending, they earn higher interest out of lending and they follow a better credit management system.

Suggestions

The following are the suggestions that may be adopted by the bank to effectively manage NPA.

1) The Public sector banks may assess the quality and marketability of the assets secured before granting loans.
2) The risks may be reduced and controlled by granting loans to diverse sectors.
3) The Public sector banks should have well equipped recovery mechanism by adopting immediate attention to NPA's at the earliest.
4) RBI may insist and assist banks to adopt scientific techniques for credit appraisal and effective credit recovery mechanism.

Conclusion

The nonperforming assets affect the profitability of banks. It indicates a negative impact in the balance sheet of banks. The Public sector bank group nonperforming assets are accelerating at a greater pace. So, the Indian commercial banks should adopt proper techniques in appraising credit and effective collection procedures to recover NPA in order to avoid any crisis in the banking sector and to increase profitability in the forthcoming years successfully.

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SECURE FILE STORAGE ON CLOUD USING HYBRID CRYPTOGRAPHY

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Abstract

Cloud computing is used in many areas like industry, military, educational institutions etc. to store huge amount of data. The aim is to retrieve secured datafrom the cloud based on the request of user. Storing data on cloud will be faced many challenges and issues. To overcome and provide the solution to the existing issues exists more number of ways. The techniques of cryptography and steganography are more popular and play a critical role of data security. Then the use of a single algorithm is not effective for high level security to keep data secured in cloud. This paper aims to focus to the security of data in cloud using symmetric, asymmetric key cryptographic algorithms and steganography. In this proposed system AES and RSA algorithms are used to provide security for data and LSB steganography technique is for key information security. In this method, the file is first encrypted using AES algorithm. Then the encrypted file is again encrypted using RSA algorithm. Further, the keys are inserted into an image using LSB technique with secured and strongauthenticity. The Stego image is send to the intended valid receiver andauthentication of registered email. Then at the receiver side, the file has to be decrypted in reverse process of the above said encryption procedures.

***Keywords*:** Cloud Computing, Challenges, hackers, Cryptography, Steganography techniques.

I. Introduction

Cloud Computing is an emerging style of IT delivery in which application data and resources are rapidly, provisioned and provided as standardized offerings to users over the web in a flexible pricing model. Cloud delivery models can be classified into three types such as public, private and hybrid clouds.Cryptography is a method of protecting information and communications through the uses of codes, so that only those for whom the information is intended can read and process them. The prefix “crypt” means hidden and the suffix “graphy” means writing. In today’s computer-centric world, cryptography is often associated with scrambling plaintext into ciphertext known as encryption, then the reverse process is known

as decryption. It can be classified into three types such as symmetric, asymmetric and hash functions. In cryptography, a hybrid cryptosystem is one which combines the convenience of as asymmetric-key cryptosystem with the efficiency of a symmetric-key cryptosystem.Steganography is the practice of concealing a message within another message or a physical object. LSB Steganography is a steganography technique in which it hides text messages inside an image by replacing Least Significant Bit of image with the bits of message to be hidden.

II. Related works

Mavridis I., Pangalos G. [1], discussed the operational and security issues of mobile components in distributed environments. In 2000, Erik Olson and Woojin Yu, [2] discussed various symmetric key algorithms and their usage in mobile computing, specifically in the Palm Pilot, which uses Motorola's Dragon Ball-EZ processor. In 2000, Wendy Chou [3], the explosive growth in the usage of mobile and wirelessdevices demands a new generation of Public Key Cryptography (PKC) schemes, and the limitations on power, bandwidth to provide security in mobile devices, use of Elliptic Curve Cryptography (ECC), its security, performance and also its applications.In 2002, Limor Elbaz [4], implemented PKC in security of wireless devices and the use of Public Key Infrastructure (PKI) in current as well as in the future applications of mobile phones. In 2003, Dharma P. Agrawal et al.[5], discussed the technology in mobile computing users by combining wireless networking and mobility which serves anytime and anywhere with of various new applications and also services. In 2006, Hanping Lufei and Weisong Shi [6], discussed the emergence of heterogeneous devices and diverse networks, and the difficulty in using a one-size-fits-all encryption algorithm. They also explained the deployment of encryption algorithms to choose an appropriate encryption algorithm from multiple algorithms based on the characteristics of heterogeneous mobile computing environments.

In 2008, Abhishek Kumar Gupta [7], discussed the need for information as a driving force for the incoming growth in Web technology, wireless communication, and portable computing devices and also explained the field of mobile computing (computing and communication) with the aim of providing seamless computing environment for mobile users, which are all dependent on information and it is available only by accessing a network. In [2009], S. Krishna Mohan Rao and Dr. A Venugopal Reddy [8], discussed Data dissemination in asymmetrical communication environment, where the capacity of the downlink

communication is much greater than the uplink communication capacity and it is best suited for mobile environment. In [2009], widespread growth in applications for resource-limited Wireless Sensor Networks (WSN), the need for reliable and efficient security mechanisms and also analyzed the suitability of the algorithm for resource-limited wireless network security by M. Razvi Doomun, and KMS Soyjaudah [9].

In [2009], Kar and Banshidhar Majhi[10], proposed an efficient password security of Multi-Party key exchange protocol based on elliptic curve discrete logarithm problem (ECDLP), and these protocols allow a group of parties communicating over a public network to establish a common secret key called Session Key and also build protocol for password authentication model, where group members were assumed to hold an individual password rather than a common password and two one-way hash functions to build the security level high. In [2009], Mooseeop Kim et.al. [11], proposed a compact architecture for a cryptographic engine on a mobile platform, which has very stringent limitations with respect to the circuit area and the consuming power.In [2010], Bruno P.S. Rocha et. al [12], demonstrated a security service, which works as a middleware, to dynamically change the security protocols used between two peers and these changes can occur based on variations on wireless medium parameters, system resource usage, available hardware resources, application-defined Quality of Service (QoS) metrics, and desired data security levels. In [2010], Sathish Alampalayam Kumar [13], suggested a mobile agent based mobile computing system, the classification of various types of security attacks, the security solutions for those types of attacks proposed by various schemes and the open research issues in providing security for mobile agent based computing systems.In [2011], Sameer Hasan et. al. [14], proposed a non-server (that is P2P) architecture PKCto secure the mobile communications. They used NTRU algorithm for public key cryptography in non-server architecture and tested on real equipment, the solution security and potentialrisks.

In [2011], Rahat Afreen and S.C. Mehrotra [15], discussed the ECC emerged in its proper implementation in various directions to analyze in hardware as well as software platforms. Helena Rifa-Pous and Jordi Herrera- Joancomarti [16], discussed the performances of different cryptographic algorithms in PDAs and compared it with device’s basic costs in terms of operating system, screen, and network interfaces to determine the overhead and the results were used to estimate the costs of network security protocols design.

In [2011], Jagdish Bhatta and Lok Prakash Pandey [17], proposed a software level cryptographic protocol implementations to measure the energy level through the device's serial port, running them and measuring their power consumption. In [2012], K. Sathish Kumar et. al. [18], explained the mobile hand-held device in an efficient way to deliver real time data to users. In [2012], Masoud Nosrati et. al. [19], proposed an algorithm for security mechanism in different types of mobile devices and the operation systems. In [2012], Ravinder Singh Mann et. al. [20], presented the comparative analysis of ECC, AES and RSA algorithms experimentally with parameters such as computation time and complexity of the algorithms. Based on the result it was concluded that ECC has more complexity when compared to AES and RSA in mobile devices.

In [2013], Giripunje et al. [21], discussed many differences in mobile devices, their capabilities, computational powers and security requirements in networking environments. In [2013], Ameya Nayak [22], discussed the growing android community, its malware attacks, security concerns, aid in serving as the continuous challenges of identifying current, future vulnerabilities as well as incorporating security strategies against them and this focus on mobile devices.In [2013], Srikanth Pullela [23], discussed the performance issues like handoffs, routing etc. Then he further addressed that security is another key issue, which needs to be considered when the communication channel is set up. Also protocols are being proposed for different applications like wireless application protocol, 802.11 etc. Most of them are based on the public and private keycryptography.

In [2013], V. Gayoaso Martinez and L. Hernandez Encinas [24], have discussed the ECC, one of the best options for protecting sensitive information. In [2013], Muhammad Waseem Khan [25], explained that short message service (SMS) is one of the frequently used mobile services with universal availability in all GSM networks but the SMS facility has not achieved secure transmission of plaintext between different mobile phone devices. In [2013], Ram Ratan Ahirwal and Manoj Ahke [26], explained the Diffie-Hellman scheme as one of the key exchanging cryptosystem, and no messages are involved in this scheme and using this key and ECC for encryption and decryption. In [2014], Sathish Kumar et. al. [27], have discussed about the mobile hand-held device are used in an efficient way to deliver real time data to the users in the battle field military applications and the use of security features in military applications such as data confidentiality, authentication etc., which are not readily offered by mobile environment. In [2014], Hamed Khiabani et. al. [28], explained the extensive

deployment of wireless networking, mobile and embedded devices, other pervasive computing technologies that are prone to security threats for which nobody will be prepared for. Security and privacy are the main concerns in mobile computing which can be observed from several perspectives including hardware, operating systems, networks, databases, user interfaces, and applications.

In [2014], Seema P. Nakhate, and R.M. Goudar [29], have implemented a secured password based mutual authentication protocol for client-server computing using ECC framework which provides secure communication between client and server with the help of user email-id and mobile phone authentication device for mobile handheld device. In [2015], Vishnu V and Shobha R [30], discussed the security in Wireless Sensor Networks (WSN). They have applied dynamic election of Cluster Head (CH) mechanism and two evolutionary approaches SET-IBS and SET- IBOOS, since it provides security in data transmission and reduces data losses due to nodes failure, less residual energy selected in CH. It improves the lifetime of network by increasing time of FND (First Node to die).

In [2015], Tanmoy Kumar Bishoi et. al. [31], proposed an algorithm to encrypt the data using symmetric key encryption technique and now it can be improved by using variable length key.In [2015], Sujithra M et. al. [32], due to high performance computing techniques, cryptographic algorithms are implemented and tested in Local as well as Cloud environment. They have revealed that storing mobile data in cloud increases efficiently and AES algorithm performs better when compared with other algorithms in Mean processing time. In [2016], Said Bouchkaren and Saiida Lazaar [33], discussed secure data transmission through Internet. They have designed and implemented a new secret key cryptosystem due to a number of iterations of encryption and decryption of data in blocks, using cellular automata and compared them with AES algorithm and also they proved that the new algorithm resists against statistical attacks, faster than AES-256, achieved good confusion and diffusion tests.

A cloud can be private, public or a hybrid. A public cloud sells services to anyone on the internet. A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people, with certain access and permissions settings. A hybrid cloud offers a mixed computing environment where data and resources can be shared between both public and private clouds. Regardless of the type, the goal of cloud computing is to provide easy, scalable access to computing resources and IT services.Cloud infrastructure [34]

involves the hardware and software components required for the proper deployment of a cloud computing model. Cloud computing can also be thought of as utility computing or on-demand computing.

Today data communication mainly depends upon digital data communication, where prior requirement is data security, so that data should reach to the intended user. So for providing data security many cryptography techniques are employed, such as symmetric and asymmetric techniques [35]. Many different approaches have also been proposed to provide data protection in the cloud, such as AES, DES, and RSA, but Existing systems often fail when only a certain form of encoding is utilised, either AES, OR DES, OR RSA depending on a consumer requirement. However, the major issue with this scheme is that each encryption is done with encryption keys, and if these keys are leaked in some manner, the entire data is destroyed, so we need a solution that can have additional security [36]. Cloud users start considering the protection of their information stored on those servers managed with the help of a third party the fear of records Breach. Facts protection is wanted to curtail this statistics breach and lots of information threats. Cryptography performs a main position in records security. To offer security to cloud storage, users use hybrid encryption [37] in place of a single encryption algorithm. A hybrid cryptosystem combines the ease of a public-key cryptosystem with the performance of a symmetric-key cryptosystem

A potent approach for protecting digital data, including files, is hybrid cryptography. Hybrid cryptography offers quick and secure communication and storage of sensitive information by combining the benefits of both symmetric-key and public-key cryptography. A file is encrypted using a symmetric key in a hybrid cryptography system for secure file storage [38], and the file is then further encrypted using the recipient's public key. The recipient can then ensure that only permitted parties can access the file by decrypting the symmetric key with their private key.

The rapid proliferation of cloud computing has necessitated advanced security mechanisms to safeguard sensitive data stored in remote servers. However, this paradigm shift has raised several security concerns, particularly safeguarding private information stored on faraway cloud servers. This hybrid cryptographic framework [39], for the secure data storage requirements of cloud computing time-limited access control, adaptive key management, and two strong encryption methods: RSA and Advanced Encryption Standard - One Time Password (AES-OTP). The effectiveness of the suggested framework is confirmed by

thorough performance assessments, which show astonishing accuracy, precision, recall, and F1-score values of 99.12%, 98.78%, 98.11%, and 98.56% in protecting private information from unauthorized access and guaranteeing its secrecy in cloud storage settings.The rapid adoption of cloud computing has ushered in unparalleled opportunities for efficient data storage and processing, but it also brings forth significant challenges related to information security [40].

III. Problem Definition

Cryptography techniques can be able to translate the original data into unreadable form using keys. They are divided into symmetric key cryptography and asymmetric key cryptography. So only authorized person can access data from cloud server. Cipher text data is visible for all people. Symmetric key cryptography algorithm (AES) requires low delay for data encode and decode but provides low security. Public key cryptography algorithm (RSA) accomplished high level security but increases delay for data encode and decode. Steganography hide the secret data existence into envelope. In this technique existence of data is not visible to all people. Only valid receiver knows about the data existence. Three bit LSB technique used for image steganography. Sensitive data of user hide into cover image.

AES and RSA algorithms are used into hybrid algorithm. AES algorithm requires a single key and RSA algorithm requires two keys. So, hybrid algorithm, three keys are used. For data upload on cloud, mandatory keys are AES secret key and RSA public key. Private key of RSA and AES secret key are essential to download data from cloud. Whenever owner makes an effort to upload data on cloud first the file is stored in a directory for short time. In the encryption process, the first step is to apply AES algorithm to encrypt the file after that RSA algorithm is applied on the encrypted data. Reverse process is followed for decryption. After applying keys that file is converted into encoded form and stored on cloud server. Key is rotated to achieve high level security.

IV. Existing System

Now a days cloud plays a major role to store data. So many steps have been taken to secure it. On the side of cryptography, at first, one symmetric algorithm is used but it is less secure. So one asymmetric algorithm is used but it takes some more time. Then multiple symmetric algorithms are used but that work is similar to the previous one. The weakness of all these encryption systems is that the form of the output data (text), if intercepted, alerts the intruder

to the fact that information being transmitted may have some importance and that it is therefore worth attacking and attempting to decrypt it. This aspect of cipher text transmission can be used to propagate disinformation, achieved by encrypting information that is specifically designed to be intercepted and decrypted.In this case, it is assumed that the intercept will be attacked, decrypted and the information retrieved. There is less security when transmitting the data from one end to another.

V. Proposed System

Cryptography is the most effective way to achieve data security. And here two level encryption and decryption takes place using the best symmetric and asymmetric algorithms (ie) owner does double encryption and upload the file. So two keys are required for decryption. User can view the uploaded file but only in an encrypted format and requires keys for decryption. Keys are sent only to the valid user through mail on request. Also key is not sent in a normal way but hide behind an image with password. The advantage of this techniques are i) The file is secured, as it is being encrypted using two encryption algorithms which are AES and RSA, ii) The key is also sage as it embeds an image using LSB and iii) The system is robust in nature since the data is kept secured on cloud server which avoids unauthorized access.

VI. System Design

The home page contains the links for the owner (Sender) and the user (Receiver). The owner pages requires the login If the owner fires the correct ID and password then it will be redirected to the next page else there will be an alert message. The owner have to browse the file, generate the key and encrypt using AES. Again the owner have to browse the encrypted file, generate the keys and again using RSA. Finally, the owner can browse any of the key, provide a password and hide behind any of the image. The user can browse that image and extract the key by giving the password.The key requests module shows the list of key requests by the users for a particular file. The owner can send the key to the user through mail.The user page requires the login. If the user gives the correct ID and password then it will be redirected to the next page else there will be an alert message.The new users have to register themselves by giving unique username, password, mail id, phone number and address.The user can choose from the list of files uploaded by the user and request key for that file.On receiving the key the user can first decrypt the encrypted file using RSA.The user

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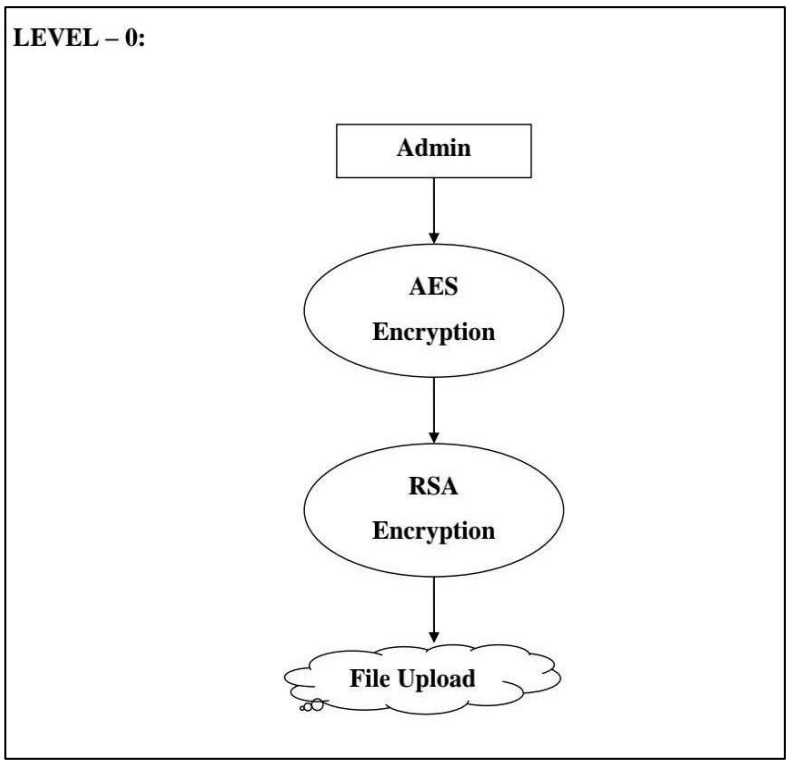
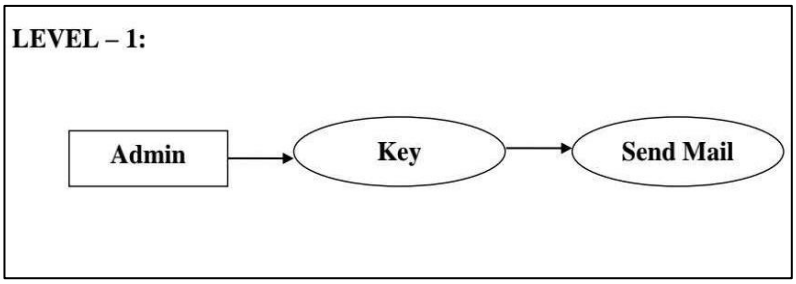
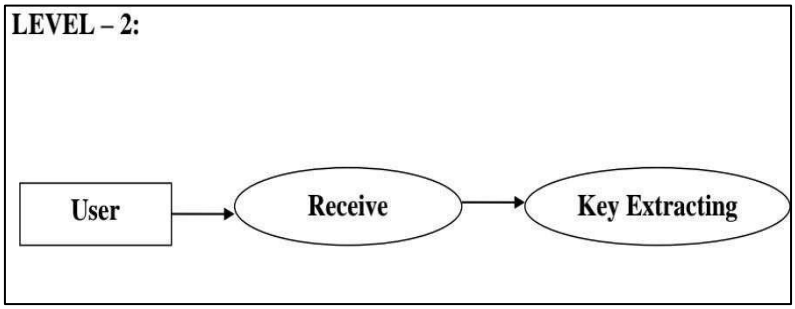
can finally decrypt the already decrypted file using AES and get the result. The various level-0 to level-3 clearly shows the process involved in a system.

VII. Data Flow Diagram







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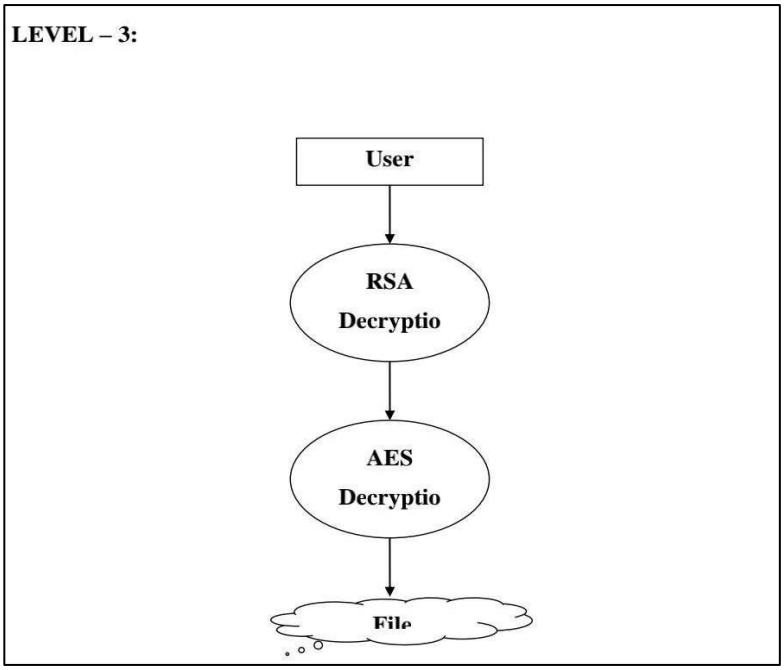

VIII. Screenshots

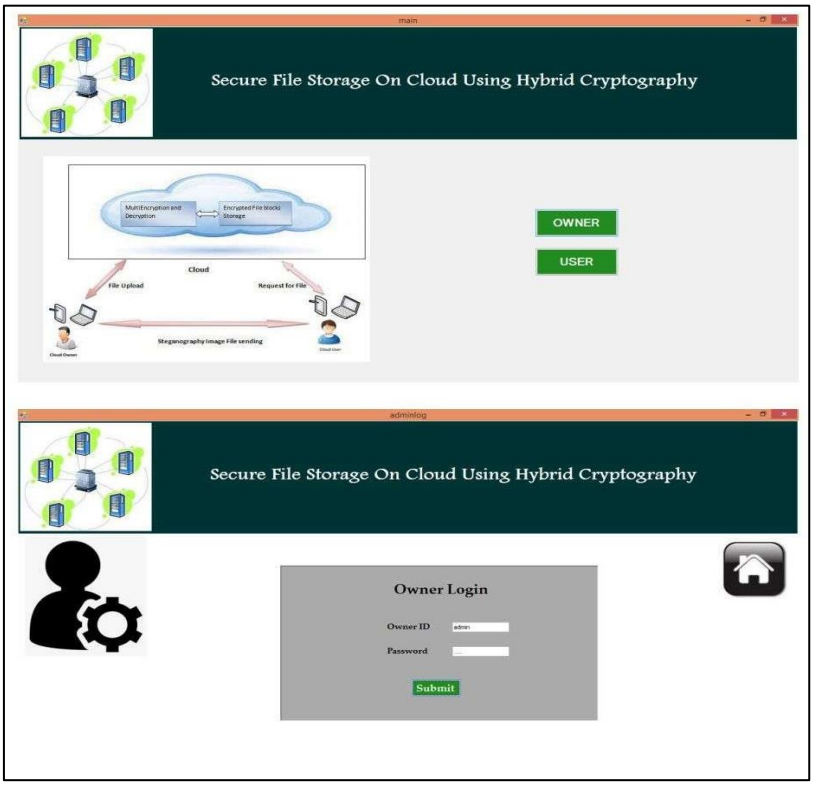

Figure 1. Owner Login

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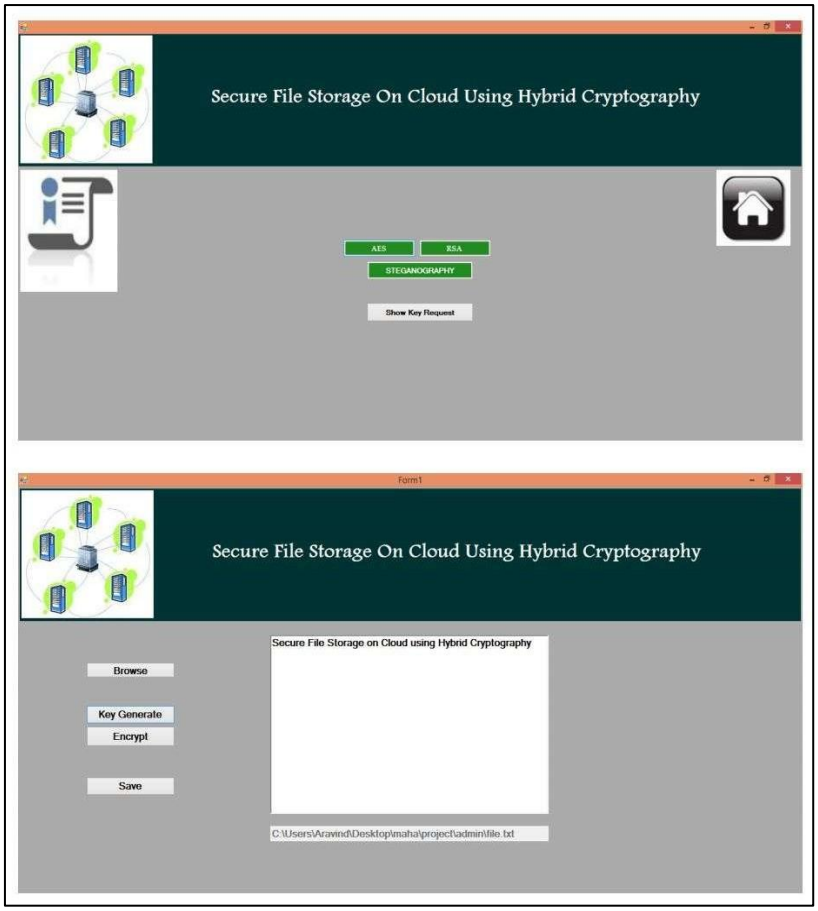

Figure 2. Key Generation and Encryption of a File using AES

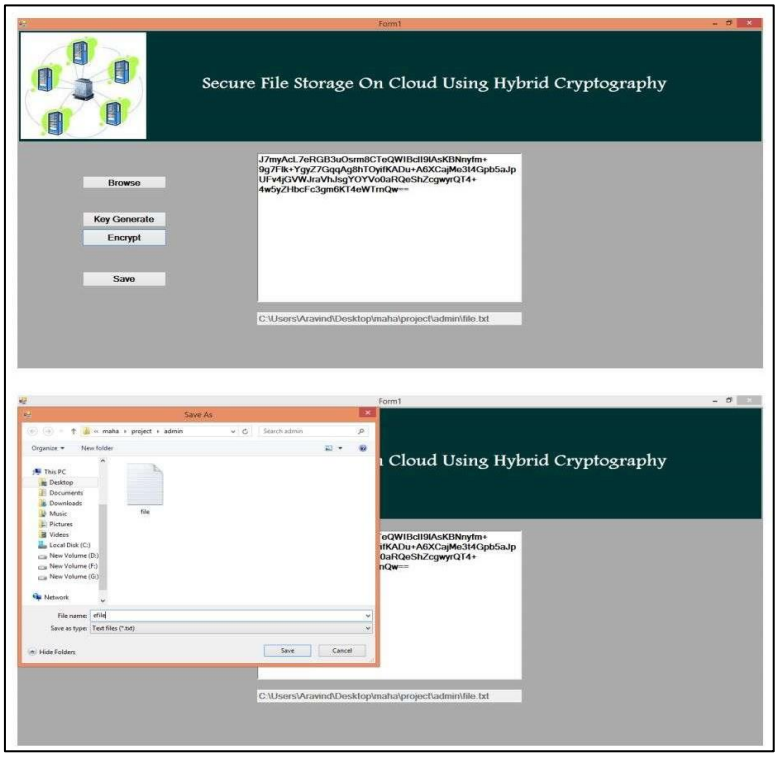

Figure 3. Encrypted and saved

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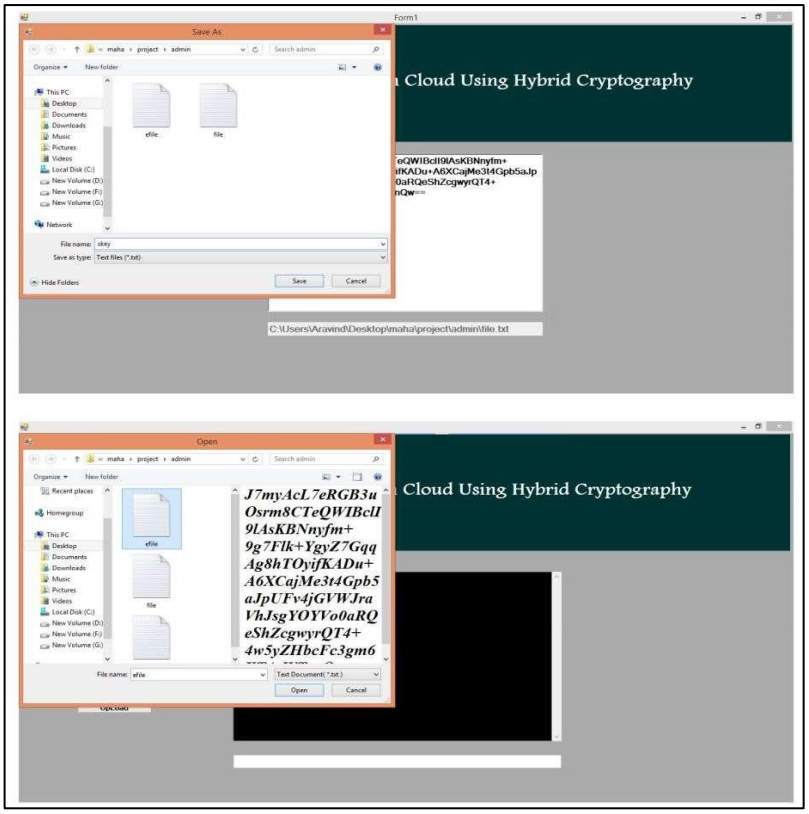

Figure 4. Saved File again Encrypted using RSA

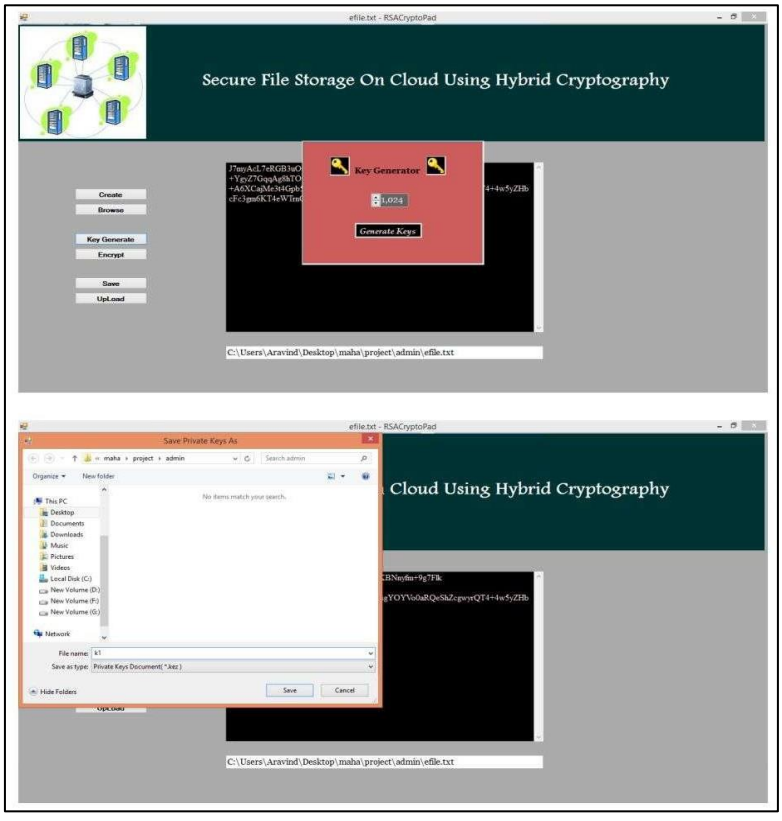

Figure 5. Key Generation

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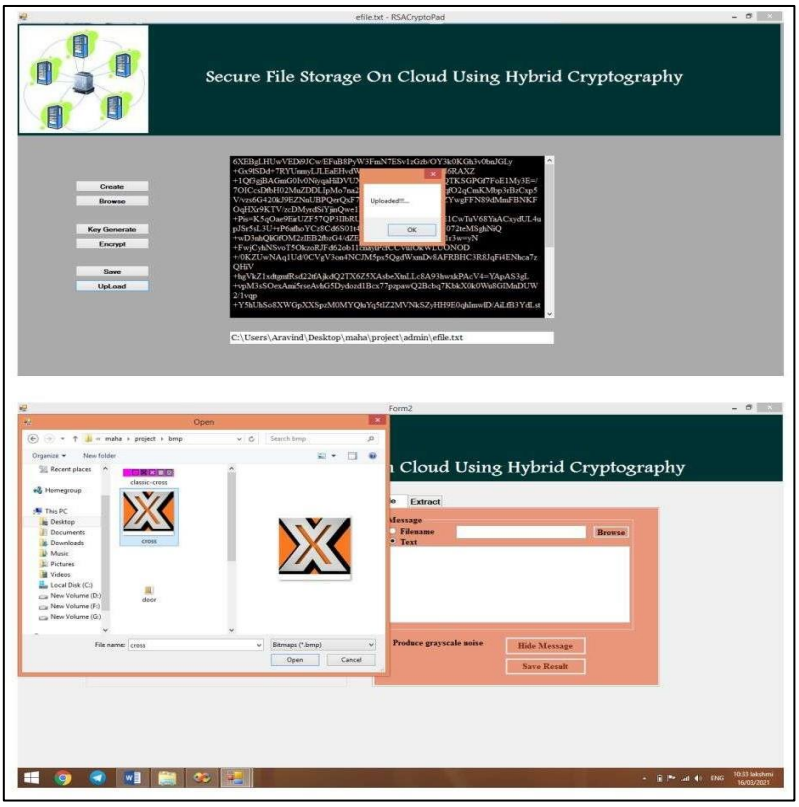

Figure 6. File Upload in cloud

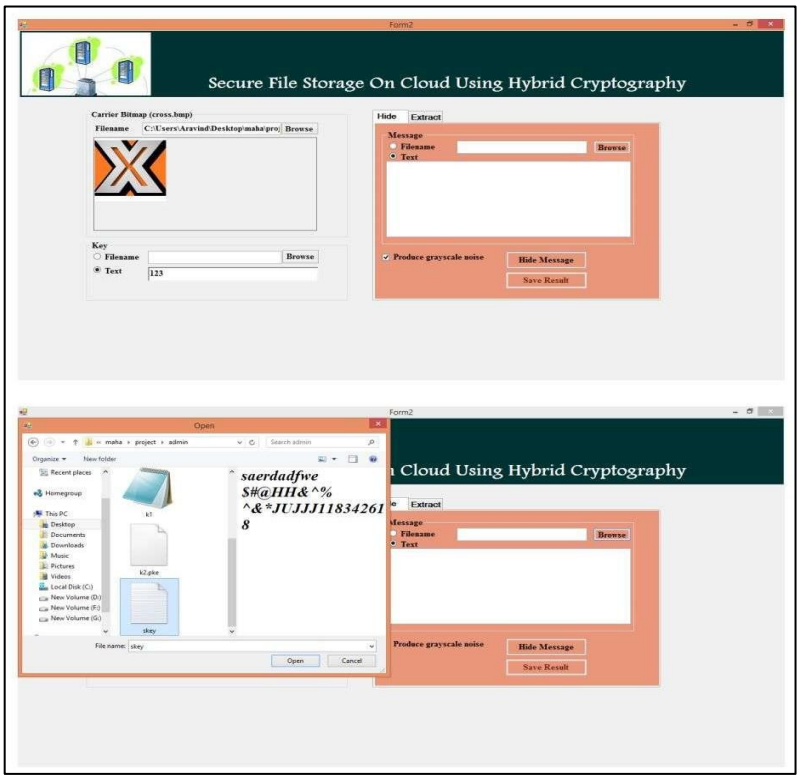

Figure 7. Gray Scale and hiding

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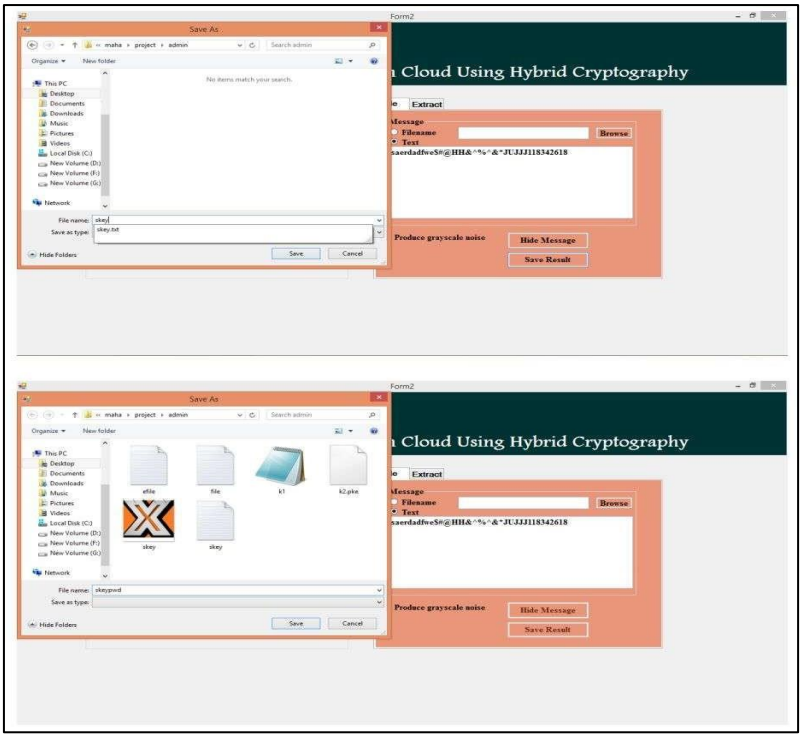

Figure 8. File stored

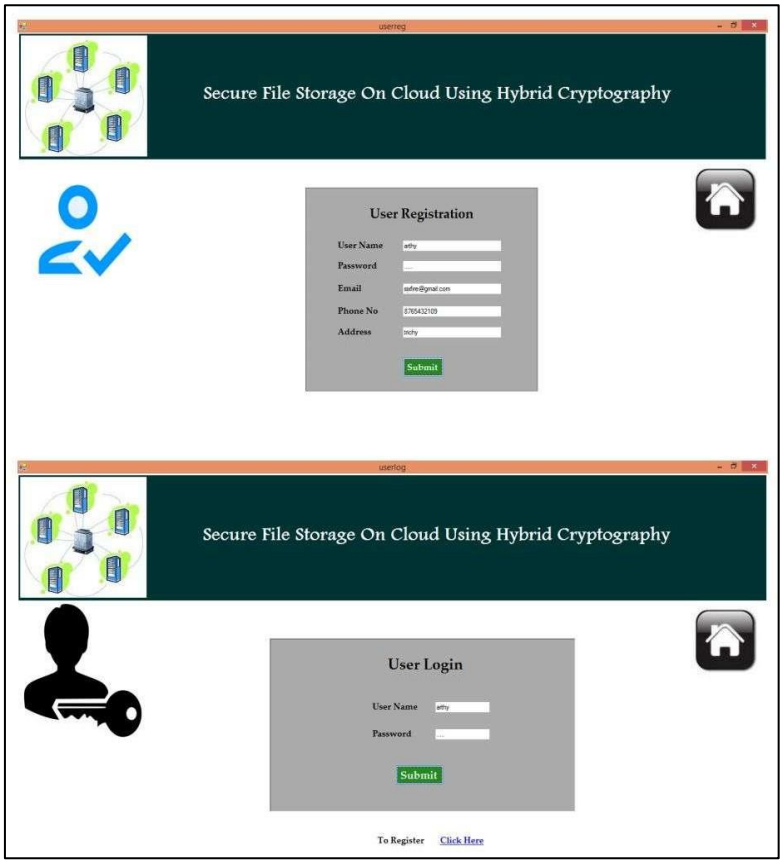

Figure 9. User Registration

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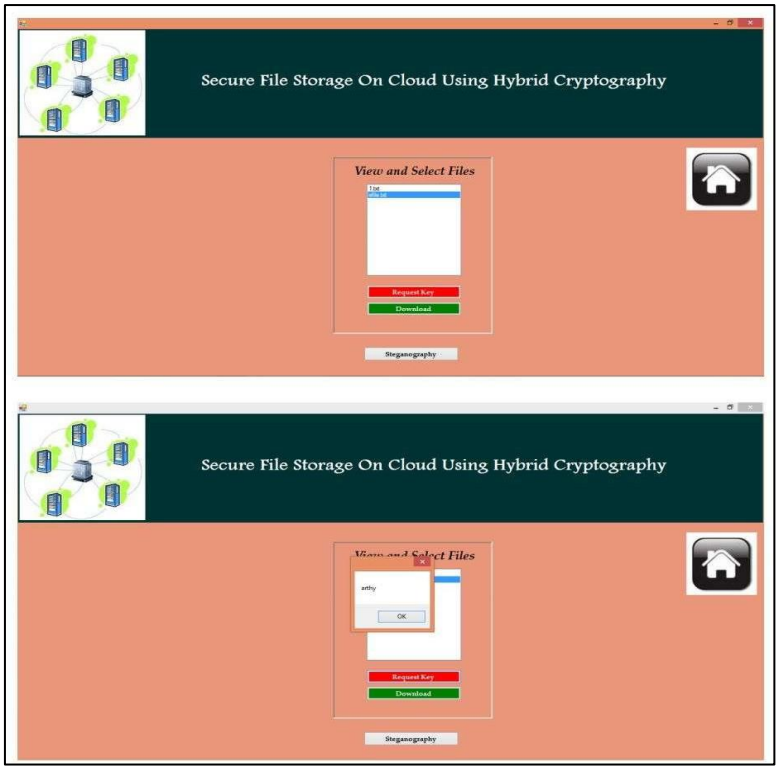

Figure 10. Use Steganography

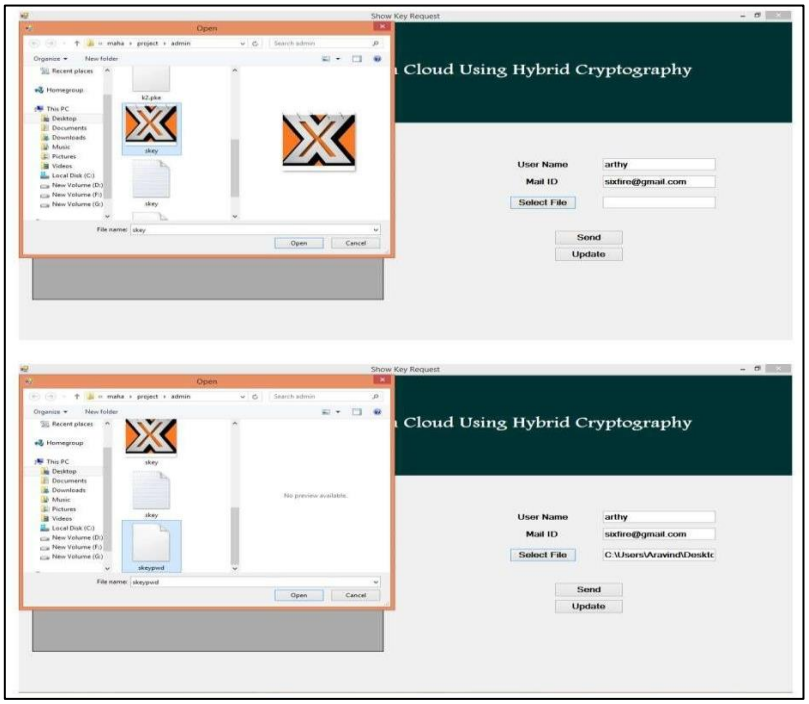

Figure 11. Upload a file to cloud

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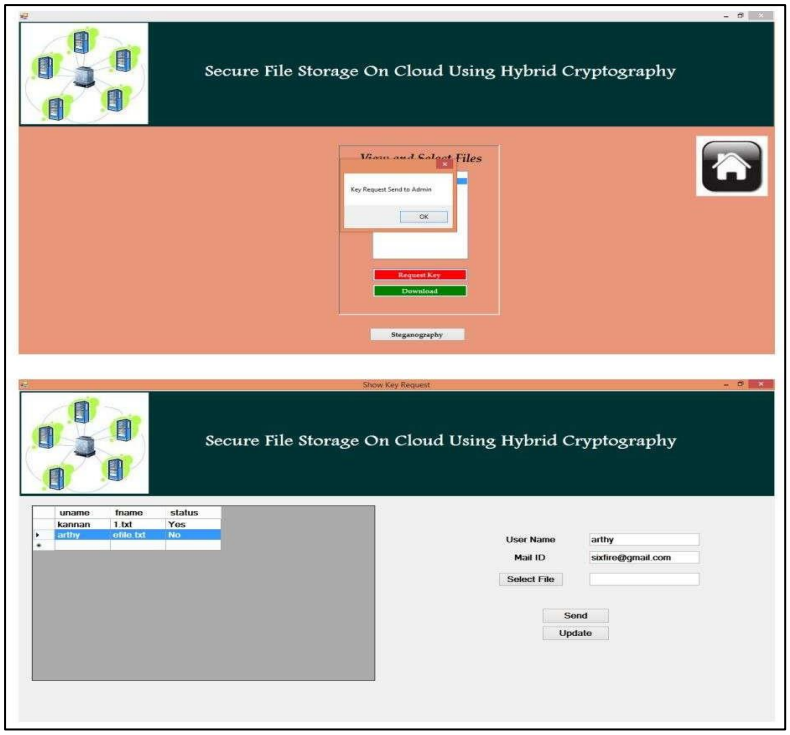

Figure 12. Authentication of user

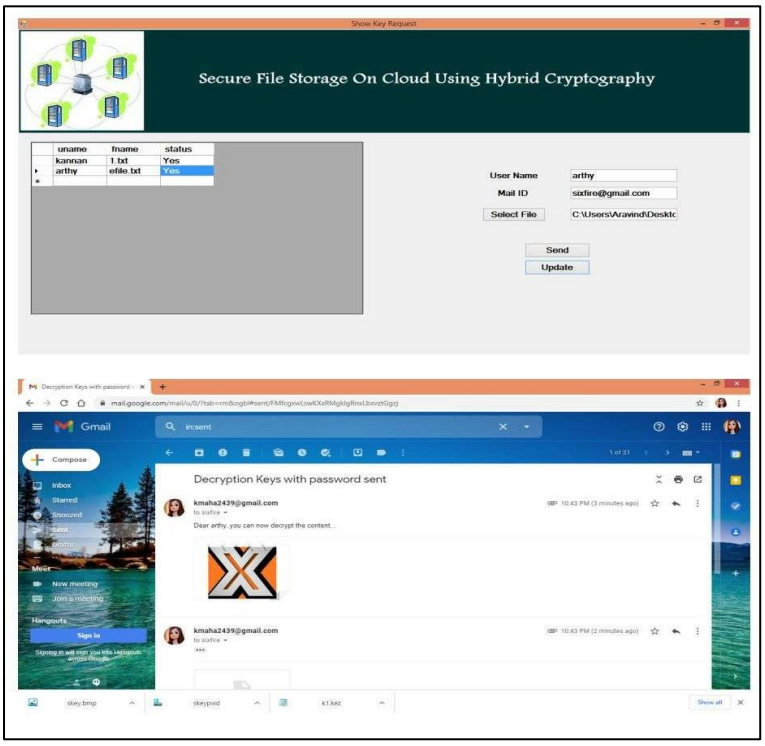

Figure 13. Decryption key with password sent to the user

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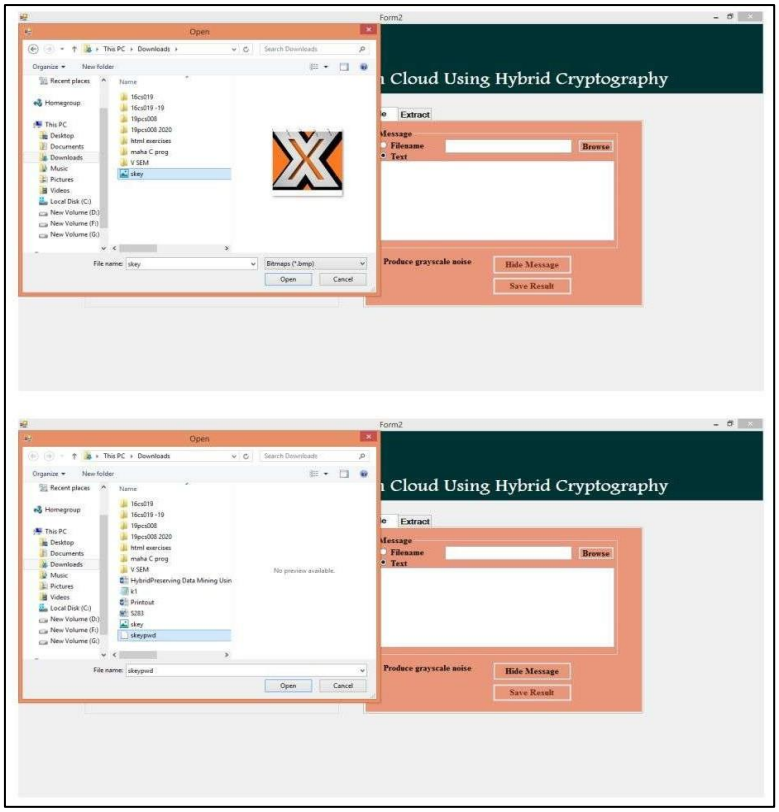

Figure 14. Key Storage

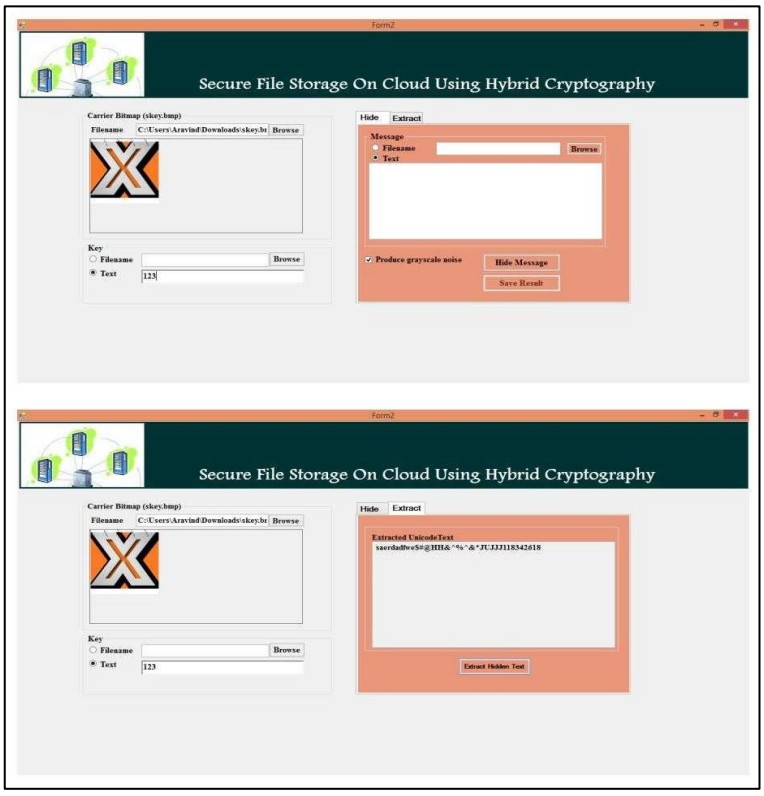

Figure 15. Browse a file to decrypt

 ISBN 978-93-95323-22-2

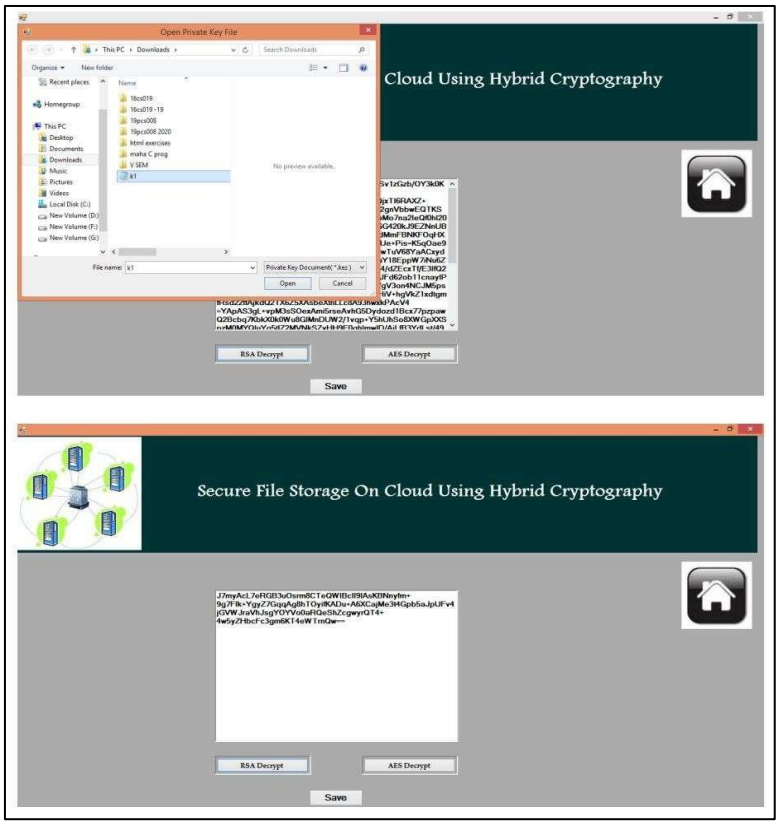

Figure 16. RSA Decrypt and AES Decrypt

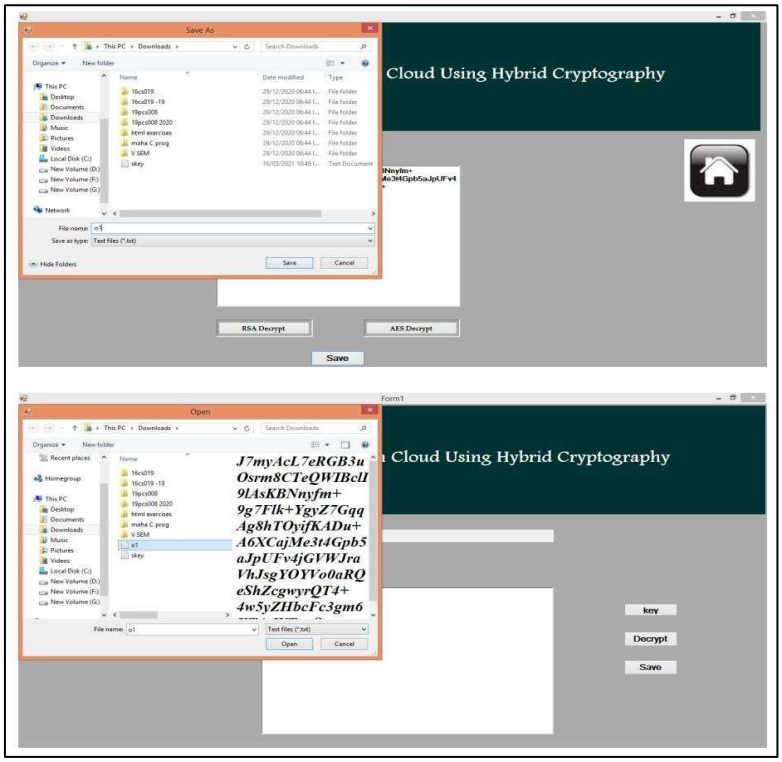

Figure 17. Decrypted and stored

 ISBN 978-93-95323-22-2

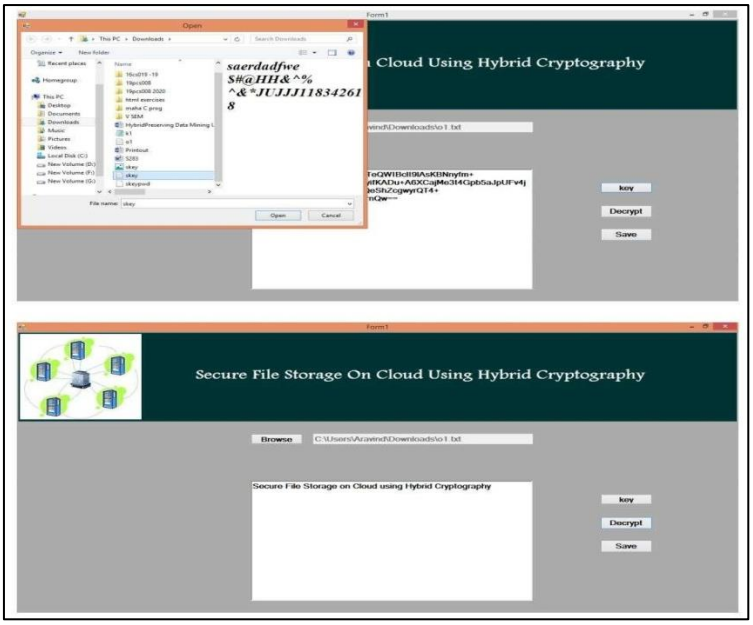

Figure 18. Hiding text messages

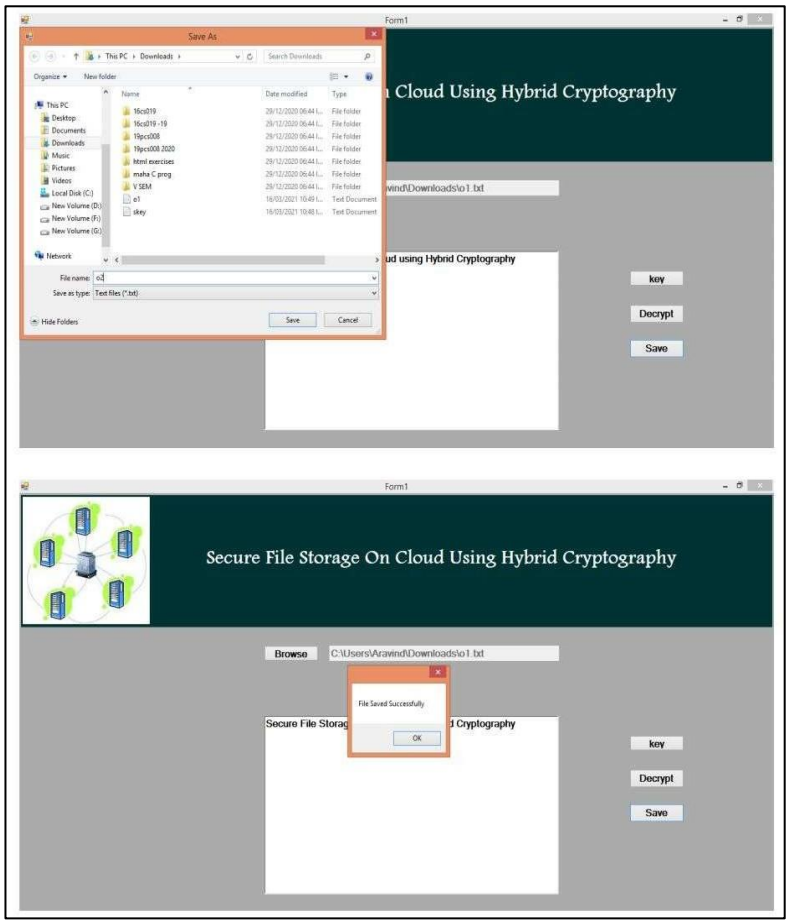

Figure 19. Download file

 ISBN 978-93-95323-22-2

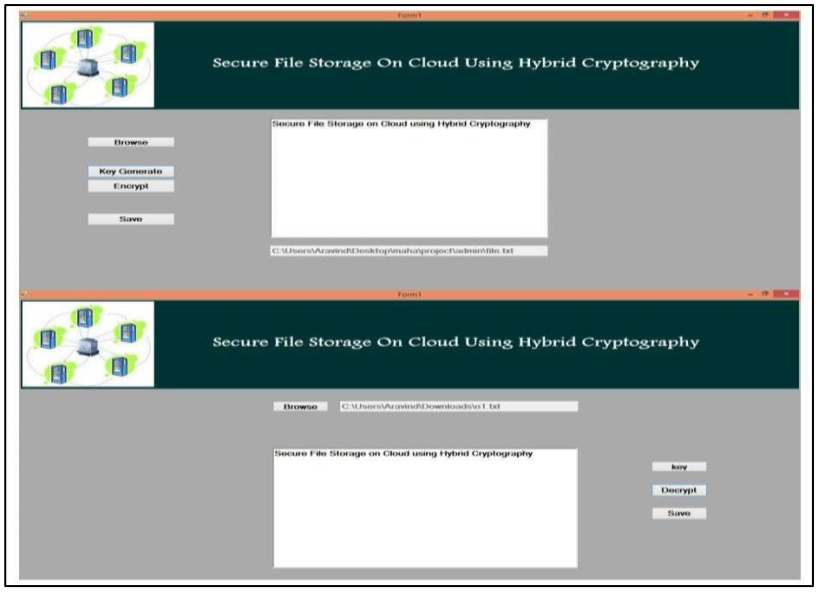

Figure 20. Key Generation

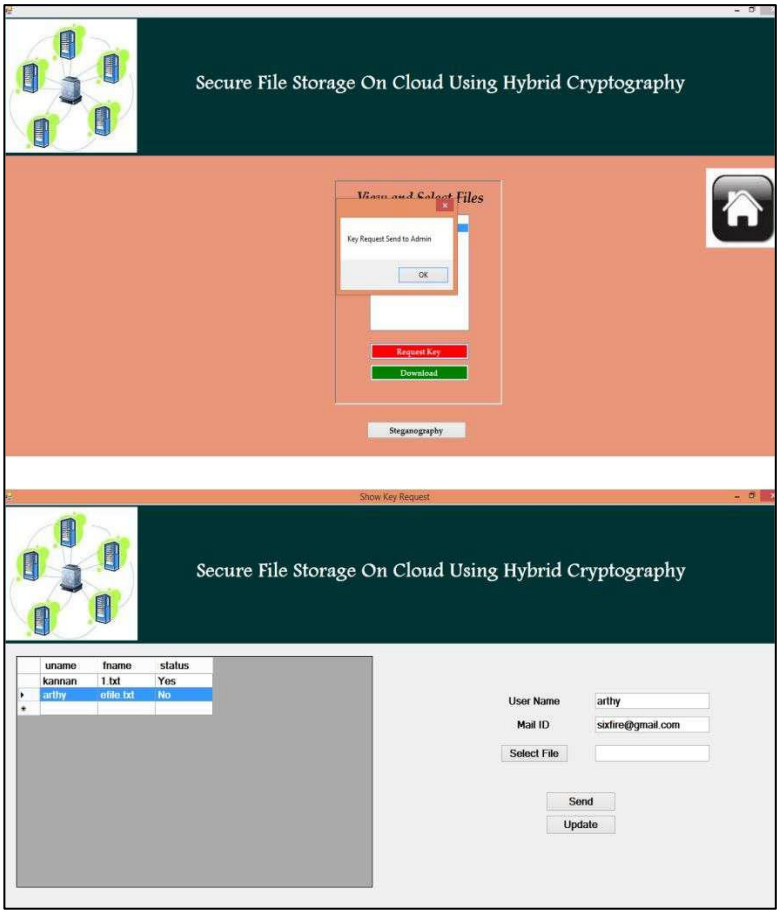

Figure 21. Authenticated Users with file details

IX. Results and Discussion

From the results it is observed that the symmetric algorithm takes 3 to 7 seconds to process 10 to 50 MB of files and provides 25% of security and asymmetric algorithm takes 15 to 20 seconds to process 10 to 50 MB of files and provides 50% of security. While the hybrid approach of the combines AES and RSA algorithms takes 2o to 25 seconds to process 10 to 50 MB of files but provides 70% of security. This achieves more time but more security with the same file size.

X. Conclusion

Cloud security issues can be solved using cryptography and steganography techniques. Data security is achieved using AES and RSA algorithms. Data integrity is accomplished using hybrid algorithm and key information security is accomplished using LSB technique. With the help of proposed security mechanism, data integrity, high security, medium delay, authentication and confidentiality parameters are accomplished. Text file encryption and decryption using hybrid algorithm need little more time but provide more security with respect to existing system algorithm.In future, this can be further implemented to achieve high level of security using hybridization of some other cryptographic algorithms.

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A STUDY ON SOCIO-ECONOMIC CONDITIONS OF SALES WOMEN IN TIRUCHIRAPPALLI TOWN

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Abstract

Women play a prominent role in contributing to our economy. Empowering women and their status are essential to achieve economic and social advancement. From time immemorial, in the development of our society, Indian women in general have played a significant role. Women's empowerment and their full participation based on equality in all spheres of society are fundamental for the achievement of equality, development, and peace. As per Census 2011, the work participation rate for women is 25.51 percent as compared to 25.63 percent in 2001. The Work Participation rate of Women has reduced marginally in 2011 but there is an improvement from 22.27 percent in 1991 and 19.67 percent in 1981. The work participation rate for women in rural areas is 30.02 percent as compared to 15.44 percent in urban areas. Retailing is one of the important industries in India recorded for almost 10 percent of the nation's GDP. Retailers are the major employers in today's society. But now, the Retail sector is becoming more organized with a better pay scale. But even in the informal textile Retail shops, Women have to face numerous problems as they have to manage both sides of life that is work and family.

Therefore, the study analyses the Socio-Economic conditions of Sales Women in Tiruchirappalli town as they are the part of the Retail sector. The Tiruchirappalli town have many retail shops which are providing employment opportunities to Women in and around Tiruchirappalli town. Therefore, the aim of the present study is to analyse the income and expenditure and various problems faced by the Sales Women in the informal textile Retail shops in Tiruchirappalli city.

Key Words: **Unorganized sector, Retail Sector, Sales Women**

Introduction

"Women and Men are equal in every human concern in this world. Women play a prominent role in contributing to our economy. Empowering women and their status are essential to achieve economic and social advancement. The development of our society, Indian women

played a significant role. Women's empowerment and their full participation based on equality in all spheres of society are fundamental for the achievement of equality, development, and peace [1].As per Census 2011, the work participation rate for women is 25.51 percent as compared to 25.63 percent in 2001. The Work Participation rate of Women has reduced marginally in 2011 but there is an improvement from 22.27 percent in 1991 and 19.67 percent in 1981. The work participation rate for women in rural areas is 30.02 percent as compared to 15.44 percent in urban areas[2].

In the Indian Economy, the Retail industry plays a very important role by contributing to the Gross Domestic Product and employment opportunities to the poorer sections of the society. It also attracts numerous educated unemployed to this field, due to the non-availability of jobs in the formal sector and drop-outs due to the unemployment situation of the country.

The textile garment shops both in organized and unorganized sectors provide a large number of employment opportunities to the poor and migrant women workers. Retailing involves a wide range of activities centred around the sale of goods and services directly to consumers for personal or household use. It covers various sectors, from food and clothing to automotive and electronics, and includes both formal, organized retail outlets and informal, small-scale vendors. The retail industry significantly contributes to both employment and economic growth, particularly in developing economies like India [3].

The working population in any country is determined by multiple factors such as age distribution, gender ratio, and life expectancy. In labour economics, these factors are crucial in defining the potential size of the workforce, influencing productivity, and determining the overall socio-economic fabric of the nation. For example, in many developing countries, younger populations contribute to a larger informal workforce, particularly in sectors like retail [4].

The unorganized sector refers to economic activities not regulated by formal legal frameworks, such as taxation, licensing, or employment contracts. Theories such as W.W. Lewis' dual-sector model and the Haris-Todaro model explain how labour moves between formal and informal sectors. These models highlight the existence of regulated, well-established and informal sectors with lower wages, minimal job security, and less regulation. In India, the unorganized sector encompasses a large percentage of the workforce, which includes small businesses and informal labour arrangements."According to the National Commission for Enterprises in the Unorganized Sector (NCEUS), 93 percent of India's workforce is employed in the informal sector, which plays a major role in providing employment across both rural and urban areas. Informal

employment includes jobs such as daily wage labour, construction work, street vending, tailoring, domestic work, and home-based businesses.

This sector primarily consists of small, unincorporated businesses owned by individuals or families. These enterprises typically have fewer than ten workers and operate on a proprietary or partnership basis. Unorganized workers, therefore, include those without access to formal job benefits such as social security, unlike workers in the organized sector. In this study, weaim to analyse the income, expenditure, and challenges faced by saleswomen working in informal textile retail shops in Tiruchirappalli town [5].

Objectives

- To analyze the Socio-Economic conditions of the saleswomen working in informal textile retail shops in Tiruchirappalli town.
- To investigate the challenges and difficulties encountered by the respondents in their work environment.

Methodology

This study is based on both primary and secondary data. Primary data was collected through a questionnaire administered to 50 respondents in Tiruchirappalli town using the random sampling method. Secondary data was sourced from books, theses, journals, magazines, and research websites. Tiruchirappalli was chosen as the study area due to its significant retail activity, particularly in informal textile shops, which provide employment to many women. The town is divided into several areas, including Theppakulam, Singarathoppu, Chathiram Bustand, and Thilainagar. Theppakulam,

Singarathoppu, and ChathiramBustand were specifically selected for this study as they have a high concentration of retail shops employing a large number of saleswomen, making them ideal locations for examining the socio-economic conditions and challenges faced by these women.

Table 1: Demographic profile of the respondents

Particulars	Number of Respondents	Percentage
Age		
Below 25	13	26
25 – 35	29	58
35–45	6	12
Above 45	2	4
Total	**50**	**100**
Religion		
Hindu	40	80
Muslim	3	6
Christian	7	14
Total	**50**	**100**
Community		
BC	26	52
MBC	11	22
SC	13	26
Total	**50**	**100**
Educational Qualification		
Primary level	5	10
Higher secondary level	23	46
Graduate level	22	44
Total	**50**	**100**
Marital status		
Married	31	62
Unmarried	19	38
Total	**50**	**100**
Type of Residence		
Own	34	68
Rented	16	32
Total	**50**	**100**

Source: Primary data

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Age: A significant portion of the respondent's58 percent fall within the 25-35 age group, suggesting that many are in the early stages of their careers. The smaller percentage 4 percent of respondents aged over 45 indicates fewer older individuals in the workforce, possibly due to career transitions or early retirement in this sector.

Religion: The majority of respondent's 80 percent are identified as Hindu, with smaller groups comprising Christians 16 percent and Muslims 6percent. This religious distribution reflects the broader demographic pattern of the region and highlights the religious diversity present in the workforce.

Caste: In terms of social categories, 52 percent of respondents belong to the Backward Class (BC), 22 percent to the Most Backward Class (MBC), and 26 percent to the Scheduled Caste (SC). This breakdown suggests that a substantial proportion of the workforce comes from historically disadvantaged communities, which may reflect broader socioeconomic dynamics in the area.

Education: Educationally, 44 percent of respondents have attained a graduate-level education, indicating a relatively educated workforce. However, despite their qualifications, many are working out of financial necessity to support their families. A smaller group 10 percent has only completed primary education, reflecting some disparity in educational attainment.

Marital Status: The data shows that 62 percent of respondents are married, suggesting that a significant number of women are balancing both family and professional responsibilities. The remaining 38 percent are unmarried, potentially indicating a younger demographic still establishing their careers.

Housing: Housing data reveals that 68 percent of respondents own their homes, often through inheritance or family ownership, which suggests some level of financial security. However, 32 percent live in rented homes, primarily due to financial constraints, indicating that a portion of the workforce still struggles to achieve homeownership.

Table 2: Working conditions of the respondents

Particulars	Number of Respondents	Percentage
Working Days		
6 days	39	78
7 days	11	22
Total	**50**	**100**
Working hours per day		
6 – 8hours	11	22
8– 10 hours	20	40
10-12 hours	13	26
12-14 hours	6	12
Total	**50**	**100**
Years of Experience		
1-2 years	8	16
2- 4years	18	36
4-6 years	24	48
Total	**50**	**100**
Monthly Income		
Below 6,000	23	46
6,000 – 8,000	20	40
Above 8,000	7	14
Total	**50**	**100**
Health problems		
Back pain	15	30
Leg pain	24	48
Body pain	11	22
Total	**50**	**100**

Source: Primary data

Income and Employment: Income, which is vital for meeting daily expenses, is earned in exchange for providing services or goods. The data highlights that 78 percent of the respondents work 6 days a week, with Sunday as their only day off. Meanwhile, 22 percent of the respondents work all 7 days, including Sundays, to earn additional income. This suggests that a considerable portion of the workforce takes on extra work to meet financial needs.

Working Hours: In terms of working hours, 40 percent of respondents work 8 to 10 hours daily, which reflects a standard full-time schedule in many industries. However, 12 percent of respondents work extended hours, ranging from 12 to 14 hours a day, possibly driven by the need for extra income or demands of the job. The long working hours of this group indicate potential financial pressure or the nature of the job requiring longer shifts.

Length of Service: The length of service provides insight into the respondents' experience levels. The data shows that 16 percent have worked for 1-2 years, 36 percent have worked for 2-4 years, and the largest group, 48 percent, have been employed for 4-6 years. This suggests that the majority of the respondents have significant experience in their current jobs, with many working for 4-6 years. Longer service usually correlates with increased skills, experience, and potential for higher salaries or promotions.

Income Distribution: The income levels of respondents reveal that 46 percent earn less than 6,000 rupees per month, while 40 percent earn between 6,000 and 8,000 rupees, and 14 percent earn above 8,000 rupees. Permanent employees generally receive higher pay, while temporary workers tend to earn lower wages based on their years of service.

Health Issues: The nature of the work has significant physical implications for the respondents. The data shows that 78 percent suffer from both back pain and leg pain, which is likely due to the long hours spent standing while on the job. This highlights the physically demanding nature of their work environment. In contrast, 22 percent report general body pain, which could be linked to various work-related physical stresses. These health issues reflect the need for better working conditions or interventions to alleviate the strain on workers.

Conclusion

The retail industry is a key part of India’s economy, contributing around 15% to its GDP. In this study, the unorganized retail sector in and around Tiruchirappalli provides significant

employment opportunities for women. However, despite these opportunities, women face various challenges. The study found that their wages are largely determined by work experience, with education playing a critical role in improving income, social status, and career prospects.

Despite their contributions, women in this sector lack social security benefits and often suffer from occupational health issues such as back and knee pain. Many women enter this work voluntarily to support their families, but long hours and low wages can hinder their productivity. To improve their situation, higher wages, access to government schemes, and medical and financial support should be provided to enhance their living standards and ensure better futures for their families.

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OPPRESSION OF THE OPPRESSED-A FEMINISTIC READING OF BAMA FAUSTINA'S PONNUTHAYI

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Abstract

Bama Faustina's *Ponnuthayi* probes into systemic oppression experienced by marginalized communities. The novel reveals the pervasive inequalities faced by the oppressed, exploring themes of social injustice, discrimination, and resilience. Characters in the story endure the harsh realities of caste-based exploitation, gender inequality, and economic disenfranchisement, highlighting the structural barriers that perpetuate their marginalization. Through vivid storytelling and empathetic character portrayals, Bama Faustina critiques the entrenched power dynamics and advocates for social reform and empowerment of the oppressed.

Keywords: Oppression, Marginalization, Social Injustice, Discrimination, Caste Exploitation, Gender Inequality, Economic Disenfranchisement, Resilience, Social Reform, Empowerment

Feminism is an ideology that argues for equal rights for both genders by challenging and addressing systemic inequalities and injustices that affect women and marginalized groups. It has evolved through various waves, each expanding its focus from legal rights and suffrage to broader issues like workplace discrimination, reproductive rights, and intersectionality. Dalit feminism is the response to mainstream feminism in India which never addressed the question of caste and gender and whose main focus was only on class and gender. The history of Dalit feminism dates back to the 19th century. Pioneers from India like Jotirao Phule, Chattrapati Shahu Maharaj, and B.R. Ambedkar fought against oppression based on caste, gender, and patriarchy. Dalit literature in India emerged as a powerful voice reflecting the experiences and struggles of the Dalit community. It spans around various genres including poetry, novels, and autobiographies. Writers like Urmila Pawar, Kalyani Thakur Charal, Bama Faustina, and Kancha Ilaiah have contributed significantly to Dalit feminism, shedding light on caste-based discrimination and social injustice. They used

literature as a tool to amplify voices, dismantle stereotypes, and contribute to social changes by highlighting the struggles faced by Dalit women within the broader feminist discourses.

Bama Faustina Soosairaj is an Indian writer known for her works addressing issues of social justice, caste discrimination, and women's rights. She has authored works like *Karukku*, an autobiography, *Sangati*, a novel , and *Kisumbukkaran*, a collection of short stories . In the novel *Sangati* she does not follow a traditional plot structure but rather presents a series of interconnected vignettes and narratives. In *Karukku*, Bama provides insights into her experiences as a Dalit Christian.

The condition of Dalit women is more vulnerable than non-Dalit women and this paper explores Bama's representations of Dalit women in her short story *Ponnuthayi*. This paper unfolds the double oppression faced by Dalit women and emphasizes the intersectionality of caste and gender discrimination, as Dalit women are subjected to encounter gender-based oppression like patriarchy, domestic violence, and gender bias in addition to caste-based discrimination.

Ponnuthayi revolves around the story of Ponnuthayi who is married to an alcoholic and abusive man Mookandi. Her life becomes fateful because of Mookandi who is a vagabond and she finds it difficult to make ends meet to feed her four children. She holds a small business selling fruits and vegetables causing much distress to her neighbours who resent the fact that she survived, doing business, unlike the other women who worked as wage labourers for landlords. Mookandi works for four days and remains at home for the rest of the days picking up fights with Ponnuthayi. He beats her to a pulp and tries to grab her wages so that he can go out. She is not ready to be the voiceless victim of her husband's atrocious nature and thus decides to break the fetters of wedlock that confines her. Ponnuthayi, the married young woman and the mother of four children, walks away from her family leaving her children to Mookandi saying that even he holds the same responsibility as her in raising their children, much to the discontentment of her parents and her community.

Dalit women bear the brunt of the systemic male dominance over female. Bama, representing her community's women, asserts that while all women experience subjugation to men, Dalit women endure the harshest consequences, facing the dual oppression of both patriarchy and the caste system. Bama's portrayal of Ponnuthayi being beaten up by her husband Mookandi who is the actual culprit, showcases the brutal reality of the subjugation of women in Dalit community."One day, Mookandi upped and sold her cow but didn't give

her any money for it. It was after the ensuing fight, having been beaten black and blue that she came back to her mother's place". (Faustina 3)

Dalit men undergo a bad treatment at the hands of upper caste men who are the landlords. They in turn vent out their suppressed anger, male pride, and authority on their wives. Bama doesn't shy away from describing violent, domestic, or street quarrels. Ponnuthayi is oppressed by her community when she tries to break the fetters of patriarchy. Women of her community are more committed to bringing down Ponnuthayi's stern decision to become an entrepreneur.

He should have given her a beating or two from the very beginning to keep her under his thumb. Didn't do that, now he's suffering. If a man can't keep his wife under his control, he isn't a man! His moustache is an insult to him!" said Govindan, and laughed loudly. Look at her, walking away so arrogantly! What can't she toil like the rest of the village to earn her daily meal? She wants to do business like some upper caste person! She is too much!What kind of women is she? Not one bit of love for her own children! Roaming around like a man! Have you ever seen a women leave her children with her husband like this.

She is abused, and blamed by her parents when she boldly decides to leave her husband forcing him to take care of their children. Ponnuthayi's father replies calmly " Please be patient, mappile .That day the foolish girl went to the station through ignorance. Give me few more days. I myself will advise her well and bring her over".

Bama mirrors the state of suffering and depression of her women and also reveals the vigour, courage, and resilience of Dalit women even amid all misery. In her works, we hear the voices of many women, some in pain, some in anger, some in frustration, and some out of courage. Her characters often embody courage and a quest for dignity and empowerment, challenging stereotypes and advocating for social change.

Through Ponnuthayi, Bama explores the adverse facets of internal patriarchy and illustrates the unwavering reaction of a strong-willed woman. Bama confronts established perceptions of the term 'woman' through the character Ponnuthayi, highlighting her ability to challenge systems that sustain gender disparity and ultimately attain a superwoman persona.

Subaltern theory,developed by Gayatri Chakravorty Spivak, examines the voices and experiences of marginalized groups that are often excluded from dominant historical narratives and discourses. In her influential essay can the Subaltern Speak? Spivak argues

that the subaltern, those who are socially, politically, and economically oppressed, often cannot represent themselves within the structures of power that define mainstream discourse. Spivak's work highlights the need for critical reflection on who gets to speak and how their voices are received and interpreted. Subaltern theory has a close connection with Dalit feminism. Regarding oppression, Spivak emphasizes the importance of understanding power dynamics and intersectionality, highlighting the need for deconstructing dominant narratives to challenge and address systemic inequalities. Subaltern theory and Dalit feminism seek to provide a platform for the voices of women, who have historically been silenced and overlooked. Oppression of the marginalised is a pervasive societal issue that requires collective awareness and action to address systematic inequalities and promote justice. Oppressed, ruled, and still being ruled by patriarchy, caste, and religion, Dalit women are forced to break all the strictures of society to live. Throughout her work, Bama uses the Dalit Tamil dialect more consistently, overturning received notions of decorum and propriety, by bridging spoken and written styles consistently. *Ponnuthayi* serves as a powerful narrative that raises awareness about the unique challenges faced by Dalit women and emphasizes the importance of addressing both gender and caste-based discrimination to achieve social equality and justice for them.

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UTHAMANATHAR TEMPLE AT KEERANUR - A STUDY

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Abstract

Uthamanathar temple is located in Keeranur village, Kulathur taluk of Pudukkottai district in Tamil Nadu, India. It is situated 25 kms from the district headquarters Pudukkottai. The Uthamanathar temple centre of the Keeranur is renowned for its rich architecture and inscriptions. The Temple is at woprakara complex, the main shrine in the inner prakara has vimana, mukha-mandapa, maha-mandapa in the middle. Lord Shiva, the presiding deity, is known as Uthamanathar, and the goddess is named as Brahathambal. There are twelve inscriptions within the temple complex. The earliest inscription in the Uttamanathar temple complex belongs to Ko-Illango Muttaraiyar (IPN-237). The temple also features elegant early Sculptures, particularly those of Dakshinamurti, Bhairava, and Chandeswara which denote the temple's antiquity. This study aims to bring to light the history and architecture of the temple through data collected from field study.

Keywords: Uttamanathar, Early Chola Temple, Aditya Chola I

Introduction

Uthamanathar Temple is located in Keeranur village, Kulathur taluk of Pudukkottai district in Tamil Nadu, India. It is situated 25 kms from the district headquarters Pudukkottai. The Uthamanathar Temple centre of the Keeranur is renowned for its rich architecture and inscriptions. The Temple is a two prakara complex; the main shrine in the inner prakara has vimana, mukha-mandapa, maha-mandapa in the middle. Lord Shiva, the presiding deity, is known as Uthamanathar, and the goddess is named as Brahathambal. There are twelve inscriptions within the temple complex. The earliest inscription in the Uttamanathar temple complex belongs to Ko-Illango Muttaraiyar (IPN-237) [1]. The early inscription mentions the presiding deity as Uttamadanisvarattu Perumanadikal (IPN-237) [2]. The Chola and later Pandya inscriptions mention the deity as ‘Udaiyar Uttamadanisvaramudaiya Nayanar’ (IPN-145 [3] and 546) [4]. According to the Vijayanagar inscriptions, the deity is referred to as Uttamadanisvaramudaiya Nayinar (IPN-690) [5]. The two inscriptions of unknown dynasties mention the deity as Uttama Sozhishvaramudaiya Thambhiranar (IPN-928 [6] and 954) [7]. The present name of the deity, ‘Uttamanathar,’ is not found in the inscriptions. The temple also features elegant early Sculptures, particularly those of Dakshinamurti, Bhairava, and

Chandeswara which denote the temple's antiquity. This study aims to bring to light the history and architecture of the temple through data collected from field study.

Objectives

This article aims to study the architecture and inscriptions of this temple complex to highlight the history and architectural excellence of the temple. Data collected from field visits serve as the primary source for this study.

The Temple Complex

Uthamanathar temple is a two prakara complex with a gopura in theeast.The entire temple is about three feet below the ground level. The gopura is a five -tier structure with huge compound wall extending on both sides encompassing the temple complex. In the outer prakara the shrine of Goddess Brahadambalis seen on the northern side. Amaha-mandapa is seen on the western side adjoining the second prakara wall. A Nandi, kodimaram and balipitha are found in maha-mandapa oriented towards the main shrine. The inner prakara has a single tier gopura and encompassed by compound wall, adjoining the wall on the inner side is seen the Thiruchurrumalika. The main shrine lying in the centre of the inner prakarahas a vimana, mukha-mandapa, maha-mandaba and open pillared mandapa facing east. The Thiruchurrumalika extends on the southern, western, northern and eastern side of the prakara. Shrine of various associate deities are seen in the thiruchurru, the shrine of Lord Ganesa is seen on the south western side, shrines of Lord Surya, and Lord Bhairavar are seen in the northeastern side.

The Main Gopuram

The main gopura is a five-tier structure raised on a upapitha, the aditala of the gopura is a stone edifice and the superstructure is cement structure. The aditala has an padabandhaa dhishthana, bhitti and prastara. The gopura is segmented as karna-panjara-salai; karna in the corners, salai in the middle and panjara in between. All the segments are projected and decked with a pair of pilasters. In addition, the salai is further projected. The projection of the segments creates recession in between and decked with kumba panjara. The super structure is a newly constructed brick and cement structure. The gopura is crowned with sala sikhara.

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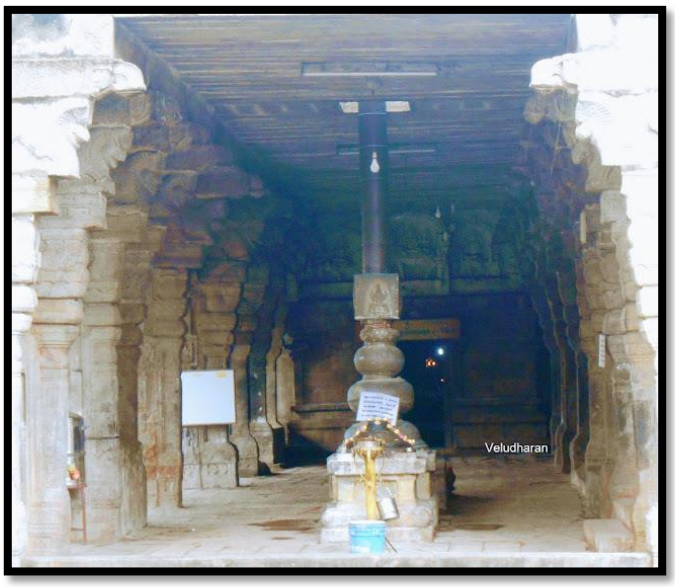
The Main Gopuram of the Uthamanathar Temple



The Outer Prakara

The main gopura leads to the outer prakara. In the outer prakara on the northern side the shrine of Goddess Brahadambal is seen. A maha-mandapa is seen on the western side adjoining the second prakara wall. The pillars in the maha-mandapa are giant and ornamental; the ornamentation denotes that it belongs to Vijayanagar period. The Goddess Brahadambal shrine consists of vimana, mukha-mandapa and mahamandapa.

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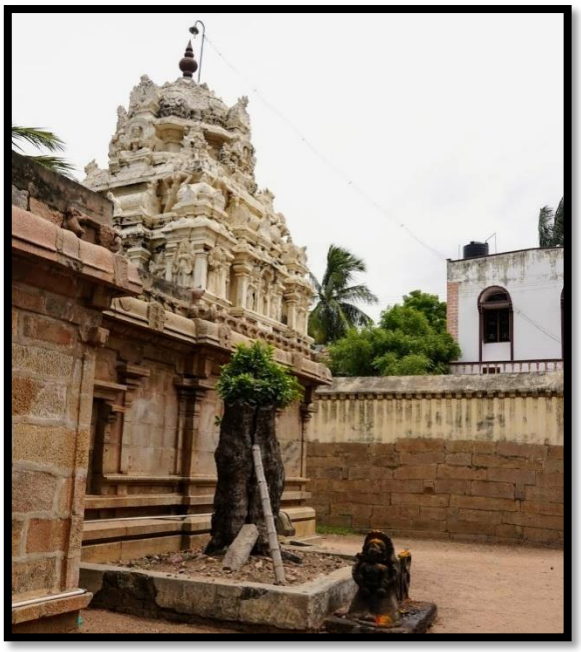

The Goddess Shrine

The Goddess Brahathambal shrine consists of a dvi-talamisra vesara vimana, mukha-mandapa and maha-mandapa, all are facing south. The vimana has apadabandha adhishthana, bhitti and prastara forming the aditala. The bhitti is cantoned by four brahmakatha pilasters with all the head components. The sala division is additionally beautified with the presence of koshthas with makharatorana. Tenon type potikas are seen on the top of the pilasters. The potika supports the prastara elements like uttira, vajana, valabhi and kapota with kudu arches. Above the kapota rests the bhumi desa denoting the end of the tala. The super structure is a newly constructed brick and cement structure. The vimana is crowned with vesarasikhara.

The Vimana of Uttamanathar Shrine

The viamana of Uttamanathar shrine is an ekatala misra vesara vimana. The aditala of the vimana is nagara whereas the griva and sikhara are vesara. The vimana has an adhishthana, wall and roof. The adhishthana is pratibandha type with upana, jagati, prati series. The pratis are formed as bold figures formed pairing each other. The wall that raise above the adhishthana is cantoned by four brahmakantha pilasters on each side. The brahmakantha pilasters have capital ornamentation of kattu, kalasam, tadi, kumbha, pali, phalaka and virakantha. The potikas resting above the pilasters are plain angular in type and bear the prastara of the vimana. Uttira, vajana, valabhi and kapota forms the prastara elements. It is quite interesting to see swan series in the valabhiinstead of Bhuta frieze. The swan frieze is a remarkable feature to mention about this vimana. In addition, the absence of

koshthasis also highlighting to mention. The sanctum is cubical chamber and houses Lord siva in the form of Linga and in the name Uthamanathar. The avudaiyar is square and the bana is rudra with a gomukha towards north.

The mukha-mandapa has the same features of the vimana. The maha-mandapathat follows the mukha-mandapa also has pratibandha adhishthana, wall cantoned by plain brahmakantha pilasters, plain angular potikas that bear the prastara of the mandapa. The maha-mandapa is followed by open pillared mandapa.

Inscriptions

Epigraphical records serve an important primary source to ascertain history in its proper perspective. Twelve inscriptions are found in this temple complex. The inscriptions are located on the walls of the vimana, mandapa, and prakara in the temple. These inscriptions have been copied, and their texts were published by the Pudukkottai State under the title "Inscriptions of Pudukkottai State" in 1929.The temple contains inscriptions from various dynasties, including the Muttaraiyas, Cholas, Pandya, and Vijayanagar. Among the twelve inscriptions, two belong to the Muttaraiyas, three belong to the Cholas, one to the Pandya, four to the Vijayanagar, and two inscriptions do not specify the dynasty to which they belong. The earliest inscription in the Uttamanathar temple complex belongs to Ko-Illango Muttaraiyar (IPN-237). Other inscriptions of Kulothunga Chola III, Rajaraja Chola III, Maravarman Kulasekara Pandya, Viruppanna Udaiyar, Vira Pokkarayan, Vira Prathabha Maharayar, and Achyutadeva Maharaya are also found in this temple complex.

Many inscriptions in the Uttamanathar temple record the activities of the assembly of Keeranur, which was involved in receiving endowments and other temple-related activities. From the inscriptions, it is gleaned that Uttamadanisvaramudaiyar temple is located at Keeranur in Vadasiruvayinadu, a subdivision of Jayasinga kulakalavalanadu (IPN-145). During the Vijayanagar periods, this place became apadaipattru of Keeranur. The names of several villages are also mentioned in the inscriptions, such as Valuvamangalam, Nanjil, Perunsevur, Sunaiyakkudi, Kallikkudi, Viraikkudi, Perunjaiyur, Oduvur, Melaipuduvayal, Kilaipuduvayal, Valambhakkudi, Naharattumalai, Vadasiruvanadu, Irainkudi, Sattimangalam, Pallattur, Puliyur, Panaiyur, Kulamangalam, and Sevvalur.

The inscriptions in this temple record the endowments provided for daily offerings, festival offerings, and various other temple services (IPN-145). Most of the inscriptions found in this temple record the donation of devadana land for various services, including the lighting of

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perpetual lamps and food offerings in the temple (IPN-744) . A Vijayanagar period inscription records that the temple tank wall was reconstructed with bricks by Silamban, son of Thattan Suriyan, and Chokkan Mahaithavarkala Thattan (IPN-690). From the inscriptions, it is understood that the practice of land donation for religious purposes was followed for a long period, and regular services with offerings were conducted for the presiding deity of the temple.

Inscription on the Wall of Uthamanathar Temple

Suga Theertham

Conclusion

The Uttamanathar temple at Keeranur is rich in architecture and inscriptions. The inscriptions gleans the temple was under continuous patronization of succeeding dynasties of Tamil country. The earliest epigraphically record belongs to thirteen regnal year of Ko-Illango Mutharaiya that corresponds to 804 C.E. It establishes the fact that

Uttamanatharvimana and mukha-mandapa existed in the early part of the Ninth century C.E. The absence of koshthas in the Uttamanatharvimana, presence of swan frieze in the valabhi of the vimanaand mukha-mandapaare remarkable features to mention. It is important to recollect here, absence of koshthas in the vimana is also seen in the temples viz., Sendalai, Vijayalaya Choleeswaram and Visalur which are Muttaraiya establishments. On the basis of inscriptional record, we can assign late eighth or early ninth century C.E. as the period of temple, besides, architecture traits also corroborates it to early period. Hence, on the basis of geographical location, period and architecture Uttamanathar shrine can be assigned to Muttaraiyas.

End Notes

1. Field visits were done by the researcher on the following dates to collect data about the temple 27-08-2023,01-09-2024
2. Inscriptions of The Pudukkottai State No. 237
3. IPS No. 237
4. IPS No. 145
5. IPS No. 546
6. IPS No. 928
7. IPS No. 954
8. IPS No. 145
9. IPS No. 237
10. IPS No. 145
11. IPS No. 145
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CHEMICAL CHANGES OF RICE ON STORAGE IN SELECTED PADDY VARIETIES

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Abstract

This study investigates the chemical changes that occur during the storage of selected paddy rice varieties. The research focuses on key chemical components such as moisture content, free fatty acids, amylose, and protein levels. Over time, changes in these parameters can affect the nutritional qualities of rice. The results demonstrate that prolonged storage increases free fatty acids and moisture content, contributing to rancidity and quality degradation. Variations among different paddy varieties were also observed. Understanding these changes is crucial for improving storage practices and maintaining rice quality post-harvest.

Keywords: Paddy, Protein, Seeds, glucose and fructose

Introduction

The grain, called rice (Oryza sativa L.) for more than 8000 years, has been the companion of human kind. It is the most important food commodity in Asia, particularly in South and SouthEast Asia, where more than 90 per cent of rice is produced and consumed. Paddy (Oryza sativa L.) is one of the most important staple food crops which is a major source of nutrients in many parts of the world. Paddy is second largest major cereal crop a member of grass family (Graminaceae), which produces starchy seeds. Rice is used as an important staple food by the people in many parts of the world after wheat. Rice is used as a source of nourishment for more than half of the world's population, thus, making it as second most important cereal grain.

Rice contributes about 60–70% of total calories and one-third of daily protein requirement, not only as a dietary staple but also as a convenience food in the form of expanded (puffed) rice, as breakfast cereal, snack foods, multigrain flakes, puffed, popped, flaked, and extruded products.

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A major part of mankind can be divided up into rice eaters and wheat eaters. Rice is chiefly grown in the warmer regions of the globe, in those parts which are well provided with water through regularly occurring monsoon periods. The processing of rice requires different grain, types and textural qualities for use in various kinds of prepared convenience rice based products such as dry breakfast cereals, quick cooking rice and baby foods.

The use of ready-to-use products has assumed considerable importance in recent years owing to some unique properties of rice starch, its own special flavor, also its texture – modifying properties in formulation and processing. One of the ready-to-use products which have got considerable importance among the rice products is rice flakes.

Quality evaluation of selected paddy cultivars was studied by Lakshmi Priya (1996). She observed the changes in physical, chemical and cooking quality in the selected varieties. A decreasing trend in the nutrient, such as starch, protein, amino acid, total sugar and thiamine were noted during storage of raw and parboiled rice. The amylose, amylase and reducing sugar has increased during storage. Suitability amylose for preparation of fermented product (*idli*) and ready to eat rice products (flakes and puffed) were also carried out. Instant *idli* mix prepared by mixing rice and blackgram flours in the ratio of 4:1, packed and stored at room temperature showed the changes in moisture, pH, acidity, starch, reducing sugar, total sugar, protein, lysine, methionine and thiamine during the study period (Jagan Mohan, 1999).

Therefore screening the suitable paddy varieties for table purpose, special preparations and product developments are very much required. Considering the nutritional needs and the importance of quality evaluation, in the present study, selected rice varieties, IR-64 and CO-43 were analyzed. Hence, with this in view a study was undertaken with following objectives:

Objectives of the Study

1. To study the characteristics of selected rice varieties.

2. To estimate the chemical composition of selected rice.

3. To study the storage behavior of the rice.

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Review of Literature

Scenario of Paddy in India

Rice (*Oryza sativa*) is the most important cereal crop in the developing world and is the staple food for over half of the world's population. Report suggest that rice was cultivated in India from as early as 1500-2000 B.C. About 95 per cent of the world's rice is produced in developing countries and 92 per cent of it in Asia alone. India is the second largest producer in rice, after China (Indra Ravindranath, 2000).

Varieties

India classifies its rice into only two categories: non-basmati (which includes more than 35 varieties) and basmati. According to the new classification, India will now have three categories: Indian long grain (with around 20 varieties of normal long grain), Indian aromatic (with around 10 superior varieties), and basmati. The new category of Indian aromatic rice will be of more expensive than normal long grain but costs lower than the traditional basmati. The reclassification of non-basmati has become necessary in order to ensure that superior rice varieties, apart from basmati, are able to create a niche for themselves both in the domestic and global markets (Anon, 1998).

The International Rice Research Institution (IRRI) in the Philippines has developed about 400 different varieties of super rice, to be tested in India over the next two years. The major research areas will include improvement and development of rained rice, hybrid rice technology, biotechnology, germ plasm collection and exchange, and rice based cropping systems. Scientists estimated that India has to produce 2.5 million tonnes of rice additionally every year with the same or less land and water resources. ICAR and IRRI have signed a work plan agreement for two years 1999-2000 for collaboration of rice research (Anon, 1999). The Indian Agricultural Research Institute (IARI) has developed several new varieties of wheat and hybrid rice, including hybrid basmati, to overcome the recent stagnation in food grain production in the country's major agricultural belts (Anon, 2000).

Chemical Constituents

Parboiling brings about profound changes in all the major components of rice which result in its physical and physico-chemical properties. Starch, protein and fat are greatly affected during parboiling both in their organization and in their disposition. Gelatinization of starch is the most obvious changes during parboiling. A part of gelatinsed starch gets

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reassociated during drying to steamed paddy. The total protein and its amino acid composition are reported to remain unchanged. Total fat in milled parboiled rice is less than in milled raw rice. Parboiled milled rice had more B-complex vitamins and minerals (Amarjeet Kaur and Sekhon, 1996)

The effect of parboiling, hand-pounding and machine-milling on chemical composition of rice was studied by Sadhna Singh et al. (1999). Parboiled rice was found to have higher protein and ash contents and low free amino acids and free fatty acids as compared to non-parboiled rice. In contrast to machine-milled rice, hand-pounded rice contained not only higher protein, fat and ash, but also high free fatty acid, indicating poor storage quality. Irrespective of various treatments, different genotypes under experiment showed significant variation for proteins, free amino acids, fat and total ash contents.

Proteins, fats, vitamins and minerals are present in greater quantities in the removable bran layer than in the remaining polished endosperm (Houston and Kohler, 1970 and Roberts, 1979). Veena Pal et al. (1999) studied the effect of degree of polishing on proximate composition of milled rice. Milled rice samples of different degrees of polish (0-11.35 %) obtained by varying the time of milling were evaluated for proximate composition. The data revealed that the proteins, fat and ash contents decreased linearly with increase in degree in polish, as these constitutes were mainly concentrated in the peripheral layers of kernel, which were removed during polishing.

Juliano (1985) compiled the proximate composition of paddy, brown rice, milled rice and bran. The starch content of paddy was about 53.4, for brown rice 66.4, for milled rice 77.6, for bran 13.8 and for the polish in the range of 41.5-47.6 per cent while that of protein contents (N x 5.95) were 5.8-7.7, 7.1-8.3, 6.3-7.1, 11.3-14.9 and 11.2-12.4 per cent for paddy, brown rice, milled rice, bran and polish respectively. Crude fat content in the order of paddy, brown rice, milled rice, bran and polish were 1.5-2.3, 1.6-2.8, 0.3-0.5, 15.0-19.7 and 10.1-12.4 per cent respectively.

Barber and Barber (1980) analyzed the minor organic constituents like free-sugars. The major sugars of rice embryo and endosperm were sucrose, in addition to small amount of raffinose, glucose and fructose and glucose the principle reducing sugar. The total sugar content of the embryo varied from 8 to 25 and reducing sugar ranged from 4 to 11 per cent.

Marium Begum and Ruma Bhattacharyya (2000) studied the fat contents in milled raw and cooked forms of seven rice varieties of Assam. The results showed that the cooked rice had lower levels of fat content as compared with raw grains. Ether extractives ranged from 1.63-2.74 in raw rice and 0.17-0.38 per cent in cooked rice.

The oil content of raw and parboiled brown rice remained unchanged, when milled to the same degree. Parboiled rice contained less oil than raw rice whereas the oil content of parboiled bran was more than raw rice bran (Pillaiyar, 1988). Increase in oil content of bran was attributed to the outward movement of the oil during parboiling which was further accelerated with increase in temperature and duration of soaking as well as increase in pressure of steaming (Vasan et al., 1971).

Vitamins were generally present in higher levels in brown rice than in raw milled rice. Distribution of vitamins in different milling fractions varied from 2.9-6.1 µg/g in brown rice while that of milled rice and bran varied between 0.1 and 1.1 and 12 and 24 µg/g respectively. The paddy as such contained 2.6-3.3 µg/g of thiamine. Vitamins such as riboflavin and niacin were not in free form. (Pillayar, 1988).

Bhattacharya and Ali (1985) reported that water soluble vitamins such as thiamine and nicotinic acid were more in milled parboiled rice than in raw rice. There was no change or little change in the constituent of brown rice after parboiling. The parboiling process had reduced the loss of minerals like phosphorus, calcium, iron, manganese and molybdenum.

The thiamine content of raw and parboiled rice at different percentage of polishing were discussed by Swaminathan (1987). At 5 per cent polishing the thiamine content was reported as 290 and 420, at 10 per cent, 180 and 380 at 15 percent 100 and 290 at 20 per cent, 40 and 200 mg/100g for raw and parboiled rice respectively. Thus the results proved that as the degree of polishing increased, the thiamine content was decreased in both the raw and parboiled rice.

The mineral composition of the rice grain depend upon the availability of soil nutrients during crop growth. Minerals were generally present in higher levels in brown than in milled rice. The calcium content varied from 0.1-0.8 in paddy, 0.1- 0.5 in brown rice, 0.1-0.3 in milled rice while in bran it was 0.3-1.2 (mg/g). Magnesium content of paddy, brown rice, milled rice and bran were 0.6-1.5, 0.2-1.5, 0.2-0.5 and 5-13 (mg/g) respectively. Phosphorus content in bran was highest 11.25 mg/g followed by paddy and brown rice with 1.7-3.9 and 1.7-4.3 mg/g respectively and in milled rice it was only 0.8-1.5 mg/g. Phytin phosphorus content in bran varied in the range of 9-22 mg/g followed by brown rice (1.3-2.7)

and paddy (1.8-2.1) and in milled rice it was found to be in the range of 0.3-0.7 mg/g (Juliano, 1980).

Bajwa et al. (1999) studied the effect on extended milling. On milling characteristics, chemical composition cooking quality and black tip discoloration in Indian rice. Extended milling of rice decreased the incidence of mycoflora and reduced black tip discoloration but reduced the head rice yield and kernel weight. Protein content, ash, reducing sugars, non-reducing sugars and free fatty acids increased whereas amylose decreased significantly with the increase in the number of discolored grains. Discolored rice required significantly less time to cook, showed decreased water uptake, reduced kernel elongation and losses. Cooking time decreased, water uptake, elongation in cooked rice and gruel solid loss increased with an increase in the degree of milling. Correlation co-efficient between the different variables were calculated.

Assessment of suitability of selected rice varieties for production of expanded rice was studied by Vijayalaxmi Kamaraddi and Jamuna Prakash. The results indicated a strong positive correlation between amylose content and expansion ratio and a negative correlation between protein and amylose content, length expansion ratio and volume expansion ratio.

Selected quality attributes of paddy rice as affected by storage temperature history studied by Zaixi Shua *et.al.,* (2021). The results suggested that order changes of high- and low-temperature conditions can affect the intermediate quality of the stored rice but have limited influence on the final quality.

Materials and Methods

The materials used and methods adopted for the study are given in detail.

Materials

Two varieties of paddy viz., IR - 64 (Variety 1 – V_1) and CO- 43 (Variety 2 – V_2) were purchased in bulk from local market at Madurai. The chemicals used in the study were either LR (Laboratory Reagent), AR (Analytical Reagent), or GR (General Reagent) grade. Equipment's used in the study were Avery balance, Electronic balance, Thermometer, Hot water bath, Autoclave, Hot air oven, Muffle furnace, Soxhlet apparatus, Kjeldahl digestion mantle, Distillation apparatus, Colorimeter, Centrifuge and LPG gas was used for heating purpose. The Packaging materials were Stainless steel container (250 g capacity) and high density polyethylene (HDPE) laminated with polypropylene (PP) were used for packing the products and the REVO bag closure was used to stitch the bag for conducting storage study.

Methods

Packaging

Each treated sample (200 g) of each variety was packed in stainless steel container (P1) and polyethylene laminated with polypropylene bags (P2) for conducting the storage study (6 months). The chemical changes before and after storage was noted. The changes in the quality characteristics were noted during the study period.

Chemical Analysis

The two paddy varieties (IR 64 and CO 43) were packed in the packaging material and the chemical analysis was carried in a period of 30 days for six months. Moisture, protein, starch, total sugar, fat, amino acids and thiamine were observed during storage.

Results and Discussion

Rice serves as a staple food for the majority of the population in the world. A considerable quantity of rice is converted into many products and is marketed in various rice consuming countries. In the present investigation, parboiling (PB) by two methods, raw paddy (RR) treated by two methods and milling of paddy were carried out for the selected paddy samples. Their physico-chemical characteristics, storage behavior, effect of packaging materials were studied. The data obtained were statistically analyzed and discussed in this chapter.

Characteristics of selected paddy

The paddy varieties selected for study were IR 64 and CO 43 and their features are given below:

Table 1: Features of the paddy varieties selected for the study

S.No.	***Strain***	***Parentage***	***Crop Duration (days)***	***Grain yield (kg/ha)***	***Specific features***
1.	IR 64	Multicross	Short duration for Rabi season (115-120)	6000-7000	The grain is long slender with fine rice
2.	CO 43	Dasal x IR 20	Medium duration for Rabi season (135)	5000-6000	Short statured, medium slender fine, white rice

Source: Rangaswamy and Jebaraj (1999).

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Chemical Changes in Parboiled and Raw Rice during Storage

Moisture

The moisture content of parboiled and raw rice stored in stainless steel container and HDPE bag showed a steady decrease in both the samples, in all other treatments throughout the storage period. The moisture content of parboiled rice decreased from 12.6 to 11.2 and 11.1, 12.7 to 11.4 to 11.2, 12.5 to 11.1 and 10.8, 12.6 to11.3 and 10.9 per cent for V1 PB1, V1 PB2, V2 PB1 and V2 PB2 respectively and raw rice decreased from 12.8 to11.5 and 11.3, 12.9 to11.6 and 11.4, 12.6 to11.4 and 11.2, 12.7 to 11.5 and 11.3 per cent for V 1 RR 1 , V 1 RR 2, V 2 RR 1 and V 2 RR 2 stored in the packaging materials (P1 and P2) respectively. All the raw rice samples exhibited higher moisture content than the parboiled rice samples.

Protein

The parboiled rice exhibited a slight decrease in the protein content during the storage period. It decreased from 6.66 to 6.47 and 6.39, 6.91 to 6.73 and 6.71, 7.00 to 6.87 and 6.82 and 7.21 to 7.01 and 6.99 per cent for V 1 PB 1 , V 1 PB 2 , V 2 PB 1 and V 2 PB 2 packed in P 1 and P 2 respectively. The raw rice samples exhibited higher percentage of protein content than parboiled rice samples. The protein content of raw rice samples decreased from 7.32 to 7.06 and 7.06, 7.51 to7.31 and 7.28, 8.00 to 7.83 and 7.78 and 8.19 to 7.99 and 7.95 per cent for V 1 RR 1 , V 1 RR 2 , V 2 RR 1 and V 2 RR 2 in P 1 and P 2 respectively.

Starch

The parboiled and raw rice samples recorded a steady decrease in the starch content during the storage period. The initial values of parboiled rice samples were 64.3, 64.8, 66.7 and 67.0 per cent for V 1 PB 1, V 1 PB 2, V 2 PB 1 and V 2 PB 2 respectively. The corresponding final values in both the packaging materials (P 1 and P 2) were 62.7 and 62.4, 63.2 and 63.0, 64.9 and 64.7 and 65.1 and 64.9 per cent respectively. The initial values of raw rice samples were 69.4, 68.3, 70.0 and 69.5 per cent for V 1 RR 1, V 1 RR 2, V 2 RR1 and V 2 RR 2 respectively. At the end of storage 67.1 and 66.9, 66.2 and 65.9, 67.9 and 67.7 and 67.4 and 67.1 per cent of starch was observed in the raw rice samples packed in P 1 and P 2 respectively.

Amylose

The increase in amylose activity was observed during the storage period in parboiled and raw rice samples. The initial values were 14.1, 14.3, 10.4 and 10.5 for parboiled rice and 20.2, 21.0, 15.2 and 15.9 per cent for raw rice samples. The corresponding final values observed after 180 days of storage were 16.8 and 17.5, 17.4 and 17.7, 13.7 and 14.0, 14.3 and 14.4 per cent for parboiled rice and 23.0 and 23.3, 24.4 and 24.6, 18.5 and 18.8, 19.3 and 19.5 per cent for raw rice in both the packaging materials for V 1 PB 1 , V 1 PB 2 , V 2 PB 1 , V 2 PB 2 and V 1 RR 1 , V 1 RR 2 , V 2 RR 1 and V 2 RR 2 respectively. The increase in amylose content between varieties and between treatments was seen more or less closer with a few exceptions.

Reducing sugar

The reducing sugar content of parboiled and raw rice samples showed an increasing trend throughout the storage period. The initial reducing sugar content of the parboiled rice samples were slightly higher than the raw rice but at the end of storage period the actual increase in both the samples (parboiled and raw) seems to be more or less similar. The variety V 2 (parboiled and raw rice) exhibited higher values than variety V 1. The initial and final reducing sugar contents of parboiled rice ranged between 0.11 and 0.21 for V 1 and 0.16 and 0.23 per cent for V 2 respectively. Similarly the raw rice samples ranged between 0.08 and 0.16 for V 1 and 0.11 and 0.21 per cent for V 2 respectively.

Total sugar

A steady reduction in total sugar content was observed between varieties, treatments and packaging materials. The total sugar content of parboiled rice samples decreased from 0.10 to 0.06 and 0.05, 0.12 to 0.05 and 0.04, 0.13 to 0.07 and 0.06, 0.12 to 0.6 and 0.05 per cent for V 1 PB 1 , V 1 PB 2 , V 2 PB 1 and V 2 PB 2 in P 1 and P 2 respectively. Similarly the raw rice samples decreased from 0.16 to 0.09 and 0.07 for V 1 RR 1, 0.17 to 0.10 and 0.09 for V 1 RR 2, 0.18 to 0.11 and 0.10 for V 2 RR 1 and 0.20 to 0.13 and 0.12 per cent for V 2 RR 2 in P 1 and P 2 respectively.

Fat

The fat content of parboiled and raw rice samples exhibited a very slight change before and after storage. The change in the fat content of parboiled rice ranged from 0.22 to 0.20 and 0.19 for V 1 PB 1 , 0.24 to 0.23 and 0.21 for V 1 PB 2 ,0.30 to 0.27 and 0.25 for V 2

PB 1 and 0.31 and 0.29 and 0.27 per cent for V 2 PB 2 and for raw rice, 0.48 to 0.43 and 0.41 for V 1 RR 1 , 0.49 to 0.43 and 0.40 for V 1 RR 2 , 0.53 to 0.50 and 0.48 for V 2 RR 1 and 0.50 to 0.54 and 0.52 per cent for V 2 RR 2 at initial and final stages of storage, for the samples packed in P 1 and P 2 respectively. Raw rice samples had slightly higher fat content than parboiled rice samples.

Table 2: Changes in fat, lysine, methionine and thiamine content of parboiled rice during storage (DWB)

Parameters	**V_1PB_1**		**V_1PB_2**		**V_2PB_1**		**V_2PB_2**	
	P_1	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**
Fat (g/100 g)								
Initial	0.22	0.22	0.24	0.24	0.30	0.30	0.31	0.31
Final	0.20	0.19	0.23	0.21	0.27	0.25	0.29	0.27
Lysine (mg/g of N)								
Initial	198.0	198.0	200.6	200.6	194.1	194.1	196.0	196.0
Final	196.9	195.8	198.9	198.3	192.0	191.1	195.0	194.9
Methionine (mg/g of N)								
Initial	170.6	170.6	175.4	175.4	163.1	163.1	167.5	167.5
Final	169.5	169.0	174.3	174.0	162.0	161.8	166.1	165.9
Thiamine (mg/100 g)								
Initial	0.19	0.19	0.21	0.21	0.14	0.14	0.16	0.16
Final	0.17	0.15	0.19	0.17	0.12	0.10	0.13	0.11

Amino acids

Lysine

The parboiled and raw rice samples showed a notable change in the lysine content. The initial lysine content ranged between 194.1 and 200.6 and 200.4 and 205.9 mg/g of N for parboiled and raw rice samples respectively. The corresponding values after 180 days of

storage ranged between 191.1 and 198.3 and 198.1 and 203.9 mg/g of N for parboiled and raw rice respectively.

Methionine

A slight variation was observed in the methionine content of both the varieties in all the treatments on storage. The methionine content of parboiled rice had been reduced from 170.6 to169.5 and 169.0 for V 1 PB 1, 175.4 to 174.3 and 174.0 for V 1 PB 2,163.1 to 162.0 and 161.8 for V 2 PB 1 and 167.5 to 166.1 and 165.9 mg/g of N for V 2 PB 2 between 0 and 180 days of storage, packed in P 1 and P 2 respectively. Similarly the raw rice values reduced from 174.3 to 173.7 and 173.1 for V 1 RR 1, 178.9 to 177.5 and 177.0 for V 1 RR 2, 170.0 to 169.0 and 168.8 for V 2 RR 1 and 173.3 to 172.3 and 171.9 mg/g of N for V 2 RR 2 , in P 1 and P 2 on storage respectively.

Thiamine

The parboiled rice had higher thiamine content than the raw rice. The initial and final thiamine contents of parboiled rice samples were 0.19 to 0.17 and 0.15 for V 1 PB 1, 0.21 to 0.19 and 0.17 for V 1 PB 2 , 0.14 to 0.12 and 0.10 for V 2 PB 1 and 0.16 to 0.13 and 0.11 mg/100g for V 2 PB 2 packed in P 1 and P 2 respectively. Similarly the raw rice samples decreased from 0.05 to 0.04 and 0.03 for V 1 RR 1, 0.06 to 0.04 and 0.03 for V 1 RR 2, 0.04 to 0.03 and 0.02 for V 2 RR 1 and 0.04 to 0.03 and 0.02 mg/100g for V 2 RR 2 packed in P 1 and P 2 respectively.

Table 3: Changes in fat, lysine, methionine and thiamine content of raw rice during storage (DWB)

Parameters	**V_1RR_1**	**V_1RR_2**			**V_2RR_1**		**V_2RR_2**	
	P_1	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**
Fat (g/100 g)								
Initial	0.48	0.48	0.49	0.49	0.53	0.53	0.56	0.56
Final	0.43	0.41	0.43	0.40	0.50	0.48	0.54	0.52
Lysine (mg/g of N)								
Initial	203.6	203.6	205.9	205.9	200.4	200.4	201.5	201.5
Final	201.7	201.0	203.9	203.3	198.9	198.1	199.9	199.1

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Methionine (mg/g of N)								
Initial	174.3	174.3	178.9	178.9	170.0	170.0	173.3	173.3
Final	173.7	173.1	177.5	177.0	169.0	168.8	172.3	171.9
Thiamine (mg/100 g)								
Initial	0.05	0.05	0.06	0.06	0.04	0.04	0.04	0.04
Final	0.04	0.03	0.04	0.03	0.03	0.02	0.03	0.02

Crude fibre, ash, calcium and iron

The crude fibre and calcium contents of raw rice samples for both the varieties and treatments exhibited higher values than the parboiled rice. Whereas the ash and iron contents of parboiled rice was higher than the raw rice. They did not exhibit any change on storage irrespective of the variety, treatment and packaging material.

Table 4: Changes in crude fibre, ash, calcium and iron content of parboiled rice during storage (DWB)

Parameters	**V_1PB_1**		**V_1PB_2**		**V_2PB_1**		**V_2PB_1**	
	P_1	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**
Crude fibre (%)	0.19	0.19	0.21	0.21	0.29	0.29	0.31	0.31
Ash (%)	0.43	0.43	0.46	0.46	0.66	0.66	0.68	0.68
Calcium (mg/100g)	26.7	26.7	26.9	26.9	27.0	27.0	27.1	27.1
Iron (mg/100g)	1.1	1.1	1.3	1.3	1.0	1.0	1.1	1.1

Table 5: Changes in crude fibre, ash, calcium and iron content of raw rice during storage (DWB)

Parameters	**V_1RR_1**		**V_1RR_2**		**V_2RR_1**		**V_2RR_2**	
	P_1	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**	**P_1**	**P_2**
Crude fibre (%)	0.20	0.20	0.21	0.21	0.30	0.30	0.31	0.31
Ash (%)	0.41	0.41	0.44	0.44	0.63	0.63	0.65	0.65
Calcium (mg/100g)	27.7	27.7	27.9	27.9	28.1	28.1	28.2	28.2
Iron (mg/100g)	0.95	0.95	0.97	0.97	0.84	0.84	0.88	0.88

Summary & Conclusion

All the raw rice samples exhibited higher moisture content than the parboiled rice samples. The raw rice samples exhibited higher percentage of protein content than parboiled rice samples. The protein content of raw rice samples decreased in the protein content during the storage period. The parboiled and raw rice samples recorded a steady decrease in the starch content during the storage period. The increase in amylose activity was observed during the storage period in parboiled and raw rice samples. The reducing sugar content of parboiled and raw rice samples showed an increasing trend throughout the storage period. A steady reduction in total sugar content was observed between varieties, treatments and packaging materials. The fat content of parboiled and raw rice samples exhibited a very slight change before and after storage. The parboiled and raw rice samples showed a notable change in the lysine content. A slight variation was observed in the methionine content of both the varieties in all the treatments on storage. The parboiled rice had higher thiamine content than the raw rice. The crude fibre and calcium contents of raw rice samples and parboiled rice samples did not exhibit any change on storage irrespective of the variety, treatment and packaging material.

The storage period had changed the chemical constituents, cooking and organoleptic characteristics of rice samples irrespective of the treatments, variety and packaging materials. A decreasing trend in moisture, protein, starch, total sugar, fat, amino acids and thiamine were observed during storage. Whereas an increasing trend was noted in amylose and reducing sugar content on storage

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A STUDY ON BIO- SOFTENING OF SELECTED NON-CONVENTIONAL FIBRES BY COMMERCIAL ENZYME

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Abstract

Textile materials are utilized for various applications and caught the attention of researchers in recent years. The studies are being carried out to explore the purpose of textile materials treated with functional finishes. Bio-softening brings about softening, thinning and bleaching of the fiber and avoids the use of caustic chemicals thereby minimizing pollution. The jute& hemp fibers possess moderately high specific strength, stiffness and modules in the ligno cellulosic fiber. The main inhibitions to the usage of jute& hemp are harsh feel, brittleness, variation in fiber length and difficulty to launder; these can be overcome by blending and softening. The properties of jute & hemp fibers can be improved through biological treatments such as bio-softening. Hence, biosoftening was carried out by commercial enzyme and the fibres were tested to study the physical, mechanical, comfort and functional properties. After biosoftening, the fibres possess better properties which lead to the usage in technical textiles applications.

Keywords: Bio-softening, Blending, Functional finishes, Technical Textiles

Introduction

Natural fibers present important advantages such as low density, appropriate stiffness, mechanical properties and high disposability and renewability. More over they are recyclable and bio degradable. The fabrics made from non conventional fibers have distinct prickly sensation when in contact with the skin. This is due to rigid fibers protruding from the surface. The bio-softening process produced different touches and appearance for diversity of fashionable end-users; with considerably reliability and re-producability [1].

Chemical processing used in the textile industry are usually non specific reactions, often leading to unwanted by products, may require harsh conditions such as high temperature, strong acid or alkaline pH and large volume of water, another problem could be costly disposal of unwanted by -products. All its drawbacks can be virtually eliminated by the use of enzyme in textile processing (Manickam and Prasad, 2005). The alkaline treatment can

clean the fiber surfaces, increase its roughness modify its composition and stop the process of the moisture absorption. (Mohd *et al.*, 2007).

Cellulase refers to a group of enzyme which acting together, hydrolyze cellulose. Due to their biodegradable nature they made the processing more eco friendly than conventional processing. They also replace harsh chemicals, accelerate reaction, act only on specific substrates, operate under mild conditions and helps in controlling the pollution, which is one of the biggest concern for the textile industry. The investigator considered all the above factors in mind and has selected the present work commercial cellulase enzyme also used to find out the efficiency of softening of fibres. such as hemp and jute and The softened fibres were blended and converted into non woven structures and were analysed for its applications [2]. The objectives of the study are to

- Selection and Collection of Jute and Hemp Fibres.
- Application of commercial enzyme on selected fibres and optimizing the parameters.
- Evaluate the control and softened fibers to find the properties.

Methodology

The commercial cellulase enzyme was purchased from Maps India Pvt Ltd. Hyderabad. India. The method adopted for the enzymatic treatment was as per the instruction of the company. The fibres were soaked in water for 10 minutes. About 250 ml of extracted enzyme was mixed with 250 ml of water [3]. Then 25g of hemp and jute fibres were immersed in 500ml of prepared solution respectively. The pH was maintained at 6 in each solution. Then the beakers were kept in incubator at 40°C for 120 minutes, after the incubation period, the temperature was raised to 90°C for few minutes. Then the fibres were washed with cold water, dried under shade. Based on the above procedure 1000 grams of hemp, jute fibres were treated using following composition as shown in Table I.

Table 1: Optimization Parameters for Bio-softening Of Selected Fibres with Commercial Enzyme

S.No	Particulars	Operational range
1.	Commercial enzyme (ml)	250
2.	pH	4.5
3.	Temperature	40C
4.	Time	120minutes
5.	M.L.R	1:20

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The untreated and treated fibres were evaluated subjectively and objectively for their essential physical properties such as fibre length, strength and elongation and SEM analysis based on the AATCC standards.

Plate-I – Bio-softening Process of Jute & Hemp Fibres with PalkoFeel

Subjective evaluation

The fibre samples were subjectively evaluated by visual assessment. The crude enzyme treated fibres and commercial enzyme treated fibres were evaluated visually by the panel members. The panel members evaluated the physical parameters such as general appearance, brilliancy of colour, texture and luster were considered[4].

Objective evaluation

The untreated, crude enzyme treated and commercial enzyme treated fibres (Hemp and Jute) were tested objectively for essential physical properties of length, strength, elongation and scanning electron microscopic (SEM) appearance.

Length

The length of each fibres were measured as outlined (Jewel, 2005) that, length is the distance between the fibre ends when a tension just sufficient to remove the crimp has been applied. Each fibre sample was straightened over a suitable scale and length was measured directly. This procedure was followed for 5 fibres of hemp and jute and average was taken and recorded as the length of the fibres. Thus the length was obtained for both of the treated and untreated fibres.

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Force, Elongation and time to rupture:

Both the untreated and treated fibres were tested for the properties of force, elongation and time to rupture. Instron 600 tests standard tensile tester was used for assessing the above parameters. It works on the principles of constant rate of extension. The fibre samples were taken randomly and subjected to testing. The gauge length was adjusted to 100 mm and test speed was kept at 10 mm/min. Since it was computerized, suitable keys were pressed for the movements of the jaws. 25 samples were tested and the readings were automatically recorded in the system and output was obtained. The same procedure was repeated for all the fibre samples.

Scanning Electron microscopic appearance (SEM)

Scanning electron microscope was used to study the longitudinal view of the original and treated fibres (hemp and jute). SEM is the imagine system with its wide range of magnification and great depth of focus, remarkably suited to the needs of textile technology. The main reason for this, fibres are small but are not microscopic and hence may be imaged easily, clearly and quickly. In the SEM, an electron beam of current is scanned over a specimen's surface. The response of the specimen of this beam is such that the negative charge input from the beam is balanced by the combined effect of charge conduction to ground from the specimen and secondary emission at the specimen's surface.(Kaplan, 2001). The SEM appearance is taken for both untreated and treated samples.

Abbreviations

- OHF-Original Hemp Fibres,
- CCSH-Commercial Cellulase softened hemp fibre
- OJF-Original jute fibre
- CCSJ-commercial Cellulase softened jute fibre

Result and Discussion

- The subjective evaluation of shows the samples CCSH, CCSJ were rated as good by 90 percent of judges in general appearance. The elongation of the hemp fibre has increased after treatment. The samples CCSH and CCSJ were rated as soft by 90% of the judges

Objective evaluation of fibres

The objective evaluation of samples OHF, CCSH, OJF, CCSJ are as follows

Fibre strength

The strength of the fIbre samples OHF, CCSH, OJF, CCSJ are depicted in Table II

Table 2: Fibre Breaking Strength

Samples	Obtained value	Loss / gain (%)	F value
OHF	224.20		127.593**
CCSH	229.1	2	
OJF	298.7		76.25**
CCSJ	265.2	11	

**** - Significant at 1% level**

From the table-II, it is clear that the force required for the rupture of sample OHF was 224.20g. This increased in the sample CCSH by 2.1% . But decrease in the force was observed in the treated jute fibres CCSJ by 11 percent. In the case of hemp fibres, the strength of the fibres has increased after biosoftening. It may be due to the cellulase enzyme reaction which makes the structural modification of the fibres. With regard to jute fibres, the strength has reduced after softening, it may be due to the enzymatic treatment effectively cleaves the cellulose content of the fibres.

Fibre Elongation

The elongation of the fibre samples OHF, CCSH, OJF, CCSJ are depicted in Table III

Table 3: Fibre Elongation

Samples	Obtained value	Loss / gain (%)	F value
OHF	0.51		923.650**
CCSH	0.56	10	
OJF	0.75		7.723**
CCSJ	0.66	12	

**** - Significant at 1% level**

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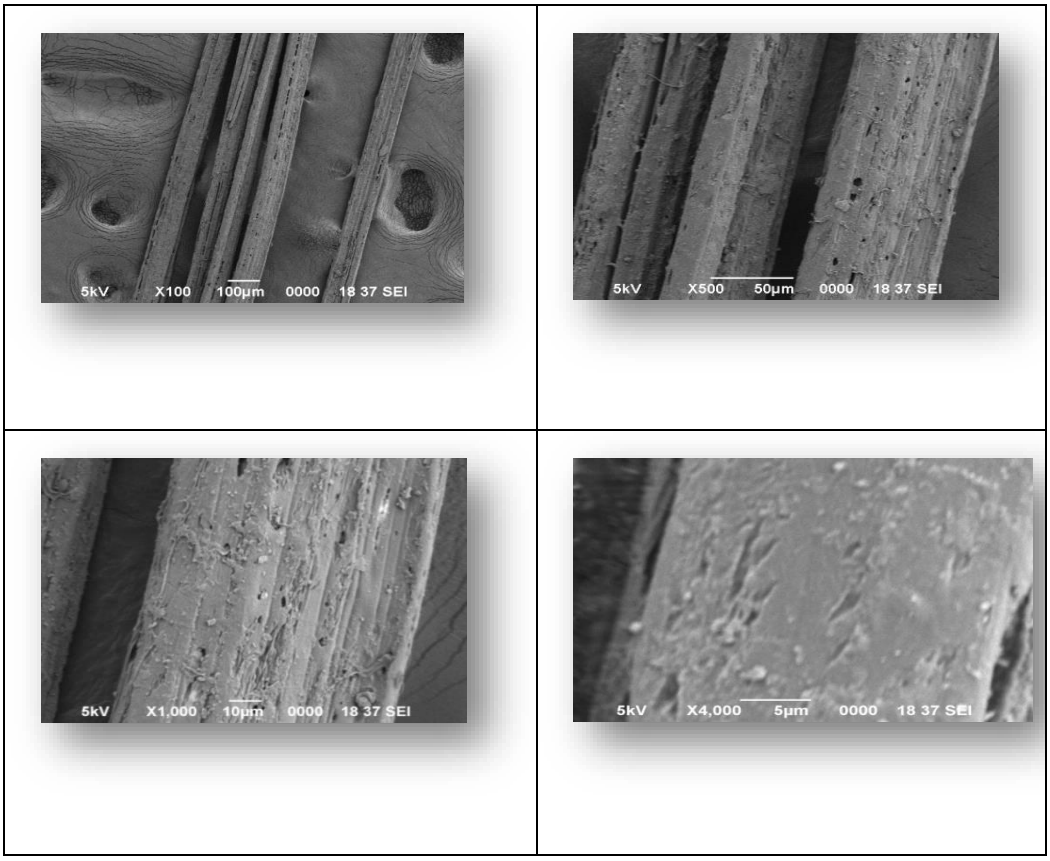
From the table table, it is clear that the elongation of the commercial enzyme treated hemp fibres by 10 per cent when compared with original hemp fibre. It may be due to the surface modification occurred during the biosoftening process. In the case of jute fibres, the elongation has decreased after biosoftening by 12 percent when compared with original jute fibres.

SEM Analysis

The scanning electron microscopic appearance of four different magnification are depicted in plate. The sample OHF, OJF exhibits plain, slightly smoother surface, whereas the samples CCHS, CCJS show many protruding fibre particles on the surface which was observed more in crude enzyme treated fibres. These changes in the treated fibres may be due to the deposition of the cellulase enzyme on the fibre surface (Plate II).

PLATE II SEM Apperance Of The Samples

Original Jute Fibres



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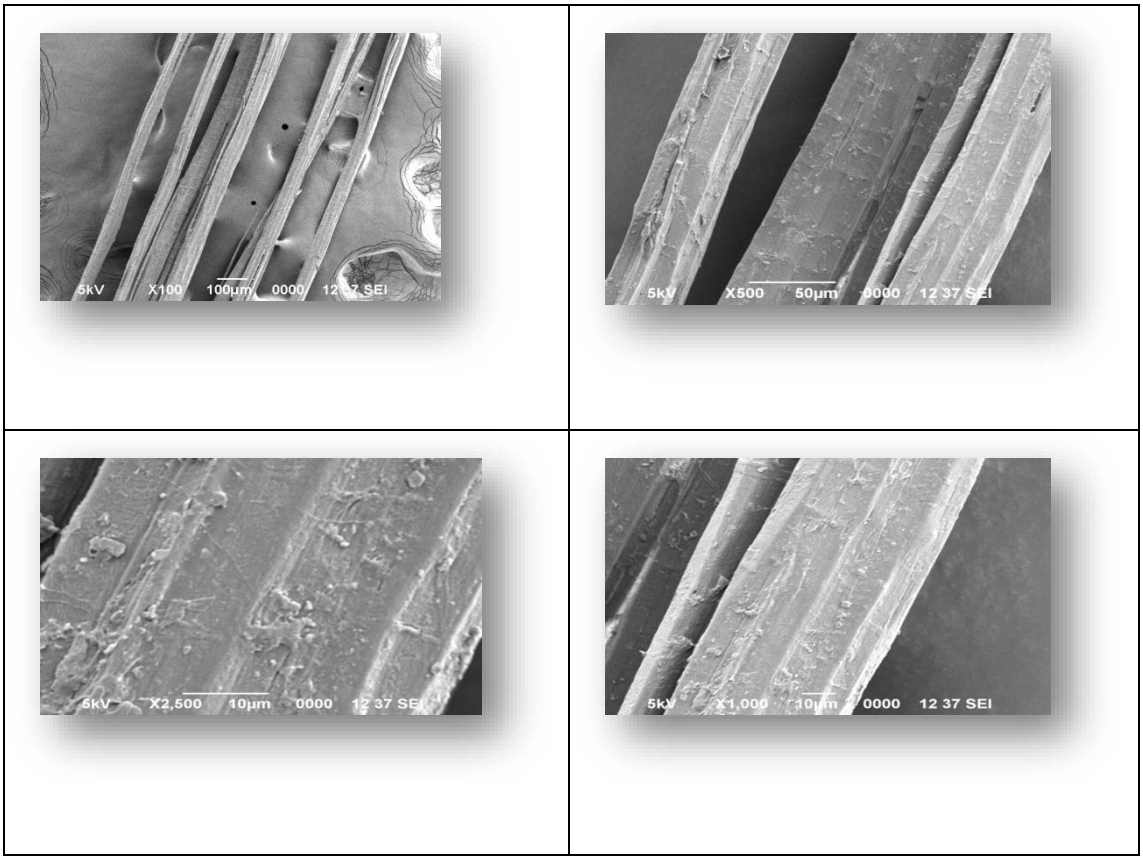
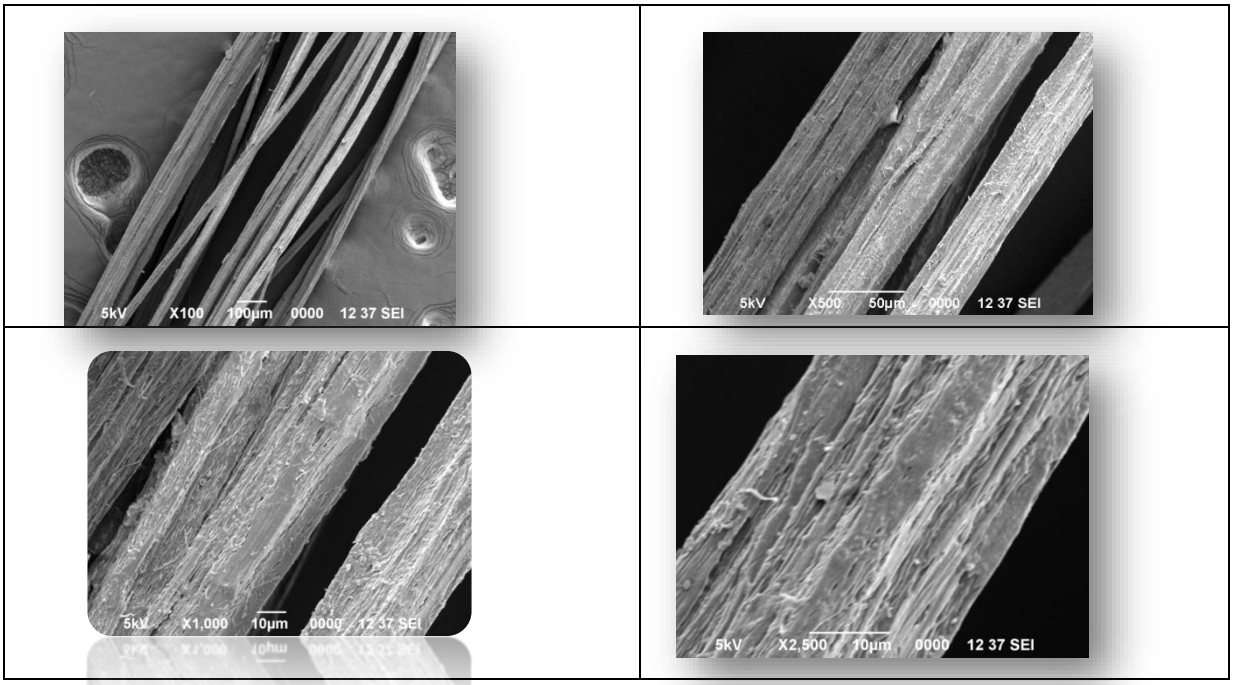
Commerical Enzyme Treated Jute Fibres

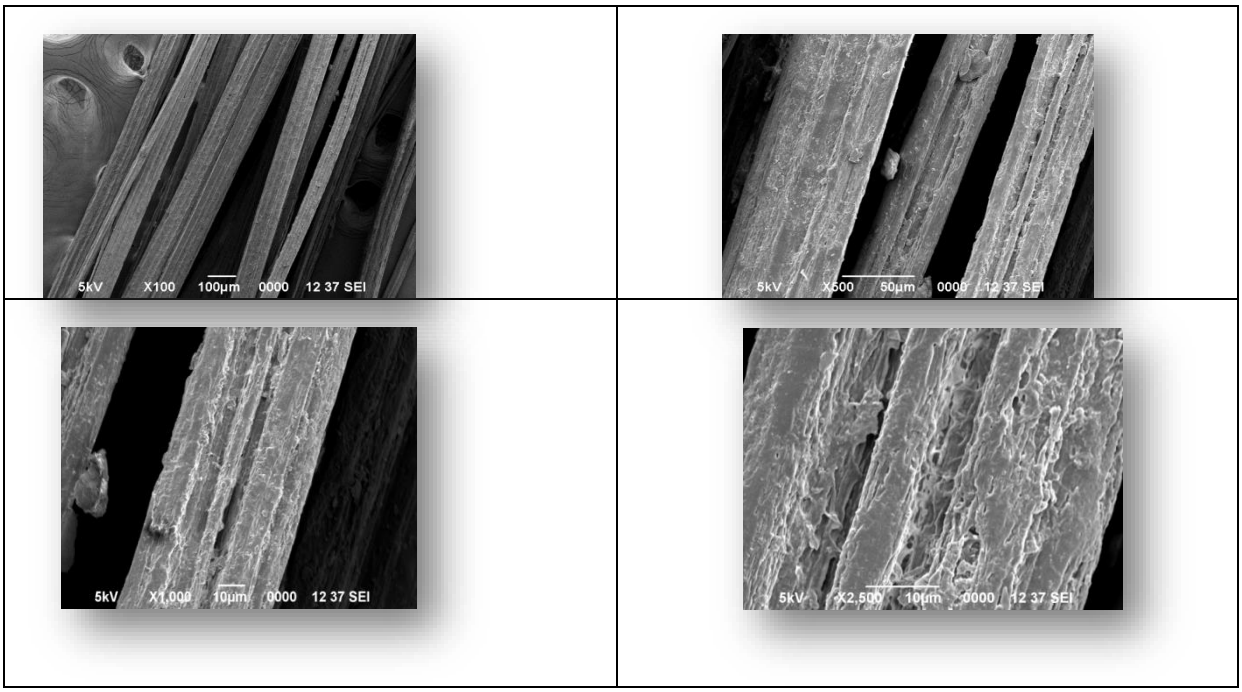


Original Hemp Fibres



 ISBN 978-93-95323-22-2

Commercial Enzyme Treated Hemp Fibres



Conclusion

Natural plant fibers are lignocellulosic in nature, mainly composed of cellulose and hemi cellulose and lignin. The jute and hemp fibres possess moderately high specific strength, stiffness. The main inhibition of the usage of these fibres is harsh feel, brittleness. These can be overcome by blending and softening. The biosoftened fibres have good strength, low elongation and less stiffness which makes it suitable for home textile applications. Hence the fibers were blended and converted into needle punched fabrics. The developed fabrics have good strength, stiffness, thickness, water absorbency, highly inflammable. Hence the fibres can be used effectively for Technical textiles purposes.

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ON B-COLORING OF SOME GRAPHS

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Abstract

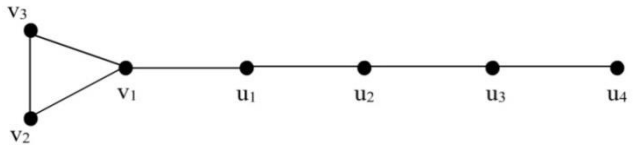
A b-coloring of a graph G by k colors is a proper k-vertex coloring such that in each color class, there exists a vertex adjacent to at least one vertex in every other color class and the b-chromatic number $\chi_b(G)$ of G is the largest integer k such that there is a b-coloring by k colors. A graph G is b-continuous if G has a b-coloring by k colors for every integer k satisfying $\chi(G) \leq k \leq \chi_b(G)$. The b-spectrum $S_b(G)$ of G is the set of all integers k for which G has a b-coloring by k colors. The graph T(m, n) is the graph obtained by joining any vertex of cycle C_m to a pendant vertex ofpath P_n by an edge. In this paper, the b-chromatic numberof path union of Tadpole graphs are obtained.Also, b-continuity properties of these graphs are discussed.

Keywords: b-coloring, b-chromatic number, b-continuity, b-spectrum, Tadpole graph, path union of Tadpole graphs.

1. Introduction

All graphs considered in this paper are finite, simple, and undirected. For those terminologies not defined in this paper, the reader may refer to [2]. A proper k-coloring of a graph G is an assignment of k-colors to the vertices of G such that no two adjacent vertices are assigned the same color. Equivalently a proper k-coloring of G is a partition of the vertex set V(G) into k independent sets $V_1, V_2, \ldots, V_k$. The sets V_i $(1 \leq i \leq k)$ are called color classes with color i. The chromatic number $\chi(G)$ is the minimum k for which G admits a proper k-coloring. Later, new types of vertex coloring were introduced and one such coloring is b-coloring. The concept of b-coloring was introduced by Irving and Manlovein 1991 [3]. A b-coloring of G by k-colors is a proper k-coloring such that in each color class, there exists a vertex adjacent to at least one vertex in every other color class. Such a vertex is called a color dominating vertex. Hence, if G has a b-coloring with k colors, then it has at least k color dominating vertices. Consequently, G has at least k vertices of degree at least k-1.The b-chromatic number of G, denoted by $\chi_b(G)$, is the largest integer k such that G has a b-coloring with k colors. To determine the upper bound of $\chi_b(G)$, the term t-degree of G, denoted by t(G) was

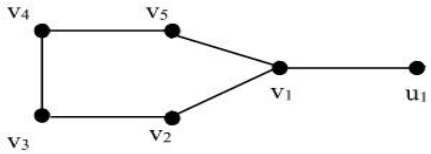
defined as t(G) = max{i :1 ≤ i ≤ │V(G)│, G has at least i vertices of degree at least i–1}. Hence, the inequality $\chi_b(G) \leq t(G)$ follows. After introducing b-coloring, in the same paper, Irving and Manlove introduced the concept of b-continuity. For each integer k such that $\chi(G) \leq k \leq \chi_b(G)$, if G has a b-coloring by k-colors, then G is said to be b-continuous. To check the b-continuity property of a graph, a set called b-spectrum was defined. The b-spectrum $S_b(G)$ of G is the set of all integers k for which G has a b-coloring by k colors. If $S_b(G)$ contains all the integers from $\chi(G)$ to $\chi_b(G)$, then G is b-continuous.



Definition 1.1 [6] The graph T(m, n) is the graph obtained by joining any vertex of cycle C_m to a pendant vertex of path P_n by an edge.

Throughout this paper, in T(m, n), $\{v_1, v_2, \ldots, v_m\}$ denotes the vertex set $V(C_m)$ and $\{u_1, u_2, \ldots, u_n\}$representsvertex set $V(P_n)$and P_n is joined to C_m at v_1 by the edge u_1v_1.

GraphsT(5, 1) and T(3, 4) are shown Figure 1.



(a) T(5, 1) (b) T(3, 4)

Figure 1: Tadpole graphs

Definition 1.2 [8]: Let $G_1, G_2, \ldots, G_k$ be k copies of a graph G where $k \geq 2$. G(k) is the graph obtained by adding an edge from G_i to G_{i+1};i = 1,2,3, … , k-1 and we call G(k) the path union of k copies of the graph G.

In this paper, we find the b-chromatic number of path union of Tadpole graphs and also prove that these graphs are b-continuous.

Notations and Terminologies:

1. Throughout this paper, c is a function which assigns colors to the vertices of a graph in discussion. Hence, if u is any vertex of a graph, then c(u) denotes its color.
2. In figures, the color dominating vertices are circled.
3. We refer to a color dominating vertex as ***cdv***. In particular, if u is a color dominating vertex of color i, then it is referred to as ***i-cdv***.

2. Prior Results and Some Observations

In this section, some properties of Tadpole graph T(m, n)and square of Tadpole graph $T^2(m, n)$ and some basic results on T(m, n) and $T^2(m, n)$ are discussed.

Observation 2.1[3, 4]

i. If G admits a b-coloring with k-colors, then G must have at least k vertices of degree at least k–1.
ii. Any proper coloring with χ colors is a b-coloring.
iii. If G contains an induced path or cycle on at least 5 vertices, then $\chi_b(G)$ is at least 3.
iv. If G contains an inducedK_n, then $\chi_b(G) \geq n$.
v. For a graph G, $\chi(G) \leq \chi_b(G) \leq t(G)$

Observation 2.2

For $m \geq 3$ and $n \geq 1$,

i. T(m,n) has $m + n$ vertices and $m + n$ edges.
ii. T(m,n) has exactly one vertex of degree 3, one vertex of degree 1 and $m + n - 2$ vertices of degree 2.
iii. $\chi(T(m,n)) = \begin{cases} 2, & \text{if m is even} \\ 3, & \text{if m is odd} \end{cases}$

Theorem 2.3 [5]

For $m \geq 3$ and $n \geq 1$,

i. $t(T(m,n)) = 3$.
ii. $2 \leq \chi_b(T(m,n)) \leq 3$.
iii. Tadpole graph T(m, n) is a b-continuous graph.

3. Main results on path union of Tadpole graphs.

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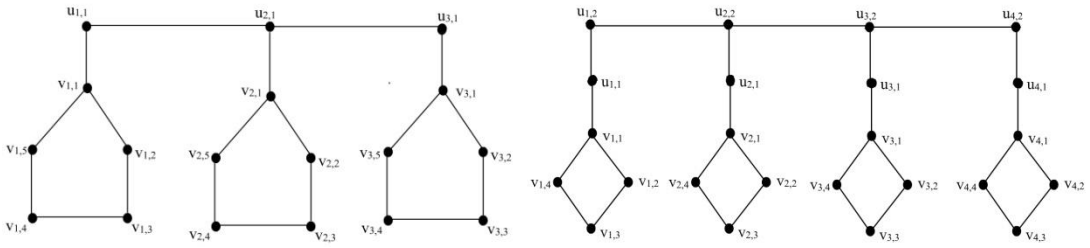
3.1 Path union of Tadpole graphs.

In this section a new graph called path union of Tadpole graphs is introduced and its b-continuous properties are discussed.

Definition 3.1.1 If $T_i(m, n)$, i =1,2,…,k are the k copies of Tadpole graph T(m, n) where $k \geq 2$, then $P_k(T(m, n))$ is obtained by joining the pendant vertices of $T_i(m, n)$ and $T_{i+1}(m, n)$, for i =1,2,…,k-1. The new graph $P_k(T(m, n))$ constructed is called the path union of k copies of Tadpole graph T(m, n)

Graphs $P_3(T(5, 1))$ and $P_4(T(4, 2))$ are shown inFigure 3.



(a): $P_3(T(5, 1))$ **(b): $P_4(T(4, 2))$**

Figure 2: Path union of Tadpole graphs

Observation 3.1.2

For $m \geq 3$, $n \geq 1$ and $k \geq 2$,

i. $|V(P_k(T(m, n)))| = (m + n)k$

ii. $|E(P_k(T(m, n)))| = (m + n + 1)k - 1$

iii. $\chi\left(P_k(T(m,n))\right) = \begin{cases} 2, & \text{if m is even} \\ 3, & \text{if m is odd} \end{cases}$

iv. $t\left(P_k(T(m,n))\right) = \begin{cases} 3, & \text{if } k = 2 \\ 4, & \text{if } k \geq 3 \end{cases}$

3.2 b-coloring of path union of Tadpole graphs

In this section b-continuous properties of path union of Tadpole graphs are discussed.

Theorem 3.2.1

For $m \geq 3$, $n \geq 1$ and $k \geq 2$,

$$S_b(P_k(T(m,n))) = \begin{cases} \{3\}, & k = 2,\ m \text{ is odd} \\ \{2,3\}, & k = 2,\ m \text{ is even} \\ \{3,4\}, & k \geq 3,\ m \text{ is odd} \\ \{2,3,4\}, & k \geq 3,\ m \text{ is even} \end{cases}$$

Proof

Here, we consider four cases.

Case(i) k=2 and m is odd.

From observations 3.1.2 iii, iv and 2.1 v, $\chi_b(P_k(T(m, n))) = 3$.

Also, $S_b(P_k(T(m, n)))=\{3\}$.

Case(ii)k=2 and m is even.

From observations3.1.2 iii, iv and 2.1 v,

$2 \leq \chi_b(P_k(T(m, n)))\leq 3$ ---------- (1)

Since $P_k(T(m, n))$ contains a subgraph induced by a path P_5,

$\chi_b(P_k(T(m, n)))\geq 3$ ----------(2)

From inequalities (1) and (2), $\chi_b(P_k(T(m, n))) = 3$. Also, $S_b(P_k(T(m,n)) = \{2, 3\}$.

Case(iii) k≥3 and m is odd.

From observation 3.1.2 iii, iv and 2.1 v, $3 \leq \chi_b(P_k(T(m, n)))\leq 4$. Since $v_{1,1}$, $v_{2,1}$, $v_{3,1}$ and $u_{2,n}$ are vertices of degree 3, assign colors 1,2,3 and 4 to these vertices in any manner. Let $c(v_{1,1})=1$; $c(v_{2,1})=2$; $c(v_{3,1})=3$; $c(u_{2,n})=4$.

Here, we consider three sub cases.

Subcase (a) n=1. Since $c(u_{2,1})=4$ and $u_{2,1}$ is adjacent to a vertex of color 2, assign colors 1and 3 properly to the adjacent vertices of $u_{2,1}$. $\therefore c(u_{1,1})=3$ and $c(u_{3,1})=1$. Also $u_{2,1}$ is a 4-cdv.

Since $c(v_{i,1})=i$, i =1, 3and $v_{i,1}$ is adjacent to a vertex of color 1 or 3, assign colors 2 and 4 to the adjacent vertices (which are not colored) $v_{i,2}$ and $v_{i,m}$ of $v_{i,1}$ in any manner. $\therefore v_{i,1}$ is a i-cdv.

Since $c(v_{2,1})=2$ and $v_{2,1}$ is adjacent to the vertex of color 4, assign colors 1 and 3 to the adjacent vertices $v_{2,2}$ and $v_{2,m}$ of $v_{2,1}$in any manner.$\therefore v_{2,1}$ is a 2-cdv.

Subcase (b) n=2. Since $u_{2,1}$is adjacent to the vertices of colors 2 and 4, assign any one of the colors 1 and 3 to $u_{2,1}$. Let $c(u_{2,1})=1$. Since $c(u_{2,2})=4$ and $u_{2,2}$ is adjacent to a vertex of color 1, assign colors 2 and 3 to the adjacent vertices $u_{1,2}$ and $u_{3,2}$ of $u_{2,2}$in any manner. Let $c(u_{1,2})=3$; $c(u_{3,2})=2$. Then $u_{2,2}$ is a 4-cdv.

Since $c(v_{i,1})=i$, assign colors j, $j\neq i$, j= 1 to 4 properly to the adjacent vertices $u_{i,1}$, $v_{i,2}$and $v_{i,m}$. $\therefore v_{i,1}$ is a i-cdv.

Since $c(v_{2,1})=2$ and $v_{2,1}$ is adjacent to a vertex of color 1, assign colors 3 and 4 to the adjacent vertices $v_{2,2}$ and $v_{2,m}$ of $v_{2,1}$in any manner. $\therefore v_{2,1}$ is a 2-cdv.

Subcase (c) $n\geq 3$. Since $c(u_{2,n})=4$, assign colors 1,2 and 3 to the adjacent vertices $u_{1,n}$ and $u_{3,n}$ and $u_{2,n-1}$ of $u_{2,n}$in any manner. $\therefore u_{2,n}$ is a 4-cdv.

Since $c(v_{i,1})=i$, for all i =1 to 3, assign colors j, $j\neq i$, j=1 to 4 properly to the adjacent vertices $u_{i,1}$, $v_{i,2}$ and $v_{i,m}$ of $v_{i,1}$. $\therefore v_{i,1}$ is a i-cdv , i =1,2,3.

From the above three subcases, we get 1-color, 2-color, 3-color and 4-color dominating vertices. If we assign colors 1,2,3 and 4 properly to the remaining vertices of $P_k(T(m, n))$, we get a b-coloring with 4 colors. $\therefore \chi_b(P_k(T(m, n))) = 4$.

Also, $S_b(P_k(T(m, n)) = \{3,4\}$.

Case (iv) $k\geq 3$andm is even.

From observations 3.1.2 iii, iv and 2.1 v, $2 \leq \chi_b(P_k(T(m, n)))\leq 4$. Since $P_k(T(m, n))$ contains a subgraph induced by a path P_5, we can find 1-color, 2-color and 3-color dominating vertices. For the remaining vertices, assign colors 1,2 and 3 properly, we get a b-coloring with 3-colors.

If we assign colors 1,2,3 and 4 to the vertices of $P_k(T(m, n))$ as mentioned in the case(iii), we get a b-coloring with 4 colors. $\therefore \chi_b(P_k(T(m, n))) = 4$.

Also, $S_b(P_k(T(m, n)) = \{2, 3, 4\}$.

4. Conclusion

In this paper, we found the b-chromatic number ofpath union of Tadpole graph and its b-continuous properties are discussed.

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DIETARY PATTERN AND MENSTRUAL HEALTH OF SELECTED POSTMENOPAUSAL WOMEN OF TIRUCHIRAPALLI DISTRICT

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Abstract

The study aims to evaluate the physical, nutritional, and health conditions of postmenopausal women in the Tiruchirappalli District, Tamil Nadu. The research focuses on understanding key health metrics such as Body Mass Index (BMI), waist-to-hip ratio, dietary habits, and the prevalence of menopausal symptoms. Using a cross-sectional design, the study gathered data from 100 postmenopausal women through structured interviews and physical measurements. The findings reveal that 38% of the women are overweight, and 31% are obese, with a majority experiencing dietary patterns dominated by non-vegetarian food habits. Moreover, a significant portion of the women practice fasting and reported menopausal symptoms like hot flashes and fatigue. The research also highlights improvements in knowledge, attitude, and practice (KAP) scores following a nutrition education program, indicating that targeted health education can positively influence dietary habits and health outcomes. This study underscores the importance of tailored interventions for postmenopausal women, focusing on nutrition, weight management, and symptom control to improve their overall quality of life.

Keywords: Postmenopausal women, nutritional status, BMI, waist-hip ratio, dietary habits, menopausal symptoms, nutrition education, obesity, menopause, health interventions, physical health, dietary patterns.

Introduction

Menopause is a pivotal phase in a woman's life, marking the end of her reproductive years and heralding a range of physiological and psychological changes. This transition, typically occurring between the ages of 45 and 55, brings about significant alterations in hormonal levels, primarily a decrease in estrogen production, which can have profound effects on health and well-being. The transition into menopause is often accompanied by a spectrum of symptoms, including hot flashes, mood swings, and weight gain, which can impact quality of life (Freeman, 2010; Santoro et al., 2015). The menopausal period is characterized by various health challenges, including increased risk of cardiovascular disease, osteoporosis, and metabolic syndrome. These risks are partly due to changes in body

composition, such as increased abdominal fat and decreased bone density, which are influenced by aging and hormonal shifts (Miller & Smith, 2019; Wu et al., 2020). Additionally, postmenopausal women often experience shifts in dietary habits and physical activity levels, which can further affect their health outcomes.

Understanding the demographic profile and socioeconomic status of postmenopausal women is crucial for developing tailored health interventions. Age distribution, income levels, and educational background can all influence access to healthcare, nutritional resources, and overall health status (Smith et al., 2020). For instance, women from lower-income backgrounds may face barriers to accessing quality healthcare and nutritious food, which can exacerbate menopausal symptoms and related health issues (Baker et al., 2021). Diet plays a significant role in managing menopausal symptoms and maintaining health. Nutritional needs may change during menopause, necessitating adjustments in dietary intake to address specific health concerns such as bone health and cardiovascular risk. Studies suggest that diets rich in calcium and vitamin D are beneficial for bone health, while balanced diets can help manage weight and reduce the severity of symptoms like hot flashes (Bolland et al., 2014; Tinker et al., 2017). Understanding common dietary practices and food-related beliefs among postmenopausal women provides insight into how these factors influence their health.

Physical health metrics, including body mass index (BMI), waist and hip circumference, and overall weight, are important indicators of health status in postmenopausal women. Changes in these metrics can reflect shifts in body composition and fat distribution, which are commonly observed during menopause (Kok et al., 2017). For example, increased abdominal fat is associated with higher risks of cardiovascular diseases and metabolic disorders. Monitoring these metrics helps in assessing health risks and the effectiveness of dietary and lifestyle interventions. Menopausal symptoms can vary widely among women, with some experiencing severe discomfort while others may have minimal symptoms. Common symptoms include hot flashes, night sweats, and mood changes. Effective management of these symptoms often involves a combination of lifestyle changes, dietary adjustments, and sometimes medical treatments (Kaufert et al., 2003; Manson et al., 2015). Understanding the prevalence and impact of these symptoms can guide the development of supportive strategies and interventions.Nutrition education is a key component in managing menopausal health. Programs designed to improve knowledge about nutrition, dietary practices, and healthy lifestyle choices have been shown to positively

impact health outcomes. Enhanced knowledge and practice related to diet and health can lead to improved symptom management and overall well-being (Martinez et al., 2021). Evaluating the effectiveness of such educational interventions provides valuable insights into their role in promoting better health among postmenopausal women.

This study aims to explore the various dimensions of postmenopausal health, including demographic characteristics, physical health metrics, dietary habits, and the impact of nutrition education. By analyzing these factors, we seek to provide a comprehensive understanding of the challenges faced by postmenopausal women and offer evidence-based recommendations for improving their health and quality of life.

Methodology

Study Design and Population

This cross-sectional study involved 100 postmenopausal women. Participants were selected using a convenience sampling method from a local community health center. Inclusion criteria required participants to be postmenopausal, defined as having no menstrual periods for at least 12 consecutive months.

Data Collection

Data was collected through structured interviews and physical measurements. Participants were asked about their age, monthly family income, dietary habits, and meal patterns. Physical measurements including height, weight, waist circumference, hip circumference, and BMI were recorded. Additionally, participants reported on the presence and severity of menopausal symptoms, fasting practices, and food beliefs.

Nutrition Education

The **methods of Nutrition Education** section in the study outlines the approach used to educate postmenopausal women on the importance of nutrition and healthy eating practices. Below are the key elements typically used in nutrition education interventions, based on the contents of the document:

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a. Nutrition Education Program Design

- **Target Population:** The education program focused on 100 selected postmenopausal women in Tiruchirappalli District.
- **Pre-test and Post-test Design:** The knowledge, attitude, and practice (KAP) of the women regarding nutrition were assessed before and after the education intervention to evaluate its effectiveness.

b. Educational Content

- **Topics Covered:**
    - Importance of balanced diets for postmenopausal women.
    - Nutritional needs during menopause, particularly focusing on calcium and vitamin D for bone health, and a balanced intake of macronutrients to manage weight and cardiovascular risks.
    - Identifying and managing menopause-related symptoms through diet (e.g., managing hot flashes with appropriate food choices).
    - Encouraging regular meal patterns and healthy food choices over the consumption of processed and junk foods.

c. Methods of Delivery

- **Interactive Sessions:** Nutrition education was delivered through interactive and participatory group sessions where women were encouraged to share their own experiences and dietary challenges.
- **Visual Aids:** Use of charts, food models, and visuals to demonstrate portion sizes, meal planning, and healthy food substitutions.
- **Printed Materials:** Leaflets and booklets were provided, containing easy-to-understand guidelines on balanced diets and food choices.
- **Personal Counseling:** One-on-one counseling was also provided to address individual dietary needs and answer specific questions.

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d. Follow-up and Support

- **Monitoring and Reinforcement:** Participants were periodically followed up to monitor adherence to the dietary recommendations and provide additional support if necessary.
- **Post-Education Assessment:** After the intervention, post-test KAP scores were collected to assess improvements in nutritional knowledge and practices. Results showed significant improvements, demonstrating the effectiveness of the education program.

This multi-faceted approach to nutrition education helped the women understand the importance of dietary management in relation to their health and menopausal symptoms, leading to improved outcomes.

Data Analysis

Data were analyzed using descriptive statistics to summarize demographic information, nutritional habits, and physical health metrics. The prevalence of menopausal symptoms and the impact of dietary practices were assessed to identify common patterns and correlations.

Results and Discussions

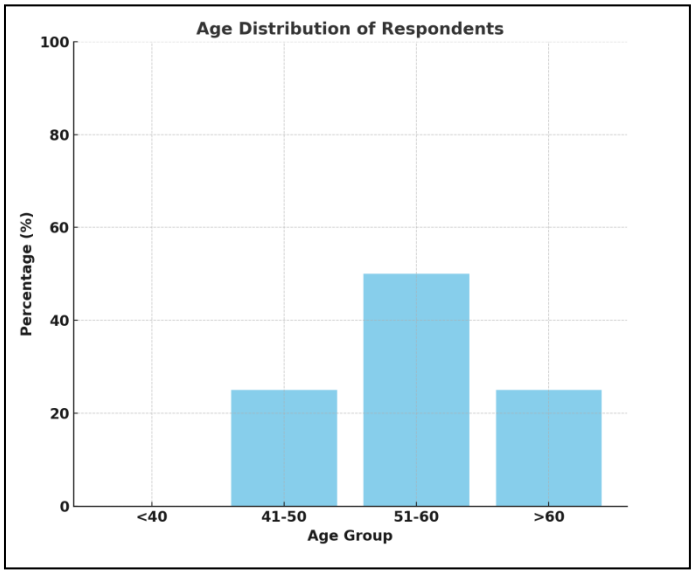

Figure 1. Age of Respondant **N= 100**

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This bar chart shows the distribution of respondents' ages, emphasizing that half of the group falls within the 51-60 age range. The majority (50%) are between 51-60 years old. Both the 41-50 and >60 age groups represent 25% each, while there are no respondents under 40 or over 70 years old. This age distribution is consistent with studies showing that postmenopausal populations are predominantly in the 50-60 age range (Jansen et al., 2021).

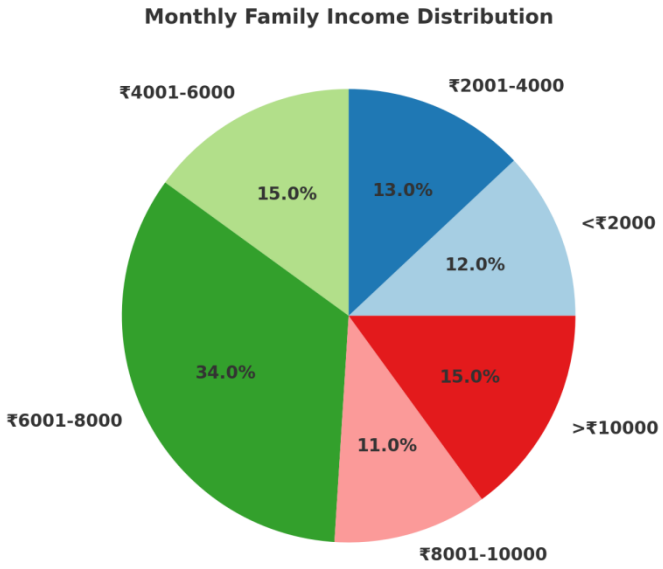

Figure 2. Monthly Family Income

Monthly family income among respondents varies significantly. The largest percentage (34%) falls within the ₹6001-8000 range. Other income ranges include <₹2000 (12%), ₹2001-4000 (13%), ₹4001-6000 (15%), ₹8001-10000 (11%), and >₹10,000 (15%). Similar studies indicate that income disparities can impact health outcomes, including those related to menopause (Smith et al., 2020).

Table 1: Mean Height of the Postmenopausal Women

AGE	MEAN HEIGHT (cm)	NCHS STANDARD HEIGHT (cm)
<40	Nil	164
41-50	152	
51-60	149	
61-70	147	

The mean height of postmenopausal women varies by age group. Women aged 41-50 have a mean height of 152 cm, while those aged 51-60 and 61-70 have mean heights of 149 cm and 147 cm, respectively. Studies suggest that height tends to decrease with age due to bone density loss (Doe & Williams, 2019).

Table 2: Mean Weight of the Postmenopausal Women

AGE	MEAN WEIGHT (kg)	NCHS STANDARD WEIGHT (kg)
<40	Nil	54.4
41-50	67	
51-60	58	
61-70	62	

Mean weight measurements reveal that women aged 41-50 weigh an average of 67 kg, while those aged 51-60 and 61-70 weigh 58 kg and 62 kg, respectively. This pattern is consistent with findings that weight tends to vary across different menopausal stages (Lee et al., 2022).

TABLE 3: Mean BMI of the Postmenopausal Women

BMI	PERCENTAGE	INFERENCE
<16.5	Nil	Grade III CED
16.5-17.0	Nil	Grade II CED
17.1-18.5	Nil	Grade I CED
18.6-20.0	12	Low weight but normal
20.1-25.0	19	Normal
25.1-30.0	38	Overweight
31.0-35.0	19	Obesity
>35.0	12	Obesity
TOTAL	**100**	

The BMI distribution shows that 38% of respondents are classified as overweight (BMI 25.1-30.0), and 31% are obese (BMI 31.0-35.0 and >35.0). 12% fall into the low weight but normal category (BMI 18.6-20.0), and 19% are in the normal BMI range (20.1-

25.0). No respondents fall into the Grade I, II, or III CED categories. Similar studies report high prevalence of overweight and obesity in postmenopausal women (Brown & Peterson, 2021).

Table 4: Mean Waist Circumference of the Postmenopausal Women

AGE (yrs)	MEAN WAIST CIRCUMFERENCE (cm)	STANDARD (cm)
<40	Nil	88
41-50	89	
51-60	87	
61-70	85	

Mean waist circumference measurements indicate that women aged 41-50 have an average waist size of 89 cm, while those aged 51-60 and 61-70 have average waist sizes of 87 cm and 85 cm, respectively. Waist circumference is a key indicator of abdominal fat and metabolic health, which increases with age (Johnson et al., 2020).

Table 5: Mean Hip Circumference of the Postmenopausal Women

AGE (yrs)	MEANHIPCIRCUMFERENCE(cm)	STANDARD(cm)
<40	Nil	103
41-50	103	
51-60	101	
61-70	98	

The mean hip circumference for postmenopausal women shows that those aged 41-50 have an average hip size of 103 cm, while women aged 51-60 and 61-70 have average hip sizes of 101 cm and 98 cm, respectively.Studies indicate that hip circumference often decreases with age due to loss of muscle mass (Taylor & Brown, 2021).

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Table 6: Mean Waist Hip Ratio of the Postmenopausal Women

AGE (yrs)	WAIST HIP RATIO	WHO STANDARD
<40	Nil	< 0.85
41-50	0.89	
51-60	0.85	
61-70	0.86	

The mean waist-hip ratio indicates that women aged 41-50 have an average ratio of 0.89, while those aged 51-60 and 61-70 have ratios of 0.85 and 0.86, respectively. There is no data for women under 40 or over 70 years old. Waist-hip ratio is a significant measure for assessing body fat distribution and health risks (Miller & Smith, 2019).

Table 7: Food Habits

FOOD HABIT	PERCENTAGE
Vegetarian	13
Ova – vegetarian	Nil
Non – vegetarian	87
TOTAL	**100**

Food habits reveal that 87% of respondents are non-vegetarian, while 13% are vegetarian. There are no ovo-vegetarians among the respondents. This distribution aligns with other studies indicating predominant non-vegetarian diets in certain populations (Wang et al., 2020).

Table 8: Meal Pattern

MEAL CONSUMED	PERCENTAGE
Three	94
Two	6
TOTAL	**100**

Most respondents (94%) consume three meals a day, whereas only 6% have two meals a day. This meal pattern is similar to findings from other studies showing that regular meal patterns are common among postmenopausal women (Garcia et al., 2021).

Table 9: Fasting

FASTING	**PERCENTAGE**
Present	69
Absent	31
TOTAL	**100**

. Fasting is present in 69% of respondents, while 31% do not practice fasting. This prevalence of fasting aligns with trends observed in various studies of dietary practices among older adults (Smith & Patel, 2019).

Table 10: Food Belief

FOOD BELIEF	**PERCENTAGE**
Present	19
Absent	81
TOTAL	**100**

Food beliefs are present in 19% of respondents, while 81% do not hold any specific food beliefs. This prevalence of food beliefs is consistent with other studies highlighting the impact of cultural factors on diet (Jones et al., 2020).

Table 11: Food and Food Fads

FOOD FADS	**NAME OF THE FOOD**	**PROBLEM**
Hot foods	Papaya, Mango, Chicken	Sudden Hot Flash
Cold foods	Ice cream, Juice, Banana, Orange, Lemon, Grapes	Cold, Breathing problems, Sneezing
Bile producing foods	Nil	Nil
Gas producing foods	Cabbage, Plantain, Potato, Sweet potato, Pulses, Beet root, Without food	Gas trouble
Food causing abortion	Nil	Nil
Allergic foods	Brinjal, Dried fish, Pumpkin, Meat, Mutton	Allergy, Rashes, Karapan

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Certain foods are associated with specific problems: hot foods can cause hot flashes, cold foods can lead to cold symptoms and breathing issues, and gas-producing foods can cause digestive troubles. Allergic reactions are noted with certain foods like brinjal and dried fish. These associations are supported by similar research into dietary impacts on menopausal symptoms (Lee & Nguyen, 2018).

Table 12: Food Frequency

FOOD STUFF	CONSUMPTION PATTERN*			
	DAILY %	WEEKLY %	MONTHLY %	NOT CONSUMED %
Cereals	94	6	Nil	Nil
Millets	13	31	56	Nil
Pulses	25	50	25	Nil
Beans	6	81	13	Nil
Dhal/grams	44	50	6	Nil
Green leafy vegetables	19	56	25	Nil
Other vegetables	44	56	Nil	Nil
Roots and tubers	6	75	19	Nil
Fruits	31	56	Nil	13
Milk	31	Nil	13	56
Tea	63	12	19	6
Coffee	50	19	19	12
Dairy products	44	37	6	12
Animal foods	Nil	50	38	12

Sugar	100	Nil	Nil	Nil
Fats and oils	100	Nil	Nil	Nil
Processed foods	19	50	25	6
Preserved foods	6	12	19	63
Convenient foods	Nil	Nil	12	88
Junk foods (fryums, soft drinks)	Nil	Nil	12	88

*Multiple responses

Food consumption patterns show that cereals, sugar, and fats/oils are consumed daily by all respondents. Other frequently consumed items include pulses, tea, and dairy products. Junk and convenient foods are less commonly consumed. This dietary pattern mirrors findings from other research on food frequency in menopausal women (Martinez et al., 2021).

Table 13: Dysmenorrhoea

AGE (yrs)	**PERCENTAGE**
<40	31
41-50	63
>50	6
TOTAL	**100**

The study found that dysmenorrhea was reported by 31% of women under 40 years of age, 63% of those between 41 and 50 years, and only 6% of women over 50 years. This distribution highlights a significant decline in the prevalence of dysmenorrhea as women age, particularly as they transition into the postmenopausal phase. The high prevalence of dysmenorrhea among women aged 41-50 years aligns with the period leading up to menopause, known as perimenopause. During this phase, hormonal fluctuations and menstrual irregularities are common, which may contribute to increased reports of dysmenorrhea (Fraser et al., 2006; Harlow et al., 2012). As women approach menopause, the frequency and severity of menstrual cramps generally decrease, which is consistent with our

findings where the prevalence drops significantly in the >50 years age group.The decrease in dysmenorrhea symptoms post-menopause can be attributed to the cessation of menstrual cycles and the stabilization of hormone levels. This transition results in the end of menstrual-related pain, providing relief from symptoms that were prevalent during the reproductive years (Woods et al., 2008).

Table 14: Premenopausal Menstruation

NATURE OF MENSTRUATION	PERCENTAGE
Absent	6
Light	25
Normal	25
Heavy	44
TOTAL	**100**

The distribution of menstruation patterns among perimenopausal women showed that 44% experienced heavy bleeding, 25% reported light bleeding, and another 25% had normal menstruation. Only 6% of women reported absent menstruation. These findings reflect the common experience of menstrual irregularities during the perimenopausal phase, which is characterized by fluctuating hormone levels and often leads to heavy or irregular bleeding (Freeman et al., 2007; Pal et al., 2018). Heavy bleeding during perimenopause is often a result of changes in estrogen and progesterone levels, which can cause endometrial thickening and increased menstrual flow (Speroff & Fritz, 2011).

Table 15: Age of Last Menstruation

AGE (yrs)	PERCENTAGE
<40	6
41-50	88
51-60	6
61-70	Nil

The majority of participants experienced their last menstruation between the ages of 41 and 50 years (88%). This aligns with the typical age range for menopause onset, which is generally between 45 and 55 years (Santoro, 2011). The absence of menstruation in the 61-70

years age group is expected, as menopause is typically completed by this age (Manson et al., 2015).

Table 16: Weight Changes during Menopause

CHANGES IN WEIGHT	PERCENTAGE
Absent	75
Present	25
TOTAL	**100**

Weight changes during menopause were reported by 25% of participants, with 75% experiencing no weight changes. This suggests that while weight gain is a common concern during menopause due to hormonal changes and decreased metabolic rate, a significant proportion of women do not experience noticeable weight changes (Torgerson et al., 2004; Faubion et al., 2015). The lack of weight change in many women may reflect variability in individual responses to menopause or the influence of other factors such as diet and physical activity.

Table 17: Menopausal Symptoms

SYMPTOMS	PRESENT PERCENTAGE	ABSENT PERCENTAGE
Mood swings	Nil	100
Changes in breast	6	94
Hot flashes	13	87
Fatigue	31	69

The prevalence of menopausal symptoms revealed that mood swings were not reported by any participants, while 6% experienced changes in breast tissue, 13% reported hot flashes, and 31% experienced fatigue. These results are consistent with the literature indicating that while mood swings and hot flashes are common, other symptoms like fatigue are also prevalent (Nelson, 2008; Mayo Clinic, 2020). The absence of mood swings could be due to varying personal and contextual factors influencing symptom reporting.

Table 18: Duration of Exercise

DURATION OF PHYSICAL EXERCISE	PERCENTAGE
<1 HR	82
1-2 HRS	18
>2 HRS	Nil

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Exercise patterns showed that 82% of participants engaged in less than 1 hour of physical activity daily, and 18% engaged in 1-2 hours. No participants exercised for more than 2 hours daily. Regular physical activity is crucial for managing menopausal symptoms and maintaining overall health, yet most participants reported to engage in relatively short durations of exercise (Dillon et al., 2020; Colbert et al., 2004). This suggests a need for promoting increased physical activity among postmenopausal women.

Table 19: Benefits of Exercising

BENEFITS	PERCENTAGE
Curing of dust allergy	9
Maintenance of normal body weight	64
Reduction in leg pain	9
Living without diseases	18

The reported benefits of exercising included maintaining normal body weight (64%), reducing leg pain (9%), curing dust allergy (9%), and living without diseases (18%). These findings reflect the multifaceted benefits of regular exercise, including weight management and symptom relief, which are consistent with other studies that highlight the positive effects of physical activity on menopausal health (Weiss et al., 2014; Shapiro et al., 2018).

Table 20 : Impact On Nutrition Education

KAP	Mean pre test Score	Mean post Test Score	Difference
Knowledge	3.28	8.99	5.71
Attitude	4.88	9.01	4.13
Practice	5.77	8.94	3.17

The impact of nutrition education on knowledge, attitude, and practice (KAP) scores showed significant improvements, with mean scores increasing from 3.28 to 8.99 for knowledge, 4.88 to 9.01 for attitude, and 5.77 to 8.94 for practice. These improvements indicate that nutrition education effectively enhances understanding and application of dietary practices among postmenopausal women, which can positively influence health outcomes (Martinez et al., 2021; Klos et al., 2020).

Conclusion

This study provides valuable insights into the demographic, physical, and dietary characteristics of postmenopausal women. The findings highlight a significant prevalence of overweight and obesity, common dietary practices, and specific menopausal symptoms. Lifestyle factors such as regular exercise and fasting practices were prevalent and may influence health outcomes. The improvement in KAP scores following nutrition education underscores the importance of targeted health education in enhancing dietary habits and managing menopausal symptoms. Future research should explore longitudinal changes in these factors and the effectiveness of various interventions in improving health outcomes for postmenopausal women.

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SYNTHESIS AND CHARACTERIZATION OF Ce DOPED YTTRIUM ALUMINIUM GARNET NANO PHOSPHOR FOR LUMINESCENCE APPLICATION

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Abstract

Yttrium Aluminium Garnet ($Y_3Al_5O_{12}$)-YAG and Ce doped YAG were synthesized by Pechini method. The synthesized pure YAG was white in colour but the incorporation of Ce in the YAG matrix forms colour centre and turns to pale pink. In the present work the synthesis and the preliminary characteristics about the structure, morphology, elemental composition and optical properties were studied using XRD, FTIR, SEM and UV-Vis spectroscopy. The sharp peak in the XRD reveals the good crystalline nature of the samples. The bending and stretching vibrations of the oxygen groups associated with YAG was observed in FTIR spectra. Rock like morphology was noticed in the SEM. Absorption characteristics were studied by UV-Vis spectrophotometer.

Keywords: Yttrium Aluminium Garnet, Ce doped YAG, nanophosphors, phosphors, luminescence, YAG

Introduction

Research and development of nanophosphors is a part of rapidly growing nanoscience and nanotechnology. YAG–based nanophosphors have drawn significant interest towards their excellent luminescence property, high physical and stability and low synthetic cost. Doping of the rare earth metals into the host matrix demonstrate an approach to develop highly efficient and stable nanophosphors for light and display technology. Especially these phosphors have applicability in the field of colour television display, flat panel display, plasma display panels, device indicators, automobile, headlights, etc. and hence they are emerging as an important class of the optical materials [1].

Recently, *S.A. Hassanzadeh-Tabrizi et al*[2]reported cerium-doped yttrium aluminium garnet (YAG:Ce) powder that were synthesized by Pechini method. Pure YAG phase after heat treatment at 800 ºC for 3 h and no intermediate phase was observed and the average size of the particles was about 70 nm. The photoluminescence spectrum of the crystalline YAG:Cephosphors showed the green-yellow emission with 5d→ 4f transition as the most

prominent group. Similarly green phosphor $Y_3Ga_5O_{12}$: Tb (YGG) was synthesized by *NanfeiZhua et al*[3]. The excitation and emission spectra of photoluminescence were used to characterize the luminescent properties. The excitation spectrum is dominated by the 4f→5d transition of Tb^{3+} at 263 nm. The strong emission peaks for the highly-doped phosphors are 489 and 543 nm. *V. Tucureanu et al*[4]reported that cerium doped yttrium aluminium garnet (YAG:Ce) phosphors for producing superior photoluminescence efficiency, by solid-state reaction, sol gel and (co) precipitation methods and by co−doping with rare earth elements, a red/blue shift was observed in the spectrum. It was seen that the transition from the amorphous phase to the crystalline phase appears at 800 ºC. Similarly *Manisha Upasani et al*[5]synthesized Mg co-doped YAG:Ce phosphors synthesized by single step combustion synthesis method by mixed fuel at 500 ºC. The doping effect of Mg on the luminescence intensity of YAG:Ce was studied and the results showed that the luminescence intensity of YAG:Ce decreases significantly with the increase in concentration of Mg. Three Y–Al–O compounds, $Y_3Al_5O_{12}$ (YAG), $YAlO_3$ (YAP), $Y_4Al_2O_9$ (YAM) which were polycrystalline powders was reported by *Masaaki Harada et al*[6]. It was noted that all three compounds were obtained in a single phase. Thermal analysis showed that the crystallization temperatures were 900 ºC for YAG and YAM, and 1100 ºC for YAP, which was 300 ºC lower than that, reported by sol–gel process and also reported the phase development of each compound with temperature. *Case Collins Reza T et al*[7]studied the luminescence performance of yttrium aluminium garnet ($Y_3Al_5O_{12}$) phosphors as a function of Cr^{3+} concentration which showed excellent emission in the PL spectra indicated the strong influence of the processing method on the optimized YAG: Cr^{3+} performance.

Yttrium aluminium garnet can be a useful matrix to dope certain rare earth elements to enhance the luminescent property of YAG. In this work, we report on the preparation of pure Yttrium Aluminium Garnet ($Y_3Al_5O_{12}$)-YAG and YAG:Ce are synthesized by Pechini method. This may lead to differences in their optical and luminescent properties. The changes in their properties can be studied by using various characterisation techniques such as x-ray diffraction (XRD), Fourier transform infrared (FT-IR), scanning electron microscope(SEM) and UV-Vis spectroscopy.

Experimental Techniques

Pure yttrium nitrate $Y(NO_3)_3.6H_2O$, aluminium nitrate (Al $(NO_3)_3.9H_2O$) cerium niterate hexahydrate($Ce(NO_3)_3.6H_2O$), citric acid ($C_6H_8O_7$), ethylene glycol ($C_2H_6O_2$) and distilled water (H_2O) were used for the synthesis. Yttrium Aluminium Garnet ($Y_3Al_5O_{12}$) was

synthesized by Pechini method which involves stirring, drying and calcination. Here pure Al $(NO_3)_3.9H_2O$, Y $(NO_3)_3.6H_2O$ were used as cation source. These nitrate salts that behaves as anion were dissolved in 80 ml of distilled water and citric acid at the ratio of 1:2. These metal salts were dissolved at molar ratio, Y: Al of 3:5 respectively. This mixture was stirred until a clear solution was obtained. Ethylene glycol which acts as a polymerization agent was added into the solution. The solution was continuously stirred at 80 ºC until gel was formed. After the gel formation, the gel was dried in oven at 100 ºC for 18h. Then preheated for 4 h at 600 ºC. This powder was crushed and fired at 1200 ºC for 4 h then pure yttrium aluminium garnet nano powder was obtained. In the case ofCe doped-$Y_3Al_5O_{12}$, cerium was added in 1.0mol % with the cation source and stirred in 80 ml of distilled water followed by same process as YAG.

Results and Discussion

YAG nanophosphors were synthesized by Pechini Method. The resultant particles were characterized by XRD, SEM, FTIR and UV-Visanalysis. The structural information of the prepared samples was analyzed through X-ray diffraction and their functional groups by Fourier transform infrared spectra. The surface morphology of the compound was examined by scanning electron microscope. Optical properties of the nanophosphors are analysed by UV-Visible spectrophotometer.

Structural Properties

X-ray Diffraction (XRD) Analysis

The structural analysis of YAG phosphors were analyzed using X-Ray diffraction. Figure 1 shows the typical X-ray diffraction profiles of the obtained YAG and Ce-YAG. The X-ray diffraction (XRD) pattern was recorded at room temperature of 2θ range from 10° to 80°. A pure cubic YAG phase was resulted for all the synthesized nano powders and it is in accordance with the JCPDS no. 33-0040. All the peaks are corresponding to YAG ($Y_3Al_{12}O_9$) phase and no other crystalline phases are detected. The absence of impurity peaks suggests that the added dopant Ce forms a complete solid solution with the YAG matrix thereby no change in phase occurs. The peaks are indexed as per the card number.

The high intensity peaks were observed at 18.0, 20.8, 27.7, 29.6, 33.1, 36.5, 41.0, 46.6, 52.8, 55.2, 57.6, 61.5 respective to the (211), (220), (321), (400), (420), (422), (521), (532), (444), (640), (642), (800) (hkl) crystal planes [8]. The average crytallite size is calculated using Scherrer formula

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$$\tau = K\lambda/\beta\cos\theta \quad (1)$$

where, τ is mean size of the ordered (crystalline) particles, K is shape factor (≈ 0.9), λ is wavelength of X-ray K_α line, β is the line broadening at half the maximum intensity (FWHM) in radians and θ is the Bragg angle in radians. In the present work crystallite size was found to be vary between 32-38 nm and the values are listed in Table 1.

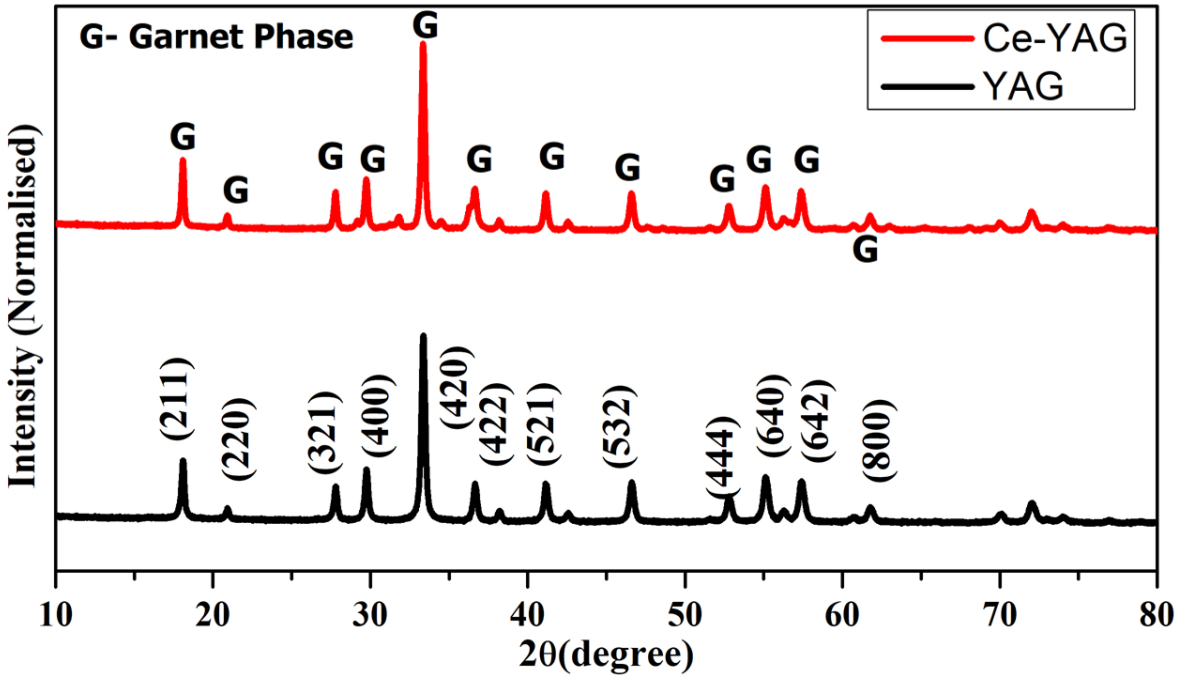

Figure 1. XRD graph of YAG nanophosphors

Lattice parameter *a* for cubic structure is calculated from the XRD spectra using the following formula,

$$1/d^2 = h^2 + k^2 + l^2/a^2 \quad (2)$$

where, 'a' refers to the cubicYAG lattice parameter, and h, k, l are the crystalline face indexes and 'd' is the interplanar distance. The volume of the cell and lattice parameters 'a' for samples are also summarized in Table 1.

Table 1. Crystalline Size, Lattice Parameter and Volume of the Cell of YAG Samples

SAMPLE	CRYSTALLITE SIZE (nm)	LATTICE PARAMETER'a' (nm)	VOLUME OF THE CELL (Å^3)
YAG	35	1.8816	6.661
Ce:YAG	33	1.8892	6.742

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Fourier Transform Infrared (FT-IR)Analysis

FTIR spectra of the YAG are shown in figure 2. The band at 790 cm^{-1}represents the characteristics of Al-O vibrations and the peaks at 727, 572 and 4770 cm^{-1} represent the characteristic vibration of Y-O [9-11]. The FTIR spectrum of YAG nanophosphor particles are recorded in the wave number range 3500 cm^{-1} to 500 cm^{-1} in ATR mode at room temperature. The bands and corresponding functional groups are summarized in Table 2. From the graph, it is clear that the samples have same structural variation as suggested by XRD.

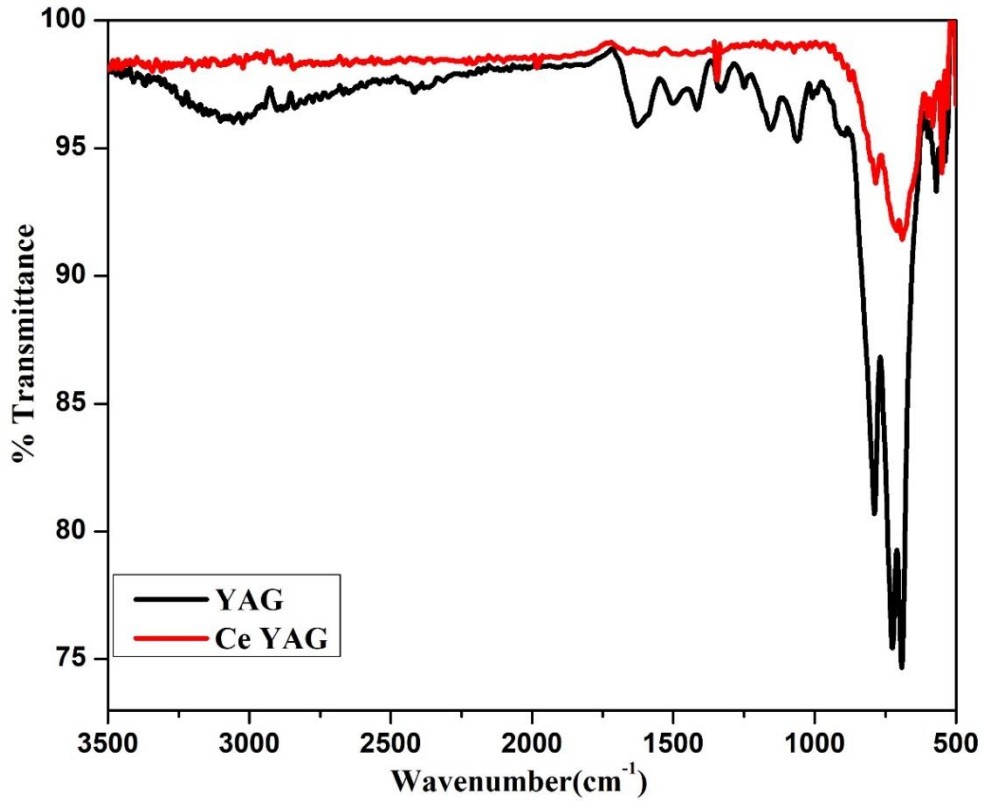

Figure 2. FTIR spectrum of YAG nanophosphors

Table 2. FTIR band assignments for YAG nanoparticles

WAVE NUMBER (cm^{-1})	BAND ASSIGNMENTS
790	Absorption due to Al-O vibrations
727	Absorption due to vibration of Y-O
572	Absorption due to vibration of Y-O

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Surface Properties

Scanning Electron Microscope (SEM) Analysis

. The SEM micrographs are presented in figure 3. Surface morphology of the synthesized nanoparticles were examined at room temperature.The micrographs reveal that there is poor agglomeration but there is no proper grain shape. Surface micrograph showed plate like structure for YAG and the addition of Ce into the YAG matrix yields spherical structure. The porous structure also vanishes after the addition of Ce and uniformly sized particles are obtained.

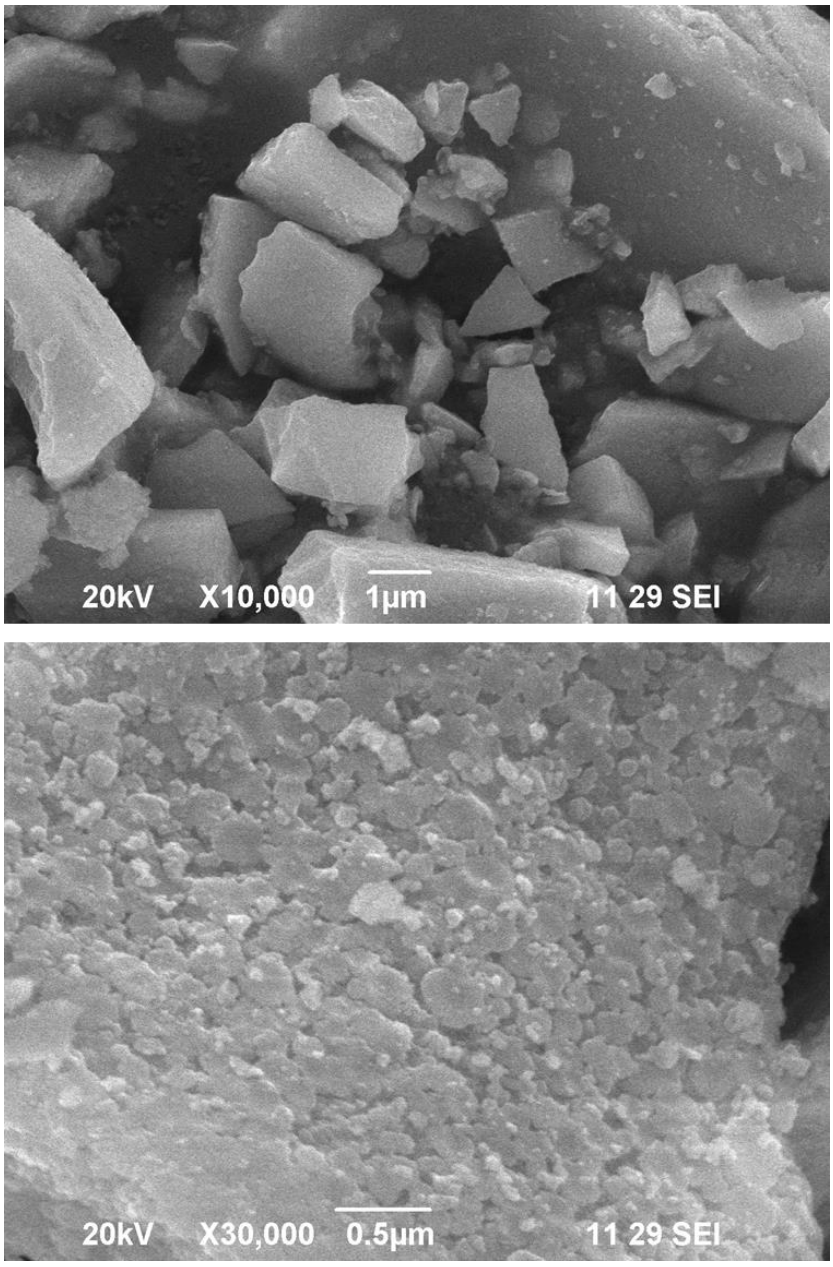

Figure 3. SEM Images of YAG phosphors

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UV- Visible absorption Spectroscopy

Ultraviolet–visible spectroscopy refers to absorption spectroscopy or reflectance spectroscopy in part of the ultraviolet and visible regions of the electromagnetic spectrum. The absorption or reflectance in the visible range directly affects the apparent color of the chemicals involved. The electronic transition of atoms and molecules occur in this region of the spectrum. The uv-visible absorption spectra of pure YAG and Ag doped YAG were recorded using V-670 Spectrophotometer (double beam instrument) from 400 to 800 nm.

The optical absorption spectra of the pure YAG and Ce doped YAG are shown in figure 4. The absorption peak in the visible range at 420 nm is due to the incorporation of Ce in YAG matrix. The narrow gap between the valence and conduction band gives rise to surface plasmon resonance. The area under the absorption peaks increase as concentration of Ce in YAG increases. It can be seen that this peak exhibits blue shift [12]. On the other hand, the broad band absorption in the UV region of spectra can be attributed to the inter-band transition of electrons in silver nanoparticles [8].

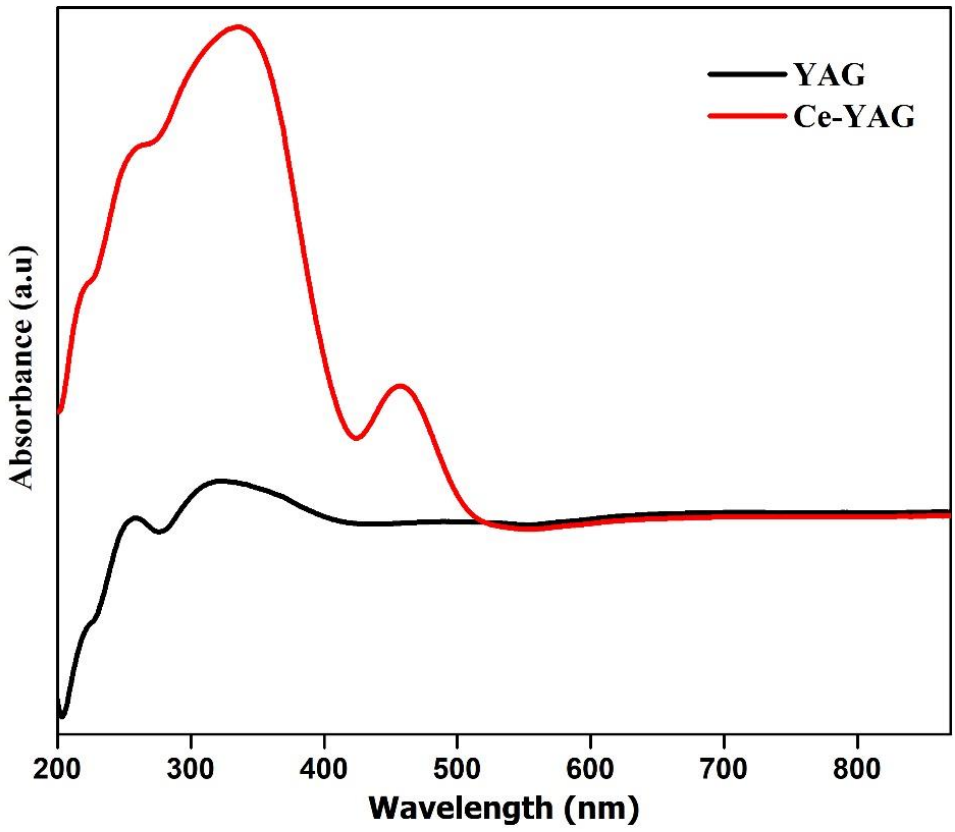

Figure 4. UV-Vis spectra of YAG phosphors

Conclusion

$Y_3Al_5O_{12}$ yttrium aluminium garnet nanophosphors and Ce doped YAG was prepared by Pechini method. The pure phase of YAG and cubic structure was confirmed from the XRD pattern. The peaks were indexed as per the JCPDS data. The sharp peak in the XRD reveals the good crystalline nature of the samples. Lattice expansion is indicated by the shift towards lower diffraction angle after the Ce addition is also visible in the XRD pattern. The bending and stretching vibrations of the oxygen groups associated with YAG was observed in FTIR spectra. Tube like morphology was noticed in the SEM and increase in crystallite size is also perceived after Ce was doped in YAG matrix. The melting of grain suggested that the sintering temperature is high. The presence of Ce in YAG matrix is attested from the characteristic absorption peak present in the UV-Vis spectrum.

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உ.வே.சாவின் தமிழ்ப்பற்றும் – தமிழ்ப்பணியும்

க. கரும்பாயி
தமிழ்த்துறை, சீதாலட்சுமி இராமசுவாமி கல்லூரி, திருச்சிராப்பள்ளி.

ஆய்வுக்சுருக்கம்

கல் தோன்றா மண் தோன்றாகாலத்தே முன் தோன்றிய மூத்தமொழியாம் செம்மொழியான தமிழ் மொழியின் சிறப்புக்கு முதன்மையாக விளங்குவன சங்க இலக்கியம் ஆகும். அத்தகு சிறப்புமிகுந்த இலக்கியங்களைப் பல துன்பங்களுக்குக் கிடையே தேடிக் கண்டுபிடித்து பதிப்பித்த பெருமைக்குரியவர் உ.வே.சாமிநாதையர் ஆவார். அனைவராலும் தமிழ்த்தாத்தா எனப் போற்றுதலுக்குரியவர். தமிழ் வளர்த்த பெருமகனார் உ.வே.சாமிநாதையரின் தமிழ்ப்பற்றினையும், தமிழ்ப்பணியையும் ஆராய்வது இக்கட்டுரையின் நோக்கமாகும்.

திறவுச்சொற்கள்: சங்க இலக்கியம், ஓலைச்சுவடி, பதிப்பித்தல் , தமிழ்ப்பணி, பதிற்றுப்பத்து.

Abstract

Sangha literature is primarily a feature of the classical Tamil language, the oldest language that appeared before Kal Thandha Man Thandhaka. U. V. Saminathayar is the proud person who searched for and published such special literature amidst many hardships. He is admired by all as the grandfather of Tamil. The purpose of this article is to examine the Tamil knowledge and Tamil work of U.V.Saminathayar, who raised Tamil.

Keywords: Classical literature, Manuscript, Publishing, Tamil service, Padhitrupathu.

முன்னுரை

உ.வே.சாமிநாதையர், தஞ்சை மாவட்டத்தில் உள்ள உத்தமதானபுரம் என்னும் ஊரில் 1885 ம் ஆண்டு பிப்ரவரித் திங்கள் பத்தொன்பதாம் நாள் வேங்கடசுப்பையர்- சரஸ்வதி தம்பதிகளுக்கு மகனாகத் தோன்றினார். இவரது இயற்பெயர் வேங்கடராமன் என்பதாகும்.இளமையில் கல்வி கேள்விகளில் சிறந்து விளங்கிய இவர் தன் தந்தை வேங்கட சுப்பையரிடத்திலும் பின் அரியலூரில் சடகோபையங்காரிடத்திலும்,

செங்கணம் விருத்தாசல ரெட்டியாரிடத்திலும் கல்விகற்றார். 1870 ஆம் ஆண்டு முதல் மகாவித்துவான் மீனாட்சிசுந்தரம்பிள்ளை அவர்களிடம் மாணவராகச் சேர்ந்தார்.

தமிழின் பெருமை இன்றைய மக்களிடையே பரவுவதற்குப் பழைய தமிழ் நூல்களையும், இலக்கிய இலக்கணங்கள் மற்றும் பல சிறந்த நூல்களையும் படிக்க வேண்டும் என்கின்ற அறிவுரையை உ.வே.சா. கூறியுள்ளார்.

"தமக்கு விளங்கும் சில பாடல்களும் நூல்களுமே சிறந்தனவென்றும் தமக்கு விளங்காதனவாயின் அவை குறைபாடுடையன வென்றும் சிலர் எண்ணிக் கொண்டு பழைய நூல்களையும் அவற்றைப் படித்தவர்களையும் புறக்கணிக்கின்றர் அச்செயல் ஆதரிக்கத் தக்கதன்று" என்று குறிப்பிட்டுள்ளர்.

ஆசிரியப்பணி

கும்பகோணம் கல்லூரியில் தமிழாசிரியராகச் சேருவதற்குப் பல சோதனைகள் நடந்தன. அவற்றில் ஒன்று ஐந்து நிமிடங்களில் அறுசீர்க்கழிநெடிலாசிரியப்பாவிருத்தமொன்றை இயற்ற வேண்டும் எனக் கூற,அடுத்த ஐந்து நிமிடத்தில்,

"வாயந்த புகழ் படைத்திலங்குமீனாட்சி
சுந்தரநாவலவன் பாலே
ஏய்ந்தமிழ் ஆய்ந்தமுறைக் கியைவுறநீ
இதுகாறும் இனிதின் வேய
ஆய்ந்தவளநகர்க்குடந்தைக் காலேஜில்
நின்னிடமெற் களித்தல் நன்றே
வேய்ந்தமிழ் முதற்புலமைத் தியாகரா
சுப்பெயர்கொள் மேன்மையோனே"

என்று பாடியதைக் கேட்டு அனைவரும் மகிழ்ந்தனர். 1880 ஆம் ஆண்டு பிப்ரவரி 16 ஆம் தேதி பணியில் சேர்ந்தார். பின் சென்னை மாநிலக் கல்லூரிக்கு 1903 ஆம் ஆண்டுபணியில் 1919 ஆம் ஒய்வுபெற்றார். 1924 முதல் 1927 வரை அண்ணாமலை செட்டியாரின் மீனாட்சி தமிழ்க்கல்லூரியின் தலைவராக பணியாற்றினார்.

தமிழ்ப்பணி

உ.வே.சா அவர்கள் தமிழர்கள் தமிழில் தனித்துவம் பெற்றுத் திகழ வேண்டும் என்ற விரும்பியவர்.செல்லரித்துப் போன பெருமை வாய்ந்த தமிழ் நூல்களைக் கண்டுமனம் வாடினார். நம் முன்னோர்கள் நமக்களித்ததமிழ் இலக்கியச் செல்வங்களை எவ்வாறேனும் பாதுகாக்க வேண்டும் என்றுமுனைப்புடன் வாகனவசதி இல்லாதஅந்நாட்களில் கால்நடையாகவே சென்று ஓலைச்சுவடிகளைக் சேகரித்து சரிபார்த்து திருத்தமான முறையில் தமிழ் இலக்கியங்களைக் காப்பாற்றினார். கணக்கிலடங்கா நூல்களைப் பதிப்பித்தும், அந்நூல்களைப் படித்து, அதில் உள்ள ஆழ்ந்த கருத்துகளைஎல்லாம் மக்கள் எளிதில் புரிந்துகொள்ளும் வண்ணம் உரையும் எழுதியுள்ளார். சிறந்த பதிப்பாசிரியர் மட்டுமின்றி உரையாசிரியராகவும் இருந்து தமிழ்ப்பணி ஆற்றியுள்ளார்.

பதிப்பாசிரியர்

பதிப்புஉலகின் தந்தைஎன்றுபாராட்டப் பெறும் உ.வே.சாஅவர்கள் நூல் உருவாக்கத்திற்குஎன்றுதனித்தபதிப்புக் கொள்கைகளையும்,கோட்பாடுகளையும் உருவாக்கிக் கொண்டவர். பதிப்புப் பணிசுவடிவெளியீடுகளில் முதன்மைவாய்ந்தது.ஒருநூலைப் பதிப்பிக்கும் முன்புநன்குஆழமாகப் படித்து,அந்நூலுக்குதேவையானசெய்திகளைச் சேகரித்துவிடுவார். பின் அந்நூலின் பிரதிகள் எவரெவரிடம் இருக்கின்றனஎனத் தேடிஅவற்றைப் பெறுவதைவழக்கமாகவைத்திருந்தார்.

பதிப்புப் பணியில் முதல்நூல்

திருநெல்வேலியில் "வேணுவனலிங்கத் தம்பிரான்" கட்டியமடாலயத்திற்கு " சுப்பிரமணியதேசிகவிலாசம்" என்றுபெயர் வைக்கப்பட்டது. அதன் திறப்புவிழாவிற்கு வந்திருந்த புலவர்கள் எல்லாம் சிறப்பித்துப் பாடியபாடல்களை முதல் நூலாகப் பதிப்பித்து 1878 - ல் வெளியிட்டார். இரண்டாவதாகப் பதிப்பித்த நூல் 1883- ல் மீனாட்சிசுந்தரம் பிள்ளை எழுதிய திருக்குடந்தைப் புராணம். மூன்றாவதாக 1885 -ல் ஸ்ரீமத்தியார்ச்சுனமான்மியம் பதிப்பிக்கப்பட்டது. பின்னர் பதிப்பித்த நூல்கள் முக்கியத்துவம் பெற்றவை.

சங்க இலக்கியங்கள்

பத்துப்பாட்டு(1889), புறநானூறு(1894), ஐங்குறுநூறு(1903), பதிற்றுப்பத்து(1904), பரிபாடல்(1918),பத்துப்பாட்டு மூலம்(1931), புறநானூறு மூலம்(1936), பெருங்கதை மூலம்(1936), குறுந்தொகை(1937) ஆகியன. காவியநூல்கள் - சீவகசிந்தாமணி(1887), சிலப்பதிகாரம்(1892), மணிமேகலை(1898), பெருங்கதை(1924), உதயகுமாரகாவியம்(1935). புராணநூல்கள் - திருக்குடந்தைப் புராணம்(1883),திருப்பெருந்துறைப் புராணம்(1892),வீரவனப் புராணம்(1903), சூரைமாநகரப் புராணம்(1904),திருவாரூர்த் தியாகராசலீலை(1905), திருவாலவாயுடையார் திருவிடையாடற் புராணம்(1906), தனீயூர்ப் புராணம்(1907), மண்ணிப்படிகரைப் புராணம்(1907), திருக்காளத்திப் புராணம்(1912), விளத்தொட்டிப் புராணம்(1934),ஆற்றூர்ப் புராணம்(1935), தணிகாசலப் புராணம்(1939), வில்லைப் புராணம்(1940), புறப்பொருள் வெண்பாமாலை(1895), நன்னூல்-மயிலைநாதர் உரை(1925),நன்னூல்-சங்கரநமச்சிவாயர் உரை(1926),தமிழ் நெறிவிளக்கம்(1937), சிவக்கொழுந்துதேசிகர் பிரபந்தத் திரட்டு(1932), குமரகுருபரசுவாமிகள் பிரபந்தத் திரட்டு(1939), தண்டபாணிவிருத்தம்(1891), திருத்தணிகைத் திருவிருத்தம்(1904), திருக்கழுக்குன்றச் சிலேடைவெண்பா(1937), சிவசிவவெண்பா(1937), திருக்குற்றாலச் சிலேடைவெண்பா(1940), திருக்காளத்திநாதர் இட்டகாவியமாலை(1938), மகரநெடுங்குழைக்காதர் பாமாலை(1939), திருமயிலைத்திரிபந்தாதி(1930), சங்கரநயினார் கோயில் அந்தாதி(1934), திருமயிலையமகஅந்தாதி(1936), மதுரைசொக்கநாதர்

மும்மணிக்கோவை(1932),வலிவலமும்மணிக்கோவை(1932). இரட்டைமணிமாலைகள் - நீலி இரட்டைமணிமாலை(1874),பழனி இரட்டைமணிமாலை(1932), களக்காட்டுச் சத்தியவாகீசர் இரட்டைமணிமாலை(1932).பிரபந்தங்கள் - சீகாழிக் கோவை(1903), திருவாவடுதுறைக் கோவை(1903),பழமலைக் கோவை(1935),கலைசைக் கோவை(1935), சிராமலைக் கோவை(1937),திருவாரூர்க் கோவை(1937). உலாநூல்கள் - திருப்பூவணநாதர் உலா(1904), திருக்காளத்திநாதர் உலா(1904),தேவைஉலா(1925), திருவாரூர் உலா(1905),மதுரைச் சொக்கநாதர் உலா(1931),கடம்பர் கோயில் உலா(1932), சங்கரலிங்கஉலா(1933),திரு இலஞ்சிமுருகன் உலா(1935), திருக்கழுக்குன்றஉலா(1938). தூது நூல்கள் - கச்சிஆனந்தருத்திரேசர் வண்டுவிடு தூது(1888), தமிழ் விடுதூது(1930), பத்மகிரிநாதர் தென்றல் விடுதூது(1932), மான் விடுதூது(1936), அழகர் கிள்ளைவிடு தூது(1938), புகையிலைவிடுதூது(1939). பிள்ளைத்தமிழ் நூல் - பழனிபிள்ளைத்தமிழி(1932). குறவஞ்சி நூல் - திருமலையாண்டவர் குறவஞ்சி(1938),கலம்பக நூல் - திருப்பாதிரிப் புலியீர்க்கலம்பகம்(1908). பரணிநூல்கள் - தக்கயாகப் பரணி(1930), பாசவதைப் பரணி(1933)போன்ற நூல்களைப் பதிப்பித்து தமிழ் மொழிக்குப் பெருமைசேர்த்தார்.

உரைநடைநூல்கள்

உரைநடை நூல்களையும் உ.வே.சா எழுதியுள்ளார். மத்தியார்ச்சுனமான்மியம்(1885), புத்த சரிதம்(1898),மணிமேகலைக் கதைச்சுருக்கம்(1898),உதயணன் கதைச்சுருக்கம்(1924),சங்கத்தமிழும் பிற்காலத்தமிழும் (1928), ஸ்ரீ மீனாட்சிசுந்தரம் பிள்ளையவர்களின் சரித்திரம் முதல் பாகம்(1933), ஸ்ரீ மீனாட்சிசுந்தரம் பிள்ளையவர்களின் சரித்திரம் இரண்டாம்; பாகம்(1934),நான் கண்டதும் கேட்டதும்(1936), திருநீலக்கண்டநாயனார் சரித்திரம்(1936), நல்லுரைக்கோவை-1(1937), நல்லுரைக்கோவை-2(1937), நல்லுரைக்கோவை-3(1938), நல்லுரைக்கோவை-4(1939),திருவள்ளுவரும் திருக்குறளும்(1936), கனம் கிருஷ்ணையர் (1936),கோபாலகிருஷ்ண பாரதியார்(1936), மகாவைத்தியநாதையர் (1936), இயற்கைநாயனார் சரித்திரக் கீர்த்தனை(1936), செவ்வைச் சூடுவார் பாகவதம்(1941), நினைவு மஞ்சரி1(1942), நினைவுமஞ்சரி 2(1946),வித்துவான் தியாகராசச்

செட்டியார்(1946), என் சரித்திரம்(1950) ஆகியன இவர் எழுதிய உரைநடை நூல்களாகும்.

உரையாசிரியர்

உ.வே.சாபதிப்பாசிரியர் மட்டுமல்லாமல் சிறந்த உரையாசிரியராகவும் இருந்துள்ளார். உரை எழுதியும், மூலபாடவேறுபாடுகளை ஆராய்ந்து குறிப்புரையும் எழுதி வெளியிட்டுள்ளார். குறுந்தொகைக்கு இவர் எழுதிய உரை குறிப்பிடத்தக்கது. குறுந்தொகை பாடல்களுக்கு உரைவகுக்கும் பொழுது தன் கருத்திற்கு ஆதாரமாக பல நூற்களிலிருந்து மேற்கோள்களைப் பாடல் எண்களோடு ஒப்பிட்டு விளக்கியுள்ளார். மேலும் குறுந்தொகைக்கு பதவுரை, விசேடவுரை மேற்கோள் விளக்கம், ஒப்புமைப்பகுதி ஆகியவற்றை வழங்கியுள்ளார். இரட்டைகாப்பியங்களில் ஒன்றான மணிமேகலைக்கும் எழுதிய உரை குறிப்பிடத்தக்கதாகும்.

உ.வே.சாவின் தமிழ்ப்பணிக்குகிடைத்தபாராட்டுகள்

உ.வே.சாவின் தமிழ்ப்பணியைப் பாராட்டிசென்னை அரசுபாராட்டி சிறப்புசான்றிதழும், ஆயிரம் வெண்பொற்காசுகளும் அளித்தது. இந்திய அரசு 1906-ஆம் ஆண்டு " மகாமகோபாத்தியாயா" என்னும் பெரும் பட்டத்தை வழங்கிச் சிறப்பித்தது. புரதர்மமகா மண்டலத்தார் "திராவிடவித்யா பூஷணம்" என்னும் சிறப்புப் பெயரைவழங்கி சிறப்பித்தனர். காஞ்சி காம கோடிபீடத் தலைவர் "தாஷிணாத்தியகலாநிதி" என்னும் பட்டத்தை வழங்கினார். சென்னைப் பல்கலைக்கழகம் 1932-ல் டாக்டர் பட்டம் வழங்கிக் கௌரவித்துள்ளது. சென்னை திருவான்மியூரில் உ.வே.சாபெயரில் நூலகம் அமைத்துத் தமிழக அரசு பெருமை சேர்த்துள்ளது. 1935 ஆம் ஆண்டு அவருக்கு மணிவிழா தமிழகம் முழுவதும் கொண்டாடப்பட்டது. 1942 ஆம் ஆண்டு ஏப்ரல் 28 ல் இறைவனடி சேர்ந்தார்.

முடிவுரை

தமக்கென முயலாபிறர்க்கென வாழ்பவர்கள் இருத்தலால் தான் இவ்வுலகம் நிலைபெற்றிருக்கிறது என்பார் சங்கப்புலவர். இப்பொன்மொழிக்கு ஏற்ப காண்பதற்கு அரிய ஓலைச்சுவடிகளை எல்லாம் கண்டுஎடுத்து, செம்மைப்படுத்தி பதிப்பித்த உ.வே.சாமிநாதையரின் தமிழ்பற்றினையும், தமிழ்ப்பணியையும் தமிழ் மொழி என்றும் நிலைத்திருப்பதைப்போல் அவரின் புகழ் என்றும் நிலைத்திருக்கும்.

துணைநூற் பட்டியல்

1. என் சரித்திரம் - டாக்டர் உ.வே.சாமிநாதையர் நூல் நிலையம்,சென்னை.
2. உ.வே.சாமிநாதையரின் பதிப்புத் திறன், தமிழியல்துறை, அண்ணாமலைப் பல்கலைக்கழகம், 2011.

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தமிழ்மொழியின் சொல் வளம்

மு. உஷா
தமிழ்த்துறை, சீதாலட்சுமி இராமசுவாமி கல்லூரி, திருச்சிராப்பள்ளி.

முன்னுரை

இவ்வுலக மொழிகள் ஏறத்தாழ மூவாயிரம் அவற்றுள், தமிழே தொன்மையும், முதன்மையும், தாய்மையும், தலைமையும்,தாய்மையும் வாய்ந்தது. பொன்னினும்,மணியினுஞ் சிறந்தாகவும், உணவினும், மருந்தினும் இன்றியமையாததாகவும்,தெய்வமும் திருமறையுமெனக் கன்னியாகவும் நம் முன்னோர்கள் போற்றி வளர்த்தது செந்தமிழேயாகும். இதன் சிறப்பை எடுத்துக்கூற இயலாது. இனிமை, எளிமை, நீர்மை என்னும் பொருளில் தமிழைக் கூறலாம். உலகமொழிகள் பலவற்றுக்கு எழுத்து, சொல், யாப்பு, அணி ஆகியன உண்டு. ஆனால் தமிழ்மொழிக்கு மட்டும் தான் பொருளுக்கு இலக்கணம் உண்டு. ஆகையால் தமிழை ஐந்திலக்கணம் என்கின்றனர். இத்தகைய மொழிக்கு இன்னொருசிறப்பும் உண்டு. எண்ணற்ற புலவர்களாலும், அரசர்களாலும் சங்கம் வைத்து நடத்தப்பட்ட ஒரேமொழி தமிழ்மொழி ஆகும். இத்தகைய சிறப்புப்பெற்ற தமிழ்மொழியில் உள்ள சொல் வளத்தினை இங்கு கட்டுரையாக காணலாம்.

திறவுச்சொற்கள்: **ஐந்திலக்கணம்**, **திருமறை**, **செந்தமிழ்**, **தெய்வம்**.

Abstract

There are approximately three thousand languages in the world, and Tamil is the most ancient, the most important, the mother, the leader, and the mother. Our forefathers cherished Senthamizhe as the best of gold and silver, essential for food and medicine, and as a virgin who is divine and holy. Its excellence cannot be overstated. Tamil can be said to mean sweetness, simplicity and wateriness. Many languages of the world have letters, words, syllables and groups. But only Tamil language has grammar for subject. That is why Tamil is called Aintilakanam. Tamil was the common language practiced by countless poets and kings. Such special vocabulary in Tamil language can be found here as an article.

Keywords: Pentagram, Hide, Senthamil, Goddess

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தமிழ் வளம்

தமிழ் வளம் என்பது வளர்பொருளாய் அமைவது. வானத்து மீனைக் கணக்கிடவல்லாரும் கணக்கிடமாட்டாமை போல நொடியும் நொடியும் வளர்வது. பொருள் வளம், சுவை வளம்,சொல் வளம் எல்லாவற்றிலும் குறையே காண முடியாத மொழியாக தமிழ்மொழி விளங்குகிறது. இதன் சிறப்பைசிலசொற்களின் உருவாக்க அடிப்படையில் கண்டு வியக்கலாம். நாம் உண்ணுகின்ற சோற்றைக் குறிக்கும் சொல் அவிழ்பதம், அவிழ்தல், மலர்தல், விரிதல், விடுபடல் போன்ற சொற்களில் கூறப்படுகின்றது. இவ்வாறு ஒவ்வொரு சொற்களும் பல பொருள்களில் வருவது தமிழ்மொழிக்கே உள்ள சிறப்பாகும்.

அந்தோ

அந்தோ என்னும் சொல் 'ஐயோ' என்னும் பொருளாக அமைகின்றது. தொல்காப்பியத்தில் அந்தோ என்பது 'அந்தீற்று ஓ' என வழங்கப்படுகிறது. அந்தோ என்னும் சொல் பழந்தமிழ் இலக்கியங்கள் முதல், இக்கால இயல் வழக்கு வரை இயன்று வருகின்றது.

உணர்வு வெளிப்பாட்டில் வெளிப்படும் சொற்களுள் ஒன்று என்பதற்கு,

"அந்தோஅளியேன் வந்தனென் மன்ற" (புறம் -- 238)

"அந்தோஎந்தைஅடையாப் போரில்" (புறம் -- 261)

"அந்தோதானேஅளியன் தாயே

நொந்தழிஅவலமொடென்னாகுவள்கொல்" (நற்றிணை – 324)

"வயங்கினாளென்றுறுகாதிர்மற் றந்தோ

மயங்கினாளென்று மருள்திர் காங்கன் மின்" (கலித்தொகை – 143)

ஆகிய பாடல் வரிகளை கூறலாம்.

அந்தோ என்னும் இவ்வுணர்வு வெளிப்பாட்டுச் சொல் ஏனை உணர்வு வெளிப்பாட்டுச் சொற்களோடு ஒப்புநோக்கத்தக்கது.

களைதல்

விதைத்து வளர்வது பயிர். விதையாமல் தோன்றி வளர்வது களை. எப்பயிர் ஆனாலும் பயிராவதும் களையாவதும் விதைப்பது விதையாததைப் பொறுத்தது. களையை அகற்றுதல், களைதல் எனப்படும். ஆனால் களைதற்குரியது களை எனப்பட்டது. களைவெட்டுதல் பொருள் தரும் சொல் 'கட்டல்' ,'களைதல்' என்பன களைதல் -- கள்தல் -- கட்டல் என வருகிறது.

"கொலையிற் கொடியாரைவேந்தொறுத்தலபைங்கூழ்

களைகட் டதனோடுதேர்" (திருக்குறள் - 550)

எனும் குறளில் களைகட்டுதலைச் சுட்டகின்றார் வள்ளுவர்.

மேலும்,

"உடுக்கை இழந்தவன் கைபோலஆங்கே

இடுக்கண் களைவதாம் நட்பு" (திருவள்ளுவர் -788)

என்று துயர் களைவதையும் கூறுகின்றார்.

களைவெட்டல், களைகொத்தல், களைகொய்தல், களைபறித்தல், களைஎடுத்தல், களைசுரண்டல், களைபரண்டல், களைகிள்ளல்,களைகல்லல், களைஅகழ்தல், களைபிடுங்கல் முதலியசொற்கள் தமிழின் தனி வளத்தைக் குறிக்கின்றது.

சலம்

வாய்க்காலில் நீர் ஒடுகின்றது. அதில் ஒருவன் தன் கையை வைத்து 'நில் நில் ' தடுக்கின்றான். நீர்,நில்லாமல் 'சலசல' என்னும் ஒலியுடன் ஓடுகின்றது. கையை வைத்து நீரைத் தடுத்தவனுக்கு,தான் தடுத்து நிறுத்தியதற்கு நீர் அழுவது போலத் தோன்றுகிறது. அதனால்,

"இரைந்ததென் அழுவையோ"

"செல்!செல்!"

என விடுத்தான். இது மனோன்மணிய நாடகத்தில் வரும் ஒரு காட்சியாகும். நீர் 'சலசல' என்னும் ஒலியுடன் ஓடுவதால் 'சலம்' என்னும் பெயர் பெற்றது.

"சலசலமும்மதம் சொரிய" (சீவகசிந்தாமணி – 82)

என்று சீவகசிந்தாமணி கூறுகின்றது. 'சலம்;' ஆகிய நீர் சமையலுக்குக் கட்டாயம் வேண்டும். அச்சமையல் அறையிலே தான் கலங்களைத் தேய்த்தல், கழுவிக் கொட்டல்,வடித்தல் ஆகியன நடக்கும் என்பதால் சலத்தோடு பொருந்திய சொற்களால் இவை அமைகின்றது.

சவட்டுதல்

சவட்டுதல் என்பது பழந்தமிழ்ச் சொல். அழித்தல், துன்புறுத்தல், வருத்தல், சிதைத்தல், அறைதல், வாட்டுதல் முதலிய பொருள்களில் வரும். பல்கால் மெல்லுதலும்,பல்கால் மிதித்தலும் சவட்டுதலேஆகும்.

"மன்பதைசவட்டுங் கூற்றமுன்ப" (பதிற்றுப்பத்து – 84)

"வம்பவடுகர் பைந்தலைசவட்டி" (அகம் -- 375)

"அறைகல் இறுவரைமேல் பரம்புசவட்டி" (கார்நாற்பது – 17)

மேற்கூறிய பாடல்வரிகள் சவட்டி என்பதைக் குறிக்கின்றது. மழைசவட்டிவிட்டது என்றும், நோய் ஊரையே வளைத்துச் சவட்டிவிட்டது என்றும்,கதிரைச் சவளமிதிக்க வேண்டும் என்றும்,வெற்றிலையை ஓயாமல் மென்று சவக்களித்து விட்டது என்றும் பெரிதும் நம் மக்களிடம் வழக்கத்தில் உள்ள சொற்களாகும்.

பல்

பற்று என்பது 'பல்' என்பதன் வழியாக வந்த சொல். பல் என்பது வெண்மை குறித்த சொல். "பலபல" என விடிந்தது என்னும் வழக்கிலும் 'பால்' என்னும்

சொல்லினும் வெண்மைப் பொருள் உள்ளதைநாம் அறியமுடியும். பல் என்பது 'பள்' எனத் திரிந்தும் வெண்மைப் பொருள் தருதலைப் பளபள, பளப்பளப்பு, பளிச்சிடல் என்பவற்றிலும் காண இயலும்.

உழவுக் கருவிகளுள் ஒன்று 'பலகுச் சட்டம்' . அதனைப் பயிரூடுஅடித்தலைப் பலகடித்தல் என்பர். பலகு, பலுகு எனவும் வழங்கப்படும். களைகுத்தி போல் பல் பல்லாகிய முளைகளையுடையது அப்பலகு என்பதாகும். அதன் பெயர் பொருளைத் தெளிவாக அறிந்தோர்' பல்லியாடுதல்' என்பார்கள். இதுகொழுவோடு சேர்க்கப்பட்டதும் பற்கள் உன்னதுமான பலகையோடு அமைந்த கலப்பையே ஆகும். இதனை,

"பூழிமயங்கப் பலவுழுதுவித்திப்

பல்லியாடிய" (புறப்பாட்டு – 120)

புறப்பாட்டு எடுத்தியம்புகின்றது.

பிடி

பிடி என்பது 'பிடித்து' அள்ளும் அளவைக் குறித்தது. கைப்பிடி எனவும் பொருள்படும். ஒரு பிடி மண்ணை அள்ளிக் கற்றது கைம்மண் அளவு, கல்லாதது உலகளவு எனக்காட்டினார் ஔவையார்.

"தொடிப்பழுதி கஃசா உணக்கின் பிடித்தெருவும்

வேண்டாதுசாலப்படும்" (திருக்குறள் -1037)

என திருவள்ளுவரும் திருக்குறளில் 'பிடித்து' என்பது பிடியளவைக் குறிக்கும் என்கின்றார்.

உழவர் தம் மாடுகளைப் 'பிடி' என்னும் அளவில் அளவிட்டுக் கூறுதலும், நால்விரல் மடித்து பெருவிரல் அல்லது கட்டைவிரல் ஒன்று நிமிர்த்திய உயரம் என்பதும் அளவேயாகும். பிடிஎன்னும் அளவைப்பெயர் 'பித்தல்' என்னும் தொழில் பெயர்க்கு மூலமாகி விரிவடைந்து பற்றுதல், அகப்படுதல் ஆகிய பொருளைத் தந்தது.

“பிடித்தாலும் பிடித்தாய் புளியங்கொம்பைப் பிடித்தாய்” என்று வரும் பழமொழி பற்றுதல் பொருளில் வந்துள்ளது.

கழிசடை

கழிசடை என்பது தலை சீவுகின்ற போது முடிசீப்புடன் வருகிறது. உதிர்கின்ற முடிதானே உதிர்ந்த முடிக்கு என்ன மதிப்பு இருக்கின்றது. தலையில் இருக்கும் பொழுது எத்தனைஎத்தனை எண்ணெய், எத்தனை முறை கண்ணாடியில் தன்னைத்தானே பார்த்துக் களித்தல் எல்லாம் ஆயின. உதிர்ந்த முடி உடலிலோ, உடையிலோ ஒட்டியிருப்பின் அருவருப்பாய்த் தொடாமல் தொட்டெடுத்து ஊதித் தள்ளுகிறோம். இல்லையேல் விரலால் சுண்டி கீழே வீழ்த்துகிறோம். கையையும் கழுவுகிறோம். இந்தமாற்றம் ஏன்? அதன் நிலைமாற்றமே இம்மதிப்பு மாற்றத்திற்கு அடிப்படையாகும். இதனைத் தெளிவாகத் தெரிந்த திருவள்ளுவர் கற்பவர் நெஞ்சில் படுமாறு,

“தலையின் இழிந்தமயிரனையர் மாந்தர்
நிலையின் இழிந்தக் கடை” (திருக்குறள் -- 964)

என்கின்றார்.

வெள்ளோடு

வெள்ளப்பெருக்கின் போது மட்டும் நீரோடும் ஓடு வெள்ளோடு எனப்படும். நீருக்கு நிறமில்லை என்பது அறிவியல். ஆனால் நிலத்தில் பட்ட நீருக்கு நிலத்தின் நிறமே நிறமாய் ஆகி விடுவது கண்கூடு. அன்புடைய தலைவன் தலைவியர் நெஞ்சக்கலப்பு, நிலத்தொடும் இயைந்த நீருக்கு ஒப்பாக ஒரு புலவர்க்கு தோன்றுகிறது. இதனை அவர்,

“செம்புலப் பெயல்நீர் போல
அன்புடைநெஞ்சஞ் தாம்கலந் தனவே” (குறுந்தொகை – 40)

என்கின்றார். இதனைப் பாடியவர் பெயர் இன்னாதென அறியாத தமிழகம். அவரைதம் உவமையாலே ‘செம்புலப் பெயல்நீரார்’ என கூறுகின்றது.

“புலத்தின் புத்தேள்நாடுஉண்டோநிலத்தொடு

நீரியைந் தன்னார்அகத்து” (திருக்குறள் --1323)

எனத் திருக்குறளும் கூறுகின்றது.

போர்க்களத்தில் பெருக்கெடுத்து குருதி வெள்ளம்,உடைப்பட்ட முரசத்தின் உள்ளே பாய்ந்து ஓடுவது, செங்குளத்துத் தூம்பின் வழியே நீர் ஓடுவது போன்றது என்கின்றது களவழி நாற்பது.

ஈரோடு

ஒரு காலத்து நான்முகன் ஐந்தலையனாக இருந்தான். அவன் தலைஒன்றை, சிவன் கிள்ளிவிட்டான். அத்தலையோட்டில் இருந்துகுருதி வழிந்து கொண்டிருக்கிறது. அவ்ஈர ஓடு சிவன் கையை கவ்விக்கொண்டு, விடாமல் இருந்தது. பின்னர் விடுபட்ட இடம் ஈரோடு என பெயர் வந்த வகை இவ்வாறாக அமைகின்றது. இரண்டு ஓடுகள் உடைய இடம் ஈரோடு எனப்பட்டது.

ஓரோடு ‘சிற்றோடு’ மற்றோர் ஓடு ‘பேரோடு’ . இரண்டு ஓடுகளும் தனித்தனியே ஓடுகளாகவும், ஊர்களாகவும் உள்ளன. அவ்வீரோடும் சார்ந்த ஊர் ஈரோடு ஆகும்.

அக்கப்போர்

அக்கப்போர் என்பது இந்நாள் பொதுமக்கள் வழக்குச் சொல்;. கல்வியறிவு அறவே இல்லாத பொதுமக்களிடத்துத் தோன்றித் கற்றோர் முதல் அனைவரிடத்தும் ஊன்றியுள்ள சொல்லாகும்.

அக்கப்போர் சிறுபோர் என்பது பொருந்துவது அன்று. போர் போரே! சிறுபோர் ஆயினும்,பெரும் போராயினும் சரியே. கலகம், கலகலப்பு, சண்டை, சச்சரவு இப்படிப் பலசொற்கள் வழக்கில் உள்ளதாகஅமைகின்றன.போர் என்பதுபொரு அல்லது ஒப்பு என்பதன் வழியாக வந்தசொல். ஒத்த இருவருக்குள் ஏற்படுவதே போர் ஆகும். மறுத்துப் பேசுதலைச் சொற்போர் என்றும் மன உளைச்சலை உண்டாக்கும் போரினை

பேச்சுப்போர், ஏச்சுப்போர், கருவுதல் போர் என்றும் கூறுவர். கலகம், தொல்லை, தொந்தரவு முதலிய சொற்களும் இதனில் அடங்கும்.

கவி

கவி என்பது குனி, கவிழ் என்னும் பொருள் தரும் ஏவற் சொல். அதுதலை கவிந்து அல்லது கவிழ்ந்து இருக்கும் குரங்குக்குப் பெயர்ச் சொல்லாயும் அமைகின்றது. களவு செய்து பிடிபட்ட போதில் தலை கவிழ்ந்து நின்றுகாலால் நிலங்கிளைத்தலைக் குறிக்கிறது சங்கப்பாட்டு. களவுக் காதலன் தலைவியை நோக்கினாள். அவள் கண்ணுக்கு ஒப்பாகேன் என்று குவளை நாணிக் கவிழ்ந்தது என்பதை,

"காணிற் குவளைகவிழ்ந்ததுநிலனோக்கும்

மாணிழைகண்ணொவ்வேம் என்று" (திருக்குறள் -- 1114)

திருக்குறள் குறிப்பிடுகின்றது.

பூனைக்காலி என்னும் செடிக்குக் 'கவி' என்பதொரு பெயர் உண்டு. அதன் பூ கவிழ்ந்திருப்பதால் பெற்ற பெயராகும். 'கவிழ்' ,'தும்பை' என்னும் செடிப்பெயரும் கவியும் பூவால் பெற்றதேயாகும்.

குண்டு

குர்,குல், குள், குண்ண முதலாம் வேர்களின் வழியாகப் பிறக்கும் சொற்கள் வட்டம், வளையம், உருட்சி, திரட்சி முதலிய பொருள்களைத் தருவதாக குண்டு என்ற சொல் அமைகின்றது. 'குண்டுமல்லிகை' குண்டின் வடிவ மணமும் பரப்புகின்றது. குண்டு எறிதல் என்னும் விளையாட்டுக் கருவிநாம் அறிந்த ஒன்று. அணுக்குண்டுக் கொடுமை சொல்ல வேண்டியது இல்லை. குண்டுகுண்டாக எழுதுதல் பாராட்டுக்குரியதாகும். குண்டுசட்டி, குண்டுசெம்பு (உருண்டைச் செம்பு, உருளி என்பதும் அது)குண்டா, குண்டான், குண்டாச்சட்டி, குண்டுவட்டில் (கும்பா) என்பன வழக்கில் உள்ள உண்கல வகைகள் ஆகும்.

குண்டெழுத்தாணி பண்டு வழக்கில் இருந்த எழுத்தாணிகளுள் ஒன்று. அதன் தலையில் 'குண்டு' அமைப்பு இருக்கும் குண்டு அரமும் உண்டு. அதன் பெயர் குண்டரம். கட்டடவேலைக்குப் பயன்படுவது நூல்குண்டு. குண்டுமணி என்பது உருண்டு திரண்டமணி. குன்றி மணியைக் குண்டுமணி, குண்டுமுத்து என்பதும் வழக்கு. வளைந்துசுருளும் சுருட்டைப் பாம்புக்குக் குண்டலி என்பது பெயர். ஆல வட்டமெனத் தோகை விரித்தாடும் மயிலுக்கும் குண்டலி என்ற பெயர் உண்டு. உருண்டு திரண்ட குதிரை, காளை ஆகியவற்றைக் குண்டைஎன்பது இலக்கியவழக்கு.

குண்டு என்பது ஆழம் என்றும், குழி என்றும்,நன்செய் நிலம் என்றும் பொருள் தரும். மேலைக்குண்டு, கீழைக்குண்டு எனவயல் நிலம் சுட்டப்படுவதும்,குண்டும் குழியுமாக்கிடக்கிறது எனக் கூறப்படுவதும் அறியத்தக்கதாகும். குண்டம் பாய்தல் என்பது பூக்குழியில் இறங்குதல் ஆகும். கதிரோன் பெயராலும் திங்களின் பெயராலும் விளங்கிய நீர்த்துறைகள் முறையே சூரிய குண்டம்,சோமகுண்டம என வழங்கப்பட்டமை சிலம்பால் அறியவரும் செய்தியாகும். குண்டுநீர் இலஞ்சி, குண்டு கண் அகழி, குண்டுநீர், குண்டகழ், குண்டுகயம் என்பன சங்ககாலத்தில் ஆட்சியில் இருந்த சொற்களாகும். இவ்வாறுகுண்டு என்ற சொல் பலபொருள்களைத் தருகின்றது.

முடிவுரை

இளம் பயிர் வகைக்கு நாற்று,குருத்து, பிள்ளை,குட்டி, மடலி, வடலி, பைங்கூழ் என்ற சொற்களைப் பயன்படுத்தினர். இவ்வாறு ஒவ்வொரு சொல்லுக்கும் பலபொருள்களை தமிழ்மொழி தருகின்றது. அதனால்தான் மேலை நாட்டறிஞர் ஜி.யு.போப், தமிழை நன்குகற்று அதன் சிறப்பினை உணர்ந்ததால் தமது கல்லறையில் "ஒருதமிழ் மாணவன்" என்றுபொறிக்கச் செய்தார். திராவிடமொழிகளின் பழம்பெருமைக்கும், கலப்பில்லாத தூய மொழிவளம், இலக்கிய வளம், பண்பாட்டு வளம் ஆகியவற்றுக்கும் ஒருஅருங்கலச் செப்பமாக தமிழ்மொழி விளங்குகிறது என்றால் மிகையாகாது.

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BEHAVIOURAL STUDY OF INDIAN MAJOR CARPS ON EXPOSURE TO CHLORPYRIFOS

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Abstract

One of the consequences of technological progress in the agricultural revolution has been the release of many chemicals into the environment. Although various alternative pest control methods have been available in recent years, the use of chemical pesticides, insecticides, and fungicides is still the mainstay in modern agricultural practice. Fish are very vulnerable to water pollution from the environment. Therefore, certain types of pesticides can seriously impair the behavioural, physiological, and health state of fish, and these pollutants, like insecticides, may seriously harm specific physiology and biochemical processes. In this research, we aimed to observe the behaviour of Indian Major Carps when exposed to a pesticide. The carps were collected from the Cauvery River at Tiruchirappalli District and were subjected to 200 ppm of organochlorine pesticide Chlorpyrifos. Initial screening identified the 200 ppm concentrations as the most effective, and therefore, they were chosen for detailed reporting. During the experimental period, In the control aquaria, the dissolved oxygen concentration remained relatively stable throughout the experimental period, with no significant fluctuations observed. Conversely, in the aquaria exposed to 200 ppm chlorpyrifos, only minor variations in dissolved oxygen concentration were detected over the course of the experiment, indicating no substantial impact on this parameter. we observed significant changes in the fish's behaviour. Initially, the fishes appeared sluggish and showed signs of reflex loss, air gulping, erratic swimming, mucus secretion, The dissolved carbon dioxide, pH, and temperature exhibited varying results in both the control and test aquaria. Significant differences were observed between the control and the aquaria exposed to chlorpyrifos, with each parameter showing distinct trends during the experimental period. scale loss, jerky movement, leaping out of water, and thick mucus covering their bodies. All the chlorpyrifos-exposed fishes exhibited behavioural disabilities and unfortunately, did not survive beyond the 6th day, unlike the control group. This study highlighted the adverse effects of even small accumulations of pesticide and its residues on

fishes, leading to changes in behaviour, accumulation in their bodies, and ultimately resulting in mortality. Consumption of affected fish without discrimination can lead to chronic disorders and have negative impacts on human health.

Keywords: Chlorpyrifos, Indian major carps, Behavioural pattern, water parameters

Introduction

General agricultural use of pesticides has been the release of a large number of chemicals into the environment. It carries with it potential hazards to aquatic animals, birds, and man besides direct exposure to toxic residues in food and indirectly to the environment. The pesticide residues were found to cause impairment in the behavioural, and reproductive system in aquatic animals. A common source of protein in diets across the nation is fish. In India, about half of the population eats fish. It is quickly digested and a high source of protein. In addition to being a wonderful source of vitamins and minerals, fish helps to promote heart and brain health, reduce high blood pressure, prevent arterial plaque development, and boost immunity. Unfortunately, a variety of factors are already contaminating fish in India's freshwater habitat. One of the most well-known sources of environmental contamination is pesticide use, which results in the evident pollution of the aquatic environment by seeping into freshwater habitats through rainfall and flooding. Pesticide residue accumulates in the soil and water, poisoning the biota and making its way up the food chain. Because of their limited solubility and quick disintegration, these insecticides have a short half-life in the water column, making it challenging to evaluate the exposure of aquatic ecosystems to them. However, because these pesticides are extremely hazardous to aquatic life, it is crucial to supervise their use. An organism may adapt to both internal and external stimuli through behavior, which helps it meet the challenge of surviving in a changing environment. Behavior that has been transposed is also the outcome of environmental variable adaptations. As a result, behavior is a selective reaction that is always changing because of direct interaction with the physiological, chemical, social, and physical elements of the surroundings. Brewer and Little [7].

In this regard, it is necessary to study the effect of Chlorpyrifos on the behavioural changes of Indian major craps, including loss of reflex, air gulping, erratic swimming, mucus secretion, loss of scale, jerky movement, leaping out of the water, thick mucus covering over the whole body and mortality rate.

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Material and Methods

Sample collection

Fingerlings of Indian Major Carps were collected from the Cauvery River at Tiruchirappalli, Tamil Nadu, India during September 2023 and were brought to the laboratory at the Research Department of Zoology, Seethalakshmi Ramaswami College, Tiruchirappalli using oxygen filled polythene bags. The average weight of the fish is ±7 g and a length of 11 cm was recorded.

Acclimatization of Fish samples

Fishes were disinfected in sodium chloride and Potassium permanganate solution. For the period of 15 days, the fishes are acclimatized in glass aquaria (43 x 20 x 23cm) containing fresh tap water pH -7.2, Temperature 32° C, photo-period - 12 hours, with a sample size of 10 fishes. Every 12 hours, they were fed with a prepared feed of equal volume of rice bran and oil cake as pellets. Routine cleaning of aquaria was done, one-third of the water was replaced and the excretory waste and food debris were removed.

Chlorpyrifos

Chlorpyrifos is an organophosphate insecticide. The chemical formula of chlorpyrifos is $C_9H_{11}C_{13}NO_3PS$ (O, O-Diethyl O-(3,5,6-trichloropyridin-2-yl) phosphorothioate) and its molecular weight is 350.57 $gmol^{-1}$.

Test animal

In this study, ten fishes of Indian Major carp were assimilated in the volume of fifteen cubic liter of tap water in an aquarium tank. The length and weight of the fishes were measured. A randomly chosen concentration of 200 ppm of chlorpyrifos was added to the aquaria. The experiment was conducted in triplicate. Each aquarium was monitored carefully to check the behavioral changes and mortality. Dead fishes were removed from the aquarium. Water quality parameters were maintained over the experimental period.

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Examination of water quality parameter

Throughout the experimental period, water quality parameters such as dissolved oxygen (DO), dissolved carbon dioxide, pH, and temperature were examined. Dissolved oxygen was determined by Winker's method; pH and temperature were measured by using Eutech Instruments pH Tutor (made in Singapore) at systematic breaks.

Observation of external morphological deviations

During the experimental period, the external morphological changes were observed and recorded carefully for every 24-hour interval. The external morphological pattern of fingerlings such as swimming movement, appearance, gill, eyes, fin, etc. was observed at one-hour intervals and recorded. The mortality of fingerlings was also observed, and the information was registered.

Results and Discussion

Dissolved oxygen, carbon dioxide, temperature, and pH were recorded at regular intervals. During the experimental period the behavioral changes and morphological defects were observed. In the aquaria, the water was changed every 24-hour interval, in this condition dissolved oxygen content fluctuated in both the control and test aquaria. (Fig. 1)

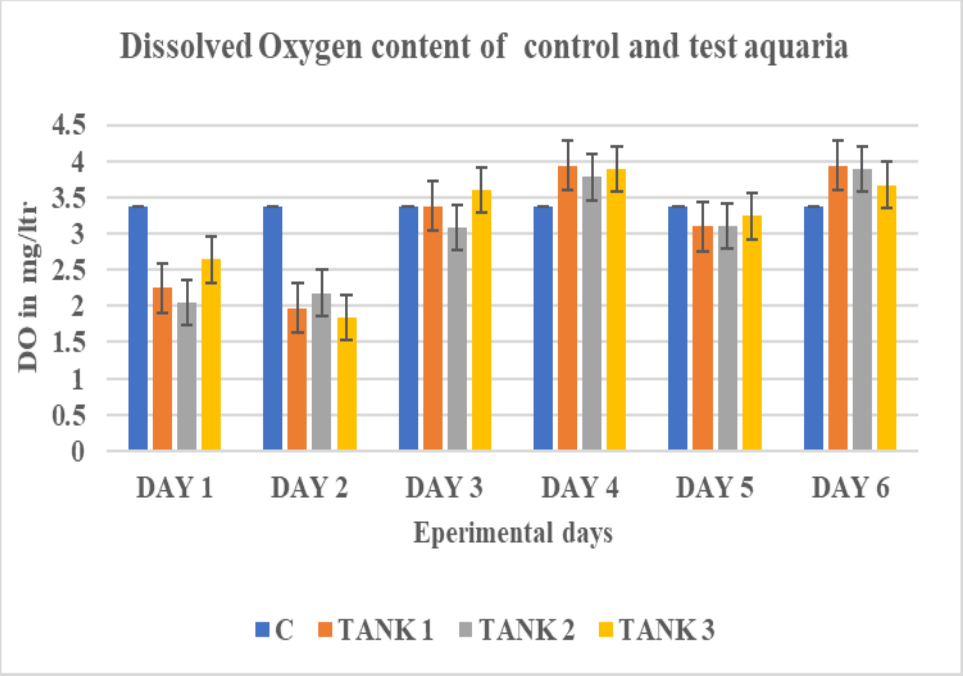

Figure 1. Dissolved Oxygen of control and test aquaria of Experimental days

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In comparison to the 200ppm chlorpyrifos exposed tank, dissolved oxygen content was inconsistent. The dissolved carbon dioxide of the control and test aquaria was unstable (Fig. 2).

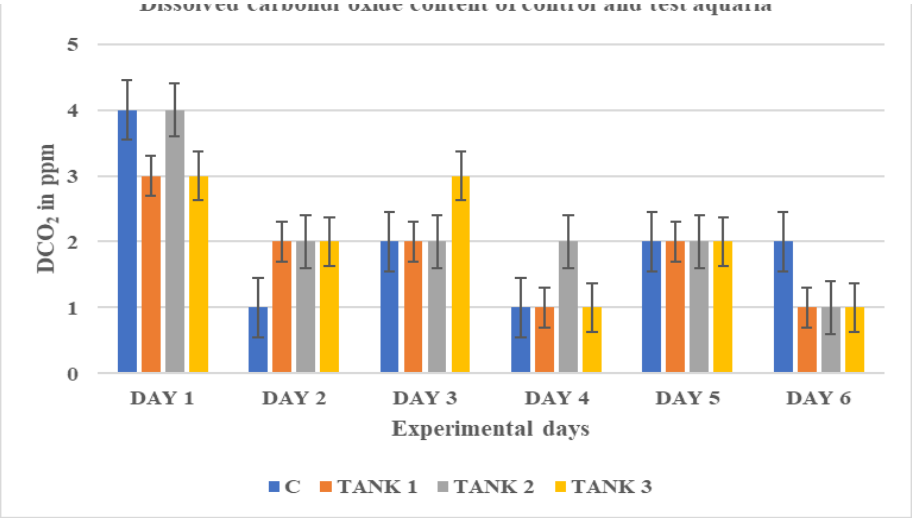

Figure 2. Dissolved Carbondi oxide content of control and test aquaria

The pH of the Control and test aquaria did not show any notable changes (Fig. 3).

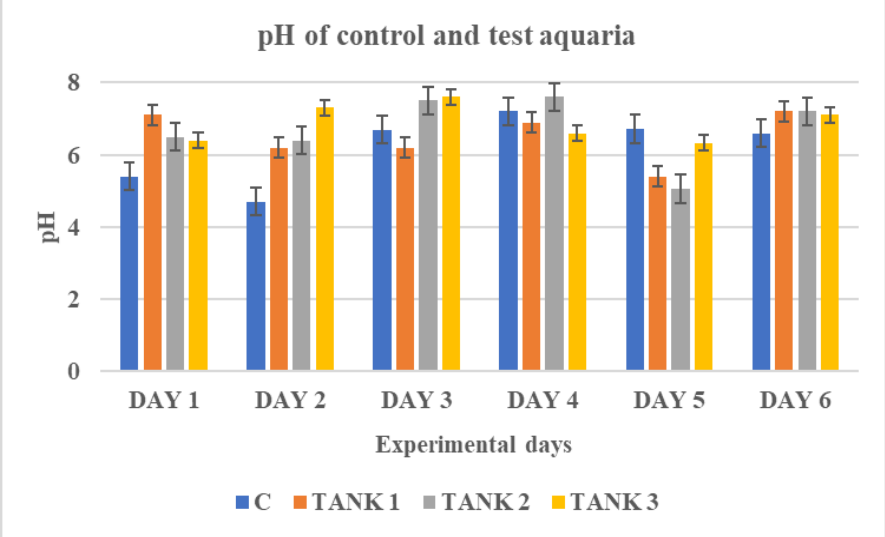

Figure 3. pH of control and test aquaria of Experimental days

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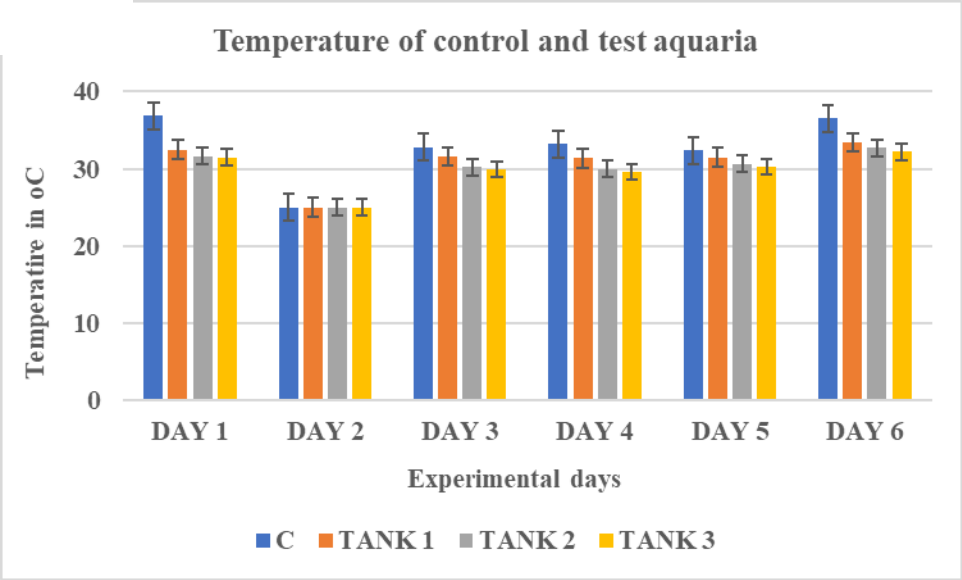

Figure 4. Temperature of control and test aquaria of Experimental days

Control and test aquaria were observed at every 2 hours in 10 hours of intervals Chlorpyrifos exposed aquaria tank fishes exhibited irregular, erratic, rushing swimming activities, loss of equilibrium, and sinking to the bottom (Plate B). In this study, fishes exposed to chlorpyrifos cause mortality which is tabulated in Table 1 &Plate C, shows that 30% of fish mortality registered on 3rd day of exposure, followed by 40, 80 and 100 percentage of mortality on the 4th, 5th and 6th hours of exposure.

Plate A: Showing the Control aquaria – normal swimming pattern

Plate B: Showing the erratic swimming of fish in test aquaria

Plate C: Showing the mortal fish removed from the test aquaria

Table 1*:* Mortality percentage of *Indian Major Carps*exposed to 100 ppm of chlorpyrifos

Hours	**Control (percentage)**	**100 ppm Chlorpyrifos exposed (percentage)**
Day 1	0	0
Day 2	0	0
Day 3	0	30
Day 4	0	40
Day 5	0	80
Day 6	0	100

The pesticide and its residues enter into various portals including gills, skin, and gastrointestinal tract the contaminants reach into the blood and subsequently to different organs or systems. Since Pesticides are known to modify the behaviour of animals when exposed to toxic levels. Moustafa A. Abbassy *et al*. [8] stated that p,p-DDE, P-DDD, and dieldrin pesticide residues in muscle, liver, and gills tissues of fish samples of Edko Lake in Egypt. Residues of OCPs might pose health implications if fish were consumed fresh. Accumulation of these persistent pesticides in body tissues because of consumption of contaminated fish might lead to acute or chronic health effects.

Behavioural irregularity is accord with Ramesh Halappa and Muniswamy David [12] in their research in Common carp fingerlings were exposed to different concentrations (0.120 to 0.200 mg/L) of an organophosphate pesticide, chlorpyrifos (20% EC) for 96 h. Fish in toxic media exhibited irregular, erratic, and darting swimming movements, hyperexcitability, loss of equilibrium, and sinking to the bottom. This irregular behaviour coincides with the current study which is tabulated in Table 2, at every 24-hour interval under two hours of observation the control and chlorpyrifos-exposed aquaria have their behavior notable and charted. The carp were found under stress, but mortality was insignificant in both the sublethal concentrations. Caudal bending was the main

morphological alteration during the exposure periods stated by Halappa and David according to contemporary study were noted the damage and the bending caudal fin were shown in Plate 3. The behavioural and morphological changes may be due to the inhibition of acetylcholinesterase activity.

Table 2: Showing the selected behavior response of control and chloripyrifos-exposed fishes

Experiment	Behaviour	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day
Control aquaria response	Loss of reflex	-	-	-	-	-	-
	Air gulping	-	-	*	*	*	*
	Erratic swimming	-	*	*	*	*	*
	Mucus secretion	-	-	-	-	-	-
	Jerky movement	-	-	-	-	-	-
	Leaping out of water	*	-	-	-	-	-
	Thick mucous covering over the whole body	-	-	-	-	-	-
Test aquaria response	Loss of reflex	-	*	**	**	***	***
	Air gulping	-	**	**	**	***	***
	Erratic swimming	*	***	***	***	***	***
	Mucus secretion	-	-	*	*	*	**
	Jerky movement	*	**	**	**	***	***
	Leaping out of water	*	*	**	*	*	*
	Thick mucous covering over the whole body	-	-	-	-	*	*

in an h(-) not exhibited, * < below 5 times in an hour, ** < below 10 times in an hour, *** < above 10 times hour. The current study in agree with Sameena Khan *et al*.,[13] concluded that the behavioural and genotoxic alterations in common carp Cyprinus carpio could be applied as possible biomarkers in risk assessment and monitoring programs for pesticide contamination of aquatic ecosystems. They stated that induced behavioural toxicity in

Cyprinus carpio such as a drop in swimming velocity reduced swimming activity, and retarded opercular movements on exposure to chlorpyrifos and dimethoate. In addition, they specified that behavioral changes may be caused by the changes in the nervous system triggered directly or through metabolic or physiological activities. These effects are diverse and known to differ at different concentrations.

Locomotion parameters are sensitive endpoints and useful biomarkers in behavioural studies of freshwater toxicity, the applied bioassay could be a valuable tool in water quality monitoring in connection with Eissa *et al.,* [3], investigated the impact of exposure to sublethal waterborne cadmium on locomotory parameters of three freshwater teleosts fishes *Cyprinus carpio*, *Australoheros facetum* (sin. *Cichlasoma facetum*) and *Astyanax fasciatus*, native to Pampean ecosystems in Argentina. Fish were exposed to cadmium solution in the medium and evaluated the swimming activity and speed of the fish. The cadmium metal provoked different responses of both parameters after 4–7 days of exposure. They concluded that studied species differed in their susceptibility to the toxicant as well as in their capacity to return to basal values.

Rao[12] made similar observations following RPR-V (a novel phosphorothionate insecticide, 2-butenoic acid-3-[diethoxy phosphinothionyl] ethyl ester) exposure to euryhaline fish, Oreochromis mossambicus. He concluded that an excess secretion of mucus in fish forms a non-specific response against toxicants, thereby probably reducing the toxicant contact. Mucus also forms a barrier between the body and the toxic medium, to minimize its irritating effect, or to scavenge it through epidermal mucus. Hossain *et al*., [5], findings were in harmony with the current results that they stated that the Fingerlings of three Indian major carps, *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* were exposed to different concentrations of chlorpyrifos for a period of 96 h of the tested concentrations, chlorpyrifos at a dose of 6.65 ppm, cadusafos at 2.0 ppm and diazinon at a dose of 8.40 ppm or above induced 100% mortalities within 96 h of exposure. In addition, they stated that pesticide-induced behavioural abnormalities included erratic movements, rapid operculum activities, jumping of fish out of the test media, violent spasms, and convulsions.

Holmstedt, *et al.,* [4] specified that *Indian Major Carps* exhibited irregular, erratic, and darting swimming movements and loss of equilibrium followed by hanging vertically in

water. The above symptoms may be due to inhibition of acetylcholinesterase (AChE) activity leading to accumulation of acetylcholine (ACh) in cholinergic synapses ensuing hyperstimulation. Since inhibition of AChE activity is a typical characteristic of organophosphate compounds.

Katja *et al*., [6] concluded that the gulping of air may help to avoid contact with the toxic medium and to ease respiratory stress which accords with the current study. The surfacing phenomenon i.e., significant preference of upper layers in exposed groups may be due to elevated demand for oxygen during the exposure periods.

According to Muralidharan *et al*. [9], the degree/rate of Organochlorine accumulation in fish is largely influenced by their feeding habits. Organochlorine pesticides are lipophilic and tend to accumulate in tissues with a high fat content that is characterized by low turnover rates which was deliberated by Borrell & Aguilar [1]. Toxicity produces histological and biochemical alterations in the organs of animals, these act as one kind of stress, so the organisms can respond to it by developing the necessary potential to counteract the toxicity stress which was discussed by Ogundiran *et al*., and Kamble SM *et al*., [10,15]. Dede [2] found a very low level of *Oreochromis niloticus* causes behavioural alterations, external morphology changes, and mortality of fingerlings.

Hutton and colleagues [14] selected three widely used pyrethroid pesticides (bifenthrin, cyfluthrin, and cyhalothrin) and subjected silverside embryos to each pesticide for 96 hours at a concentration of one nanogram. The results showed that the fish exposed to the pesticides at the larval stage exhibited hypoactive behavior, or decreased activity, which may have contributed to their reduced foraging behavior compared to the control group in the wild. In contrast, the fish in the second generation, who were not exposed to pesticides other than through their parents, exhibited hyperactive behavior, behaving overstimulated and swimming more than the control group.

Conclusion

Our study investigated the behavioral response of *Indian Major Carp* to Chlorpyrifos exposure significantly alters the behavioral patterns. The elusive variations were noted such as reduced foraging activity and increased erratic swimming behavior, these effects became more pronounced, with observable dysfunctions in swimming behaviour, opercular beating rate, and surfacing behaviour have been documented as sensitive indicators of physiological stress hyperactivity, erratic, undirected jerky swimming of fish with disruption of nervous and muscular coordination. These findings have significant implications for the management and regulation of Chlorpyrifos use in agricultural practices and highlight the importance of implementing measures to minimize its impact on non-target species. Future research should focus on elucidating the underlying mechanisms driving these behavioral changes and assessing the long-term ecological consequences of Chlorpyrifos exposure on aquatic communities.

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A STUDY ON IMPACT OF SOCIAL MEDIA ON ONLINE CONSUMER BUYING BEHAVIOR WITH REFERENCE TO TIRUCHIRAPPALLI DISTRICT

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Abstract

This study entitled "A study on impact of social media on online consumer buying behaviour with reference to Tiruchirappalli district". To understand the consumer buying behaviour in the mobile telephony industry, to understand how consumer actually make social media for buying decisions. The study is descriptive in nature. Primary data is collected from direct sources using methods like surveys, interviews. The primary data for this study was collected through structured questions from 30 respondents in Trichy. The sampling technique used in this study is snowball sampling. Statistical tools used for data analysis are percentage analysis and chi-square test. This study revealed that it helps to know the positive and negative impact among customers and to give suggestion to the marketers. Finally the study shows that social media has a great influence in the behaviour of the consumers and those who received the information on social media to be of higher quality and greater quantity than expectations were more satisfied overall.

***Keywords**:* Social media, Consumer, Buying behaviour

Introduction

Social media has become an essential part of our daily lives, transforming the way we communicate, share our experiences, and connect with others. However, its impact goes beyond socializing as it has significantly influenced the way we shop. Online shopping has become increasingly popular in recent years, and social media has played a crucial role in this shift. As these platforms have grown in popularity, businesses have recognized their potential to connect with customers and promote their products. This research explores the complex and multifaceted impact of social media on consumer behavior in online shopping, including the various factors that come into play.

Social media has become an essential tool for businesses looking to engage with consumers and promote their products (Alalwan et al., 2017; Chaffey & Smith, 2017; Mangold & Faulds, 2009). From Facebook and Instagram to Twitter and Pinterest, social media

platforms provide businesses with a powerful way to reach their target audience and connect with them on a personal level (Kaplan & Haenlein, 2010). In today's digitallandscape, businesses rely heavily on social media to market their products and services (Liang & Turban, 2011).

Moreover, social media allows businesses to create and share content that is specifically tailored to their audience (Shen & Bissell, 2017). This means that businesses can create engaging, relevant, and informative content that resonates with their target customers, helping to build a loyal following and drive sales. By building a strong social media presence and engaging with consumers on a personal level, businesses can establish themselves as credible and trustworthy sources of information and build long-term relationships with their customers. One of the key advantages of social media in online shopping is the ability to personalize and target advertising. Social media platforms allow businesses to gather data on consumers, including their preferences, demographics, and browsing behavior. This data can be used to create highly personalized and targeted advertising campaigns that resonate with consumers and drive sales. By leveraging this data, businesses can deliver more relevant and meaningful advertising to their target audience, leading to increased engagement and conversions. Social media platforms also provide businesses with a way to engage with customers in real-time, gather feedback, and address concerns quickly.Social media has had a profound impact on consumer behavior in online shopping, and businesses have come to rely heavily on these platforms to connect with their customers and drive sales. From building trust and credibility with consumers to providing valuable feedback on products and services, social media offers businesses a range of advantages that have helped to transform the way they market and sell their products. However, with these advantages come challenges as well, and businesses must be prepared to navigate the ever-changing landscape of social media in order to succeed in today's digital marketplace. By understanding the impact of social media on consumer behavior and developing effective social media strategies, businesses can build strong relationships with their customers and drive long-term growth and success.

Literature Review

Lilima (2020) The research arguably the most fundamental unique element of social media which influences consumer purchase behavior is the ability of social network platforms to promote dual forms of communication between the user and the firm.

Kirti (2019) The study shows that social networking sites shows different variety of goods with new brands available in the market. They also provide information about the different brands of different products. Social media sites provide lots of comments and feedback about the desired products. As a result, the consumer gets the necessary information on the different products of the different brands.

Gulzar and Maqbool (2018) The researcher founds that Social media is about creating high quality contents that are consumer relevant and as such more focused towards building relationships between consumers and companies. Social media marketing has offered consumers a tremendous amount of accessibility and transparency of relevant information. Social media influences consumer mindsets and their intention to buy.

Putter (2017) This study examine the emerging focus of marketers is on the use of user generated content that is created by consumers in response to specific brands and influences the perception of other consumers. Factors that influence brand perception and intention to buy include things like views of others posted demonstrated in social media posts.

Research Methodology

Research Design

Research design is a blueprint for conducting research aimed at answering the research question. The design of the study is descriptive in nature.

Importance of the Study

This study helps to know the positive and negative impactson customers and to give suggestions to marketers. The importance of the study is to understand consumer buying behavior towards social media.

Objectives of the Study

- To study online consumer buying behavior and awareness on social media to identify the online communities to share information ideas.
- To study the factor influencing consumers' buying behavior.
- To know the satisfaction level of consumers towards online buying behavior.

Sampling Method

A convenient sampling method is used to collect the data from the respondents.

Limitations of the Study

- This study is limited to Tiruchirappalli hence it cannot be generalized.
- Consumers often change their preferences and responses in time and hence there is a possibility of certain unreliable data.
- A limited number of respondents i.e., 30 surveys is confined for this study.

Data Analysis and Interpretation

Table 1: Demographic Profile

S.No	Age	Total Number Of Respondents
1	18-25	15
2	26-35	10
3	36-45	3
4	45 and above	2
	Total	**30**
S.No	**Gender**	**Total Number of Respondents**
1	Male	17
2	Female	13
	Total	**30**
S.No	**Marital status**	**Total Number of Respondents**
1	Married	20
2	Unmarried	10
	Total	**30**
S.No	**Educational Qualification**	**Total Number of Respondents**
1	PG	12
2	UG	8
3	Diploma	4
4	HSC	6
	Total	**30**
S.No	**Designation**	**Total Number of Respondents**
1	Student	7
2	Homemaker	12
3	Private employee	18
4	Government employee	3
	Total	**30**

S.No	Annual income	Total Number of Respondents
1	Rs. 1-3 lakhs	15
2	Rs. 3-5 lakhs	12
3	Rs. 5-10 lakhs	8
4	Above 10 lakhs	2
	Total	**30**

Source: Primary Data

Interpretation

The above table shows that 15% of respondents fall under the age group 18-25, 17% of respondents are male, 20% of respondents are married, 12% of respondents are post-graduates, 18% of respondents are private employees, 15% of respondents are belongs to annual income Rs.1-3 lakhs.

Hypothesis

H0- There is no significance difference between age and social media app
H1- There is a significance difference between age and social media app

Table 2: Test Statistics

	Age	**Social Media**
Chi-Square	8.600[a]	17.733[b]
Df	2	3
Asymp. Sig.	.014	.000
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 10.0.		
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		

Interpretation

From the table, the p-value (.014) is less than a significant level (0.05) it accept the alternative hypothesis and concludes that there is a significance difference between age and social media.

Hypothesis

H0- There is nosignificance difference between low-price and trendy goods

H1- There is a significance difference between low-price and trendy goods

Table 3: Test Statistics

	Offer low price	**Trendy Goods**
Chi-Square	12.667[a]	16.667[a]
Df	4	4
Asymp. Sig.	.013	.002
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		

Interpretation

From the table, the p-value (.013) is less than a significant level (0.05) it accepts the alternative hypothesis and concludes that there is a significance difference between offering low price and trendy goods.

Hypothesis

H0- There is no significance difference between educational qualification and product information

H1- There is a significance difference between educational qualification and product information

Table 4: Test Statistics

	Educational Qualification	**Product Information**
Chi-Square	9.733[a]	11.667[b]
Df	3	4
Asymp. Sig.	.021	.020
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		

Interpretation

From the table, the p-value (.021) is less than a significant level (0.05) it accepts the alternative hypothesis and concludes that there is significance difference between educational qualification and product information.

Hypothesis

H0- There is no significance difference between annual income and age
H1- There is a significance difference between annual income and age

Table 5: Test Statistics

	Annual Income	**Age**
Chi-Square	16.133[a]	8.600[b]
Df	3	2
Asymp. Sig.	.001	.014
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 10.0.		

Interpretation

From the table, the p-value (.001) is less than significant level (0.05) it accepts the alternative hypothesis and concludes that there is significance difference between annual income and age.

Hypothesis

H0- There is no significance difference between annual income and efficient transaction
H1- There is a significance difference between annual income and efficient transaction

Table 6: Test Statistics

	Annual Income	**Efficient in Transaction**
Chi-Square	16.133[a]	31.000[b]
Df	3	4
Asymp. Sig.	.001	.000
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		

Interpretation

From the table the p-value (.000) is less than the significant level (0.05) it accept the alternative hypothesis and concludes that there is significance difference between annual income and efficient transaction

Hypothesis

H0- There is no significance difference between annual income and offers and discounts
H1- There is a significance difference between annual income and offers and discounts

Table 7: Test Statistics

	Annual Income	**Offers and discounts**
Chi-Square	16.133[a]	12.333[b]
Df	3	4
Asymp. Sig.	.001	.015
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		

Interpretation

From the table the p-value (.001) is less than the significant level (0.05) it accept the alternative hypothesis and concludes that there is significance difference between annual income and offers and discounts.

Hypothesis

H0- There is no significance difference between time-saving and quick deliver

H1- There is a significance difference between time-saving and quick deliver

Table 8: Test Statistics

	Time Saving	**Quick delivery**
Chi-Square	27.667[a]	17.667[a]
Df	4	4
Asymp. Sig.	.000	.001
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		

Interpretation

From the table the p-value (.001) is less than significant level (0.05) it accepts the alternative hypothesis and concludes that there is significance difference between timesaving and quick deliver

Hypothesis

H0- There is no significance difference between quick delivery and buying from the shop

H1- There is a significance difference between quick delivery and buying from shop

Table 9: Test Statistics

	Quick Deliver	**Buy from Shop**
Chi-Square	17.667[a]	9.733[b]
Df	4	3
Asymp. Sig.	.001	.021
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		
b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		

Interpretation

From the table, the p-value (.021) is less than significant level (0.05) it accepts the alternative hypothesis and concludes that there is significance difference between quick delivery and buy from the shop

Hypothesis

H0- There is no significance difference between designation and social media

H1- There is a significance difference between designation and social media

Table 10 : Test Statistics

	Designation	**Socialmedia**
Chi-Square	11.067[a]	17.733[a]
Df	3	3
Asymp. Sig.	.011	.000
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 7.5.		

Interpretation

From the table the p-value (.000) is less than significant level (0.05) it accepts the alternative hypothesis and concludes that there is significance difference between designation and social media.

Hypothesis

H0- There is no significance difference between efficient in transactions and easily located

H1- There is a significance difference efficient in transactions and easily located

Table 11: Test Statistics

	Efficient in Transaction	**Easily Located**
Chi-Square	31.000[a]	33.667[a]
Df	4	4
Asymp. Sig.	.000	.000
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.		

Interpretation

From the table the p-value (.000) is less than significant level (0.05) it accepts the alternative hypothesis and concludes that there is significance difference in efficient in transactions and easily located

Conclusion

The overall conclusion of the study is that social media drives consumers' intention to buy. However, there is a need to enhance the social media campaign to stimulate consumers' interest using the correct social media variables. The study concludes that the most engaging social media variable is social media word of mouth. Viral communication on social networks circulates faster and is more believable than information generated by the company. The study concludes that company-generated content negatively affects consumer intention. Therefore, mobile telecom companies shouldminimize their generated posts and promote user-created posts and sponsored word-of-mouth marketing. The study also concludes that social media platforms in themselves do not drive intended purchase behavior. Therefore, companies may run social media campaigns on any social platform. The major weakness of the study was that the model used was never empirically tested before. Upon a successful test in this study, we recommend future researchers to further test the model in different environments to enhance its robustness. Future researchers may also consider adding the influence of the mediating effect of age and gender on social media marketing and purchase behavior.

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SMART HOME AUTOMATION SYSTEM USING INTERNET OF THINGS

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Abstract

Smart Home Automation system using Internet of things has an architecture which includes remote servers with sensors. The servers are located on the cloud, which can manage any number of sensors at the same time. This paper outline about the working of various sensors which is used to automate the smart home, that minimize the human work and reduce the utilization of the power resources. It also gives the clear explanation about the various working aspects of the sensors and other IOT devices. IOT devices are pieces of hardware components such as sensors, gadgets, appliances and machines, that are programmed for certain applications. This process can transmit the data over the internet or other networks. Network, it a multiple devices are interconnected to each other in order to make a communication over the internet or any other network. Smart devices in our home are connected together and they are controlled by a master home automation controller, which is also referred as smart home hub. IOT based Smart home automation mostly works on with wireless communication protocol. This paper lists the most notable and apparent advantage of IOT.

Keywords: Sensors, Gadgets, Smart Home, Motion Capture, Network, Data Transmission.

I. Introduction

An Intelligent House

An intelligent house always keeps you in the stay informed and in control of everything happening in and around our home, whether we are in the kitchen or across the world [1]. All the smart devices in the home are connected together and they are controlled by a master home automation controller, which is referred as the smart home hub. Hub is the hardware device that acts as the major central point of the smart home system. The devices can process, senses the data and communicate wirelessly.

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Sensors

Sensors are used for sensing things and the devices acts as the detection device. A device that provides a usable output in response to a specified measurement. The output of the sensor is a signal which is converted to a human readable form.

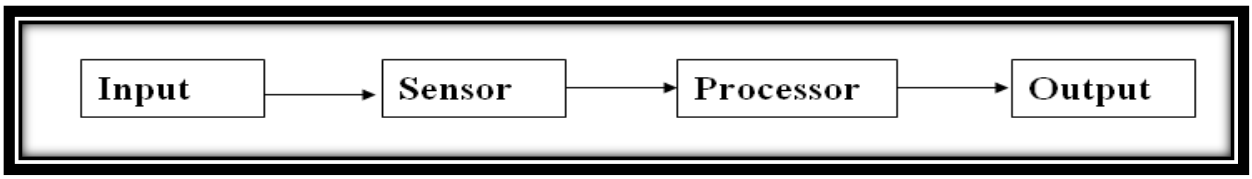

Figure 1. Data Processing Method of the Sensors

II. Cloud Based Networking

Cloud based networking involves storage and maintenance of data over the Internet location. The user has flexibility to access the data from any location of the world. Real time monitoring and notification is one of the key features of IOT based automation**.**

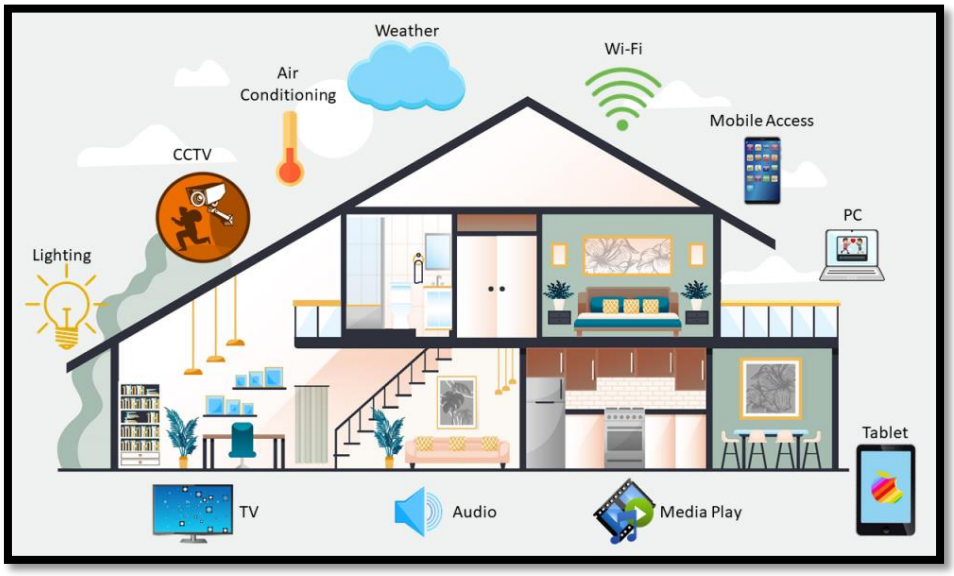

Figure 2. Smart Home Automation System

III. Sensors - The IoT Hardware

Sensors help us to create a smart home, the basic sensors that make a home as a automated home.

a) **Fire Detection:** Fire is the number one cause of property damage. Fire detection sensors detect smoke and harmful gases and monitor the overall air quality in the home.

b) **Open and Close Door Sensors :** This kind of sensors will let us to know when people are entering and learning the house and even turn lights on and off as doors are opened and closed.

c) **Video Doorbell:** The Video doorbell is a theft Deterrent sensor. This device allows you to see who is at our door from our smart phone.

d) **Motion Sensors:** It detects motion and movements in our home. It stands as a guard for our home. Motion sensors can be connected to smart cameras, where it can automatically capture or activate the footage of Intruders**.** Motion sensors will instantaneously notify the user through E-mail, SMS, Calls or App Notifications. It detects unwanted motion or intrusion, and the user is alerted through the Applications [2]. User can quickly turn on the IOT based home security smart camera to check the status of the unwanted motion from any location around the world.

Figure 3. Motion Sensors

IV. HUB

Hub is a gateway; network hardware device for connecting multiple networking devices together and making them act a single network segment. It acts as the major central point of the smart home system. Intercom hub is common connection point, which is known as network hub.

The device data transmission that is connected to hub can process, senses and communicate wirelessly [3]. Hub is used to receive the input and communicates the output to the network located over the Internet. It transfers the signals to the target sensor and the desired action takes place, new status data is uploaded in the cloud networks.

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a) Intercom – HUB

A sensor has been installed to create a smart home. It should be managed from one location and that is our HUB. The smart home hub and intercom system allows us to access all the sensors via our smart phone [4]. IOT Sensors can use wireless technology such as the Bluetooth, Zig Bee, Wifi and Z-wave for the data communication.

Figure 4. Wireless technologies for Data Communication

Bluetooth : Bluetooth is a short range wireless technology standard that is used for exchanging of data.

Zig Bee : Zonal Inter Communication Global Standard. It is a standard based wireless technology. Zig bee protocol supports the mesh network structure.

Wifi : Wireless fidelity, It belongs to the family of wireless network protocol. It helps the users to connect to the internet wirelessly with the help of Wifi router. It is a technology that connects devices to the internet using radio frequency.

Z – Wave: Z Wave is a wireless communication protocol used primarily for residential and commercial building automation. It is primarily used in smart home network, allowing smart devices to connect and exchange data.

b) Smart Lighting

Smart lighting allows us to turn ON/OFF the entire house when the person is leaving or arriving.

c) Smart Home CCTV and Smart Home Camera

Smart camera is designed to monitor and record activities in and around the home. [5]. These camera are connected to our home's wireless network, allowing us to access them remotely through our smart phone, tablet or computer. Smart home Closed circuit television is known as Video surveillance closed circuits means broadcasts are limited to a selected group of monitor.

Surveillance cameras are designed to monitor our homes to warn us in the event of an incident or intrusion [6]. It is mostly dedicated to the detection of intrusions and being able to detect and prevent burglaries.

Smart security camera features: Remote Video monitoring, Two way audio communication, Motion detection alerts, Smart recording and playback, Starlight – low light performance, Advanced Video Analytics, Long range infra red night vision.

Figure 5. Smart Camera

How the smart security camera works?

IOT based home security smart camera to check the status of the unwanted motion from any location around the world. Surveillance cameras are designed to monitor our homes to warn us in the event of an incident or intrusion. It is mostly dedicated to the detection of intrusions and being able to detect and prevent burglaries.

Smart home cameras store the images on the SD card that is inserted directly into the camera. Wifi cameras usually send the video footage directly to a cloud, Footage is even send to the smart phone or tablet.

Benefits of smart home CCTV: Smart home security system offers 24/7 protection which protects our belongings. This IOT device monitors more than any other real time devices. It saves money and integrated well home automation and we can access our security camera from any part of the world.

d) Smart Lock

A smart lock is an electro mechanical lock that is designed to perform locking and unlocking operation on a door via an electronic keypad, biometric sensors, access card, Bluetooth or Wifi from a registered mobile device [7] .Smart locks with built in connectivity of IOT

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devices allow you to lock and unlock our front door remotely, using an App and it can be also paired with smart home security systems. Digital lock comes with fingerprint sensors, RFID cards Radio frequency Identification refers to a wireless system comprised to RFID tags and RFID reader, Personal Identification Number –PIN, and One time password-OTP. In addition to this smart lock, smart door has been modeled with IOT, in future our door can be unlocked with facial recognition.

Figure 6. Smart Lock Using the Finger Print

e) Smart Door

The doors of our future will not need keys. To unlock our house, the smart door can use facial recognition. We can trigger consecutive reactions of other devices in our home, such as light switching, fan and television can be turned ON [8]. These are all possible with the configuration of the connectivity in the smart door.

f) Smart Doorbells

The Smart door bells camera gives us a clear view of who is outside of our door. *ARLO ESSENTIAL VIDEO DOORBELL* can capture the view of 180^0 of our front side view and records the video footage up to 5minutes in length [9]. It is a IOT device that is very strong in distinguishing between the people, animals and packages.

Figure 7. Smart Doorbells

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g) Smart Speakers

Smart Speakers will play any kind of music which we want to listen, anytime, with a simple voice command. In addition to this feature we can listen to audio books, play games or ask alexa or google to tell you a joke. The three best smart speakers are Amazon's Alexa, Google Assistant and Apple's Siri.

Figure 8. Smart Speakers

h) Smart Home Devices

In addition to the above mentioned devices, the well modified devices are present in the real world market to make our home more automated and very secured [10]. The top internet of things devices are Google Home Voice controller, Amazon Dash Button, Amazon echo voice controller, Philips Hue Hue go, August Doorbell Cam, August Smart Lock, Canary, Nest smoke alarm, Mr Coffee Smart coffee marker, Google Nest is a line of smart home products including smart speakers, smart displays, streaming devices, thermostats, smoke detectors, routers and security systems which includes smart door bells, smart locks and smart cameras.

V. Conclusion

We conclude this paper by highlighting the various aspects of the IOT devices. IOT devices have been taken the place of traditional devices and entered in all the spheres of our lives from home to real time environment. IOT devices are purely integrated with high definition technology, which helps us to communicate or interact over the internet and also it can be manager and controlled remotely from any part of the globe. This paper gives a brief knowledge about the Internet of Things, IOT based home automation system mostly works with the wireless communication protocol. Protocol is defined as a set of rules and regulations that should be followed during implementation of network establishment in the automation of smart home. We say that Internet of things devices to take over the whole world in the upcoming future. Internet of things technologies will penetrate almost all spheres of our daily life and make our lives more comfortable and protected.

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AN ANALYSIS OF CUSTOMER SATISFACTION TOWARDS ONLINE SHOPPING IN TIRUCHIRAPPALLI CITY

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Abstract

In the time of globalization, electronic promotion is an extraordinary insurgency. Over the final decade greatest trade organizations are running with mechanical alter. Online shopping or promoting is the utilization of innovation (i.e., computer) for way better showcasing execution. Retailers are formulating procedures to meet the requests of online customers; they are active in considering shopper behavior in the field of online shopping, to see the customer demeanors towards online shopping. Subsequently, have too chosen to consider consumer's demeanors towards online shopping and particularly examine the variables affecting buyers to shop online.

Keywords: Customer Satisfaction, Customer Behavior, Online Shopping.

Introduction

Online shopping makes it possible for customers to buy products, services, etc. It describes the act of making instantaneous, direct purchases from online vendors without the need for mediocre service. The act of buying products and services from retailers online is known as online shopping. Since the advent of the World Wide Web, retailers have attempted to offer their goods to customers online. Customers can shop while seated in front of their computers and visit online retailers from the comfort of their homes.

Online retailers sell a wide variety of goods to consumers. Nearly anything is available for purchase from businesses who sell goods online. An extensive selection of hundreds of products, including books, clothes, appliances, toys, hardware, software, and health insurance, are available for purchase from online retailers. Because it's convenient, a lot of individuals choose to shop online. It explores countless options and even finds things that aren't sold in stores when we shop online.

Online shopping removes the necessity of rummaging through a store's inventory, carrying large purchases like shirts, belts, shoes and pants under one arm. The main idea behind the program is to enable online shopping for clients and to let them browse the store and select the products and items they want. The product statistics are stores at the server

facet (shop). The clients and the things are shipped to the deal with information submitted through them is handled by the server. The application is initially divided into modules for customers who wish to purchase articles. The second is for the storekeepers who maintain and update the documentation regarding the items and the customers'.

Objectives of the study

- To assess the overall level of customer satisfaction.
- To identify the factors influencing customer satisfaction.
- To evaluate the customers' perception of online shopping.
- To explore the challenges faced by online shopping.

Importance of the study

Customer satisfaction has been recognized as an important element that drives the customer retention and loyalty. Creating happy customers is difficult especially in the online environment an environment where interaction between company personnel and the customer is minimal. Customer satisfaction is critical to establishing long-term client relationships and maintaining profitability, so understanding the factors leading to a satisfied customer is of the utmost importance. For this reason, this study examines customer satisfaction with different dimensions of service quality in online shopping.

Data Collection

- Both primary and secondary data can be adopted in thisstudy in order to collect the most accurate information.
- Primary data gathered using the questionnaires. Secondary data were collected through books, journals and websites.

Research Design

The research design is a logical and systematic plan prepared for directing a research study. The convenience sampling techniques were adopted for this study.

Limitations of the Study

- The study is confined to Tiruchirappalli city only.
- The study is based on the customer behaviors of online shopping.

Review of Literature

Chen and Dubinsky 2019, Everybody makes comparable assertions. The lists of factors that influence a customer's inclination to shop in physical stores and online don't seem to differ all that much. However, people's sensitivity to each element can differ greatly in virtual markets. Depending on whether a customer is buying online or in-store, there might be significant differences in price sensitivity, brand relevance, and the kinds of possibilities that are investigated.

Kwak Miyazaki and Fernandez 2018, Higher educated individuals typically have more power over the entire purchasing process and are more likely to make tighter demands due to their enhanced knowledge and self-confidence.

Emmanouilides and Hammond 2018, It is not very possible to forecast someone's likelihood of making an online purchase based on their demographics. The consumer's lifestyle, including whether or not he is connected, and any time restraints, also play a big part. The capacity for risk-taking is also essential. Customers who shop online are more prone to take chances. Consumers who shop online for cheaper prices but resist this because they want to fully benefit from the environment's informative advantages because they are worried about their personal information being compromised.

Andrews and Currim 2018, A customer's understanding, degree of trust, and preference for the convenience and financial benefit of online buying over alternative options all influence how they view the advantages and disadvantages of this arrangement.

Rao et al., 2016, Understanding whether or not buyers wind up making a purchase in an online marketplace depends on figuring out their pre-purchase intents. One area of research on online consumer behaviour is the examination of the variables that influence these choices. Among the factors examined are transaction security, supplier quality, pricing considerations, information and service quality, system quality, privacy and security risks, trust, the enjoyment of online shopping, and the perceived quality of the products.

Teo et al., 2017, It is still very likely that more research will be done to fully understand all the factors impacting consumers' pre-purchase intentions. Comet's head of direct channels, Simon Rigby, explains: "Our goal is to satisfy the needs of as many customers as possible." We can better serve our customers if we conduct daily study into their interests and

behaviour. We are thus able to offer a range of goods and services, as well as fundamental degrees of assurance.

Emarketer 2015, Reviewed research that showed that the Internet was more influential than offline media on the purchase of consumer electronics, but not on the purchase of clothing, beauty products, or home improvement products. The practice of buying and selling goods and services has been revolutionized by internet marketing. It has simplified and streamlined the shopping experience in many ways.

Data Analysis and Interpretation

Table 1: Demographic Profile of the Respondents

Factors	**Category**	**No. of Respondents**	**Percentage (%)**
Gender	Male	40	40
	Female	60	60
Age	Below 20 years	25	25
	21 - 30 years	35	35
	31 - 40 years	22	22
	Above 40 years	18	18
Location	Village	20	20
	Town	30	30
	City	50	50
Profession	Student	40	40
	Business	25	25
	Professional	25	25
	Service	10	10
Educational	Higher Secondary	10	10
	Graduate	50	50
	Post Graduate	35	35
	Illiterate	05	05
Family status	Nuclear family	62	62
	Joint family	38	38
	Below Rs. 10,000	20	20

Monthly Income	Rs.10,001to Rs. 20,000	25	25
	Rs.20,001 to Rs. 30,000	35	35
	Above Rs. 30,000	20	20
Onlineshopping websites	Flipkart.com	40	40
	Amazon.com	30	30
	Myntra.com	12	12
	Snapdeal.com	10	10
	Olx.com	08	08
Sources of awareness	Online Advertisement	60	60
	Offline Advertisement	07	07
	Friends	23	13
	Newspaper	04	04
	Television	06	06
Product purchased	Electronics	15	15
	Mobiles	21	21
	Computer	04	04
	Home appliances	10	10
	Games	02	02
	Garments	04	04
	Footwear	07	07
	Watches	08	08
	Jewels	02	02
	Men’s Accessories	11	11
	Women’s Accessories	10	10
	Baby care	02	02
	Books	04	04
Preference	Time saving	40	40
	Information Availability	10	10
	Less Stress	05	05
	Less Expensive	20	20
	Best Offers	10	10
	Service Quality	15	15

Frequency of Purchase	Daily	10	10
	Weekly	19	19
	Monthly	51	51
	Yearly	20	20
Mode of Payment	Credit cards	20	20
	Debit cards	20	20
	Online bank transfer	10	10
	Cash on delivery	50	50

Source: Primary Data

Interpretation

From the above table, it is interpreted that majority 60% of the respondents are female, 35% percentage of the respondents are falling under the category of below 21 - 30 years age group, 50% percentage of the respondents are falling under the category of City location, 40% of the respondents are in students, 50% of the respondents are Graduate level, 62% of the respondents are belonging to nuclear family, 35% of the respondents are earning the monthly income Rs. 20,001 to Rs. 30,000 only, 40% of the respondents visited Flipkart.com,60% of the respondents get awareness about websites through online advertisement and 21% of the respondents purchased Mobiles via online channels.

Table 2: Level of Satisfaction of the Respondents

Factors	**Opinion**	**No. of Respondents**	**Percentage (%)**
Choice of availability of products	Strongly Disagree	06	06
	Disagree	04	04
	Neither Agree nor Disagree	26	26
	StronglyAgree	54	54
	Agree	10	10
Facts consider before online Shopping	Product Rating	26	26
	Product Review	40	40
	Advise for offline store	04	04
	Comparison of price	20	20
	Referred by friends	10	10

Detailed information about the product	Strongly Disagree	02	2
	Disagree	08	08
	Neither Agree nor Disagree	22	22
	Strongly Agree	20	20
	Agree	48	48
Easy to choose and make comparison with other products	Strongly Disagree	01	01
	Disagree	09	09
	Neither Agree nor Disagree	30	30
	Strongly Agree	10	10
	Agree	50	50
Quality of information provided in online shopping	Strongly Disagree	02	02
	Disagree	02	02
	Neither Agree nor Disagree	30	30
	Strongly Agree	18	18
	Agree	48	48
Website layout helps in searching the products easily	Strongly Disagree	06	06
	Disagree	02	02
	Neither Agree nor Disagree	24	24
	Strongly Agree	18	18
	Agree	50	50
Safe and secure with online shopping	Strongly Disagree	08	08
	Disagree	14	14
	Neither Agree nor Disagree	26	26
	Strongly Agree	40	40
	Agree	12	12

Source: Primary Data

Interpretation

From the above table, it is interpreted thatmajority 54% of the respondents Strongly Agree with the choice of products available in Online shopping, 48% of the respondents Agree with the detailed information about the products in Online shopping,50% of the respondents Agree with the easy to choose and make comparison with other products,48% of the respondents Agree with the Quality of Information provided inonline shopping, 50% of the respondents Agree with the Website layout helps in searching the products easily and 40% of the respondents Strongly Agree with the Safe and secure with online shopping.

Table 3: Problems faced by the Respondents while Online Shopping

S. No.	Problems	**No. of Respondents**	**Percentage (%)**
1	The product did not arrive at all	08	08
2	The product arrived in a damaged condition	16	16
3	The wrong product was sent	08	08
4	Not quality goods & services	14	14
5	Others	04	04
6	None of these	50	50

Source: Primary Data

Interpretation

From the above table,indicates thatmajority 50% of the respondents did not face any of the problems in online shopping.

Findings

- Majority 60% of the respondents are female
- 35% percentage of the respondents are falling under the category of below 21 - 30 years age group
- 50% percentage of the respondents are falling under the category of City location
- It is disclosed that majority 40% of the respondents are students
- Majority 50% of the respondents are Graduate level
- Majority 62% of the respondents are belonging to nuclear family
- Majority 35% of the respondents are earning the monthly income Rs. 20,001 to Rs. 30,000 only

- Majority 40% of the respondents visited Flipkart.com.
- Majority 60% of the respondents get awareness about websites through online advertisement
- Majority 21% of the respondents purchased Mobiles via online channels
- Majority 40% of the respondents Prefer online shopping for time saving
- Majority 51 % of the respondents make purchase on Online Shopping Monthly
- Majority 50 % of the respondents make payment through Cash on delivery in online shopping
- Majority 54% of the respondents Strongly Agree with the choice of products available in Online shopping
- Majority 48% of the respondents Agree with the detailed information about the products in Online shopping
- Majority 50% of the respondents Agree with the easy to choose and make comparison with other products in Online shopping
- Majority 48% of the respondents Agree with the Quality of Information provided in Online shopping
- Majority 50% of the respondents Agree with the Website layout helps in searching the products easily
- Majority 40% of the respondents Strongly Agree with the Safe and secure with online shopping
- Majority 50% of the respondents did not face any of the problems in online shopping

Suggestions

Online shopping is becoming more popular day by day with the increase in the usage of World Wide Web known as www. The customer's need for online selling has become challenge for marketers. The consumer's attitudes towards online shopping, making improvement in the factors that influence consumers to shop online and working on factors that affect consumers to shop online will help marketers to gain the competitive advantage over others.

Conclusion

Online shopping has truly revolutionized and influenced our society as a whole. This use of knowledge has opened new doors and opportunities that enable for a more suitable

lifestyle today. Variation, quick service and reduced prices were three significant ways in which online shopping influenced people from all over the world. However, this concept of online shopping led to the potentials of fraud and privacy conflicts. It has shown that it is possible for criminals to use the system and access personal information.

Today with the latest features of skill, measures are being taken in order to stop hackers and criminals from unsuitably accessing private databases.Through privacy and security policies, website creators are doing their best to put an end to this immoral practice. By doing so, society will stay to depend upon online shopping, which will allow it to remain a wonderful success in the future.

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REAL TIME WATER QUALITY MONITORING SYSTEM USING IOT

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Abstract

Water pollution is one of the main threats in recent times. The polluted water can cause various diseases to humans and animals, which in turn affects the ecosystem. If water pollution is detected in an early stage, suitable measures can be taken and critical situations can be avoided. To make certain the supply of pure water, the quality of the water should be examined in real-time. Smart solutions for monitoring of water pollution are getting more and more significant these days with innovation in sensors, communication and Internet of Things (IOT) technology.[1]

This paper proposes a cost effective and efficient IoT based smart water quality monitoring system which monitors the quality parameters uninterruptedly. The developed model is tested with three water samples and the parameters are transmitted to the cloud server for further action. The conventional method of testing water quality is to gather samples of water manually and send to the lab to test and analyze. It is time consuming, wastage of man power, and not economical. The water quality measuring system that I have implemented to check the quality of water in real time through various sensors (one for each parameter: pH, turbidity, temperature) to measure the quality of water. Turbidity is a one which indicate the presence of Pathogens, absorbs the pollutants such as nutrients, metals and organic compounds. Turbidity level changes daily. Regular monitoring is necessary. Turbidity sensors are used to measure water quality in a variety of settings, including drinking water treatment plants, industrial wastewater treatment plants, and private water supplies.

The ESP32 module in the system transfers data collected by the sensors to the microcontroller wirelessly, and an IOT technology transfers wirelessly the data further from the microcontroller to the smart phone/PC. In this paper, a detailed review of the latest work implemented in the arena of smart water pollution monitoring system is presented.

Keywords: IOT, The ESP32 module, deteriorated, Ubi dots Cloud Service.

Introduction

Water is one of the most essential natural resource that has been gifted to the mankind. But the rapid development of the society and numerous human activities speeded up the contamination and deteriorated the water resources. For above water quality monitoring is necessary to identify any changes in water quality parameters from time-to-time to make sure its safety in real time [2]. The three main categories of Water Quality parameters are Physical, Chemical and Biological. The Physical parameter includes Temperature and Turbidity. Chemical Parmeter include Acidity, Alkalinity. Biological Parameter include bacteria, nutrients etc.[3].

Among the above parameters, Turbidity, Acidity and Alkalinity and temperature are analyzed using the sensors in this paper. There are lot of challenges and limitations in water quality sensors. Even though, there are certain challenges by proper routine maintenance, we can keep the sensors in working condition. The necessity for IoT technology is to indicate the turbidity level of water to CPSB and through which to other monitoring stations indicate the muddy level contamination of water (Turbidity checking) , thus avoids the water pollution supplied to all the stations. To lessen the water related illnesses and prevent water contamination, we need to quantify water parameters, for example, pH, Turbidity, Temperature, Dissolved Oxygen, Salinity. For exact observing of water quality, we built up an IoT based water quality measurement system which is low cost and sustainable[4][5]. The Central Pollution Control Board (CPCB) has established a series ofmonitoring stations on water bodies across the country which monitor the water quality either monthly or yearly basis. This is done to ensure that the water quality is being maintained or restored at desired level. It is important that it is monitored on regular basis.

Water quality monitoring helps in evaluating the nature and extent of pollution control required, and effectiveness of pollution control measures. All the stations will operate in real time and central station can access data from any of the above stations using GPRS/GSM or 3G cellular services. State pollution boards and CPCB zonal offices can also access data from central station. Large amount of data can help to take right decisions and also to implement intime accordingly.

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Proposed System

Nowadays, water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. Pure water has 7pH value, less than 7pH has acidic, more than 7pH has alkaline. The range of pH is 0-14. For drinking purpose it should be 6.5-8.5pH. Turbidity measures the large number of suspended particles in water that isinvisible. Higher the turbidity higher the risk of diarrhea, cholera, etc. Lower the turbidity the water is clean. Temperature sensor measures how the water is, hot or cold. Flow sensor measures the flow of water through flow sensor. Figure-1 shows the block diagram of the system.

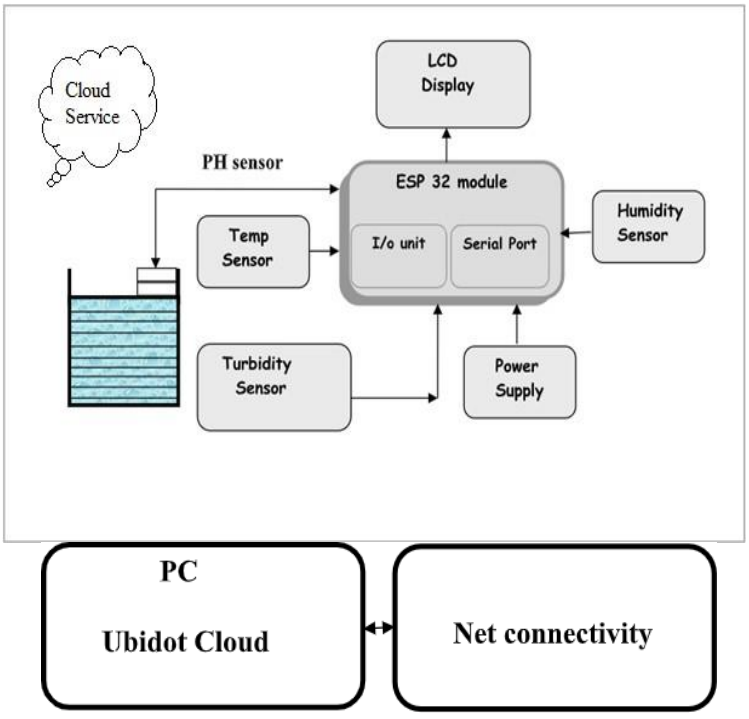

Figure 1: Block Diagram of Proposed System

In this proposed block diagram several sensors (temperature, pH, turbidity, DHT(11) is connected to ESP32 controller. The core controller is accessing the sensor values and process them to transfer the data through internet. ESP32 is used as a core controller. The sensor data can be viewed on the internet Wi-Fi system in Ubi dots Cloud Service.

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ESP32 Microcontroller

The ESP32 is a series of low-cost and low-power System on a Chip (SoC) microcontroller developed by Express if that include Wi-Fi and Bluetooth wireless capabilities and dual-core processor. The ESP32 is successor of ESP8266, loaded with lots of new features. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single core variations, but Xtensa LX7 dual-core microprocessor or a single core RIVSC microprocessor includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. Figure-2 and Figure-3 shows the functional block diagrams of WiFi and Bluetooth module of ESP32 Microcontroller.

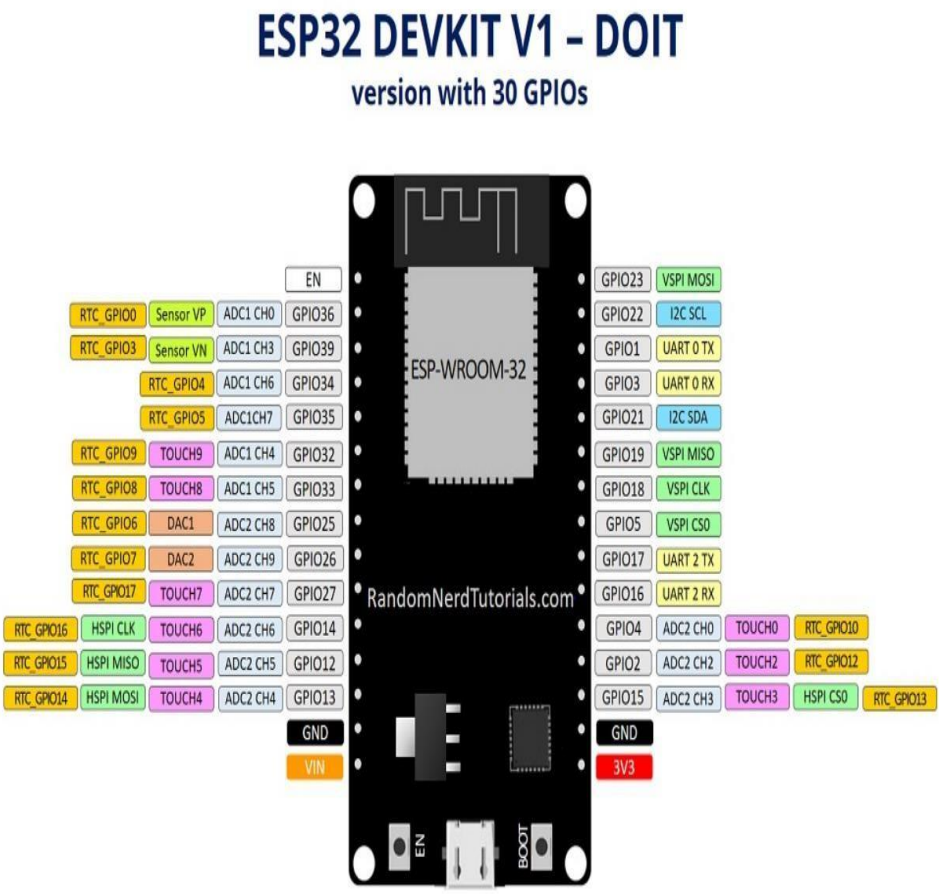

Figure 2: Esp32 Wi-Fi & Bluetooth Block Diagram

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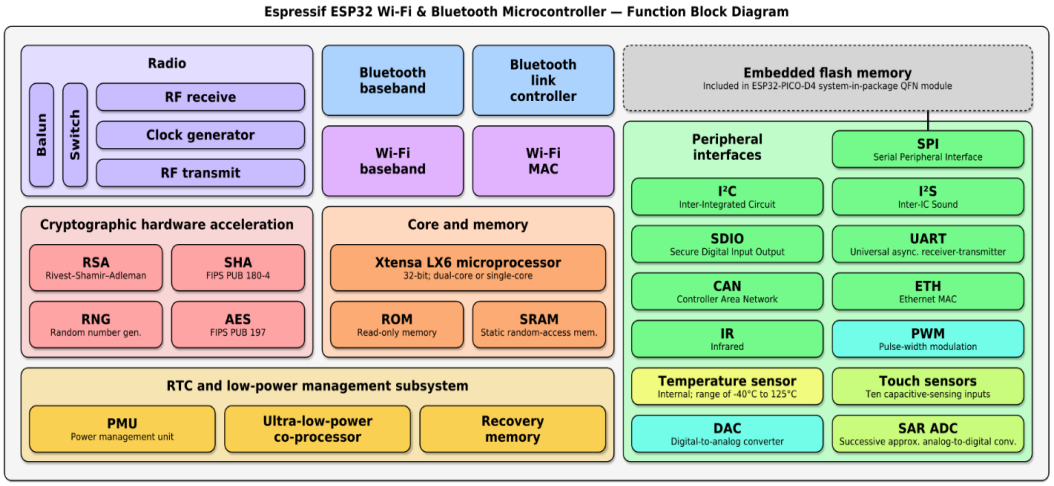

Figure 3: ESP32 Wi-Fi & Bluetooth Microcontroller – Functional Block Diagram

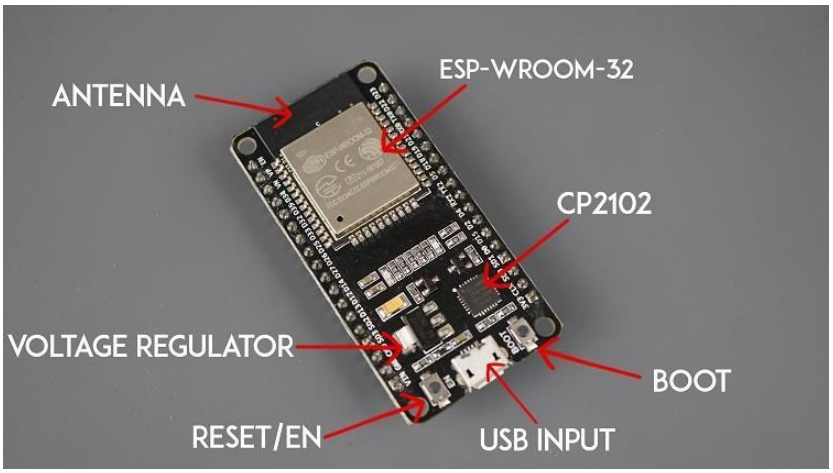

Figure 4: Components of ESP32 Pin Diagram

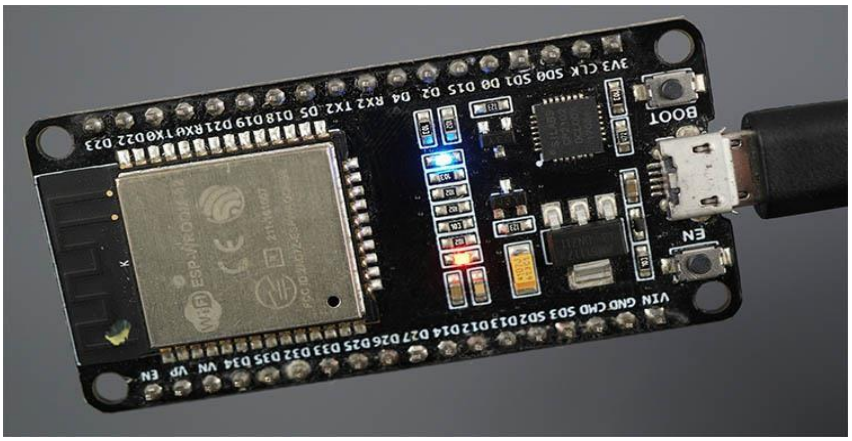

Figure 5: ESP32 board

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It comes with a micro USB interface for connecting the board and computerto upload code or apply power. It uses the CP2102 chip (USB to UART) to communicate with computer via a COM port using a serial interface. Another popular chip is the CH340. This board also comes with a RESET button (may be labeled EN) to restart the board and a BOOT button to put the board in flashing mode (available to receive code).

Pin Diagram of ESSP32 Microcontroller is shown in Figure-4. Some ESP32 boards(Figure-5) may not have a BOOT button. It also comes with a built-in blue LED that is internally connected to GPIO 2. This LED is useful for debugging, to give some sort of visual physical output. There's also a red LED that lights up when you provide power to the board. The ESP32 is a series of chip microcontroller developed by Express if.

ESP32 Specifications

Figure 6: ESP32 module: ESP-WROOM-32

Wireless connectivity Wi-Fi: 150.0 Mbps data rate with HT40

Bluetooth: BLE and Bluetooth Classic , **Processor:** Tensilica Xtensa Dual-Core 32-bit LX6 microprocessor, running at160 or 240 MHz, **eFuse** : 1 Kbit

ROM: 448 KB , **SRAM:** 520 KB ,**RTC fast SRAM**: 8 KB ,**RTC slow SRAM**: 8KB

Embedded flash: flash connected internally via IO16, IO17,SD_CMD,SD_CLK, SD_DATA_0 and SD_DATA_1 on ESP32-D2WD and ESP32- PICO-D4. 0 MiB, 2 MiB, 4 MiB

Low Power: ensures that you can still use ADC conversions.

Peripheral Input/Output: peripheral interface with DMA that includes capacitive touch

Analog-to-Digital Converter , Digital-to-Analog Converter , Inter-Integrated Circuit ,Universal Asynchronous Receiver/Transmitter , Serial Peripheral Interface , Integrated Inter chip Sound , Reduced Media-Independent Interface ,Pulse-Width Modulation.

 ISBN 978-93-95323-22-2

ESP32 WI-FI Features

- Wireless Networking standard:802.11 b/g/n
- Wi-Fi multimedia
- Diverse antenna
- Defragmentation to smoothen the data
- It supports 4 virtual Wi-Fi interfaces

ESP32 Bluetooth

- It increase the power control
- Adaptive Frequency Hopping
- Standard HCI supports SDIO/SPI/UART
- It can advertise and scan simultaneously

pH Sensor

The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale ranging from 0-14 with a neutral point being 7. Values above 7 indicate a basic solution and below 7 is acidic [6]. It operates on 5V power supply and is easy to interface with Arduino. pH is a quantifiable reading of amount of free hydrogen and hydroxyl ions in a liquid. Water with pH lower than 7 is likely to be contaminated and may
be unsafe to drink (Cirino, 2018). Osman etal (2018) utilized PH-4502C analog pH sensor which has been shown in figure-7 [7]

Figure 7: pH sensor

A full pH range from 0 to 14 is measurable by the sensor and it operates at temperature of 0-60ºC. Its probe is a hydrogen ion sensitive glass bulb and the

output in mV will depend on the changes in the relative hydrogen ion concentration between internal and external of the glass bulb (Omega, n.d.). Its breakout board has a port for the BNC connection with the probe as well as a port specifically for connection of temperature sensor, DS18B20 to log the temperature (DIYMore, 2020). Memon etal (2020) used SEN0161 analog pH meter by DFRobot that is specially designed for Arduino controllers. Powered by 5V, it also has a measuring range of 0 to 14 pH with accuracy of ±0.1 pH and measuring temperature of 0-60ºC. It has BNC connector and re-calibrated in buffer solution during each use (DFRobot, n.d.).

Turbidity Sensor

Figure 8: Turbidity sensor

Turbidity is a measure of how cloudy or muddy water is, and is determined by how much light is refracted off materials in the water. The more light that is refracted, the higher the turbidity. Turbidity is a measure of the cloudiness of water. Turbidity indicates the degree atwhich the water loses its transparency. It is considered as a good measure of the quality of water. Turbidity blocks the light needed by submerged aquatic vegetation.

It also raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight. The operating voltage is 5 V with response time of less than 550 ms.[7]. Turbidity sensor is shown in the figure-8. The sensor works by projecting a light and measuring the amount of light transmittance and scattering rate. The units of turbidity is in Nephelomotric Turbidity Units (NTU). A low light transmittance indicates that the water is very cloudy and the output voltage would be low. This sensor can operate in water temperature from 5 to 90 NTU. The top of the probe is not waterproof so only the bottom part of probe is submerged in the water.

 ISBN 978-93-95323-22-2

Temperature Sensor

Temperature Sensor is used with the model name of DS18B20 from Maxim Integrated. It is used due to its ability to be submerged fully in water at long hours coupled with its programmable capability with 9-bit to12-bit resolution that makes it ideal for IoT system without requiring external components. It is a direct-to-digital sensor with temperature range of−55 ºC to 125 ºC and accuracy of ± 0.5 ºC.

Humidity Sensor (DHT11)

The DHT-11 Digital Temperature and Humidity Sensor is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). Humidity sensors are the devices that are used to measure the humidity present in the air. Humidity is defined as the amount of water content in the air. Humidity refers to space, whereas, the term moisture refers to the water content present in the solids for liquids.

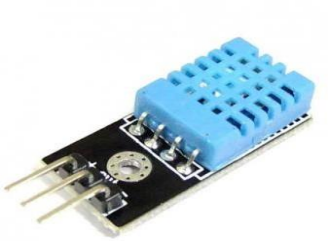

Figure 9: Humidity sensor

LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi- segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. Typical 16x2 LCD A liquid crystal display is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs).

Embedded C Language

Embedded C is a set of language extensions for the C language by the C Standards Committee to address commonly issues that exist between C extensions for different embedded systems. Embedded C programming typically requires nonstandard extensions to the C language in order to support enhanced microprocessor features like fixed-point arithmetic, multiple distinct memory banks and basic I/O operations. It uses most of the syntax, semantics of standard C, e.g., main () function, variable definition, datatype declaration, conditional statements, loops, functions, arrays, strings, structures, union, bit operations, macros, etc.

ARDUINO IDE

The ESP32 can be programmed using different firmware and programming languages.

- Arduino C/C++ using the Arduino core for the ESP32
- Espressif IDF (IoT Development Framework)3
- Micropython
- JavaScript
- LUA

Applications

It can be used in villages, rivers and sea basins. Prevent Legionella with IoT flow Monitoring. Maintain a continuously healthy water Supply with an IoT water Quality Monitoring Systems. Detect and fix wasteful leaks with flow monitoring,

Uses of Acids

Vinegar, a diluted acetic acid solution is used as a food preservative. Sulphuric acid is widely used in batteries. Nitric acid and sulphuric acid are used in the production of explosives, dyes, fertilizers and paints. Phosphoric acid is the main constituent in different soft drinks.

Uses of Bases

Sodium hydroxide is used in the production of soap, paper and rayon. Slaked lime or calcium hydroxide is used in the production of bleaching powder. Magnesium hydroxide is used as a laxative. Ammonium hydroxide is an essential reagent in laboratories.

Future Scope

- ❖ Detecting the more parameters for most secure purpose
- ❖ Increase the parameters by addition of multiple sensors
- ❖ By interfacing relay we controls the supply of water

Conclusion

Monitoring of Turbidity, pH & Temperature of Water makes use of water detection sensor with unique advantage and existing GSM network.[8] The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So the water quality testing is likely to be more economical, convenient and fast. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production, etc. By keeping the embedded devices in the environment for monitoring enables smart environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e. it can interact with other objects through the network. Then the collected data and analysis results will be available to the end user through the Wi-Fi.

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PSYCHE AND FEMINISM IN SYLVIA PLATH'S *THE BELL JAR*

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Abstract

This paper is an attempt to explore Psyche and Feminism in Sylvia Plath's *The Bell Jar*. Her novel,*The Bell Jar* is associated with psyche and feminism. In this novel, she examines the social conditions of her age and deals with feminism as the theme in *The Bell Jar* . Esther Greenwood is the main character who faces the issues on feminism, by exploring the cause of her mental agony experiencred in her life in the American society of her time. The novel can be compares Sylvia Plath's tragic end with that of Esther Greeenwood. The objective of this paper is to find out how the themes of "psyche" and "feminism" are preoccupied in the entire novel *The Bell Jar* by Sylvia Plath.

Keywords: Struggle, Feminism, Depression, Electra complex, Suicide and Madness

Sylvia Plath is considered as a one of the most dynamic and admired writers of the twentieth century. By the time she took her life at the age of thirty, Plath had a following in the literary community. During this year, her work attracted the attention of various kinds of readers, who saw in her singular verse an attempt to catalogue despair, violent emotion and obsession with death. Sylvia Plath was born on November 21, 1932, at Boston. She was the daughter of German immigrant college professor, Otto Plath and her mother Aurelia Schubert was one of her father's students. Her early years were spent near the seashore, but her life abruptly changed when her father died in 1940.

Her well-known poem 'Daddy' concerns her troubled relationship with her father and her feelings of betrayal when he died. The artistry of 'Daddy', which is exquisite as its theme, is unique. Rajani points out that Gordon Lameyer discussing the schizophrenic nature of death in *The Bell Jar* says the even Daddy is spoken by the author's evil double, resenting her father's death and consequent loss of love which contribute to reducing her Electra complex.

On February 11, 1963, she committed suicide and died. Ted Hughes published three other volumes of her work posthumously, including *The Collection of Poems* which was the recipient of the 1982 Pulitzer Prize. Sylvia Plath was the first poet to won the Pulitzer Prize after her death.

The Bell Jar was first published in London in January 1963 by William Heinemann Limited, under the pseudonym Victoria Lucas. Sylvia Plath had adopted the pen name for the publication of her first novel because of its literary value and she did not believe it was a "serious work".The central themes of Sylvia Plath's early life are the basis for *The Bell Jar*.

Early in the novel, Esther reads the story about a Jewish man and a nun who meet under a fig tree. Their relationship is doomed just as she feels her relationship with Buddy Willard is also doomed. Later, the tree becomes a symbol of the life choices that face Esther. She imagines that each fig represents a different life. She can only choose one fig but she wants all of them. She sits paralyzed with indecision and the figs rotten and falls to the ground.

When Esther tries to take care of herself, she finds that her body seems determined to live. Esther remarks that if it were up to her, she could kill herself in no time but she must with the tricks get out of her body. The beating heart symbolizes this bodily desire for life. When she tries to drown herself her heart beats, "I am I am I am". It repeats the same phrase when Esther attends Joan's funeral.

"In Joan's grave, I took a deep breath and listened to the old brag of my heart. I am I am I am" (TBJ 199).

Feminism is a collection of movements and ideologies aimed at defining, establishing and defending equal political, economic and social rights for women. This includes seeking to support the rights and equality of women in domestic violence, sexual harassment, and sexual assault. Feminism is mainly focused on women's issues because feminism seeks gender equality. Sylvia Plath's novel '*The Bell Jar'* focuses on the feminist perspective because of its male and female stereotypes are ideas that have shaped our culture. It is essential to look at texts from different eras in the 1950's. This novel highlights the more hidden aspects of the female experience, and the stereotypical power imbalance between the sexes. In many ways, this novel is a feminist text centered on the struggles of a young woman who is unable to reach her goals in our male-dominated society. The opening chapter of the novel focuses on the feminist perspective.

"It was a queer, sultry summer, the summer they electrocuted the Rosenberg, and I didn't know what I was doing in New York" (TBJ 1). This line immediately expresses the sexual tension of Esther's experience as a young girl focused on the confinements of a male-

dominated society. Linda Wagner says that *The Bell Jar* represents the cultural alienation and the resulting frustration of talented women at the time of the 1950's.

In 1950s, the society was one of sexual repressions, where women were not allowed to display their sexuality. In this novel, Esther is focused on the male expectations of women during the 1950's, and their desire for women to remain 'pure' and 'innocent'. Esther sees these qualities as more of a curse than a blessing.

The heroine Esther is facing the problem of being denied a life that would accommodate the opportunities given to men as well as women. The novel deals especially with the feminist issue of a woman searching for her identity.She begins to think about her future and the decisions would have to make her life in New York. Esther had been always such a high achiever; failure had never occurred.

There are a few specific symptoms of depression and quotes that perfectly exemplify them in the particular case of Miss Esther Greenwood: like the general thought, insomnia, loss of interest and the thoughts of suicide. About midway into the novel, morose thoughts of suicide dominate the text, so that the reader is apprehensive and already depressed when they open up the yellow pages of Plath. Talk about depression; however she cannot bring herself to spoil the clear whiteness of her wrists, no matter how sad she is, Eventually, Esther overdoses on several pills unsafely guarded by her mother and crawls into the darkness of her basement to die. " Wrapping my black coat round me like my own sweet shadow, I unscrewed the bottle of pills and started taking them swiftly, between gulps of water, one by one by one"(TBJ 138). It emphasises the thoughts of suicide.

In this novel, Plath shows us how women were discriminated against through the eyes of a sensitive young artist. Though she conveys the important message that actions such as these are morally incorrect and can lead the victims to experience unfortunate fates such as Esther's mental breakdown. It is important to keep such things as this in mind when reading the novel and this feminist point of view is the central purpose of *The Bell Jar.*

The woman's physical confinement to the house or kitchen, marriage and motherhood as death to the self and mother identification as a course are all related to the themes shared by Plath in the novel *The Bell Jar*. Feminist critics have pointed out how women confined to the domestic sphere, lose access to the public sphere which confers on men authority, prestige and cultural value, a state of affairs should be avoided since the connection between the

woman's reproductive functions and her domestic role is only an artificially created one, however obvious it may seem in *The Bell Jar* also.

Plath's final vision for herself and its representation as death are most beautifully described in edge. She resorts to compulsive ritualized suicide attempts to get back to her daddy. Suicide means for her the voluntary disentanglement of the psyche from the hold on it of the world as well as the beginning of a new search for perfection.

It is the journey of the pure female in search of the pure male. Most criticisms of Plath tend to see her obsession with death as a neurotic symptom, the expression of an urge to join the dead father of a daughter with an Electra complex, which results in a long escalating drive toward suicide. The idea or thought of suicide expressed through the phrase 'clear of the shadow of death' becomes the focus point of various influences, chief among them being the psychological inheritance of family legacy which consists of private affections like "Two suicides". This is a reference to Plath's suicide attempts, the shock treatment and the agonising process of recovery. All these become according to Jung's theory of the unconscious (both collective and personal), a part of the child's psyche just as these events in time become the subject matter of *The Bell Jar.* In this novel she contemplates several ways of committing suicide- by drowning, hanging, slashing her wrist and finally an overdose of sleeping pills each one of which fails for some reason or the other.

Sylvia Plath is often dismissed as a 'feminist'. It is important to make the distinction that her themes are appropriately feminine. Her bitterest poems against the psychic dominance of father, husband and the institution of marriage are far from any feministic propaganda.

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A STUDY ON OCCUPATIONAL HAZARDS AMONG HEALTHCARE EMPLOYEES IN GASTRO CARE HOSPITAL, TRICHY

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Abstract

Healthcare employees face a multitude of occupational hazards that can impact their physical and mental well-being, ultimately affecting patient care and outcomes. This study aims to identify and explore the prevalence of occupational hazards among healthcare employees, including physical, chemical, biological, and psychological risks. A comprehensive review of existing literature and primary data collection through surveys and interviews reveal alarming rates of musculoskeletal disorders, needle stick injuries, exposure to infectious diseases, and stress-related burnout. The findings highlight the need for healthcare organizations to prioritize employee safety and well-being through evidence-based interventions, policy changes, and supportive work environments. By addressing these occupational hazards, healthcare organizations can reduce the risk of injury and illness, improve job satisfaction, and enhance the quality of patient care.

Keywords: occupational hazards, healthcare employees, workplace safety, employee well-being, patient care.

Introduction

Occupational hazards are **risks associated with working in specific occupations**. The Occupational Safety and Health Administration (OSHA) describe five categories of occupational hazards namely physical safety hazards, chemical hazards, biological hazards, physical hazards, and ergonomic risk factors .In other words, occupational hazard explain the risks of illnesses or accidents in the workplace.

An occupational hazard is something unpleasant that a person experiences or suffers as a result of doing their job. It terms both long-term and short-term risks associated with the workplace environment and is a field of study within occupational safety and public health. Short term risks may include physical injury, while long-term risks may be increased risk of developing cancer or heart disease

Aim & Objectives of the Study

The main aim of the study is to examine the level of Occupational Hazards among Healthcare Employees in Gastro care Hospital, Trichy.

- To Establish and maintain a safe occupational environment in the workplace to protect the well-being of all employees.
- To Ensure the physical, mental, and social well-being of workers by implementing comprehensive health and safety practices.
- To Implement strategies and measures aimed at significantly reducing workplace accidents and related incidents.
- To Advocate for and uphold high safety standards for employees to create a culture of safety and responsibility within the organization.

Research Methodology

Research involves generating new knowledge and creatively applying existing knowledge to address specific issues. This process includes describing, explaining, predicting, and controlling observed phenomena. In this study, primary data was gathered through a well-structured questionnaire completed by 50 employees at Gastro Care Hospital in Trichy. Additionally, secondary data was sourced from articles, journals, and websites.

Review of Literature

Nankongnab, Noppanun, et al. "Occupational hazards, health conditions and personal protective equipment used among healthcare workers in hospitals, Thailand." ***Human And Ecological Risk Assessment: An International Journal*** **27.3 (2021): 804-824.**

This study aimed to evaluate occupational hazards, health conditions and personal protective equipment used among healthcare workers. Information from the sample size of 1,128 healthcare workers was collected using questionnaires. The healthcare workers participated in this study was from five departments including inpatient, outpatient, surgery and anaesthesia, nutrition service and hospital support services departments in five hospitals in Thailand. The results indicated that the majority of healthcare workers were female; these healthcare workers work 9.0 to 11.1 hours/day on average and were exposed to several chemical,

biological and physical hazards. The healthcare workers in the nutrition service department reported the highest percentage of musculoskeletal disorder and respiratory problems. The highest percentage of skin problems were reported by healthcare workers in surgery and anesthesia department. The results showed musculoskeletal disorder, respiratory and skin problem significantly differed among healthcare workers in the five departments including the wrists/hands upper back, chest pain symptoms, and dry/wound symptoms. Healthcare workers did not have adequate protection from work-related hazards in their workplace. Health education programs, control measures and organizational policies should be implemented to mitigate the hazards for healthcare workers in hospitals.[1]

Kumar, Amit, and Ansuman Panigrahi. "Occupational health hazards among health care personnel working in public health facilities in Bhubaneswar, India." ***Journal of Public Health*** **29 (2021): 633-639.**

The aim of the study is to assess the occupational health hazards and associated risk factors among health care personnel working in public health facilities in Bhubaneswar. The method used for the study is a cross-sectional study was conducted involving 172 health care personnel working in 22 urban primary health centers and four community health centers in the Bhubaneswar. During the period from January to December 2017.

Data Analysis and Interpretation

Table 1: Demographic profile of the Respondents

Sl. No	**Particulars**	**Opinion**	**%of Respondents**
1.	**Age**	Below 25 years	**51**
		25-30 years	**22**
		41-50 years	**27**
		Total	**100**
2	**Department**	Clinical	**82**
		Non- Clinical	**18**
		Total	**100**

Source: Primary Data

Relevant data were collected using a semi-structured interview schedule. From this study Multivariate regression analysis revealed that female gender, health care personnel other than doctors, working overtime, dissatisfaction with workplace atmosphere, and not using the necessary personal protective equipment were independent predictors for experiencing a biological hazard. Finally the study concluded that Health care personnel in public health facilities experience multiple hazards in their workplaces. Results indicate the need for designing and implementing strategies to promote the occupational health of this important section of society.[2]

The above table shows that 51% of the respondents lies in the age group of below 25 years , 82% of the respondents are belongs to clinical department.

Table 2: Factors Influencing Occupational Hazard Among Health Care Services

Sl. No	**Particulars**	**% of Respondents**				**Total**
		HS	**S**	**DS**	**HDS**	
1	Safety Measures	86	8	6	-	100
2	Waste Disposal Method	94	6	-	-	100
3	Clinical Wastage Handling	86	9	5	-	100
4	Fire Extinguisher	88	10	2-	-	100
5	Training Program about Infection Control	87	11	2	-	100
6	Preventive Measure while handling chemicals	86	14	-	-	100
7	Maintenance of First Aid Equipment	92	8	-	-	100
8	Vaccination Programme for Employee	88	12	-	-	100
9	Sterilization Method	92	8	-	-	100
10	Self Protection	86	14	-	-	100

HS- Highly Satisfied **S-** Satisfied **DS-** Dissatisfied **HSD-** Highly Dissatisfied

Source: Primary Data

The above table shows that 86% of the respondents are satisfied with the Safety Measures, 94 % of the respondents are satisfied with the Waste Disposal methods,86 % of the respondents are satisfied with Clinical Wastage Handling, 88% of the respondents are satisfied with the Fire Extinguisher, 87 % of the respondents are satisfied with the Training Program about

Infection Control, 86 % of the respondents are satisfied with the Preventive Measure while handling chemicals, 92 % of the respondents are satisfied with the Maintenance of First Aid Equipment, 88 % of the respondents are satisfied with the Vaccination Programme for Employee, 92 % of the respondents are satisfied Self Protection in the Organisation.

Suggestions

- Strengthen and improve safety measures within the hospital to ensure a safer environment for all.
- Increase the frequency and reach of training programs focused on infection control throughout the organization.
- Implement additional strategies and resources to enhance self-protection for employees in the hospital.

Conclusion

Hospitals and healthcare facilities have many unique occupational health and safety hazards that can potentially affect the health and performance of healthcare professionals. The impact of such hazards on healthcare professionals poses a serious public health issue. Therefore, controlling, eliminating, or reducing exposure can contribute to a stronger healthcare system. The level of safety management in the Gastro Care Hospital is found to be Satisfactory. The Management periodically monitor the physical and mental health of the employees and takes necessary steps

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LEAP ZAGREB INDEX OF SOME CHEMICAL TREES

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Abstract

A topological index (2-D descriptor) is a numeric number, which gives some useful information about shape and analysis of molecular structure. In this work, one of the degree based topological index, say the Leap Zagreb index of ten octane isomers are determined and the Leap Zagreb index with physico-chemical properties of ten octane isomers such as entropy, acentric factor, enthalpy of vaporization (HVAP) and standard enthalpy of vaporization (DHVAP) are compared. And also the level correlation of Leap Zagreb index with physico- chemical properties of ten octane isomers using the least squares fitting procedure in SPSS is examined.

Keywords: Molecular graph, Molecular descriptor , Topological Index.

Introduction:

Graph theory is the study of relationship between the vertices (nodes) and edges (lines). Formally, a graph is denoted as a pair G(V, E),where V represents the finite set of vertices and E represents the finite set of edges. [4]. Chemical Graph theory is the study of molecular graphs. A molecular graph is a collection of points representing the atoms in the molecule and set of lines representing the covalent bonds. These points are named vertices and the lines are named edges in graph theory language. That is, the topological representation of a molecule is called molecular graph. In graph theory, Tree is a connected graph which contains no cycle. In Chemical graph theory, chemical tree is a tree in which no vertex of degree greater than 4.

Topological index is numerical value that is applied to a graph and can be used to explain specific graph properties through algebraic structures. It is acted as a tool for analyzing many physico-chemical properties of molecules without performing any experiment. It is used to develop the quantitative structure-activity relationships (QSARs) in which the biological activity or other properties of molecules are correlated with their chemical structure.

Numerous topological indices are used by the chemists [1,6]. In which degree-based topological indices, distance-based topological indices and mixed-based topological indices are three important topological indices. The Zagreb index is one of the degree-based topological indices. The first and second Zagreb indices have been introduced more than forty years ago[5]. In recent years, more modified Zagreb indices have been introduced such as Zagreb coindices [2], reformulated Zagreb indices [7], Zagreb hyper index [3], multiplicative Zagreb indices , multiplicative sum Zagreb index , and multiplicative Zagreb coindices [8] etc.

In 2017, the new graph invariant Leap Zagreb index have been introduced by A. M. Naji ,et al.,. It is classified into vertex based and edge based Leap Zagreb indices.

The vertex based Leap Zagreb index is also called as first Leap Zagreb index and also defined as $LM_1 = \sum_{v \in V(G)} d_2(v)^2$. where $d_2(v)$ denotes number of second neighbor of v.

The edge based Leap Zagreb index is also called as second Leap Zagreb index and also defined as $LM_2 = \sum_{uv \in E(G)} d_2(u)\, d_2(v)$, where $d_2(u)$ denotes number of second neighbor of u.

In organic chemistry, Octane is a hydrocarbon with the chemical formula C_8H_{18} and there are actually 18 different isomers of octane. These isomers have the same molecular formula but different arrangement of atoms. In Chemical graph theory, these octane isomers are tree. Particularly, these are Chemical trees. Out 18 isomers of Octane 10 isomers of Octane have chosen for testing physico chemical properties with first and second Leap Zagreb indices. The following are the 10 octane isomers 2-Methylheptane, 3-Methylheptane, 4-Methylheptane,2, 2-Dimethylhexane,2,3-Dimethylhexane,2,4-Dimethylhexane,2, 5-Dimethylhexane, 2, 2,3-Trimethylpentane 2,2,4-Trimethylpentane,2,3,4-Trimethylpentane

Chemical applicability of Leap Zagreb index on isomers of octane

The topological indices with the high correlation factor are of foremost important in quantitative structure-property relationships (QSPR) and quantitative structure-activity relationships (QSAR) analysis. In this work, we discuss the linear regression analysis of Leap Zagreb index LZ(V) and LZ(E) with entropy(S), acentric factor(AcentFac), enthalpy of vaporization(HVAP) and DHVAP of isomers of octane.

Table 1: Experimental values of the entropy, Acent Fac, HVAP, DHVAP and the corresponding value of LZ(V) and LZ(E) of octane isomers.

S. No.	Alkanes	S	Acent Fac	DHVAP	HVAP	LZ(V)	LZ(E)
1	2-methyl-heptane	109.84	0.377916	9.484	70.3	28	20
2	3-methyl-heptane	111.26	0.371002	9.521	71.3	28	25
3	2-methyl-heptane	109.32	0.371504	9.483	70.91	30	24
4	2,2-dimethyl-hexane	103.42	0.339426	8.915	67.7	50	24
5	2,3-dimethyl-hexane	108.02	0.348247	9.272	70.2	36	33
6	2,4-dimethyl-hexane	106.98	0.344223	9.029	68.5	31	23
7	2,5-dimethyl-hexane	105.72	0.35683	9.051	68.6	36	23
8	2,2,3-trimethyl-pentane	101.31	0.300816	8.826	67.3	56	44
9	2,2,4-trimethyl-pentane	104.09	0.30537	8.402	64.87	62	23
10	2,3,4-trimethyl-pentane	102.39	0.317422	9.014	68.37	44	40

The linear regression models for the entropy, acentric factor, DHVAP and HVAP using the data of Table 1 using the least squares fitting procedure as implemented in SPSS software. The fitted models for LZ(V) and LZ(E) are follows:

Acent factor=0.425(±0.014)-0.002(±0.000)LZ(V)

DHVAP =10.142(±0.177)-0.026(±0.004)LZ(V)

Entropy=0.115.565(±2.191)-0.233(±0.052)LZ(V)

HVAP=74.550(±1.005)-0.143(±0.024)LZ(V)

Acentric factor=0.403(±0.027)-.002(±0.001)LZ(E)

DHVAP =9.358(±0.429)-.009(±0.015)LZ(E)

Entropy=113.220(±3.368)-0.250(±0.116)LZ(E)

HVAP=69.891(±2.400)-0.039(±0.083)LZ(E)

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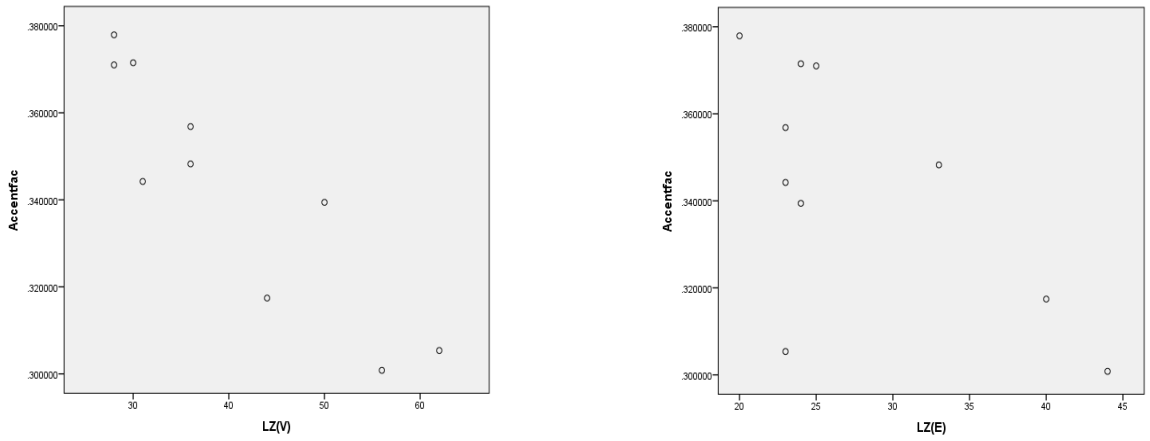
Table 2: Correlation coefficient and residual standard error of regression models on LZ(V)

Physical Property	Absolute value of the correlation coefficient	Residual standard error
Acentric Factor	**0.905**	0.0125
DHVAP	**0.908**	0.1562
Enthalpy	**0.843**	1.9325
HVAP	**0.903**	0.8863

Table 3: Correlation coefficient and residual standard error of regression models on LZ(E)

Physical Property	Absolute value of the correlation coefficient	Residual standard error
Acentric Factor	0.639	0.0226
DHVAP	0.21	0.3641
Enthalpy	0.606	2.8597
HVAP	**0.903**	2.03762

(a) (b)



Scatter diagram of (a) AcentFac on LZ(V) (b) AcentFac on LZ(E) superimposed by the fitted regression line

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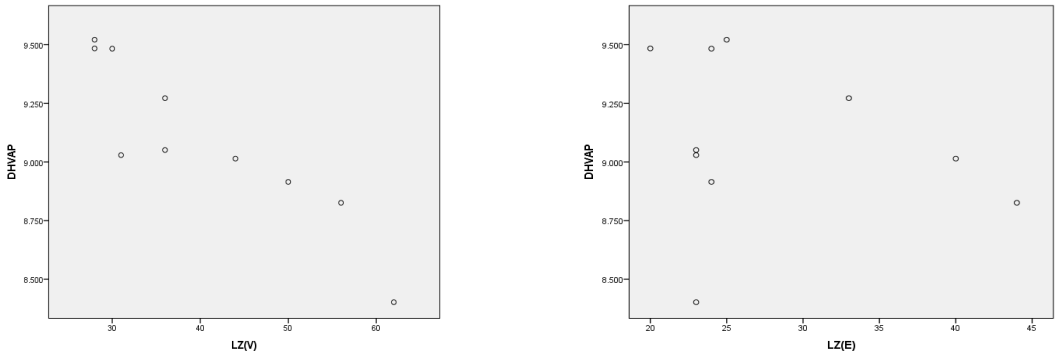
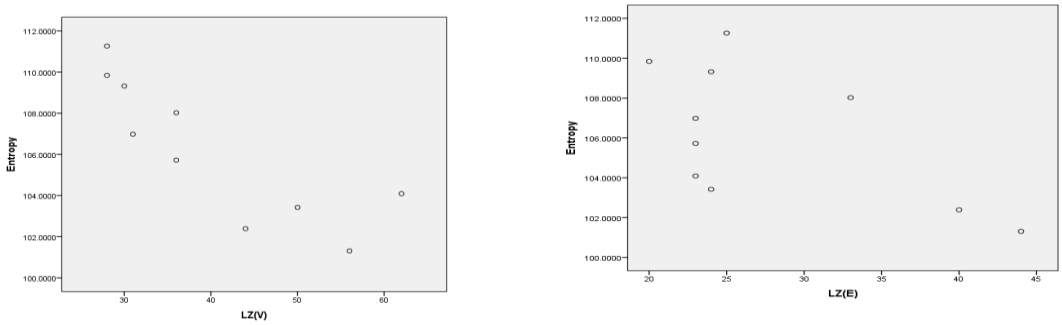
(a) (b)



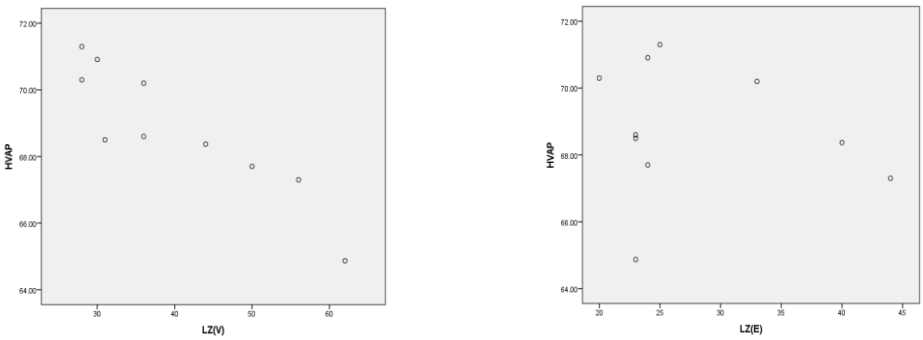
Scatter diagram of (a) DHVAP on LZ(V) (b) DHVAP on LZ(E) superimposed by the fitted regression line

(a) (b)



Scatter diagram of (a) ENTROPY on LZ(V) (b) ENTROPY on LZ(E) superimposed by the fitted regression line

(a) (b)



Scatter diagram of (a)HAVP on LZ(V) (b) HAVP on LZ(E) superimposed by the fitted regression line

Conclusion

The study of topological indices is one of the most active studied fields in chemical graph theory. In this work, we have used Leap Zagreb indices (LZ(V) and LZ(E)), in the field of mathematical chemistry, it has chemical applicability in determining several physico-chemical properties of octane isomers as it has coefficient of correlation close to 1. It was tested using a dataset of octane isomers. Interestingly, we have noticed that LZ(V) highly correlated with all the chemical properties , But LZ(E) not highly correlated with all the chemical properties except the HVAP value. Chemical graph theory is an essential tool for studying molecular structure and has an important impact on the development of chemical sciences.

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தேவ நேயப் பாவாணரின் தமிழ்ப்பணி

கு. புஷ்பாவதி
தமிழ்த்துறை, சீதாலட்சுமி இராமசுவாமி கல்லூரி, திருச்சிராப்பள்ளி.

ஆய்வுச்சுருக்கம்

பாவாணர் குழந்தை உள்ளத்தவர். பிறரிடத்து பரிவுக் காட்டி வாழ்பவர். தமக்கு செய்த உதவி சிறிதெனினும் பணைத்துணையாகக் கொண்டு பாராட்டி மகிழ்வார். தன்மானத்தை இழக்க நேரிடினும், தமிழ்க்குடியின் மானத்தை உயர்த்தி நிற்க வைப்பேன் என்று தமிழுக்காக வாழ்ந்தவர். மறைக்கப்பட்ட தமிழின வரலாற்றையும், சிதைக்கப்பட்ட ஒப்புயர்வற்ற மொழியையும், தமிழின் பெருமையும் உலகறியச் செய்தது மட்டுமன்றி என்றும் நீங்கா இடம் பிடித்து தனக்கு நிகர் இல்லாத மொழியாக உயர்வு படுத்தியவர் பாவாணர். எனவே தமிழ் வளர்த்த சான்றோர்களின் வகைப்படுத்தலில் இவருடைய படைப்புகளை ஆய்வது மிக முக்கியமாகும். அதுவே இக்கட்டுரையின் நோக்கமாக அமைகிறது.

திறவுச்சொற்கள்: இலக்கணப் புலமை, தமிழ் ஆக்கப் பணி, ஆய்வுத் திண்மை

Abstract

Bawanar is a child bearer. He who lives by showing compassion to others. He appreciates and appreciates any help done to him as a co-worker. Even if he lost his dignity, he lived for the Tamil that he would uphold the dignity of the Tamil girl. The hidden history of the Tamil people, the incomparable language that has been corrupted, It was Bavanar who not only made the pride of Tamil known to the world but also took the place of Neinga and promoted it as a language that has no equal. Therefore, it is very important to study his works in the classification of Tamil cultured sages. That is the purpose of this article.

Keywords: Grammatical proficiency, Tamil creative work, Exploratory strength.

முன்னுரை

தொன்மை இயன்மை தூய்மை தாய்மை
முன்மை வியன்மை வளமை மறைமை
எண்மை இளமை இனிமை தனிமை
ஒண்மை இறைமை அம்மை செம்மை
எனும்பதி னாறும் இன்றமிழ் இயல்பெனப்
பன்னுவர் மொழிவலர் பாவாணர் தாமே– (செந்தமிழ்ச் சிறப்பு – புலவர் அ.நக்கீரன் பக்.15)

மனிதன் எங்கு முதன்முதலில் தோன்றினானோ அங்குத்தான் ஞால முதன்மொழியும் தோன்றியிருக்க முடியும். அவ்வகையில் நோக்கும் போது குமரி மக்களே முதன்மை மக்களாக தோன்றியுள்ளனர். அவன் பேசிய மொழியே முதன் மொழியாகும். அதுவே நாம் பேசும் தாய்மொழியாம் தமிழ் மொழி என்பதில் அசைக்க முடியாத கருத்தை உடையவர் பாவாணர்.

பாவாணரின் தமிழ்ப்பணி

"சாகும்போதும் தமிழ்ப்படித்துச் சாகவேண்டும்
எந்தன் சாம்பலிலும் தமிழ் மணந்துவேகவேண்டும். - கே.சச்சிதானந்தம் (ஆனந்தத் தேன் - கவிதைத் தொகுப்பு)

எனும் தமிழ் பாவலர்கள் எழுதி வைத்துச் சென்ற வைர வரிகளுக்கு நம் முன்னே இலக்கணமாக வாழ்ந்தவர் அரும்பெரும் அறிஞர் பாவாணர் ஆவார். தனக்கென வாழாது தமிழ்க்கென வாழ்ந்தவர். ஒரு முறை தாம் ஏற்ற பணிகளிலிருந்து விலக வேண்டிய நிலையில் கவலையுறாது திட நெஞ்சுடன், எனக்கு மனைவியும் உண்டு, மானமும் உண்டு அதை விட தமிழ் மீது ஆர்வம் உண்டு. நான் வெளியேறினேன், தமிழும் என்னோடு வெளியேறியது என்று குறிப்பிடுகிறார். மேலும் இத் தமிழ்நாடானது மறைமலையடிகளையும் போற்றவில்லை, என்னையும் போற்றவில்லை. தமிழ் மீது உயிராக இருக்கும் ஒரு சில தமிழன்பர்களாலே நான்

வாழ்கிறேன் என்று வருத்தமுடன் அண்ணாமலைப் பல்கலைக் கழகத்திலிருந்து வெளியேறினார். பாரதிதாசன் தம் குயில் இதழில்,

"நாவலந் தீவுக்கு நந்தமிழே தாயென்று
கூவும் அதுவுமோர் குற்றமா? பாவிகளே
தேவநே யர்க்குச் செயுந்தீமை செந்தமிழர்
யாவர்க்கும் செய்வதே யாம்"

பாவாணர்க்காக பதிகம் பாடியுள்ளார். வறுமை தம்மை வாட்டிய பொழுதும் தமிழ் மீது கொண்ட மோகம் சொல்லாய்வுக்காக பல நூல்களை வாங்க வைத்தது. இந் நூல்கள் அரசு பணத்தில் அல்ல, தம் உழைப்பால் கிடைத்த ஊதியம் கொண்டே வாங்கியுள்ளார். இது அவர் தமிழ் மீது கொண்ட ஆர்வத்தை துள்ளியமாக வெளியிடுவதாகவே அமைகிறது.

பாவாணரின் பார்வையில் செந்தமிழின் சிறப்பு

மொழியானது இந்நாட்டில் பொதுவாய்க் கருதப்படுகிறபடி இறைவனால் படைக்கப்பட்டது அன்று, இயற்கையாலும் அன்று, மாந்தனால் என்றால் அதுவுமன்று, இது நம் முன்னோர்களால் சிறிது சிறிதாக ஆக்கப்பெற்றதாகும். இங்ஙனம் ஆக்கப் பெற்ற மொழிகள் உண்மையில் ஒரு சிலவே. அச்சிலவே, அவற்றின் பல்வேறு நிலைகளில் நிகழ்ந்த திரிபு, சுருக்கம், பெருக்கம், கட்டு, கலப்பு என்னும் ஐம்முறைகளால் ஏறத்தாழ மூவாயிரம் மொழிகளாகக் கிளைத்து உலகமெங்கும் பரவியிருக்கின்றன. அம் மூலமொழிகளுள் முதன்மையானது தமிழே: அது தோன்றிய இடம் மாந்தன் பிறந்த இடமாகிய குமரி நாடே எனப் பாவாணர் தமது ஆய்வின் வழி வெளிப்படுத்தியுள்ளார்.

மேலும், தமிழன் தோன்றிய முதல் இடம் என்பதால் கன்னியாகுமரி மாவட்டத்துக்கு "குமரி" என்ற பெயர் வந்தது. The Primary Classical Language of the World'என்ற புத்தகத்தை ஆங்கிலத்தில் எழுதினார். இந்நூலில் தமிழ் மொழியிலிருந்து சொற்கள் எப்படி பிறமொழிகளுக்குச் சென்று புதிய சொற்கள் உருவானது என்பதை ஆராய்ந்து கூறியுள்ளார். "தமிழ் திராவிட மொழிகளுக்குத்

தாய்;,ஆரிய மொழிகளுக்குத் தாய், ஆரிய மொழிகளுக்கு மூலம்" என ஆதாரங்களுடன் வித்திட்டவர். மேலும் கிரேக்கம், இலத்தீன், சமஸ்கிருதத்தில் பல தமிழ்ச் சொற்கள் இருப்பதை நிரூபித்துக் காட்டியவர். இக் கருத்தை நிலைநாட்டும் பொருட்டு முப்பத்தைந்துக்கும் மேற்பட்ட நூல்களை இவர் இயற்றியுள்ளார். தமிழை வடமொழி பிணிப்பினின்று மீட்பதே என் வாழ்க்கைக் குறிக்கோள் என்றவர்.

பாவாணர் பாட்டனார் முத்துச்சாமித் தேவர் தஞ்சை மாவட்டத்து நீடாமங்கலத்தைச் சேர்ந்தவர். சங்கரன் கோவிலில் இருந்த மேனாட்டுக் கிறித்துவக் குரவரின் வளமனைக் காவற்காரனாகப் பணியாற்றினார். இவர் மகன் ஞானமுத்து. அவருக்குப் பிறந்தவரே நம் நூலாசிரியர் ஞா.தேவநேயர். தனித்தமிழுக்குப் பரிதிமாற் கலைஞர் வித்தூன்றினர், மறைமலையடிகளார் நீருற்றி வளர்த்தார். பாவாணரோ களையெடுத்து எருவிட்டுக் காத்து வளர்த்தார்.

'தமிழ் தேசியத்தின் தந்தை' என அழைக்கப்படும் பாவலரேறு பெருஞ்சித்திரனார் 'தென்மொழி இயக்கம்' என்ற அமைப்பை நடத்தி வந்தார். இவ் இயக்கம் தேவநேய பாவாணரின் வளர்ச்சிக்கு மிகப்பெரிய அளவில் உதவியது. அந்த இயக்கமே 'மொழி ஞாயிறு' என்ற பட்டம் வழங்கி கௌரவித்தது. மேலும் இவரது தமிழ்ப்பணியும், தமிழுக்காக இவர் ஆற்றிய பணியைக் கண்டு, மலேசியா அரசு தபால்தலை வெளியிட்டு பெருமை சேர்த்தது. பாவாணரின் குருவான மறைமலையடிகளார், பாவாணரின் சொற்பிறப்பியல் என்ற நூலுக்கு முன்னுரை எழுதியது மட்டுமன்றி, அவரை புகழ்ந்தும் கூறியுள்ளார். பாவாணரின் ஆய்வில் குறிப்பிடத்தக்கது 'தமிழ்தான் உலகிலேயே முதன் மொழியாக தோன்றிய செம்மொழி' என்ற ஆய்வே அனைவரையும் கவனிக்க வைத்தது.

மொழி நூல் பேரறிஞராகவும், தமிழ் மொழி அறிஞர்களில் இவருக்கு நிகரில்லாத பெருமையுடையவரும், ஆரிய இருளில் மூழ்கிக் கிடக்கின்ற செந்தமிழ்ச் சிறப்பை உலகுக்கு விளக்கப் பிறந்தவர் மொழி ஞாயிறு பாவாணர். குன்றின் மேல் ஏற்றிய தமிழ் விளக்குகளாக இவருடைய தமிழ் ஆராய்ச்சி நூல்கள் விளங்குகின்றன. இந்நூல்கள் மெய்காணும் நோக்கோடு, நடுநிலை

பிறழாது ஆய்வு நெறி நின்று காணப்படுகின்றன. சான்றாக, தொல்காப்பியர் காலத்தில் வைகை ஆறும் மதுரையும் தோன்றவில்லை. குமரியாறு ஓடியதற்கான சான்றுகள் அதிகம் உள்ளன. பின்னர் மூன்றாம் கடல் கோளால் குமரி ஆறும் அழிந்தது என்றும் பரந்துபட்ட நோக்கில் ஆராய்ச்சியை மேற்கொண்டு 'தமிழன் பிறந்தகம்' என்னும் தலைப்பில் இலக்கியச் சான்றுகளோடு பாவாணர் வெளியிட்டுள்ளார். இத்தகைய ஆராய்ச்சி நூல் தமிழ் மீது இவர் கொண்ட ஆர்வத்தை விளக்குவதாகவே அமைந்துள்ளது.

'எல்லாச் சொல்லும் பொருள் குறித்தனவே' (தொல். பொருள். 512) என்ற தொல்காப்பியரின் நூற்பாவின் படி. நிலைதிணைக்குரிய பெயர்களுள் பல கண்டப் பெயராகவும் நாட்டுப்பெயராகவும், ஊர்ப் பெயராகவும் வழங்கி வந்தன என்பதை இன்றளவும் அவற்றுக்கு வழங்கும் பெயர்களால் அறிகிறோம். சான்று, குமரி, பனை, தெங்கு, பாலை, நாவல், நெல்லி இன்னும் பலவற்றைக் காணலாம். அடுத்து, தமிழ் மொழியின் பெருமையை பறைசாற்றும் படி, வேறெந்த மொழிகளிலும் இல்லாத முத்தமிழின் சிறப்பைப் பல காரணங்கள் கூறி பாவாணர் மும்மை என்ற பெயரால் வழங்குகிறார்.

"ஓங்க லிடைவந் துயர்ந்தோர் தொழவிளங்கி
ஏங்கொலிநீர் ஞாலத் திருளகற்றும் - ஆங்கவற்றுள்
மின்னேர் தனியாழி வெங்கதிரோன் றேனையது
தன்னே ரிலாத தமிழ்" (தண்டியலங்கார உரை மேற்கோள்)

என்று பண்டையோரால் சிறப்பிக்கப்பெறும் தமிழ், உலக முதன்மொழி என மொழியாராய்ச்சியால் ஏற்றுக் கொள்ளக் கூடியதாக உள்ளது. இதையே பாவாணர் நன்னூலார் கூறிய நூற்பா வழி உறுதியாகக் கூறுகின்றார். சான்றாக,

"எண்பெயர் முறைபிறப் புருவம் மாத்திரை
முதலீ றிடைநிலை போலி யென்றா
பதம்புணர்ப் பெனப்பன் னிருபாற் றதுவே" (நன்னூல் - 57)

இவற்றினுள் எழுத்திலக்கணம் பன்னிரண்டனுள் 'முதலீ றிடைநிலை' என்பன தமிழுக்கே சிறப்பாக உரியதாக சுட்டிக்காட்டுகின்றார்.

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“வினையின் நீங்கிய விளங்கிய அறிவின்

முனைவன் கண்டது முதனூ லாகும்” (தொல்காப்பியம் - தெளிவுரை - முனைவர் ச.வே.சுப்பிரமணியம் - மரபியல் - 640)

முதனூலாக விளங்கும் தமிழ் இயல்பாகவே செம்மையுடைமையன. தமிழ் எனினும் செந்தமிழ் எனினும் ஒன்றே. தமிழின் திரிபாகிய கொடுந்தமிழினின்றும் பிரித்துக் கூறவே செந்தமிழ் எனப்பட்டது. இத் தமிழ் ஒன்றே மிகுந்த இலக்கண வரம்புடையது.

“கண்ணு தற்பெருங் கடவுளும் கழகமோ டமர்ந்து

பண்ணு றத்தெரிந் தாய்ந்தவிப் பசுந்தமிழ் ஏனை

மண்ணி டைச்சில இலக்கண வரம்பிலா மொழிபோல்

எண்ணிடைப்படக் கிடந்ததா எண்ணவும் படுமோ?” (திருவிளையாடற் புராணம் - நாட்டுப்பற்று – 57)

என்று பரஞ்சோதி முனிவர் தருக்கிக் கூறியதைத் தமிழரனைவரும் சிறப்பாகத் தமிழ்ச்சைவர் கவனித்தில் கொள்ளுதல் சிறப்புடையதாக அமைகிறது.

“வடமொழியும் இந்தியும் மற்றும் வடக்கிற்

படுமொழியும் என்ற பலவும் - தடவியே

அந்தமிழே ஆதி என்னும் தேவநே யர்தாம்

எந்தமிழர் எல்லார்க்கும் வேந்து!” - பாவேந்தர்

என்ற பாவேந்தர் போற்றுதற்குரிய பாவாணர், ஆரவாரம் என்பது கடல் அலையைப் போன்றது. புரட்சி என்பது எரிமலையைப் போன்றது என்பார். தமிழ் மொழியானது புரட்சிகரமானது. அது மட்டுமன்றி தமிழ்ப்பயிரில் உருவாகும் களைகள் தான் இந்தியும், வடமொழியும். இவையே தமிழர் வாழ்வை, தமிழர் வனப்பைத் தாவிக் கடித்திடும் நாய் என்பார். அந்நாயை நாம் தடிகொண்டு விரட்டிட வேண்டும். திராவிடம், திராவிடநாடு என்னும் ஆரியச்சார்புச் சொற்களை அறவே ஒழித்து தூய்மையுணர்த்தும் தமிழ் - தமிழர் - தமிழ்நாடு என்னும் சொற்களையே இனி வழங்கவும் முழங்கவும் வேண்டும்.

“இவ்வுலகில் தமிழனைப் போல் முன்பு உயர்ந்தவனுமில்லை. பின்பு தாழ்ந்தவனுமில்லை” என்று கவலை கொண்ட நெஞ்சினர் பாவாணர் அவர்கள், தாழ்வுகளுக்கான காரணங்களை மக்களுக்கு உணர்த்துவதால், அறியாமை நீங்கி விழித்தெழுவர்: மக்கள் தாய்மொழியுணர்வு பெறுவர்: தமிழ்காக்கப்படும் என்ற நம்பிக்கையைக் கொண்டவர் பாவாணர். ‘இசைத்தமிழ்;’ என்னும் தலைப்பின் கீழ் அகத்தியம், பரிபாடல், பேரிசை, இந்திரகாளியம், பஞ்ச பாரதீயம் முதலிய பண்டை இசைத்தமிழ் நூல்களும் - குறுவல் குணநூல், கூத்து நூல் முதலிய பண்டைத் தமிழ் நூல்கள் அயலார் சூழ்ச்சியால் மீட்க, தமிழ் கொஞ்சம் கொஞ்சமாக இறந்தொழிந்தனவே என்று பாவாணர் நெஞ்சம் கலங்குகிறார். இவ்வாறு தமிழ் மொழியிலும் மொழித்திருடர்கள் உள்ளதை வெளிப்படுத்தியுள்ளார்.

“இயற்சொல் திரிசொல் திசைச்சொல் வடசொலென்

றனைத்தே செய்யுள் ஈட்டச் சொல்லே” (தொல்காப்பியம் - தெளிவுரை - முனைவர் ச.வே.சுப்பிரமணியம் - பாடல்.880)

“அவற்றுள்

இயற்சொற் றம்மே

செந்தமிழ் நிலத்து வழக்கொடு சிவணித்

தம்பொருள் வழாமை இசைக்குஞ் சொல்லே” (தொல்காப்பியம்- தெளிவுரை - முனைவர் ச.வே.சுப்பிரமணியம் - பாடல்.1285)

“செந்தமிழ் சேர்ந்த பன்னிரு நிலத்தும்

தங்குறிப் பினவே திசைச்சொற் கிளவி” (தொல்காப்பியம் - தெளிவுரை - முனைவர் ச.வே.சுப்பிரமணியம் பாடல்.886)

என்று தொல்காப்பியக் கருத்துக்களை முன்வைத்து தமிழ் மொழியின் தோற்றத்தையும், தமிழ் மொழியின் சிறப்பையும் தெளிவாக வெளிப்படுத்துகிறார்.

“தனக்கென வாழ்வது சாவுக்கு ஒப்பாகும்

தமிழ்க்கென வாழ்வதே வாழ்வதாகும்”. (பாவேந்தர் பாரதிதாசன் - பாவேந்தம்-15-பக்.154)

என்ற பாரதிதாசன் கூற்றுப்படி தமிழ் மீது உயிராக விளங்கியவர் பாவாணர்.

“தமிழ்க்கெனப் பிறந்து தமிழ்த்கென வளர்ந்து
தமிழ்க்கெனப் பயின்று தமிழ்க்கெனப் பயிற்றித்
தமிழ்க்கென ஓய்ந்து தமிழ்க்கென ஆய்ந்து
தமிழ்க்கென வாழும் தமிழே வாழி”! (பாரதிதாசன் - கனிச்சாறு தொகுதி 7. ப.128)

தமிழுக்காகத் தன்னை முழுமையாக அர்ப்பணித்துக் கொண்டவரான இவர் தனித்தமிழ் இயக்கத்தின் வேர்களில் ஒருவராகக் கருதப்படுபவர். ‘மொழி ஞாயிறு’ என்ற போற்றப்பட்டவர் 79ஆம் வயதில் மறைந்தார். இவர் பாவாணர், பாவலர், நற்றமிழ் நாவலர், இலக்கண வித்தகர், நுண்மாண் நுழைபுல எழிலர் எனப் பல பெயர்களால் வழங்கப்படுகின்றார்.

முடிவுரை

பாவாணர் தமிழ் மொழிக்கு மிகுந்த தொண்டாற்றியவர். தமிழ் மொழியின் தூய்மையும் வளமையும் எத்தகையது என்பதை ஆராய்ந்து உலகிற்கு வெளிப்படுத்தியது மட்டுமன்றி தமிழர்களின் பெருமையை உலகம் உணரும்படி பறை சாற்றியவர்.

“பல்லுயிரும் பலஉலகும் படைத்தளித்துத்
துடைக்கினும் ஓர்
எல்லையறு பரம்பொருள்முன் இருந்தபடி
இருப்பது போல” (செம்மொழி இலக்கியச் சிறப்பியல்புகள் - டாக்டர்.மு.கோவிந்தராசன் - பக் .9)

என்ற கூற்றுப்படி, பரம்பொருளுக்கு நிகரான தமிழ் மொழியின் சிறப்பை உலகிற்குக் காட்டிய ஒளிவிளக்காகத் திகழும் பாவாணர் அவர்களே!

எத்துணை மொழிகள் உருவாகினும் தமிழ் மொழிக்கு நிகர் இல்லை.
தமிழ்மொழி எப்பொழுதும் உன் பெருமையை பறைசாற்றும்;
இதில் ஐயமில்லை.
தமிழன்னையை வணங்குவதைக் காட்டிலும் வேறு சிறப்பில்லை.
தமிழ் வாழ்க! தமிழ் வெல்க! தமிழ் ஓங்குக!
தமிழர் புகழ் எட்டு திசையும் முழங்குவதாக!

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தமிழ் வளர்த்தசான்றோர் - அடியார்க்குநல்லாரின் உரைத்திறன்

ம. மணிமேகலை
தமிழ்த்துறை, சீதாலட்சுமி இராமசுவாமி கல்லூரி, திருச்சிராப்பள்ளி.

முன்னுரை

அடியார்க்குநல்லார் என்ற இனிய பெயரையுடையவர் சிலப்பதிகாரத்திற்கு உரை இயற்றிய சான்றோர் இவர் அரும்பத உரையாசிரியர்க்குப் பின்னர் உரை இயற்றியவர். இவருக்கு முன்னும் சிலர் சிலப்பதிகாரத்திற்கு உரை இயற்றி இருக்கலாம் என்று கருத இடமுண்டு. பிறர் கொண்ட பாடங்களையும் உரைகளையும் இவர் ஆங்காங்கே சுட்டிச் செல்கிறார். இக்கட்டுரையில் தமிழ் வளர்த்த சான்றோர் வரிசையில் சிலப்பதிகாரத்திற்கு சிறந்த முறையில் உரைவகுத்த அடியார்க்குநல்லாரின் உரைத்திறன் குறித்து ஆராயப்படுகிறது.

திறவுச்சொற்கள்: அடியார்க்குநல்லார், முத்தமிழ், சிலப்பதிகாரம்

Abstract

Silapathikaram marked a turning point in the history of Tamil literature. Silampu shows the state of enjoyment in the literary life of Tamils from solos to kappiyam. Silampu first kappiyam, the primary kappiyam, Muthamilkh kappiyam After Silampu, no other kappiyam has appeared that reflects the art and culture of the Tamil race. Although many texts appear for this special copy, Adiyarku Nallar's text is one of the best. In the modern age of science, Tamil has been able to stand out for itself, and the main reason is that it is not easy to transcribe Adiyarku Nallar Silambakia Muthamilkh Kappiyam. It can only be written by someone like Muthamil Vidhakar, Tamilkalanjiam Adiyarku Nallar. The purpose of researching this book is because this book will help others to understand the text by looking at it from many angles. Only a well-versed vidhak can write a text for the sylambam, which is a muttamik kappiyam. Similarly, just as Adiyarku Nallar reflects the artistic life, society, and kiss of the Silampu Tamil, Nallar's text is also a reflection of Tamilness according to the source. This teacher, who came to write a letter for Silapathikaram, had boundless knowledge

and training. This can be seen line by line in Adiyarku Nalla's speech. If it were not for his speech, we would not have realized the merits of Silapathikaram and he witnessed the destruction of music and drama that would have been absent and lost to know the merits of ancient Tamil. He felt that he should at least convey the merits of ancient Tamil. This study is an expression of that. Therefore, the importance of this article is that the descriptive method is critical.

***Keywords**:* Adiyarkunallar, Muthamizh, Silappathikaram

அடியார்க்கு நல்லாரின் வாழ்க்கை

இவருடைய குலம் சமயம் இன்னவெனப் புலப்படவில்லை எனினும் இவரது காலம் நச்சினார்க்கினியர் காலத்திற்கு முந்தியதாகும் என்று மட்டும் கருதப்படுகிறது இவருரைக்குச் சிறப்புபாயிரமாகக் காணப்படும் செய்யுட்களால் இவருக்கு நிரம்பையர் காவலர் என்று ஓர் பெயருண்டு என்பதும் அக்காலத்திலிருந்த பொப்பண்ணகாங்கெயர்கோன் என்னுந் தோன்றல் இவருக்கு உதவிசெய்து ஆதரித்த வள்ளலார் "இவருக்குநிரம்பையர் காவலரென்னும் பெயர் ஊரால் வந்ததென்றும் நிரம்பை என்னும் ஊர் கொங்கு மண்டலத்தில் குறும்புநாட்டில் பெருங்கதையின் ஆசிரியராகிய கொங்குவேளிர் பிறந்த விசயமங்கலத்தின் பக்கத்தில் உள்ளது.

திருஞானசம்பந்தர் தம் தேவாரப் பாடலில் "கண்ணுளார் கருவூருளான் நிலை அண்ணலார் அடியார்க்குநல்லாரே" என்று சிவபெருமானை 'அடியார்க்குநல்லார்' என்றபெயரால் அழைக்கின்றார். அப்பெயரைத் தாங்கிய இவ்வுரையாசிரியர் சைவசமயத்தவர் என்பர். புறவாயாக்கைப் பெரியோன்' (சிலப் 5-16) என்றஅடிக்கு ' என்றும் பிறவாதயாக்கையுடைய இறைவன்' இவர் எழுதுகின்றார்.

உரையின் இயல்பு

முத்தமிழ் காப்பியம் என்று போற்றப்பெறும் சிலப்பதிகாரத்திற்குஉரை இயற்றிய இவரை.

"ஓரும் தமிழொரு மூன்றும் உலகின் புறவகுத்துச்

சேரன் தெரித்தசிலப்பதிகாரத்திற் சேர்ந்தபொருள்

ஆரும் தெரியவிரித்துரைத்தான் “

என்று கூறுகின்றது சிறப்புபாயிரச் செய்யுள் ஒன்று. ‘பருந்தும் நிழலும் என பாவும் உரையும் பொருந்த எல்லாப் பொருளும் தெரிந்து நல்லமிர்தம் பாலித்தான்’ என்று மற்றொரு செய்யுள் இவரைப் போற்றுகின்றது.

“பருந்தும் நிழலும் எனப் பவும் உரையும்

பொருந்து நெறி எல்லாப் பொருளும் - தெரிந்துஇப்

படியார்க்குநல்அமிர்தம் பாலித்தான் நன்னூல்

அடியார்க்குநல்லான் என் பான்”

என்ற செய்யுள் சிலப்பதிகாரத்திற்கு இவர் உரை இயற்றியதை உலக மக்களுக்கு நல்லமிர்தம் பாலித்தாய்ப் போற்றுகின்று

அடியார்க்குநல்லார் அவையடக்கமாக

“எழுத்தின் திறன்அறிந்தோ இன்சொற் பொருளின்

அழுத்தம் தனில்ஒன்றுஅறிந்தோ --- முழுத்;தும்

பழுதற்றமுத்தமிழன் பாடற்குஉரைஇன்று

எழுதத் துணிவதேயான்”

என்று கூறுவதாய் உள்ளது ஆனால் இவர் எழுத்தின் திறன் அறிந்தவர்: இன்சொற் பொருளின் அழுத்தம் அறிந்தவர்:; பழுதற்றமுத்தமிழன் பாடற்குச் செவ்விய உரை கண்டவர் என்பதை இவரதுஉரையே நன்கு உணர்த்தும்.

சிலப்பதிகாரத்தின் அருமை பெருமைகளை எல்லாம் இவரது உரையால் தான் தமிழகம் நன்கு அறிந்தது. இவரது உரை இல்லாமல் போய் இருந்தால் எத்தனையோ அரிய செய்திகள் வெளிப்படாமல் மறைந்து இருக்கும். முத்தமிழ் வித்தகராகிய இவர் பண்டைத் தமிழ் இலக்கண இலக்கியங்களில் ஊறித்திளைத்தவர்;: சிறப்பாக உரை இயற்றும் திறன் வாய்ந்தவர். இவரது உரையின் வாயிலாகப் பழந்தமிழரின் பலதிறம்

பட்டகலை வளங்களைப்பற்றி எத்தனையோஅரிய கருத்துகள் வெளிப்பட்டன. இவர் தரும் ஒளியில் தான் பழந்தமிழ்க் கலைகள் நன்கு தெரிகின்றன.

இவருடைய நடை எதுகை மோனை நிரம்பியதாக இருக்கும் இனியஓசையுடன் கவிதைபோல் அமைந்துள்ளது ஒவ்வொரு காதையிலும் முன் பின் சிறப்புகளை சுட்டிக் காட்டுவது இவரது தனிச் சிறப்பாகும்.

கதையும் கட்டுக்கோப்பும்

ஊர்கான் காதையில்இகோவலன் மதுரையினுள் சென்று அந்நகரிலுள்ள வணிகரைக் கண்டு அவர்களிடம் உதவிபெறும் நோக்கத்துடன் கவுந்தியடிகளிடம் விடை பெறுகின்றான்.

இதனை

"தேன்னகர் மருங்கின் மன்னர் பின்னோர்க்கு

என்னிலைஉணர்த்தியான்வருங் காறும்

பாதக் காப்பினள் பைந்தொடி"

என்றஅடிகளில் மிகத்தெளிவாக் இளங்கோவடிகள் உணர்த்துகின்றார்.

கண்ணகியைமாதரியிடம் அடைக்களமாகத் தரும்போதுஇ

"மாதரிகேள்:இம் மடந்தைதன் கணவன்

தாதையைக் கேட்கில் தன்குலவாணர்

அரும்பொருள் பெறுநரின் விருந்தெதிர் கொண்டு

கருந்தடங் கண்ணியொடுகடிமனைப் படுத்துவர்

இடைக்குலமடந்தைக்குஅடைக்கலம் தந்தேன்"

என்று கூறுகின்றார்.

உரைத்திறன்

காடுகாண் காதையில் (9) அன்றுஅவர் உறைவிடத்து அல்கினர் என்பதற்குவிளக்கம் கூறுகையில் இங்ஙனம் கூறியது. 'ஆறைங் காதம்' என்றமையானும் இகாவதம் அல்லது கடவார் ஆகி பன்னாள் தங்கிச் செல்நாள் ஒருநாள் என்றமையானும் ஈண்டும் 'அன்றுஅவர் உறைவிடத்து ஒழிந்து ஆண்டு அல்கினர் அடங்கி என்றமையானும் சிலநாள் சென்ற வழிச் செலவு இருந்து ஆறிச்சென்றமை உணர்வதற்கு எனக் கொள்க" என்று உரைக்கின்றார்.

இந்திரவிழாவூரெடுத்த காதையில் "வச்சிரநாடு" என்பதற்குச் "சோணைக் கரை" என்று பொருள் கூறுகின்றார்;. சோணை என்னும் ஆற்றங்கரையில் இருந்த நாடு வச்சிரநாடாகும். காடுகாண் காதையில்

"கந்தன் பள்ளிக் கடவுளர்க் கெல்லாம்

அந்தில் அரங்கத்துஅகன்பொழில்"

என்ற அடிகளில் குறிப்பிடும் அரங்கம் என்பது 'திருவரங்கம்' என்றுஎழுதுகின்றார்

முடிவுரை

ஆடியார்க்கு நல்லாரின் உரைத்திறன் எனும் தலைப்பில் அடியார்க்கு நல்லாரின் வாழ்க்கை உரையின் இயல்பு சிலப்பதிகாரகதையும் அதை எடுத்துரைக்கும் விதமும் இவரின் தனிச் சிறப்பும் எத்தனையோ எண்ணிலடங்கா உரைகள் இயற்றப்பட்டிருந்தாலும் அடியார்க்குநல்லார் உரைதனித் தன்மைவாய்ந்தது என்பது இவ்வாய்வு இக்கட்டுரையில் தமிழ் வளர்த்த சான்றோர் வரிசையில் சிலப்பதிகாரத்திற்கு சிறந்த முறையில் உரைவகுத்த அடியார்க்கு நல்லாரின் உரைத்திறன் குறித்து ஆராயப்பெற்றுள்ளது.

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