International Journal of
SCIENCE AND HUMANITIES

Volume 7, Number 1 : January - June 2021

ISLAMIAH COLLEGE PUBLICATIONS

ISLAMIAH COLLEGE (AUTONOMOUS), VANIYAMBADI

INTERNATIONAL JOURNAL OF SCIENCE AND HUMANITIES

EDITORS-IN-CHIEF

EDITORIAL BOARD

For further information relating to Publication of your papers, you are requested to contact the Principal, Islamiah College (Autonomous), Vaniyambadi. You can also send your feedfack to the following mail id

principal@islamiahcollege.edu.in

ISLAMIAH COLLEGE PUBLICATIONS
ISLAMIAH COLLEGE (AUTONOMOUS)
VANIYAMBADI – 635 752, INDIA

MESSAGE FROM EDITORS' DESK

It gives us an immense pleasure in bringing out the seventh volume of International Journal of Science and Humanities with your incessant support. International Journal of Science and Humanities being published by Islamiah College has been successfully marching towards its sixth year by providing a platform for authors in exhibiting their talents in the form of their research articles on various disciplines such as English, Chemistry, Bio-Chemistry, Commerce, Management, History, Sociology, Public Administration, Political Science, Physics, Economics and Mathematics.

Since it is the International Journal, we are invariably committed to do our best by ensuring that the articles published by the authors of various disciplines are free from error, plagiarism and biased. However, we will never compromise on the quality of journal as our journal is subjected to peer review. All the papers of different disciplines are thoroughly scrutinised by our peer review members who are employed in various reputed institutions all over the world.

Therefore, we humbly request you to provide your valuable suggestions in further strengthening this Journal and always extend your support by publishing your quality articles in our reputed International Journal of Science and Humanities.

Disclaimer

APPEAL

I am delighted to introduce this issue of International Journal of Science and Humanities (IJSH) to the students and research community on behalf of Islamiah College (Autonomous), Vaniyambadi, a century old institution serving for the cause of education to socially, economically and educationally weaker sections of the society. The IJSH, is a peer reviewed research journal of interdisciplinary nature that cater the needs of the teaching and research society. The aim of the journal is not only to provide a space for leading research work but also provide a platform for the budding researchers to publish their maiden attempt in the field of science and humanities. The objective of IJSH is to publish up-to-date, high-quality and original research papers alongside relevant and insightful reviews.

The initiative to start this journal was taken by Janab L.M Muneer Ahmed, the Secretary & Correspondent of this College with an aspiration to keep the research vibrant in this campus. Now, the torch is handed over to me from June 2016 onwards to run this journal on non-profitable basis without compromising its aims and objectives. At this juncture, I appeal to all teaching and research communities to concentrate on both teaching and research relevant to society, which are symbolically related as the two faces of the same coin. I also appeal to all reviewers and editors not to compromise with the quality of the input and promote this journal to the next level with excellent output. Finally, I pray Almighty to provide guidance for development and success of this journal. Best wishes and thanks for your contribution to the IJSH.

Mr. L.M. MUNEER AHMED
Secretary & Correspondent
Islamiah College (Autonomous)
Vaniyambadi 635 752
India

Table of Contents

Part A: Science

Part B: Humanities

Part A:

SCIENCE

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 1 – 13

http://www.islamiahcollege.edu.in

IN-VITRO ANTIOXIDANT ACTIVITY AND TOTAL PHENOLIC CONTENT OF SOLVENT EXTRACTS OF SALACIA OBLONGA WALL

S. Thirupathi and H. Abdul Jaffar Ali

Department of Biotechnology,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
jaffar.ascidian@gmail.com

Abstract

Plant-based medicines occupy a very important position in modern society. This is due to its low cost, no side effects, and the availability of natural chemicals formed in the plant's metabolic pathways. Among the herbs, Salacia oblonga is an important traditional Ayurvedic herb belonging to the Euonymus family. A resident of the tropics, *S. oblonga* has been used in traditional Indian medicinal systems. It is known for its valuable medicinal properties for the treatment of diabetes. It has potential biological activity. Antioxidants are free radical scavengers used to inhibit the formation of highly reactive species. Phytochemicals were extracted from plants in four different organic solvents and analyzed for their total phenol content and antioxidant activity by DPPH (1,1-diphenyl-2-picryl-hydradyl) radical scavenging activity. The leaf extract of *S. oblonga* showed strong free radical scavenging activity. This was evident from the DPPH radical quenching experiments based on the extract inhibition IC 50 percent. The methanol extract of S. oblonga had excellent antioxidant activity. The strong free radical trapping effect is due to the high amount of phenolic and flavonoid compounds in the aqueous root extract.

Keywords: Antioxidant Activity, Herbal Plants, Salacia Oblonga, Total Phenolic Compound, Yelagiri Hill.

1. Introduction

Many disorders of the human body, such as atherosclerosis, arthritis, Alzheimer's disease, cancer, etc., can be the result of an increased concentration of free radicals in the body. Reactive oxygen (ROS) and nitrogen (RNS) species, as the most common pro-oxidants, arise from normal metabolism or are induced by UV radiation and various pollutants. The harmful effects of a deteriorated antioxidant-pro-oxidant

balance can be largely prevented by taking antioxidant substances (Ghosh et al., 2008; Ognjanović et al., 2008). The secondary metabolites of plants have important biological and pharmacological actions such as antioxidant, antioxidant, antiallergic, antibiotic, hypoglycemic and anticancer (Borneo et al., 2008; Katalinić et al., 2004; Mulabagal and Tsay, 2004).

Medicinal plants are essential for the health of people and communities. The medicinal value of these plants lies in certain chemicals that have a certain physiological effect on the human body. The most important of these biologically active plant components are alkaloids, tannins, terpenoids, flavonoids and phenolic compounds (Anbuselvi et al 2005; Priya and Chellaram, 2011). Phenolic compounds are one of the largest and most abundant groups of plant metabolites (Hagerman et al 1998). Several studies have focused on the biological activity of phenolic compounds, which are antioxidants and free radical scavengers (Cespedes et al 2008; Reddy et al 2008). Antioxidants have already been found in plant materials and supplements. Due to their natural origin, antioxidants of plant origin are more beneficial than synthetic antioxidants (Rohman et al., 2010; Zheng and Wang, 2001). The use of natural plant antioxidants does not cause side effects, while synthetic antioxidants are genotoxic (Chen et al., 1992; Kahl and Kappus, 1993). Therefore, there are numerous studies on the biological activity and chemical composition of medicinal plants as a potential source of natural antioxidants.

The genus Salacia (family: Celastraceae) consists of several medically important species (*S. oblonga*, *S. reticulata*, *S. chinensis*, etc.) and is known as saptrangs in Ayurvedic medicine (Singh et al 2009). This plant is mentioned in Ayurveda as a remedy for the treatment of Madhumeha (the old name for diabetes) and is distributed in Sri Lanka, India, China, Malaysia and other countries (Yoshikawa et al 2002).

Salacia oblonga is a strong climbing shrub with densely warty branches. Elongated warts Leaves up to 21 $\times$ 8 cm, oblong, pointed or obtuse at the top, narrow at the base, dry green, 8-10 pairs of veins, stem 1 cm long. The stems with inflorescences are short, thick and multi-flowered. The flowers are many, greenish-yellow in color. Sepals 1.5 mm in diameter, rounded, petals 2.5 mm long, ovoid. The berry is about 4 cm in diameter, orange-red, smooth. Salacia with oblong leaves is found in evergreen and semi-evergreen forests of southern India and Sri Lanka. The flowering season is from March to May.

Salacia is a plant native to India and Sri Lanka, it belongs to the Celastraceae family. This is commonly known as poncoranti. A medicine is made from the root and stem. Salation is used for diabetes, asthma, joint pain, weight loss, and other conditions, but there is no conclusive scientific evidence to support this use. Unverified Information Salacia has long been used to treat diabetes in Ayurveda, a traditional Indian medicine. People with diabetes use Salacia wooden cups to drink water.

Some 18 varieties of salacia are grown in India. Other names for elongated salacia are ekanayaka and saptranka. The root portion of this plant has been proven for

its antimicrobial, antioxidant, anti-inflammatory and antiarthritic properties16. This bioactivity can help pharmacists isolate new drugs.

The main objective of the study was to determine the total content of phenols and their activity in the removal of free radicals in the extract of *Salacia oblonga* leaves.

2. Materials and Methods

Sample Collection

Fresh *S. oblonga* plants were collected from Yelagiri Hills, Taminadu, India. They were then authenticated by Dr. N.P.M. Mohamed Tariq, assistant. Professor of Botany, Department of Biotechnology, Islamiah College (Autonomous), Vaniyambadi. The leaves were separated and washed with water to remove debris and other impurities. They were then cut and dried in the shade for a month. The dried leaves were pulverized in ball mills and kept in an airtight container at 100°C.

Preparation of Plant Extracts

Plant extracts were prepared according to a standard protocol. The prepared plant material (10 g) was transferred to dark colored flasks and mixed with 200 ml of solvents of different polarities (water, methanol, acetone, petroleum ether) respectively and stored at room temperature. After 24 h, the infusions were filtered through Whatman No. 1 filter paper and the residue was re-extracted with an equal volume of solvents. After 48 h the process was repeated. The combined supernatants were evaporated to dryness in vacuum at 40°C using a rotary evaporator. The extracts obtained were stored in sterile test tubes and stored in a refrigerator at 4°C.

Evaluation of Antioxidant Activity

The ability of plant extracts to scavenge DPPH free radicals was evaluated using the standard method (Tekao et al., 1994), adopted with appropriate modifications (Kumarasamy et al., 2007). The stock solution of the extracts was prepared in methanol to reach a concentration of 1 mg / ml. Dilutions were made to obtain concentrations of 150, 100, 50, 25, 10 and 5 μg / ml. The diluted solutions (1 ml each) were mixed with 1 ml of DPPH methanolic solution at a concentration of 1 mg / ml. After 30 min incubation in the dark at room temperature (23°C), the absorbance at 517 nm was recorded.

Ascorbic acid was used as a standard. To exclude the absorption effect of the extracts, the absorbance of blank solutions containing 100 μl of each concentration plus 1400 μl of dH2O at 517 nm was also measured. The absorbance of DPPH relative to methanol was measured and recorded to obtain appropriate results in each experiment.

The percentage of inhibition was calculated using the following equation:

$$\%\text{antioxidant activity} = \frac{\text{(control absorbance - test sample absorbance)}}{\text{Absorption control}} \times 100.$$

IC50 values were estimated from the plot of % inhibition versus concentration using a non-linear regression algorithm. Data were presented as mean values ± standard deviation (n = 3).

Determination of the Total Phenolic Content in Plant Extracts

The concentration of phenolic compounds in plant extracts was determined by a spectrophotometric method (Singleton et al., 1999). A methanolic extract solution at a concentration of 1 mg / ml was used in the analysis. The reaction mixture was prepared by mixing 0.5 ml of methanolic extract solution, 2.5 ml of 10 % Folin-Ciocalteu reagent dissolved in water and 2.5 ml of 7.5 % NaHCO3. The blank was prepared concomitantly, containing 0.5 ml of methanol, 2.5 ml of 10 % Folin-Ciocalteu reagent dissolved in water and 2.5 ml of 7.5 % NaHCO3. The samples were incubated in a thermostat at 45°C for 45 min. The absorbance was determined using a spectrophotometer at λ_{max} = 765 nm. The samples were prepared in triplicate for each analysis and the mean absorbance value was obtained. The same procedure was repeated for the gallic acid standard solution and the calibration line was constructed. Based on the measured absorbance, the phenolic concentration (mg / ml) was read from the calibration line; then, the phenolic content in the extracts was expressed in terms of gallic acid equivalent (mg GA / g extract).

Statistic Analysis

All experimental measurements were performed in triplicate and are expressed as the mean of three analyzes ± standard deviation. The magnitude of the correlation between the variables was performed using a statistical software package SPSS (Chicago, IL) (SPSS for Windows, ver. XII, 2004).

3. Results

DPPH radicals are stable free radicals with a maximum absorption rate of 517 nm. Absorbance decreases at 515 nm in the presence of H atoms or compounds that can donate electrons. This means that stable diamagnetic molecules are formed.

Based on the decrease in the maximum absorption of DPPH radicals in the presence of antioxidant compounds, the antioxidant activity of various solvent extracts of *S. oblonga* plant was tested with DPPH scavenging tests at concentrations in the range of 150-5 μg/ml. Ascorbic acid was chosen as the standard antioxidant.

The free radical scavenging activity of the extract is expressed at IC50 concentrations of 150 μg/ml, 125 μg/ml, 100 μg/ml, 50 μg/ml, 25 μg/ml, 10 μg/ml

and 5 μg/ml. Figure 1 shows the percentages of free radical scavenging activity and corresponding IC50 values of various solvent extracts of *S. oblonga*.

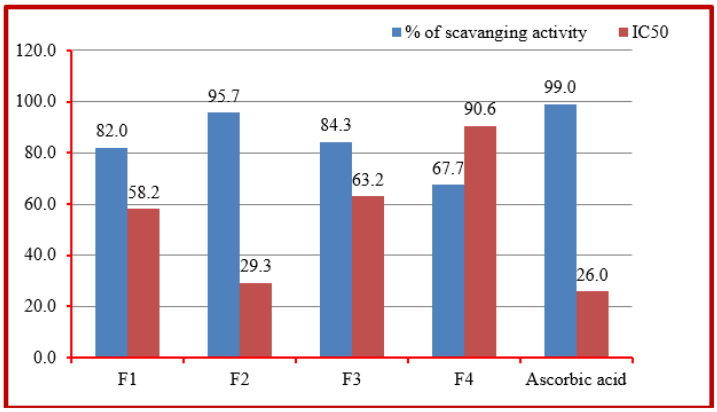


Figure 1: Percentage of Free Radical Scavenging Activity and IC50 Values of Various Fractions of Leaf of *Salacia oblonga* and Ascorbic Acid (Standard).

The inhibition rate of the aqueous extract (F1) ranged from 26.3 to 82.00 with an IC50 of 58.23 μg (Table 1). On the other hand, the inhibition rate of the methanol extract was 30.7 to 95.7 and the IC50 value was 29.27 μg (29.27 μg). Table 2). Moderate scavenging activity is indicated by the F3 of *S. oblonga*, the inhibition rate ranges from 19 to 84.3, and the IC50 value is 63.1 (Table 3). Low levels of capture activity are demonstrated by petroleum ether extracts in the range 19-66.7 with an IC50 of 90.59 (Table 4).

Table 1: Antioxidant Activity of Aqueous Extract of *Salacia oblonga*. (Each value is the average of triplicate ± standard error)

Conc (μg/ml)	n = 1	n = 2	n = 3	Mean	SD	IC50
150	83	81	82	82.0	9.0	
125	69	71	69	69.7	5.6	
100	63	62	63	62.7	6.3	
50	54	52	53	53.0	4.8	58.23
25	41	41	42	41.3	3.7	
10	35	35	34	34.7	4.2	
5	26	27	26	26.3	2.9	

The extract concentration causing 50 % extract loss and IC50 standard DPPH (color) activity was calculated from the graphical representation in Figure 2. Table 5 shows the

Table 2: Antioxidant Activity of Methanol Extract of *Salacia oblonga*. (Each value is the average of triplicate ± standard error)

Conc (μg/ml)	$n = 1$	$n = 2$	$n = 3$	Mean	SD	IC50
150	96	96	95	95.7	9.6	
125	92	93	91	92.0	8.3	
100	78	79	79	78.7	7.1	
50	67	67	66	66.7	8.0	29.27
25	54	55	54	54.3	6.0	
10	41	40	40	40.3	3.2	
5	30	31	31	30.7	2.8	

Table 3: Antioxidant Activity of Acetone Extract of *Salacia oblonga*. (Each value is the average of triplicate ± standard error)

Conc (μg/ml)	$n = 1$	$n = 2$	$n = 3$	Mean	SD	IC50
150	84	85	84	84.3	9.3	
125	71	72	74	72.3	5.8	
100	60	61	60	60.3	6.0	
50	52	51	52	51.7	4.7	63.1
25	41	42	42	41.7	3.8	
10	30	30	29	29.7	3.6	
5	20	19	18	19.0	2.1	

Table 4: Antioxidant Activity of Petroleum Ether Extract of *Salacia oblonga*. (Each value is the average of triplicate ± standard error)

Conc (μg/ml)	$n = 1$	$n = 2$	$n = 3$	Mean	SD	IC50
150	67	68	68	67.7	7.4	
125	60	58	59	59.0	4.7	
100	51	51	52	51.3	5.1	
50	40	38	40	39.3	3.5	90.59
25	31	32	42	35.0	3.2	
10	30	32	29	30.3	3.6	
5	20	19	18	19.0	2.1	

percent efficiency of DPPH removal of ascorbic acid at various concentrations. The IC50 range of the methanol extract of *S. oblonga* is close to the IC50 range of ascorbic acid (Figure 6). In conclusion, the methanol extract of *S. oblonga* was found to have higher free radical scavenging activity than other extracts.

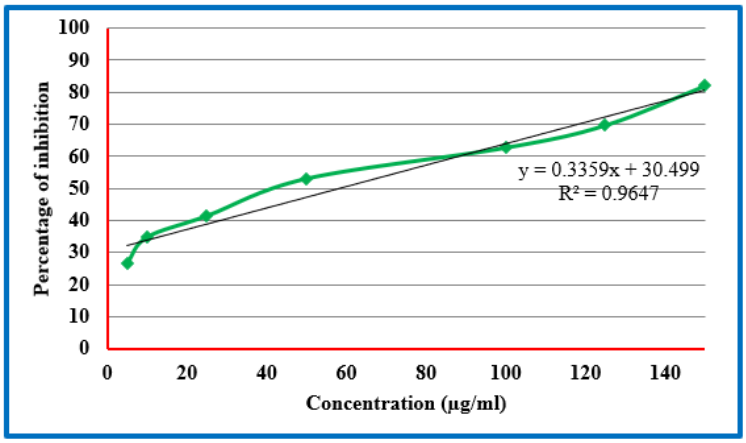


Figure 2: Calculation of IC50 Value for Antioxidant Activity of Aqueous Extract of *Salacia oblonga* leaf

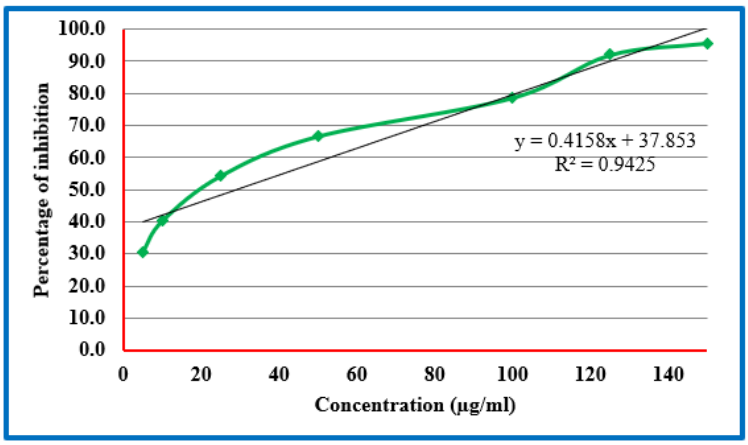


Figure 3: Calculation of IC50 Value for Antioxidant Activity of Methanol Extract of *Salacia oblonga* Leaf

Determination of Total Phenol Content

The total phenol content of various solvent extracts of Salacia oblonga was measured according to the Folin-Ciocalt method described by McDonald et al. (2001) Minor

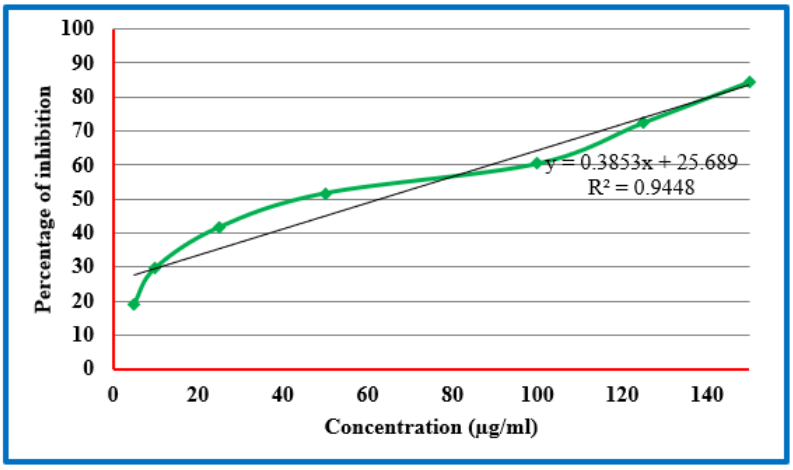


Figure 4: Calculation of IC50 Value for Antioxidant Activity of Acetone Extract of *Salacia oblonga* Leaf

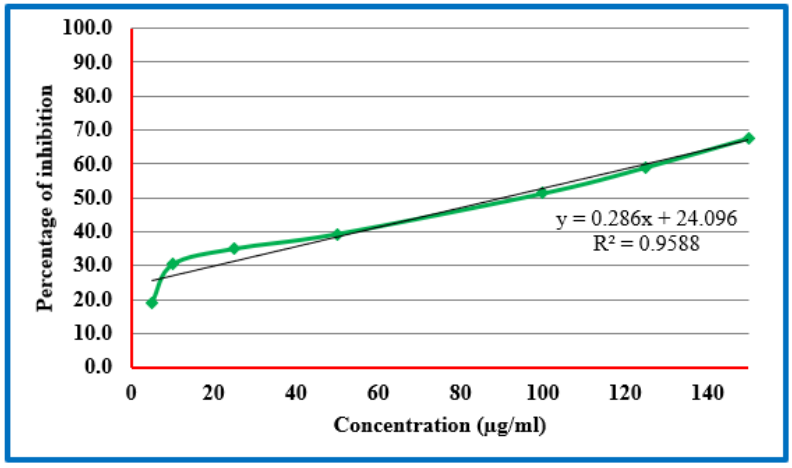


Figure 5: Calculation of IC50 Value for Antioxidant Activity of Petroleum Ether Extract of *Salacia oblonga* Leaf

modifications were made using gallic acid as standard. This method is widely used because it is simple, accurate and precise.

The total phenol content of the analyzed extract is expressed as gallic acid equivalents using the standard gallic acid curve shown in Figure 7 (standard curve formula: $y = 0.002x + 0.123R^2 = 0.987$).

The F2 phenolic compound content is 49.12 ± 4.9 mg GAE g-1 while the F4 phenolic compound content is 15.00 ± 0.48 mg GAE g-1. High antioxidant properties of F2 corresponded to high total phenol content, and extracts with low antioxidant activity

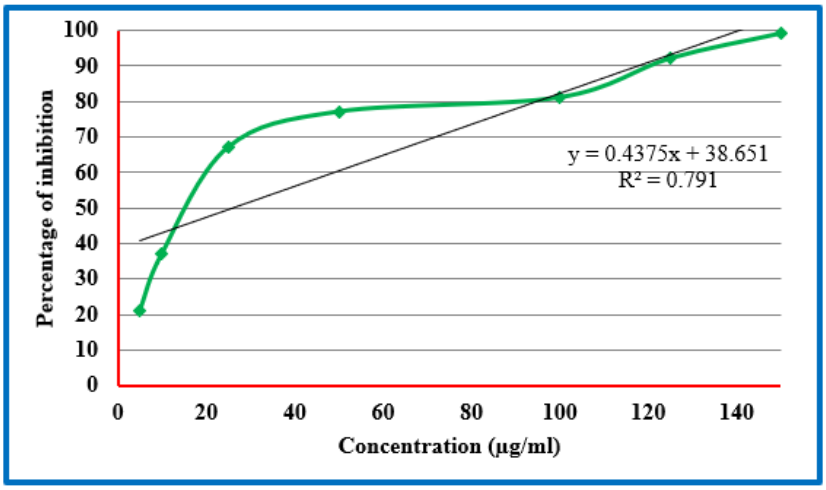


Figure 6: Calculation of IC50 Value for Antioxidant Activity of Ascorbic Acid

Table 5: Antioxidant Activity of Standard (Ascorbic Acid). (Each value is the average of triplicate ± standard error)

Conc (μg/ml)	$n = 1$	$n = 2$	$n = 3$	Mean	SD	IC50
5	27	26	26	26.33	2.11	
10	36	35	35	35.33	4.24	
25	67	67	66	66.67	6	
50	78	77	78	77.67	8.54	25.97
100	86	86	87	86.33	8.63	
125	90	90	92	90.67	8.16	
150	96	97	96	96.33	10.6	

showed relatively low total phenol content (Table 6).

4. Discussion

Organic solvents such as methanol, ethanol and acetone are often used to extract bioactive compounds (Eloff, 1998). In this study, water, methanol, acetone and petroleum ether were used as the best solvent for the preparation of the extract. A total of four fractions of *Salacia oblonga* leaf extract using four different solvents were used to test antioxidant activity and corresponding total phenolic compounds. These fractions were subjected to the DPPH test. The absorbance of the four fractions were measured and the percentage of antioxidant activity was calculated and shown in

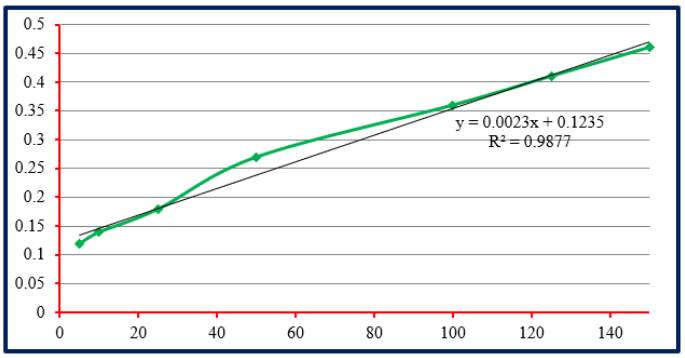


Figure 7: Gallic Acid Standard Curve. Each point is the mean of triplicate measurements from three different experiments ($n = 3$)

Table 6: Total Phenolic Contents in the Different Solvent Extracts of *Salacia oblonga* expressed in terms of Gallic Acid Equivalent (mg of GA/g of Extract) Extract mg of GA/g of Extract

Fractions	TPC (mg·GAE/g)	DPPH (IC50-μg/mL)
F1	40.08 ± 4.90	58.23
F2	49.12 ± 4.64	29.27
F3	32.45 ± 3.40	63.16
F4	15.00 ± 0.48	90.59

Table 2.

The leaf extract of *S. oblonga* showed potent free radical scavenging activity. This was evident from the DPPH radical quenching experiment based on the percent inhibitory IC50 value of the extract. Results were compared with standard ascorbic acid (96.33 % at 150 ug/ml). Of the four fractions, the second fraction of *S. oblonga* leaf extract showed the highest potential for radical scavenging activity (95.7 % at 150 μg/ml), followed by the third fraction (84.3 %), followed by the second fraction (82.0 %). The fourth fraction had the lowest percentage of antioxidant activity (67.7 %). The change in radical scavenging activity is graphically illustrated in Figure 1.

Radical scavenging activity is one of the important antioxidant mechanisms. The electron donating capacity of natural products can be measured by solution bleaching of DPPH purple (Krishnaiah et al. 2011). The potential expression of antioxidant activity is due to the presence of secondary metabolites such as phenols, flavonoids, terpenoids, alkaloids, tannins and saponins. All plants have an abundance of natural products. Therefore, plants are an important source of antioxidants.

The DPPH assay is to quantify antioxidant removal properties. Many studies have

demonstrated the potential of antioxidants through the DPPH test 19-21. This study demonstrated the greatest potential antioxidant activity of *S. oblonga* leaves through the DPPH assay. It also motivates pharmacists to use leaf pieces.

Phenolic compounds are one of the most important and ubiquitous groups synthesized during development in the plant kingdom (Naczk and Shahidi2004). Phenolic compounds are a class of antioxidants that act as free radical terminators (Shahidi and Wanasundara, 1992). Phenolic compounds are important plant antioxidants with significant scavenging activity against radicals. Therefore, for example, the antioxidant capacity may depend primarily on phenolic compounds (Zheng and Wang, 2003; Chinnici et al. 2004; Huang et al. 2009). Numerous reports have shown an association between phenols, flavonoids, and antioxidant activity (Evans et al. 1995; Chu et al. 2000; Lu and Foo 2001). The antioxidant activity of phenol is due to the presence of hydroxyl groups used to scavenge free radicals (Hagerman et al. 1998). The flavonoid effect is due to the chelating and cleansing procedures.

Acknowledgement

The facilities provided by Islamiah College (Autonomous), Vaniyambadi, Tamil Nadu, India, are gratefully acknowledged.

References

[1] Borneo, R., León, E.A., Aguirre, A., Ribotta, P. and Cantero, J.J. (2008), Antioxidant capacity of medicinal plants from the Province of Cordoba (Argentina) and their in vitro testing in model food system, *Food Chem.* **112**, 664 – 670.

[2] Chen, C., Pearson, M.A. and Gray, I.J. (1992), Effects of synthetic antioxidants (BHA, BHT and PG) on the mutagenicity of IQ-like compounds, *Food Chem.* **43**, 177 – 183.

[3] Ghosh, T., Maity, K.T., Sengupta, P., Dash, K.D. and Bose, A. (2008), Antidiabetic and in vivo antioxidant activity of ethanolic extract of Bacopa monnieri Linn. aerial parts: a possible mechanism of action, *Iranian J. Pharm. Res.* **7**, 61 – 68.

[4] Katalinić, V., Miloš, M., Kulišić, T. and Jukić, M. (2004), Screening of 70 medicinal plant extracts for antioxidant capacity and total phenols, *Food Chem.* **94**, 550 – 557.

[5] Kumarasamy, Y., Byres, M., Cox, P.J., Jasapars, M., Nahar, L. and Sarker, S.D. (2007), Screening seeds of some Scottish plants for free-radical scavenging activity, *Phytother. Res.* **21**, 615 – 621.

[6] Mulabagal, V. and Tsay, H. (2004), Plant Cell Cultures - an alternative and efficient source for the production of biologically Important secondary metabolites, *Int. J. Appl. Sci. Eng. Tech.* **2**, 29 – 48.

[7] Ognjanović, B.I, Marković, S.D., Pavlović, S.Z., Žikić, R.V., Štajn, A.Š. and Saičić, Z.S. (2008), Effect of chronic cadmium exposure on antioxidant defense system in some tissues of rats: protective effect of selenium, *Physiol. Res.* **57**, 403 – 411.

[8] Rohman, A., Riyanto, S., Yuniarti, N., Saputra, W.R. and Utami, R. (2010), Antioxidant activity, total phenolic, and total flavaonoid of extracts and fractions of red fruit (Pandanus conoideus Lam), *Int. Food Res. J.* **17**, 97 – 106.

[9] Singleton, V.L., Orthofer, R. and Lamuela-Raventos, R.M. (1999), Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent, *Methods Enzymol.* **299**, 152 – 178.

[10] Tekao, T., Watanabe, N., Yagi, I. and Sakata, K. (1994), A simple screening method for antioxidant and isolation of several antioxidants produced by marine bacteria from fish and shellfish, *Biosci. Biotechnol. Biochem.* **58**, 1780 – 1783.

[11] Zheng, W. and Wang, Y.S. (2001), Antioxidant Activity and Phenolic Compounds in Selected Herbs, *J. Agric. Food Chem.* **49**, 5165 – 5170.

[12] Chu, Y.H., Chang, C.L. and Hsu, H.F. (2000), Flavonoid content of several vegetables and their antioxidant activity, *Journal of the Science of Food and Agriculture* **80** (5), 561 – 566.

[13] Evans, R.C., Miller, N.J., Bolwell, G.P., Bramley, P.M. and Pridham, J.B. (1995), The relative antioxidants activities of plant derived polyphenolic flavonoids, *Free Radical Research* **22** (4), 375 – 383.

[14] Hagerman, A.N., Rield, K.M., Jones, G.A., Sovik, K.N., Ritchard, N.T., Hartzfeld, P.W. and Riechel, T.L. (1998), High molecular weight plant polyphenolics (tannins) as biological antioxidants, *Journal of Agricultural and Food Chemistry* **46** (5), 1887 – 1892.

[15] Zheng, W. and Wang, S.Y. (2003), Oxygen radical absorption capacity of phenolics in blueberries, cranberries, chokeberries and lingonberries, *Journal of Agricultural and Food Chemistry* **51** (2), 502 – 509.

[16] Yoshikawa, M., Shimoda, H., Nishida, H., Takada, M. and Matsuda, H. (2002), Salacia reticulata and its poly phenolic constituents with lipase inhibitory and lypolytic activities have mild antiobesity effects on rats, *The Journal of Nutrition* **132** (7), 1819 – 1824.

[17] Lu, Y. and Foo, Y. (2001), Antioxidant activities of polyphenols from sage (Salvia officinalis), *Food Chemistry* **75** (2), 197 – 202.

[18] Anbuselvi, S., Chellaram, C., Jeyanthi, R., Jonesh, S. and Edward, J.K.P. (2009), *J. Med. Sci.* **9** (5), 240 – 244.

[19] Cespedes, C.L., El-Hafidi, M., Pavon, N., Alarcon, J. and Maqui (2008), *Food Chem.* **107**, 820 – 829.

[20] Shahidi, F. and Wanasundara, P.K. (1992), *Crit. Rev. Food Sci. Nutri.* **32**, 67 – 103.

[21] Huang, Z., Wang, B., Eaves, D.H., Shikany, J.M. and Pace, R.D. (2009), *Int. J. Food Sci. Nutr.* **60**, 100 – 108.

[22] Singh, N.K., Biswas, A., Rabbani, S.I., Devi, K. and Khanam, S. (2009), *Pharmacologyonline* **1**, 127 – 33.

[23] Chinnici, F., Bendini, A., Gajani, A. and Riponi, C. (2004), *J. Agr. Food. Chem.* **52**, 4684 – 4689.

[24] Eloff, J.N. (1998), Which extractant should be used for the screening andisolation of antimicrobial components from plants? *J Ethnopharmacol* **60**, 1 – 8.

[25] Krishnaiah, D., Sarbatly, R. and Nithyanandam, R.R. (2011), A review of the antioxidantpotential of medicinal plant species, *Food Bioprod Process* **89**, 217 – 233.

[26] Naczk, M. and Shahidi, F. (2004), Extraction and analysis of phenolics in food, *J. Chromatogr A* **1054**, 95 – 111.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 14 – 22

http://www.islamiahcollege.edu.in

ANTIBACTERIAL ACTIVITIES OF THREE (CARICA PAPAYA, CALOTROPIS GIGANTEAN, FICUS BENGHALENSIS) LATEX PLANTS USED IN TRADITIONAL MEDICINE IN THE JAVADHU HILLS TRADITIONAL HEALERS

N.P.M. Mohamed Tariq, V. Meiyazhagan and M.A. Farook

Department of Biotechnology,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

This study was performed to evaluate the in vitro antibacterial potential of Ficus benghalensis, Carica papaya and Calotropis gigantean extracts against six human pathogenic bacteria, and the effect of plant material harvest times on antibacterial activities. The results indicated that all tested plant extracts showed anti-bacterial activities. Among the tested species, Ficus benghalensis was the most active. The diameters of the inhibition zones of leaf extract collected in the morning were significantly better than those collected in the afternoon or evening, indicating that Ficus benghalensis leaves should be collected in the early morning to optimize plant activity. This study supports the medical use of the three types of bacterial infection.

Keywords: Ficus Benghalensis, Carica Papaya, Leptadenia C. Gigantean, Antibacterial Potentials, Time Necessity.

1. Introduction

Infectious diseases remain a major public health problem worldwide. It remains the main cause of the high death rates recorded in developing countries, while in industrialized countries, an alarming incidence of antibiotic resistance has been observed.

The emergence of multi-drug resistance phenotypes is a major public health problem in treating bacterial infections (Okusa, 2012). The real challenge for scientists around the world today is to constantly find new drugs to combat resistant microorganisms, or compounds that are able to inhibit the resistance mechanisms of pathogenic microorganisms and thus restore antibiotic activity (Oseni et al., 2014). In

modern medical practice, the worldwide incidence of antibiotic resistance is causing an increased need for new compounds. Medicinal plants are a valuable source for this type of compounds (Hatano et al., 2005). Original herbal remedies are widely used against many infectious diseases, but only a few have been studied chemically and biologically in order to determine their active ingredients (Longanga et al., 2000).

In Javadhu hills, many plants are traditionally used against infectious diseases. Among them are Ficus benghalensis, Carica papaya, and C. gigantean, which are three latex plants from the above species. Latex cells typically contain latex, which is rich in triterpenes and other ingredients include: cyanogen glycosides, saponins, tannins, and cyclitol (Evans, 2002). Plant latex is a good source of many secondary metabolites, which show a growth inhibiting effect against bacteria, fungi, viruses, tumors, and cancer cell lines (Ujwala and Karpagam, 2013). Ficus benghalensis is used as an anthelmintic, laxative, antipyretic, and expectorant, and is also used to treat diarrhea and intermittent fevers of malaria (Sutar and Pal, 2014). Carica papaya is used in traditional medicine for stomach problems, diarrhea, gonorrhea, malaria, cough, catarrh, diabetes, and galactogogue (Gill, 1992; En Jisan et al., 2009). Calotropis gigantean is used in the management of onchocerciasis, scabies, hypertension, catarrh, skin diseases, sexual potency, and wound healing (Thomas, 2012). Some pharmacological investigations have been conducted to demonstrate its therapeutic potential (Abere and Onwukaeme, 2012; Raghavamma et al., 2013; Anywar et al., 2014). But in Javadhu hills, not much is known about this species. The aim of this study is to evaluate the in vitro antibacterial potential of aqueous and ethanolic extracts of F. benghalensis, Carica papaya, and C. gigantean against six types of human pathogenic bacteria, and then the effect of plant material harvest times on the antibacterial activities of F. benghalensis.

2. Material and Methods

2.1. Plants Material

The leaves of F. benghalensis and C. papaya were collected at the Javadhu hill, wild parts of Calotropis gigantean were collected from Katravalli village, 25 km north of Vaniyambadi. All plant products were obtained in December 2019 and identified in the Department of Botany, C. Abdul Hakkim College, Melvisharam.

2.2. Microorganisms

The microorganisms used for the antibacterial tests were Gram-positive (Staphylococcus aureus ATCC 29213 and clinical strain of Staphylococcus aureus), and Gram-negative (Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 27853, and clinical strains Salmonella typhi, Klebsiellapneumoniae) bacteria. The ATCC strains were obtained from the American Type Culture Collection, via National Institute of Public Health of Javadhu hills; whereas the clinical strains were from the Biotechnology laboratory of Islamiah College, Vaniyambadi, Thirupathur.

2.3. Extractions

The leaves of all three plants were thoroughly washed under running water, and the contents of each plant were confined to small pieces. Plant samples were dried in an air-conditioned room for two weeks. After drying, the plant parts were powdered using a grinding machine. The water extract was made by boiling 50 mg powder in 500 ml distilled water for 20 minutes. After cooling to room temperature, the extract was filtered with Whatman No. 1 paper and the vapors dried. Ethanol extraction was performed by the flow of 50 g powder in 500 ml of 70 g (v / v) ethanol, while stirring with magnetic stimulation for 48 hours. The preparations were filtered with Whatman No.1 paper and evaporated. It was stored in the refrigerator at 4 degrees Celsius until used.

2.4. Antibacterial Sensitivity Assay

If the well-propagated method was used to investigate the anti-microbial properties of the ducts as described in the National Committee for Clinical Laboratory Standards (NCCLS, 2003 Rup Roopara et al., 2015). Has gone Bacterial strains on nutrients at 18 C for 18 to 24 hours were suspended in saline solution (0.9%, w / v) containing 0.5, standard (108 CFU / ml). The suspension was used to inoculate Mullarhunton agar 90 mm diameter petri dishes on a wooden user for sterile cotton. A sterile steel bore with an inner diameter of about 6 mm was used to drill holes in the Mullar-Hunton media plates. The dry ethanolic extract was dissolved in dimethyl sulfoxide 1 (DMSO), and stagnant sterile water. The extract, positive and negative control was sent to these holes. A copy of each plate was prepared. The plates were taken out at room temperature for one hour so that they could be spread in the media to remove them before they were kept at 37 degrees Celsius for 24 hours. Antibacterial activity was assessed by measuring the anaerobic zone diameter around a well containing, 2019.

Table 1: Diameters of Growth of Inhibition Zones of Test Plant Extracts

Plant name	Extract	E.coli	P. aeruginosa	S. aureus	S. typhi	K. pneumoniae
C. papaya	Aqueous	12.5	13.2	0	13.5	0
	Ethanol	21.5	22.5	13	17	14.5
C. gigantean	Aqueous	9.5	0	11.5	0	0
	Ethanol	17.5	8.5	13.5	6.5	8
F. benghalensis	Aqueous	0	0	13	13.5	0
	Ethanol	0	0	13.5	13	11

2.5. Determination of Minimum Inhibitory Concentration (MIC) and Minimal Bactericidal Concentration (MBC)

According to the National Committee for Clinical Laboratory (NCCLS, 2003), MIC and MBC used PP-Python water microdilution in 96 good plates. The same 0.5 suspension was diluted with pepton water to inject 96 good plates with twice the serial delinquency into the extract. The concentration ranged from 20 to 0.039 mg / ml. The final volume in the wells was 200 ml. The plates were baked at 37 degrees Celsius for 24 hours. MIC was recorded as the lowest extract concentration with no significant increase in broth. MBC was recorded as the lowest extract concentration of bacterial molecules killing 99.9%. Determination of MBC values Removing the 100 ml bacterial suspension from the subculture shows no growth and nutrient plates are inoculated at 370C for 24 h.

Table 2: Minimal Inhibitory Concentrations (MIC) and Minimal Bacterial Concentration of the Active Ethanolic Extracts (mg/ml)

Bacteria	C. papaya			C. gigantean			F. benghalensis		
	CMI	CMB	CMB/ CMI	CMI	CMB	CMB/ CMI	CMI	CMB	CMB/ CMI
E.coli	0.62	0.62	1	1.25	1.25	1	NA	NA	–
P.aeruginosa	1.25	1.25	1	NA	NA	–	NA	NA	–
S.aureus	0.62	0.62	1	1.25	2.25	2	1.25	1.25	1
S.typhi	1.25	1.25	2	NA	NA	–	2.5	2.5	2
K.pneumoniae	1.25	1.25	2	NA	NA	–	2	2	2

2.6. The Influence of Harvest Time on the Activity of Extracts

To assess the effect of harvest time on the biological activity of plant extracts, the leaves of F. benghalensis were collected at three different times of the day (before 8 a.m., 12 a.m. to 1 p.m and after 5:00 pm). The accumulated plant material was treated in the same condition as before, and the extracts were tested under the same bacterial strain using the agar well disinfection method.

2.7. Data Analysis

Data were entered into SPSS 20.0. The results of each inhibition zone are presented as mean ± standard deviation (SD) of the mean of duplicates. Data were analyzed using the one-way analysis of variance (ANOVA). P-values of less than 0.05 were reflected statistically significant.

Figure 1: Variation of Inhibition Zones of Aqueous and Ethanolic Extracts of Plant Species according to Plant Material Harvest Time

3. Results and Discussion

3.1. Antibacterial Sensitivity Assay

The results of the antibacterial susceptibility test of three test plant extracts are presented in Table 1 and 2. Antibacterial activity was observed in different ways with areas of restricted diameter ranging from 6.5 ± 0.7 mm to 22.5 ± 2.1 mm. Of the three plant species tested, pneumonia was the most active. Extracts of F. benghalensis inhibited the growth of all testicular bacteria except aqueous liquor which was inactive against S. aureus and K. pneumoniae. Ethanolic extract of S. azalea inhibited the growth of experimental bacteria in prohibited diameter zones ranging from 6.5 ± 0.7 mm to 17.5 ± 2.1 mm, while an indicator of water was P. aeruginosa ATCC 27853, S. typhoid, and Was inactive against Pneumonia s. C. gigantean Horsta's extracts were active against Oreta ATCC 29213, S. aureus, Salmonella typhi, and pneumonia, and E. coli were inactive against ATCC 25922 and P. aeruginosaATCC 27853. Ethanolic extracts were more active in coli and ATCC 25922 and p. Inhibited the growth of all tested bacteria except the ethanolic extract of against Erogenousa ATCC 27853. Of the test bacteria, S. aureus ATCC 29213 was the most sensitive. Ciprofloxacin, which was used as a positive control, contained 24 ± 2.8 mm to 32.5 ± 2.1 mm and DMSO1 ging in contaminated water, which was used as a negative control. No problem was shown. Therefore, none of the observed obstructions in plant extracts were due to solvents.

Some phytochemicals, such as tannins, saponins, terpenoids, alkaloids, flavonoids, phenols and steroids, were involved in the pharmacological properties of plant species. Previous studies in India have shown that the ethanolic extract of F. benghalensis reveals

the presence of medically valuable bioactive components such as tannins, saponins, terpenoids, alkaloids, flavonoids, phenols and steroids (Sredivi et al. 2014, Raghuma et al., 2013). The presence of alkaloids, tannins, cardiac glycosides and saponins in the extract of the leaves of C. papaya was demonstrated in Nigeria (Abir and Onokiam, 2012).

Leptidenia hysterectomy was reported to contain alkaloids, saponins, phenolic glycosides, tannins, flavonoids, proanthocyanidins, and tryperpenes (Thomas, 2012). Therefore, the observed antibacterial activity may be due to the presence of these ingredients. Agreeing with our findings, Raghumma et al., (2013), found in India that the metholic extract of F. benghalensis leaves was active against E. coli, Pseudomonas aeruginosa, and S. aureus. In Ghana, Mensa et al., (2006), demonstrated that methotrexate extract from the aerial part of S. azalea inhibited the growth of S. aureus and E. coli and was inactive against P. aeruginosa.In Nigeria, Alero and Vara, (2009), found that water extraction increased E. coli growth to 30 mg / ml and in P. aeruginosa to 60 mg / ml. Our previous study shows that C. gigantean.

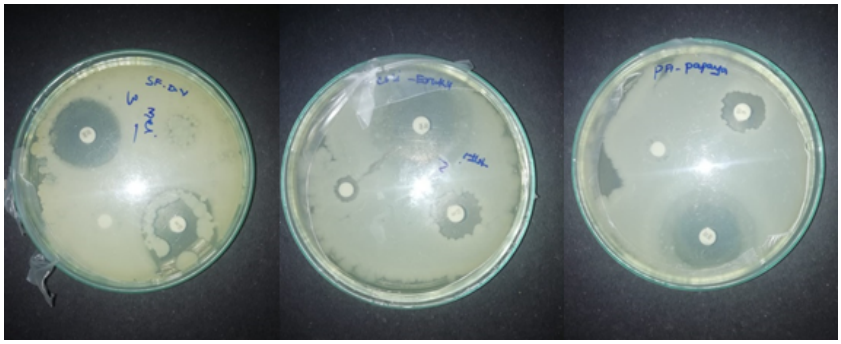


Figure 2: Variation of Inhibition Zones of Ethanolic Extracts of Papaya, Calatropis and Ficus sp.

Ethanolic extract of papaya leaves inhibits the development of E. coli and S. typhoid but only clinical strains are involved in this study (Hoko et al., 2012 and Patrick et al., 2015).

3.2. The Influence of Harvest Time on the Activity of Extracts

The biological activities of medicinal plants vary widely depending on the type of plant, the part of the plant, the geographical location, and the solvent used in the extraction. It may also depend on the condition of the plant parts, Sometimes follow certain methods for the preparation of herbal medicines, such as pruning plant material early in the morning without greeting anyone in any way (Chachakodo et al., 2012). To find out if there is a better daily time to collect plant material for medicinal use, the leaves of F. benghalensis (the most active species tested in this study) are used three times a day (GMT).) Were collected at: before 8:00 a.m., between 12:00 – 1:00 p.m., and after 5:30

p.m. These 3 samples were treated separately, extracted from water and 70% ethanol (v / v). The extracts were tested on the same organism and the results are presented in figures 1 and 2. These results show that the diameter of the restricted zone depends on the time. Prevention zone hams obtained from water or ethanol extract were better with morning leaf extracts. Water extraction data show that between the morning leaf extract and the afternoon or evening leaf extract extracted ($P < 0.05$) between P. aeruginosa ATCC 27853, S. Orish ATCC 29213, and There was a significant difference in the diameter of the S-type restricted zone.). The results of the ethanol extract were found in E. coli ATCC 25922, P. eruginosa also showed significant differences in the diameter drops of ATCC 27853, and the prohibited areas of S. typhoid, morning accumulated leaf extract compared to evening accumulated leaf extract ($P < 0.05$). Thus, it appears that the leaves of F. benghalensis should be taken early in the morning to improve antibacterial activity.

In this study, not only the ethanol extract but also the aqueous decoction of the leaves of these three plants has been tested. Decoction is the most widely used form of traditional medicine for the treatment of diseases. Therefore, the activity obtained for these liquors was consistent with the use of such plants in the treatment of bacterial infections. Although this study provides useful data on the antibacterial activity of the leaves of F. benghalensis, C. papaya, and C. gigantean, toxicological investigations are also necessary to provide the safe use of these types of drugs.

References

[1] Abere, A.T., and Onwukaeme, N. D. (2012), Pharmacognostic Evaluation of the Leaves of Secamoneafzelii (Schult) K Schum (Asclepiadaceae), *Trop J Pharm Res* **11** (1), 125 – 131.

[2] Alagesaboopathi, C. and Sivakumar, R. (2011), Antimicrobial properties of various extracts of andrographisneesianawight-an endemic medicinal species from India, *International Journal of Pharmatech research*, **3** (1), 27 – 31.

[3] Aliero, A.A. and Wara, S.H. (2009), Validating the medicinal potential of Leptadeniahastata, *Afr J Pharm Pharmacol* **3**, 335 – 338.

[4] Anywar, G., Oryem-Origa, H., and Kamatenesi-Mugisha, M. (2014), Antibacterial and Antifungal Properties of Some Wild Nutraceutical Plant Species from Nebbi District, Uganda, *British Journal of Pharmaceutical Research* **4** (14), 1753 – 1761.

[5] Evans, W.C. (2002), *Trease and Evans Pharmacognosy*, WB Saunders Ltd., London; 32 – 547.

[6] Gill, L.S. (1992), *Ethnomedical uses of plants in Nigeria*, University of Benin Press, Benin City, Nigeria, **103**.

[7] Hatano, T., Kusuda, M., Inada, K., Ogawa, T. O., Shiota, S., Tsuchiya, T. and Yoshida, T. (2005), Effects of tannins and related polyphenols on methicillinresistant Staphylococcus aureus, *Phytochemistry* **66**, 2047 – 2055.

[8] Hoekou, Y.P., Batawila, K., Gbogbo, K.A., Karou, D. S., Améyapoh, Y. and de Souza, C. (2012), Evaluation des propriétésantimicrobiennes de quatreplantes de la floretogolaiseutilisées en médecinetraditionnelledans le traitement des diarrhéesinfantiles, *Int. J. Biol. Chem. Sci.* **6** (6), 3089 – 3097.

[9] Karou, D., Dicko, M. H., Simpore, J. and Traore, A.S. (2005), Antioxidant and antibacterial activities of polyphenols from ethnomedicinal plants of Burkina Faso, *African Journal of Biotechnology*, **4** (8), 823 – 828.

[10] Longanga, O.A., Vercruysse, A. and Foriers, A. (2000), Contribution to the ethnobotanical, phytochemical and pharmacological studies of traditionally used medicinal plants in the treatment of dysentery and diarrhoea in Lomela area, Democratic Republic of Congo (DRC), *J. Ethnopharmacol*, **71** (3), 411 – 423.

[11] Mensah, A.Y., Houghton, P.J., Agyare, C., Komlaga, G., Mensah, M.L.K., Fleischer, T.C. and Sarpong, K. (2006), Investigation of activities related to wound healing of Secamoneafzelii, *Journal of Science and Technology*, **26** (3), 83 – 89.

[12] N Guessan, K., Tra Bi, F. H. and Koné, M. W. (2009), Étudesethnopharmacologiques de plantesantipaludiquesutilisées en médecinetraditionnelle chez les Abbey etKrobou d Agboville (Côte d Ivoire), *Ethnopharmacologia*, **44**, 42 – 50.

[13] Oseni, L.A., Ajisope, B.M.U. and Sunwiale, S.S. (2014), In vitro bacteria growth inhibition potential of crude extracts of different parts of Rauvolfiavomitoria against five standard strains of selected human pathogenic microbes, *World Journal of Pharmacy and Pharmaceutical Sciences*, **3** (6), 152 – 164.

[14] Patrick Y. Hoekou, Tchadjobo Tchacondo , Koffi A. Gbogbo, Damehan Tchelougou, Passimna Pissang, Simplice D. Karou, Yaovi A. Améyapoh and KomlanBatawila (2015), Antibacterial activities of three latex plants of Asclepiadaceae family used in traditional m-edicine in South Togo, *International Journal of Current Microbiology and Applied Sciences* **4** (5), 882 – 891.

[15] Raghavamma, S.T.V., Rama Rao, N., SambasivaRao, K.R.S. and DevelaRao, G. (2013), Screening the leaf extract of Pergulariadaemia (Forssk.) chiov., for its antioxidant property and potential antimicrobial activities on medicinally

important pathogens, *International Journal of Phytopharmacology*, **4** (3), 217 – 222.

[16] Rupapara, K.V., Joshi, N.H., and Vyas, K.G. (2015), Evaluation of antimicrobial activity of crude extracts of Seaweed Sargassumjohnstonii, *Int. J. Curr. Microbiol. App. Sci* **4** (2), 300 – 304.

[17] Sridevi, G., Prema, S., Sekar, S. and Sembulingam, K. (2014), Phytochemical analysis of Pergulariadaemia for its bioactive components through Gas Chromatographic Mass Spectrometry (GCMS), *IOSR Journal of Pharmacy* **4** (5), 41 – 46.

[18] Sutar, N.G., and Pal, S.C. (2014), Evaluation of analgesic activity of leaf extracts of Pergulariadaemia [Forsk] in experimental animals, *Int J Pharm PharmSci* **6** (9), 137 – 139.

[19] Tchacondo, T., Karou, D.S., Agban, A., Bako, M., Batawila, K., Bawa, M. L., Gbeassor, M. and de Souza, C. (2012), Medicinal plants use in central Togo (Africa) with an Emphasis on the Timing, *Pharmacognosy Research*, **4**, 92 – 103.

[20] Thomas, S.D. (2012), Leptadeniahastata: A Review of its Traditional uses and its Pharmacological Activity, *Med. Chem* **2**, 148 – 150.

[21] Ujwala, K. and Karpagam, K. (2013), Potential therapeutic values of plant lattices, *Int. J. Med. Arom. Plants* **3** (2), 317 – 325.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 23 – 39

http://www.islamiahcollege.edu.in

ASIAN SEA BASS, LATES CALCARIFER (BLOCH, 1790): A REVIEW

M.A. Farook and H. Abdul Jaffar Ali

Department of Biotechnology,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

Lates calcarifer (Bloch 1790), commonly called the giant sea perch or sea bass, is an economically important food fish in the tropical and subtropical regions of Asia and the Pacific. It is commercially cultivated in Thailand, Malaysia, Singapore, Indonesia, Hong Kong and Taiwan. This fish (Asian sea bass, *Lates calcarifer*) is considered as a potential candidate for commercial farming in India, because of its fast growth rate, tolerance to wide environmental conditions and its demand in domestic and export markets. Many farmers consider it as an alternative species for farming in shrimp farms abandoned due to disease problems. A significant economic loss in cultured fish worldwide in recent years has been attributed to the outbreaks of infections in aquaculture. In particular viral infections have led to disease risks in freshwater aquaculture as well as in marine farming and about 60 viruses have been reported in several fish species. The production of *L. calcarifer* decreased from 76,842 tonnes in 2015 to 56,933 tonnes in 2016 due to viral and some bacterial infections. This study reviews the current production status of Sea bass, diseases, diagnostic methods and potential drugs available to treat diseases.

Keywords: Sea bass, *Lates calcarifer*, Species, Tonnes, Barramundi, Diseases, Diagnostic methods.

1. Introduction

Aquaculture is the farming of aquatic organisms such as fish, crustaceans, mollusks and aquatic plants. It involves cultivating freshwater and saltwater fish and shellfish populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish. Aquaculture is an important industry because it earns foreign exchange to the country, provides employment especially for rural populations and produces good quality protein food. Asian sea bass, *Lates calcarifer* is distributed along the East and South West Coast on India. In spite of lack of commercial

hatchery technology for seed production, it is traditionally farmed in northeastern India using seeds collected from the wild. The limited seed availability restricts the culture during the months of May-August in West Bengal. All India Coordinated project on Brackish Water Fish Farming (1973-1985) experimental culture of sea bass was carried out in different centers. A production of up to 3.6 tonnes/ha/year has been reported under experimental culture conditions. Central Institute of Brackish Water Aquaculture (CIBA), Chennai, India has succeeded in breeding and larval rearing of sea bass in 2003. One of the major constraints limiting the aquaculture production all over the world is diseases caused by viruses, bacteria, fungi, protozoa and metazoan parasites. Among them, viruses and bacteria cause significant loss in the aquaculture sector worldwide. This study reviews the current production status of seabass fish, diseases and its diagnostic methods and potential drugs available to treat the shrimp diseases.

2. Asian Seabass, *Lates calcarifer* (Bloch 1790)

Lates calcarifer, commonly known as the Asian sea bass or giant perch, is known as barramundi in Australia and it has got many local names in India such as Kalanchi in Kerala state, Koduvai in Tamil Nadu state etc. It is an economically important food fish in Indo-Pacific countries and it is a high value fish cultured in our country. It belongs to the Family Centropomidae. It can live, grow, and mature in freshwater or brackish water but spawns in the sea. It is euryhaline thus it can survive from 0 ppt (freshwater) to 35 ppt (seawater) salinity which makes it a most suitable candidate species for culture in both marine as well as fresh water. The intensive production of this species through cage and open water culture is now being developed and practiced in India because of its quality taste, white meat and high export market value. It is commercially cultivated in Thailand, Malaysia, Singapore, Indonesia, Hong Kong and Taiwan, in both brackish water and freshwater ponds, as well as in cages in coastal waters. Because of its relatively high market value, it has become an attractive commodity of both large and small-scale aquaculture enterprises. In the early 1970's, Thai scientists have achieved success in the breeding of sea bass under captive conditions. Completion of its life cycle has also been accomplished. Growth performance of the hatchery-bred fry has been shown to be comparable with that of fry collected from the wild. Thailand is presently producing more than 100 million fry annually (Anonymous, 1985), with the Satul Fisheries Station producing more than 30 million (Kungvankij, 1984). Centropomidae is the commonly accepted family name of this species, and the recognized generic name is *Lates*.

3. Global Production Status of *L. calcarifer*

Annual barramundi production has been relatively static since 1998, at $\sim 20000-27000$ tonnes. Thailand is the major producer, with about 8 000 tonnes/year since 2001.

Indonesia, Malaysia and Taiwan Province of China are also major producers. In Asia, most barramundi are marketed at 500 – 900 g, although small numbers of larger fish (1 – 3 kg) are also sold. The production of *L. calcarifer* decreased from 76,842 tonnes in 2015 to 56,933 tonnes in 2016 due to viral and some bacterial infections. Global production status of Asian sea bass, *Latex calcarifer* is given in Fig. 1.

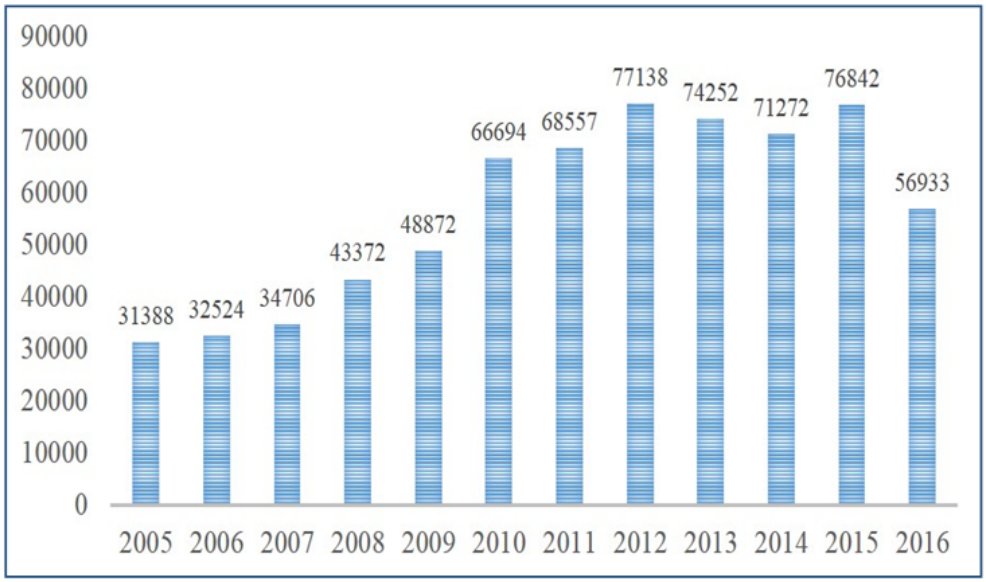


Figure 1: Production Detail of *L. calcarifer* in Tonnes

4. Diseases of *L. calcarifer*

The major diseases to which *L. calcarifer* are susceptible are summarized in Table 1.

Table 1: The Major Diseases of *L. calcarifer*

Name of the Disease	Causative Organisms
Nervous necrosis	Viral disease
Lymphocystis	
Integumentary mycosis	Fungal diseases
Branchiomycosis	
Vibrio diseases	Bacterial diseases
Bacterial haemorrhagic septicaemia	
Integumentary bacteriosis	
Streptococcosis	
Columnaris disease	

Bacterial gill disease	Spore-forming protozoa
Bacterial peritonitis	
Bacterial enteritis	
Fin and tail rot	
Epitheliocystis	
Myxosporidiosis	
Microsporidiosis	
White spot	Protozoa
Chilodonelliasis	
Trichodiniasis	
Ichthyobodosis (costiasis)	
Piscinoodiniasis	
Amyloodiniasis	
Red sore disease	
Gill fluke	Monogean trematodes
Skin fluke	
Fish louse	Copepod
Anchor worm	

5. Viral Diseases of *Lates calcarifer*

5.1. Nervous Necrosis Viruses

Viral encephalopathy and retinopathy (VER) or viral nervous necrosis is an OIE significant disease, which is caused by nodavirus, and is one of the major infectious diseases affecting the marine fish farming industry. The betanodavirus which infects fishes is the so called piscine nodaviruses and belongs to the family *Nodaviridae*. The disease, designated viral nervous necrosis (VNN) when it was first described in 1990 (Yoshikoshi and Inoue, 1990), is also known as viral encephalopathy and retinopathy (OIE, 2003). In India, the nodavirus infection responsible for high mortalities in hatchery produced larvae of *Lates calcarifer* was reported for the first time by Azad et al. (2005). This virus was isolated from infected Asian sea bass (*Lates calcarifer*) larvae during the massive outbreak in sea bass hatcheries located in Chennai and Nagapattinam of Tamilnadu, India (Parameswaran et al., 2008). Ransangan and Manin (2010) have reported disease outbreak in Sabah, Malaysia. Betanodavirus, the causative agent of VNN is a group of small viruses with particle size of between 25 nm and 30 nm in diameter, non-enveloped and having icosahedral shape. The virus has been recorded from over 40 fish species covering different geographic locations. Mortality associated with the disease is severe, reaching 100% depending on age, with younger fish being more susceptible (Munday et al., 2002). The main target organ for nodavirus infection in fish is the central nervous system (CNS), including the brain, spinal cord

and retina, where it causes extensive cellular vacuolation and neuronal degeneration (Mori et al., 1992). In naturally affected young larvae, virus was detected in the epithelial cells of skin and in the intestinal epithelium, concurrently with the nerve cells of CNS in the early stage of VNN infection. An infected fish has a spiral swimming pattern, dashes underwater and floats back to the surface, darkened body color, poor appetite, and clusters near the side of a pool. Scoliosis may also occur. Several advanced molecular diagnostic methods have been developed by various workers for the detection betanodavirus infection, such as (i) histopathological studies of affected tissues; (ii) virus isolation in cell culture from infected fish, (iii) detection of virus-specific antibodies in sera; (iv) detection of virions or viral antigens by electron microscopy, immunohistochemistry (IHC) or fluorescent antibody technique (FAT); and (v) viral genome detection by molecular techniques, such as RT-PCR, quantitative real-time PCR (RT-qPCR), dot blot or in situ hybridization (ISH) (Nguyen et al., 1996; Chi et al., 2001; Johansen et al., 2003, 2004; Mladineo, 2003; Grove et al., 2006; Nopadon et al., 2009; Lopez et al.,2010; Hick and Whittington, 2010; Mazelet et al., 2011).

5.2. Lymphocystis

Lymphocystis disease virus (LCDV) is the causative agent of lymphocystis disease affecting marine and freshwater fish worldwide. Research regarding lymphocystis disease (LCD), a common chronic disease among many salt and fresh water fish species, remains limited. LCD disease is caused by an iridovirus that is characterized by a hypertrophy of fibroblasts. The disease is normally external, affects the skin and fins, and on rare occasions it has been reported as an internal infection and the lesion observed appears as a large nodule which consists of a number of hypertrophied cells. LCD occurs in a worldwide variety of freshwater and marine fish species, and the rate of incidence appears to be increasing, severely affecting the fish farming industry (Zheng et al., 2006). The cells of infected fish appear hypertrophied with cytoplasmic and nuclear inclusions. Each cell is surrounded by a hyaline capsule. The ultrastructure of the lymphocystis virus has been investigated by Walker (1962), Walker and Weissenberg (1965), and Walker and Wolf (1962), but the technique did not allow high resolution on negative staining. Diagnosis is based on gross histological findings. Sheng et al. (2013) developed an antibody based microarray technology used for the detection lymphocystis disease in fish. Zheng et al. (2011) have reported a genetically engineered vaccine against LCDV for the prevention and control of LCD and studied the distribution and expression of immune-related genes in Japanese flounder (*Paralichthys olivaceus*) after immunization with the vaccines.

5.3. Bacterial Diseases of *Lates calcarifer*

Bacterial diseases in fish generally do not develop simply as the result of exposing a host to an infectious agent. Mostly, bacterial diseases occur as a result of the complex interactions between pathogen, fish and environmental stress, which affect the

susceptibility of the fish to diseases. Environmental stresses can affect the homeostatic mechanism of fish thus reducing their resistance to disease-causing organisms. Fish reared in intensive culture conditions are exposed to extreme environmental fluctuations and they may be more sensitive to stress than wild populations.

5.4. Hemorrhagic Disease

Aeromonas sp. is a common water-borne bacterium, which may be present in the tissue of normal young or adult fishes. Whenever fishes are exposed to environmental stress or injury, Aeromonas causes serious outbreaks of hemorrhagic disease with high mortality. Temperature, pH, high CO_2 and DO depletion, decomposition products and free ammonia in the water, can all be considered as possible factors for *Aeromonas* infection. When there is overcrowding and water salinity is low for long periods, the disease caused by *A. punctata* could be observed in the sea bass. Gross signs are usually shown by hemorrhage on the fin and tail. In heavy infections, erosion of tail and fin can be clearly seen.

5.5. Ulcerative Haemorrhagic Septicaemia

Diseases caused by *Vibrio sp.* typically appear as ulcerative haemorrhagic septicaemia. The typical symptoms of *Vibrio* disease include congestion of the fins, eccymoses and petechiae on the body surface and frequent hemorrhages and ulceration of the skin and muscle tissue. The tissues surrounding the infected anus (the vent) are usually reddened and inflamed. Internally, there is congestion and hemorrhage of the liver, spleen and kidney, frequently accompanied by the presence of necrotic lesions. The gut and particularly the rectum may be distended and filled with a clear viscous fluid. *Vibrio* disease in young fish has no well-defined clinical signs. The body is completely covered by a thick layer of mucous. Occasionally, small-unbroken lesions are present. There may be a reddening of the caudal fins and vent. Internal organs appear normal. Young fish die more rapidly than adults.

5.6. Vibriosis

The bacterium *Vibrio anguillarum* is a polarly flagellated, Gram-negative, curved rod. The causative agent of vibriosis is *V. anguillarum*, it was first described in 1909 as the aetiological agent of the 'red pest of eels' in the Baltic Sea. *Vibrio anguillarum* belongs to one of the halophilic groups of vibrios and survives at different salinities. Kodama et al., 1984 showed that extracellular products such as toxic materials, haemolysin, and protease, as well as other undefined materials, might contribute to the pathogenesis of fish vibriosis. The diagnostic methods for vibriosis are history, clinical symptoms, necropsy findings, ELISA based rapid diagnosis, isolation of the bacterium on agar plates (usually TSA or TCBS) and identification either biochemically or serologically by means of rapid agglutination test kits.

5.7. Pasteurellosis

Photobacterium damselae is a Gram-negative, extracellular pathogen isolated for the first time from a massive fish kill in Chesapeake Bay (Snieszkoet al., 1964). The etiological agents of Pasteurellosis caused by *photobacterium damselae*. Sea bass is mostly susceptible to pasteurellosis between the sizes of 1g to 60g. The disease provokes the highest mortalities in caged bass between 5g and 40g. Thus, for bass, pasteurellosis is mostly a problem during the first summer in the grow-out facilities. In hatcheries where warm borehole water is used (> 18°C), pasteurellosis constitutes a major threat all year round. It is a temperature dependent disease. *Pasteurellosis* presents itself in the hatcheries as a hyper-acute or acute septicaemia. Usually there are no alarming signs. The fish behave normally and feed well hours before the disease strikes. When ill symptoms develop on sea bass, these comprise lip and lower jaw inflammation and necrotic skin patches on the body flanks, dorsal area and tail. The fins, mainly thoracic, dorsal and caudal may be eroded. Overall, there is no haemorrhagic appearance. Skin and fin erosions are covered with mucus, thus the lesions appear in the water as white patches. The gills are inflamed with excessive mucous secretions and most often show areas of necrotic tissue next to congested areas. The liver is most often congested; the spleen is grossly enlarged (splenomegaly) and the kidney pale and oedematous. The diagnostic methods of *Pasteurellosis* are history, clinical symptoms, necropsy findings, ELISA based rapid diagnostic kits, isolation of the bacterium on agar plates (usually TSA or BHI agar) and identification either biochemically or serologically by means of rapid agglutination tests.

5.8. Streptococcosis

Streptococcal disease caused by *Streptococcus iniae* is one of the major bacterial diseases in fish. Streptococci are Gram-positive bacteria. Streptococcal disease in fish is mainly caused by three bacteria *S. iniae*, *S. difficile* and *S. agalactiae*. *S. iniae* is the most common and pathogenic one in the marine environment. Since 1992, mortality due to *Streptococcosis* in sea-cultured barramundi has increased and the pathogen is now considered as the most important bacterial species affecting the successful sea-culture of barramundi in northern Queensland. The disease usually persists as a low-level, chronic infection with mortalities occurring daily, mainly in juvenile fish. The clinical signs of disease are very similar to those described by other authors (Kusuda et al. 1976, Perera et al. 1994), including bilateral exophthalmia, darkened body pigmentation and ascites. Usually, fish infected with *S. iniae* become lethargic and refuse to feed. As these bacteria target the brain and nervous system, erratic swimming, disorientation and swirling behaviors are commonly observed. Very often, fish show unilateral or bilateral exophthalmia with opacification of the cornea. Petechial hemorrhage can be present at the base of the fins, or around the mouth, operculum or anus. Darkening of the skin is another common external sign. Internally, the symptoms are typical of a systemic

bacterial infection with presence of ascites, splenomegaly, enlarged kidney, pallor and hemorrhages of the liver. The diagnostic methods are history, clinical symptoms, necropsy findings, ELISA based rapid diagnostic tests, isolation of the bacterium on agar plates (usually Macconkey agar) and identification either biochemically or serologically by means of rapid agglutination tests.

5.9. Columnaris Disease

Columnaris disease caused by *Flexibacter columnaris* is one of the diseases commonly found in juvenile sea bass which are raised in water of low salinity during rainy and winter seasons. Gross signs observed are saddle-shaped lesions in the mid-body position about the dorsal fin of the fish. The bilaterally symmetrical lesion appears as a fuzzy, pale yellow white plaque, with dark margins, often eroding in the epidermis. Clinically, the condition may be chronic, acute or peracute. The Gram negative, aerobic bacillus (about 12 um) can be isolated from the lesion of the diseased fish.

5.10. Parasitic Diseases

Protozoans are probably the most important group of animal parasites affecting fish. Many reports from all over the world indicate great losses in fish culture caused by protozoans. Obligate parasites such as the ciliate *ichthyophthirius* and certain species of the *cnidosporidians* are responsible for many of these losses. Protozoans cause harm to fish mainly by mechanical damage, secretion of toxic substance, occlusion of the blood vessels, depriving the host of nutrition and rendering the host more susceptible to secondary infections. Some of the most common clinical signs are changes in swimming habits, such as loss of equilibrium, flushing or scraping, loss of appetite, abnormal colouration, tissue erosion, excess mucous production, haemorrhage, and swollen body or distended eyes.

5.11. Vaccinations

Vaccine is a biologically based preparation intended to establish or to improve immunity in animals against a particular disease or group of diseases. Vaccines work by exposing the immune system of an animal to an "antigen" a piece of a pathogen or the entire pathogen and then allowing time for the immune system to develop a response and a "memory" to accelerate this response in later infections by the targeted disease-causing organism. Consequently vaccinated fish are less likely to develop disease if exposed to the pathogen. This capability is linked to a shorter response time to produce protective antibodies, and a stronger response as compared to non-vaccinated fish. Different types of vaccines such as live vaccine, heat or formalin killed whole cell vaccine, recombinant protein vaccine and DNA vaccines have been tried to protect the fish from nodaviral infection (Sidersis, 1997; Yuasa et al., 2002; Sommerset et al., 2003; 2005; Pakingking et al., 2010). The first viral vaccine for fish was against a

carp rhabdovirus, causing spring viremia of carp (SVC). Commercially available IPNV vaccines are based on either inactivated cell culture propagated virus or recombinant structural proteins. Most IPNV vaccines exist as polyvalent oil adjuvanted vaccines. Different recombinant subunit vaccines based on the IHNV and VHSV membrane glycoprotein have been less successful (Lorenzen et al., 1993, 1998, 2002; Lecocq-Xhonneux et al., 1994; Cain et al., 1999; Simon et al., 2001). However, DNA vaccines encoding the same viral glycoproteins are remarkably efficacious. Indeed these DNA vaccines are protective when used at small doses and efficacious as early as 4-8 days and for up to 2 years post vaccination (Corbeil et al., 2000 a, b). Today most of the available virus vaccines for aquaculture are based on inactivated virus or recombinant subunit proteins. Inactivated/killed viral vaccines are generally not efficacious unless delivered by injection and, as relatively high doses are needed to achieve protection, cost effective inactivated viral vaccines are difficult to develop. Live viral vaccines have been tested with good results in fish (Lopez Doriga et al., 2001; Ronen et al., 2003).

5.12. Live Vaccine

Vaccination with a live vaccine is in reality an infection (with an attenuated strain), and if the vaccine strain is shed by vaccinated fish, an effective dissemination of the antigen in the population would take place over an extended time period. Live vaccines also have the advantage that they stimulate the cellular branch of the immune system (Marsden et al., 1996). Nishizawa et al. (2012) and Oh et al. (2013) reported the assessment of sevenband grouper (*Epinephelus septemfasciatus*) vaccinated with live vaccine of nervous necrosis virus (NNV) at low rearing natural seawater temperature. Oh et al. (2013) have investigated the long term NNV kinetics in sevenband grouper by administering a NNV live vaccine at natural seawater temperature to conduct a safety assessment of the vaccine and its practical application.

5.13. Inactivated Vaccine

Young seven band groupers have been vaccinated with inactivated RGNNV and this vaccination induced the production of neutralizing antibodies and also provided protection against an experimental challenge with the homologous virus at different time points post-vaccination (Yamashita et al., 2005). Kai and Chi, (2008) have tried two chemicals namely binary ethylenimine (BEI) and formalin to inactivate HGNNV and the results revealed that the survival of fish vaccinated with BEI-inactivated vaccine was (79%) higher when compared to formalin-inactivated vaccine (39%). The formalin inactivated vaccine induced antibodies and conferred substantial protection against betanodavirus infection in groupers as observed by high survival rates (RPS: 86-100%) in vaccinated fish challenged with the homologous virus (Pakingking et al., 2010).

5.14. Recombinant Vaccine

Nakai (2000) and Tanaka et al., (2001) have reported encouraging survival with preliminary vaccination trials using recombinant nodavirus coat protein as the immunogen and the presence of virus-neutralizing antibodies after immunization. Tanaka et al. (2001) demonstrated that immunization of young seven band grouper (*Epinephelus septemfasciatus*) by intramuscular injection of recombinant coat protein produced neutralizing antibodies in high titres. Husgaroet al. (2001) demonstrated vaccination with an oil-emulsified recombinant partial capsid protein from SJNNV in juvenile turbot by intra peritoneal injection and observed 83% relative percent survival (RPS) value. Yuasa et al. (2002) used recombinant coat protein from RGNNV, and detected virus-neutralizing antibodies in previously intramuscularly injected humpback grouper (*Cromileptes altivelis*). Recombinant capsid protein vaccination induces protection against Atlantic halibut nodavirus in juvenile turbot (Sommerset et al., 2005). Thiery et al. (2006) have developed a vaccine using virus-like particles (VPL) made from a single type of VNN coat protein spontaneously assembled in a baculovirus expression system and vaccinated sea bass (*Dicentrarchus labrax*) intramuscularly. Lin et al. (2007) have reported an oral vaccine composed of *Artemia*-encapsulated recombinant *E. coli* expressing the NNV capsid protein gene in larvae of grouper (*Epinephelus coioides*) and the results revealed that the vaccinated larvae showed a high degree of protection after challenge with NNV. Overgard et al. (2013) have studied the immune response in Atlantic halibut (*Hippoglossus hippoglossus L.*). Following administration of an experimental vaccine comprising 10μg recCP plus OA, 50μg recCP plus OA in combination with an oil adjuvant (OA).Vimal et al. 2014 have cloned the capsid protein gene of nodavirus in pRSET B and the construct was named as r-FNCP. The size of the capsid proteinwas 42kDa and it was named as r-FNCP42. The r-FNCP42 protein was expressed as a protein with a 6-histidine tag in *Escherichia coli* BL21 with IPTG induction. Asian sea basswas immunized with purified r-FNCP42 mixed with complete adjuvant at a dose of 50 μg per fish and was challenged with nodavirus by intramuscular injection. The vaccinated sea bass was protected from nodaviral infection and 76% of relative percent survival (RPS) was recorded. Very recently Gonzalez-Silvera D et al. have generated a recombinant NNV (rNNV) vaccine produced in *Escherichia coli* expressing the capsid protein and administered it to European sea bass juveniles by two different routes (intraperitoneal and oral). Oral vaccine was composed of feed pellets containing the recombinant whole bacteria, and injected vaccine was composed of recombinant bacteria previously lysed. Vaccination by either route elicited a relative survival response of 100% after NNV challenge.

5.15. DNA Vaccine

Current vaccine research is oriented towards replacement of conventional vaccines with more effective and safer approaches, such as DNA vaccines. The most efficient vaccines

against viral diseases in fish to date at the experimental level are deoxyribonucleic acid (DNA) vaccines. DNA vaccines represent a powerful new approach to raising immune responses. The antigens are synthesized in transfected cells and obey the trafficking, modification, and antigen presentation rules of eukaryotic cells. Very low levels of antigen (typically nanogram levels) induce both antibody and cytolytic T-cell responses. The DNA vaccines developed for fish rhabdoviruses other than IHNV and VHSV, such as spring viraemia of carp virus and hirame rhabdovirus, have also shown promise (Shchelkunov et al., 2001; Takano et al., 2004; Vesely et al., 2004), but developing an effective DNA vaccine has been more of a challenge for other fish pathogens. A recent report indicated that a high level of protection was induced in Atlantic salmon by using a plasmid encoding the whole polyprotein of IPNV (Mikalsen et al., 2004). Sommerset et al. (2003) developed a DNA vaccine using gene encoding glycoprotein of viral hemorrhagic septicemia virus (VHSV) and challenge experiments revealed that the immunity established is cross protective against heterologous fish rhabdoviruses and also against nodavirus. Protection and antibody response induced by intramuscular DNA vaccineencoding for viral haemorrhagic septicaemia virus (VHSV) G glycoproteinin turbot (*Scophthalmus maximus*) has been reported (Pereiro et al., 2012). Xu et al. (2012) have developed DNA vaccine for salmonid alphavirus superior protection against Atlantic salmon (*Salmo salar L.*).Vimal et al. have developed DNA vaccine for fish nodavirus and named it as DNA vaccine (pFNCPE42 DNA-pcDNA3.1). Asian seabass was immunized with pFNCPE42-DNA vaccine at a dose of 20 μg per fish and were challenged with betanodavirus by intramuscular injection. The vaccinated seabass was protected from nodaviral infection and 77.33% of relative percent survival (RPS) was recorded.

6. Conclusion

Fish farming plays an important role in India, contributing to increased food production, higher economic growth and increased employment opportunities. The practice of fish farming has offered opportunity to increase incomes for farmers. A range of public and private sector investments are needed to realize the potential for growth and expanding economic output in fish farming sector. Further researches are needed in Sea bass production technology and strictly maintain standard operating procedures. Disease free and healthy sea bass fish fingerlings are required for successful running of fish ponds. Low-cost pellet feed industries would help to increase farmers profit margins. Research in seed and feed production areas need to be given due attention, considering existing technology, the transfer, adaption and development of new technology.

7. Acknowledgement

The authors thank the management and the Principal, Islamiah College (Autonomous) for having given the constant encouragement and support to carry out this review work.

References

[1] Anonymous (1985), Working paper on sea bass production and culture workshop, *Brackishwater Fisheries Division, Department of Fisheries* **4**, 60 – 78.

[2] Azad, I.S., Shekhar, M.S., Thirunavukkarasu, A.R., Poornima, M., Kailasam, M., Rajan, J.J.S., Ali, S.A., Abraham, M. and Ravichandran, P. (2005), Nodavirus infection causes mortalities in hatchery-produced larvae of Lates calcarifer: first report from India, *Diseases of Aquatic Organisms* **63**, 113 – 118.

[3] Cain, K.D., LaPatra, S.E. and Shewmaker, B. (1999), Immunogenicity of a recombinant infectious hematopoietic necrosis virus glycoprotein produced in insect cells, *Disease of Aquatic Organisms* **36**, 67 – 72.

[4] Chi, S.C., Lo, B.J. and Lin, S.C. (2001), Characterization of grouper nervous necrosis virus (GNNV), *Journal of Fish Diseases* **24**, 3 – 13.

[5] Corbeil, S., Kurath, G. and LaPatra, S.E. (2000a), Fish DNA vaccine against infectious hematopoietic necrosis virus: efficacy of various routes of immunization, *Fish and Shellfish Immunology* **10**, 711 – 723.

[6] Corbeil, S., LaPatra, S.E., Anderson, E. and Kurath, G. (2000b), Nanogram quantities of a DNA vaccine protect rainbow trout fry against heterologous strains of infectious hematopoietic necrosis virus, *Vaccine* **18**, 2817 – 2824.

[7] Gonzalez-Silvera, D, Guardiola, F.A, Espinosa, C., Chaves-Pozo, E., Esteban, M.Á. and Cuesta, A. (2019.), Recombinant nodavirus vaccine produced in bacteria and administered without purification elicits humoral immunity and protects European sea bass against infection, *Fish and Shellfish Immunology* **88**, 458 – 463.

[8] Grove, S., Faller, R., Soleim, K.B. and Dannevig, B.H. (2006), Absolute quantification of RNA by a competitive real-time PCR method using piscine nodavirus as a model, *Journal of Virological Methods* **132**, 104 – 112.

[9] Hick, P. and Whittington, R.J. (2010), Optimisation and validation of a real-time reverse transcriptase-polymerase chain reaction assay for detection of betanodavirus, *Journal of Virological Methods* **163**, 368 – 377.

[10] Husgaro, S., Grotmol, S., Hjeltnes, B.K., Rodseth, O.M. and Biering, E. (2001), Immune response to a recombinant capsid protein of striped jack nervous necrosis virus (SJNNV) in turbot Scophthalmus maximus, and Atlantic halibut Hippoglossus hippoglossus, evaluation of a vaccine against SJNNV, *Disease of Aquatic Organisms* **45**, 33 – 44.

[11] Johansen, R., Amundsen, A., Dannevig, B.H. and Sommer, A.I. (2003), Acute and persistent nodavirus infection in spotted wolfish Anarhinchas minor, *Diseases of Aquatic Organisms* **57**, 35 – 41.

[12] Johansen, R., Grove, S., Svendsen, A.K., Modahl, I. and Dannevig, B. (2004), A sequential study of pathological findings in Atlantic halibut, Hippoglossus hippoglossus (L.), throughout one year after an acute outbreak of viral encephalopathy and retinopathy, *Journal of Fish Disease* **27**, 327 – 341.

[13] Kai, Y.H. and Chi, S.C. (2008), Efficacies of inactivated vaccines against betanodavirus in grouper larvae (Epinephelus coioides) by bath immunization, *Vaccine* **26**, 1450 – 1455.

[14] Kungvankij, P., Pudadera, B.J. Jr, Tiro L.B. Potestas, I.O. (1984), *Biology and culture of sea bass (Laces calcarifer)*, NACA Training Manual Series No **3**, 67.

[15] Lecocq-Xhonneux, F., Thiry, M. and Dheur, I. (1994), A reocmbinat viral hemorrhagic septicemia virus glycoprotein expressed in insect vells induces protective immunity in rainbow trout, *Journal of General Virology* **75**, 1579 – 1587.

[16] Lin, C.C., Lin, J.H.Y., Chen, M. and Yang, H.L. (2007), An oral nervous necrosis virus vaccine that induces protective immunity in larvae of grouper (Epinephelus coioides), *Aquaculture* **268** (1– 4), 22: 265 – 273.

[17] Lopez, J.B., Cherif, N., Garcia, R.E., Infante, C., Cano, I., Castro, D.,Hammami, S., Borrego, J.J. and Alonso, M.C. (2010), A combined RT-PCR and dot-blot hybridization method reveals the coexistence of SJNNV and RGNNV betanodavirus genotypes in wild meagre (Argyrosomusregius), *Journal of Applied Microbioliology* **109**, 1361 – 1369.

[18] Lopez-Doriga, M.V., Smail, D.A. and Smith, R.J. (2001), Isolation of salmon pancreas disease virus (SPDV) in cell culture and its ability to protect against infection by the wild type agent, *Fish and Shellfish immunology* **11**, 505 – 522.

[19] Lorenzen, N., Olesen, N.J. and Jorgensen, P.E. (1993), Molecular cloning and expression in Escherichia coli of the glycoprotein gene of VHS virus, and immunization of rainbow trout with the recombinant protein, *Journal of General Virology* **74**, 623 – 630.

[20] Lorenzen, N., Lorenzen, E., Einer-Jensen, K., Heppell, J., Wu, T. and Davis, H. (1998), Protective immunity of VHS in rainbow trout (Oncorhynchus mykiss, Walbaum) following DNA vaccination, *Fish and Shellfish Immunology* **8**, 261 – 270.

[21] Lorenzen, N., Lorenzen, E., Einer-Jensen, K. and LaPatra, S.E. (2002), DNA vaccines as a tool for analyzing the protective immune response against rhabdoviruses in rainbow trout, *Fish and Shellfish immunology* **12**, 439 – 453.

[22] Marsden, M.J., Vaughan L.M., Foster, T.J. and Secombesmykiss, C.J. (1996), A live (delta aroA) Aeromonas salmonicida vaccine for furunculosis preferentially stimulates T-cell responses relative to B-cell responses in rainbow trout (Oncorhynchus mykiss), *Infectious Immunology*, **64** (9), 3863 – 3869.

[23] Mazelet, L., Dietrich, J. and Rolland, J.L. (2011), New RT-qPCR assay for viral nervous necrosis virus detection in sea bass, Dicentrarchus labrax (L.): application and limits for hatcheries sanitary control, *Fish and Shellfish Immunology* **30**, 27 – 32.

[24] Mikalsen, A.B., Torgersen, J., Alestrom, P.,Hellemann, A., Koppang, E. and Rimstad, E. (2004), Protection of Atlantic salmon Salmo salar against infectious pancreatic necrosis virus after DNA vaccination, *Diseases of aquatic Organisms* **60** (1), 11 – 20.

[25] Mladineo, I. (2003), The immunohistochemical study of nodavirus changes in larval, juvenile and adult sea bass tissue, *Journal of Applied Ichthyology* **19**, 366 – 370.

[26] Mori, K., Nakai, T., Muroga, K., Arimoto, M., Mushiake, K. and Furusawa, I. (1992), Properties of a new virus belonging to Nodaviridae found in larval striped jack (Pseudocaranx dentex) with nervous necrosis, *Virology* **187**, 368 – 371.

[27] Munday, B.L., Kwang, J. and Moody, N. (2002), Betanodavirus infections of teleost fish: a review, *Journal of Fish Diseases* **25**, 127 – 142.

[28] Nakai, T. (2000), *Recent advances in the diagnosis and control of viral nervous necrosis (VNN) in groupers*, APECFWG 02/2000, Development of a Regional Research Program on Grouper Virus Transmission and Vaccine Development, October 2000, Bangkok, 18 – 20.

[29] Nguyen, H.D., Nakai, T. and Muroga, K. (1996), Progression of striped jack nervous necrosis virus (SJNNV) infection in naturally and experimentally infected striped jack Pseudocaranx dentex larvae, *Diseases of Aquatic Organisms* **24**, 99 – 105.

[30] Nishizawa, T., Gye, H.J., Takami, I. and Oh, M.J. (2012), Potentiality of a live vaccine with nervous necrosis virus (NNV) for sevenband grouper Epinephelus septemfasciatus at a low rearing temperature, *Vaccine* **30**, 1056 – 1063.

[31] Nopadon, P., Aranya, P., Tipaporn, T., Toshihiro, N., Takayukid, K., Masashi, M. and Makoto, E. (2009), Nodavirus associated with pathological changes in adult spotted coralgroupers (Plectropomusmaculatus) in Thailand with viral nervous necrosis, *Research in Veterinary Science* **87**, 97 – 101.

[32] Oh, M.J., Gye, H.J. and Nishizawa, T. (2013), Assessment of the sevenband grouper Epinephelus septemfasciatus with a live nervous necrosis virus (NNV) vaccine at natural seawater temperature, *Vaccine* **31**, 2025 – 2027.

[33] Overgard, A.C., Patel, S., Nostbakken, O.J. and Nerland, A.H. (2013), Atlantic halibut (Hippoglossus hippoglossus L.) T-cell and cytokine response after vaccination and challenge with nodavirus, *Vaccine* **31**, 2395 – 2402.

[34] Pakingking Jr. R., Bautista, N.B., de Jesus-Ayson, E.G. and Reyes, O. (2010), Protective immunity against viral nervous necrosis (VNN) in brown-marbled grouper (Epinephelus fuscogutattus) following vaccination with inactivated betanodavirus, *Fish and Shellfish Immunology* **28**, 525 – 533.

[35] Parameswaran, V., Rajesh Kumar, S., Ishaq Ahmed, V.P. and Sahul Hameed, A.S. (2008), A fish nodavirus associated with mass mortality in hatchery-reared Asian Sea bass, *Lates calcarifer*, *Aquaculture* **275**, 366 – 369.

[36] Pereiro, P., Martinez-Lopez, A., Falco, A., Dios, S., Figueras, A., Coll, B. Novoa. and Estepa, A. (2012), Protection and antibody response induced by intramuscular DNA vaccine encoding for viral haemorrhagic septicaemia virus (VHSV) G glycoprotein in turbot (Scophthalmus maximus), *Fish and Shellfish Immunology* **32**, 1088 – 1094.

[37] Ransangan, J. and Manin, B.O. (2010), Mass mortality of hatchery-produced larvae of Asian seabass, *Lates calcarifer* (Bloch), associated with viral nervous necrosis in Sabah, Malaysia, *Veterinary Microbiology* **145**, 153 – 157.

[38] Ronen, A., Perelberg, A. and Abramowitz, J. (2003), Efficient vaccine against the virus causing a lethal disease in cultured Cyprinuz Carpio, *Vaccine* **21**, 4677 – 4684.

[39] Vimal, S., Farook, M.A., Madan, N., Abdul Majeed, S., Nambi, K.S.N., Taju, G., Sundar raj, N., Venu, S., Subburaj, R., Thirunavukkarasu, A. R. and Sahul Hameed, A.S. (2014), Development, distribution and expression of a DNA vaccine against nodavirus in Asian Sea bass, *Lates calcarifer* (Bloch, 1790), *Aquaculture Research* **47** (4), 1209 – 1220.

[40] Vimal, S., Madan, N., Farook, M.A., Nambi, K.S.N., Abdul Majeed, S., Rajkumar, T., Venu, S., Thirunavukkarasu, A.R. and Sahul Hameed, A.S.,

Production of recombinant vaccine using capsid gene of nodavirus to protect Asian sea bass, *Lates calcarifer* (Bloch, 1790), *Aquaculture* **(418–419)**, 148 – 154.

[41] Shchelkunov, I.S., Oreshkova, S.F., Shchelkunova, T.I., Nikolenko, G.N., Kupinskaya, O.A. and Voronova, O.S. (2001), *Comparative testing of experimental SVC-vaccines developed with the use of recombinant DNA technology* (abstract). In Book of Abstracts, 10th International Conference of the European Association of Fish Pathologists (EAFP). 10-14 September, Dublin. EAFP, Denmark, **173**.

[42] Sheng, X., Xu, X. and Zhan, W. (2013), Development and application of antibody microarray for lymphocystis disease, *Journal of Virological Methods* **189**, 243 – 249.

[43] Sideris, D.C. (1997), Cloning, expression and purification of the coat protein of encephalitis virus (DlEV) infecting Dicentrarchus labrax, *Biochemistry and Molecular Biology International* **42**, 409 – 417.

[44] Simon, B., Nomellini, J. and Chiou, P. (2001), Recombinant vaccines against infectious hematopoietic necrosis virus: production by the Caulobactercrescentus S- layer protein secretion system and evaluation in laboratory trials, *Diseases of Aquatic Organisms* **44**, 17 – 27.

[45] Sommerset, I., Lorenzen, E., Lorenzen, N., Bleie, H. and Nerland, A.H. (2003), A DNA vaccine directed against a rainbow trout rhabdovirus induces early protection against a Nodavirus challenge in turbot, *Vaccine*, **21** (32), 4661 – 4667.

[46] Sommerset, I., Skern, R., Biering, E., Bleie, H., Fiksdal, I.U., Grove S. and Nerland A.H. (2005), Protection against Atlantic halibut nodavirus in turbot is induced by recombinant capsid protein vaccination but not following DNA vaccination, *Fish and Shellfish Immunology* **18** (1), 13 – 29.

[47] Takano, T., Iwahori, A., Hirono, I. and Aoki, T. (2004), Development of a DNA vaccine against hirame rhabdovirus and analysis of the expression of immune-related genes after vaccination, *Fish and Shellfish Immunology* **17** (4), 367 – 374.

[48] Tanaka, S., Mori, K., Arimoto, M., Iwamoto, T. and Nakai, T. (2001), Protective immunity of sevenband grouper, Epinephelus septemfasciatus Thunberg, against experimental viral nervous necrosis, *Journal of Fish Diseases* **24**, 15 – 22.

[49] Thiery, R., Cozien, J., Cabon, J., Lamour, F., Baud, M. and Schneemann, A. (2006), Induction of a protective immune response against viral nervous necrosis in the European sea bass Dicentrarchus labrax by using betanodavirus virus-like particles, *Journal of Virology* **80**, 10201 – 10207.

[50] Vesely, T., Pokorova, D., Einer-Jensen, K. and Lorenzen, N. (2004), *DNA vaccination of small carp (Cyprinus carpio) against SVCV: the protective effect depends on temperature*, In Book of Abstracts, 6th International Symposium on Fish Immunology, 26-29 May, Turku, Finland, **43**.

[51] Walker, R. and Wolf, K. (1962), Virus array in lymphocystis cells of sunfish, *American Zoologist* **2**, 566.

[52] Walker, R. and Weissenberg, R. (1965), Conformity of light and electron microscopic studies on virus particle distribution in lymphocystis tumor cells of fish, *Annals of the New York Academy of Sciences* **126**, 375 – 395.

[53] Xu, C., Mutoloki, S. and Evensen, O. (2012), Superior protection conferred by inactivated whole virus vaccine over subunit and DNA vaccines against salmonid alphavirus infection in Atlantic salmon (Salmo salar L.), *Vaccine* **30**, 3918 – 3928.

[54] Yamashita, H., Fujita, Y., Kawakami, H. and Nakai, T. (2005), The efficacy of inactivated virus vaccine against viral nervous necrosis (NNV), *Fish Pathology* **40**, 15 – 21.

[55] Yoshikoshi, K. and Inoue, K. (1990), Viral nervous necrosis in hatchery-reared larvae and juveniles of Japanese parrotfish, Oplegnathusfasciatus (Temminck and Schlegel), *Journal of Fish Diseases* **13**, 69 – 77.

[56] Yuasa, K., Koesharyani, I., Roza, D., Mori, K., Katata, M. and Nakai, T. (2002), Immune response of humpback grouper, Cromileptes altivelis (Valenciennes) injected with the recombinant coat protein of betanodavirus, *Journal of Fish Diseases* **25** (1), 53 – 56.

[57] Zheng, F.C., Sun, X.Q., Liu, H.Z. and Zhang, J.X. (2006), Study on the distribution and expression of a DNA vaccine against lymphocystis disease virus in Japanese flounder (Paralichthys olivaceus), *Aquaculture* **261**, 1128 – 1134.

[58] Zheng, F., Sun, X., Wu, X., Liu, H., Li, J., Wu, S. and Zhang, J. (2011), *Immune Efficacy of a Genetically Engineered Vaccine against Lymphocystis Disease Virus: Analysis of Different Immunization Strategies*, Evidence-based Complementary and Alternative Medicine: eCAM.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 40 – 49

http://www.islamiahcollege.edu.in

ETHNOBOTANICAL SURVEY OF MEDICINAL PLANTS USED BY LOCAL ABORIGINAL COMMUNITY IN GYANAMALAI HILLS AND NEKNAMALAI HILLS, THIRUPATTUR DISTRICT, TAMILNADU, INDIA

P. Govindaraj and N.P.M. Mohamed Tariq

Department of Biotechnology,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

An ethnomedicinal survey was carried out in 15 of 28 villages and Ambur and Vaniyambadi regions (700–1600 msl). Door to door surveys and group discussions, applying semi-structured questionnaires were conducted with traditional healers and villagers in local language (Tamil also Telugu). Informant Consensus Factor (ICF) was computed to analyse collected ethnomedicinal data. Two places in the South Eastern Ghats of Tamilnadu, India. Local communities still possess large traditional knowledge of plants and their therapeutic uses and that the link of that traditional knowledge to modern research could be of importance for the isolation of new phytotherapeutic compounds leading to the development of novel therapeutic active agents. Some of the ethnomedicinal plants are facing high threats and are becoming rare, and conservation initiatives are needed to conserve them for sustainable management in the region.

Keywords: Conservation, Informant consensus factor, Medicinal plants, Sustainable use, Traditional knowledge.

1. Introduction

The Eastern Ghats is the dynamic area, covering over 25% of the Indian subcontinent and harbouring about 8000 species of angiosperms, 1748 of which are used for their therapeutic properties [Malik ZA et.al., 2015]. The region has been well known for its rich ethnomedicinal flora since ancient times [Ballabha B and Chaurasia OP, 2009]. Plants are used since long time to cure intense chronic diseases, and also as a source of food, shelter and clothing. Due to very low expense and good results these medicinal practices are transmitted through generation to generation and still practiced in different

communities. These valuable medicinal plants contain rich bioactive compounds which serve various pharmacological activity. Ethnic people depend on the plants around them to gain economic values and primary health care benefits which is based on need, observation, experience of older ethnic people, and trial and error [Kunwar RM et. al., 2016]. The study area is interesting due to wide geographic and climatic condition and medicinal plants diversity of Gyanamalai hills and Neknamalai hills makes this region an especially valuable treasure home of a wide range of wild medicinal and aromatic plants. Ethnic people, shepherd and traditional medicinal practitioner (Vaidyars) inhabit within a range of 700-1600 msl and have high knowledge of medicinal plants uses. Local wooden and stone tools are commonly used to prepare medicinal remedies. Most diseases cured by local herbalist are common problems such as respiratory diseases, aches and pains, wounds and musculoskeletal ailments. Inhabitants often use local medicinal plants without prior advice of local traditional healers because they are using these plants since generations. In these connections, the present study was carried out to provide an overview of the knowledge of medicinal plants of the local and traditional healers of Gyanamalai hills and Neknamalai hills area and to evaluate the status of these useful medicinal flora for identification of new drugs for health needs and suitable source of income for livelihood of inhabitants. We hypothesize that plant use at Gyanamalai hills and Neknamalai hills would show similar response to other Eastern Ghats regions, and that the local medicinal flora would have been over harvested. The first step of diagnosis by local healers is checking the pulse rate then examining the forehead, eyes, tongue and in some cases also the urine. The body temperature and colour are major key factors to identify health problems. Medicinal plants play a vital role in the local economy and health care, and demand is increasing. Many populations of medicinal plants seem to drastically decline due to overexploitation and unsustainable harvesting. Most of the important alpine medicinal plants are becoming rare and endangered.

2. Methods

Study Area and Sites

The Gyanamalai hills and Neknamalai hills is located between the coordinates 30°37′07.88″ to 30°15′13.47″ N and 79°03′41.79″ to 78°46′07.95″ E (Google Earth Pro Us dept. of State Geographer 2021) in district Thirupattur Eastern Ghats of Tamilnadu, India. Medicinal plants sampling was done from Gyanamalai hills of Eastern Ghats (750 – 1020 msl) to lower altitudes (50 m) (Fig. 1).

Annual average rain fall is around 150–200 mm with temperature ranging from 20 to 28°C in winter and 28 to 35°C in summer (High land to lower hills). This study was conducted in Gyanamalai hills and Neknamalai hills of Thirupattur district, located in north east Tamilnadu. The total area is about 500 km^2 including 23 villages, with a

Figure 1: A Satellite View of Gnanamalai Hills, Ambur (from 9.6 km)

total estimated population of 2,750. Most of the inhabitants live in small villages, and few families are shepherds and stay mostly in Gyanamalai areas for 7 – 10 months a year. Most of the inhabitants are farmers. Medical facilities are rare in Gyanamalai hills and Neknamalai hills, and most of the health problems are cured traditionally by local medicine (Fig. 2). For chronic diseases people have to travel more than 10 – 20 km from their village to get attention at health facilities. Most of the younger generation, especially men, migrate to cities in order to find employment. Women and elder people live in the villages. Inhabitants are generally belonging to two major group, vaithiyar and Natural healer (about 15%, 20% respectively), Most people speak Tamil and telugu is the secondary language of the region. Mountain terrace farming is abundant in region, with three crops a year: Rabi (October–April/May e.g. Tomato, Brinjal, Mustard), Kharif (April–October e.g. Rice, Corn), and Jayad (May–October e.g. Cucumber, Pumpkin, Beans, Marry gold).

Figure 2: A Satellite View of Neknamalai Hills, Vaniyambadi (from 11.9 km)

3. Data Collection

A total of 55 individuals were surveyed during the study. Among them some key participants which were experienced and rich knowledge of the medicinal flora were selected for collection and identification of local medicinal plants. All interviews were conducted after obtaining oral and verbal prior informed consents from all individual participants. The study was conducted during October 2020 to May 2021 in randomly selected villages of Gyanamalai (Murugan temple region) and information about local medicinal plants was also gathered from tamilar and telugar in the Gyanamalai regions, and their homesteads. Household survey was conducted using individual personal meetings and group discussions as well as field surveys [Timmermans K 2003 and Mohamed Tariq, et. al., 2018]. Questionnaires were set in English, but interviews were conducted in local language (Tamil also Telugu) for more convenience and accuracy. As the first author is local person of region so easy understanding and conversations with local people, together more information. List of local medicinal plants with common name were prepared and photographs were also supplemented for more information about uses and identification. For more reliable information, diseases base questionnaires were used. Information about medicinal plants include local name, plant parts used, drug preparation, mode of administration and doses were recorded. For verification and agreement about the medicinal uses, information given by a respondent was discussed in households as group discussion [Parinitha, M.,2005]. Twenty-five key participants including 13 traditional healers, two shepherds, and 12 other local inhabitants were interviewed and their experience, knowledge of medicinal plants, methods of drug preparation, and practicing with traditional tools, etc. were verified. Monthly schedules were made for data and plant collection including two surveys were made in January and May. So the participants were interviewed at their homes or at pastures. Medicinal plants were catalogued, and their voucher specimens were collected. Collected samples were identified with the help of a local flora and further verified through comparison with prior collections from the botanical survey of India (BSI, Southern circle Herbarium, Madras). Plant names were also checked in "Tropicos" http://www.tropicos.org as well as "The Plant List" (http://www.theplantlist.org), and all preserved specimens deposited at the Herbarium of Tamilnadu.

4. Results and Discussion

Socio-Economy

During the ethnomedicinal survey, a total of 25 people were interviewed, including shepherds at Neknamalai region (700 – 1020 msl), forests and their homesteads during January –April 2021. The sociological profile of the participants is given in Table 1.

Most participants were from 50 to 65 age group. Only 25 participants were traditional healers (Vaidyar and Natural healers) and the key informants for this study. Less than 9 % participants were < 40 years old, about 30% were illiterate, while many of the young practitioners hold a degree/diploma (Table 2). Almost all illiterates were > 50 years older.

Table 1: DISTRIBUTION OF PLANTS UNDER DIFFERENT HABITS IN GYANAMALAI HILL

S.NO.	HABITS	NO. OF SPECIES
1	Herb	40
2	Shrub	25
3	Climber	12
4	Tree	23
5	Bulb	5
6	Woody shrub	1
7	Climbing herb	1

Table 2: DISTRIBUTION OF PLANTS UNDER DIFFERENT HABITS IN NEKNAMALAI HILL

S.NO.	HABITS	NO. OF SPECIES
1	Herb	38
2	Shrub	21
3	Climber	09
4	Tree	17
5	Bulb	4
6	Woody shrub	2
7	Climbing herb	1

Ethnomedicinal Plants

A total of 38 medicinal plant species belonging to 22 genera of 26 families including 3 gymnosperm species and 35 angiosperms (12 monocotyledons and 23 dicotyledonous) presented in (Table 3) was reported. The most represented families were Asteraceae (5 species), followed by Polygonaceae, Ranunculaceae, Rosaceae (4 species each) and Berberidaceae, Poaceae, Zingiberaceae (3 species each). Picrorhiza kurroa and

Aconitum heterophyllum were common ethnomedicinal plants among all participants because these plants are culturally important as they have long been using for generations and due to their rich bioactive constituents.

Table 3: ETHNOMEDICINAL PLANTS USED BY THE TRIBAL PEOPLE OF NEKNAMALAI REGION

S.No.	Botanical Name	Family	Local Name	Habit	Parts used	Used	Mode of action
1	Michelia champaga, L	Magnoliaceae	Champagam	Tree	Leaves	Scorpion bite	Leaf juice in taken orally
2	Cocculus hirsutus, Diels	Menispermaceae	Kattukodi	Small tree	Leaves	Anemia	Leaf jiice taken internally
3	Tiliacora acuminata,	Menispermaceae	Perunkattu kodi	Climbing shrub	Leaves	Snake bite	Paste and root decoction, etc.
4	Brassica juncea	Cruciferae	Kadugu	Herb	Leaves	Ear worund	Juice used internally
5	Hybanthus enneaspermus,	Violaceae	Orithal thamarai	Herb	Leaves	Fever, sperm counting	Decoction and direct used
6	Aegle marmelos, (L.) Corr. Serr.	Rutaceae	Vilvam	Tree	Leaves	Diarrhea	Leaf juice used internally
7	Limonia acidissima L.	Rutaceae	Vilam	Tree	Root, Fruit	Snake bite, Indijestion	50 ml of root juice mixed with hot water is used
8	Azadirachta indica, A.Juss.	Meliaceae	Vembu	Tree	Leaves	Insect bite, stomach pain, Burns	Leaves with turmeric applied externally for poisonous bites and juice taken internally
9	Melia azedarach, Hiern	Meliaceae	Malai vempu	Tree	Leaves, stem , bark	Rheumatism, skin, teeth, etc.	Leave paste applied on the body, stem used as toothbrush, etc.,
10	Dodonaea angustifolia, L.f.	Sapindaceae	Viraali	Shrub	Leaves, root	Fever, Rherumatism, skin infections , diarrhea, sexual disorders	Leaves are used body problems, decoction used in diarrhea, etc.,

11	Clitoria ternatea, L.	Fabaceae	Sanku poo	Vine (Climber)	Leaf and flower	Swelling of legs and mentural problem	Fresh leave paste with pepper is applied on swelling of legs and flower decoction is used for female problem.
12	Dalbergia latifolia, Roxb.	Fabaceae	Eatti maram	Tree	Root, bark	Menorrhagia	Root paste is applied water daily cure.
13	Indigofera as-palathoides, Vahl.	Fabaceae	Sivanar vembu	Shrub	Whole palnt	Diarrhea	Plant juice taken internally used.
14	Mucuna gigantea, DC.	Fabaceae	Poonai kali	Shrub	Roots	Stomach pain	Root juice used for internally
15	Cassia alata. L.	Caesalpini-aceae	Seemai agathi	Shrub	Leaf	Snake bite	Leaves paste used externally
16	Cassia auriculata. L.	Caesalpini-aceae	Aavarai	Shrub	Seed, leaves	Diabetes, Hair growth	Seed powder used for internally, hair wash
17	Albizia richardiana, (L.)	Mimosaceae	Vagei	Tree	Leaves	scorpion bite	Leave tonic is used orally
18	Mimosa pudica, L.	Mimosaceae	Thotta sinungi	Herb	Whole plant	Prevent Excess menstrual bleeding	Whole plant Juice is used internally
19	Terminalia arjuna, W. & A.	Combre-taceae	Marutham	Tree	Bark, leaves	Menstrual problem Dysentery, earache	Leave juice is used for internally
20	Terminalia chebula, Retz.	Combre-taceae	Kadukkai	Tree	Fruit	Diges-tive,antiseptic and diuretic	Fruit powder is used for internally
21	Cissus quadrangu-laris,	Vitaceae	Pirantai	Shrub	Leaves, Stem	Gas trouble, Bone fracture, worms kill	Stem and leave paste is used to cure bone fracture and root passed used
22	Indigofera as-palathoides	Fabaceae	Sivanar vembu	Shrub	Whole plant	Diarrhea	Whole plant juice taken internally
23	Syzygium cumini	Myrtaceae	Naval maram	Tree	Bark, Seed	Chest pain, painful mestruration, Diabetic	Bark powder with ghee taken internally and seed powder taken internally

24	Oenothera glazioviana,	Onagraceae	Anthi man-tharai	Herb	Seed	Reduces cholesterol level, Sedative	Seed powder is used for internally
25	Coccinia grandis	Cucur-bitaceae	Ko-vaikodi	Climber	Leaves	Ulcer	Leaves juices are taken internally
26	Bogonia malabarica	Begoniaceae	Kalthama-rai	Shrub	Leaves	Asthuma	Leaf juice with ginger taken internally
27	Anacyclus pyrethrum,	Asteraceae	Akkarakaram	Herb	Root, flower	Paralysis, dental pain, sexual weekness, impotency, Diabetes	Root powdered with milk used internally
28	Eclipta alba	Asteraceae	Manchal karisalamkanni	Herb	Whole plant	Snake bite	Whole plant juice is used orally
29	Emilia sonchifolia	Asteraceae	Seedevi senkaluneer	Herb	Root	Diarhea	Root juice is used internally
30	Kleinia grandiflora	Asteraceae	Muyal kathu	Shrub	Leaves	Joints pains, Ear problem	Leaf paste is used externally
31	Xanthium strumarium	Asteraceae	Marul oomathai	Herb	Whole plant	Rheumatic joint pains, itching	Whole plant paste is used externally
32	Wrightia tinctoria,	Apocynaceae	Vetpalai	Tree	Leaves	Toothache, toothbrush, folk medicine	Leaves are applied for externally
33	Hemidesmus indicus,	Asclepi-adaceae	Nannari	Herb	Root	Pimples in the face	Root paste is used and aerial root of Aalamaram(Ficus benhalensis) applied externally
34	He-liotropium indicum,	Boraginaceae	Thel koduku poondu	Shrub	Leaves, flowers	regulates menstruation, wounds, scorpion bites, ophthalmic, cornea is inflamed	Extract of flowers regulates menstruation, where large doses are abortive. Juice of the leaves and castor oil is used internally
35	Curculigo orchioides, Gaertn.	Amarylli-daceae	Nila-panai	Herb	Root, Rhi-zome/tuber	Toothache, and thyroid	Root paste are used for orally to toothache and rhizome used for internally for thyroid

36	Gloriosa superba, L.	Liliaceae	Kan-valipoo or Kazhap-pai Kilangu	Climber	Tuber, seed	Inflammation, abortyion	Kanvalipoo or Kazhappai Kilangu
37	Arisaema tortuosum, Schott	Araceae	Kattu chenai	Shrub	Corn	Cure piles	Corms boiled with tamarind taken internally
38	Vetiveria zizanioides, Nash.	Poaceae	Vettiver	Herb	Root	Vattai, skin disease, hair problem	Root tonic is used for orally,coconut oil mixed with vettiver to cure

Life Forms and Plant Parts Used

In current study, 56% of the species were herbs, surveyed by trees (23%), shrubs (12%), and climbers (9%), similar to other studies carried out in Himalaya [Malik ZA. et.al.,], Traditional healers often use herbs and trees most normally as medicine because of their easy handiness [Mohamed Tariq. et. al.,]. Besides this, herbs can be used with easiness in herbal training methods and extraction of bioactive compounds [21]. Less part of climbers might be due to less availability and difficult to harvest from massive growth of supporting material (Tree) in temperate area. Accessibility is found as a major reason to use the plants in Himalaya followed by cultural reason. In present study different plant parts were used to make herbal preparation of drugs. The common plants parts were roots (26%) followed by leaves (20%), fruit (8%), bark and rhizome (7%) whole plant, tuber and seeds (each 6%), aerial part and stem or branches (each 5%), flower, latex resin or gum, bulb, (each 1%). Root were frequently used in folklore of Jakholi for herbal preparations similar to Root proportion is high probably due to root consist rich of active ingredients. Leaves were second most useful plant part it might be due to easy availability and it is thought that leaves contain more easily extractable phytochemicals, crude drugs and many other mixtures which may be proven as valuable regarding phytotherapy.

5. Conclusion

Current paper is the first attempt of survey in Gyanamalai hills and Neknamalai hills, Tamilnadu (Eastern Ghats), India. Asteraceae, Polygonaceae, Ranunculaceae and Rosaceae were the most used families and root were the most commonly used plant parts in the area. Aconitum heterophyllum, Megacarpaea polyandra, Picrorhiza kurroa and Rheum emodii are well known medicinal plant species, contributing important role in the local health care system of Jakholi area. Documentation of local medicinal

knowledge is also essential due to outmigration of the younger. Study of ethnomedicinal awareness helps identify the important species of the region for pharmacological importance and ecological sustainability and it also aids conservation of traditional knowledge. Traditional knowledge is based on experience passed on from generation to generation and limited only to ageing people and traditional healers. We came to the following respects to be taken while doing ethnomedicinal studies in the Eastern Ghats regions (TN) : (a) local people are quite conservative in involvement traditional knowledge about the Medicinal plants; (b) the young generation is not involved and knowledgeable about the ethnomedicinal plants and their uses; and (c) outmigration is a risk to the conservation of traditional ethnomedicinal knowledge. The present study exhibited that the medicinal plants are still very important for livelihood of local inhabitants of Neknamalai and Gnayamalai hills regions of Eastern Ghats of Tamilnadu. Some medicinal plants are at the hurried of threatened due to their Environmental factors, biology and human induced mistreatments. To sum, documentation of useful plants and the knowledge of their utilization is immediate before being gone.

References

[1] Malik, Z.A., Bhat, J.A., Ballabha, R., Bussmann, R.W. and Bhatt, B.A. (2015), Ethnomedicinal plants traditionally used in health care practices by inhabitants of western Himalaya, *J Ethnopharmacol.* **172**, 133 – 44.

[2] Ballabha, B. and Chaurasia, O.P. (2009), Medicinal plants of cold desert Ladakh used in the treatment of stomach disorders, *Indian J Tradit Knowl.* **8**, 185 – 90.

[3] Kunwar, R.M., Baral, K., Paudel, P., Acharya, R.P., Thapa-Magar, K.B., Cameron, M. and Bussmann, R.W. (2016), Land use and socioeconomic change, medicinal plant selection and biodiversity resilience in far western Nepal, *PLoS One* **11** (12), e0167812.

[4] Timmermans, K. (2003), Intellectual property right and traditional medicine: policy dilemmas at the interface, *Soc Sci Med.* **57** (4), 745 – 56.

[5] Indian Village Directory. Jakholi Villages list https://villageinfo.in/uttarakhand/rudraprayag/jakholi.html.05/06/2017.

[6] Mohamed Tariq, N.P.M., Balamurugan, V., Sabaridasan, A. and Saravanan, S. (2018), Ethnobotanical Survey of Herbal Plants at Kalvarayan hills of Tamil Nadu, India, *Research and Reviews: Journal of Herbal Sci.* **7** (2), 25 – 29.

[7] Parinitha, M., Srinivasa, B.H. and Shivanna, M.B. (2005), Medicinal plant wealth of local communities in some villages in Shimoga District of Karnataka, India, *J. Ethnopharmacol* **98**, 307 – 312.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 50 – 55

http://www.islamiahcollege.edu.in

ANTIBACTERIAL POTENTIAL OF SILVER NANOPARTICLES SYNTHESIZED USING GREEN TEA LEAVES

A. Adeela Begum and A. Nazim Ahmed

[1]*Department of Chemistry,*
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

Aim and Objective: Silver nanoparticles (AgNPs) are extensively used in biomedical fields because of their effective antimicrobial activity. Biological synthesis of nanoparticles has gained significant consideration due to its easiness, low price and absence of organic solvents. This work describes the biological synthesis of AgNPs with green tea extract. The tea polyphenols act as reducing and stabilizing agents for the nanoparticles. To develop silver nanoparticles (AgNPs) using green tea aquous extract and evaluate its antibacterial activity.

Materials and Methods: The obtained nanoparticles were extensively characterized by ultraviolet-visible spectroscopy (UV–vis). Antibacterial Potential of Silver Nanoparticles synthesized using green tea leaves were analyzed by invitro susceptibility test.

Results: The UV-visible absorption spectrum of the green synthesized AgNPs showed a broad peak at 436 nm which indicates the formation of nanosized particles of Ag. The antibacterial activity of the biogenic AgNPs was demonstrated against Escherichia coli (E. coli), Klebsiella pneumoniae (K. pneumoniae), Salmonella Typhimurium (S. Typhimurium), and Salmonella Enteritidis (S. Enteritidis) bacterial strains. Salmonella Typhimurium and Salmonella Enteritidis were found to be the more sensitive to the nanoparticles, with a minimum inhibitory zone of 20 mm, respectively.

Interestingly, Silver Nanoparticles Synthesized using green tea leaves showed an antibacterial activity, they were also not toxic to human. Thus, green tea synthesized AgNPs could find important biomedical applications in the combat of pathogenic bacteria.

Keywords: Silver nanoparticles, Epigallocatechingallate, antibacterial activity.

1. Introduction

In recent years, nanoparticles and its biological activity have been extensively studied when compared to the plant materials due to their interesting physical and chemical properties.Green tea is commonly used as traditional health drink, which contains a variety of nutrients and functional components, including tea polyphenols, catechins (Pasrija & Anandharamakrishnan, 2015). The important catechins present in green tea extract are epicatechin (EC), epicatechingallate (ECG), epigallocatechin (EGC) and epigallocatechingallate (EGCG). Epigallocatechingallate (EGCG) is the major catechin, comprising of about 40% of the catechins in green tea (Sharangi, 2009), which has health benefits such as antimicrobial, anti-carcinogenic, anti-oxidative, anti-diabetic, anti-viral,and cancer preventive properties (Chen et al., 2019; Yokotani & Umegaki, 2017).

EGCG has low bioavailability due to the absorption process and catechins could be damaged through degradation during absorption and distribution process (Zhao et al., 2019).

Numerous studies have revealed that the nano sized materials can encapsulate, protect and release bioactive substances, such as drugs and nutrients without any degradation and help to increase bioavailability (Liang et al., 2017). In this study, silver nano particles were prepared to enhance the stability and effectiveness in the delivery and facilitate drug entry to protect it from biometabolic modifications. Among the other types of nanoparticles, AgNPs as a kind of metallic nanoparticle have been described to possess greater biomedical application(Bhattacharya & Mukherjee, 2008).

EGCG is also confirmed to be a promising bacterial inhibitor due to various biological effects on oral streptococci (Wu & Wei, 2002).AgNPs offer a large surface area for interaction with bacteria, which allow the nano particles to attach to the cell membrane and easily penetrate into the bacteria, thus AgNPs have extensive range of antibacterial activities (Wu et al., 2015, Devanesan et al.,2021). In this study, we aimed to determine the antibacterial activity ofAgNPs synthesized from green tea extract against pathogenic bacteria.

2. Materials and Methods

2.1. Preparation of Silver Nanoparticles

The synthesis of AgNPs using green tea leaves extracts was done weighing ten gram of green tea leaves in a beaker containing 100 mL of distilled water and maintained at 60°C for 10 min. After 10 min, the tea extract was filtered using 0.45 mm Millipore membrane filter and followed by 0.2 mm Millipore membrane filter. For synthesis of AgNPs, 12 mL of tea extracts was added into 100 mL of AgNO3 (1 mM) in Erlenmeyer flask at room temperature. Color changes of the solution were observed. The synthesized

AgNPs were characterized by UV-vis spectroscopy (Kholoud et al., 2010).

2.2. UV–Visible Spectral Analysis of AgNPs

The synthesis of nanoparticles was monitored using both visual observation of the colour and UV–visible spectral analysis (UV-VIS. Spectrometer). It was noticed that the filtrate was colourless before incubation with silver nitrate then the colour turned to dark brown after complete reduction of silver ions. Silver nanoparticles were scanned using spectrophotometer at wavelengths from 200 to 800 nm [Mahmoudet al., 2013]. The filtrate without silver nitrate was used as a blank sample.

2.3. Bacteria Strains Preparation

Escherichia coli (E. coli), Klebsiella pneumoniae(K. pneumoniae), Salmonella Typhimurium (S. Typhimurium), and Salmonella Enteritidis (S. Enteritidis) were obtained from the Pathology Department, CMC Hospital, Vellore.All thebacteria strains were cultured in Mueller Hinton broth (MHB)(Merck, Germany) at 37°C for 24 h with 200 rpm agitation.

2.4. In Vitro Susceptibility Test

Disk Diffusion Method

The antibacterial activity of AgNPs Synthesized using green tea leaves against some selected Gram-negative foodborne bacteria was carried out using Kirby-BauerDisk Diffusion Susceptibility Test method (Bauer et al., 1966).The bacteria strains were spread on the Mueller-Hinton agar (MHA) (Merck, Germany) using sterile cotton swab. Sterile blank antibacterial susceptibility disk was used in the test. The disks were loaded with 10 μL of tea leaves extracts, silver nitrate solution (1 mM), and solution containing tea leaves mediated synthesized AgNPs separately. The disks were then placed on the agar plate and incubated at 37°C for 24 hrs. The zone of inhibition was observed after 24 h of incubation.

3. Results and Discussion

This study was aimed to evaluate the antibacterial activity of green synthesized AgNPs. The green synthesized AgNPs used in this study were characterized by UV-vis spectroscopy. The UV-visible absorption spectrum of the green synthesized AgNPs showed a broad peak at 436 nm which indicates the formation of nanosized particles of Ag.

The antibacterial activity of AgNPs was determined against four species of Gram-negative foodborne pathogens: E. coli, K. pneumoniae, S. Typhimurium, and S. Enteritidis.

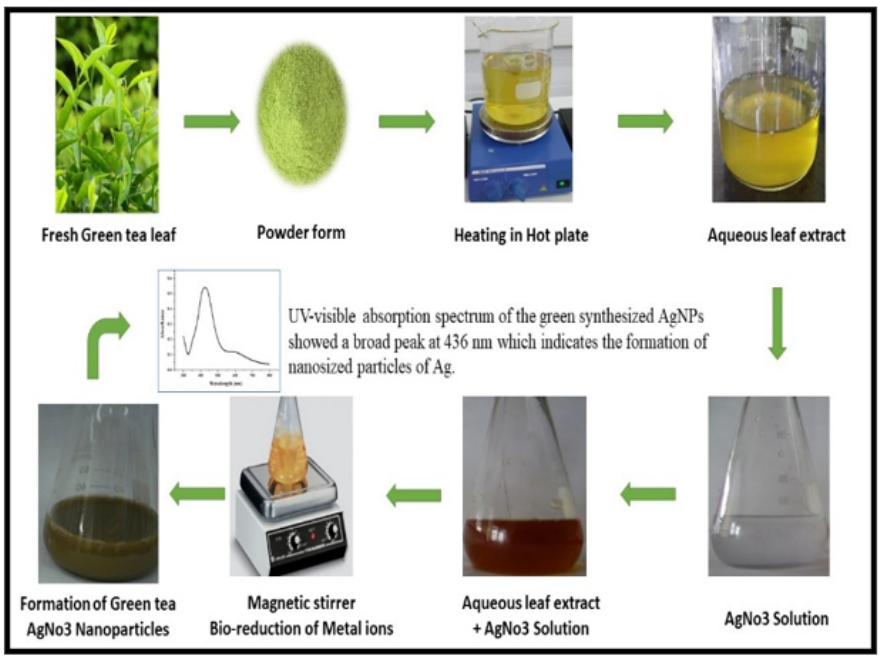


Figure 1: Flow Chart for the Synthesis of Silver Nanoparticles using Green Tea Leaves and its Characterization using UV-Visible Absorption Spectrum

Table 1: Disk Diffusion Tests of Green Tea AgNPs

Bacteria	Diameter of inhibition zone (mm)
Escherichia coli	15
Salmonella Typhimurium	20
Klebsiella pneumonia	10
Salmonella Enteritidis	20

The results from disk diffusion test of the AgNPs are summarized in Table 1. For the disk diffusion test, the presence of clear zone around the AgNPs disk suggesting that the AgNPs possessed antibacterial activity which is able to inhibit the growth of the Gram-negative foodborne pathogens.

4. Conclusion

Silver nanoparticles prepared in green tea extract showed significant antibacterial activity against the selected Gram-negative foodborne pathogens. Thus, AgNPs might be a good alternative to develop as antibacterial agents against the multidrug resistant

strains of bacteria. The applications of AgNPs may lead to valuable findings in various fields such as medical devices and antimicrobial systems.

Conflict of Interest

The authors declare that there are no conflicts of interest.

References

[1] Bhattacharya, R. and Mukherjee, P. (2008), Biological properties of "naked" metal nanoparticles, *Advanced Drug Delivery Reviews* **60** (11), 1289 – 1306.

[2] Chen, W., Zou, M., Ma, X., Lv, R., Ding, T. and Liu, D. (2019), Co-Encapsulation of EGCG and Quercetin in Liposomes for Optimum Antioxidant Activity, *Journal of Food Science* **84** (1), 111 – 120.

[3] Kholoud, M.M., Abou El-Nour, Ala'a Eftaiha, Abdulrhman Al-Warthan, and Reda A.A. Ammar (2010), Synthesis and applications of silver nanoparticles, *Arabian Journal of Chemistry* **3**, 135 – 140.

[4] Liang, J., Yan, H., Wang, X., Zhou, Y., Gao, X., Puligundla, P. and Wan, X. (2017), Encapsulation of epigallocatechin gallate in zein/chitosan nanoparticles for controlled applications in food systems, *Food Chemistry* **231**, 19 – 24.

[5] Mahmoud, M.A., Al-Sohaibani, S.A., Al-Othman, M.R., Abd El-Aziz, A. and Eifan, S.A. (2013), Synthesis of extracellular silver nanoparticles using Fusarium semitectum (KSU-4) isolated from Saudi Arabia, *Digest J Nanomat Biostruct* **8** (2), 589 – 96.

[6] Pasrija, D. and Anandharamakrishnan, C. (2015), Techniques for extraction of green tea polyphenols: A review, *Food & Bioprocess Technology* **8** (5), 935 – 950.

[7] Sharangi, A. B. (2009), Medicinal and therapeutic potentialities of tea (Camellia sinensis L.) – A review, *Food Research International* **42** (5-6), 529 – 535.

[8] Wu, J., Yu, C., Tan, Y., Hou, Z., Li, M., Shao, F., et al. (2015), Effects of prenatal exposure to silver nanoparticles on spatial cognition and hippocampal neurodevelopment in rats, *Environmental Research* **138**, 67 – 73.

[9] Yokotani, K. and Umegaki, K. (2017), Evaluation of plasma antioxidant activity in rats given excess EGCg with reference to endogenous antioxidants concentrations and assay methods, *Free Radical Research* **625** 51(2), 193 – 199.

[10] Zhao, J., Tian, Z. and Chen, L. (2011), Effects of deamidation on aggregation andemulsifying properties of barley glutelin, *Food Chemistry* **128** (4), 1029 – 1036.

[11] Devanesan, S. and AlSalhi, M.S. (2021), Green synthesis of silver nano particles using the flower extract of Abelmoschus esculentus for cytotoxicity and anti microbial studies, *International journal of Nanomedicine* **16**, 343 – 3356.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 56 – 61

http://www.islamiahcollege.edu.in

A STUDY ON STOCHASTIC INTEGRATION ON SPACES OF MODELLED DISTRIBUTIONS

A. Mohamed Ali[a] **and R. Ravi Raj**[b]

[a]*Associate professor, Department of Mathematics*
Islamiah College (Autonomous), Vaniyambadi – 635 752
Tirupattur District, Tamil Nadu, India
[b]*Assistant Professor of Mathematics*
Kuppam Engineering College
Kuppam – 517 425, Chittoor District (AP), India

Abstract

The Besov spaces of modelled distributions are shown to be UMD Banach spaces and of martingale type 2. As a consequence, this gives access to a rich stochastic integration theory and to existence and uniqueness results for mild solutions of semilinear stochastic partial differential equations in these spaces of modelled distributions and for distribution-valued SDEs.

Keywords: UMD and M-type 2 Banach Spaces, Regularity Structures, Stochastic Integration in Banach Spaces.

1. Introduction

This paper is devoted to prove that the Besov spaces $\mathcal{D}^{\gamma}_{p,q}$ of modelled distributions are UMD Banach spaces and of martingale type 2. These Banach space properties open the door to apply highly developed stochastic integration theory on the spaces $\mathcal{D}^{\gamma}_{p,q}$. For example one can integrate predictable $\mathcal{D}^{\gamma}_{p,q}$-valued processes with respect to Brownian motion. One successful application of stochastic integration on Banach spaces lies in the area of stochastic partial differential equations, which we will discuss in more details below. For a more comprehensive introduction and treatment of stochastic integration on Banach spaces.

Let $(\Omega, \mathcal{F}, \mathbb{F}, \mathbb{P})$ be a complete filtered probability space, $I \subset \mathbb{R}, \mathbb{F} := (\mathcal{F}_t)_{t\in I}$ be an increasing family of sub-σ-algebra of $\mathcal{F}$ and X be a Banach space with norm $\|\cdot\|_X$. The expectation operator with respect to $\mathbb{P}$ is denoted $\mathbb{E}$ and the corresponding conditional expectation by $\mathbb{E}[\cdot|\mathcal{F}_t]$ for $t \in I$. A process $(M_t)_{t\in I}$ is a X-valued martingale if and only if $M_t \in L^1(\Omega, \mathcal{F}_t, \mathbb{P}; X)$ for all $t \in I$ and

$$\mathbb{E}[M_t|\mathcal{F}_s] = M_s \quad \mathbb{P}\text{-}a.s., \quad \text{for all } s, t \in I \text{ with } s \le t.$$

A sequence $(\xi_i)_{i\in\mathbb{N}}$ is called martingale difference if $(\sum_{i=0}^{n} \xi_i)_{n\in\mathbb{N}}$ is a X-valued martingale. To rely on stochastic integration theory on Banach spaces, one needs to require some additional properties on the Banach space X.

2. Stochastic Integration On Spaces Of Modelled Distributions

Definition 2.1. *Let $(\Omega, \mathcal{F}, \mathbb{P})$ be a complete probability space.*

- *A Banach space $(X, \|\cdot\|_X)$ is of martingale type p for $p \in [1,\infty)$ if any X-valued martingale $(M_n)_{n\in\mathbb{N}}$ satisfies*

$$\sup_n \mathbb{E}\left[\|M_n\|_X^p\right] \leq C_p(X) \sum_{n\in\mathbb{N}} \mathbb{E}\left[\|M_n - M_{n-1}\|_X^p\right]$$

  for some constant $C_p(X) > 0$ independent of the martingale $(M_n)_{n\in\mathbb{N}}$ and $M_{-1} := 0$.

- *A Banach space $(X, \|\cdot\|_X)$ if of type p for $p \in [1,2]$ if any finite sequence $\epsilon_1, \ldots, \epsilon_n : \Omega \to \{-1,1\}$ of symmetric and i.i.d. random variables and for any finite sequence $x_1, \ldots, x_n$ of elements of X the inequality*

$$\mathbb{E}\left[\left\|\sum_{i=1}^{n} \epsilon_i x_i\right\|_X^p\right] \leq K_p(X) \sum_{i=1}^{n} \|x_i\|_X^p$$

  holds for some constant $K_p(X) > 0$.

- *A Banach space $(X, \|\cdot\|_X)$ is called an UMD space or is said to have the unconditional martingale difference property if for any $p \in (1,\infty)$, for any martingale difference $(\xi_j)_{j\in\mathbb{N}}$ and for any sequence $(\epsilon_i)_{i\in\mathbb{N}} \subset \{-1,1\}$ the inequality*

$$\mathbb{E}\left[\left\|\sum_{i=1}^{n} \epsilon_i \xi_j\right\|_X^p\right] \leq \tilde{K}_p(X)\mathbb{E}\left[\left\|\sum_{i=1}^{n} \xi_i\right\|_X^p\right]$$

  holds for all $n \in \mathbb{N}$, where $\tilde{K}_p(X) > 0$ is some constant.

Let us remark that Hilbert spaces and finite dimensional Banach spaces are always UMD spaces.

Coming back to a regularity structure $\mathcal{T} = (A, T, G)$ with an associated model (Π, Γ) and let us assume now additionally that each T_α is an UMD space for $\alpha \in A$. Under this assumption the space $T_\gamma^- = \bigoplus_{\alpha<\gamma} T_\alpha$ is again an UMD space, since A is locally finite and T is a finite product of UMD spaces.

Proposition 2.1. Let $\mathcal{T} = (A, T, G)$ be a regularity structure with a model (Π, Γ) as in the Definition **??**. Suppose that $\gamma \in \mathbb{R}$ and that the Banach space T_α is an UMD space for every $\alpha \in A$. Then, the space $\mathcal{D}^\gamma_{p,q}$ is an UMD spaces, too, for $1 < p < \infty$ and $1 < q < \infty$. If the Banach space T^-_γ is additionally of type 2, then $\mathcal{D}^\gamma_{p,q}$ is of martingale type 2 for every $p \geq 2$ and $q \geq 2$.

Proof. Since every T_α with $\alpha \in A_\gamma$ is an UMD space by assumption, every $L^p(\mathbb{R}^d; T_\alpha)$ is also an UMD space. Furthermore, let μ be the Borel measure on $\mathbb{R}$ defined by

$$\mu(h) := \frac{1}{\|h\|_{\mathfrak{s}}^{|\mathfrak{s}|}} \, \mathrm{d}h,$$

the corresponding L^q-space $L^q_\mu(B(0,1); L^p(\mathbb{R}^d; T_\alpha))$ is again an UMD space for every $\alpha \in A_\gamma$. Consequently the finite product space

$$\prod_{\alpha \in A_\gamma} \Big(L^p(\mathbb{R}^d; T_\alpha) \times L^q_\mu(B(0,1); L^p(\mathbb{R}^d; T_\alpha)) \Big)$$

is an UMD space. We will show that $\mathcal{D}^\gamma_{p,q}$ is a closed linear subspace in the above product space and we can conclude that $\mathcal{D}^\gamma_{p,q}$ is an UMD space.

For this purpose we define for every $\alpha \in A_\gamma$ the following mappings

$$\Phi^\alpha_1 : \mathcal{D}^\gamma_{p,q} \to L^p(\mathbb{R}^d; T_\alpha) \quad \text{via} \quad f \mapsto f^\alpha$$

and

$$\Phi^\alpha_2 : \mathcal{D}^\gamma_{p,q} \to L^q_\mu(B(0,1); L^p(\mathbb{R}^d; T_\alpha)) \quad \text{via} \quad f \mapsto \Big[h \mapsto \frac{f^\alpha(\cdot + h) - (\Gamma_{\cdot+h,\cdot} f(\cdot))^\alpha}{\|h\|_{\mathfrak{s}}^{\gamma-\alpha}} \Big],$$

where f^α is the projection of f onto T_α and $\dfrac{f^\alpha(\cdot + h) - (\Gamma_{\cdot+h,\cdot} f(\cdot))^\alpha}{\|h\|_{\mathfrak{s}}^{\gamma-\alpha}}$ is an element in $L^p(\mathbb{R}^d; T_\alpha)$ such that

$$\frac{f^\alpha(\cdot + h) - (\Gamma_{\cdot+h,\cdot} f(\cdot))^\alpha}{\|h\|_{\mathfrak{s}}^{\gamma-\alpha}}(x) = \frac{f^\alpha(x + h) - (\Gamma_{x+h,x} f(x))^\alpha}{\|h\|_{\mathfrak{s}}^{\gamma-\alpha}}$$

for all $x \in \mathbb{R}^d$.

Clearly, the mapping $\left(\Phi^\alpha_1 \times \Phi^\alpha_2\right)_{\alpha \in A_\gamma}$ is an isometry from $\mathcal{D}^\gamma_{p,q}$ onto its image in the product space

$$\prod_{\alpha \in A_\gamma} \Big(L^p(\mathbb{R}^d; T_\alpha) \times L^q_\mu(B(0,1); L^p(\mathbb{R}^d; T_\alpha)) \Big),$$

so that we can embed $\mathcal{D}^{\gamma}_{p,q}$ into the above product space as a closed linear subspace. The space $\mathcal{D}^{\gamma}_{p,q}$ is therefore UMD, too. The previous construction is similar. Since every UMD space of type 2 is a Banach space of martingale type 2 as shown, one concludes that $L^p(\mathbb{R}^d; T_\alpha)$ and $L^q_\mu(B(0,1); L^p(\mathbb{R}^d; T_\alpha))$ are of martingale type 2 for every $p \in [2,\infty), q \in [2,\infty)$ and $\alpha \in A_\gamma$, and the same argument as before applies. □

we can now formulate and prove our main theorem. Like in the Fubini theorem the order of reconstruction and stochastic integration can be interchanged:

Theorem 2.1. *Let $\gamma > \alpha_0 := \inf A, \alpha_0 \notin \mathbb{Z}$ and $\mathcal{T} = (A, T, G)$ be a regularity structure together with a model (Π, Γ) and T_α is an UMD space for every $\alpha \in A$. Let $(\Omega, \mathcal{F}, \mathbb{F}, \mathbb{P})$ be a complete filtered probability space and W be Brownian motion on $[0,T]$ for some $T \in (0,\infty)$. Let H be a $\mathcal{D}^{\gamma}_{p,q}$-valued process for some $1 < p < \infty$ and $1 < q < \infty$ which is locally L^2-stochastically integrable with respect to W, then the order of "integration" can be interchanged*

$$\Big\langle \mathcal{R}((H \bullet W)), \psi \Big\rangle = \Big(\langle \mathcal{R}(H), \psi \rangle \bullet W \Big) \tag{2.1}$$

for every test function $\psi \in \mathcal{B}^r$ with $r > |\alpha_0|$. Here $(H \bullet W)$ stands for the stochastic integral of H with respect to W and $\mathcal{R}$ denotes a reconstruction operator for $\mathcal{T} = (A, T, G)$ and (Π, Γ).

Proof. **Step 1:** First we assume that H is an elementary process which can be written as

$$H(\omega, t) = \sum_{n=1}^{N} \sum_{m=1}^{M} \mathbf{1}_{(t_{n-1}, t_n]}(t) \mathbf{1}_{A_{mn}}(\omega) f_{mn}$$

where $0 = t_0 < t_1 < \cdots < t_N = T, A_{mn} \in \mathcal{F}_{t_{n-1}}$ for all $m = 1, \ldots, M$ and are pairwise disjoint, $f_{mn} \in \mathcal{D}^{\gamma}_{p,q}$ for all m and n. Here $\mathbf{1}_{A_{mn}}$ denotes the indicator function of the set $A_{n,m}$.

Then it holds that for all $t \in [0,T]$,

$$(H \bullet W)_t = \sum_{n=1}^{N} \sum_{m=1}^{M} \mathbf{1}_{A_{mn}} (W_{t \wedge t_n} - W_{t \wedge t_{n-1}}) f_{mn},$$

and therefore $\mathcal{R}((H \bullet W)_t) = \sum_{n=1}^{N} \sum_{m=1}^{M} \mathbf{1}_{A_{mn}} (W_{t \wedge t_n} - W_{t \wedge t_{n-1}}) \mathcal{R} f_{mn}$ as well as

$$\Big\langle \mathcal{R}((H \bullet W)_t), \psi \Big\rangle = \sum_{n=1}^{N} \sum_{m=1}^{M} \mathbf{1}_{A_{mn}} (W_{t \wedge t_n} - W_{t \wedge t_{n-1}}) \langle \mathcal{R} f_{mn}, \psi \rangle.$$

On the other hand, we have

$$\langle \mathcal{R}(H)(\omega,t),\psi\rangle = \sum_{n=1}^{N}\sum_{m=1}^{M} \mathbf{1}_{(t_{n-1},t_n]}(t)\mathbf{1}_{A_{mn}}(\omega)\langle \mathcal{R}f_{mn},\psi\rangle$$

which is an real-valued elementary process. Hence, we indeed have

$$\Big(\langle \mathcal{R}(H),\psi\rangle \bullet W\Big)_t = \sum_{n=1}^{N}\sum_{m=1}^{M} \mathbf{1}_{A_{mn}}(W_{t\wedge t_n} - W_{t\wedge t_{n-1}})\langle \mathcal{R}f_{mn},\psi\rangle.$$

Obviously now we obtain (1.1) for all elementary processes H. □

Step 2: Now suppose that H is a L^2-stochastically integrable process. There exists a sequence $(H_n)_{n\geq 1}$ of elementary processes such that

$$H_n \to H \quad \text{in} \quad L^2(\Omega,\mathbb{P};\gamma(L^2([0,T],\mathrm{d}t);\mathcal{D}^{\gamma}_{p,q})),$$

where $\gamma(L^2([0,T],\mathrm{d}t);\mathcal{D}^{\gamma}_{p,q})$ denotes the space of γ-radonifying operators from the space $L^2([0,T],\mathrm{d}t)$ into $\mathcal{D}^{\gamma}_{p,q}$

$$(H\bullet W) = \lim(H_n\bullet W) \quad \text{in} \quad L^2(\Omega;C([0,T];\mathcal{D}^{\gamma}_{p,q})).$$

Now we choose an $\bar{\alpha}<\alpha_0$ with $\lfloor\bar{\alpha}\rfloor = \lfloor\alpha_0\rfloor$. For $\gamma>0$ and Theorem **??** (for $\gamma<0$) we know that $\mathcal{R}:\mathcal{D}^{\gamma}_{p,q}\to\mathcal{B}^{\bar{\alpha}}_{p,q}$ is a continuous linear mapping, which implies that

$$\mathcal{R}((H\bullet W)) = \lim_{n\to\infty}\mathcal{R}((H_n\bullet W))$$

uniformly in $t\in[0,T]$ with respect to the Besov topology on $\mathcal{B}^{\bar{\alpha}}_{p,q}$. Since $\mathcal{B}^{\bar{\alpha}}_{p,q}$ can be embedded in the dual of C^r_0 for $r\geq\lfloor\bar{\alpha}\rfloor=\lfloor\alpha_0\rfloor$, we can derive that

$$\Big\langle \mathcal{R}((H\bullet W)),\psi\Big\rangle = \lim_{n\to\infty}\Big\langle \mathcal{R}((H_n\bullet W)),\psi\Big\rangle$$

in $L^2(\Omega;C([0,T];\mathbb{R}))$ for any $\psi\in\mathcal{B}^r\subset C^r_0$.

On the other hand, since the operator $\mathcal{R}$ and the dual pairing $\langle\cdot,\psi\rangle$ are continuous, the ideal property of γ-radonifying operators implies that $\langle\mathcal{R}(H),\psi\rangle$ is L^2-stochastically integrable with respect to W and

$$\mathbb{E}\Big[\|\langle\mathcal{R}(H_n),\psi\rangle - \langle\mathcal{R}(H),\psi\rangle\|^2_{L^2([0,T],\mathrm{d}t)}\Big] \leq \|\mathcal{R}\|^2\|\psi\|^2_{C^r_0}\,\mathbb{E}\Big[\|H_n-H\|^2_{\gamma(L^2([0,T],\mathrm{d}t);\mathcal{D}^{\gamma}_{p,q})}\Big],$$

which implies that $\langle\mathcal{R}(H_n),\psi\rangle$ converges to $\langle\mathcal{R}(H),\psi\rangle in L^2(\Omega\times[0,T],\mathbb{P}\times\mathrm{d}t)$ as n tends to infinity and therefore by It o isometry we obtain that

$$\Big(\langle\mathcal{R}(H),\psi\rangle\bullet W\Big) = \lim_{n\to\infty}\Big(\langle\mathcal{R}(H_n),\psi\rangle\bullet W\Big)$$

in $L^2(\Omega; C([0,T];\mathbb{R}))$ for any $\psi \in \mathcal{B}^r \subset C_0^r$. Since we have

$$\left\langle \mathcal{R}((H_n \bullet W)), \psi \right\rangle = \left(\langle \mathcal{R}(H_n), \psi \rangle \bullet W \right)$$

for every n by the result from Step 1, we obtain (1.1) for such H.

Step 3: Now suppose that H is locally L^2-stochastically integrable with respect to W. A standard localization argument together with the result from Step 2 then provides that (1.1) holds for all such H.

3. Conclusion

In this paper, we discussed about the stochastic integration theory and proved theorem on stochastic integration on spaces of modelled distributions.

References

[1] Brzeźniak, Z., Kok, T.: *Stochastic evolution equations in Banach spaces and applications to the Heath-Jarrow-Morton-Musiela equations*. Finance Stoch. 22(4), 959-1006 (2018)

[2] Hairer, M.: *Introduction to regularity structures*. Braz. J. Probab. Stat. 29(2), 175-210 (2015)

[3] Mandrekar, Vidyadhar, Rüdiger, Barbara: *Stochastic integration in Banach spaces*, volume 73 of Probability Theory and Stochastic Modelling. Springer, Cham, (2015). Theory and applications

[4] Triebel, H.: *Theory of Function Spaces*. Birkhäuser Verlag, Basel (2010). Reprint of the 1983 Edition

[5] Van Neerven, J.M.A.M., Veraar, M.C., Weis, L.: *Stochastic integration in UMD Banach spaces*. Ann. Probab. 35(4), 1438-1478 (2007)

[6] Van Neerven, J.M.A.M., Veraar, M.C., Weis, L.: *Stochastic evolution equations in UMD Banach spaces*. J. Funct. Anal. 255(4), 940-993 (2008)

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 62 – 67

http://www.islamiahcollege.edu.in

A STUDY ON TOPOLOGICAL OPERATORS OVER IFMS OF SECOND TYPE

R. Srinivasan[a], K. Mariyam Jameela[b] and V. Prabhavathi[c]

PG & Research Department of Mathematics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
[a]srinivasanmaths@yahoo.com
[b]mariyajameel.mj@gmail.com
[c]prabhavathi.kv83@gmail.com

Abstract

In this paper, we introduce some topological operators like Closure operator $C(A)$ and Interior operator $I(A)$ and a new operator $T(A)$ over Intuitionistic Fuzzy Multi Sets of second type. Also, we study some of its properties and their relations.

Keywords: Fuzzy Sets, Intuitionistic Fuzzy Sets, Multi sets, Intuitionistic Fuzzy Multisets.

1. Introduction

Modern set theory formulated by the German mathematician George Cantor is fundamental for the whole mathematics. In fact, set theory is the language of mathematics, science, logic and philosophy. One issue associated with the notion of set is the concept of vagueness.

Considering the unpredictable factor in decision making Lofti A Zadeh introduced the idea of Fuzzy set which has a membership function that assigns to each element of the universe of discourse, a member from the unit interval [0, 1] to indicate the degree of belongingness to the set under consideration. Atanassov subsequently proposed the concept of Intuitionistic Fuzzy Set by bringing a non-membership function together with the membership function of the fuzz set.

Among the various notions of higher order fuzzy sets, IFS proposed by Atanassov provides a flexible framework to elaborate uncertainty and vagueness. As a generalization of fuzzy sets, Yager introduced the concept of Fuzzy Multiset.

An element of a Fuzzy Multiset can occur more than once with possibly the same or different membership values. Then years after, Shinoj and Sunil made an attempt

to combine the concepts and named it Intuitionistic Fuzzy Multi Set. The present authors have introduced Intuitionistic Fuzzy Multisets of Second type which is a further extension of IFMS.

The paper proceeds as follows. In section 2 we give some basic definition of IFMSST. In section 3, we define the closure operator $C(A)$, Interior operator $I(A)$ and a new operator $T(A)$ respectively. We study various theorems and propositions related to it. The paper is concluded in section 4.

2. Preliminaries

Definition 2.1. *Let X be a nonempty set. An Intuitionistic Fuzzy Set (IFS) A in X is defined as an object of the following form*

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in X\},$$

where the functions $\mu_A : X \to [0,1]$ *and* $\nu_A : X \to [0,1]$ *denote the degree of membership and the degree of non-membership of the element* $x \in X$*, respectively, and for every* $x \in X$

$$0 \leq \mu_A(x) + \nu_A(x) \leq 1.$$

Definition 2.2. *Let a set X be fixed. An Intuitionistic Fuzzy Set of Second Type (IFSST) A in X is defined as an object of the following form*

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in X\},$$

where the functions $\mu_A : X \to [0,1]$ *and* $\nu_A : X \to [0,1]$ *denote the degree of membership and the degree of non-membership of the element* $x \in X$*, respectively, and for every* $x \in X$

$$0 \leq \mu_A^2(x) + \nu_A^2(x) \leq 1.$$

Definition 2.3. *Let X be a nonempty set. An Intuitionistic Fuzzy Multisite of second type A denoted by IFMSST drawn from X is characterized by two functions Count membership of A*(CMA) *and count non membership of A*(CNA) *given respectively by* $CMA : X \to Q$ *and* $CNA : X \to Q$ *where Q is the set of all crisp multisets drawn from the unit interval [0, 1] such that for each* $x \in X$ *the membership sequence is defined as a decreasingly ordered sequence of elements in which CMA is denoted by* $\mu_A^1(x), \mu_A^2(x), \ldots, \mu_A^n(x)$*, where* $\mu_A^1(x) \leq \mu_A^2(x) \leq \cdots \leq \mu_A^n(x)$ *and the corresponding non membership sequence will be denoted by* $\nu_A^1(x) \leq \nu_A^2(x) \leq \cdots \leq \nu_A^n(x)$ *such that for each* $x \in X$ *and* $i = 1, 2, \ldots, n$.

An IFMS of second type is denoted by

$$A = \{\langle x, (\mu_A^1(x), \mu_A^2(x), \ldots, \mu_A^n(x)), ((\nu_A^1(x), \nu_A^2(x), \ldots, \nu_A^n(x)))\rangle | x \in X\}.$$

Remark 2.1. *Since we arrange the membership function in decreasing order, the corresponding non-membership sequence may not be in increasing or decreasing order.*

Definition 2.4. *The degree of non-determinacy (uncertainty or hesitancy) of an element $x \in X$ in the IFMSST A is defined by $\pi_A^i(x) = \sqrt{\mu_A^i(x), 1 - \nu_A^i(x)^2}$ for all $x \in X$ and $i = 1, 2, \ldots, n$.*

3. Topological Operators on IFMSST

Definition 3.1. *Let A be any IFMSST then the Closure operator for any A can be defined as*

$$C(A) = \{x, K, L / x \in X\},$$

where $K = \max \mu_A^i(y)$ and $L = \min \nu_A^i(y)$.

Definition 3.2. *Let A be any IFMSST then the Interior operator for any A can be defined as*

$$I(A) = \{x, K, L / x \in X\},$$

where $K = \min \mu_A^i(y)$ and $L = \max \nu_A^i(y)$.

Example 3.1. *Consider $X = \{x, y, z, w\}$. Let A be any IFMSST defined as $A = \{\langle x : (0.5, 0.2), (0.3, 0.6)\rangle, \langle y : (0.6, 0.5, 0.4, 0.2), (0.1, 0.3, 0.2, 0.5)\rangle\}$ then the closure and interior of A is given as*

$C(A) = \{\langle x : (0.6, 0.5, 0.4, 0.2), (0.1, 0.3, 0.2, 0.5)\rangle, \langle y : (0.6, 0.5, 0.4, 0.2), (0.1, 0.3, 0.2, 0.5)\rangle\}$

$I(A) = \{\langle x : (0.5, 0.2, 0, 0), (0.3, 0.6, 1, 1)\rangle, \langle y : (0.5, 0.2, 0, 0), (0.3, 0.6, 1, 1)\rangle\}$.

Definition 3.3. *For every IFMSST, $A \neq \tilde{U}$ operator $T(A)$ can be a new topological defined as*

$$T(A) = \left\{ x, \frac{\mu_A^i(x)}{\sup_{y \in X} \left(\mu_A^i(y) + \nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y \in X} \left(\nu_A^i(y) + \nu_A^i(y)\right)} | x \in X \right\}.$$

Proposition 3.1. *For every IFMSST A, we have $T(T(A) = T(A)$.*

Proof.

$$T(A) = \left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\}$$

$$\begin{aligned}
T(T(A)) &= T\left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\} \\
&= \left\{ x, \frac{\frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}}{\frac{\mu_A^i(x)}{\sup_{z\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)} + \frac{\nu_A^i(x)}{\sup_{z\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)}}, \frac{\frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)}}{\frac{\mu_A^i(x)}{\sup_{z\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)} + \frac{\nu_A^i(x)}{\sup_{z\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)}} | x \in X \right\} \\
&= \left\{ x, \frac{\frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}}{\frac{\mu_A^i(x)+\nu_A^i(x)}{\sup_{z\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}}, \frac{\frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)}}{\frac{\mu_A^i(x)+\nu_A^i(x)}{\sup_{z\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}} | x \in X \right\} \\
&= \left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\} \\
&= T(A).
\end{aligned}$$

□

Proposition 3.2. *For every IFMSST A, we have* $\overline{T(\overline{A})} = T(A)$.

Proof.

$$T(A) = \left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\}$$

$$T(\overline{A}) = \left\{ x, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\}$$

$$\overline{T(\overline{A})} = \left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\nu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\}$$

$$= T(A).$$

□

Proposition 3.3. *For every IFMSST A, we have*

1. $T(\Diamond A) = \Diamond A$
2. $T(\Box A) = \Box A$.

Proof. We know that

$$\Box A = \{\langle x, \mu_A^i(x), \sqrt{1-\mu_A^1(x)^2}\rangle | x \in X\}$$
$$\Diamond A = \{\langle x, \sqrt{1-\nu_A^1(x)^2}, \nu_A^i(x)\rangle | x \in X\}$$

and

$$T(A) = \left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\nu_A^i(y)\right)} | x \in X \right\}.$$

Now

$$\begin{aligned} T(\Diamond A) &= T\{\langle x, \sqrt{1-\nu_A^1(x)^2}, \nu_A^i(x)\rangle | x \in X\} \\ &= \left\{ x, \frac{\sqrt{1-\nu_A^1(x)^2}}{\sup_{y\in X}\left(\sqrt{1-\nu_A^1(x)^2}+\nu_A^i(y)\right)}, \frac{\nu_A^i(x)}{\sup_{y\in X}\left(\sqrt{1-\nu_A^1(x)^2}+\nu_A^i(y)\right)} | x \in X \right\} \\ &= \{\langle x, \sqrt{1-\nu_A^1(x)^2}, \nu_A^i(x)\rangle | x \in X\} \\ &= \Diamond A. \end{aligned}$$

Therefore $T(\Diamond A) = \Diamond A$.

$$\begin{aligned} T(\Box A) &= T\{\langle x, \mu_A^i(x), \sqrt{1-\mu_A^1(x)^2}\rangle | x \in X\} \\ &= \left\{ x, \frac{\mu_A^i(x)}{\sup_{y\in X}\left(\mu_A^i(y)+\sqrt{1-\mu_A^1(x)^2}\right)}, \frac{\sqrt{1-\mu_A^1(x)^2}}{\sup_{y\in X}\left(\mu_A^i(y)+\sqrt{1-\mu_A^1(x)^2}\right)} | x \in X \right\} \\ &= \{\langle x, \mu_A^i(x), \sqrt{1-\mu_A^1(x)^2}\rangle | x \in X\} \\ &= \Box A. \end{aligned}$$

Therefore $T(\Box A) = \Box A$. □

4. Conclusion

In this paper we defined some topological operators like closure operator $C(A)$ and Interior operator $I(A)$ and a new operator $T(A)$. Some of its theorems and properties are also studied. This newly defined operator are unique in its own way as it increases both the degrees of membership and the non-membership thereby decreasing the degree of uncertainty. It has its wide applications in inter criteria analysis. There is an excellent opportunity for further research in the topic.

References

[1] Atanassov, K.T. (1986), Intuitionistic Fuzzy sets, *Fuzzy sets and Systems* **20**, 87 – 96.

[2] Atanassov, K.T. (2015), A new topological operator over intuitionistic fuzzy sets, *Notes on IFS* **21**, 90 – 92.

[3] Blizard, W.D. (1989), Multiset Theory, *Notre Dame Journal of Formal Logic* **30** (1), 36 – 66.

[4] Chang, C. (1968), Fuzzy Topological Spaces, *J. Math. Anal. Appl.* **24**, 142 – 145.

[5] Mariyam Jameela, K. and Srinivasan, R. (2018), A Study on IFMS of Type II, *IJMA* **9** (9), 10 – 13.

[6] Mariyam Jameela, K. and Srinivasan, R. (2019), A Study on operators on IFMS of Type II, *IJRAR* **6** (2), 339 – 344.

[7] Mariyam Jameela, K. and Srinivasan, R. (2020), Topological operators over IFMS of Type II, *Advances in Mathematics, Scientific Journal* **9**, 6269 – 6275.

[8] Shinoj, T.K. and Sunil Jacob John (2012), Intuitionistic Fuzzy Multiset and its application in Medical Diagnosis, *International Journal of Mathematical and Computational Sciences, WASET* **6**, 34 – 38.

[9] Shinoj T.K. and Sunil Jacob John (2015), Topological Structures on Intuitionistic Fuzzy Multisets, *International Journal of Scientific and Engineering Research* **6** (3), 192 – 200.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 68 – 73

http://www.islamiahcollege.edu.in

A STUDY ON ANTI–HOMOMORPHISMS ON INTUITIONISTIC FUZZY IDEALS OF RINGS

K. Rajesh[a,*], R. Srinivasan[b], † and B. Gurudevan[c], †

[*]*Department of Mathematics,*
Mahendra Institute of Engineering and Technology,
Thiruchengode, Namakkal 637503
[†]*PG & Research Department of Mathematics,*
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
[a]rajeshagm@gmail.com
[b]srinivasanmaths@yahoo.com
[c]bgurudevan@gmail.com

Abstract

In this paper, we define a new concept of anti-homomorphism between two intuitionistic fuzzy rings R and R' and established some of their properties.

Keywords: Fuzzy set, Fuzzy ring, Fuzzy maximal ideal, Fuzzy prime ideal, Anti-Homomorphism in Fuzzy rings and Intuitionistic Fuzzy Sets.

1. Introduction

After the introduction of fuzzy sets by Zadeh L. A [12], several researchers explored on the generalization of the notion of fuzzy set. Kumbhojkar H.V and Bapat M.S [3] defined "Not - so - fuzzy ideals", Palaniappan. N and Arjunan. K [7] defined the homomorphism, anti -homomorphism of a fuzzy and anti - fuzzy ideals, Chandrasekhara Rao. K and Swaminathan. V [2] defined the anti homomorphism in near rings.

The present authors further introduced the new concept of Anti - Homomorphisams over Intuitionistic Fuzzy Ideals of Rings. The rest of the paper is designed as follows: In Section 2, we give some basic definitions. In Section 3, we define the new concept of anti-homomorphism between two Intuitionistic fuzzy rings R and R' and established some of their properties. This paper is concluded in section 4.

2. Preliminaries

Definition 2.1 (11)**.** *Let X be a non–empty universal set. A fuzzy subset A of X is a function $A : X \to [0, 1]$.*

Definition 2.2 (11)**.** *: A fuzzy set μ of a ring R is called a fuzzy sub ring of R if for all $x, y \in R$,*

$$\mu(x - y) \geq \min\{\mu(x), \mu(y)\}$$
$$\mu(xy) \geq \min\{\mu(x), \mu(y)\}.$$

Definition 2.3 (10)**.** *: A fuzzy set μ of a ring R is called a fuzzy ideal of R if for all $x, y \in R$,*

$$\mu(x - y) \geq \min\{\mu(x), \mu(y)\}$$
$$\mu(xy) \geq \max\{\mu(x), \mu(y)\}.$$

Definition 2.4 (11)**.** *: A fuzzy ideal μ of a ring R is called a fuzzy maximal if $Im(\mu) = \{1, \alpha\}$, where $\alpha \in [0, 1)$ and the ideal $\{x \in R/\mu(x) = 1\}$ is maximal.*

Definition 2.5 (11)**.** *: A fuzzy ideal μ of a ring R is called a fuzzy prime if for any two fuzzy ideals σ and θ of R the condition $\sigma\theta \subset \mu$ implies that $\sigma \subset \mu$ or $\theta \subset \mu$.*

Definition 2.6 (11)**.** *: A fuzzy ideal μ of a ring R is called a fuzzy primary if for any two fuzzy ideals σ and θ of R the conditions $\sigma\theta \subseteq \sqrt{\mu}$ and $\sigma \not\subseteq \mu$ together imply that $\theta \not\subseteq \sqrt{\mu}$.*

Definition 2.7 (10)**.** *: Let $f : R \to R'$ be any function, a fuzzy set μ of R is called $f-$invariant if $f(x) = f(y)$ implies $\mu(x) = \mu(y)$, $x, y \in R$.*

Definition 2.8 (11)**.** *: Let R and R' be two rings. A mapping $f : R \to R'$ is called a fuzzy anti - homomorphism if $f(\mu + \sigma) = f(\mu) + f(\sigma)$ and $f(\mu\sigma) = f(\sigma)f(\mu)$.*

Remark 2.1. *For a fuzzy maximal ideal μ of a ring R, we have*

(i) *μ is fuzzy prime*

(ii) *$\sqrt{\mu} = \mu$.*

Definition 2.9 (14)**.** *: Let X be a non empty set. A Fuzzy Set A in X is characterized by its membership function* $\mu_A : X \to [0,1]$ *and* $\mu_A(x)$ *is interpreted as the degree of membership of the element x in fuzzy set A, for each* $x \in X$*. It is clear that A is completely determined by the set of tuples*

$$A = \{\langle x, \mu_A(x)\rangle | x \in X\}.$$

Definition 2.10 (1)**.** *: An Intuitionistic Fuzzy Set (IFS) A in a universal set X is defined as an object of the following form*

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in X\}.$$

where $\mu_A : X \to [0,1]$ *and* $\nu_(A) : X \to [0,1]$ *denote the degree of membership and the degree of non-membership of the element* $x \in X$ *respectively, satisfying* $0 \leq \mu_A(x) + \nu_A(x) \leq 1$.

Definition 2.11 (16)**.** *An Intuitionistic Fuzzy Set (IFS)* $A = \{\langle x, \mu_A(x), \nu_A(x)\rangle | x \in X\}$ *in X is called an Intuitionistic Fuzzy Ideal of a ring X if*

(i) $\mu_A(x-y) \geq \{\mu_A(x) \wedge \mu_A(y)\}$,

(ii) $\mu_A(xy) \geq \{\mu_A(x), \mu_A(y)\}$,

(iii) $\mu_A(u\alpha(x+v) - u\alpha v) \geq \mu_A(x)$ *(resp.* $\mu_A(x\alpha u) \geq \mu_A(x)$*)*,

(iv) $\nu_A(x-y) \leq \{\nu_A(x) \vee \nu_A(y)\}$,

(v) $\nu_A(y+x-y) \leq \nu_A(x)$,

(vi) $\nu_A(u\alpha(x+v) - u\alpha v) \leq \nu_A(x)$ *(resp.* $\nu_A(x\alpha u) \leq \nu_A(x)$*)*,

for all $x, y, u, v \in M$ *and* $\alpha \in X$.

Definition 2.12 (4)**.** *: Intuitionistic Fuzzy ideal* $P = \{\mu_P, \nu_P\}$ *of a ring R not necessarily non-constant is called Intuitionistic Fuzzy Prime Ideal, if for any intuitionistic fuzzy ideals* $A = \{\mu_A, \nu_A\}$ *and* $B = \{\mu_B, \nu_B\}$ *of R the condition* $AB \subset P$ *implies that either* $A \subset P$ *or* $B \subset P$.

Definition 2.13 (12)**.** *: Let R and* R' *be two rings, a mapping* $f : R \to R'$ *is called a Fuzzy Anti - Homomorphism, if* $f(\mu + \alpha) = f(\mu) + f(\alpha)$ *and* $f(\mu\alpha) = f(\mu)f(\alpha)$.

3. Anti-Homomorphisms on Intuitionistic Fuzzy Ideals of Rings

Definition 3.1. *Let R and R' be two rings, a mapping $f : R \to R'$ is called a Intuitionistic Fuzzy Anti - Homomorphisms, if*

(i) $f(\mu + \alpha) = f(\mu) + f(\alpha)$ *and* $f(\mu\alpha) = f(\mu)f(\alpha)$,

(ii) $f(\nu + \beta) = f(\nu) + f(\beta)$ *and* $f(\nu\beta) = f(\beta)f(\nu)$.

Proposition 3.1. *Let $f : R \to R'$ be a surjective anti-homomorphism, Let (μ', ν') be an intuitionistic fuzzy prime ideal of R', and then $f^{-1}(\mu, \nu)'$ is a fuzzy prime ideal of G.*

Proof. Let (μ_1, ν_1) and (μ_2, ν_2) be any two intuitionistic fuzzy ideals of R, such that

$$\mu_1\nu_1 \subset f^{-1}(\mu_1)'.$$

This implies that

$f(\mu_1, \nu_1) \subset ff^{-1}(\mu')\mu'$

$\Rightarrow f(\mu_2, \nu_2)f(\mu_1, \nu_1) \subseteq (\mu', \nu')$because f is an anti-homomorphism

$\Rightarrow f(\mu_2, \nu_2) \subset (\mu', \nu')$ or $f(\mu_1, \nu_1) \subset (\mu', \nu')$ because (μ', ν') is a intuitionistic fuzzy prime ideal of R'

$\Rightarrow f^{-1}(f(\mu_2, \nu_2)) \subset f^{-1}(\mu', \nu')$ or $f^{-1}(f(\mu_1, \nu_1)) \subset f^{-1}(\mu', \nu')$

$\Rightarrow (\mu_2, \nu_2) \subset f^{-1}(\mu', \nu')$ or $(\mu_1, \nu_1) \subset f^{-1}(\mu', \nu')$

$\Rightarrow f^{-1}(\mu', \nu')$ be an intuitionistic fuzzy prime ideal of R'. □

Proposition 3.2. *Let $f : R \to R'$ be an anti-homomorphism. Let (μ, ν) be any $f-$invariant intuitionistic fuzzy prime ideal of R, then $f(\mu, \nu)$ is a intuitionistic fuzzy prime ideal of R'.*

Proof. Let (μ_1, ν_1) and (μ_2, ν_2) be any two intuitionistic fuzzy ideals of R, such that

$(\mu_1, \nu_1)(\mu_2, \nu_2) \subset f(\mu, \nu)$

$\Rightarrow f^{-1}((\mu_1, \nu_1)(\mu_2, \nu_2)) \subset f^{-1}f(\mu, \nu) = (\mu, \nu)$

$\Rightarrow f^{-1}(\mu_1, \nu_1)f^{-1}(\mu_2, \nu_2) \subset (\mu, \nu)$

$\Rightarrow$either $f^{-1}(\mu_1, \nu_1) \subset (\mu, \nu)$ or $f^{-1}(\mu_2, \nu_2) \subset (\mu, \nu)$ since (μ, ν) is intuitionistic fuzzy prime ideal

$\Rightarrow ff^{-1}(\mu_2, \nu_2) \subset f(\mu, \nu)$ or $ff^{-1}(\mu_1, \nu_1) \subset f(\mu, \nu)$

$\Rightarrow (\mu_2, \nu_2) \subset f(\mu, \nu)$ or $(\mu_1, \nu_1) \subset f(\mu, \nu)$

$\Rightarrow f(\mu, \nu)$ is an intuitionistic fuzzy prime ideal of R. □

Proposition 3.3. *Let $f : R \to R'$ be a onto anti-homomorphism. If (μ, ν) is an $f-$invariant ideal of R and (μ, ν) intuitionistic fuzzy primary ideal of R, then $f(\mu, \nu)$ is a intuitionistic fuzzy primary ideal of R'.*

Proof. Let (μ_1, ν_1) and (μ_2, ν_2) be any two intuitionistic fuzzy ideals of R, such that $\mu_2, \nu_2 \subset \sqrt{f(\mu, \nu)}$ with $\mu_1, \nu_1 \not\subset f(\mu, \nu)$

$\Rightarrow \mu_2, \nu_2 \subset \sqrt{f(\mu, \nu)}$
$\Rightarrow f^{-1}((\mu_1, \nu_1)(\mu_2, \nu_2)) \subset f\sqrt{f(\mu, \nu)}(\mu_1, \nu_1)$
$\Rightarrow \sqrt{f^{-1}}f(\mu, \nu) = \sqrt{(\mu, \nu)}$ with $f^{-1}(\mu_1, \nu_1)f^{-1}f(\mu, \nu) = (\mu, \nu)$

This implies that

$f^{-1}(\mu_2, \nu_2)f^{-1}(\mu_1, \nu_1) \subset \sqrt{(\mu, \nu)}$ and $f^{-1}(\mu_1, \nu_1)$ not subset of (μ, ν) because f is anti-homomorphism
$\Rightarrow f^{-1}(\mu_2, \nu_2) \subset \sqrt{(\mu, \nu)}$
$\Rightarrow (\mu_2, \nu_2) \subset ff^{-1}(\mu_2, \nu_2) \subset f(\sqrt{(\mu, \nu)})$
$\Rightarrow \sqrt{f(\mu, \nu)}$.

Therefore $f(\mu, \nu)$ is a fuzzy primary ideal of R'. □

4. Conclusion

We have introduced a new concept of anti-homomorphism between two Intuitionistic fuzzy rings R and R' and established some of their properties. To extend this work, one can investigate the other anti-homomorphism properties.

References

[1] Atanassov, K.T. (1986), Intuitionistic Fuzzy sets, *Fuzzy sets and Systems* **20**, 87 – 96.

[2] Bakhadach, I., Melliani, S., Oukessou, M. and Chadli, L.S. (2016), Intuitionistic fuzzy ideal and intuitionistic fuzzy prime ideal in a ring, *Notes on Intuitionistic Fuzzy Sets* **22** (2), 59 – 63.

[3] Chandrasekhara Rao, K. and Swaminathan, V. (2006), anti-homomorphism in Near rings, *Jr of Inst.of maths and computer sciences (math.ser)* **12** (2), 83 – 88.

[4] Hur, K., Jang, S. Y. and Kang, H. W. (2005), Intuitionistic fuzzy ideal of a ring, *J. Korea Soc. Math. Educ. Ser. B: Pur Appl. Math.* **1** (12), 19 – 27.

[5] Kumbhojkar, H.V. and Bapat, M.S. (1991), not-so-fuzzy ideals, *Fuzzy sets and systems* **37**, 237 – 243.

[6] Kumbhojkar, H.V. and Bapat, M.S. (1991), Correspondence theorem for fuzzy ideals, *Fuzzy sets and systems* **41**, 213 – 219.

[7] Kumbhojkar, H.V. and Bapat, M.S. (1993), On semi prime fuzzy ideals, *Fuzzy sets and systems* **60**, 219 – 223.

[8] Olson, D.M. (1978), On the homomorphism for hemi rings, *IJMMS* **1**, 439 – 445.

[9] Palaniappan, N. and Arjunan, K. (2006), The homomorphism, anti-homomorphism of a fuzzy and anti fuzzy ideals, *Varahmihir Journal of Mathematical Sciences* **6** (1), 181 – 188.

[10] Sasireka, K.R. (2017), Anti-homomorphism of an intuitionistic fuzzy l-ring ideals, *International Journal of Mathematics Trends and Technology* **52** (7), 479 – 489.

[11] Sharma, P.K. (2011), Homomorphism of Intuitionistic Fuzzy Groups, *International Mathematical Forum* **6** (64), 3169 – 3178.

[12] Sheikabdullah, A. and Jeyaraman, K. (2010), Anti-Homomorphisms in Fuzzy Ideals of Rings, *Int. J. Contemp. Math. Sciences* **5** (55), 2717 – 2721.

[13] Sheikabdullah, A. and Jeyaraman, K. (2010), Anti-Homomorphisms in Fuzzy sub Groups, *International Journal of Computer Applications* **12** (8), 24 – 27.

[14] Vasantha Kandasamy, W.B. (2003), *Smarandache fuzzy algebra*, American research press, Rehoboth.

[15] Zadeh, L.A. (1965), Fuzzy sets, *Information and control*, **8**, 338 – 353.

[16] Zhan Jianming and Ma Xueling (2004), Intuitionistic fuzzy ideals of near-rings, *Scientae Math Japonicae* **61** (2), 219 – 223.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 74 – 81

http://www.islamiahcollege.edu.in

A STUDY ON GENERALIZED RELIABILITY MODELS

A. Mohammed Nizam Aalam

PG & Research Department of Mathematics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

We investigate in this paper systems reliability analysis using shock models. Two known modeling approaches are considered: the first one is a mixed shock model and the second one is based on mixed degradation and shocks. We generalize each of these two models considering a vulnerability level, $L(t)$, which is a shock magnitude under which a shock has no effect on the system degradation process. A preventive maintenance policy is proposed for systems subject to mixed degradation and shocks. A mathematical model is developed in order to determine simultaneously the optimal age T* and the optimal number of shocks N* at which a preventive maintenance action should be undertaken (whichever comes first), minimizing the average long-run maintenance cost per time unit.

Keywords: Competing Failures, Degradation, Preventive Maintenance, Reliability, Shocks.

1. Model 1: Generalized Mixed Shock Model

Generally shocks occurrences over time are modeled according to a Poisson process. We distinguish two kinds of Poisson processes:

(A) Shocks follow a homogeneous Poisson process (HPP) when the times between successive shocks are distributed exponentially and have a memoryless property. In other words, shocks are generated randomly and uniformly in time (i.e. the time from any time t to the next shock is independent of time t). Shocks occur with a stationary rate λ. Let $N(t)$ denote the number of random shocks until time t. Then the probability $H_i(t)$ that shocks occur exactly i times in time interval $(0, t]$ is given by:

$$\begin{aligned} H_i(t) &= P[N(t) = i] \\ &= \frac{(\lambda t)^i e^{-\lambda t}}{i!} \end{aligned} \tag{1.1}$$

(B) Shocks follow a non-homogeneous Poisson Process (NHPP) when shocks arrival is not stationary. In such situations, if $\Lambda(t)$ stands for the shocks occurrence rate, then the probability $H_i(t)$ that shocks occur exactly i times in time interval $(0, t]$ is given by:

$$H_i(t) = \frac{(\Lambda(t))^i e^{-\Lambda(t)}}{i!} \quad \text{where} \quad \Lambda(t) = \int_0^t \lambda(u)du \tag{1.2}$$

If shocks occur at times $T_l, T_2, \ldots$, according to NHPP, then the probability that more than $(i + 1)$ shocks occur during $(0, t]$ is:

$$P\left[T_{i+1} \leq t\right] \quad = \int_0^t H_i(u)\lambda(u)du = \sum_{j=i+1}^{\infty} H_j(t) \tag{1.3}$$

In this paper, we consider a system subject to shocks which occur at times T_j ($j = 1, 2, \ldots$). The shock magnitudes are denoted by W_i. They are assumed to be random variables, sindependent, and identically distributed with a common distribution G_W where $G_W(0) = 0$.

In order to express the system reliability function, the mixed shock model that is considered here is based on the one which combines the extreme shock and the cumulative shock models with cumulative degradation due only to shocks. Failures occur following an extreme shock whose magnitude is higher that a given critical level U (extreme shock model), or whenever cumulative damage exceeds a given degradation level threshold. The total degradation is assumed to be accumulating through shocks whose magnitude is between zero and U (cumulative shock model). In fact, this assumption is not always true. In many situations, shocks with small magnitude (minor shocks) may have no effect on the degradation process. Hence, we introduce a vulnerability level, L, below which shocks have no effect on the system degradation process; they will be called minor shocks.

Both levels L and U are either independent of time t or decreasing with respect to operating time (or number of shocks). Keeping them constant means that the system can recover from the consequences of a previous shock (i.e. the mean inter-arrival time of shocks is much larger than the mean time of recovery). In case extreme shock and cumulative shock provoke an increase in the probability of system failure, $L(t)$ and $U(t)$ are considered as decreasing with time (or number of shocks). This is usually the case for many machines and equipment. In this work, we consider the general case ($L(t)$ and $U(t)$: constant or decreasing functions).

Our proposed generalized mixed shock model will combine three major types of shocks - namely extreme shock, cumulative shock and minor shock. System failure occurs due to an extreme shock whose magnitude exceeds some given critical level $U(t)$, whereas cumulative shock causes a cumulative damage to system only in case the shock magnitude is higher than the vulnerability level $L(t)$ and lower than the critical level $U(t)$. Failures due to cumulative shocks occur whenever the cumulative damage

exceeds a certain threshold level D. Minor shocks (whose magnitude is lower than the vulnerability level $L(t)$) do not cause any damage to the system.

The proposed generalized mixed shock model is summarized as follows considering a given shock of magnitude W_i occurring at time T_i :

E.1 $U(T_i) \leq W_i$ the shock causes immediate failure of the system

E.2 $L(T_i) \leq W_i < U(T_i)$ the shock occurrence accelerates the degradation process causing additional damage $X_s(T_i)$

E.3 $W_i < L(T_i)$ the shock has no effect on the system degradation process (minor shock). Events E.1, E.2 and E.3 are mutually exclusive.

We consider the following binary variable:

$$I_{(T_i,L,U)} = \begin{cases} 1 & \text{if } L(T_i) \leq W_i < U(T_i) \\ 0 & \text{if } W_i < L(T_i) \end{cases} \qquad i = 0, 1, 2, \ldots \tag{1.4}$$

where $T_0 = 0$ and $\mathrm{I}_{(T_0,L,U)} = 0$

Suppose i shocks occur before time t, the probability that the intensities of each of these shocks are between $L(t)$ and $U(t)$ is given by:

$$\begin{aligned} P_{U,L}(t) &= P\left[L(t) \leq W_1 < U(t), L(t) \leq W_2 < U(t), \ldots, L(t) \leq W_i < U(t)\right] \\ &= \int_{L(t)}^{U(t)} dG_W^i(z) \\ &= G_W^i(U(t)) - G_W^i(L(t)). \end{aligned} \tag{1.5}$$

The cumulative damage due to random shocks by time t is given as:

$$X(t) = \sum_{i=0}^{N(t)} X_s(T_i)\, I_{(T_i,L,U)}. \tag{1.6}$$

Hence, the survival distribution of the system can be expressed as follows:

$$\begin{aligned} R_1(D,t) &= P[X(t) < D] \\ &= \sum_{i=0}^{\infty} P\left[\sum_{j=0}^{N(t)} X_s\left(T_j\right) I_{\left(T_j,L,U\right)} < D \mid N(t) = i\right] \times \mathrm{P[N(t) = i]} \\ &= \sum_{i=0}^{\infty} P\left[\sum_{j=0}^{N(t)} X_s\left(T_j\right) < D; I_{\left(T_j,L,U\right)} = 1 \mid N(t) = i\right] \times \mathrm{P[N(t) = i]} \end{aligned} \tag{1.7}$$

Yielding:

$$R_1(D,t) = H_0(t) + \sum_{i=1}^{\infty} H_i(t) G_s^{(i)}(D) \int_{L(t)}^{U(t)} dG_W^i(z) \tag{1.8}$$

where $G_s(x)$ is the Cumulative distribution function (Cdf) of $X_s(t)$ and $G_s^{(j)}(x)$ $(j = 1, 2, \cdots)$ denotes the j -fold Stieltjes convolution of any distribution $G_s(x)$ with itself; $G_s^{(0)}(x) = 1$ for $x \geq 0$.

2. Model 2: Generalized Mixed Degradation and Shock Model

In this section, we extend the generalized mixed shock model presented in previous section considering that cumulative degradation is due not only to shocks but also to internal factors. Thus, the overall damage of the system is cumulative. It is caused by (*i*) internal degradation through a random process function, $X_d(t)$ which represents the deterioration of the system corresponding to working time and (ii) external random shocks inducing cumulative damage expressed by $X_s(T_i), i = 0, 1, 2, \ldots$.

The cumulative degradation is expressed as:

$$X(t) = X_d(t) + \sum_{j=0}^{N(t)} X_s\left(T_j\right) I_{(T,L,U)}. \tag{2.1}$$

Therefore, the system reliability at time t for a given threshold level D of cumulative damage is given by:

$$\begin{aligned}
R_2(D,t) &= P[X(t) < D] \\
&= \sum_{i=0}^{\infty} P\left[\left(X_d(t) + \sum_{j=0}^{N(t)} X_s\left(T_j\right) I_{\left(T_j,L,U\right)}\right) < D \mid N(t) = i \times P[N(t) = i]\right] \\
&= \sum_{i=0}^{\infty} P\left[X_d(t) < D; I_{(T_i,L,U)} = 0; W_1 < L(t), W_2 < L(t), \ldots, W_i < L(t) \mid N(t) = i\right] \\
&\quad \times P[N(t) = i] \\
&\quad + \sum_{i=1}^{\infty} P\left[\left(X_d(t) + \sum_{j=0}^{N(t)} X_s\left(T_j\right)\right) < D;\ L(t) \le W_1 < U(t), L(t) \le W_2 < U(t), \ldots,\right. \\
&\quad \left. L(t) \le W_i < U(t) \mid N(t) = i \times P[N(t) = i\right]
\end{aligned} \tag{2.2}$$

which yields the following expression:

$$\begin{aligned}
R_2(D,t) = H_0(t)F_d(D,t) &+ \sum_{i=1}^{\infty} H_i(t)F_d(D,t)G_W^i(L(t)) \\
&+ \sum_{i=1}^{\infty} H_i(t) \int_0^D F_d(D-u,t)dG_s^{(i)}(u) \int_{L(t)}^{U(t)} dG_W^i(z)
\end{aligned} \tag{2.3}$$

where $F_d(x,t)$ is the Cdf of $X_d(t)$.

It is interesting to note that the two proposed reliability models are a generalization of several past studies. For instance in case $L(t) = 0$ and $U(t) = U$ (constant and finite):

models 1 and 2 are reduced to two types of dependent failure processes i.e. cumulative shock and extreme shock model. Hence, we obtain the following results as obtained by:

$$R_1(D,t) = H_0(t) + \sum_{i=1}^{\infty} H_i(t) G_s^{(i)}(D) G_W^i(U) \tag{2.4}$$

$$R_2(D,t) = H_0(t) F_d(D,t) \sum_{i=1}^{\infty} H_i(t) \int_0^D F_d(D-u,t) dG_s^{(i)}(u) G_W^i(U). \tag{2.5}$$

3. Maintenance Policy

In this section, we propose a preventive maintenance policy for a system subject to the generalized mixed degradation and shock model considering three types of shocks. Minor Shocks with a relatively low magnitude ($W_i < L(T_i)$) have no effect on the system, shocks with a high level of magnitude ($U(T_i) \leq W_i$) (extreme shocks) cause immediate failure, and shocks with an intermediate magnitude level ($L(T_i) \leq W_i < U(T_i)$) accelerate the degradation process by some amount $X_s(T_i)$. The cumulative damage is due to internal degradation and external random shocks.

The considered system experiences two competing dependent failure modes: type-I failure and type-II failure. Type-I failure occurs when cumulative degradation exceeds a given threshold level D. Type-II failure occurs due an extreme shock. The system is replaced preventively before failure at an age T (type-I PM action), or after having been subject to a number of shocks N (type-II PM action), whichever occurs first.

Hence, the proposed maintenance policy preconizes the following maintenance actions:

- Type-I and type-II PM actions: carried out at age T and at shock number N, respectively;
- Type-I corrective maintenance CM action: performed whenever the total damage exceeds a threshold level D.
- Type-II CM action: carried out in case one shock's magnitude exceeds the critical level U.

Working Assumptions:

- Random shocks occur according to a Poisson process.
- Failures are self-announced and are immediately fixed.
- All maintenance actions renew or bring back the system to a state as good as new.
- Durations of maintenance actions are negligible.
- The costs of Type-I PM (C_T), Type-II PM (C_N), Type-I CM (C_D) and Type-II CM (C_U) are constant and known.

– The critical level, the vulnerability level and the degradation threshold level are constant.

Our objective is to determine simultaneously the optimal age T^*, as well as the number of shocks N^* to perform PM such as the average long-run maintenance cost rate is minimum. Using classical renewal arguments, the total average maintenance cost per time unit can be expressed over a renewal cycle S. In fact, as previously stated, the system is considered to be as good as new after all maintenance actions. Hence, the expression of the long-run average maintenance cost per time unit is given by:

$$EC(T,N) = \frac{E\left[C_{\text{Total}}\left(T,N\right)\right]}{E\left[T_S(T,N)\right]} \tag{3.1}$$

where $E\left[C_{\text{Total}}\right]$ represents the expected total maintenance cost incurred within a renewal cycle, and $E\left[T_S\right]$ is the mean operating time (average duration of a renewal cycle). The following analysis will lead to the expression of the average long-run maintenance cost per time unit.

3.1. Expected Total Cost within a Cycle

The expected total maintenance cost during a cycle $E\left[C_{\text{Total}}\right]$ can be expressed as follows:

$$E\left[C_{\text{Total}}\left(T,N\right)\right] = C_T P_T(N,T) + C_N P_N(N,T) + C_D P_D(N,T) + C_U P_U(N,T). \tag{3.2}$$

The four terms of the total maintenance cost correspond respectively to type-I PM, type-II PM, type-I CM and type-II CM costs during a renewal cycle. Analytical expressions of each of these different components are developed below.

The probability P_T of having a type-I PM (at age T) is expressed as follows:

$$\begin{aligned} P_T(T,N) =& P\left[\left(X_d(T) + \sum_{i=0}^{N(T)} X_s\left(T_i\right) \mathrm{I}_{(T_i,L,U)}\right) < D; W_1 < U, W_2 < U, \ldots, W_i < U; N(T) < N\right] \\ =& \sum_{i=1}^{N-1} H_i(T) \int_0^D F_d(D-u,T) dG_s^{(i)}(u) \int_L^U dG_W^i(z) + \sum_{i=0}^{N-1} H_i(T) F_d(D,T) G_W^i(L). \end{aligned} \tag{3.3}$$

The probability P_N of having a type-II PM (after N successive shocks) is given by:

$$\begin{aligned} P_N(T,N) =& P\left[\left(X_d(T) + \sum_{i=0}^{N} X_s\left(T_i\right) \mathrm{I}_{(T_i,L,U)}\right) < D;\ W_1 < U, W_2 < U, \ldots, W_N < U; T_N \leq T\right] \\ =& \int_0^T H_{N-1}(t)\lambda(t)dt \int_0^D F_d(D-u,T) dG_s^{(N)}(u) \int_L^U dG_W^N(z) \\ &+ \int_0^T H_{N-1}(t)\lambda(t)dt F_d(D,T) G_W^N(L) \end{aligned} \tag{3.4}$$

The probability P_D of having a type-I CM (an exceeding of threshold level D of cumulative degradation) is given by.

$$\begin{aligned} P_D(T,N) &= P\left[\left(X_d(T)+\sum_{i=0}^{j}X_s(T_i)\,\mathrm{I}_{(T_i,L,U)}\right)<D;\ \left(X_d(T)+\sum_{i=0}^{j+1}X_s(T_i)\,\mathrm{I}_{(T_i,L,U)}\right)\geq D;\right. \\ &\qquad \left. W_1<U, W_2<U,\ldots,W_{j+1}<U; j+1\leq N; T_{j+1}\leq T\right] \\ &= 1-F_d(D,T)+\sum_{i=0}^{N-1}\int_0^T H_i(t)\lambda(t)dtF_d(D,T)\begin{bmatrix} G_W^i(L)G_W(U) \\ -G_W^{i+1}(L)\end{bmatrix} \\ &\quad +\sum_{i=0}^{N-1}\int_0^T H_i(t)\lambda(t)dt\begin{bmatrix} \int_0^D F_d(D-u,T)dG_s^{(i)}(u) \\ \int_L^U dG_W^i(z)G_W(U) \\ -\int_0^D F_d(D-u,T)dG_s^{(i+1)}(u) \\ \int_L^U dG_W^{i+1}(z)\end{bmatrix} \end{aligned} \tag{3.5}$$

The probability P_U of having type-II CM (extreme shock) is given by:

$$\begin{aligned} P_U(T,N) &= P\left[\left(X_d(T)+\sum_{i=0}^{j}X_s(T_i)\,\mathrm{I}_{(T_i,L,U)}\right)<D\ W_1<U, W_2<U,\ldots,W_j<U,\right. \\ &\qquad \left. W_{j+1}\geq U\, j+1\leq N; T_{j+1}\leq T\right] \\ &= \sum_{i=1}^{N-1}\int_0^T H_i(t)\lambda(t)dt\int_0^D F_d(D-u,T)dG_s^{(i)}(u)\times\int_L^U dG_W^i(z)\int_U^\infty dG_W(y) \\ &\quad +\sum_{i=0}^{N-1}\int_0^T H_i(t)\lambda(t)dtF_d(D,T)G_W^i(L)\int_U^\infty dG_W(y) \end{aligned} \tag{3.6}$$

4. Conclusion

In this paper, we discussed about the two models namely, Generalized Mixed Shock Model and Generalized Mixed Degradation And Shock Model.

References

[1] Chelbi, A. and Ait-Kadi, D. (2000), Generalized Inspection Strategy for Randomly Failing Systems Subjected to Random Shocks, *International Journal of Production Economics*, **64**, 379 – 384.

[2] Gut, A. (1990), Cumulative shock models, *Advances in Applied Probability*, **22**, 504 – 507.

[3] Li, Z.H. and Kong, X.B. (2007), Life behavior of d-shock model, *Statistics & Probability Letters*, **77**, 577 – 587.

[4] Mallor, F. and Omey, E. (2001), Shocks, runs and random sums, *Journal of Applied Probability*, **38**, 438 – 448.

[5] Nakagawa, T. (1976), On a replacement problem of a cumulative damage model, *Operational Research Quarterly*, 895 – 900.

[6] Tanner, D.M. and Dugger, M.T. (2003), Wear mechanisms in a reliability methodology, *Proceedings of the Society of Photo-optical Instrumentation Engineers*, **4980**, 22 – 40.

[7] Wang, G.J. and Zhang Y.L. (2001), δ-shock model and its optimal replacement policy, *Journal of Southeast University*, **31**, 121 – 124.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 82 – 89

http://www.islamiahcollege.edu.in

A STUDY ON MAXIMAL REGULARITY FOR STOCHASTIC EVOLUTION EQUATIONS

S. Palani

PG & Research Department of Mathematics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

We unify and extend the semigroup and the PDE approaches to stochastic maximal regularity of time-dependent semilinear parabolic problems with noise given by a cylindrical Brownian motion. We treat random coefficients that are only progressively measurable in the time variable. For linear second order equations in divergence form with random coefficients that are merely measurable in both space and time.

Keywords: Stochastic PDEs, Maximal regularity, Measurable coefficients.

1. Introduction

In this paper we consider the semilinear stochastic evolution equation

$$\begin{cases} dU(t) + A(t)U(t)dt = F(t, U(t))dt + \big(B(t)U(t) + G(t, U(t))\big)dW_H(t), \\ U(0) = u_0. \end{cases} \tag{1.1}$$

Here $A(t)$ and $B(t)$ are linear operators which are (t, ω)-dependent. The functions F and G are nonlinear perturbations.

We introduce the definitions of maximal L^p-regularity for deterministic equations and stochastic equations respectively. This extends well-known notions to the (t, ω)-dependent setting. Moreover, we allow weights in time. Also we present a way to reduce the problem with time-dependent operators to the time-independent setting. We show that if one has maximal L^p-regularity, then this implies well-posedness of semilinear initial value problems. Finally we explain a setting in which one can reduce to the case $B = 0$.

2. The Deterministic Case

Consider the following hypotheses.

Assumption 2.1. Let X_0 and X_1 be Banach spaces such that $X_1 \hookrightarrow X_0$ is dense. Let $X_\theta = [X_0, X_1]_\theta$ and $X_{\theta,p} = (X_0, X_1)_{\theta,p}$ denote the complex and real interpolation spaces at $\theta \in (0,1)$ and $p \in [1,\infty]$, respectively.

For $f \in L^1(I; X_0)$ with $I = (0,T)$ and $T \in (0,\infty]$ we consider:

$$\begin{cases} u'(t) + A(t)u(t) = f(t), & t \in I \\ u(0) = 0. \end{cases} \tag{2.1}$$

We say that u is a strong solution of (2.1) if for any finite interval $J \subseteq I$ we have $u \in L^1(J; X_1)$ and

$$u(t) + \int_0^t A(s)u(s)ds = \int_0^t f(s)ds, \quad t \in \overline{J}, \tag{2.2}$$

Note that this identity yields that $u \in W^{1,1}(J; X_0)$ and $u \in C(\overline{J}; X_0)$ for bounded $J \subseteq I$.

Definition 2.1. *(Deterministic maximal regularity) Let Assumption 2.1 be satisfied and assume that $A : [s,\infty) \to \mathcal{L}(X_1, X_0)$ is strongly measurable and $\sup_{t\in\mathbb{R}} \|A(t)\|_{\mathcal{L}(X_1,X_0)} < \infty$. Let $p \in (1,\infty), \alpha \in (-1, p-1), T \in (0,\infty]$, and set $I = (0,T)$. We say that $A \in \mathrm{DMR}(p,\alpha,T)$ if for all $f \in L^p(I, w_\alpha; X_0)$, there exists a strong solution*

$$u \in W^{1,p}(I, w_\alpha; X_0) \cap L^p(I, w_\alpha; X_1)$$

of (2.1) and

$$\|u\|_{W^{1,p}(I,w_\alpha;X_0)} + \|u\|_{L^p(I,w_\alpha;X_1)} \le C\|f\|_{L^p(I,w_\alpha;X_0)}. \tag{2.3}$$

In (2.2) we use the continuous version of $u : \overline{I} \to X_0$ and for $\alpha \in [0, p-1)$ we have

$$u \in C_{ub}(\overline{I}; X_{1-\frac{1+\alpha}{p},p}) \text{ and } u \in C_{ub}([\varepsilon,T]; X_{1-\frac{1}{p},p}), \quad \varepsilon \in (0,T).$$

If $\alpha \in (-1,0)$ the first assertion does not hold, but the second one holds on $[0,T]$ if $T < \infty$.

3. Hypothesis on A and B and the Definition of SMR

Consider the following hypotheses.

Assumption 3.1. Let H be a separable Hilbert space. Assume X_0 and X_1 are UMD spaces with type 2. Let $A : \mathbb{R}_+ \times \Omega \to \mathcal{L}(X_1, X_0)$ be strongly progressively measurable and

$$C_A := \sup_{t\in\mathbb{R},\omega\in\Omega} \|A(t,\omega)\|_{\mathcal{L}(X_1,X_0)} < \infty.$$

Let $B : \mathbb{R}_+ \times \Omega \to \mathcal{L}(X_1, \mathcal{L}(H, X_{\frac{1}{2}}))$ be such that for all $x \in X_1$ and $h \in H, (Bx)h$ is strongly progressively measurable and assume there is a constant C such that

$$C_B := \sup_{t\in\mathbb{R},\omega\in\Omega} \|B(t,\omega)\|_{\mathcal{L}(X_1,\mathcal{L}(H,X_{\frac{1}{2}}))} < \infty.$$

For $f \in L^1(I; X_0)$ and $g \in L^2(I; \gamma(H, X_{\frac{1}{2}}))$ with $I = (0, T)$ and $T \in (0, \infty]$ we consider:

$$\begin{cases} dU(t) + A(t)U(t)dt = f(t)dt + \big(B(t)U(t) + g(t)\big)dW_H(t), \\ U(0) = 0. \end{cases} \tag{3.1}$$

We say that U is a strong solution of (1.1) if for any finite interval $J \subseteq I$ we have $U \in L^0_{\mathcal{F}}(\Omega; L^2(J; \gamma(H, X_1)))$ and almost surely for all $t \in I$,

$$U(t) + \int_0^t A(s)U(s)ds = \int_0^t f(s)ds + \int_0^t \Big(g(s) + B(s)U(s)\Big)dW_H(s), \tag{3.2}$$

The above stochastic integrals are well-defined by (**??**). Identity (3.2) yields that U has paths in $C(\overline{J}; X_0)$ for bounded $J \subseteq I$.

Definition 3.1. *(Stochastic maximal regularity) Suppose Assumptions 2.1 and 3.1 hold. Let $p \in [2, \infty), \alpha \in (-1, \frac{p}{2} - 1)$($\alpha = 0$ is included if $p = 2$), $T \in (0, \infty]$, and set $I = (0, T)$. We say that $(A, B) \in \mathrm{SMR}(p, \alpha, T)$ if for all $f \in L^p_{\mathcal{F}}(\Omega \times I, w_\alpha; X_0)$ all $g \in L^p_{\mathcal{F}}(\Omega \times I, w_\alpha; \gamma(H, X_{\frac{1}{2}}))$, there exists a strong solution*

$$U \in \bigcap_{\theta\in[0,\frac{1}{2})} L^p(\Omega; H^{\theta,p}(I, w_\alpha; X_{1-\theta}))$$

of (3.1) and for each $\theta \in [0, \frac{1}{2})$ there is a constant C_θ such that

$$\|U\|_{L^p(\Omega;H^{\theta,p}(I,w_\alpha;X_{1-\theta}))} \le C_\theta \|f\|_{L^p(\Omega\times I,w_\alpha;X_0)} + C_\theta \|g\|_{L^p(\Omega\times I,w_\alpha;\gamma(H,X_{\frac{1}{2}}))}. \tag{3.3}$$

In the case $B = 0$ we write $A \in \mathrm{SMR}(p, \alpha, T)$ instead of $(A, 0) \in \mathrm{SMR}\,(p, \alpha, T)$

In the above we use a pathwise continuous version of $U : \Omega \times \overline{I} \to X_0$ and if $\alpha \in [0, \frac{p}{2} - 1)$ we even have

$$U \in L^p(\Omega; C(\overline{I}; X_{1-\frac{\alpha+1}{p},p})) \text{ and } U \in L^p(\Omega; C([\varepsilon, T]; X_{1-\frac{\alpha+1}{p},p})).$$

If $\alpha \in (-1, 0)$ the first assertion does not hold, but the second one holds on $[0, T]$ if $T < \infty$.

A variant of Remark holds for SMR. In particular, any of the estimates (3.3) implies uniqueness.

Proposition 3.1. *Suppose Assumption 2.1 is satisfied and assume X_0 is a UMD space. Assume $A \in \mathcal{L}(X_1, X_0)$.*

If A has a bounded $H^\infty-$ calculus of angle $< \pi/2$ and $0 \in \rho(A)$, then $A \in$ $\mathrm{DMR}\,(p, \alpha, T)$ for all $p \in (1, \infty), \alpha \in (-1, p-1)$ and $T \in (0, \infty]$.

In the time-independent setting the next result follows for $\alpha = 0$. The case $\alpha \neq 0$ was obtained by a perturbation argument.

Proposition 3.2. *Suppose Assumption 2.1 is satisfied. Assume $A \in \mathcal{L}(X_1, X_0)$. Let X_0 be isomorphic to a 2-convex Banach function space such that $(X_0^{1/2})^*$ has the Hardy-Littlewood property (e.g. $X_0 = L^q(O; \ell^2)$, where and $q \in [2, \infty)$).*

If A has a bounded H^∞-calculus of angle $< \pi/2$ and $0 \in \rho(A)$, then $A \in$ $\mathrm{SMR}(p, \alpha, T)$ for all $p \in (2, \infty), \alpha \in (-1, \frac{p}{2} - 1)$ and $T \in (0, \infty]$. Moreover, if X_0 is a Hilbert space, then the result in the case $(p, \alpha) = (2, 0)$ holds as well.

4. SMR for Time-Dependent Problems

The next result is a useful tool to derive $A \in \mathrm{SMR}$ from $A \in \mathrm{DMR}$ and $A_0 \in \mathrm{SMR}$ for a certain reference operator A_0 which one is free to choose. It extends the case with $A_0 = -\Delta$ on $X_0 = L^p$ with $\alpha = 0$ was considered and where $A(t)$ was a second order operator.

Theorem 4.1. *Suppose Assumptions 2.1 and 3.1 hold. Let $p \in [2, \infty), \alpha \in (-1, \frac{p}{2} - 1)$($\alpha = 0$ if $p = 2$ is allowed as well) and $T \in (0, \infty)$.*

(i) There exists a sectorial operator $-A_0$ with $D(A_0) = X_1$, and $X_{\frac{1}{2}} = D((\lambda + A_0)^{1/2})$ such that $A_0 \in \mathrm{SMR}(p, \alpha, T)$.

(ii) Assume that there is a $C > 0$ such that for all $\omega \in \Omega, A(\cdot, \omega) \in \mathrm{DMR}(p, \alpha, T)$ and (2.3) holds with constant C.

Then $A \in \mathrm{SMR}(p, \alpha, T)$.

Proof. In the proof we write

$$\mathrm{MR}_T := W^{1,p}((0, T), w_\alpha; X_0) \cap L^p((0, T), w_\alpha; X_1)$$

which we turn into a Banach space by using the sum norm.

Step 1: Progressive measurability and estimates for the deterministic part

Consider the mapping $\Lambda_T : \Omega \to \mathcal{L}(\mathrm{MR}_T, L^p(0,T,w_\alpha;X_0))$ given by $\Lambda_T(\omega) = d/dt + A(\cdot,\omega)$. Then Λ_T is strongly $\mathcal{F}_T$-measurable and each $\Lambda_T(\omega)$ is invertible. It is well-known that its inverse mapping $\omega \mapsto \Lambda_T(\omega)^{-1}$ is strongly $\mathcal{F}_T$-measurable as well. For convenience we include a short argument for this special case. Fix $\omega_0 \in \Omega$. Now $\omega \mapsto \Lambda_T(\omega)\Lambda_T(\omega_0)^{-1} \in \mathcal{L}(\mathrm{MR}_T)$ is strongly $\mathcal{F}_T$-measurable and takes values in the invertible operators. Since taking inverses is a continuous mapping on the open set of invertible mappings it follows that $\omega \mapsto \Lambda_T(\omega_0)\Lambda_T(\omega)^{-1}$ is strongly $\mathcal{F}_T$-measurable as well. Clearly, the above holds with T replaced by any $t \in (0,T]$ as well.

Now for $f \in L^p_{\mathcal{F}}(\Omega \times I; X_0)$, consider the problem

$$u' = A(t)u + f, \quad u(0) = 0.$$

The solution is given by $u(\cdot,\omega) = \Lambda_T(\omega)^{-1} f(\cdot,\omega)$ and by (ii)

$$\|u(\cdot,\omega)\|_{\mathrm{MR}_T} \leq C_1 \|f(\cdot,\omega)\|_{L^p((0,T),w_\alpha;X_0)}.$$

Moreover, by the previous observations u is strongly $\mathcal{F}_T$-measurable (as an MR_T-valued mapping) and we can take $L^p(\Omega)$-norms in the previous estimate to obtain

$$\|u\|_{L^p(\Omega;\mathrm{MR}_T)} \leq C_1 \|f\|_{L^p(\Omega\times(0,T),w_\alpha;X_0)}. \tag{4.1}$$

In the same way one can see that u is progressively measurable. Indeed, for $t \in (0,T) f|_{[0,t]}$ is strongly $\mathcal{F}_t \times \mathcal{B}([0,t])$-measurable and hence $u|_{[0,t]} = \Lambda_t^{-1} f|_{[0,t]}$ is strongly $\mathcal{F}_t$-measurable. Also, we have that $u \in SMR_T$ and that, for all $\theta \in [0, \frac{1}{2})$, $\|U\|_{SMR_{T,\theta}} \lesssim \|f\|_{L^p(\Omega\times(0,T),w_\alpha;X_0)}$.

Step 2: Main step

It remains to prove existence and estimates in the space $\mathrm{SMR}_T := \bigcap_{\theta\in[0,\frac{1}{2})} \mathrm{SMR}_{T,\theta}$, where

$$\mathrm{SMR}_{T,\theta} := L^p(\Omega; H^{\theta,p}(I, w_\alpha; X_{1-\theta})).$$

Let $f \in L^p_{\mathcal{F}}(\Omega \times I, w_\alpha; X_0)$ and $g \in L^p_{\mathcal{F}}(\Omega \times I, w_\alpha; \gamma(H, X_{\frac{1}{2}}))$. In order to prove $A \in \mathrm{SMR}(p,\alpha,T)$ consider

$$dU + AUdt = fdt + gdW, \quad U(0) = 0. \tag{4.2}$$

We will build U from the solutions of two sub-problems.

Since $A_0 \in \mathrm{SMR}(p,\alpha,T)$ we can find $V_1 \in \mathrm{SMR}_T$ such that

$$dV_1 + A_0 V_1 dt = gdW, \quad V_1(0) = 0$$

and one has the estimate, for each $\theta \in [0, \frac{1}{2})$,

$$\|V_1\|_{\mathrm{SMR}_{T,\theta}} \leq C\|g\|_{L^p(\Omega\times I, w_\alpha; \gamma(H, X_{\frac{1}{2}}))}. \tag{4.3}$$

By Step 1 we can find $V_2 \in \mathrm{SMR}_T$ such that

$$V_2' + AV_2 = f + (A - A_0)V_1, \quad V_2(0) = 0$$

and by (4.1) and (4.3)

$$\begin{aligned}\|V_2\|_{\mathrm{SMR}_{T,\theta}} &\leq C\|f\|_{L^p(\Omega\times I, w_\alpha; X_0)} + C\|(A - A_0)V_1\|_{L^p(\Omega\times I, w_\alpha; X_0)} \\ &\leq C\|f\|_{L^p(\Omega\times I, w_\alpha; X_0)} + C\|g\|_{L^p(\Omega\times I, w_\alpha; \gamma(H, X_{\frac{1}{2}}))}.\end{aligned}$$

Now it is straightforward to check that $U = V_1 + V_2$ is a solution to (4.2) and combining the estimates for V_1 and V_2 we obtain $A \in \mathrm{SMR}(p,\alpha,T)$. □

The solvability of (3.1) with $B \neq 0$ can be a delicate matter. In particular it typically requires a stochastic parabolicity condition involving A and B. However, there are several situations where one can prove an a priori estimate and where for a simple related problem one can prove existence and uniqueness of a solution in $L^p_{\mathcal{F}}(\Omega; L^p(I, w_\alpha; X_1))$. These are the ingredients to apply the method of continuity to obtain existence and uniqueness of (3.1). This is a well-known method, which we present in an abstract setting in the proposition below. For convenience let

$$\begin{aligned}E_\theta &= L^p_{\mathcal{F}}(\Omega; H^{\theta,p}(I, w_\alpha; X_{1-\theta})), \\ Z_\theta &= L^p_{\mathcal{F}}(\Omega; L^p(I, w_\alpha; X_\theta)), \\ Z^\gamma_\theta &= L^p_{\mathcal{F}}(\Omega; L^p(I, w_\alpha; \gamma(H, X_\theta))),\end{aligned}$$

where $I = (0,T)$ with $T \in (0,\infty)$. The spaces Z_θ are the spaces in which the data is chosen. The spaces E_θ are the spaces in which the solution lives.

Proposition 4.1. *(Method of continuity) Suppose Assumptions 2.1 and 3.1 hold. Let* $p \in [2,\infty), \alpha \in [0, \frac{p}{2} - 1), \theta \in [0, \frac{1}{2})$, *and* $T \in (0,\infty)$, *and set* $I = (0,T)$. *Let* $\widetilde{A} \in \mathcal{L}(X_1, X_0)$ *be given. For* $\lambda \in [0,1]$ *let*

$$A_\lambda(t) = (1-\lambda)\widetilde{A} + \lambda A(t), \quad \textit{and} \quad B_\lambda(t) = \lambda B(t).$$

Consider the problem $U(0) = 0$ *and*

$$dU(t) + A_\lambda(t)U(t)dt = f(t)dt + \big(B_\lambda(t)U(t) + g(t)\big)dW_H(t). \tag{4.4}$$

(i) *Assume that there is a constant C such that, for all $\lambda \in [0,1]$, all $f \in Z_0$, and all $g \in Z^\gamma_{\frac{1}{2}}$, any strong solution to (4.4) $U \in E_\theta \cap E_0$ satisfies*

$$\|U\|_{E_\theta} + \|U\|_{E_0} \leq C(\|f\|_{Z_0} + \|g\|_{Z^\gamma_{\frac{1}{2}}}). \tag{4.5}$$

(ii) *Assume that, for all $f \in Z_0$ and all $g \in Z^\gamma_{\frac{1}{2}}$, there exists a strong solution $U \in E_\theta \cap E_0$ to (4.4) with $\lambda = 0$.*

Then for all $\lambda \in [0,1]$, all $f \in Z_0$, and all $g \in Z^\gamma_{\frac{1}{2}}$, there exists a unique strong solution $U \in E_\theta \cap E_0$ of (4.4), and it satisfies the estimate (4.5).

In particular, the above result implies that if $(\widetilde{A}, 0) \in \mathrm{SMR}(p, \alpha, T)$ and (i) holds for all $\theta \in [0, \frac{1}{2})$, then $(A, B) \in \mathrm{SMR}(p, \alpha, T)$. Note that in (i) we only assume that, as soon as a solution $U \in E_\theta \cap E_0$ to (4.4) exists, then (4.5) holds.

Proof. The proof is a generalization of a standard method. We include the details for completeness. Note that uniqueness follows from (4.5). Let $\Lambda \subseteq [0,1]$ be the set of all points λ such that for all $f \in Z_0$ and $g \in Z^\gamma_{\frac{1}{2}}$ (4.4) has a strong solution $U \in E_\theta$. It suffices to prove $1 \in \Lambda$. We claim that there exists an $\varepsilon > 0$ such that for every $\lambda_0 \in \Lambda$, $[\lambda_0 - \varepsilon, \lambda_0 + \varepsilon] \cap [0,1] \subseteq \Lambda$. Clearly, proving the claim would finish the proof.

To prove the claim let $\lambda_0 \in \Lambda$. Fix $\lambda \in [\lambda_0 - \varepsilon, \lambda_0 + \varepsilon] \cap [0,1]$, where $\varepsilon > 0$ is fixed for the moment. For $V \in E_\theta$, let $U \in E_\theta \cap E_0$ be the solution to

$$\begin{aligned} dU(t) + A_{\lambda_0}(t)U(t)dt = {} & [f(t) + (A_{\lambda_0}(t) - A_\lambda(t))V(t)]dt \\ & + [B_{\lambda_0}(t)U(t) + g(t) + (B_\lambda(t) - B_{\lambda_0}(t))V(t)]dW_H(t). \end{aligned}$$

In this case we write $L_\lambda(V) = U$. It is enough show that $L_\lambda : E_\theta \cap E_0 \to FF_\theta \cap E_0$ is a strict contraction. Indeed, then by the Banach fixed point theorem there exists a unique $U \in E_\theta \cap E_0$ such that $L_\lambda(U) = U$ and this clearly implies that U is a strong solution of (4.4). To prove that L is a strict contraction, let us note that for $V_1, V_2 \in E_\theta \cap E_0$ and $V = V_1 - V_2$, the process $U = L_\lambda(V_1) - L_\lambda(V_2)$ is a strong solution to

$$\begin{aligned} dU(t) + A_{\lambda_0}(t)U(t)dt = {} & (A_{\lambda_0} - A_\lambda(t))V(t)dt \\ & + [B_{\lambda_0}(t)U(t) + (B_\lambda(t) - B_{\lambda_0}(t))V(t)]dW_H(t). \end{aligned}$$

Therefore, by (4.5)

$$\begin{aligned} \|L_\lambda(V_1) - L_\lambda(V_2)\|_{E_\theta \cap E_0} &\leq C\|(A_{\lambda_0} - A_\lambda)V\|_{Z_0} + C\|(B_{\lambda_0} - B_\lambda)V\|_{Z^\gamma_{\frac{1}{2}}} \\ &\leq \widetilde{C}\varepsilon\|V_1 - V_2\|_{E_0} \leq \widetilde{C}\varepsilon\|V_1 - V_2\|_{E_{\theta \cap E_0}}, \end{aligned}$$

where $\widetilde{C} = C(C_A + \|\widetilde{A}\| + C_B)$. Here we used

$$\|(A_{\lambda_0} - A_\lambda)u\|_{X_0} \leq |\lambda_0 - \lambda|(C_A + \|\widetilde{A}\|)\|u\|_{X_1},$$
$$\|(B_{\lambda_0} - B_\lambda)u\|_{X_{\frac{1}{2}}} \leq |\lambda_0 - \lambda|C_B\|u\|_{X_1}.$$

Therefore, letting $\varepsilon = \dfrac{1}{2C(C_A + \|\widetilde{A}\| + C_B)}$ we see that L_λ is a strict contraction. □

5. Conclusion

In this paper we discussed about how to determine the case and Hypothesis on A and B and the definition of SMR.

References

[1] Auscher, P. and Axelsson, A. (2011), Weighted maximal regularity estimates and solvability of non-smooth elliptic systems I, *Invent. Math.* **184** (1), 47 – 115.

[2] Clément, Ph. and Li, S. (1993-1994), Abstract parabolic quasilinear equations and application to a groundwater flow problem, *Adv. Math. Sci. Appl.* **3** (Special Issue), 17 – 32.

[3] Dong, H. and Kim, D. (2018), On L_p-estimates for elliptic and parabolic equations with A_p weights, *Trans. Am. Math. Soc.* **370** (7), 5081 – 5130.

[4] Krylov, N.V. (2000), SPDEs in $L_q((0, \tau], L_p)$ spaces, *Electron. J. Probab.* **5** (Paper no. 13), 29 (electronic).

[5] Krylov, N.V. and Lototsky, S.V. (1999), A Sobolev space theory of SPDEs with constant coefficients in a half space, *SIAM J. Math. Anal.* **31** (1), 19 – 33.

[6] Mikulevicius, R. and Rozovskii, B. (2001), A note on Krylov's L_p-theory for systems of SPDEs, *Electron. J. Probab.* **6** (12), 35.

[7] Prüss, J. (2002), Maximal regularity for evolution equations in L_p-spaces, *Conf. Semin. Mat. Univ. Bari* **285** (2003), 1 – 39.

[8] Prüss, J. and Schnaubelt, R. (2001), Solvability and maximal regularity of parabolic evolution equations with coefficients continuous in time, *J. Math. Anal. Appl.* **256** (2), 405 – 430.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 90 – 98

http://www.islamiahcollege.edu.in

A STUDY ON STOCHASTIC COMPARISONS OF RANDOM LIFETIMES IN A REPLACEMENT MODEL

Zahiruddeen and C. Navaneedhan

PG & Research Department of Mathematics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

We consider a suitable replacement model for random lifetimes, in which at a fixed time an item is replaced by another one having the same age but different lifetime distribution. We focus first on stochastic comparisons between the involved random lifetimes, in order to assess conditions leading to an improvement of the system. Attention is also given to the relative ratio of improvement, which is proposed as a suitable index finalized to measure the goodness of the replacement procedure. Finally, we provide various results on the dynamic differential entropy of the lifetime of the improved system.

Keywords: Reliability; Stochastic Orders; Scale Family of Distributions; Proportional Hazard Rates; Differential Entropy.

1. Stochastic Comparisons

Definition 1.1. *Let X be an absolutely continuous random variable with support (l_X, u_X), CDFF, and PDFf. Similarly, let Y be an absolutely continuous random variable with support (l_Y, u_Y), CDF G, and PDFg. We say that X is smaller than Y in the*

(a) *usual stochastic order ($X \leq_{st} Y$) if $\bar{F}(t) \leq \bar{G}(t) \forall t \in \mathbb{R}$ or, equivalently, if $F(t) \geq G(t)$ $\forall t \in \mathbb{R}$;*

(b) *hazard rate order ($X \leq_{\text{hr}} Y$) if $\bar{G}(t)/\bar{F}(t)$ increases in $t \in (-\infty, \max(u_X, u_Y))$ or, equivalently, if $\lambda_X(t) \geq \lambda_Y(t)$ for all $t \in \mathbb{R}$, where $\lambda_X(t) = f(t)/\bar{F}(t)$ and $\lambda_Y(t) = g(t)/\bar{G}(t)$ are respectively the hazard rates of X and Y, or equivalently if $f(x)\bar{G}(y) \geq g(x)\bar{F}(y) \forall x \leq y$;*

(c) *likelihood ratio order* $(X \leq_{\text{lr}} Y)$ *if* $f(x)g(y) \geq f(y)g(x)$ *for all* $x \leq y$, *with* $x, y \in (l_X, u_X) \cup (l_Y, u_Y)$ *or equivalently,* $g(t)/f(t)$ *increases in* t *over the union of supports of* X *and* Y*;*

(d) *reversed hazard rate order* $(X \leq_{rh} Y)$ *if* $G(t)/F(t)$ *increases in* $t \in (\min(l_X, l_Y), +\infty)$ *or, equivalently, if* $\tau_X(t) \leq \tau_Y(t)$ *for all* $t \in \mathbb{R}$, *where* $\tau_X(t) = f(t)/F(t)$ *and* $\tau_Y(t) = g(t)/G(t)$ *are respectively the reversed hazard rates of* X *and* Y.

We recall the following relations among the above-mentioned stochastic orders:

$$X \leq_{1r} Y \Rightarrow X \leq_{\text{hr}} Y \Rightarrow X \leq_{\text{st}} Y, \quad X \leq_{\text{lr}} Y \Rightarrow X \leq_{\text{rh}} Y \Rightarrow X \leq_{\text{st}} Y \tag{1.1}$$

We now investigate the effect of the replacement when the lifetime of the first item is stochastically smaller than the second in the sense of the criteria given in Definition 1.1.

Theorem 1.1. *Let* X *and* Y *be absolutely continuous nonnegative random variables. Then,*

(i) $X \leq_{\text{hr}} Y \Rightarrow X \leq_{\text{hr}} X_t^Y \leq_{\text{hr}} Y \; \forall t > 0$

(ii) $X \leq_{\text{lr}} Y \Rightarrow X_t^Y \leq_{\text{lr}} Y \; \forall t > 0$

(iii) $X \leq_{\text{rh}} Y \Rightarrow X_t^Y \leq_{\text{rh}} Y \; \forall t > 0$

(iv) $X \leq_{\text{st}} Y \Leftrightarrow X_t^Y \leq_{\text{st}} Y \; \forall t > 0$

Proof. The hazard rate of X_t^Y is given by

$$\lambda_t^Y(x) = \frac{f_t^Y(x)}{\bar{F}_t^Y(x)} = \begin{cases} \lambda_X(x), & \text{if} \quad 0 \leq x \leq t \\ \lambda_Y(x), & \text{if} \quad x > t \end{cases} \tag{1.2}$$

We observe that, if $X \leq_{\text{hr}} Y$, from (1.2), we immediately deduce $\lambda_X(x) \geq \lambda_t^Y(x) \geq \lambda_Y(x)$ for all $x \geq 0$, and so we obtain $X \leq_{\text{hr}} X_t^Y \leq_{\text{hr}} Y \forall t > 0$
Now, by taking into account, we get

$$\frac{g(x)}{f_t^Y(x)} = \begin{cases} \dfrac{g(x)}{f(x)}, & \text{if } 0 \leq x \leq t \\ \bar{G}(t), & \text{if } x > t \end{cases}$$

Hence, since assumption $X \leq_{\text{lr}} Y$ implies that $g(x)/f(x)$ is increasing in $x > 0$, and that $\dfrac{g(t)}{f(t)} \leq \dfrac{\bar{G}(t)}{F(t)}$ for all $t > 0$ by the first of (1.1), we finally obtain $X_t^Y \leq_{\text{lr}} Y$, this completing the proof of (ii).

Note that

$$\frac{F_t^Y(x)}{G(x)} = \begin{cases} \dfrac{F(x)}{G(x)}, & \text{if } 0 \le x \le t \\ \dfrac{F(t)}{G(x)} + \dfrac{\bar{F}(t)}{G(t)} \dfrac{[G(x) - G(t)]}{G(x)}, & \text{if } x > t \end{cases}$$

Hence, for $0 \le x \le t$, we have that $F_t^Y(x)/G(x)$ is decreasing in x if and only if $X \le_{\text{rh}} Y$. Moreover $F_t^Y(x)/G(x)$ is continuous in $x = t$. Finally, it is not hard to see that the derivative of $F_t^Y(x)/G(x)$ is nonpositive if $G(t) \le F(t)$ for all $t \ge 0$, i.e., $X \le_{st} Y$, this being ensured by assumption $X \le_{\text{rh}} Y$. The proof of (iii) is thus completed.

The proof of (iv) can be easily checked, by seeing that $F_t^Y(x) \ge G(x)$ for all $x \ge 0$ and $t \ge 0$, if and only if assumption $X \le_{\text{st}} Y$ holds. □

Differently from case (i) of Theorem 1.1, condition $X \le_{\text{lr}} Y$ does not imply that $X \le_{\text{lr}} X_t^Y \forall t > 0$. This can be easily checked, for instance, when X and Y are exponentially distributed with rates λ_X and λ_Y, with $\lambda_X > \lambda_Y$. In this case, one has $X \le_{\text{lr}} Y$, whereas, the ratio $f_t^Y(x)/f(x)$ is not increasing for all $x > 0$, and thus $X \le_{\text{lr}} X_t^Y$ is not true. A similar conclusion holds for the cases (ii) and (iii). Indeed, in the following example, we see that

$$X \le_{st} Y \ne X \le_{\text{st}} X_t^Y \quad \forall t > 0$$
$$X \le_{\text{rh}} Y \ne X \le_{\text{rh}} X_t^Y \quad \forall t > 0.$$

□

Example 1.1. Let X be exponentially distributed with parameter 1, and let $Y = \max\{X, Z\}$, where Z is Erlang distributed with parameters (2,2) and is independent from X. Hence, since $F(x) = 1 - e^{-x}, x \ge 0$, and $G(x) = F(x)H(x)$, with $H(x) = 1 - (1 + 2x)e^{-2x}, x \ge 0$, we immediately have that $X \le_{\text{rh}} Y$, and thus $X \le_{\text{st}} Y$. However, it is not hard to see that $F_t^Y(x)/F(x)$ is not monotonic and is not smaller than one for suitable choices of t, as shown in Figure 1. Hence, both the conditions $X \le_{st} X_t^Y \forall t > 0$ and $X \le_{\text{rh}} X_t^Y \forall t > 0$ are not true.

Theorem 1.2. *Let X, Y be random lifetimes. If* $X \le_{st} X_t^Y \forall t > 0$, *then* $X \le_{\text{hr}} Y$.

Proof. From assumption $X \le_{\text{st}} X_t^Y \ \forall\ t > 0$, we have

$$F(x) \ge F(t) + \frac{\overline{F}(t)}{\overline{G}(t)} [G(x) - G(t)], \qquad x > t > 0,$$

so that

$$\frac{F(x) - F(t)}{x - t} \frac{1}{\overline{F}(t)} \ge \frac{G(x) - G(t)}{x - t} \frac{1}{\overline{G}(t)}.$$

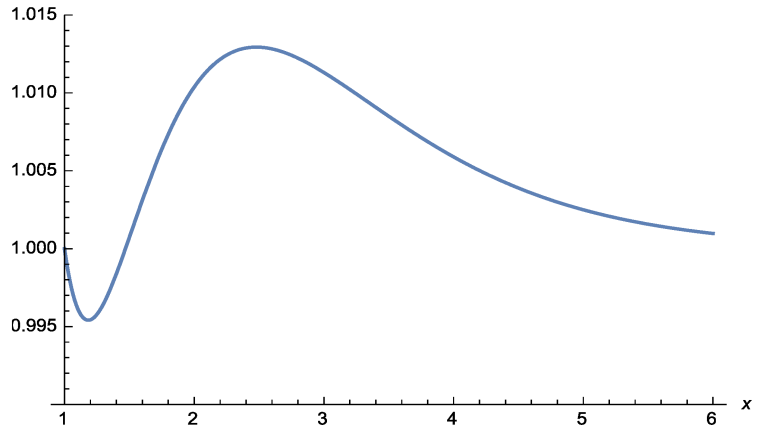


Figure 1: Plot of $F_t^Y(x)/F(x)$ for $t = 1$, with reference to Example 1.1.

In the limit as $x \downarrow t$, we have $\dfrac{f(t)}{\overline{F}(t)} \geq \dfrac{g(t)}{\overline{G}(t)}$ for all $t > 0$, thus $X \leq_{\text{hr}} Y$. □

Scale Family of Distributions

Engineers in the manufacturing industries have used accelerated test experiments for many decades. Various models for accelerated test involve time-transformations of suitable functions. The simplest case is based on linear transformations and on distribution functions. Then, let us now adapt the model to the instance in which the distributions of X and Y belong to the same scale family.

Given the random lifetimes X and Y, having distribution functions $F(x)$ and $G(x)$ respectively, we assume that X and Y belong to the same scale family of distributions, i.e.,

$$G(x) = F(\alpha x) \quad \forall x \in \mathbb{R}, \quad 0 < \alpha < 1 \tag{1.3}$$

Hence, for $0 < \alpha < 1$, one has $X \leq_{\text{st}} Y$. We recall that the quantile function of X is given by

$$Q_X(u) = \inf\{x \in \mathbb{R} \mid F(x) \geq u\}, \quad 0 < u < 1$$

Assumption (1.3) means that X and Y satisfy the proportional quantile functions model expressed by $Q_X(u) = \alpha Q_Y(u) \forall u \in (0, 1)$, where $Q_Y(u)$ is similarly defined as $Q_X(u)$. From (5), under the assumption (1.3) the distribution function of X_t^Y is

$$F_t^Y(x) = \begin{cases} F(x), & \text{if } 0 \leq x \leq t \\ F(t) + \dfrac{\overline{F}(t)}{\overline{F}(\alpha t)} \left[F(\alpha x) - F(\alpha t)\right], & \text{if } x > t. \end{cases}$$

Among the quantities of interest in reliability theory, wide attention is devoted to the residual lifetime of a given random lifetime X, defined as

$$X_t := [X - t \mid X > t], \quad t \geq 0. \tag{1.4}$$

The residual lifetime defined in (1.4) is involved in the following well-known notion of positive ageing.

Definition 1.2. *We say that X is IFR (increasing failure rate) if $X_t \leq_{st} X_s$ for all $t \geq s \geq 0$, that is, if $\bar{F}(x)$ is logconcave, or equivalently the failure rate $\lambda_X(t)$ is increasing in $t \geq 0$.*

Further Results

The expected value of X_t^Y can be expressed as

$$\begin{aligned}\mathbb{E}\left[X_t^Y\right] &= \int_0^t \bar{F}(x)dx + \int_t^\infty \left[\bar{F}(t) + \frac{\bar{F}(t)}{\bar{G}(t)}[\bar{G}(x) - \bar{G}(t)]\right] \mathrm{d}x \\ &= \mathbb{E}[X] + \frac{1}{\bar{G}(t)} \int_t^\infty [\bar{F}(t)\bar{G}(x) - \bar{F}(x)\bar{G}(t)]\mathrm{d}x.\end{aligned}$$

Hence, recalling that the mean residual life of the random lifetime X is

$$M_X(t) = \mathbb{E}[X - t \mid X > t] = \frac{1}{\bar{F}(t)} \int_t^\infty \bar{F}(x)\mathrm{d}x, \quad t \in \mathbb{R}_+, \bar{F}(t) > 0.$$

With $m_Y(t)$ similarly defined, we have

$$\mathbb{E}\left[X_t^\gamma\right] = \mathbb{E}[X] + \bar{F}(t)\left[m_Y(t) - m_X(t)\right]. \tag{1.5}$$

Let us now recall the mean residual life order.

Definition 1.3. *Let X and Y be absolutely continuous random variables with CDFs $F(t)$ and $G(t)$, and with finite mean residual lives $m_X(t)$ and $m_Y(t)$, respectively. We say that X is smaller than Y in the mean residual life order ($X \leq_{\mathrm{mrl}} Y$) if $m_X(t) \leq m_Y(t)$ for all t or, equivalently, if*

$$\frac{\int_t^\infty \overline{G}(x)\mathrm{d}x}{\int_t^\infty \overline{F}(x)\mathrm{d}x} \quad \text{is decreasing over } \left\{t : \int_t^\infty \overline{F}(x)\mathrm{d}x > 0\right\}.$$

Consequently, recalling (1.5), we immediately have the forthcoming result.

Proposition 1.1. *The relation $\mathbb{E}[X] \leq \mathbb{E}\left[X_t^Y\right]$ holds for all t if and only if $X \leq_{\mathrm{mrl}} Y$.*

We can now come to a probabilistic analogue of the mean value theorem.

Theorem 1.3. *Let X and Y be non-negative random variables satisfying $X \leq_{hr} Y$ and $\mathbb{E}[X] < \mathbb{E}\left[X_t^Y\right] < \infty$ and let $Z_t = \Psi(X, Y)$. Let g be a measurable and differentiable*

function such that $\mathbb{E}[g(X)]$ *and* $\mathbb{E}[g(Y)]$ *are finite, and let its derivative* g' *be measurable and Riemann-integrable on the interval* $[x, y]$ *for all* $y \geq x \geq 0$. *Then,* $\mathbb{E}\left[g'(Z)\right]$ *is finite and*

$$\mathbb{E}\left[g\left(X_t^Y\right)\right] - \mathbb{E}[g(X)] = \mathbb{E}\left[g'\left(Z_t\right)\right]\left\{\mathbb{E}\left[X_t^Y\right] - \mathbb{E}[X]\right\} \tag{1.6}$$

where Z_t *is the absolutely continuous random variable having* PDF

$$F_{Z_t}(x) = \frac{\bar{F}_t^Y(x) - \bar{F}(x)}{\mathbb{E}\left[X_t^Y\right] - \mathbb{E}[X]} = \frac{1}{m_Y(t) - m_X(t)}\left[\frac{\bar{G}(x)}{\bar{G}(t)} - \frac{\bar{F}(x)}{\bar{F}(t)}\right], \quad x \geq t.$$

2. Relative Ratio of Improvement

Consider a system having random lifetime X, which is replaced by Y at time t. If X is smaller than Y according to some stochastic order, we expect that the reliability of the system at time $x > t > 0$ is improved. In order to measure the usefulness of replacing the lifetime X with Y at time t, let us now introduce the relative ratio of improvement evaluated at $x > t > 0$. It is defined in terms of

$$R_t(x) := \frac{\bar{F}_t^Y(x) - \bar{F}(x)}{\bar{F}(x)} = \frac{\bar{F}(t)}{\bar{F}(x)} - 1 + \frac{\bar{F}(t)}{\bar{G}(t)}\left[\frac{\bar{G}(x)}{\bar{F}(x)} - \frac{\bar{G}(t)}{\bar{F}(x)}\right]. \tag{2.1}$$

Clearly, if $X \leq_{\mathrm{hr}} Y$, then, from point (i) of Theorem 1, it follows that $X \leq_{\mathrm{hr}} X_t^Y$ and, in turn, $X \leq_{\mathrm{st}} X_t^Y$ so that $R_t(x) \geq 0$ for all $x > t > 0$.

Example 2.1. Let $\{Z(t), t \geq 0\}$ be an iterated Poisson process with parameters (μ, λ). In other terms, such process can be expressed as $Z(t) = M[N(t)]$, where $M(t)$ and $N(t)$ are independent Poisson processes with parameters $\mu, \lambda \in \mathbb{R}^+$, respectively. Denoting by

$$T_k = \inf\{t > 0 : Z(t) \geq k\} \tag{2.2}$$

the first crossing time (from below) of $Z(t)$ through the constant level $k \in \mathbb{N}$, the corresponding survival function is

$$\mathbb{P}\left[T_k > t\right] = \exp\left\{-\lambda\left(1 - \mathrm{e}^{-\mu}\right)t\right\} \sum_{j=0}^{k-1} \frac{\mu^j}{j!} B_j\left(\lambda \mathrm{e}^{-\mu} t\right), \quad t \geq 0 \tag{2.3}$$

where $B_j(\cdot)$ is the j -th Bell polynomial. We consider a system subject to replacement policy as described where the relevant random lifetimes are given by the first-crossing times defined in (2.2), with $X \overset{\mathrm{d}}{=} T_1$ and $Y \overset{\mathrm{d}}{=} T_k$. The relative ratio of improvement of this system is then evaluated by means of (2.1). Figure 2 provides some plots of $R_t(x)$, showing that the relative ratio of improvement is increasing in x and k.

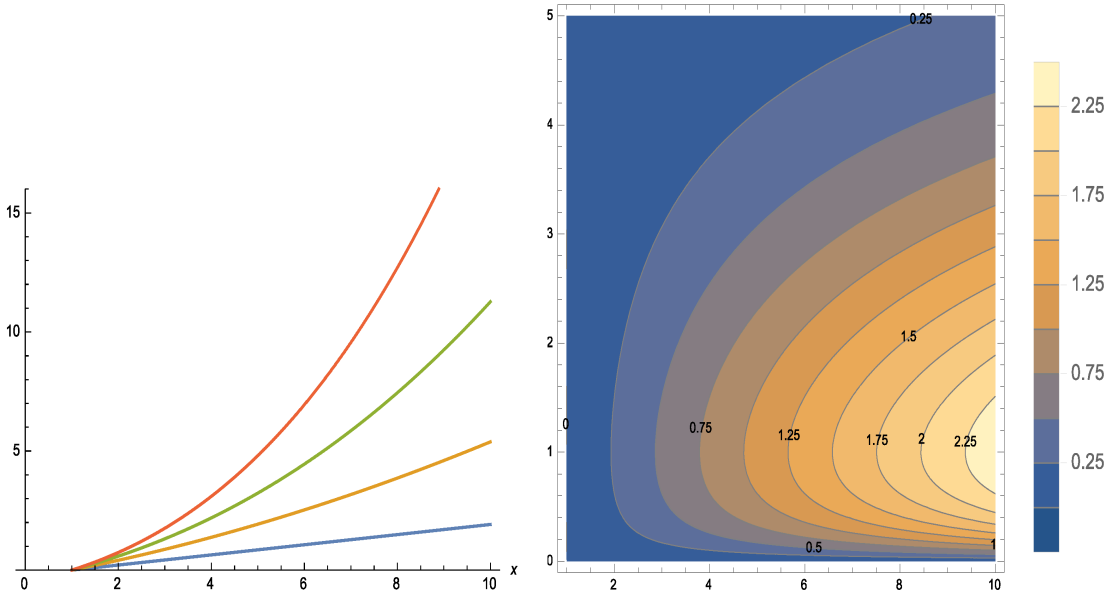


Figure 2: With reference to Example 1.1, left: plot of $R_t(x)$ for $1 < x < 10$, with $t = 1$ and $k = 2, 3, 4, 5$ (from bottom to top); right: contour plot of $R_t(x)$ for $1 < x < 10$ and $0 < \mu < 5$, with $k = 2, t = 1$ and $\lambda = 1$.

In the remaining part of this section, we restrict our attention to the special case in which X and Y satisfy the proportional hazard rates model. Hence, assuming that $\bar{G}(t) = [\bar{F}(t)]^{\theta}, \forall t \geq 0$, for $\theta > 0, \theta \neq 1$, the relative ratio defined in (2.1) becomes

$$R_t(x) = \frac{\overline{F}(t)}{\overline{F}(x)} - 1 + \left[\overline{F}(t)\right]^{1-\theta} \left\{ \left[\overline{F}(t)\right]^{1-\theta} - \frac{\left[\overline{F}(t)\right]^{\theta}}{\overline{F}(x)} \right\}, \qquad x > t > 0. \tag{2.4}$$

Here, the most interesting case is for $0 < \theta < 1$, since this assumption ensures that $X \leq_{\mathrm{hr}} Y$.

Example 2.2. Let X and Y be exponentially distributed with parameters 1 and θ, respectively, with $0 < \theta < 1$. Since $\bar{F}(t) = \mathrm{e}^{-t}, \overline{\mathrm{G}}(t) = \mathrm{e}^{-\theta t}, t \geq 0$, from (17), we have

$$R_t(x) = \mathrm{e}^{-(t-x)(1-\theta)} - 1, \quad x > t > 0.$$

Some plots of $R_t(x)$ are given in Figure 3, confirming that the relative ratio of improvement is increasing in $x - t > 0$, and is decreasing in $\theta \in (0, 1)$.

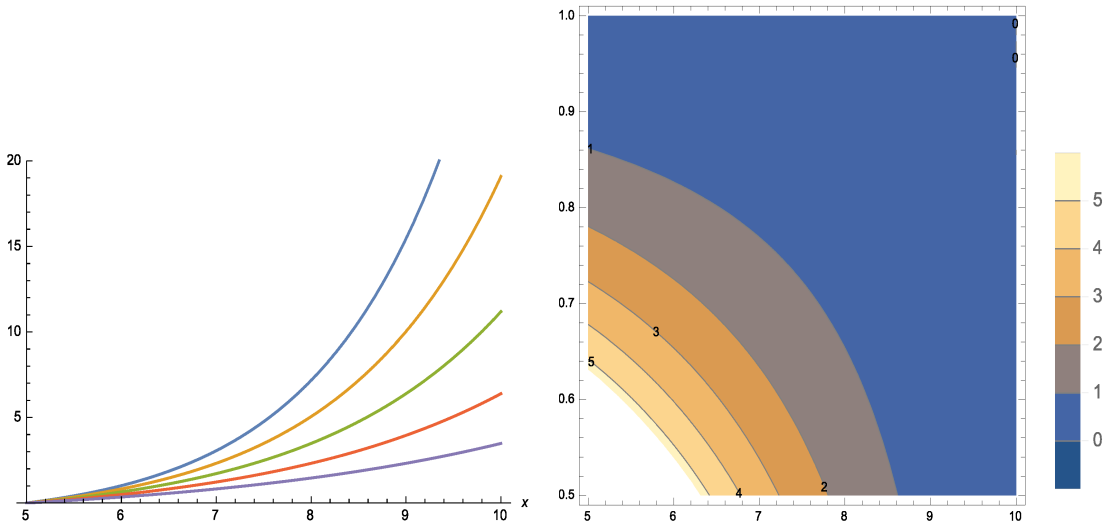


Figure 3: With reference to Example 2.1, left: plot of $R_t(x)$ for $5 < x < 10$, with $t = 5$ and $\theta = 0.3, 0.4$, 0.5,0.6,0.7 (from top to bottom); right: contour plot of $R_t(x)$ for $0.5 < \theta < 1$ and $5 < t < 10$, with $x = 10$

3. Conclusion

In this paper, The investigation has been centered first on the stochastic comparison of the resulting random lifetimes. We have proposed measuring the goodness of the replacement criteria by means of the relative ratio of improvement. The information amount provided by the dynamic version of the system lifetime differential entropy has also been considered as a relevant tool in this respect.

References

[1] Fliege, J. and Xu, H. (2011), Stochastic multiobjective optimization: sample average approximation and applications, *J. of Optimization Theory and Applications*, **151** (1), 135 – 162.

[2] Gutjahr, W. and Pichler, A. (2013), Stochastic multi-objective optimization: a survey on nonscalarizing methods, *Annals of Operations Research*, 1 – 25.

[3] Müller, A. and Stoyan, D. (2002), *Comparison Methods for Stochastic Models and Risks*, John Wiley & Sons, Chichester, UK, **330** p.

[4] Schmidli, H. (2008), *Stochastic control in insurance*, Springer-Verlag, London, **254** p.

[5] Shapiro, A., Dentcheva, D. and Ruszczyński, A. (2014), *Lectures on stochastic programming: Modeling and theory*, Second Edition, SIAM, Philadelphia, **494** p.

[6] Stancu-Minasian, I.M. (1984), *Stochastic programming with multi-objective functions*, Edeisteurrvae Academiei, Bucharest, **334** p.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 99 – 112

http://www.islamiahcollege.edu.in

STRUCTURAL AND OPTICAL PROPERTIES OF PHOSPHOR COMPOUND $Ca_3La(PO_4)_3$ DOPED RARE EARTH ION Eu^{3+} FOR SOLID STATE LIGHTING

[1]G. Shakil Muhammad, [1]M. Vijayakumar, [2]A. Duke John David, [3]K. Indumathi, [3]S. Tamilselvan

[1]*Department of Physics,*
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
[2]*Voorhees College, Vellore*
[3]*Arignar Anna Govt. Arts College, Cheyyar*

Abstract

A new host lanthanide based phosphor material Calcium Lanthanum Phosphate doped with trivalent rare earth ion - Europium ion were synthesized by conventional high temperature solid-state reaction. The synthesized luminescent materials were characterized for phase purity and luminescent properties. The structural and phase formation was confirmed by powder X-ray diffraction measurement. The optical properties of the synthesized phosphor materials were subjected to the Diffuse Reflectance Spectra and Photoluminescence excitation and emission (PLE) spectra. The RE doped phosphor materials shows sharp emission lines in orange and red regions due to the transitions from the excited $^5D_0$ state to the Stark components of ^7F_J ($J = 0$ to 4) levels in Eu^{3+}. Effect of Eu^{3+} concentrations reveals the non-quenching of photoluminescence property. The luminescence bands arising from 4f – 4f transitions are sharp bands with relatively long lifetime. The strongest excitation peak located at 396 nm is ascribed to the $^7F_0 \rightarrow ^5L_6$ transition in the near UV – region which matches well with the emission from the near – UV LED chip. The as prepared powder samples emit orange reddish light as a result of f−d and f−f transitions respectively. This study is a unique as no such luminescence data are available for this compound explicitly by the high temperature solid state reaction. The results are really reassuring in view of the prerequisite of phosphor converted - white LEDs for solid state lighting applications.

Keywords: Planckian locus, CIE, Phase formation, activator, absorption coefficient, Charge transfer.

1. Introduction

In recent years white light emitting diodes (wLEDs) phosphors are attracting considerable attention because of their widespread applications as flashlights, indicator lights, display backlighting, architectural lighting and replacement of conventional incandescence and fluorescent lamps. The applications of rare earth element compounds, especially lanthanide phosphate doped inorganic materials, have been stimulated upon broadly. Over the past a few years, they have been functional in many fields such as optical display panels, cathode ray tubes, optoelectronic devices, sensitive devices, nano scale electronic and plasma display panels due to their special chemical and physical properties. In recent years, PDPs – Plasma display panels have fascinated frequent attentions due to plenty of its luminescence applications, precisely high contrast, large viewing angle and rapid response. There is a need to fulfil these requirements in the current display and solid state technology. As a determination to design, synthesize and fabricate efficient luminescent materials worldwide, scientists have found tremendous interests in this field of research. They have been attracted particularly to control shape and size, investigate the physical, optical and luminescent properties of a new generation of light emitting materials known as – *phosphors* [1, 2]. To satisfy the demands for a number of applications, phosphors are generally in the powder form with detailed requirements on particle size and morphology [3]. We are interested mainly in investigating their photoluminescence properties. In order to get an emission in visible spectrum, the activator plays a vital role. A quite often used activator is trivalent europium ion (Eu^{3+}) for solid state lighting and display fields. It is renowned that the Eu^{3+} emits both orange and red photoluminescence (PL) from f−f transitions ($^5D_0 \rightarrow {}^7F_1$ and $^5D_0 \rightarrow {}^7F_2$), however the intensity depends on the local site symmetry of Eu^{3+}. The Eu^{3+} has a simple electronic energy level structure and its transitions are hypersensitive, i.e., they hinge on strongly on the chemical surroundings [4]. The rare earth ion-doped phosphates have been recognized as luminescent due to their rich color, high luminescence efficiencies, and excellent chemical stabilities. The CT energy generally can be transferred efficiently to the rare earth ions, such as YPO4: Eu [5], $Ca_9Y(PO_4)_7$: Eu [6], and $Ca_9Y(PO_4)_7$: Tb [7] and so on. In the present investigation, we have chosen a phosphor material as $Ca_3La_{1-x}[PO_4]_3 : {}_xEu^{3+}$, which includes of a Calcium lanthanum phosphate as a host lattices i.e., $Ca_3La[PO_4]_3$ and the activator Eu^{3+} becomes a luminescent material. The research work has been carried out to find the structural correlation and photoluminescence properties in the synthesized phosphor material. The $Ca_3La_{1-x}[PO_4]_3 : {}_xEu^{3+}$ phosphor material may be considered as a potential candidate for phosphor pumped by the near UV/blue LED.

2. Experimental Section

2.1. Materials and Synthesis

The solid state reaction method has been adopted to synthesize this new type of lanthanide phosphate $Ca_3La_{1-x}[PO_4]_3 : {}_xEu^{3+}$ at very high temperature. The following

precursors have been selected namely $CaCO_3$ - Calcium carbonate, La_2O_3 - Lanthanum Oxide, $NH_4H_2PO_4$ - Ammonium dihydrogen Phosphate and Eu_2O_3 - Europium oxide. The Precursors were measured according to stoichiometric ratio and then compound is grinded well. The powdered compound is kept inside the furnace using alumina crucible and heated slowly to a maximum of 1000°C at a rate of 150°C for 1 hour. After reaching the maximum of 1000°C, it is maintained for a duration of 20 hours. Then after this duration, the compound is made to cool and then reach room temperature. Then it is grinded again well to reach a homogeneous mixture of compound. Now, the sample is subjected to various structural and optical characterization techniques.

3. Characterization Methods

In order to find the structural and the optical properties of the synthesized phosphor compounds. The synthesized phosphor materials were subjected to the following techniques as follows XRD - X-ray Diffraction Method, DRS - Diffuse Reflectance Spectroscopy, PL - Photoluminescence [Excitation and Emission] and also, in addition to these measurements, we have used a CIE plot with a help of a MATLAB software. This software helps to find the exact region in the Planckian locus. A variety of techniques can be used for this purpose and the technical details are given in the following sections.

4. XRD - X- Ray Diffraction - Phase Formation

The structure determination and the phase formation between the Undoped and the trivalent Europium doped was confirmed by X-ray diffraction (XRD). The XRD patterns of ${}_xEu^{3+}$ doped $Ca_3La_{(1-x)}[PO_4]_3$ for two different concentrations ($x = 0.05$ and 0.1) is shown in the Figure 4.1. The reflections from all the concentrations i.e., undoped and doped phosphor compounds were found to be identical and all the peaks shown in the graph are indexed well to the patterns and are in good agreement with the powder diffraction file 2 (PDF 2) cardNo.29-0338 Calcium Lanthanum Phosphate $Ca_3La[PO_4]_3$ in the International Centre for Diffraction Data (ICDD) database. The synthesized compound crystallize in Cubic Structure with Space Group of $P2_1/n$. The unit cell parameters are $a = b = c = 9.941$Å, the volume $V = 982.40$Å^3 and the interfacial angles $\alpha = \beta = \gamma = 90°$.

There is no other phase is detected, indicating that the obtained samples are single phase and Eu^{3+} ions have been successfully incorporated in the host lattice by replacing La^{3+} ions due to their similar ionic radii and charge . The one crystallographic site of La^{3+} ions in $Ca_3La[PO_4]_3$ structure allows for a good substitution of Eu^{3+} ions in the matrix without disturbing the overall structure and locates the doping lanthanide ions in the sites with the same symmetry. Therefore, we can conclude that Eu^{3+} ions

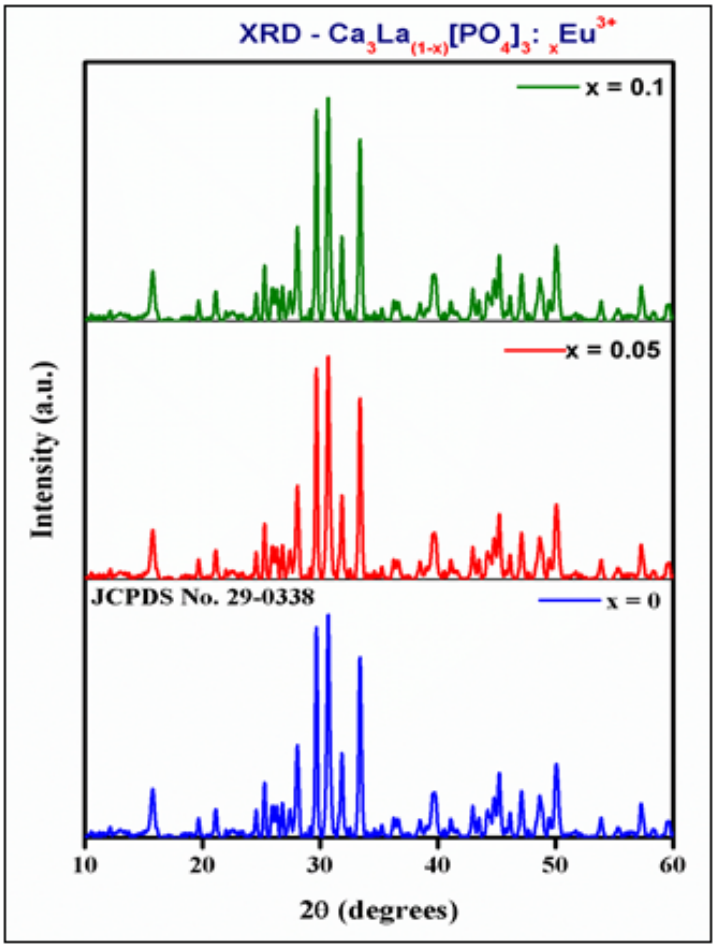


Figure 1: XRD Patterns of $Ca_3La_{(1-x)}[PO_4]_3$: $_xEu^{3+}$ (x = 0, 0.05 and 0.1)

can be doped easily to replace the La^{3+} ions in the $Ca_3La[PO_4]_3$ host lattice without any structural changes. The XRD patterns confirms a single phase phosphor material for both the undoped Calcium lanthanum phosphate $Ca_3La[PO_4]_3$ and the trivalent rare earth ion Eu^{3+} ion.

5. UV DRS - Diffuse Reflectance Spectra

The optical absorption of the host $Ca_3La[PO_4]_3$ and Eu^{3+}-substituted phosphors were observed by diffuse reflectance UV-Visible spectroscopy in the range 200-800nm.

The DRS of the host lattice $Ca_3La[PO_4]_3$ host and the Eu^{3+} substituted Eu^{3+} are shown in Figure 4.2(a) & (b) respectively. It shows a status of high reflection in the wavelength ranging from 400 to 800nm for the host and 410 to 800nm for the trivalent europium doped sample.

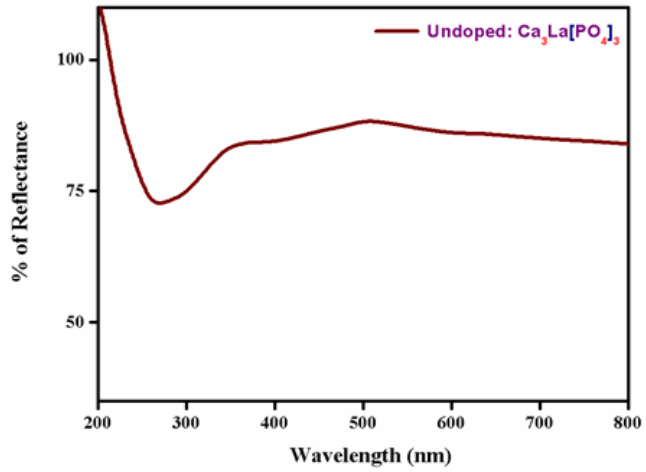


Figure 2: (a) Diffuse Reflectance Spectra of the Host $Ca_3La[PO_4]_3$ Phosphor

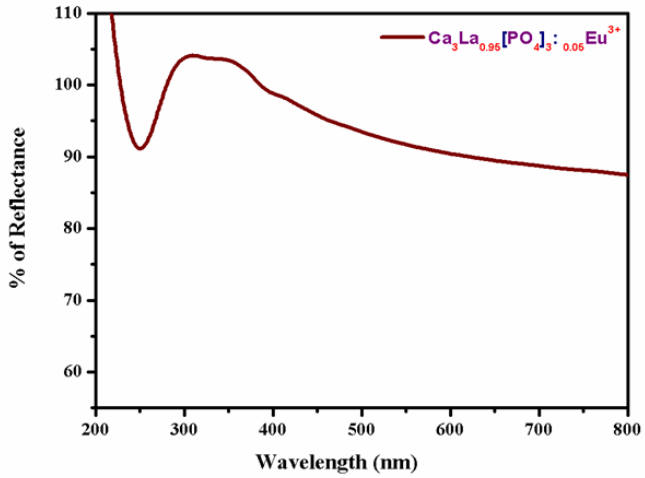


Figure 3: Diffuse Reflectance Spectra of $_{0.05}Eu^{3+}$ Doped $Ca_3La_{0.95}[PO_4]_3$ Phosphor

The absorption is the region of the Ultraviolet region for the both host and the trivalent europium doped phosphor compounds. All the three plots reveals that there is a good reflectance of the synthesized phosphor compound, which is necessary for a proper luminescence spectra.

5.1. Band Gap

To determine the band gap of synthesized phosphor material, the fundamental absorption, which corresponds to the transition from valance band to the conduction band was used. The relation between the absorption coefficient (α) and the incident

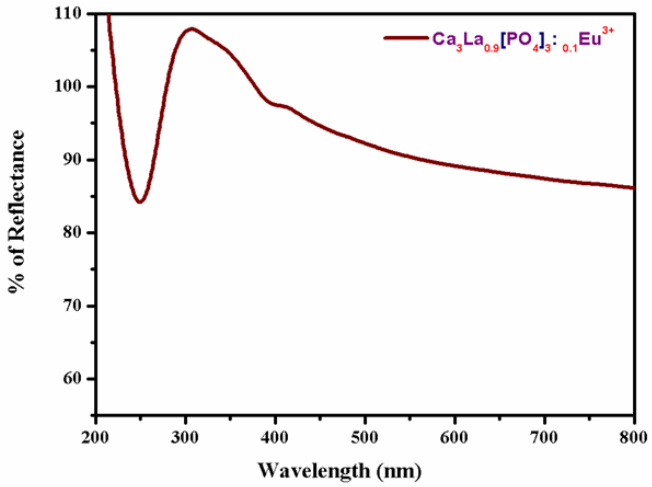


Figure 4: DRS of $_{0.1}Eu^{3+}$ doped $Ca_3La_{0.9}[PO_4]_3$ Phosphor

photon energy ($h\nu$) can be written as

$$\alpha h\nu = A(h\nu - E_g)^n \tag{1}$$

where A is constant, α is the absorption coefficient and n depends on the type of transition having values $\frac{1}{2}, 2, \frac{3}{2}$ and 3 corresponding to the allowed direct, allowed indirect, forbidden direct and forbidden indirectly respectively [Abeles. F (1972)]. The value of the band gap has been determined by extra-plotting the straight line portion of the $(\alpha h\nu)^{\frac{1}{n}}$ versus $h\nu$ graph, which is shown in the inset of Figure 4.2(d), (e) & (f).

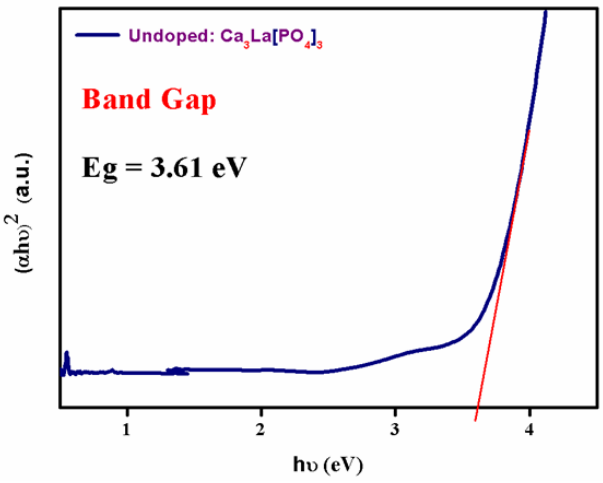


Figure 5: Band ap of Undoped $Ca_3La[PO_4]_3$ Phosphor

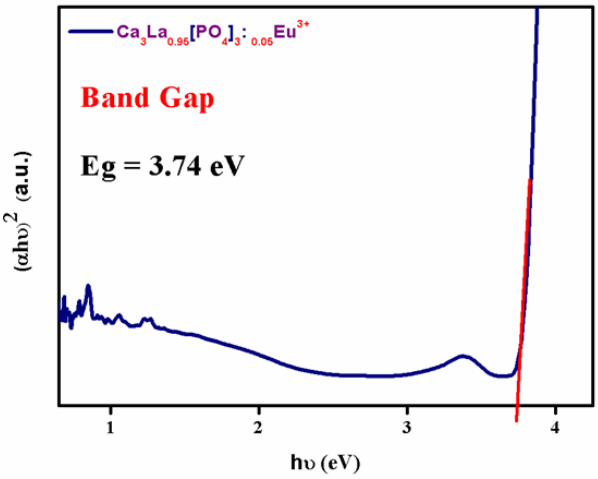


Figure 6: Band Gap $_x$Eu^{3+} Doped Ca$_3$La$_{(1-x)}$[PO$_4$]$_3$ Phosphor at $x = 0.05$

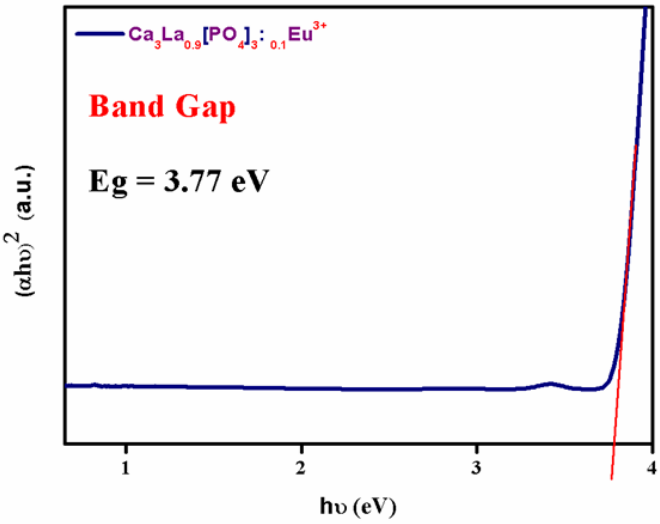


Figure 7: Band Gap of Eu^{3+} Doped Ca$_3$La$_{(1-x)}$[PO$_4$]$_3$ Phosphor at $x = 0.1$

The energy band gap Eg values of the Calcium Lanthanum phosphate doped with trivalent rare earth ions were calculated and tabulated in Table - 4.1 for different concentrations of Eu^{3+} in the host for the values $x = 0.05$ and 0.1. The obtained band gap values are suitable for the application of wLEDs.

Table 1: The Energy Band Gap [Eg] Values of the Undoped and Eu^{3+} Doped Phosphors

Conc. level of $_xEu^{3+}$ in the host	Band Gap Eg (eV)
$x = 0$	3.61
$x = 0.05$	3.74
$x = 0.1$	3.77

6. PL - Photoluminescence of Eu^{3+} Doped $Ca_3La[PO_4]_3$

6.1. Excitation Spectra

The Photoluminescence excitation spectra of the as prepared phosphor material $Ca_3La_{0.95}[PO_4]_3 : {}_0.05Eu^{3+}$ excited at λ_{ex} = 396nm is shown in Figure 4.3(a).

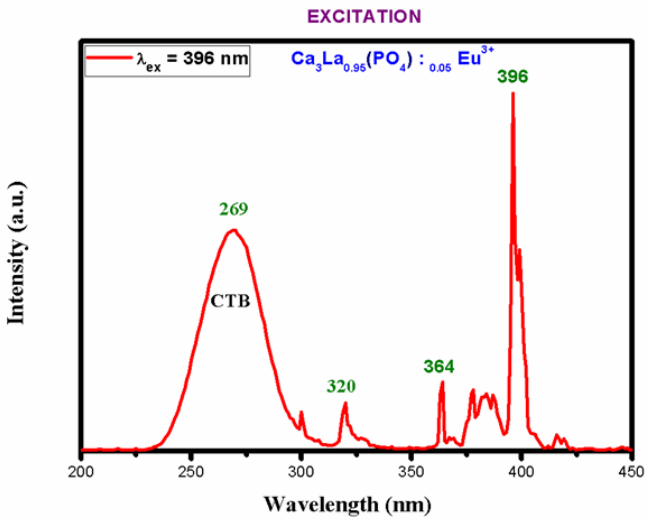


Figure 8: Photoluminescence Excitation Spectra of $Ca_3La_{0.95}[PO_4] : {}_0.05Eu^{3+}$

The other concentration of $Ca_3La_{0.9}[PO_4] : {}_0.1Eu^{3+}$ is shown in the Figure 4.3(b). The broad band centered at 269nm is attributed to the charge-transfer (CTB) between Eu^{3+} and the surrounding oxygen anions [8 - 10].The two sharp peaks with a maximum at 364 and 396 nm are attributed to the f–f transitions of Eu^{3+}, namely $_7F_0 - {}_5G_2$ and $_7F_1 - {}_5L_6$ transitions, respectively [11].

6.2. Emission Spectra

The emission spectrum of the $Ca_3La_{0.95}[PO_4]_3 : {}_0.05Eu^{3+}$ mainly locates in the orange-red spectral area (from 575 to 675 nm). As shown in the figure 4.3(c) and 4.3 (d),

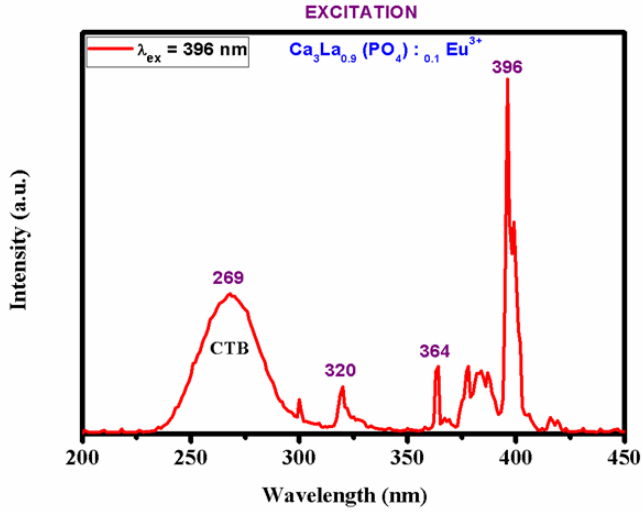


Figure 9: Photoluminescence Excitation Spectra of $Ca_3La_{0.9}[PO_4]_3 : {}_0.1Eu^{3+}$

the sharp line like emissions located at 587nm, 592nm, 612nm and 621nm correspond to the $_5D_0 \rightarrow {}_7F_1$ transition, $_5D_0 \rightarrow {}_7F_2$ transition, $_5D_0 \rightarrow {}_7F_3$ transition and $_5D_0 \rightarrow {}_7F_4$ transition [12-14]. The splitting and intensity pattern of the emission lines demonstrate that the europium has been successfully doped in the synthesized phosphor material. The orange-red emission lines at around 587 and 592 nm originating from the magnetic dipoletransitions $_5D_0 \rightarrow {}_7F_1$ and $_5D_0 \rightarrow {}_7F_2$ are the dominant bands for the as-synthesized phosphor compound $Ca_3La_{0.95}[PO_4]_3 : {}_0.05Eu^{3+}$.

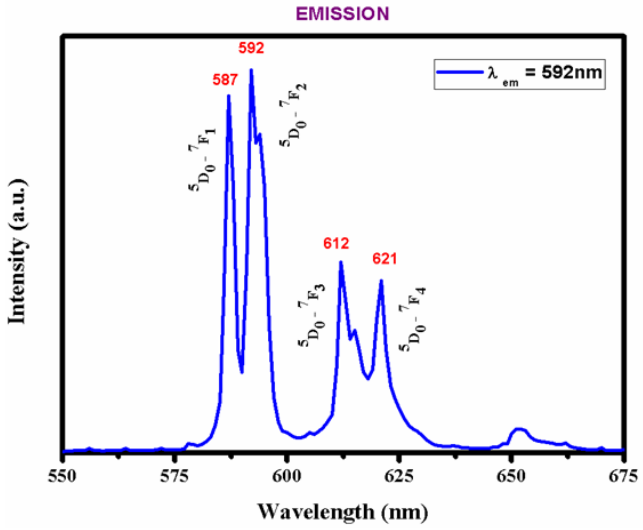


Figure 10: Photoluminescence Emission Spectra of $Ca_3La_{0.95}[PO_4]_3 : {}_0.05Eu^{3+}$

These sharp emission lines ranging from 575 to 675 nm, which are associated to the

transitions from the excited $_5D_0$ state to the Stark components of the $_7F_J$ ($J = 0, 1, 2, 3$ and 4) levels in Eu^{3+}. The red emission at 612 nm is an electric dipole transition, while the orange emission range at 592 nm is a typical magnetic dipole transition. The emission spectra are dominated by the transitions of $_5D_0 \rightarrow {}_7F_1$. According to the Judd-Ofelt theory [15], the magnetic dipole transition is permitted. However, the electric dipole transition is allowed only when the europium ion occupies a site without an inversion center and the intensity is significantly affected by the symmetry in local environments around Eu^{3+} ions. If the Eu^{3+} ions occupy an inversion symmetry site, the orange emission (magnetic dipole transition) $_5D_0 \rightarrow {}_7F_2$ (at 592 nm) is the dominant electronic transition. On the contrary, the electric dipole transition $_5D_0 \rightarrow {}_7F_3$ (at 612 nm) is the dominant one, when the Eu^{3+} occupies in the non-centrosymmetric site in the host lattice [16].

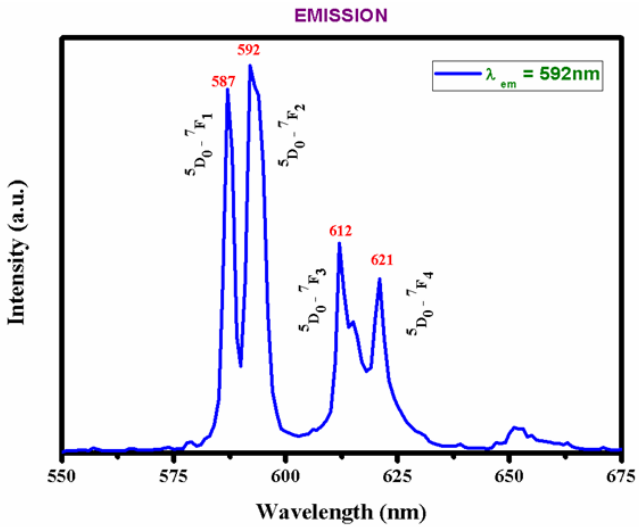


Figure 11: Photoluminescence Emission Spectra of $Ca_3La_{0.9}[PO_4]_3 : {}_0.1Eu^{3+}$

According to these sharp emission lines, it can be concluded that most Eu^{3+} ions have inversion centers and the magnetic dipole transition $_5D_0 \rightarrow {}_7F_2$ (at 592nm) is dominant.

6.3. Concentration vs Intensity of PL - Emission Spectra

The Photoluminescence emission spectra of Calcium Lanthanum Phosphate $Ca_3La_{(1-x)}Eu_x[PO_4]_3$ phosphor compounds have been synthesized with the dopant concentration ranging from $x = 0.05$ and 0.1, excited at a wavelength $\lambda_{ex} = 396$nm is shown in (a 3D plot) Figure 4.3(e). From this plot, one can observe that the increasing concentration of dopant Eu^{3+} ions from $x = 0.05$ to 0.1 in the host $Ca_3La[PO_4]_3$ results in increased intensities of both the (592 nm) $_5D_0 \rightarrow {}_7F_2$ and (612 nm) $_5D_0 \rightarrow {}_7F_3$ transitions with no concentration quenching observed, which clearly indicates that the

host (phosphate group) to Eu^{3+} (activator) energy transfer is efficient. Comparable type of emission results have been conveyed [17]. Other transitions from the $_5D_0 \rightarrow {}_7F_1$ and $_5D_0 \rightarrow {}_7F_4$, were also equally varies.

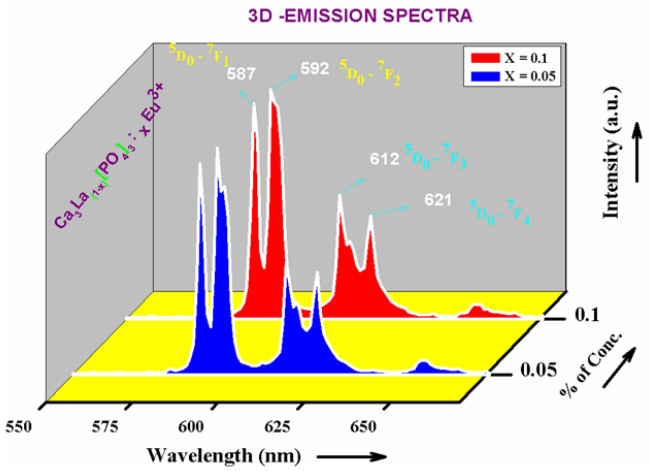


Figure 12: 3D Plot of PL Emission for the Two Concentrations $x = 0.05$ **&** 0.1

Therefore the f−f transition emission of rare earth ions predominates and the O-P Charge transfer emission is very weak due to the efficient energy transfer between the $[PO_4]_3$ to the rare earth ion Eu^{3+}. All the compositions show orange red emission, however the relative intensity only varies. The table 4.2 shows the concentration level of the trivalent rare earth ion Eu^{3+} in the host Calcium Lanthanum phosphate $Ca_3La[PO_4]_3$. This clearly ensures that there is an increase in the intensity of the emission when there is increase in activator concentration.

Table 2: Concentration Level of the Dopant and Emission Intensity

Phosphor compound Host + dopant	**Concentration of the Dopant**	**Intensity of the emission spectra**
$Ca_3La_{0.95}[PO_4]_3 : {}_{0.05}Eu^{3+}$	$X = 0.05$	$17,15,400$
$Ca_3La_{0.9}[PO_4]_3 : {}_{0.1}Eu^{3+}$	$X = 0.1$	$17,71,310$

7. CIE - Chromaticity Coordinates

The chromaticity coordinates were calculated using MATLAB software. The Photoluminescence emission intensity is taken as the source data and using the Matlab software, the two coordinate values x and y were calculated. The CIE (Commission

International de l'Eclairage - 1931) chromaticity coordinates for the $Ca_3La_{(1-x)}[PO_4]_3$ and the $_xEu^{3+}$ doped (x = 0.05 & 0.1) phosphor excited by 396 nm are calculated which is indicated by white encircle mark as shown in Figure 4.4(a) for the concentration x = 0.05 and Figure 4.4(b) shows for the concentration x = 0.1.

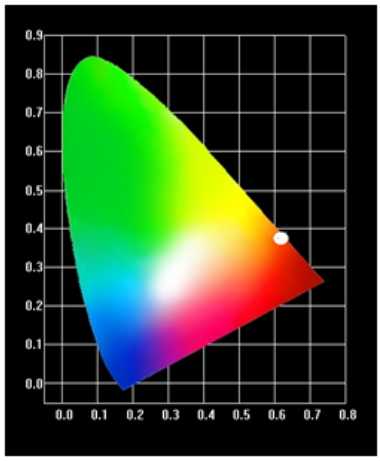


Figure 13: CIE Plot for the Phosphor Compound $Ca_3La_{0.95}[PO_4]_3 : {}_0.05Eu^{3+}$

The CIE color chromaticity coordinates was calculated for Eu^{3+} doped phosphor and the values are tabulated in the tabular column 4.2. The presently studied orange-red phosphor can be used with other suitable phosphor to compensate the lack of color if any. Hence, this phosphor material is suggested to be used as an orange-red phosphor and may find potential applications in phosphor converted WLEDs.

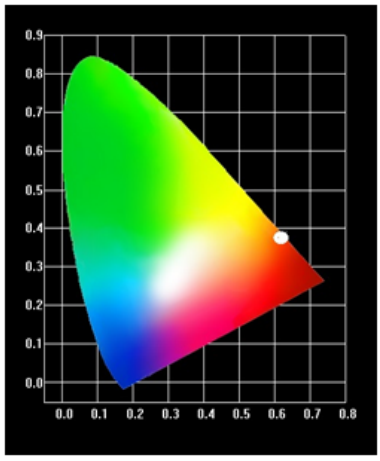


Figure 14: CIE Plot for the Phosphor Compound $Ca_3La_{0.9}[PO_4]_3 : {}_0.1Eu^{3+}$

The CIE value is calculated for the rare earth doped phosphor material and the PL emission intensity of $Ca_3La[PO_4]_3 : Eu^{3+}$ phosphor material is very much close to the

National Television Standard Committee (NTSC) standard values with ($x = 0.670$ and $y = 0.33$) [18]. Hence, this orange-red phosphor can find potential application in the white LEDs.

Table 3: X, Y Coordinate Values of the Synthesized Phosphor Materials

Phosphor compound	Conc. Level	X	Y	NTSC VALUE
$Ca_3La_{(1-x)}[PO_4]_3 : {}_xEu^{3+}$	$X = 0.05$	0.620	0.378	$X = 0.670$ $Y = 0.330$
$Ca_3La_{(1-x)}[PO_4]_3 : {}_xEu^{3+}$	$X = 0.1$	0.6211	0.378	

8. Conclusion

A new luminescent material (trivalent rare earth element - Europium) Eu^{3+} doped with Calcium Lanthanum Phosphate - $Ca_3La_{(1-x)}[PO_4]_3$ with two different concentrations of $x = 0.05$ and 0.1 were synthesized via the conventional high temperature solid-state reaction. The XRD pattern shows that the lattice parameters of synthesized compound exhibit a linear relationship between the host and doped XRD patterns, indicating that the trivalent rare earth ion [RE^{3+}] ions are well incorporated in the host lattice, its comes under the RE doped phosphor materials $Ca_3La_{(1-x)}[PO_4]_3 : {}_xEu^{3+}$ ($x = 0.05$ and 1.0) showed sharp emission lines in orange and red regions due to the transitions from the excited $_5D_0$ state to the Stark components of $_7F_J$ ($J = 0$ to 4) levels in Eu^{3+}. Unlike the previously reported results for RE-doped vanadate, this phosphor material in which Eu^{3+} shows a non-quenching of the dopant emission. The intensity of emission increases with increases in the Eu^{3+} concentration from $x = 0.05$ to $x = 0.1$ and there is no concentration quenching is observed even for higher concentrations of both dopants Eu^{3+}. It can be found that $Ca_3La_{(1-x)}[PO_4]_3 : {}_xEu^{3+}$ have efficient absorption in the region of near-UV wavelengths or blue wavelength regions. This can well match with the light from UV-LED (360-400nm) or blue LED chips (450-480nm) based on GaN semiconductor. The CIE plot well supports the Photoluminescence emission intensity and the values are very closer to the NTSC standard cards. Hence, this phosphors can be suggested to be suitable candidates for the application on near-UV white LEDs phosphors.

References

[1] Xia, Z.G., Zhuang, J.Q., Liu, H.K. and Liao, L.B. (2012), *Journal of Physics D: Applied Physics* **45**, 015302 – 015307.

[2] Han, L.L., Wang, Y.H., Zhang, J. and Wang, Y.Z. (2013), *Materials Chemistry and Physics* **139**, 87.

[3] Wang, X.X., Wang, J., Shi, J.X., Su, Q. and Gong, M.L. (2007), *Materials Research Bulletin* **42**, 1669 – 1673.

[4] Nakamura, S., Mukai, T. and Senoh, M. (1994), *Applied Physics Letters* **64** (13), 1687 – 1689.

[5] Nakajima, T., Isobe, M. and Manabe, T. (2010), *Journal of Physical Chemistry C* **114** (11), 5160 – 5167.

[6] Wawrzynczyk, D., Nyk, M. and Samoc, M. (2013), *Journal of Material Chemistry* **1** (37), 5837 – 5842.

[7] Ronde, H. and Blasse (1978), *Journal of Inorganic Nuclear Chemistry* **40** (2), 215 – 219.

[8] Patra, C.R., Alexandra, G., Patra, S., Jacob, D.S., Gedanken, A., Landau, A. and Gofer, Y. (2005), *New Journal of Chemistry* **29** (5), 733 – 739.

[9] Yis, S., Bae, J.S., Moon, B.K., Jeong, J.H., Park, J.C. and Kim, I.W. (2002), *Applied Physics Letters* **81** (18), 3344 – 3346.

[10] Schmechel, R., Kennedy, M., Seggern, H.V., Winkler, H., Kolbe, M., Fischer, R.A., Li, X.M., Benker, A. and Winterer, M. (2001), *Journal of Applied Physics* **89** (3), 1679 – 1686.

[11] Fang, Y.-P., Xu, A.-W. and Song, R.-Q. (2003), *J. Amer. Chem. Soc.* **125**, 16025 – 16034.

[12] Judd, B.R. (1962), *Phys. Rev.* **127**, 750.

[13] Ofelt, G.S. (1962), *J. Chem. Phys.* **37**, 511.

[14] Shionoya, A.S. and Yen, W.M. (Eds.) (1999), *Phosphor Handbook*, CRC Press, Boca Raton, FL., USA.

[15] Bose, H.N. (1992), Luminescence and allied phenomena, *Ind. J. Hist. of Science* **27** (4), 409 – 419.

[16] Bhagavantam, S. (1930), *Indian J. Phys.* **5**, 169.

[17] Kharsika, V.F., Komissarova, L.N., Kirichenko, A.N., Murav'ev, E., Orlovskii, V.P. and Chernyaev, A.P. (2001), *Inorg. Mater.* **37**, 831 – 835.

[18] Koike, J., Kojima, T. and Toyonaga, R. (1979), *J. Electrochem. Soc.* **126**, 1008.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 113 – 123

http://www.islamiahcollege.edu.in

NON-COVALENT INTERACTION STUDIES OF 2-CHLOROPHENOL WITH MMA IN BENZENE AT 303K USING ULTRASONIC DATA, DFT METHOD

J. Asghar, S. Sakki and L. Arul

Department of Physics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

The ultrasonic velocity (u), density (ρ) and viscosity (η) have been measured for the binary mixtures of 2-chlorophenol with methyl methacrylate at 303K. Thermodynamically parameters like adiabatic compressibility (β), intermolecular free length (L_f), Free Volume (V_f), Molar volumes (v_m), Internal Pressure(π_i), Gibbs free energy ($\triangle G$), for the liquid mixtures under discussion were calculated. Using these experimental values, the excess parameter values were evaluated. In all the excess parameters, a negative deviation was observed in 2-chlorophenol–MMA binary mixture. These deviations were explained in terms of molecular interactions between like and unlike molecules and further affirmed using DFT Method. Nuclear magnetic resonance (^{13}C-NMR) measurements have also been done to explain the molecular interaction in the binary liquid mixtures. In addition, non-covalent interactions were confirmed by the Multiwave function and VMD software packages.

Keywords: Ultrasonic velocity, Thermodynamical parameters, NMR, DFT method.

1. Introduction

Liquid-liquid mixtures' thermophysical qualities have a significant impact on their practical uses in a variety of situations. In order to evaluate the effects caused in mixtures of pure liquids, ultrasonic velocity and transport parameters such as viscosity are required [1-3]. These properties can help us better comprehend molecular interactions in liquid mixtures, because molecule dispersion is affected by molecular contact energy and a lot of research has gone into researching interactions in mixed solvents [4-10]. Methacrylates are significant commercial chemicals that are frequently utilized as a precursor in the production of acrylic polymers like polymethyl methacrylate, which is

recognized for its transparency, stability, durability, and weather resistance. Methyl methacrylate is a good glass replacement that's also utilized in dentistry. Even in orthopaedic surgery, methacrylates are utilized as a bone cement to secure prosthetic devices [11-12]. Phenol and its derivatives are industrially influential compounds, especially in manufacturing dyes, drugs, plastics, pesticides, explosives, and industrial solvents. As a result, the current research is focused on the densities, excess volumes, sound speed, adiabatic compressibility (β^E), intermolecular free length (L_f^E), free volume (V_f^E), internal pressure (π_i^E) and Gibb's free energy ($\triangle G^E$) of a binary liquid combination of 2-chlorophenol and MMA in benzene at 303K. The overall goal of this research is to leverage the composition dependency of excess amounts to better understand the nature of the molecular scale in these mixtures, which are mostly non-aqueous binary systems. The first step is based on the fact that measurements of density, excess volume, and speed of sound and excess isentropic compressibility provide means of investigating various types of intermolecular interactions.

2. Materials and Method

2.1. Materials

The mixtures 2-chlorophenol and MMA of various concentrations ranging from 0 M to 0.1M were prepared by taking analytical reagent grade and spectroscopic reagent grade chemicals with minimum assay of 99.9% and procured from E. Merck Ltd (India). The above experimental solutions are of equimolar concentrations of different solutions constituting the system which are under study.

2.2. Experimental Details

The ultrasonic velocity measurements in the 2-chlorophenol with MMA solutions are made in the ultrasonic Interferometer of fixed frequency 2 MHz (Model F-81 Mittal enterprises, New Delhi) at 303k temperature. The values of densities are measured at 303k temperature using specific gravity bottle by standard operating procedure and the viscosity using Ostwald's viscometer with an accuracy of ± 0.001% standardized with double distilled water.

Standard equations from the literatures [13-14] were used to measure acoustic parameters. The values of excess parameters can be calculated by the expression given below,

$$A^E = A_{exp} - A_{id}. \tag{1}$$

Here, $\sum A_i X_i$ is used to calculate A_{id}, A_i is the acoustical parameters and X_i the mole fraction of the mixture.

The excess Gibbs energy for activations can be calculated using the equation given

below

$$G^{*E} = RT\left[In\left(\frac{\eta V_m}{\eta_2 V_{m2}}\right)\right] - x_1 In\left(\frac{\eta_1 V_{m1}}{\eta_2 V_{m2}}\right) \text{Cal Mol}^{-1}, \quad (2)$$

where η, η_1, η_2 and V_m, V_{m1}, V_{m2} are the values of viscosity, molar volumes of pure and the mixtures, X_1 is a mole fraction of 2CP, T and R are the temperature and gas constant respectively.

2.2.1 Computational Study

The optimized molecular geometry of the title molecule is optimized by a quantum chemical method using the DFT method in the ground state at the basic set B3LYP/6-311++ [15–16]. The NCI's plot as well as lower-density plots (RDG) vs electron-density, multiplied with the second Hessian values [17–18], was performed with Multiwfn 3.6 [19], and an RDG isosurface was generated with VMD 1.9.3 [20].

3. Results and Discussion

3.1. Ultrasonic Studies

The experimental values of ultrasonic velocity, density and viscosity of binary mixture at temperature 303K are presented in Table 1.1. From these values, it is observed that in all the systems, ultrasonic speed, density and viscosity increase or decrease non-linearly with mole fraction of 2-CP. This non-linear variation is a deviation from ideal behaviour which suggests the presence of intermolecular interactions between the component molecules of the mixtures [21-22]. From the table 1.1, variation in ultrasonic velocity, density viscosity in any solution generally indicates molecular association in it. The velocity of the binary mixture increases with increase in concentration of 2-chlorophenol at 303K. Therefore, for the system (MMA + 2-chlorophenol mixture) when the MMA is introduced in to the liquid mixture, the number of aromatic molecules get reduced and hence the sound velocity of the liquid mixture increases due to the introduction of double bond (MMA).

From table1.2, the variation of adiabatic compressibility (β), free volume, free length (L_f), internal pressure with respect to the mole fraction of 2-chlorophenol is given and from the observed data the value decreases with increase in mole fraction of 2-chlorophenol. Similar observations were made by Ali and Nain [23] in their binary mixtures and reported that the interactions become stronger with decreases of adiabatic compressibility. The values of excess/deviation parameters such as the excess values of Molar Volume (V_m^E), adiabatic compressibility (β^E), free length (L_f^E), free volume (V_f^E), internal pressure (π_i^E) and Gibb's Free Energy ($\triangle G^E$) of the binary liquid systems are reported in Table 1.3. Excess molar volume, V_m^E, is an important volumetric property by which molecular interactions between the component molecules in liquid mixtures

can be assumed. The magnitude and the sign of V_m^E can be qualitatively examined by considering the physical, structural and chemical contributions [24]. The extent/degree of volume compression or volume expansion decides the magnitude and sign of the V_m^E Negative excess molar volumes indicate possibility of dominance/existence of strong interactions between unlike molecules in the liquid mixture [25], whereas positive values indicate predominance of dispersion forces between the molecules in the mixture [26]. The variation of excess molar volume (V_m^E) with mole fraction of 2-chlorophenol at 303k. The excess molar volume is considered as the resultant contribution from several opposing effects such as chemical, physical and structural [27-29].

The perusal of table 1.3 exhibits the values of excess adiabatic compressibility (β^E) for 2-chlorophenol with MMA liquid systems. The negative values of β^E are associated with a structure-forming tendency, while positive values are an indication of structure-breaking tendency due to hetero-molecular interaction between the component molecules of the mixtures. The positive values of excess adiabatic compressibility which indicates the loosely packed molecules in the mixtures resulting due to shape and size. The variation of excess adiabatic compressibility with increasing mole fraction of 2-chlorophenol is given in table 1.3. Table 1.3 shows that the excess adiabatic compressibility at 303K has a negative deviation for the entire concentration range of phenol. The magnitude of negative deviation reaches a maximum at X1= 0.5124 mole fraction of 2-chlorophenol and then becomes less and less negative with further increase in concentration of 2-chlorophenol in MMA. The excess free length and excess molar volume also exhibits a similar behaviour as that of excess adiabatic compressibility at 303 K. Negative deviations of β^E, L_f^E and V^E at 303 K has been observed from the ideal behaviour.

Excess adiabatic compressibility at 303K shows a negative deviation for the entire composition range of MMA. The deviation becomes increasingly negative with increasing strength of interaction between the components of liquid mixture. In MMA-2-Chlorophenol system, phenol is a highly associated liquid and acetone is highly polar and also a proton acceptor. Hence, in the present binary mixture MMA-2-Chlorophenol, the specific interaction responsible for association is likely to be through hydrogen bonding, dipole-dipole interactions or formation of complexes due to charge transfer. In MMA-2-Chlorophenol system, the complex formation may be through hydrogen bonding between MMA-2-Chlorophenol molecules. From the structure of the molecules of the constituents, it can be inferred that the oxygen atom of carbonyl group ($C = O$) of MMA may be involved in $O - H - - - O$ bonding with the hydroxyl group (OH) of 2-Chlorophenol molecule. L_f^E at 303 K also shows negative deviation for the entire composition range of 2-Chlorophenol. The negative deviation in L_f^E indicates that ultrasonic waves cover a longer distance due to decrease in intermolecular free length describing the dominant nature of hydrogen bonding between unlike molecules of the binary mixture. From the Table 1.3, the excess internal pressure (π_i^E) which is usually described in terms of molecular interaction, whose negative excess values for all the

liquid systems suggest that strong molecular association between the unlike molecules.

Table 1: The Value of Density (ρ), Viscosity (η), Velocity (U) and Molar Volume (V_m) of 2-Chlorophenol with Methyl Methacrylate at 303 k

Concentration		Density (ρ) Kg/m^3	Viscosity (η) ($\times 10^{-3}$ NS m^{-3})	Ultrasonic velocity (U) (ms^{-1})	Molar volumes V_m (m^3/mol)
X1	X2				
0	1	938	1.3524	1175	106.85
0.0797	0.9203	951	1.2551	1229	107.7
0.2504	0.7496	965	1.2942	1247	111.23
0.438	0.562	986	1.4211	1291	114.23
0.6452	0.3548	994	1.5098	1313	119.22
0.8752	0.1248	1005	1.5929	1335	124.45
1	0	1221	2.2601	1400	105.34

Table 2: The Value of Adiabatic Compressibility (β), Free Volume (V_f), Free Length (L_f), Internal Pressure (π_i) and Gibbs Free Energy ($\triangle G$) of 2-Chlorophenol with Methyl Methacrylate at 303 k

Concentration		Adiabatic Compressibility (β) (N^{-1}m^2)$\times 10^{-10}$	Free Volume (V_f) (m^{3}mol^{-1})$\times 10^{-8}$	Free length (L_f) (m) $\times 10^{-10}$	Internal Pressure (π_i) (Pa) $\times 10^{-4}$	Gibbs free energy ($\triangle G$) (KJmol^{-1}) $\times$ 10^{-20}
X1	X2					
0.0000	1.0000	7.7192	9.1493	5.5125	437	2.0834
0.0797	0.9203	6.9571	11.3170	5.2333	404	2.0785
0.2504	0.7496	6.6662	11.8371	5.1228	390	2.0782
0.4380	0.5620	6.0821	11.6583	4.8932	385	2.0782
0.6452	0.3548	5.8303	11.7884	4.7908	373	2.0787
0.8752	0.1248	5.58344	12.0811	4.6883	359	2.0799
1.0000	0.0000	4.1772	8.00718	4.0551	461	2.0807

3.2. C^{13} NMR Studies

NMR parameters (nmr = giao) were calculated with a single-point calculation, using one functional and basis set combinations; B3LYP/6-311+G(2d, p) using the optimized

Table 3: The Excess Parameter Value of 2-Chlorophenol with Methyl Methacrylate at 303 k

Concentration		Excess Molar volumes V_m^E (m^3/mol)	Excess Adiabatic compressibility β^E / ($\times 10^{-10}$ m^2 N^{-1})	Excess Free Length L_f^E/($\times 10^{-10}$m)	Excess Free Volume V_f^E / ($\times 10^{-8}$ m^3mol^{-1})	Excess Internal Pressure π_i^E / ($\times 10^6$N m^{-2})	Gibb's Free Energy $\blacktriangle G^{*E}$ / ($\times 10^{-20}$KJmol^{-1})
X1	X2						
0.0000	1.0000	0	0	0	0	0	0
0.0559	0.9441	−104.49	−4.9393	−4.3343	−5.8390	−493	−2.0855
0.1858	0.8142	−100.96	−5.2302	−4.4449	−5.3197	−507	−2.0859
0.3475	0.6525	−97.96	−5.8143	−4.6745	−5.4984	−512	−2.0858
0.5541	0.4459	−92.97	−6.0661	−4.7768	−5.3688	−524	−2.0853
0.8274	0.1726	−87.73	−6.3130	−4.8794	−5.0754	−538	−2.085
1.0000	0.0000	0	0	0	0	0	0

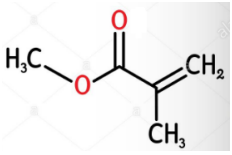
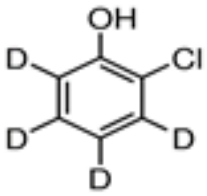
structures from the analysis. This one available and basis set combination was selected due to previous calculations giving good agreement between theoretical calculated chemical shifts [31–33]. NMR studies were used to shed light on the underlying mechanism of solubilization and to establish the preferential interactions simultaneously with functional groups of binary mixtures. The detection and analysis of the chemical shift perturbation ($\triangle\delta$) in NMR spectra has been extensively applied to prove the existence of solvent-solute interactions [34–35]. The downfield shift (to lower magnetic fields) of the resonance relative to the first component is represented by a negative sign ($-\triangle\delta$) and an upfield shift (to higher magnetic fields) is shown by a positive sign ($+\triangle\delta$).

^{13}C NMR spectra of pure and the equimolar binary mixtures of 2-chlorophenol, MMA, 2-Chlorophenol+MMA are shown in figs. 1- 3. In the case of pure acids, the carbon of the COOH group of MMA absorbs at 164ppm respectively. Mixing of MMA with 2-chlorophenol under investigation leads to considerable shifts in the position of carbon absorption peaks of MMA at 166ppm. These are summarized in Table 1.4. The sign and magnitude of these chemical shifts give information about the H-bonding interaction between heteromolecules.

3.3. Discriminating Weak Interaction Types by Filling Color to RDG Isosurface

The reduced density gradient (RDG) is calculated using Multiwfn. [36] Such as RDG is then visualized, from which the hydrogen bond can be easily recognized. By combining the RDG function and the $r(r)$ function, we can distinguish between the type and

Table 4: Carbon Chemical Shift Data for the Pure and Binary Systems.

Molecules	Carbon in	δ (ppm)	δ in mixture (ppm)	$\nabla\delta$ (ppm)
MMA 	**O-C=O**	**164.466**	**166.302**	**1.836**
	-C=	125.008	122.692	−2.316
	=CH2-	112.153	119.104	6.951
	-CH3	45.718	47.393	1.675
	-CH3	8.462	7.593	−0.869
2-chlorophenol 	-C-OH	134.1476	136.580	−2.432
	-C-CL	121.2672	121.087	0.180
	-CH-	112.8623	112.270	0.593
	-CH-	111.7718	111.665	0.107
	-CH-	105.426	103.896	1.531
	-CH-	102.2849	102.830	−0.545

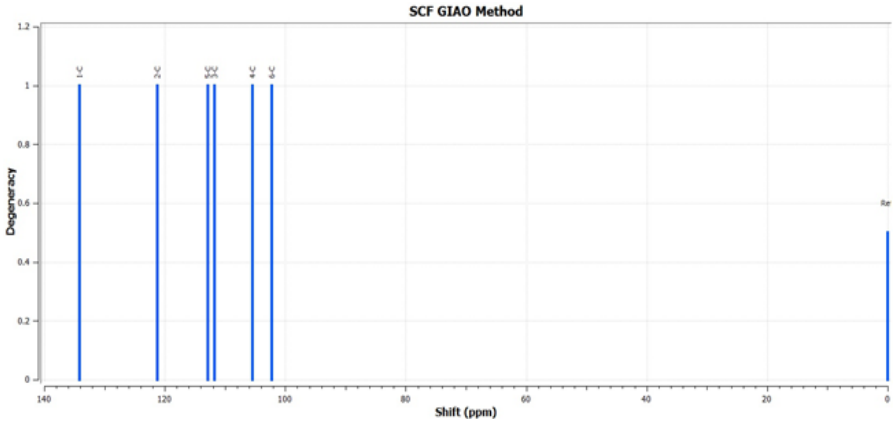


Figure 1: ^{13}C NMR Spectrum of Pure 2-Chlorophenol at DFT/BYLYP/6-311++

intensity of weak interaction [37]. The equation can be expressed as

$$RDG(r) = \frac{1[\nabla\rho(r)]}{2(3\pi^2)^{\frac{1}{3}}\rho(r)^{\frac{4}{3}}} \tag{1}$$

$$\Omega(r) = \sin n(\lambda_2(r))\rho(r) \tag{2}$$

where *RDG* is the reduced density gradient and $\rho(r)$ is the total electron density. According to atom in molecule (AIM) theory, [38] the relationship between the second largest Eigen value λ_2 and $\rho(r)$ of the electron density Hessian matrix as shown in Eq. (2), $\rho(r)$ is an important measure of weak interaction intensity, while the type of weak interaction is represented by the sign λ_2 function.

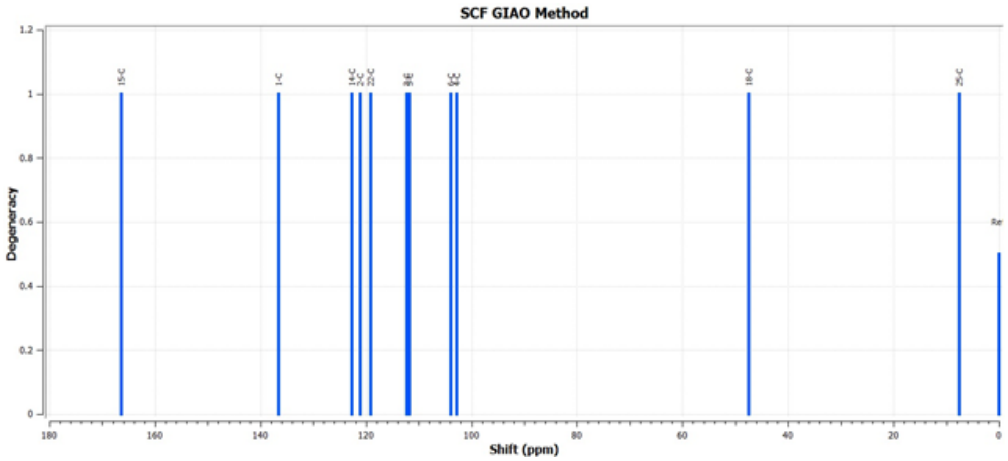


Figure 2: ^{13}C NMR Spectrum of 2-Chlorophenol with MMA at DFT/BYLYP/6-311++

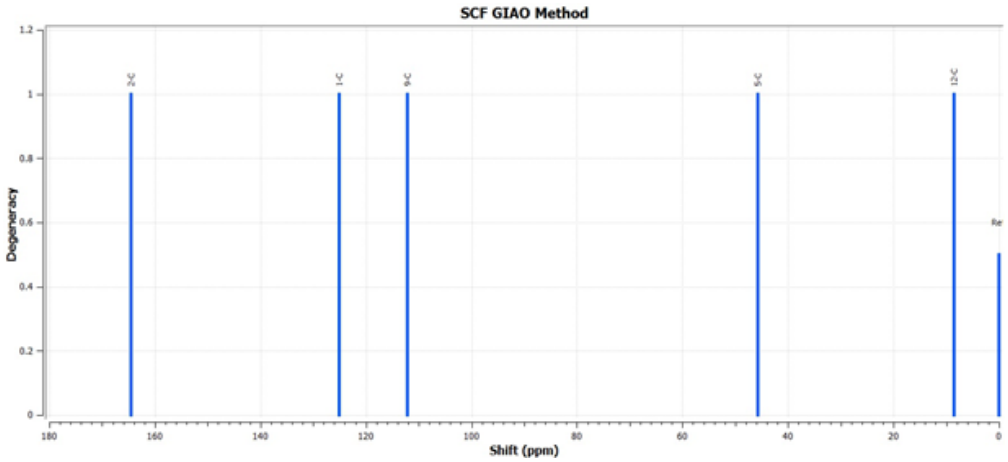


Figure 3: ^{13}C NMR Spectrum of Pure MMA at DFT/BYLYP/6-311++

Therefore, the weak interactions of different types can be analyzed by drawing the scatter graph of function 1 (RDG) and function 2($\Omega(r)$). The function obtained by multiplying the function of $\rho(r)$ and sign (λ_2) and thus yielding the RDG isosurface is shown in Fig. 4 (a) with a contour value of 0.5 and the RDG isosurface ranging from −0.04 to 0.02. The spike of the hydrogen bond is located at −0.036 a.u., which indicates that the hydrogen bond is extremely strong in the phenol with methyl acetate mixture. Similarly, the weak interactions can be distinguished in Fig. 3.6(b). It can be explicitly observed from Fig. 4 (b) that there is a strong hydrogen bond between OH .....O=C.

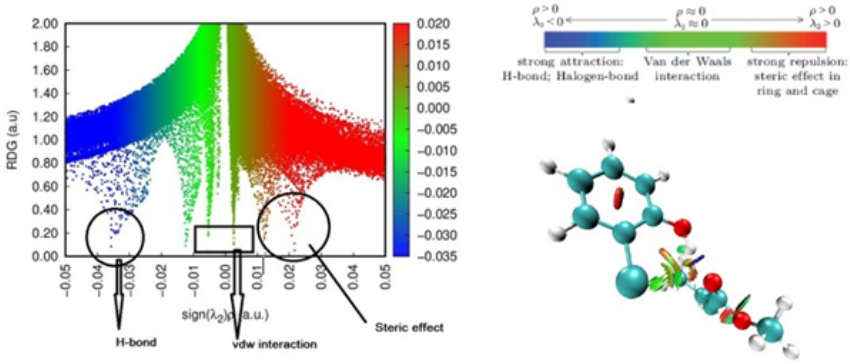


Figure 4: (a) Plot of Reduced Density Gradient (RDG) versus $\Omega(r)$ for Function Value 1 and Function Value 2. (b). (Color Online) (b) Different Types of Weak Interactions represented by Different Color Gradients as well as RDG Isometric Surfaces.

4. Conclusion

The various acoustical parameters such as adiabatic compressibility, relaxation time, free length, free volume, internal pressure, and Gibb' free energy have been evaluated from the measured ultrasonic velocity, density and viscosity values for the binary mixtures. The excess thermo dynamical functions such as the excess values of Molar Volume (V_m^E), adiabatic compressibility (β^E), free length (L_f^E), free volume (V_f^E), internal pressure (π_i^E) and Gibb's Free Energy ($\triangle G^E$) are calculated for the ternary mixtures of 2-chlorophenol with MMA in the temperature range 303k. All these parameters show negative deviation in the composition range X1= 0-1 mole fraction of 2-chlorophenol and at room temperatures studied. The mixtures show a maximum negative deviation at 1:1 ratio indicating that the formation of complexes is much stronger at this temperature. In the binary mixtures studied, the formation of complexes is due to the formation of hydrogen bonds between the oxygen of carbonyl group (C=O) of MMA, with the hydroxyl group (OH) of 2-chlorophenol. ^{13}C NMR spectra compliment the existence of an H-bond between the constituents. Since both the disbandment of MMA and 2-chlrophenol intermolecular hydrogen bonding causes shielding at the COOH carbon site, it is only the chemical shift of carbon of MMA that indicates the strength of hydrogen bonding.

References

[1] Thirumaran, S., Mathammal, R. and Thenmozhi, P. (2012), *Chem. Sci. Trans.* **1** (3), 674 – 682.

[2] Thirumaran, S. and George, D. (2009), *ARPN J Eng and Appl Sci.* **4**, 1 – 11.

[3] Rajagopal, K. and Chenthilnath, S. (2010), *Ind. J. Pure and Appl. Phys.* **48**, 326 – 333.

[4] Ali, A. Nain, A. K., Chand, D. and Lal, B. (2005), *Ind. J. Chem.* **44**A, 511 – 515.

[5] Wankhede, D. S., Wankhede, N.N., Lande, M. K. and Arbad, B.R. (2006), *Ind. J. Pure and Appl. Phys.* **44**, 909 – 916.

[6] Nayak, J. N., Mrityunjaya, I.A. and Aminabhavi, T.M. (2003), *J. Chem. Eng. Data* **48**, 1489 – 1494.

[7] Radhamma, M., Sivakumar, K. and Rao, M.V.P. (2004), *Ind. J. Chem. Technol.* **11**, 710 – 713.

[8] Trenzado, J. L., Matos, J.S., Segado, L. and Carballo, E. (2001), *J. Chem. Eng. Data* **46**, 974 – 983.

[9] Kannappan, V. and Santhi, R. J. (2004), *Ind. J. Chem.* **43** A, 1431 – 1433.

[10] Garcia, B., Alcalde, R., Aparicio, S. and Leal, J. M. (2002), *Phys. Chem. Chem. Phys.* **4**, 5833 – 5840.

[11] Stickler, M. and Rhein, T. (2000), *Polymethacrylates* in Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim.

[12] Webb, J. C. and Spencer, R. F. (2007), *J. Bone Joint Surg Br.* **89**, 851 – 857.

[13] Kubendran, R., Liakath Ali Khan, F., Asghar, J., Aravinthraj, M. and Udayaseelan, J. (2011), *Arch. Appl. Sci. Res.* **3** (2), 568 – 576.

[14] Udayaseelan, J., Liakath Ali Khan, F., Asghar, J., Aravinthraj, M. and Kubendran, R. (2011), *Arch. Appl. Sci. Res.* **3** (3), 296 – 301.

[15] Becke, A.D. (1993), *J. Chem. Phys.* **98**, 5648.

[16] Lee, C., Yang, W. and Parr, R.G. (1988), *Phys. Rev. B.* **37**, 785.

[17] Glendenning, E.D., Reed, A.E. and Carpenter, J.E. (1998), Weinhold, NBO version 3.1, TCL, University Wisconsin, Madison.

[18] Erin R. Johnson, ShaharKeinan, Paula Mori-Sa´nchez, Julia Contreras-Garci ´a, Aron J.Cohen, Weitao Yang (2010), *J. Am. Chem. Soc.* **132**, 6498 – 6506.

[19] Lu. Tian, Feiwu Chen, Multiwfn (2012), A multifunctional waveform analyzer, *J. Comput. Chem.* **33**, 580 – 592.

[20] William Humphrey, Andrew Dalke, Klaus Schulten (1996), VMD - Visual Molecular Dynamics, *J. Molec. Graphics.* **14** (1), 33 – 38.

[21] Wankhede, D.S., Lande, M.K. and Arbad, B.R. (2005), *J Chem Eng Data* **50**, 261.

[22] Aralaguppi, M.I. and Baragi, J.G. (2006), *J Chem Thermodyn* **38**, 434.

[23] Eyring, H. and Kincaid, J.F. (1938), *Journal of Chemical physics* **6**, 620 – 629.

[24] Rajendran., et.al. (1994), *Bull World Health Org* **72**, 985 – 996.

[25] Nikolic.,et.al. (1983), *Fusion* **3**, 259.

[26] Bellamy et.al., *Proc. Roy. Soc.* (London) **289**, (1965), 509.

[27] Mehta, S.K., Ram, G., Rajat, C. and Bhasin, K.K. (2009), *J. Chem. Thermodyn.* **41**, 1389.

[28] Ali, A., Hyder, S. and Nain, A.K. (2000), *Ind.J. Phys.* **74** B, 63.

[29] Johnson, E.R., et al. (2010), *J. Am. Chem. Soc.* **132**, 6498.

[30] Fraser, J. A., Lambert, L. K., Pierens, G. K., Bernhardt, P. V. and Garson, M. J. (2013), *J. Nat. Prod.* **76**, 1432 – 1440.

[31] White, A. M., et al. (2015), Rearranged diterpenes and norditerpenes from three Australian Goniobranchus mollusks, *J. Nat. Prod.* **79**, 477 – 483.

[32] Pierens, G.K., Venkatachalam, T. and Reutens, D.C. (2015), *Magn. Reson. Chem.*

[33] Avent, A.G., Chaloner, P.A., Day, M.P., Seddon, K.R. and Welton, T. (1994), *J. Chem. Soc. Dalton Trans.* **23**, 3405 – 3413.

[34] Gupta, M. and Kumar, S. (2014), Proceeding of the International Conference on Machine Learning, Electrical and Mechanical Engineering (ICMLEME'2014) Jan 8–9, 2014 (Dubai (UAE)).

[35] Chierotti, M.R. and Gobetto, R. (2008), *Chem. Commun.* 1621 – 1634.

[36] Mehta, S.K., Ram, G., Rajat, C. and Bhasin, K.K. (2009), *J. Chem. Thermodyn.* **41**, 1389.

[37] Lu, T. and Chen, F. (2012), *J. Comput. Chem.* **33**, 580.

[38] Tang, W., Sanville, E. and Henkelman, G. (2009), *J. Phys.: Condens. Matter.* **21**, 084204.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 124 – 132

http://www.islamiahcollege.edu.in

THERMO DYNAMICAL PROPERTIES AND FTIR STUDIES OF THE BINARY MIXTURE 2-CHLOROPHENOL IN METHYL ACETATE AT DIFFERENT TEMPERATURES

J. Asghar, L. Arul and S. Sakki

Department of Physics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

Molecular interactions in binary mixtures of 2-chlorophenol with Methyl acetate in benzene system at different temperatures have been studied using the ultrasonic method. Ultrasonic velocity, density and viscosity measurements have been carried out in the above system at different temperatures. These experimental data have been used to calculate adiabatic compressibility (β), free length (L_f), free volume (V_f), internal pressure (π_i), viscous relaxation time (τ). In addition, the results have been used to estimate the ultrasonic parameters in respective components. The intermolecular interaction between Methyl acetate and 2-chlorophenol was found to be effective. It showed a strongness in the hydrogen bonding according to the theoretical FTIR spectra for the mixture of Methyl acetate and 2-chlorophenol, which agrees with the thermodynamical parameter values.

Keywords: Molecular Interaction, Ultrasonic Velocity, Thermodynamical Parameters, Ultrasonic and FT-IR Method.

1. Introduction

The study of molecular interaction in liquid mixtures is important for understanding the structural characteristics of molecules. The structural arrangement and form of the molecules are influenced by intermolecular interactions. Microwave absorption studies of dielectric relaxation of polar molecules in non-polar solvents have been widely utilized to examine molecular structures, including molecular interactions, in liquid mixtures [1, 2]. Phenol and its derivatives play an important role in the production of colors, medicines, polymers, insecticides, explosives, and industrial solvents. Esters are also used to make cellulose, lipids, cosmetics, thermoplastics, lacquers, and resins, as well as serving as an important artificial flavoring [3-8]. Paint, nail polish remover,

and other items commonly include methyl acetate as a solvent. They also function as hydrogen bond acceptors in hydrogen bonding. The thermodynamical characteristics of a liquid mixture are crucial for creating many theoretical models and predicting how the mixture is agglomerated, as well as the strengthening of intermolecular and intramolecular connections due to various industrial uses [9 – 10]. In the current work, an attempt has been made to examine the hydrogen bonding between the system 2-chlorophenol with Methyl acetate in benzene at various temperatures, keeping both industrial and scientific interests in mind. This research contributes to a better understanding of the molecular orientation process.

2. Materials and Method

2.1. Materials

The mixtures 2-chlorophenol and MA of various concentrations ranging from 0 M to 0.1M were prepared by taking analytical reagent grade and spectroscopic reagent grade chemicals with the minimum assay of 99.9% and procured from E. Merck Ltd (India). The above experimental solutions are of equimolar concentrations of different solutions constituting the system that is under study.

2.2. Experimental Details

The ultrasonic velocity measurements in the 2-chlorophenol with MMA solutions are made in the ultrasonic Interferometer of fixed frequency 2 MHz (Model F-81 Mittal enterprises, New Delhi) at 303k temperature. The values of densities are measured at 303k temperature using specific gravity bottle by standard operating procedure and the viscosity using Ostwald's viscometer with an accuracy of ±0.001% standardized with double distilled water. The theoretical FTIR studies performed the DFT method at B3LYP/6311++ basic set.

2.2.1 Thermodynamic Parameters

Adiabatic Compressibility (β):

$$\beta = \frac{1}{U^2\rho}$$

where U is the velocity in m/s, ρ is the density in kg/m^3.

Free Volume (V_f):

$$V_f = \left(\frac{M_{eff}U}{K\eta}\right)^{\frac{2}{3}}$$

where V_f is free volume in m^{3}mol^{-1}K is a constant independent of the nature of liquids and temperature. (K=4.28 $\times$ 10^9), η is the viscosity in NSm^{-2} and U is the velocity in

m/s, M_{eff} is the effective molecular weight, which is expressed as

$$M_{eff} = (X_1M_1 + X_2M_2 + X_3M_3).$$

Free Length (L_f):

$$L_f = K_T\sqrt{\beta}$$

L_f is the free length in meter, β is the adiabatic compressibility, and K is Jacobson's constant. This constant is a temperature-dependent parameter whose value at any temperature (T) is given by $(93.875 + 0.345T) \times 10^{-8}$.

Internal Pressure (π_i):

$$\pi_i = bRT\left(\frac{K\eta}{U}\right)^{\frac{1}{2}}\left(\frac{\rho^{\frac{2}{3}}}{M_eff^{\frac{7}{6}}}\right)$$

where π_i is the internal pressure in P_a, b is the packing fraction assumed as 1.78 for polymers R is the Universal gas constant 8.314, and T is the temperature in Kelvin.

Viscous Relaxation Time (τ):

$$\tau = \frac{4}{3}\eta\beta$$

where η is the viscosity in NSm^{-2} and β is the adiabatic compressibility in $N^{-1}m^2$.

3. Results and Discussion

3.1. Ultrasonic Studies

The values of density (ρ), Viscosity (η), ultrasonic velocity (u) were taken for the three temperatures are displayed in the table-1. Furthermore, from these observed values various acoustical parameters like adiabatic compressibility (β), free length (L_f), free volume (V_f), internal pressure (π_i), acoustic impedance(Z), molar volume (V_m) have been evaluated and is presented in the tables 2 and 3 and figure 1-2. It is observed that density, velocity decreases with an increase in mole fraction of alcohols. This is due to the number of hydrocarbon groups or chain length of methyl acetate and decrease in sound velocity occurs at a lower mole fraction of the mixture. This behavior is different from the ideal mixture behavior. The present free volume result can be interpolated qualitatively by taking into account the fact that (i) contraction due to the free volume difference between unlike molecules (ii) contraction due to hydrogen bond formation between 2-chlorophenol and Methyl acetate through C=O...H-O and (iii) Specific interactions between the 2-chlorophenol and Methyl acetate molecules. Addition of the pure methyl acetate in 2-chlorophenol disrupts the latter's associated structure, causing free molecules.

From Table-2, it is seen that the values of adiabatic compressibility, free length, free volume and internal pressure for binary mixture increase with the concentration of solute molecules. This result indicates that molecular association is taking place

between 2-chlorophenol and acetate molecules. This association is due to hydrogen bonding between the hydrogen atom of the phenol molecule and the oxygen atom of the Methyl acetate molecule (O-H...O = C) [11]. These 2-chlorophenol molecules may interact with dipole-dipole forces, in addition to hydrogen bonding with acetate molecules in the mixture. However, the increase in temperature makes the free length increase as expected due to the thermal expansion of the liquids. It is one of the predomination factors to the nature of ultrasonic velocity in the mixtures [12]. The decrease in the value of adiabatic compressibility and free length with increase in ultrasonic velocity further strengthens the process of complex formation between the molecules through hydrogen bonding [13] due to which structured arrangement is affected. The variation of free volume and internal pressure with mole fraction are given in Table 2. It is observed that as the concentration of the 2-chlorophenol increases, free volume decreases, whereas internal pressure increases. Due to this, close packing of molecules inside the shield takes place. The increase in pressure also indicates chelation through hydrogen bonding, supporting the present investigation [14-15]. However, as temperature rises, increased free volume and decreased internal pressure are noted in this system at different temperatures.

Table 1: The Values of Density (ρ), Viscosity (η) and Velocity (U) of 2-Chlorophenol+ Methyl Acetate + Benzene at 303K, 313K and 323K

Mole Fraction		**303K**			**313K**			**323K**		
X_1	X_3	ρ **Kgm^{-3}**	η **10^{-3}Nsm^{-2}**	U **ms^{-1}**	ρ **Kgm^{-3}**	η **10^{-3}Nsm^{-2}**	U **ms^{-1}**	ρ **Kgm^{-3}**	η **10^{-3}Nsm^{-2}**	U **ms^{-1}**
0.0000	0.6004	1065	0.9954	1559	1061	0.8992	1389	1058	0.7347	1347
0.1001	0.5002	1062	1.1202	1339	1057	0.9024	1288	1050	0.7809	1256
0.2005	0.4001	1061	2.0165	1312	1055	1.0702	1256	1048	0.7854	1229
0.3003	0.3003	1059	2.0987	1284	1043	1.0987	1227	1045	0.9674	1206
0.4004	0.2002	1055	2.1812	1255	1049	2.0716	1203	1041	1.0501	1183
0.5005	0.1002	1052	2.2463	1260	1046	2.1367	1208	1038	2.0152	1186
0.6009	0.0000	1047	2.3452	1263	1043	2.2189	1211	1035	2.0974	1204

Table 2: The Values of Adiabatic Compressibility (β), Free Length (L_f) and Free Volume (V_f) of 2-Chlorophenol+ Methyl Acetate + Benzene at 303K, 313K and 323K

Mole Fraction		303K			313K			323K		
X_1	X_3	β 10^{-10} $N^{-1}m^2$	L_f $10^{-10}m$	V_f $10^{-7}m^3$ mol^{-1}	β 10^{-10} $N^{-1}m^2$	L_f $10^{-10}m$	V_f $10^{-7}m^3$ mol^{-1}	β 10^{-10} $N^{-1}m^2$	L_f $10^{-10}m$	V_f $10^{-7}m^3$ mol^{-1}
0.0000	0.6000	5.1435	5.0384	3.2982	6.1185	5.5660	3.1672	6.5044	5.8162	3.3011
0.1000	0.5000	7.1836	5.9335	2.6811	7.7537	6.2465	2.7582	8.1844	6.5031	3.3121
0.2000	0.4000	7.4757	6.0485	2.4271	8.1521	6.3985	2.6281	8.5425	6.6382	2.9861
0.3000	0.3000	7.7947	6.1715	2.1891	8.5387	6.5427	2.4441	8.8855	6.7651	2.7551
0.4000	0.2000	8.1577	6.3085	2.149	8.9048	6.6595	2.3841	9.3285	6.9595	2.6971
0.5000	0.1000	8.1277	6.2965	1.9511	8.8598	6.6525	2.1771	9.2845	6.9082	2.5041
0.6000	0.0000	8.1187	6.2935	1.9191	8.8428	6.5115	2.1401	9.2655	6.9021	2.5691

3.2. FTIR Spectrum Analysis

FTIR spectroscopy is an efficient instrument analysis tool for the characterization of polar chemical substances and molecular structure [16]. The FTIR spectrum of the pure and binary mixtures was performed in the Gaussian 09 windows at the B3LYP/6-311++ basic set. The spectra are shown in Fig. (1-3). The spectra for the mixture of Methylacetate-2-chlorophenol at equal mole fractions showed a significant behavior for the hydrogen bonding. They explained the non-ideal behavior and the deviation in the thermodynamic properties as stated in the previous sections. As seen in the FTIR spectra, the broadening in the hydrogen peak referred to the intermolecular interaction effect and the sharpening was explained as the intramolecular interaction effect. From figure 1-3, the pure 2-chlorophenol spectra show a broad O-H stretch at 3633 and 3232 cm^{-1}, occurs, while the most important peak in the pure methyl acetate shows a strong C=O peak at 1796 cm^{-1}. While, for the mixture of Methyl acetate –2-chlorophenol system, the equimolar causes a slight shift in the place of the C=O peak to a wavenumber at 1736 cm^{-1}. The hydrogen bonding effect was found to be strong for the present mixture and led to the strong intermolecular interaction between Methyl acetate and 2-chlorophenol. The result of the FTIR spectra agrees with the impact of the thermodynamic parameter and the conclusions stated by other researchers [17].

Table 3: The Values of Internal Pressure (π_i), Specific Acoustic Impedance (Z) and Viscous Relaxation Time (τ) of 2-Chlorophenol+ Methyl Acetate + Benzene at 303K, 313K and 323K

Mole Fraction		303K			313K			323K		
X_1	X_3	π_i 10^{-6}Pa	Z 10^3Kg $m^{-2}S^{-1}$	τ 10^{-12}S	π_i 10^{-6}Pa	Z 10^3Kg $m^{-2}S^{-1}$	τ 10^{-12}S	π_i 10^{-6}Pa	Z 10^3Kg $m^{-2}S^{-1}$	τ 10^{-12}S
0.0000	0.6000	140.5	94.9002	11.6122	136.6	89.1022	10.3912	132.6	87.4412	9.3261
0.1000	0.5000	143.3	94.8966	11.2031	145.1	92.2810	10.1032	136.7	90.1244	9.2213
0.2000	0.4000	149.6	94.2433	11.9111	147.5	92.1233	10.8222	142.4	90.1009	9.8230
0.3000	0.3000	157.2	92.7152	12.2271	151.8	90.6221	9.1321	146.8	88.3051	10.2287
0.4000	0.2000	157.9	90.8292	13.3212	153.2	98.5925	12.1412	147.4	86.2295	11.2272
0.5000	0.1000	166.7	89.6562	13.6120	159.9	87.2392	12.3023	151.9	85.9102	11.5210
0.6000	0.0000	167.1	89.8085	13.5520	160.5	87.7125	11.3255	149.3	85.4155	11.4350

4. Conclusion

In the present investigation, the various acoustical parameters such as adiabatic compressibility, free length, internal pressure and acoustic impedance have been evaluated from ultrasonic velocity, density and viscosity for the binary liquid mixtures of 2-chlorophenol with Methyl acetate at different temperatures. From the above studies, it is concluded that the interactions are present between the 2-chlorophenol + methyl acetate and these interactions are observed to be decreasing with the increase of temperatures. The result of the FTIR shows an agreement to the result of the thermodynamical parameters and proves that the intermolecular hydrogen bonding between Methyl acetate and 2-chlorophenol is to be strong for the equimolar mixture and can be concluded from the slight shift in the place of the C=O peak to a wavenumber.

References

[1] Jorg, M. and Ghoneim, A. (1995), *Turley and M. Stockhausen. Phys. Chem. Liq.* (UK), **29**, 263.

[2] Sastry, N.V., Thakor, R.R. and Patel, M.C. (2009), *J. Mol. Liq.* **144**, 13 – 22.

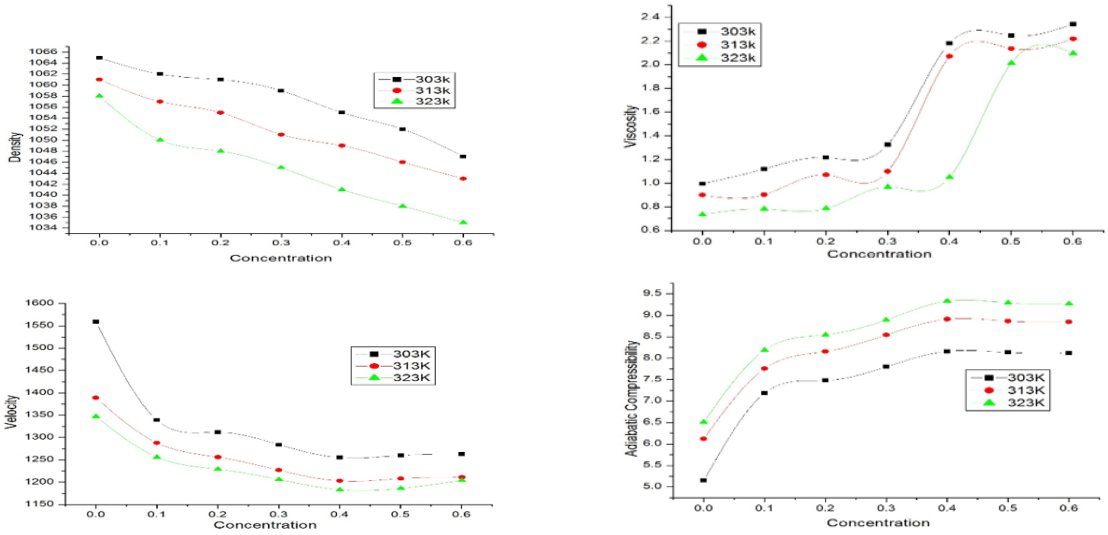


Figure 1: Plots of Density (ρ), Viscosity (η) , Velocity (U) and Adiabatic Compressibility (β) Vs Mole fraction of 2-Chlorophenol+ Methyl Acetate + Benzene at 303K,313K and 323K

[3] Reddy, G.S., Subbaiah, M.V., Boddu, V.M. and Krishnaiah, A. (2008), *J. Mol. Liq.* **141**, 94 – 98.

[4] Wankhede, N.N., Wankhede, D.S., Lande, M.K. and Arbad, B.R. (2006), *J. Chem. Thermodyn.* **38**, 1664 – 1668.

[5] Salguero, C.B., Fadrique, J.G. and Amigo, A. (2010), *J. Chem. Eng. Data.* **55**, 2905 – 2908.

[6] Verevkin, S.P., Kozlova, S.A., Emelyanenko, V.N., Nikitin, E.D., Popov, A.P. and Krasnykh, E.L. (2006), *J. Chem. Eng. Data.* **51**, 1896 – 1905.

[7] Aralaguppi, M.I., Jadar, C.V. and Aminabhavi, T.M. (1999), *J. Chem. Eng. Data.* **44**, 441 – 445.

[8] Garcia, B., Alcalde, R., Leal, J.M. and Mantos, J.S. (1997), *J. Chem. Soc. Faraday Trans.* **93**, 1115 – 1118.

[9] Mahan, Y., Liew, C.N. and Mather, A.E. (2002), *J. Solution Chem.* **31**, 743 – 756.

[10] Singh, P. J. and Sharma, K. S. (1996), Dielectric behaviour of ketone-amine binary mixtures at microwave frequencies, *Pramana* **46**, 259 – 270.

[11] Ali, A., Hyder, S. and Nain, A.K. (2000), *Indian J. Phys.* **74**B (1), 63.

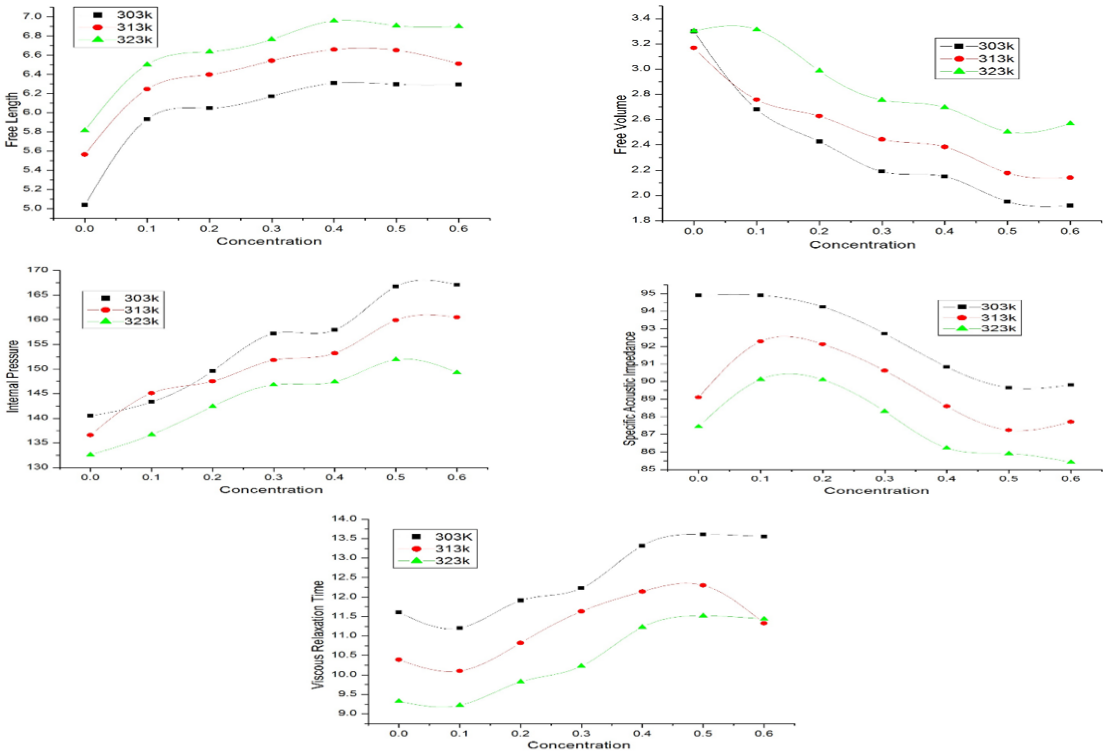


Figure 2: Plots of Free Length (L_f) , Free Volume (V_f), Internal Pressure (π_i), Specific Acoustic Impedance (Z), Viscous Relaxation Time (τ) Vs Mole Fraction of 2-Chlorophenol+ Methyl Acetate + Benzene at 303K, 313K and 323K

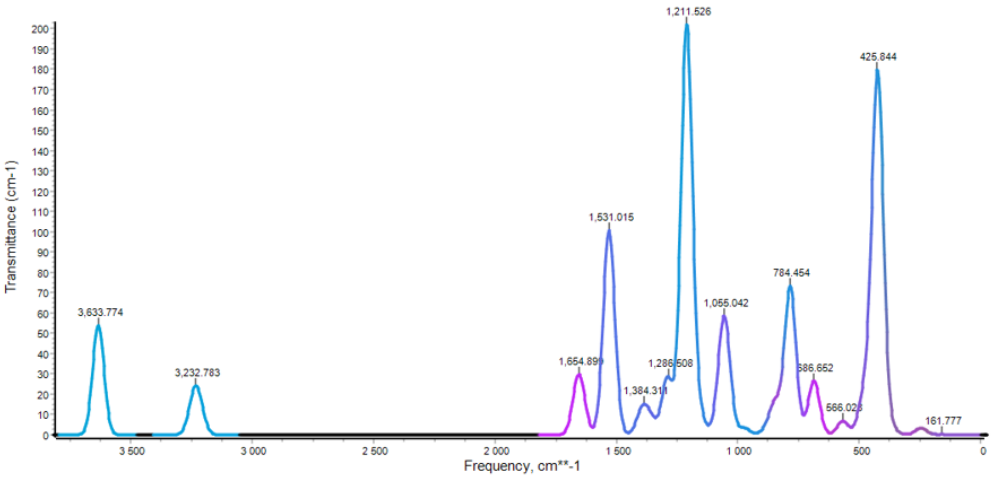


Figure 3: FTIR Spectrum of Pure 2-Chlorophenol

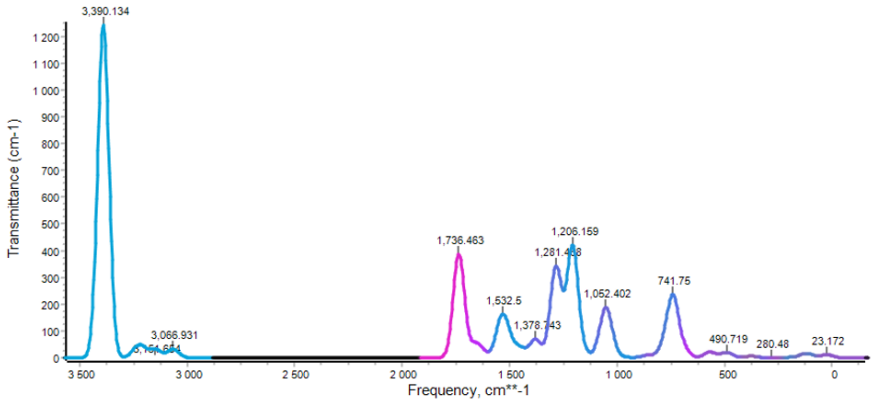


Figure 4: FTIR Spectrum of Equimolar Binary Solution of Methyl Acetate with 2-Chlorophenol

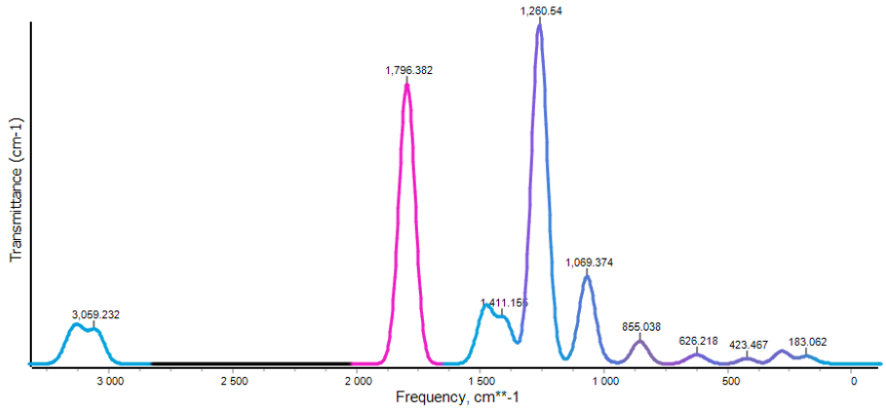


Figure 5: FTIR Spectrum of Pure 2-Methyl Acetate

[12] Madhu Rastogi, et.al. (2001), *Indian J. Pure & Applied Phys.* **40**, 256.

[13] Erying, H. and Kincaid, J. F. (1938), *J. Chem. Phys.* (USA), **6**, 620 – 629.

[14] Rajendran, V., et.al. (1994), *J. Pure & Applied of Ultrasonics* **16**, 16.

[15] Kannapan, A. N. and Palaniappan, L. (1999), *Ind. J. Physics* **73**(B), 531.

[16] Wei, Q., Guo, X., Wang, Y. and Yang, H. (2013), *Journal of Molecular Liquids* **177**, 225 – 228.

[17] Hasan, M., Hiray, A.P., Kadam, U.B., Shirude, D.F., Kurhe, K.J. and Sawant, A.B. (2011), *Journal of Chemical & Engineering Data* **47** (2), 262 – 269.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 133 – 140

http://www.islamiahcollege.edu.in

MELIA DUBIA LEAF EXTRACT MEDIATED GREEN ROUTE FOR THE SYNTHESIS OF HYDROXYAPATITE NANOPARTICLES FROM EGGSHELL BIOWASTE & ITS CHARACTERISATIONS

S. Farjana, A.M. Shaistha Praveen and J. Mohemed Ali

Department of Physics,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

In this research paper we discussed on the synthesis and characterize on green hydroxyapatite (HAPNP and GHAPNP) nano particles by green synthesis methodology. The GHAPNP nano particle is prepared by using medicinal plant Melia dubia the structured pattern of synthesis nano particle is carried out using XRD, EDAX and SEM. The anti microbial work is using gram +ve and gram -ve bacteria. The GHAPNP nano particle can be used for versatile uses due to ecological, compatible and harmless nature of 52 and 54 nm average sizes of NPs.

Keywords: Eggshell, Hydroxyapatite, Microwave-Irradiation Synthesis, Melia Dubia, green synthesis.

1. Introduction

Hydroxyapatite is equivalent to the minerals of bone and teeth by chemical configuration [1] are type of composite in nano scale mainly of hydroxyapatite and fibers [2]. The usage of calcium phosphate salts to be successfully replaced the tissues of bone over the decades. A calcium phosphate playing a significant role for tissues , bones and also for usage in medical research [3]. Hydroxyapatite represents direct physicochemical method of bonding with bone and bio material utility [4]. For the few decade biological impact coral, nacre, fish bone materials are properly derived for functional biomaterial usage [5]. Eggshell is a type of composite material consisting of calcium carbonate and organic material, calcium phosphate and magnesium carbonate for conversion of egg shell to hydroxyapatite. A microwave assisted synthesis methodology for usage of plants for synthesis of nano particle are of recent interest M.dubia leaf extract is used to synthesis nano materials.

2. Materials and Methods

Materials and Process

The chemicals employed for production are calcium carbonate derivative from eggshell [l], ethylene diamine tetra acetic acid disodium hydrogen phosphate and sodium hydroxide. All the reagents are used as obtained exclusive of supplementary refining and double distilled water as the solvent. Finely carved Melia dubia leaves are reserved in blender jar and milled well with the process of 65 ml of double distilled water. The extorts are filtered, and stored at below the $1/7^{th}$ of room temperature in Tamilnadu zone to make use of it.

Experimental Procedure

Eggshells are accumulated and engrossed in boiling water to eliminate the interior membrane and outside pollutants. After dried for an hour, they are properly grinded into powder, engrossed in sodium hypochlorite and stirred for half a day, to eradicate the unwanted organic constituents. The acquired products are extensively washed with the doubly distilled water and dried in oven for 5-6 h at 120°C. The preparatory materials used are eggshell resultant calcium carbonate, disodium hydrogen phosphate, and EDTA as chelating agent. For the synthesis of purest HAp, initially of 0.1 M of EDTA is dissolved in doubly distilled water, then eggshell consequent calcium carbonate is gradually added into the EDTA solution to form Ca-EDTA complex.

Then the equipped response combination is put in microwave oven irradiated by way of microwave for 910 seconds counting. The white precipitate is washed in double distilled water and dried in hot air oven at 120°C for 5.5 h. For the synthesis of HAPNP nanorods using leaf extract, initially 0.1 M of EDTA is dissolved in double distilled water, then eggshell derived calcium carbonate is slowly added into the EDTA solution to form Ca-EDTA complex. After that 0.07 M of Na_2HPO_4 is added drop wise added into the obtained Ca-EDTA complex solution. Then stirring is continued for 32 minutes to obtain clear transparent reaction mixture. Then the prepared reaction mixture is put in microwave oven) and irradiated with microwave for 28 minutes. The green precipitate is washed in double distilled water and dried in hot air oven at 120°C for 5.5 h.

3. Characterization Technique

Antibacterial Activity

The Anti bacterial action of sample where performed by AGARWELL diffusion methodology. The inoclum contains 1000 kCFU - ML^{-1}. The Mueller-Hinton agar plants which are properly structural analysis are used with versatile μL. The plates are then incubated in the upright position for 24 hours in a bacteriological incubator around

room ambient heat effect. After incubation, the diameters of the growth inhibition zones are measured in mm. Three replicates are carried out for each sample against each of the tested organism.

4. Result and Discussion

XRD Analysis

Figure 1 and 2 shows the XRD hydroxyapatite (HAPNP and GHAPNP) obtained using eggshell as the initial nature for calcium. The 2 theta values are well composed with the JCPDS file: 09/0432. They synthesis nature are hexagonal in nature. The table 1 shows the parameter. The average crystallite size is in 52 and 54 nm corresponding to the HAPNP and GHAPNP

Table 1: Crystallite Size from powder XRD patterns

Sample	Average crystallite size (nm)
HAPNP	52.16
GHAPNP	54.12

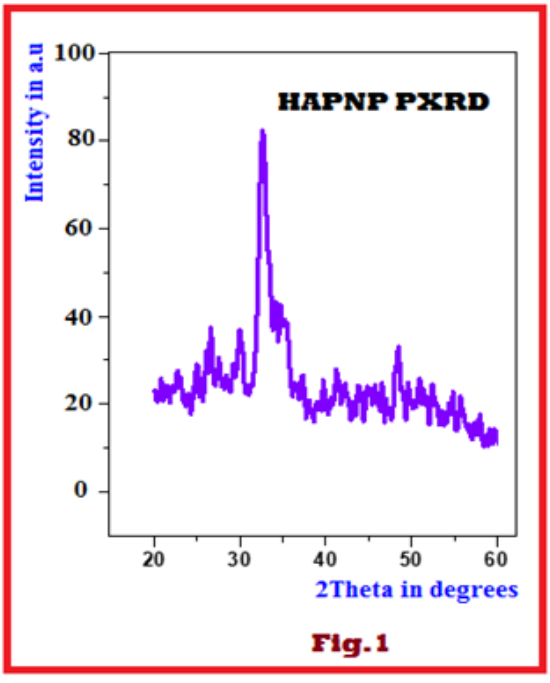


Figure 1: Powder XRD Pattern of HAPNP

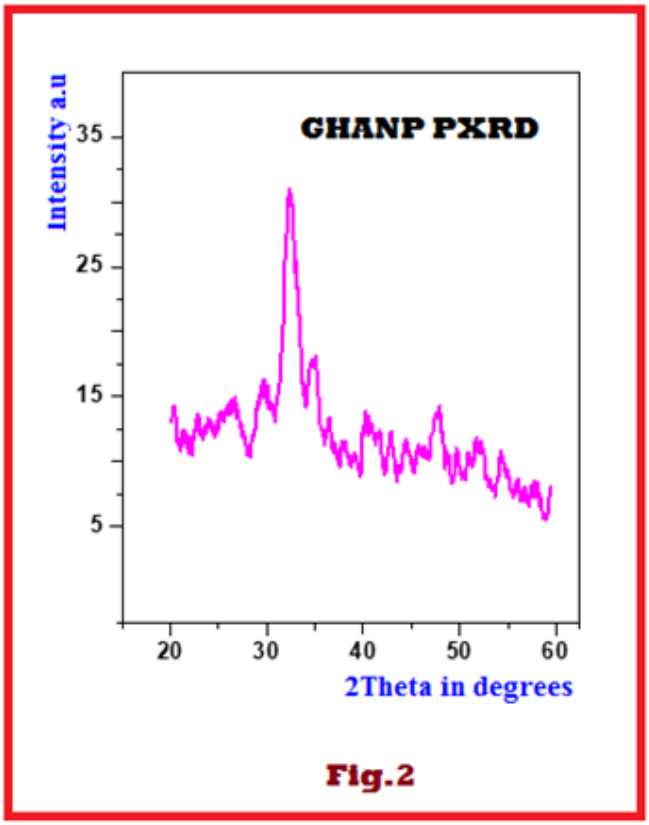


Figure 2: Powder XRD Pattern of GHAPNP

FE-SEM Analysis & EDAX Analysis

The morphological pattern of HA is analysed using FE SEM. Morphological pattern of MD : HA is displayed in figure 3a and 3b from this images the spherical and rod like pattern nano material is analysed. Formation of agglomeration crystallites is attributed to uncontrolled coagulation.

The EDAX spectrum is properly employed to get the elements representation to the sample. It is shown in figure 4a and 4b. The presence of O, Ca, B, is pattern is same element and the confirms that the sample of HA forms. The EDAX pattern (B) depicts clearly the presence of main constituents such as Ca, P and O in the structure of as-synthesized HAP nanoparticles along with C, Na and Si ions.

Figure 3: (a), (b) FESEM of HAPNP and HAPNP using Melia Dubia Leaf Extract of 30 μm and 12 μm respectively

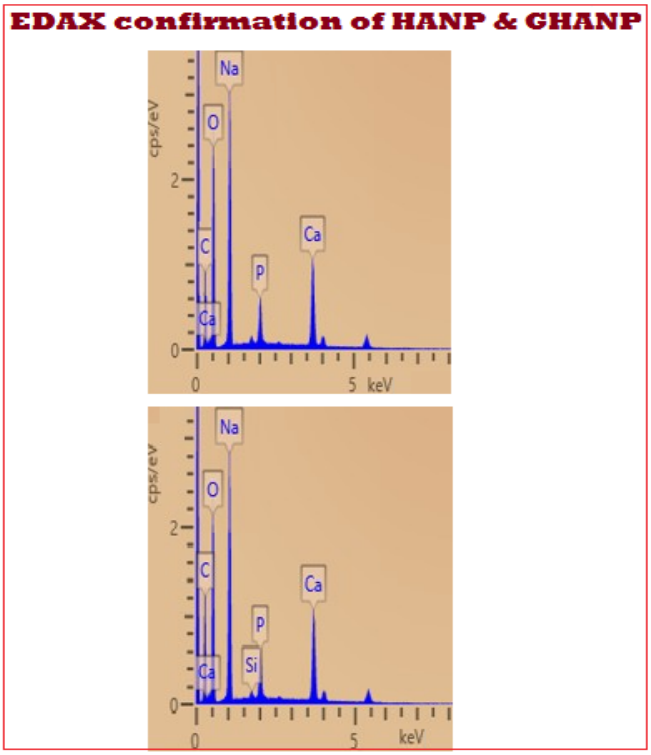


Figure 4: (a), (b) EDX Spectrum of HAPNP and HAPNP using Melia Dubia Leaf Extract

Antibacterial Activity for Plant Mediated HAPNP

The antibacterial action is portrayed for HA with the inhibition zone of E. coli and pseudomas aureus as Gram-negative bacterias and S. aureus and E. faecalis both as Gram-positive bacteria. The EDTA inhibition is 7 in E. coli, S. aureus and E. faecalis bacteria varies 12 in pseudomas aureus. The inhibition zones of the extract are 19 mm in E. coli and pseudomas aureus respectively. The inhibition zones of the extract are 18 and 21 in contrast to S. aureus and E. faecalis respectively. The inhibition zones of ciprofloxacin are 34, 21, 25 and 34 mm against E. coli, pseudomas aureus S. aureus and E. faecalis respectively. Different concentrations resulted in functional inhibition zones against four types of bacteria as mentioned properly in Table.2. The effect is due to the impact of the structure as in Fig.5 for super cell and with 10Å translation vector and 7 nm 4*4 portrayal of nanoscaling.

Table 2: Antibacterial inhibition concentration of GHAPNP

Species	Inhibition in mm
1	7
2	12
3	19
4	18
5	21
6	34
7	21
8	25
9	34

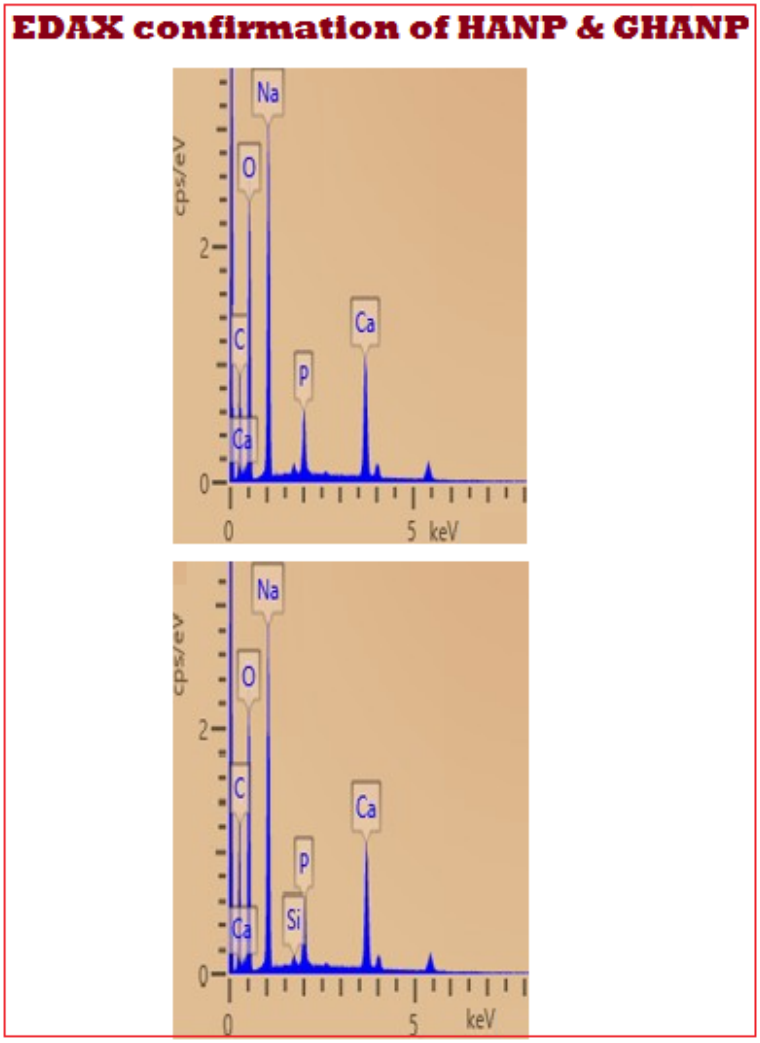


Figure 5: 3*3*3 Super cell of HA structure and 3*3*3 with 1Å translation and portrayal of 7 nm of 4*4 case for devices

5. Conclusion

The current reading completed that Melia dubia leaf extract Hydroxyapatite nanorods MD:HAPNP can be quickly green synthesized using Melia dubia leaf extract as 52 nm and 54 nm. These nanorods are low-cost, non-hazardous and ecological responsive. The green synthesized MD:HAPNP nanorods had superior antibacterial action against Gram positive and Gram negative bacteria. The outcomes of this study exemplify a extensive variety of outstanding applications of MD:HAPNP as nanorods in biomedical fields in the future. The work may be extended for mechano work and coating mechano work as well as bio-fungal work and some device uses in future.

References

[1] Seeram Ramakrishna (2004), *zheng-ming huang series on biomaterials and bioengineering, An introduction to biocomposite*.

[2] Hench, L.L. (1991), Bioceramics: From concept to clinic, *J Am Ceram Soc* **74**, 1487.

[3] Zhou, H. and Lee, J. (2011), Nanoscale Hydroxyapatite particles for bone tissue engineering, *Acta Biomaterial* **7** (7), 2769 – 2781.

[4] Derozhkin, S.V. (2010), Nanosized and nanocrystalline calcium orthophosphates, *Acta Biomatter* **6**, 715 – 34.

[5] Adeogun, A.I., Ofudje, E.A., Idowu, M.A., Kareem, S.O., Vahidhabanu, S. and Babu, B.R. (2018), Biowaste-derived hydroxyapatite for effective removal of reactive yellow 4 dye: equilibrium, kinetic, and thermodynamic studies, *ACS Omega* **3** (2), 1991 – 2000.

Part B:

HUMANITIES

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 143 – 157

http://www.islamiahcollege.edu.in

A STUDY OF E-BANKING SCENARIO IN INDIA

S. Aslam Basha and T. Mohamed Ilyas

PG & Research Department of Commerce,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
(Affiliated to Thiruvalluvar University, Serkadu, Vellore)
saslambasha2007@gmail.com
tmi-islamiah@yahoo.co.in

Abstract

The Growth of Overall economic and global markets has a role to play in transforming the modern banking scenario. E- Banking or Electronic Banking is amajor innovation in the field of Banking. Finland was the first country in the world to have taken a lead in E-banking. In India, it was ICICI Bank which initiated E-banking as early as 1997 under the brand name Infinity. Electronic banking (E-banking) is a generic term encompassing internet banking, telephone banking, mobile banking etc. Banking is now no longer confined to the branches where one has to approach the branch in person, to withdraw cash or deposit a cheque or request a statement of accounts. This research paper will introduce you to e-banking giving the meaning, functions, types, advantages and challenges in adoption of e-banking. It also aims at suggesting some ways for making e-banking successful in the developing country like India.

Keywords: E-Banking, Personal Banking, ECS.

1. Introduction

In recent years the word economy has gone through a new phenomenon which is considered as one of the most important changes in the industrial revolution i.e. The birth of "Internet based Economy". Considering the benefits of using internet the banks have started to invest in this newly created market. Banks are playing an important role in the economic development of the country. It involves investment in various sectors of the economy. The bank collects small savings from the public for investment in various projects. In general banking, the banks perform various agency services for their customer and helps in the economic development of the country. In true Internet banking, any inquiry or transaction is processed online without any reference to the

branch (anywhere banking) at any time. Providing Internet banking is increasingly becoming a "need to have" than a "nice to have" service. The net banking, thus, now is more of a norm rather than an exception in many developed countries due to the fact that it is the cheapest way of providing banking services. The rapid development of E-banking services carries risks as well as benefits.

With the rapid development of technology, internet plays a significant role in changing the banking scenario. It provides an online platform for various banking transactions through which it offers various services like online payment, online fund transfer, online stock trading and online shopping. The use of internet as a delivery channel for banking services is increasing widely in the banking sector. Internet banking facilities enable financial institutions and customers to access their accounts, transactions and getting information about financial products & Services. Now a day's most of the commercial banks have launched various services through internet banking including latest service like opening online savings bank accounts and demand for these services is increasing rapidly.

2. Introduction to e-Banking

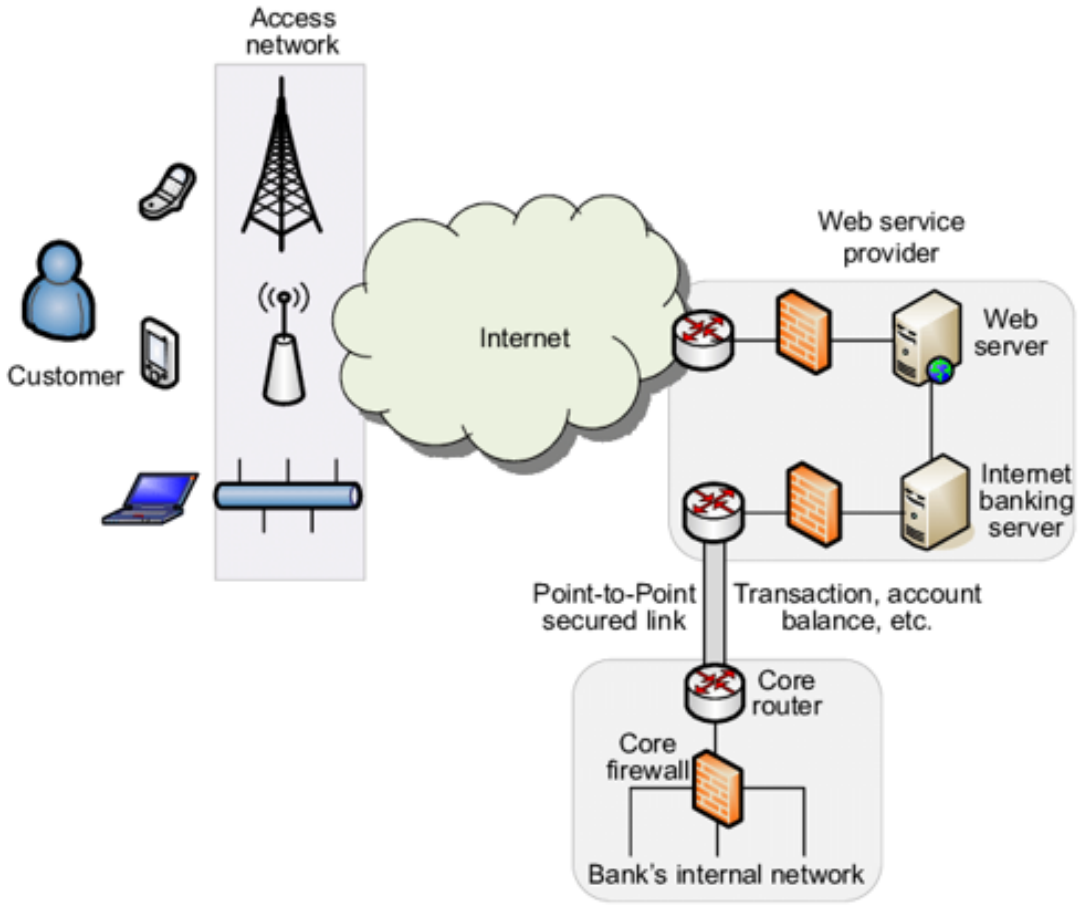
Banking/E-Banking/ online Banking/Internet Banking/personal computer banking /home banking /remoteelectronic banking/mobile banking/ web banking, these are the synonyms for the Electronic Banking. It is the electronic way of doing the banking transactions by a customer of a bank or other financial institution.

Banking consumers today have more options than before:

- "brick and mortar" institution (has a building and personal service representatives).
- "brick and click" institution (physical structure + Internet banking services).
- "virtual bank (no public building – exists only online)".

E-Banking is defined as the automated banking service available to customers through electronic, interactive communication channels. E-banking includes the systems that enable financial institution, customers, individuals or business to access accounts, transact business, or obtain information on financial products and services through a public or private network, including the Internet. Customers access e-banking services using an intelligent electronic device, such as personal computer (PC), Personal Digital Assistant (PDA), Automated Teller Machine (ATM), Kiosk, or Touch Tone Telephone. Hence, it refers to perform the basic banking transactions by customers round the clock through electronic media.

3. Electronic Banking - Architecture



4. Evolution of E-Banking in India

Opening up of economy in 1991 marked the entry of foreign banks. They brought new technology with them. Banking products became more and more competitive. There was need for differentiation of products and services. It was ICICI Bank who introduced online banking in 1996.

To cope with the pressure of growing competition, Indian commercial banks have adopted several initiatives and e-banking is one of them. The competition has been especially tough for the public sector banks, as the newly established private sector and foreign banks are leaders in adoption of e-banking. Indian Banks offer to their customers following e-banking products and services:

- Automated Teller Machines (ATMs)

- Internet Banking
- Mobile Banking
- Tele Banking
- SMS Banking
- Electronic Alert
- Point of Sale banking
- E-Statements
- Debit and Credit Card Services
- ECS (Electronic Clearing Services)
- EFT (Electronic Fund Transfer)
- RTGS (Real Time Gross Settlement)
- Electronic Clearing Cards
- Smart Card
- Door Step Banking.

The three major facilities that the banks offer to their customers are:

- **Convenience** – Complete your banking at your convenience in the comfort of sitting at your home or office.
- **No More Qs** – There are no queues at an online bank.
- **24 × 7 Service** – Bank online services provide 24 hours a day, 7 days a week and 52 weeks a year.

5. Objectives of the Study

1. To identify various e-banking services/functions adoptedby banks in India.
2. To study and analyze the progress made by Indian banking industry in adoption of technology.
3. To study the challenges faced by banks operating in India and make recommendations to tackle these challenges.

6. Importance of E- Banking to Banks

- Lesser Transaction Costs – electronic transactions are the cheapest modes of transactions.
- A reduced margin for human error – since the information is relayed electronically, there is no room for human error.
- Lesser Paperwork – digital records reduce paperwork and make the process easier to handle. Also, it is environment-friendly.
- Reduced fixed costs – A lesser need for branches which translates into a lower fixed cost.
- More Loyal customers – since e-banking services are customer-friendly, banks experience higher loyalty from its customers.

Customers

- Convenience – a customer can access his account and transact from anywhere $24 \times 7 \times 365$.
- Lower cost per transaction – since the customer does not have to visit the branch for every transaction, it saves him both time and money.
- No geographical barriers – In traditional banking systems, geographical distances could hamper certain banking transactions. However, with e-banking, geographical barriers are reduced.

Business

- Account reviews – Business owners and designated staff members can access the accounts quick using an online banking interface. This allows them to review the account activity and also ensure the smooth functioning of the account.
- Better Productivity – E-banking improves productivity. It allows the automation of regular monthly payments and a host of other features to enhance the productivity of the business.
- Lower costs – Usually, costs in banking relationships are based on the resources utilized. If a certain business requires more assistance with wire transfers, deposits, etc., then the bank charges it higher fees. With online banking, these expenses are minimized.

- Lesser errors – Electronic banking helps reduce errors in regular banking transactions. Bad handwriting, mistaken information, etc. can cause errors which can prove costly. Also, easy review of the account activity enhances the accuracy of financial transactions.
- Reduced fraud – Electronic banning provides a digital footprint for all employees who have the right to modify banking activities. Therefore, the business has better visibility into its transactions making it difficult for any fraudsters to play mischief.

7. Features of E-Banking

E-banking is the practice of making bank dealings via Internet. By switching to electronic bills, statements, and payments at any time and anywhere. It allows the banking users to do various services with the click of a mouse. The following are some of the features of E-Banking services offered by banks to their customers:

- Pay bills
- Schedule payments in advance
- Transfer funds
- Manage all accounts in one place
- Apply for a loan or credit card
- View images of your cheques online
- Purchase and mange FD (Fixed Deposits) accounts
- Order Traveler's Cheque
- Increase your overdraft limit
- Order a cheque book
- View up-to-the-minute account statements and balance
- View automatically updated spending report.
- Track your payment history
- Download Statement of Accounts
- Integrate the data with personal finance programs

- Apply for various types of loan
- Change contact details
- Utilize investment search
- Take advantage of online brokerage
- Get SMS alerts
- Verify terms and conditions
- Chat with your customer assistant department.

8. Advantages of e-Banking

- Very low setup cost.
- Capability to cater to a very large customer base.
- Saves operational costs.
- Banks can offer a lot of personalized services to their customers.
- Reduction of burden on branch banking.
- Ensures round the clock banking transactions to customers
- Banks are able to provide efficient, economic and quality service to customers.
- Assists in increasing the speed of response to customers' requirements.

9. Limitations of e-Banking

- Difficult for Beginners
- Trust and Responsibility
- Inconvenience
- Inability to Handle Complex Transactions
- Financial jargon
- Security Issues
- Technology Issues

- Virtual Assistance
- Complicated Websites
- Not suitable for Illiterate and the elderly people.

10. Current Scenario of E-Banking in India

E-Banking has become an integral part of banking system in India;. The Concept of E-banking is of fairly recent origin in India. Till the early 90's traditional mode of banking i.e., branch-based banking was prevalent, but after that non-branch banking services were started.The Government of India enacted the IT (Information and Technology) Act, 2000, with effect from the 17th October, 2000. To examine different aspets of Internet banking, RBI (Reserve bank of India) has set up a committee on Internet Banking. The committee has focused on three major areas of Internet banking, Technology and Security issues, Legal Issues and regulatory and supervisory issues. RBI had accepted the suggestions and recommendations of the working committee and accordingly issued guidelines to banks to implement Internet Banking in India. The old Traditional or manual systems which were prevalent in Indian banking system for centuries seems to replace by modern technology.

11. Private Sector Banks and Foreign Banks Operating in India

In India, the banks are divided or classified into different categories. Every category or type of bank has its functions to perform. The Reserve Bank of India (RBI) is having the highest baking regulator authority in India. It regulates the monetary policy in the country. In this post, I have compiled the list of private banks in India 2021.

12. Private Sector Banks

Private Sector Banks refer to those banks where the majority of the stake is maintained by private individual and Institutions not by the Government. As per the Reserve bank of India report dated 14 July, 2020, at present there are 21 (twenty-one) Private Banking Institutions are Operating in India. They offer all the banking services to the customers just like public sector banks. Examples of private sector banks are ICICI Bank, HDFC Bank, IndusInd Bank, and Axis Bank, etc.

In India, there are two types of private sector banks

1. Old Private Sector Banks (emerged before 1968).
2. New Private Sector Banks (emerged after 1968).

The old private sector banks are smaller in size compared to the new private sector banks.

Table 1: Private Sector Banks Operating in India

S. No.	Name of the Bank	No. of Branches	Year of Establishment	Headquarter
1	Axis Bank	4528	1993	Mumbai, Maharashtra
2	Bandhan Bank	670+	2015	Kolkata, West Bengal
3	CSB Bank	417	1920	Thrissur, Kerala
4	City Union Bank	700+	1904	Kumbakonam, Tamil Nadu
5	DCB Bank	334	1930	Mumbai, Maharashtra
6	Dhanlaxmi Bank	270+	1927	Thrissur city, Kerala
7	Federal Bank	1284	1931	Aluva, Kochi
8	HDFC Bank	5430	1994	Mumbai, Maharashtra
9	ICICI Bank	5288	1994	Mumbai, Maharashtra
10	IDBI Bank	1892	1964	Mumbai, Maharashtra
11	IDFC FIRST Bank	260	2015	Mumbai, Maharashtra
12	IndusInd Bank	2000	1994	Pune, Maharashtra
13	J&K Bank	1038	1938	Srinagar, Jammu, and Kashmir
14	Karnataka Bank	857	1924	Mangaluru, Karnataka
15	Karur Vysya Bank	779	1916	Karur, Tamil Nadu
16	Kotak Mahindra Bank	1500+	2003	Mumbai, Maharashtra
17	Nainital Bank	150	1922	Nainital, Uttarakhand
18	RBL Bank	398	1943	Mumbai, Maharashtra
19	South Indian Bank	876	1929	Thrissur, Kerala
20	Tamilnad Mercantile Bank	509	1921	Tuticorin, Tamilnadu
21	YES Bank	1000+	2004	Mumbai, Maharashtra

Source: RBI report on Foreign Banks as on 14 July, 2020

13. Foreign Banks Operating in India

Here are the foreign banks in India list (list of international banks in India), I have collected from various sources. Just take a quick look at the private foreign banks in India (foreign sector banks in India) mentioned in the table below.

At present, there are 46 total foreign banks operating in India as per the Reserve Bank of India Report as on July 14, 2020. Table 3 below shows the list of Foreign Banks with its country of Incorporation and its Branches in India.

Table 2: Foreign Banks in India

S. No.	Name of the Bank	Branches in India	Headquarter	Country of Incorporation
1	AB Bank Ltd.	1	Dhaka, Bangladesh	Bangladesh
2	Abu Dhabi Commercial Bank Ltd	1	Abu Dhabi, United Arab Emirates	UAE
3	American Express Banking Corporation	1	New York, United States	USA
4	Australia and New Zealand Banking Group Ltd.	3	Melbourne, Australia	Australia
5	Barclays Bank Plc	6	London, United Kingdom	United Kingdom
6	Bank of America	4	Charlotte, North Carolina, United States	USA
7	Bank of Bahrain & Kuwait BSC	4	Manama, Bahrain	Bahrain
8	Bank of Ceylon	1	Colombo, Sri Lanka	Sri Lanka
9	Bank of China	1	Beijing, China	China
10	Bank of Nova Scotia	2	Toronto, Canada	Canada
11	BNP Paribas	8	Paris, France	France
12	Citibank N.A	35	New York, United States	USA
13	Cooperatieve Rabobank U.A	1	Utrecht, Netherlands	Netherlands
14	Credit Agricole Corporate & Investment Bank	5	Paris, France	France
15	Credit Suisse A.G	1	Zürich, Switzerland	Switzerland
16	CTBC Bank Co. Ltd.	2	Nangang District, Taipei, Taiwan	Taiwan
17	DBS Bank India Limited**		Singapore	Singapore
18	Deutsche Bank	17	Frankfurt, Germany	Germany
19	Doha Bank Q.P.S.C	3	Doha, Qatar	Qatar
20	Emirates Bank NBD	1	Dubai, United Arab Emirates	UAE

21	First Abu Dhabi Bank PJSC	1	Abu Dhabi, United Arab Emirates	UAE
22	FirstRand Bank Ltd	1	Johannesburg, South Africa	South Africa
23	HSBC Ltd	26	London, England, UK	Hong Kong
24	Industrial & Commercial Bank of China Ltd.	1	Xicheng District, Beijing, China	China
25	Industrial Bank of Korea	1	Jung-gu, Seoul, South Korea	South Korea
26	J.P. Morgan Chase Bank N.A.	4	New York, USA	USA
27	JSC VTB Bank	1	Moscow, Russia	Russia
28	KEB Hana Bank	2	Seoul, South Korea	South Korea
29	Kookmin Bank	1	Seoul, South Korea	South Korea
30	Krung Thai Bank Public Co. Ltd.	1	Watthana, Bangkok, Thailand	Thailand
31	Mashreq Bank PSC	1	Dubai, United Arab Emirates	UAE
32	Mizuho Bank Ltd.	5	Chiyoda City, Tokyo, Japan	Japan
33	MUFG Bank, Ltd.	5	Chiyoda City, Tokyo, Japan	Japan
34	NatWest Markets Plc	1	London, United Kingdom	United Kingdom
35	PT Bank Maybank Indonesia TBK	1	Senayan, Jakarta, Indonesia	Indonesia
36	Qatar National Bank (Q.P.S.C.)	1	Doha, Qatar	Qatar
37	Sberbank	1	Moscow, Russia	Russia
38	SBM Bank (India) Limited**		Port Louis, Mauritius	Mauritius
39	Shinhan Bank	6	Jung-gu, Seoul, South Korea	South Korea
40	Societe Generale	2	Paris, France	France
41	Sonali Bank Ltd.	2	Dhaka, Bangladesh	Bangladesh
42	Standard Chartered Bank	100	London, England, UK	United Kingdom
43	Sumitomo Mitsui Banking Corporation	2	Chiyoda City, Tokyo, Japan	Japan

44	United Overseas Bank Ltd	1	Singapore	Singapore
45	Westpac Banking Corporation	1	Sydney, Australia	Australia
46	Woori Bank	3	Jung-gu, Seoul, South Korea	South Korea

Source: RBI report on Foreign Banks as on 14 July, 2020

14. National Financial Switch

National Financial Switch (NFS) is the largest network of shared automated teller Machines (ATMs) in India. It was designed, developed and deployed by the Institute for Development and Research in Banking Technology (IDRBT) in the year 2004, with the aim of inter-connecting the ATMs in the country and facilitating convenience banking. It is run by the National Payments Corporation of India (NPCI).

15. Automated Teller Machine (ATM)

The first ATM in India was set up in the year 1987 by HSBC (The Honkong and Shanghai Banking Corporation Limited) in Mumbai. The Indian Banks' Association (IBA) set up Swadhan, the first network of shared ATMs in India in the year 1997. It was managed by India Switch Company (ISC) for five years, and allowed cardholders to withdraw cash from any ATM in the network. They charge fee if cardholders with other banks use the ATM. In the year 2002, the network connected over 1000 ATMs of the 53 member banks of the association. The number of ATMs under the National Financial Switch (NFS) network amounted to over 252 thousand as of June 2021. The NFS is India's largest network of ATMs with nearly 1,200 affiliated members and over 300 million transactions.

16. Factors Causing E-Banking Success

E-Banking practices in India is significantly low when compared with western countries. In recent years, banks have attempted to create awareness among its customers to hance the E-banking operation. Some of the factors which are responsible for E-Banking implementation are:

- Convenience is a main factor in adopting internet banking, which helps the customers to access banking services at any time anywhere 24×7 and time-saving.
- Cost and promotion is the factor which helps the customer to do the transaction

online because it is cheaper than branch banking and extensive promotion and advertisements about e-banking help in created awareness.

- Prior Internet knowledge and information on internet banking helps the customer to do banking activities quickly and safely.
- E-banking provides enhanced services to a customer like banks regularly invest new online products and interactive customer care mode is available to instantly solve queries.
- Nowadays banks assuring their customer about Security and privacy which gives confidence among customer, where banks safely maintain the information of the customer without any kind of leakage.

17. Challenges in Adopting Electronic Banking

Now a days electronic banking is a norm rather than an exception for the banks. But in spite of its offers numerous assistances for the customer to make banking easy and convenient but there are many challenges which customers are facing in the adoption of electronic banking. Some of the challenges are stated below:

1. Customers refuse to adopt electronic banking service because of security threat. Electronic banking frauds like spyware, Phishing, internet theft, spamming etc. are still very much widespread.
2. High startup cost and insufficient infrastructure for the setting up of electronic delivery networks.
3. All banking transactions cannot be performed electronically. Many banking activities require personal visits to the branches by the customers.
4. The risks of revealing the financial information of the customers with others hence customers are having a fear of privacy issue.
5. Insufficient knowledge of using electronic banking and lack of preparedness by customers and banks in technological adoption.
6. The most serious threat faced by electronic banking is that it is not safe and secures all the time. There may be loss of data due to technical faults.
7. The Nationalised Banks and Commercial banks have stiff competition from foreign banks and new Private Sector Banks. It brings various challenges before the banks such as product positioning, innovative ideas and channels, new market trends etc.,

8. Banks are restricting their administrative folio by converting manpower into machine power i.e., banks are decreasing manual power and getting maximum work done through machine power. Skilled and specialized manpower is to be utilized and result oriented targeted staff will be appointed.

18. Recommendations

The following are certain recommendations to popularize e-banking services and products:

- **Create awareness about e-banking:** Banks should create awareness among people about e-banking products and services. Customers should be made literate about the use of e-banking services and products.

- **Special arrangements by banks:** Special armaments should be made by banks to ensure full security of customer funds. Technical defaults should be avoided by employing well trained and expert technicians in the field of computers so that loss of data can be avoided.

- **Adoption of Technology:** Banks should use latest technologies with timely update of secure customer valuable money from the hands of hackers.

- **Specialized Training:** Employees should be given special technical training for the use of e-banking, so that they can further encourage customers to use the same.

- **Organizing Seminars and Workshops:** Seminars and workshops should be organised on the healthy usage of e-banking specially for those who are ATM or Computer illiterate.

- **Cater to need of Customers:** E-Banking Services should be customized on the basis of age, gender, occupation etc., so that need and requirements of people are met accordingly.

- **Proper Infrastructure:** Banks as well as Governments should make huge investments for building their infrastructure.

- **Security arrangements by customers:** Customers should never share personal information like PIN numbers and passwords etc., with anyone including the employees of the banks. Documents that contain confidential information should be safeguarded. For safety precautions customers should change their ATM PIN numbers and e-banking Log in IDs and Transaction Passwords regularly. Customers should also make sure that after using the e-banking service they should sign out properly.

19. Conclusion

From the above study, it is concluded that the E-Banking is an indispensable in the Banking Sector. Despite of too many obstacles in establishing, implementing and functioning of E-Banking but at the same time it has bright future in India. It is golden path for banking sector in India to maximize its profits and also the customer base. That's why E-banking can never be neglected. Moreover, the recommendations provided in this research are useful for the banks and also for the customers for better service and satisfaction respectively. Thus, only those banks will survive in the future which will manage the changes as per technological developments and customer requirements because future of the banks ultimately stays in the hands of customers. They should be satisfied at any cost.

Banks are making sincere efforts to popularise the e-banking services and products. Younger generation is beginning to see the convenience and benefits of electronic banking. In years to come, e-banking will not only be acceptable mode of banking but will be preferred mode of banking.

References

[1] Shubhara Jindal, Study of E-Banking Scenario in India, *International Journal of Science and Research (ISJR)*, ISSN(Online) : 2319-7064.

[2] Sangeetha, N.P. (2019), *A Study of E-Banking Services by Commerce Banks in Madurai District*.

[3] Shaik, Shakir, and Noor Basha Abdul (2013), E-Banking Service in India Scenario, *International Journal of Management Research and Reviews*.

[4] Sharma, Geeta (2016), Study of Internet Banking Scenario inIndia.

[5] Lal, Dr. Roshan, and Dr. Rajni Saluja E-Banking: The India Scenario, *Asia pacific Journal of Marketing and Management*.

[6] Chauhan and Choudhary (2015), *Apeejay-JournalofManagement Sciences and Technology* **2** (3), June - 2015 (ISSN -2347-5005).

[7] Reserve Bank of India, Annual Report, various years, Report on trend and progress of banking in India.

[8] Suhas, D. and Ramesh, H.N., E-banking and its growth in India – A synoptic view.

[9] Research artilces from www.researchgate.net

[10] Wikipedia.org.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 158 – 177

http://www.islamiahcollege.edu.in

INVOLVEMENT OF SUPERVISORS IN MENTORING SUBORDINATE WORKERS (A Study of Unorganised Leather Industrial Units in Vaniyambadi Town)

[1]S. Azeem Ahmed, [2,a]T. Mohamed Ilyas and [2,b]V. Mahmudul Hasan

[1]*Department of Business Administration,*
Mazharul Uloom College, Ambur – 635 802.
(Affiliated to Thiruvalluvar University, Vellore–632115, Tamilnadu, India)
[2]*PG & Research Department of Commerce*
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
(Affiliated to Thiruvalluvar University, Vellore–632115, Tamilnadu, India)
[1]azeemsa1204@gmail.com
[a]tmi-islamiah@yahoo.co.in
[b]vmvmhasan@gmail.com

Abstract

Mentoring in leather industrial units find its place at all levels but high intensity is felt at supervisory level i.e., amongst the supervisor and workers. The researcher has taken unorganised leather units of Vaniyambadi town of Thirupattur district in Tamilnadu which is an important region having considerable number of leather units. The researcher realised that the role of supervisors are very much significant in unorganised leather industrial units because of its nature and hence only unorganised leather units of the region are considered for the purpose of study, with the help of friends and others who are very much associated to leather industry in Vaniyambadi, the researcher could identity ninety such units both in and around Vaniyambadi.

Keywords: Attachment, Communication, Friendliness, Reflection and Endurance.

1. Introduction

Leather is one of the most widely traded commodities globally. The growth in demand for leather is driven by the fashion industry, especially footwear. Apart from this, furniture and interior design industries, as well as the automotive industry also demand

leather. The leather industry has a place of prominence in the Indian economy due to substantial export earnings and growth. The Indian leather industry accounts for around 12.93 per cent of the world's leather production of hides/ skins.

The Indian leather industry occupies a place of significance in the Indian economy in view of its substantial export earnings, employment generation and development. This sector known for its consistency in high export earnings and is amongst the top ten foreign exchange earners for the country. The Indian leather sector has shown impressive growth over the past four decades from being a traditional rural and artisan based, inward-looking industry in the 1970s, to a modern, sophisticated, outward looking industrial sector in this decade. Pragmatic Government policies coupled with daring entrepreneurship displayed by the private sector placed the industry in the present status. A 'focus sector' in the Make in India programme, the Indian leather industry is expected to achieve a turnover of $ 27 billion in the next five years. This figure may slightly differ because of the unexpected drop in the overall movement of leather and leather-based commodities due to COVID-19 pandemic worldwide including India.

Mentoring is a system of semi-structured guidance whereby one person shares his/her knowledge, skills and experience to support others to progress in their own lives and careers. Mentors need to be readily available and prepared to offer help as the need arises - within agreed bounds. No Industry is an exception to this concept. In earlier days it was presumed that the concept of mentoring has nothing to do with leather Industry and constrained its scope only to organisations. Later, it was realised that the concept is aptly used in many industries including Leather Industry. Now mentoring finds its place in almost every walk of life. This research talks about relationship of metros with mentees and suggests for better implementation of the concept and to realise more effectiveness in it.

Mentoring in leather industrial units find its place at all levels but high intensity is felt at supervisory level i.e., amongst the supervisor and workers. The researcher has taken unorganised leather units of Vaniyambadi town of Thirupattur district in Tamilnadu which is an important region having considerable number of leather units. The researcher realised that the role of supervisors are very much significant in unorganised leather industrial units because of its nature and hence only unorganised leather units of the region are considered for the purpose of study, with the help of friends and others who are very much associated to leather industry in Vaniyambadi, the researcher could identity ninety such units both in and around Vaniyambadi.

2. Need and Significance of the Study

Order of the day compelled every Leather Industrial units irrespective of the level at which it functions and the workers in to have this concept of mentoring in their premises and leather industrial units are not an exception to it. The concept of mentoring in gained momentum right from the beginning of twenty first century itself when many western

countries realised the importance of it and introduced in their education institution. In India the concept was introduced in technical types of institution first and slowly extended to institution offering non-technical courses.

The concept was slowly entered in every other sector including industry. Its presence though exists in leather industrial units, it is least realised. This is truer in unorganised leather industrial units where the existence is felt with more intensity particularly amongst the supervisors and workers may be due to the bossism enjoyed by the supervisors.

3. Statement of the Research Problem

The regulations of courses country wide are evident that the concept of mentoring exists in the system. Qualitative data are comparatively less available which is very much equivalent to nil. When someone talks about qualitatively, it is a must for him or her to view the concept from psychological perspective in the sense the 'relationship perspective' attached to the concept of mentoring. In this research work, a humble attempt has been made to study from this lagging perspective. The success or failure of the concept of mentoring is largely dependent on the relationship exist between the mentor and mentees. To be more specific the success or failure depends more on the commitment shown by the mentors towards the mentees. Hence, an urge realised to know the commitment of mentors (i.e., supervisors) in these unorganised leather industrial units towards their respective mentees (workers) from a single aspect called 'relationship' which is the base for other aspects of the concept. To get clear on this one should understand that mentorship requires involvement from both the parities to it - the mentor and mentee. The mentorship is comparatively more successful when both the parties to mentorship are free to select the opponent. That is the mentors are allowed to select the mentees and mentees are also given sufficient freedom in selecting or rejecting the mentor while deciding about.

This scenario is much difficult rather impossible in the present Indian working environment because the respective owners of these unorganised industrial units are rely more on few people whom they appoint as their supervisors in manufacturing units and in most of the cases mentors are assigned without the mentees nod and are expected to be in the bond of mentor-mentee relationship either for the entire service period or at least for a defined period of time. In such a situation it becomes very much necessary on the part of the supervisors to be more careful in exercising their powers while discharging their duties. It is their bounded responsibility to establish a good bond between himself or herself with the assigned mentee or mentees. This nature has raised a kind of problem that many supervisors are just supervisors for the name sake without realising the interest mentoring role entrusted to the position, by showing bossing and by maintaining only official records fail themselves in maintaining relationships. In this situation, if the supervisors are not really committed enough towards their respective workers, the purpose of mentorship will not surely be served. This problem has raised

few research questions into the minds of researchers.

- Do the supervisors are really attached to workers?
- Can the same be scaled?
- Is it possible to increase the commitment by following some suitable suggestions? and if so, what they are?

4. Objectives of the Study

To get the answers for the above research questions, the researcher has framed the following research objectives.

1. To study the attachment of supervisors with the workers in the given setup.
2. To gauge the supervisors' involvement in a very simple way.
3. To make suggestions to the supervisors to increase their involvement.

5. Research Methodology

Research methodology has been presented in the following sub paragraphs.

Nature of Data

To fulfill the objective mentioned above the researcher thought to get the help from both the primary data and secondary data. It would be very difficult to understand the research problem in a very clear way unless a brief understanding on the different concepts of mentoring is known and hence an attempt has been made to present the same using secondary data. For collecting the data on supervisors' involvement, a specially designed questionnaire has been used.

Population

With the help of friends and others who are very much associated to leather industry, the researcher could identify sixty such industrial units in and around Vaniyambadi which can be categorised as unorganised leather industrial units. Hence, the target Population is these sixty units. The supervisors working in these sixty units are the target population.

Sample Size and Sample Methodology

The sample size has been fixed as thirty. The convenience sampling technique has been adopted to enjoy maximum convenience on the part of the researcher. The researcher accepted every such supervisor, from unorganised leather industrial units' situation in Vaniyambadi town who accidently met him and agreed to be the sample respondent, as

sample till the number reached thirty. Hence, the methodology adopted for the purpose of study is Convenience - cum - Accidental Sampling.

Questionnaire

Rubin's love and liking scale was used by Late Prof. V.M. Md. Anwer Basha, Former Vice-Principal & Head of the PG & Research Department of Commerce, Islamiah College (Autonomous), Vaniyambadi, Thirupattur District, Tamilnadu, India and designed a twelve statement questionnaire with modifications for a similar survey on mentoring in educational institutions of higher learning - a psycho-analytical perspective in the year 2010. The same redesigned love scale has been used here for the purpose of study.

Validation of the Tool

For validating the tool used for the research study, reliability test named 'Cronbach Alpha Test' was carried out and the results showed a value of 0.881. Therefore, the tool used for the purpose of the study is very suitable to be used.

Statistical Tool Used

To make the study understandable not only to the learned people but also to layman, it has been decided not to use complicated statistical tools and to use only very simple and widely used tool of percentiles. The entire interpretations areon the percentile-based frequency distribution.

Pilot Study

To test the feasibility of the usage of the said questionnaire, pilot study has been done with four supervisors working in four different leather industrial units whom the researcher met and convinced to be the respondent for the purpose of pilot study. The responses obtained from these four Supervisors proved that the questionnaire does not require any updation and therefore it has been decided to use the same research tool without any further modification in it.

6. Conceptual Definitions

Mentor

Mentor is a relationship in which a more experienced or more knowledgeable person helps to guide a less experienced or less knowledgeable person. The mentor may be older or younger than the person being mentored, but they must have a certain area of expertise. It is a learning and development partnership between someone with vast experience and someone who wants to learn. Interaction with an expert may also be necessary to gain proficiency with/in cultural tools. Mentorship experience and

relationship structure affect the "amount of psychosocial support, career guidance, role Modeling and communication that occurs in the mentoring relationships in which the protégés and mentors engaged. A mentor is a person who has professional and life experience and who voluntarily agrees to help a mentee develop skills, competencies, or goals. Put another way, a mentor is an advisor and role model who is willing to invest in the mentee's personal growth and professional development.

Mentee

A Mentee is the person being mentored by a mentor. A mentor is the main person you rely on to give you advice and guidance, especially in your career. If you have a mentor, you are the mentee. A Mentee is someone who has identified a specific personal or professional goal and who believes that the guidance and help of a mentor - and being held accountable to the mentor can help them achieve their goal.

Mentoring

Mentoring is a supportive learning relationship between a caring individual who shares knowledge, experience and wisdom with another individual who is ready and willing to benefit from this exchange, to enrich their professional journey.

According to David Clutterbuck, 'mentoring involves primarily listening with empathy, shar¬ing experience, professional friendship, developing insight through reflection, being a sounding board, encouraging.

Involvement

Employee involvement is the direct participation of staff in activities that help the business fulfil its mission and attain its goals. This approach makes the employees along with the leadership responsible for growing the company, hitting business metrics, and solving organizational issues.

Involvement or employee involvement can be defined as creating an environment in which an employee participates more in the day-to-day decision making which leads to a better relationship with the manager. More direct participation by employees helps the organization to achieve its goals rapidly and effortlessly.

Supervisor

A supervisor, or also known as foreman, boss, overseer, facilitator, monitor, area coordinator, or sometimes gaffer, is the job title of a low-level management position that is primarily based on authority over a worker or charge of a workplace. A supervisor can also be one of the most senior in the staff at the place of work, such as a Professor who oversees a PhD dissertation. Supervision, on the other hand, can be performed by people without this formal title, for example by parents. The term supervisor itself can be used to refer to any personnel who have this task as part of their job description.

A supervisor is responsible for the productivity and actions of a small group of employees. The supervisor has several manager-like roles, responsibilities, and powers.

Two of the key differences between a supervisor and a manager are (1) the supervisor does not typically have "hire and fire" authority, and (2) the supervisor does not have budget authority.

Supervisor is the person who is usually rich in experience in all respects, assigns duties to the subordinate workers and monitors how the subordinates are discharging their assigned tasks. It need arises, guides the subordinates in fulfillment of the given task. Usually, the supervisors are comparatively trust worthy people to the departmental heads or managers or owners of the industrial units. In the present study, 'supervisors' refers to those who work in the unorganised leather industrial units, with the said designation 'supervisor' situated in Vaniyambadi Town Thirupattur District of Tamilnadu.

Worker

The definition of a worker is a person or animal that performs a specific or necessary task or who completes tasks in a certain way. A person who works diligently on his homework for hours a day is an example of a hard worker.

Worker is the lowest level employee working in an Industrial Units whose immediate boss is his Supervisor. In this study, workers are those labour who work with the unorganised leather industrial units, at the bottom level under the direct supervision of same supervisors, situated in Vaniyambadi town of Thirupattur District of Tamilnadu.

Unorganised Industrial Units

Unorganised leather industrial units are such small units which are not completely organised in all aspects right from infrastructure, other facilities, human resource, to licensing. They are the units with insufficient facilities. They are the units which are not complete in all aspects to categorise it under 'Small Scale Industry' too.

7. Review of Literature

Daniel R. Ilgen, Richard B. Peterson, Beth Ann Martin, Daniel A. Boeschen (1981) have recorded the supervisor and subordinate reactions to performance appraisal sessions. Sixty supervisor-subordinate pairs were sampled before and after annual performance appraisal interviews used to discuss the subordinates' goal accomplishments over the past 12 months. The pairs were randomly selected from exempt employees of an industry headquartered in the Northwest. The data showed little agreement between superiors and their subordinates on pre appraisal conditions of interest but moderate agreement on the affective orientation of the interview, objective qualities of it, and the nature of subordinate performance. However, in spite of the agreement across pairs on the pattern of performance discussions (reflected by supervisor subordinate correlations), they did not agree on the level of performance; mean differences between the groups still existed after the sessions.

Terri A. Scandura, and Ethlyn A. Williams (2004) have done a research entitled 'transformational leadership: The role of supervisory career mentoring' which was published in Journal of Vocational Behaviour. They say that the leaders may need to serve as mentors to activate transformational leadership and promote positive work attitudes and career expectations of followers. To test this premise, incremental effects of transformational leadership and mentoring over each other were examined using N=275 employed MBAs. Respondents with supervisory mentors reported receiving higher levels of career mentoring than respondents with non-supervisory mentors. Supervisory career mentoring (SCM) and transformational leadership had incremental effects over each other for job satisfaction. SCM had mediating effects over transformational leadership for organizational commitment and career expectations. Career mentoring by non-supervisory mentors was not associated with career expectations but there were incremental effects with idealized influence and inspirational motivation for job satisfaction and organizational commitment. Implications for the changing role of mentorship in organizations are discussed.

Hansenand Sofie Dahl(2020) have done a research entitled 'Mentoring Migrants: A Qualitative Study of Needs, Employment & Integration in Denmark'. In the wake of the so-called Refugee Crisis in 2015, Danish Government reformed the policy framework for immigrant integration. To support and promote the new changes, the Danish Government offered project funding to set up volunteer-based mentoring programmes aimed at improving newcomers' chances of accessing the labour market. Through qualitative interviews this research work explored how needs of the newcomers are constructed and targeted within eight specific projects.

8. Analysis and Interpretation

To make the study understandable not only to the learned people but also to layman, it has been decided not to use complicated statistical tools and to use only very simple and widely used tool of percentiles. The entire interpretations are on the percentile-based frequency distribution.Data have been collected from the target audience on a structured questionnaire with twelve statements each on a particular aspect of mentoring. Therefore, the analysis and interpretation have been presented under these twelve headings namely, attachment, level of understanding, expected intelligence, communication, friendliness, satisfactory relationship, reflection, stress level (attention seeking / attentiveness), helping tendency, relational happiness, anger management and endurance. Statistical Package for Social Sciences (SPSS) has been used to accurately carry out the frequency distribution. The following table will depict the analysis information on the above twelve aspects.

Attachment

Attachment is a deep and enduring emotional bond that connects one person to another across time and space. Attachment does not have to be reciprocal. Attachment theory explains how the mentor-mentee relationship emerges and influences subsequent

Table 1: Analysis of Data

S.No.	Aspect of Mentoring		SDA	MDA	N	MA	SA	Total
1	Attachment	Fr.	02	04	08	03	13	30
		%	6.7	13.3	26.7	10	43.3	100
2	Level of Understanding	Fr.	01	09	05	04	11	30
		%	3.3	30	16.7	13.3	36.6	100
3	Expected Intelligence	Fr.	04	05	03	11	07	30
		%	13.3	16.7	10	36.7	23.3	100
4	Communication	Fr.	03	08	02	05	12	30
		%	10	26.7	6.7	16.7	40	100
5	Friendliness	Fr.	03	07	06	05	09	30
		%	10	23.3	20	16.7	30	100
6	Satisfactory Relationship	Fr.	06	04	03	08	09	30
		%	20	13.3	10	26.7	30	100
7	Reflection	Fr.	02	04	09	08	07	30
		%	6.6	16.7	30	20	23.3	100
8	Stress Level (Attention Seeking / Attentiveness)	Fr.	03	11	05	07	04	30
		%	10	36.7	16.7	23.3	13.3	100
9	Helping Tendency	Fr.	04	06	07	03	10	30
		%	13.3	20	23.3	10	33.3	100
10	Relational Happiness	Fr.	04	05	08	06	07	30
		%	13.3	16.7	26.6	20	23.3	100
11	Anger Management	Fr.	02	03	05	13	07	30
		%	6.7	10	16.6	43.3	23.3	100
12	Endurance	Fr.	04	05	03	09	09	30
		%	13.3	16.7	10	30	30	100

development. In this research context, emotional bond that connects supervisors with their respective subordinate workers across time and space is to be seen. In this environment, reciprocal attachment from workers is also expected.

43.3 per cent of the respondents have strongly agreed that 'Workers and they are attached to each other'. A 10% percent of the supervisors have moderately agreed that they are attached to their workers. Totally, 53.30% have shown green signal for this attachment statement. A total of 20% of the respondents are disagreed to the above statement. 26.7% of the respondents have opted for 'neutral' option in the scale.

This shows that 1/4th of the supervisors have not realized the importance of attachment with their own subordinate workers. Another 1/5th of the supervisors have negative feeling with respect to the above statement.

Therefore, the misconceptions exist amongst 45% of the supervisors that the attachment is not at all required in the workplace or attachment will hamper the working relationship need to be changed by orientation by middle level management. Opportunities and situations to be created in the work place like cafeteria to not only feed them but also to inculcate and increase the bonding and attachment amidst the supervisors and subordinate workers.

8.1. Level of Understanding

Understanding here refers to the mental wave length synchronisation between the supervisor and the workers in select situations particularly connected to workplace environment. Understanding is a must in every setup and more important in the work environment. Here, understanding refers to the existence of understanding between the supervisors and the workers working under their direct supervision. It is presumed that good level of understanding is one of the basic requirements in the mentoring concept. Being the supervisor as mentor and subordinate workers as mentees, a strong level of understanding is expected among them so as to have a good work environment.

A 36.6% of the respondents have strongly agreed to the statement '*there is understanding between me and my subordinate workers*' and 13.3% have moderately agreed to the same. Therefore, a total of 47.9% of the supervisors have agreed that they have an understanding with their respective subordinate workers. A total of 33.3% of the supervisors have negative idea about the requirement of 'understanding' between the two sets of people. A 16.7% of the supervisors have opted for 'neutral' option which means they have not so far realised the significance of 'understanding' which is very much needed amongst the supervisors and the respective workers.

It is required to orient the supervisors on the serious requirement of understanding between the supervisors and the respective subordinate workers.

Expected Intelligence

Intelligence has been defined in many ways: the capacity for logic, understanding, self-awareness, learning, emotional knowledge, reasoning, planning, creativity, critical thinking, and problem-solving. More generally, it can be described as the ability to perceive or infer information, and to retain it as knowledge to be applied towards adaptive behaviours within an environment or context.

It is clear from the above table that 36.7% of the supervisors are moderately agree to the statement '*my subordinate workers came to my expectation in terms of intelligence*'. 23.3% of the respondents are strongly agree to the statement. A total of 60% of the supervisors, A total 30% of the supervisors disagree to the statement apart from 10% of the supervisors have opted for 'neutral'.

These forty percent of the supervisors may be having huge expectations towards the subordinate workers. They are suggested not to have over expectations for the basic reason that most of the subordinate workers are uneducated and illiterates. They have to openly discuss with their respective subordinates about the expectations they have against each one of them, on case by case basis.

Communication

Communication is simply the act of transferring information from one place, person or group to another. Every communication involves (at least) one sender, a message and a recipient. This may sound simple, but communication is actually a very complex subject. The transmission of the message from sender to recipient can be affected by a huge range of things. These include our emotions, the cultural situation, the medium used to communicate, and even our location. Here, communication refers to the information transmitted between the supervisors and the workers. The questions being posed to the mentees, the questions raised by mentees, the answers for the above from the mentees and mentors, doubts being raised, the clarification of the above doubts, and all such conversations resulting in the fulfilment of the workplace environment come under the scope of this communication process.

From the above table, it is understood that 40.0% of the respondents are strongly agree to the statement '*I have no difficulty in communicating with my subordinate workers*' and another 16.7% of the respondents are moderately agree to the same. Therefore, a total of 56.7 percent of the supervisors find no difficulty in communicating with their respective subordinate workers. A 6.7% of the supervisors have opted for 'neutral' option which means they are the one who did not realize the significance of communication in mentor-mentee relationship. More dangerously, 10% of the respondents have strongly disagreed to the above statement and 26.7% of the respondents have moderately disagreed to the same. That means 36.7% of the supervisors have negative idea about the communication requirement.

The supervisors have to undergo some short-term course on communication either online or off-line by their own interest or by the intervention of top management or middle management, as the case may be.

Friendliness

Friendliness is a quality of openness and warmth that makes oneself feel welcome and at ease. The friendliness is evident from facial expressions, body language, and, most importantly, in the way one treats other people. Other words for friendliness include *cordiality* and *kindness*. It refers to the quality or state of being friendly. Here, friendliness refers to state of being friendly by supervisors with their workers.

From the above table it is found that 30.0% of the respondents are strongly agree to the statement '*I expect to always be friendly with my subordinate workers*' and another 16.7% of the supervisors moderately agree to it. Therefore, totally 46.7% of

the supervisors have expressed the expectations of their subordinates from them when it comes to friendliness that they seek friendship from their own supervisors. 1/3rd of the supervisors do not believe in, rather do not want any kind of friendship from their side towards their own subordinate workers as they disagree to the above said statement. Another 1/5th of the supervisors have opted for 'neutral option' which means they have not at all considered 'friendship' as an important phenomenon in a working environment.

Those supervisors, who disagree, need to be given proper induction about the subordinate workers with whom they are expected to move with, so as to pave the way to develop friendship amongst them. Those supervisors, who have opted for neutral option, need to be oriented through middle management personnel or through human resource department, if available in the organisation,to imbibe the relevance of friendliness in the work group by way of one-to-one counselling or group counselling.

Satisfactory Relationship

The statement 'our relationship is most satisfying' simply refers to the satisfactory feeling of supervisors towards their respective workers in terms of accepting them as their mentees. They feel either happy or ok with their respective workers. This statement talks about supervisor-worker relation - the working relation between supervisors and their workers.

It is evident from the table that 1/3rd of the supervisors are strongly agree to the statement '*our relationship is most satisfying*' which means they are satisfied with their respective mentees in terms of working relationship. 56.7% of the supervisors have negative feeling towards this statement, which means they feel that satisfactory relationship in the workplace has no role in the effective and efficient discharge of duties. Further, 1/10th of supervisors have no faith in the statement at all, that is the reason why they have opted for neutral option the five-point likert scale.

An urgent need has been emanated to bring the psychological change in 2/3rd of the supervisors, so as to acknowledge the satisfactory relationship in the workplace. Case studies of different fields may be discussed to prove that there is an unparallel role of satisfactory relationship in the work place.

Reflection

In working environment, we reflect in order to learn something, or we learn as a result of reflecting, and the term 'reflective learning' emphasises the intention to learn from current or prior experience. Reflection is a type of thinking aimed at achieving better understanding and leading to new learning.

It appears from the above table that 23.3% of the respondents are strongly agree to the statement '*My main consideration is shaping my subordinate workers how he/she would reflect?*' and another 20% of the supervisors are moderately agree to the above said statement, which means a total of 43.3% of the supervisors are agree that their main

intention behind mentoring is mentees' learning and their career development. 23.3% of the supervisors find negative relationship between mentoring and learning and self-development of mentees. A considerable portion i.e., 30% of the supervisors, have no idea about the relevance of mentoring in mentees' learning and self-development.

By showing the organisational chart and organisation's vision and mission, next level of administrative requirements at supervisory level as well as middle level management as well as zero defect discharging of duty at bottom level, may be explained to the supervisors who either disagree or opted for neutral, by middle level administrators. The role and the need of reflection in mentor-mentee relationship can be imbibed in the complex minds of these supervisors. Many success stories both in the form of articles and video clippings are available on reflection and its benefits in career growth and advancement. They may be circulated among them so as to create a positive approach amidst them towards reflection.

Stress Level or Attention Seeking or Attentiveness

Stress in ones' life may be emanating from different sources which depends on various reasons and situations, one such reason or situation to experience it, is the inattentiveness of the opponent. Here, the expectation of a normal supervisor is that when he/she is sharing some information or expecting the presence of some subordinate, full attention of the opponent to be towards the supervisor. In its absence, the concerned supervisor starts feeling stressful.

A total of 46.6% of the supervisors have agreed to the statement 'whey my subordinate workers don't pay attention to me, I get upset', while 36.6% of them have disagreed. Rest of 16.8% of the supervisors; have opted for 'neutral' option in the scale so as to avoid any extremeness on agreement or disagreement of the said statement.

By being attentive, if these supervisors show interest while upward communication from their own subordinate workers, they too will learn to behave reciprocally. This will take considerable time, but will surely work. Instead of showing upset mood in front of the subordinate workers on their non-attentiveness, caring attitude is exhibited upon their behaviour, gradually; the subordinate workers will become attentive.

Helping Tendency

Helping others is not only good for those who lend helping hand and a good thing to do. It also makes us happier and healthier too. Doing things for others - whether small, unplanned acts or regular volunteering - is a powerful way to boost our own happiness as well of those around us. Here, the help being offered from the supervisors' side towards their respective workers. Helping tendency is a natural expectation of oneself from any natural human being and supervisor is not an exception to it. Helping tendency though spoke about the supervisors here, it is quite natural that the same supervisors often may expect reciprocal from their own subordinates. This is so because both the supervisors and subordinates are natural human beings.

Of the sampled supervisors, 43% of them have agreed to the statement '*I try to always help my subordinate workers through difficult times*', while 33.3% have disagreed to it. Another 23.3% of them have opted for 'neutral' option the likert scale. The 1/3rd of the supervisors who disagreed and those who opted for neutral, put together constitute 56.6%, who may be having machinistic approach towards their respective sub-ordinates.

Human-approach based dealings are the need of the hour. The subordinates are required to orient towards this. For this purpose, some live examples, from the same organisation in which the supervisor is working, may be used to boost the morale of the supervisors in this regard.

Relational Happiness

Most of us probably don't believe and need a formal definition of happiness; we know it when we feel it, and we often use the term to describe a range of positive emotions, including joy, pride, contentment, and gratitude. Relational happiness refers to the positive feeling of happiness one enjoys by relating it with some relative action or thing. Here, relational happiness refers to the quantum of happy feeling in supervisors which depend on the happy feeling of the respective workers.

The supervisors, here, are treated in fatherly role. Unlike a father in most of the families rather in almost all families, get and feel happiness in relation to the happiness of their family members especially younger ones in the family be he/she a son/daughter, grand-son/ grand-daughter, younger brother or younger sister, even spouse for that matter, a supervisor in a working environment is expected to develop the sense of feelings towards their respective subordinate workers.

Thirty percent of the supervisors have agreed to the statement '*I cannot be happy unless I place my subordinate workers' happiness before my own*', while 43.3% of the supervisors have disagreed to the same. That means they have negative idea that the more they care to the happiness of the subordinates, the more that interferes in the personal happiness of the supervisors. More than a quarter subordinates have simply opted for 'neutral' option in the scale.

This is because of the negative feelings they have developed in their minds by relating their happiness with the happiness of the subordinate workers. Slowly, positivity to be inculcated in the minds of such supervisors by continuously talking to them about the positivity and its positive impact on one's life. The job may aptly be done by the human resource department, if available. In its absence, the middle level management may take the responsibility.

Anger Management

Anger is an emotion characterised by antagonism toward someone or something you feel has deliberately done you wrong. Anger can be a good thing. It can give you a way to express negative feelings, for example, motivate you to find solutions to problems.

But excessive anger can cause problems. Anger is a weakness but people think of it as strength. In actuality, the person who does not display anger has more inner strength than the one who displays it. First, the sparks set you on fire and then you burn others. So, that fire not only hurts you, but hurts others as well.

Though two third of the supervisors have agreed to the statement '*whenever my subordinate worker gets angry with me, I still love him/her*', one third of them are either disagree or kept silence. This clearly shows that two third of the supervisors know anger management while one third of the supervisors are so either because of their young age with no or less tolerance or old age with non-tolerance, when it comes to angriness.

Anger Management courses are available online both at free of cost and on payment of prescribed fee, which insist us on proper meditation or diet and offer nice practice whereby one can develop control over his/her anger. The subordinates who have disagreed or kept mum for the statement, need to undergo such courses to develop anger management.

Endurance

Endurance (also related to sufferance, resilience, constitution, fortitude, and hardiness) is the ability of an organism to exert itself and remain active for a long period of time, as well as its ability to resist, withstand, recover from, and have immunity to trauma, wounds, or fatigue. Endurance here refers to the tolerance or the patience the supervisors are experiencing due to their subordinates' behaviours.

From the above table and pie chart, it is evident that 60% of the supervisors have agreed to the statement 'I would endure all things for the sake of my subordinate workers' while 30% of them disagree to it. A 10% of the supervisors have opted for 'neutral' option in the scale. This shows that about 40% of the supervisors are intolerant as well as impatient when it comes to the behaviour of their respective subordinate workers.

By developing the understanding about mentorship, one can develop tolerance and patience. By clear understanding of the expectations of the management from supervisors as mentors, they can relate the expectations with the given role and relating the same with the organisational objectives, vision and mission; they can increase their tolerance level and their patience. Success stories of good leaders worldwide will also help these supervisors to develop their tolerance and patience level.

This chapter helped us in understanding the detailed analysis and interpretation of the analysed data and the next and last chapter will present the summary of the study in the form of findings, suggestions, scope for future studies and conclusion.

9. Summary and Conclusion

This part presents the summary of the study in the form of findings, suggestions, scope for future studies and conclusion.

9.1. Findings of the Study

The findings of the study are presented in the following paragraphs.

1. 1/4th of the supervisors have not realized the importance of attachment with their own subordinate workers. Another 1/5th of the supervisors have negative feeling with respect to the above statement.

2. Around 17% of the supervisors have not so far realised the significance of 'understanding' which is very much needed amongst the supervisors and the respective workers.

3. Forty percent of the supervisors may be having huge expectations towards the subordinate workers. They are suggested not to have over expectations for the basic reason that most of the subordinate workers are uneducated and illiterates.

4. A total of 56.7 percent of the supervisors find no difficulty in communicating with their respective subordinate workers, while 36.7% of the supervisors have negative idea about the communication requirement.

5. 1/3rd of the supervisors do not believe in, rather do not want any kind of friendship from their side towards their own subordinate workers as they disagree to the given statement for 'friendliness' in the questionnaire. Another 1/5th of the supervisors have not at all considered 'friendship' as an important phenomenon in a working environment.

6. 56.7% of the supervisors have negative feeling towards 'satisfactory relationship', which means they feel that satisfactory relationship in the workplace has no role in the effective and efficient discharge of duties.

7. A total of 43.3% of the supervisors are agree that their main intention behind mentoring is mentees' learning and their career development. 23.3% of the supervisors find negative relationship between mentoring and learning and self-development of mentees. A considerable portion i.e., 30% of the supervisors, have no idea about the relevance of mentoring in mentees' learning and self-development.

8. Nearly half of the supervisors have agreed that they get upset if their subordinates don't pay attention for their call.

9. The 1/3rd of the supervisors who disagreed and those who opted for neutral, put together constitute 56.6%, who may be having machinistic approach towards their respective sub-ordinates.

10. 43.3% of the supervisors have disagreed to the statement on relational happiness. That means they have negative idea that the more they care to the happiness of the subordinates, the more that interferes in the personal happiness of the supervisors.

11. two third of the supervisors know anger management while one third of the supervisors are so either because of their young age with no or less tolerance or old age with non-tolerance, when it comes to angriness.

12. About 40% of the supervisors are intolerant as well as impatient when it comes to the behaviour of their respective subordinate workers.

9.2. Suggestions for the Improvement in Mentoring

Based on the above findings, the different suggestions for the betterment of mentor-mentee relationship have been made in the following paragraphs.

1. The misconceptions exist amongst 45% of the supervisors that the attachment is not at all required in the workplace or attachment will hamper the working relationship need to be changed by orientation by middle level management. Opportunities and situations to be created in the work place like cafeteria to not only feed them but also to inculcate and increase the bonding and attachment amidst the supervisors and subordinate workers.

2. It is required to orient the supervisors on the serious requirement of understanding between the supervisors and the respective subordinate workers.

3. For the forty percent of supervisors who have huge expectations towards the subordinate workers, it is suggested not to have over expectations for the basic reason that most of the subordinate workers are uneducated and illiterates. They have to openly discuss with their respective subordinates about the expectations they have against each one of them, on case by case basis.

4. The supervisors have to undergo some short-term course on communication either online or off-line by their own interest or by the intervention of top management or middle management, as the case may be.

5. Those supervisors, who disagree, need to be given proper induction about the subordinate workers with whom they are expected to move with, so as to pave the way to develop friendship amongst them. Those supervisors, who have opted for neutral option, need to be oriented through middle management personnel or through human resource department, if available in the organisation, to imbibe the relevance of friendliness in the work group by way of one-to-one counselling or group counselling.

6. An urgent need has been emanated to bring the psychological change in 2/3rd of the supervisors, so as to acknowledge the satisfactory relationship in the workplace. Case studies of different fields may be discussed to prove that there is an unparallel role of satisfactory relationship in the work place.

7. By showing the organisational chart and organisation's vision and mission, next level of administrative requirements at supervisory level as well as middle level management as well as zero defect discharging of duty at bottom level, may be explained to the supervisors who either disagree or opted for neutral, by middle level administrators. The role and the need of reflection in mentor-mentee relationship can be imbibed in the complex minds of these supervisors. Many success stories both in the form of articles and video clippings are available on reflection and its benefits in career growth and advancement. They may be circulated among them so as to create a positive approach amidst them towards reflection.

8. Instead of showing upset mood in front of the subordinate workers on their non-attentiveness, caring attitude is exhibited upon their behaviour, gradually; the subordinate workers will become attentive.

9. Human-approach based dealings are the need of the hour. The subordinates are required to orient towards this. For this purpose, some live examples, from the same organisation in which the supervisor is working, may be used to boost the morale of the supervisors in this regard.

10. For the statement of happiness, it is suggested to slowly inculcate positivity in the minds of supervisors by continuously talking to them about the positivity and its positive impact on one's life. The job may aptly be done by the human resource department, if available. In its absence, the middle level management may take the responsibility.

11. Anger Management courses are available online both at free of cost and on payment of prescribed fee, which insist us on proper meditation or diet and offer nice practice whereby one can develop control over his/her anger. The subordinates who have disagreed or kept mum for the anger related statement, need to undergo such courses to develop anger management.

12. By developing the understanding about mentorship, one can develop tolerance and patience. By clear understanding of the expectations of the management from supervisors as mentors, they can relate the expectations with the given role and relating the same with the organisational objectives, vision and mission; they can increase their tolerance level and their patience. Success stories of good leaders worldwide will also help these supervisors to develop their tolerance and patience level.

9.3. Scope for Future Research

The following are the different possibilities of research by the present researcher or by some prospective researcher.

1. The same study may be applied on organised leather industrial units of the district or any other district or in our state or in any other state or in our country or any other country.

2. Relational study can also be done by comparing organised industrial units and unorganised industrial units.

3. The similar study can be applied in educational setup at school level and collegiate level.

4. Comparative study can also be made in schools and higher educational institutions.

5. The same type of study can be made in any other industry or field.

9.4. Conclusion

Mentorship is no doubt a beneficial thing for any organisational or institutional setup including leather units provided it is carried out with due seriousness and interest. Otherwise, this will also be one amongst others; the absence or presence of which will not bring any considerable change in the set up. Mentorship is an Art which need to be practiced scientifically to get maximum benefit out of it.

References

[1] Mahmudul Hasan, V., Zakir Hussain, K., et.al., "Teachers' Involvement in Students' Mentoring – A Study of University & College Teachers in India", Unpublished.

[2] Daniel R. Ilgen, Richard B. Peterson, Beth Ann Martin, Daniel A. Boeschen (1981), Supervisor and subordinate reactions to performance appraisal sessions, **28** (3), 311 – 330.

[3] Terri A. Scandura and Ethlyn A. Williams (2004), Mentoring and transformational leadership: The role of supervisory career mentoring, *Journal of Vocational Behavior*, **65** (3), 448 – 468.

[4] Hansen, Sofie Dahi (2020), Mentoring Migrants: A Qualitative Study of Needs, Employment & Integration in Denmark.

[5] En.wikipedia.org

[6] dictionary.com

[7] trainingjournal.com

[8] washington.edu

[9] www. leatherindia.org

[10] www.indiamart.com

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 178 – 182

http://www.islamiahcollege.edu.in

WEDLOCK REMAINS UNLOCKED: A CRITICAL STUDY ON MARRIAGES AND LOVE AFFAIRS IN SALMAN RUSHDIE'S MIDNIGHT'S CHILDREN

A. Shahul Hameed

Department of English,
The New College, Chennai - 600 014, Tamilnadu, India
Ashahul97@gmail.com

Abstract

Salman Rushdie's Midnight's Children is a novel often read as a typical example of postcolonial national tale. It being a must read novel, has been instrumental to so many research scholars, who could present articles and research papers at different levels on varied themes. Although the predominant theme identified in the novel by different scholars seems to be historiography; which is presented here in a new way, rejecting the accepted sense of reality, this paper's aim is highlight a domestic theme as most of the events of the nation and that of the protagonist of the novel, Saleem, an individual, are evident. The findings of the study bring out a message that all the marriages and love affairs taking place in the story narrated by Saleem, invariably are cracked and unsuccessful. This indicates that the life style of the post colonial Indians started reflecting the life of the Colonizers, who did not believe in a life with a strong bond between husband and wife.

Keywords: Hanipha, Methwold, Emerald and Wedlock.

Overview

The first marriage, in the story that stretches for 62 years, is between Dr. Adam Aziz, who completes his Medical Graduation in Germany and Naseem, a daughter of a land lord Ghani. The mismatching problem between them starts from the second day of their marriage itself. Dr. Adam Aziz, as German educated, feels unhappy in seeing his wife continuously with an orthodox Muslim way of wearing purdah. While asking her to come out from this,

> he says, 'Your shirt covers you from neck to wrist to knee. Your loose pajamas hide you down to and including your ankles. What we have left are your feet and face. Wife, are your face and feet obscene?

Here is Naseem's response to her husband's expectation cum order, "she says in muffled tones. 'You, or what? You want me to walk naked in front of strange men.' (He has told her to come out of purdah)".

Thus, the wedlock between them becomes miserable. However, they are able to manage to be together for some years and to surprisingly give birth to three daughters and two sons.

The next marriage that takes place here in the novel is between Nadir Khan, an activist and Mumtaz, the second daughter of Dr. Adam Aziz. This marriage comes to an end when Dr. Adam Aziz by chance gets to know the fact that Mumtaz and Nadir Khan have not been involved in sharing their bed as husband and wife even after two years. It comes to light that his daughter is still a virgin. The news makes Nadir Khan think of leaving his wife,

> a note, addressed to Mumtaz, signed by her husband, three words long, six syllables, three exclamation marks: Talaaq! Talaaq! Talaaq! I divorce thee. I divorce thee. I divorce thee.

An another marriage of Mumtaz is arranged between her and Ahmed Sinai, a business man, who changes her name as Amina in view of deliberately avoiding the talks occurred now and then about Nadir Khan and Mumtaz. Amina is unable to forget her first husband and is affected by insomnia. It is understood that Amina tries to adapt herself to have a happy life with her present husband, so

> she resolved to fall in love with her husband bit by bit. her mind clogged up with Nadir Khan and insomnia, found she couldn't naturally provide Ahmed Sinai with these things

but all the attempts seem to fail and the married life is collapsed when she expresses her wish to have got conceived of a child of Nadir Khan, her first husband though impregnated by Ahmed Sinai.

Wee William Winkie, a street entertainer and Vanita, a maid who is working for William Methwold's estate, are the next couple, whose married life too ends in failure. William Methwold, the English estate owner before leaving India,stands as a reason for it.

> MrMethwold invited Winkie and his Vanita to sing for him, privately, in what is now my parents' main reception room; and after a while he said, 'Look here, Wee Willie, do me a favour, man: I need this prescription filling, terrible headaches, take it to Kemp's Corner and get the chemist to give you the pills, the servants are all down with colds.' Winkie, being a poor man, said Yes sahib at once sahib and left; and then Vanita was alone with the centre-parting, feeling it exert a pull on her fingers that was impossible to resist, and as Methwold sat immobile in a cane chair, wearing a lightweight cream suit with a single rose in the lapel, she found

> herself approaching him, fingers outstretched, felt fingers touching hair; found centre-parting; and began to rumple it up. So that now, nine months later, Wee Willie Winkie joked about his wife's imminent baby and a stain appeared on an Englishman's forehead.

The marriage that comes next in the story is between Hanipha, a movie producer and Pia, a movie star. It becomes problematic once the popularity of the couple in the field of film making starts deteriorating. She discloses the mismatching factors one by one and gets departed.

> Actress Pia froze in an attitude of disbelief. 'O God! Such a family I have come to! My life is in ruins, and you offer tea; your mother offers petrol! All is madness...' I am great actress, and here I sit surrounded by tales of bicycle-postmen and donkey-cart drivers! What do you know of a woman's grief? Sit, sit, let some fat rich Parsee film-producer give you charity, never mind that your wife wears paste jewels and no new saris for two years; a woman's back is broad, but, beloved husband, you have made my days into deserts! Go, ignore me now, just leave me in peace to jump from the window! I will go into the bedroom now,' she concluded, 'and if you hear no more from me it is because my heart is broken and I am dead.' More doors slammed: it was a terrific exit.

Parvati, a witch and one of the midnight's children, requests Saleem to marry her after helping him in different crisis by her magical powers. As Saleem denies, "Parvati-the-witch became pregnant in order to invalidate my only defense against marrying her."

All the people in the ghetto, where now Saleem lives, go against the pregnant Parvati as the illegitimate child would be fatherless. Saleem marries her just to save the child from becoming an orphan. Immediately after the marriage she dies. Hence this married life also is found unsuccessful.

Padma, the loyal listener is assured by Saleem that he would marry her at the end of his historical account. He himself prophesies that on 31st birthday, which is also the 31st anniversary of India's Independence, he would die on the very same day, disintegrating into millions of specks of dust. This wedding also could be considered to be unsuccessful when it occurs so.

Apart from finding out so many unsuccessful marriages in the story, several other love affairs also are found with the same sort of mismatching problems that make all the affairs into pieces. To mention a few, Ahmed Sinai;s love towards Alia, the first daughter of Dr. Adam Aziz ends in failure as he is compelled to marry Mumtaz, the second daughter, who was so dark in colour. Alia develops anger against them and expects for a chance to take revenge,

> Alia's hatred of the man who had abandoned her and of the sister who had married him grew into a tangible, visible thing

The next love affair is of Mary Pereira's, a midwife at a clinic and Joseph D'costa, a radical socialist. She tries to impress her revolutionary lover by switching the name tags on the two baskets, where the new born babies of Amina and Vanita are kept. Amina and Ahmed leave the hospital with Saleem, the narrator, while their true biological child, Shiva, is raised in the slums by a poor singer. Her plan becomes an utter failure as her lover dies and starts frightening her in dreams as a ghost highlighting her guilt. She suffered a lot out of this act,

> The ghost of Joe D'Costa did not, so far as I know, follow Mary Pereira into exile; however, his absence only served to increase her anxiety. She began, in these Marine Drive days, to fear that he would become visible to others besides herself, and reveal, during her absence, the awful secrets of what happened at DrNarlikar's Nursing Home on Independence night. So each morning she left the apartment in a state of jelly-like worry, arriving at Buckingham Villa in near-collapse; only when she found that Joe had remained both invisible and silent did she relax.

The wife of Saleem's neighbour falls in love with a man and is found betraying her husband. When this affair is brought out to her husband by Saleem's magical power, he brings it to an end by killing both of them involved in the love affair.

Zafar, son of Saleem's aunt Emerald, who is married to Major Zulfikar, is engaged to the daughter of Prince. The fiancée decides never to marry Zafar when her nightmare shows the bedwetting matter of the groom. Likewise, the love of Mutasim, the son of the Prince on Jamila also is found to be unsuccessful as she turns down his proposal and he ends up dying in a war. The next important love is of Saleem. He falls in love with Evie, an English girl but she loves Sonny. The happiness of love making lasts only six months as it is stated,

> Before I climbed into my first pair of long pants, I fell in love with Evie; but love was a curious, chain-reactive thing that year I loved Evie for perhaps six months of my life; two years later, she was back in America, knifing an old woman and being sent to reform school.

The last unsuccessful love to be mentioned is of Saleem's. He continues loving her own sister Jamila, who is popularly known as Brass Monkey, even after repeated warnings given by his sister and so many others. On an occasion, when he finds himself working for Pakistan Army, like a dog using his tracking skill. Saleem thinks that this might be a punishment given by Jamila for his love towards her. Thus the affair ends.

Conclusion

The textual analysis of the complete novel provides us with a note that there is not even a happy ending wedlock or a love affair that is shared by the narrator and to our shock all the affairs altogether are found to be unlocked.

Work Cited

Primary Source: Rushdie, Salman. Midnight's Children (1980). New York: Random House, 2006. Print.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 183 – 188

http://www.islamiahcollege.edu.in

CONTRIBUTIONS OF NAWAB GHULAM MOHAMMED GHOUSE KHAN BAHADUR - A STUDY

Tajunnisa and D. Abul Fazal

Department of History,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

The Carnatic region was administered by the Nawabs of Carnatic under Nizams of Hyderabad with Arcot as their Capital for around 150 years i.e. from 1690 AD to 1855 AD. The study focuses on the role of Nawab Ghulam Mohammed Ghouse Khan Bahadur who was the twelfth Nawab of Carnatic region in 1825 A D. He is until date remembered in the lineage of Nawabs for his generosity, philanthropy and knowledge in literature. However, his role and contributions to the society remain concealed in the History of Tamil Nadu. Moreover, the European records and their views about Nawabs are insufficient and trivial. Not many scholars have attempted to bring into light the contributions of Nawabs or had it as a subject of their study. This paper will illustrate the contributions of Nawab Ghulam Mohammed Ghouse Khan Bahadur and highlight the significant features of his rule in social, cultural and religious fields.

Keywords: Carnatic Nawabs, Ghulam Mohammed Ghouse Khan, Contributions, literature.

1. Introduction

Ghulam Mohammed Ghouse Khan Bahadur was born to the Eleventh Nawab of the Carnatic, Nawab Azamjah (1820 – 1825 AD) on 25 August 1824 [1]. Nawab Ghulam Mohammed Ghouse Khan was only fifteen-month infant when he lost his father. On the forty first day of his father's death, he ascended the throne as the Nawab of Carnatic, but all the administration was taken over by his paternal uncle Azimjah. In the year 1842 AD, when he was eighteen he was assigned as the Nawab by Viceroy Lord Elphinstone [2]. Unfortunately, his span of life was very short. He passed away at the age of 31 after ruling for twelve years. In 1855 AD, he joined his eternal journey of life after death. He was the last Nawab in the lineage who lived in Kalas Mahal (Chepauk Palace). He

had no male heir to ascend the throne after him. The offspring of Nawab Azimjah, his paternal uncle were the only deserving successors of the Carnatic region, but as per the Doctrine of Lapse of Lord Dalhousie all the Carnatic territories were annexed to British East India Company [3]. However, Nawab Ghulam Mohammed Ghouse Khan ruled only for 12 years, his contributions and generosity for the subjects makes him unforgettable and unique.

2. A Brief Glimpse of Nawab Ghulam Mohammed Ghouse Khan's Contributions

Establishment of Madarsa-E-Azam

The very famous school in Madras, ***Madarsa-e-Azam*** was founded by Nawab Ghulam Mohammed Ghouse Khan in 1851 AD. It was chiefly established for the children of civil servants and nobles. He donated an amount of Rs.12,000 per annum for the school (one fifth of the revenue he received from the British) [4]. The school was exclusively established for the children of noble stock connected with the Court of Nawabs, yet it provided admission for the common public also. Foundation of school vividly describes the emphasis that Nawab gave to education. He also promoted English Learning along with Urdu, Persian and Arabic [5].

Establishment of Kutub Khana-E-Aam (Public Library)

Nawab Ghulam Mohammed Ghouse Khan was the founder of ***Kutub Khana-e-Aam Mufeed Ahll-e-Islam***. This Public Library came into existence from 1851 AD. Nawab donated a grant of Rs.700 towards the library and an allowance of Rs.35 every month for its maintenance. His uncle Azimjah contributed Rs.250 for the same and when the idea of establishing this Public Library was announced, a huge collection of that time Rs.1984 was made on the spot. Some eminent personalities like Sir Henry Pottinger, the Governor presented 75 books, and Governor General in Council of Calcutta sent 106 books for the library. From the funds, collected 107 books were brought [6]. The library building was taken on rent of Rs.9 per month [7]. The library is located at the Triplicane High Road, Triplicane, Chennai. Later on, many written and printed books as well as manuscripts were bought from all over the country and the world.

Establishment of Langer Khana (Feeding House)

Nawab Ghulam Mohammed Ghouse Khan laid foundation of many ***Langer Khanas*** (Feeding Houses) under the auspices of a Welfare Association. It was called as ***Madras Carnatic Widows Welfare Society***. These houses sheltered deserted women and widows. The Nawab donated sufficient amount of money for the maintenance of these houses [8].

Establishment of Sara-I-Ghousia (Lodging)

Nawab Ghulam Mohammed Ghouse Khan was truly a social thinker and involved in fulfilling several welfare schemes. Generally, Nawabs, English officers and Rich Families of the society spent their time in boating, hunting and sightseeing as their leisure time activities in Madras. This place was also helpful for the travelers to take break during their journey especially to those who go to Hyderabad and Bombay. Therefore, the Nawab planned to establish a 'Sarai' (Lodge) at Red Hills in Chennai. The construction work was assigned to Salar-ul-Mulk to accomplish the task. He also constructed a tank for drinking water [9].

Establishment of Charitable Hospitals

Nawab Ghulam Mohammed Ghouse Khan was highly concerned about the well-being of his people and providing good medical facilities to them. Therefore, he established several hospitals in his regions within the easy reach of the people. Well-experienced and talented team of doctors were appointed to undertake the Hospital Management. Along with the medical aid, the in-patients were fed free of cost. Specialized units were there to deal with eye problems and diseases. Doctors were paid incentives for their devoted service. The most admirable feature in these hospitals was the incentives rewarded to the doctors. Whenever a patient was discharged from the hospital after the treatment and the recovery, the doctors were granted Rs.10 per patient [10]. Nawab Ghulam Mohammed Ghouse Khan converted the famous Shadi Mahal (Marriage Hall) at Triplicane in Madras into a Unani Hospital [11]. Even the European Physicians were appointed to run this hospital. Hakeem Mohammed Tipu was the Chief Chemist in that Hospital and the dispensary was at the rear side of the Marriage Hall.

3. Generosity towards The Poor

Generally, all the Nawabs had a soft corner for the poor and they donated certain amount for the poor people monthly and annually. Nawab Ghulam Mohammed Ghouse Khan was one-step ahead of other Nawabs that he cared more for the poor. Every month he granted an allowance for widows and deserted women for their orphanages for the orphan and destitute under the care of experienced staff. He used to organize free distribution camp at Walajah Road in Chennai where D1 Police Station is situated presently. This Welfare Scheme for widows is still being followed, but the amount is distributed by the Collector of Madras [12].

4. His Interest in Literature

Nawab Ghulam Mohammed Ghouse Khan Bahadur had a deep sense of interest for literature. He always intended to promote Urdu, Arabic and Persian literature in Carnatic region. He was deeply interested in '***Mushaira***' (A Poetical Assembly). To feed his interest he started '*Mushaira*' in 1846 AD and appointed two judges to find criticism of the poetry recited by the contemporary poets. In these assemblies, only celebrated poets were allowed. Every individual had the right to criticize the poetry. Nawab Ghulam Mohammed Ghouse Khan himself was a great poet and a critic who used to point out the defects of the poetry immediately when he heard them [13].

Translation of Literary Works

Nawab Ghulam Mohammed Ghouse Khan's craze for literature found no bounds. He was not only a poet and critic but also a great translator. He took deep interest in translating the famous works in languages other than Persian and Urdu. He himself composed many poems and had read the works of other poets. Once he assigned **Mirza Abdul Baqi** to translate the Turkish work of Ali Sher Nawai, which was known as ***Majalis-ul-Nafais*** into Persian language [14]. This literary work has the life history of the renowned poets and other literary personalities.

Printing Press and Newspapers

Nawab Ghulam Mohammed Ghouse Khan Bahadur laid the foundation of many printing presses during his rule. He also encouraged the printing and publishing largely. The Krishna Raj Press - the Government Press of his time printed ***Deewan-e-Taban*** in 1834 AD. This Press also printed and published a number of books under the names **Qazi Badruddowlah's** ***Favid-e-Badria*** in 1845, ***Gulzar-e-Hidayath*** in 1847, and Nawab's own work on the Bibliography of poets ***Gulzar-e-Azam*** in 1855 AD. The other presses that printed Urdu books were The Anwari Press, Azeezia Press, Azeezi Press, Azeemul Akbar Press, Mazharul Ajaib Press and Nizamul Matabe Press [15].

In 1841 AD, the first Urdu weekly printed by Jammmul Akbar Press which was owned by Syed Rahmathullah. The name of the weekly was 'Jameemul Akbar' in South India. The publishing of daily in Urdu was also brought into existence and the important Urdu dailies Mazharul Ajaib, Azam-al Akbar, Javeed-e-Rozgar, Shamshul-Akbar, Makhzanul Akhbar, Azam-al-Akhbar, Jame-ul-Akhbar, Subh-e-Sadiq, etc. The people of Carnatic region developed the habit of reading and welcomed these dailies [16].

5. Religious Contributions

Nawab Ghulam Mohammed Ghouse Khan had constructed many mosques in the different places of his region. Idgah Masjid of Madras is one of his famous contributions in the year 1845 AD. Nawab was brought up in a religious atmosphere under the guardianship of his uncle Azimjah and so had great concern for the construction of mosques for the public at their reachable and convenient distances. '*Meelad-un-Nabi*', the Birthday of the exalted Prophet Mohammed (PBUH) was celebrated in the Khalas Mahal in a very grand and auspicious manner every year. Nawab Ghulam Mohammed Ghouse Khan also donated vast acres of lands along with funds for the construction of temples and churches [17]. His donations and generosity was not limited only upto Muslims and constructions of mosques. Secularism was revealed in all his activities.

6. Conclusion

Nawab Ghulam Mohammed Ghouse Khan Bahadur was a great ruler among the Nawabs of Carnatic. His contributions towards social, cultural and religious stream were marvelous and remembered even today. He was a great patron of literature and encouraged new poets and scholars. In fact, the Persian and Islamic study found a new blooming era in his rule. Nawab was not only a critic of poetry, but also a talented poet and translator. He had composed many poems in Urdu and Persian using the pseudonym '*Azam*'. One of his unforgettable and remarkable contributions for the society was 'Establishment of Madrasa-e- Azam School'. The Muslims started learning English since the reign of Nawabs and the school is being functioned at Mount Road in Chennai even today. When he passed away a salute of twenty-one Gun Shots was offered with due respect at his funeral. Though he lived and ruled for a short period, he left behind him several unforgettable and everlasting contributions.

References

[1] Muhammad Yousuf Kokan (1974), Arabic and Persian in Carnatic, Madras, P. 351.

[2] Dr. S.K. Khadri and U.M. Khalilullah (1990), A Brief History of The Nawabs of Carnatic and Princes of Arcot, Madras, P. 13.

[3] Ibid.

[4] Ibid.

[5] Muhammad Yousuf Kokan, *Op.cit*, p. 361.

[6] Asifa Shakir, *Tamil Nadu Mein Urdu Ghazal*, Unpublished Ph.D Thesis, University of Madras, Chennai, p.58.

[7] Muhammad Yousuf Kokan, *Op.cit*, p. 360.

[8] Ruqqat-i-Walajahi, Madras Government Oriental Manuscripts Series No.46, p. II.

[9] Dr. S.K. Khadri and U.M. Khalilullah, *Op.cit*, p.12.

[10] Muhammad Yousuf Kokan, *Op.cit*, p. 360.

[11] Ramaswami N.S. (1984), *Political History of Carnatic under the Nawabs*, New Delhi, p. 338.

[12] Muhammad Yousuf Kokan, *Op.cit*, p. 361.

[13] Javeeda Habeeb, History of Urdu Literature in Tamil Nadu, Chennai, pp. 34 – 53.

[14] Ibid.

[15] Muthiah, S. (2008), Madras, Chennai - A 400 years record of the First City of Modern India, Chennai, Volume I, p. 129.

[16] Ibid.

[17] Ibid, p. 13.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 189 – 197

http://www.islamiahcollege.edu.in

GROWTH OF INDUSTRIES DURING THE PERIOD OF KAKATIYAS OF WARANGAL, AS REFLECTED IN INSCRIPTIONS

A. Sheerin Fathima and Mohammad Osman Pasha

PG & Research Department of History,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

Kakatiyas of Warangal ruled the Telugu speaking area nearly 168 years. They maintained peace and harmony among the people of different sects and established stable government in south India. The kings of this dynasty contributed much for the development of agriculture and concentrated for the irrigation development in the eastern part of Deccan. It is an accepted fact that the name of the Kakatiyas is symbolically associated with irrigation system. The tanks and lakes of the period are still serving the farmers of Andhradēša. The development of agriculture and industry gave scope for the remarkable development in trade and commerce as a result of which the Andhra country witnessed development in every sphere. The development of industries under the Kakatiyas to have a probe into the factors that contributed for their development.

Keywords: Andradesa, Adayam, raika , Kamatamu, kirruchepullu, silpis.

1. Introduction

In the history of South India, the Käkallyas of Warangal occupied an important place. Starting their rule from Telangana, the Kakatiya Kings extended their way slowly all over the land of the Telugus. They were the undisputed monarch of entre Andhra dēsa between AD. 1168 and 1323. They maintained the magnity of the Kitchen till at last it was overwhelmed by the armies of the sultans of Delhi.

The age of the Kakatiyas is marked with significance especially in the fields of agriculture, irrigation and industry. It is an accepted fact that the name of the Kakatiyas is symbolically associated with irrigation system. The tanks and lakes of the period are still serving the farmers of Andhradēša. The development of agriculture and industry gave scope for the remarkable development in trade and commerce as a result of which the Andhra country witnessed development in every sphere. Therefore the present study

is undertaken to throws light on the aspect of industry under the Kakatiyas to have a probe into the factors that contributed for their development [1].

Though agriculture was the main occupation in the Andhra country during the Kakatiya period, a large number of industries and handicrafts also flourished in Andhradeśa during the period under review. Most of these were managed by well organized guilds. They may be divided into the following categories 1. Textile 2. Jewel making. 3. Cosmetics and perfumery, 4. Diamond-mining, 5. Leather industry 6. Sculpture, 7. Ivory, 8.Fisheries 9.Bamboo-works , 10 Pottery [2].

2. Textile Industry

This is one of the oldest and most important industries which flourished greatly. particularly during the period of the Kakatiyas. A great variety of designs and different qualities of textiles were manufactured by the weavers. Inscriptions and literature provide us valuable information regarding the variety of textiles produced during this period. The cloth manufactured can be divided into two categories cotton and silk, cotton cloth of all varieties produced on a large scale was exported other interior centers. deer horses and many other types were in use and some of the varieties of cloth were called often the places where they were produced. For instance,"soravatars and Kamvarams were the names given to clothes manufactured in suravaram and Kamavaram, two famous villages in the Coastal region. It is very reasonable to presume that dyeing and printing were well known [3].

This was the most important of the cottage Industries in the Andhra country during the period in question as evidenced by a host of references in the literature as well as the accounts of foreign traveler, Macro-Polo. And we also came to know from the evidences that it highly skilled Kakatiya Andhra weavers used to produce finest and most delicate garments. The Kings, queens, nobles and wealthy people loved to wear the clothes of fine texture and beauty, as a result, the textile industry received great encouragement [4].

Many inscriptions refer to the provision made for the supply of clothes to the Brahamins, temple servants and students which were obviously of ordinary quality. We have valuable references in literature regarding varieties of saris produced during the period with which we are concerned. Narinachoda, a poet of the 12th century, while describing the grander of the lord Siva's marriage with Parvati, states that the pillars of the Kalyānamandapa were covered with a fine cloth, this shows that there was a practice of covering the pillars or the Kalyānamandapas with a probable beautiful cloth of a good variety. He, further mentions the silk saris, the ends of which were knit fine golden thread. The ladies of the well do families were wearing particularly on special occasions, the silk saris of superior variety which had golden threads interwoven at the edges [5].

According to Palakuri Somanada's Basavapuranam different kinds of saris wore by

the women during this period were

1. Mani pattu.
2. Gowrigangayamu.
3. Marakata pattu.
4. Vell pattu.
5. Netrampu Pattu.
6. Chini.
7. Gajavalamu,
8. Gajavalamu,
9. Hamsa pādi,
10. Vinavall,
11. Varanasipattu
12. Rajavallabhamu,
13. Pancchanipattu,
14. Bhavajatilakamu,
15. Rāyaśēkharamu,
16. Váyumeghamu,
17. Mandolaravi,
18. Sandhyārāgamu,
19. Chandratapamu,
20. Indranilamu,
21. Sannadananchu,
22. Megha-vanne,
23. Saradhi,
24. Mahendrabhushanamu,
25. Tavarajambu [6].

The Ranganatha Ramayanam refers to a woman wearing a Raka (bodice) stitched and having a golden laced border. Another woman wore a raika having mirrors In the sculptural representations of the period, men and women are shown wearing stitched dresses, Siddheswara caritra, while giving the statistics of the houses of the people of different communities living in the capital city, mentions that there were 15.000 houses of dress- makers [7].

Tailoring was an important subsidiary industry in textiles. There is no epigraphical evidence about it. But there is some information regarding the tailor (with hand stitch) in Kridābhiramamu and Ranganātha Rāmāyanamu. Some women stitched their bodice themselves at home. However, tailors (kutrapuvandru) were also there to stitch clothes. They were paid for their services. Mostly they were patronized by the wealthy and fashionable ladies of the day [8].

Thus, the Kakatiya Kingdom was famous for textile industry and cloth was manufactured on a large scale not only to meet the needs of the local people but also for export to foreign countries. It seems that silk produced here had great demand in both foreign and local market. There were 25,000 houses of weavers who were engaged in weaving silk cloth in the capital city where as the number of the houses of cotton weavers in Warangal city was 9,500. This number might have exceeded in the coastal trade centres like Ghantasala, Machilipatanam, Korangi, Pedaganjam, Cinaganjam, Narasapur, Mötupalli, Hamsaladivi, etc".

3. Jewel Making Industry

Like the other industries, another important industry of the Kākatiya period was jewelery. Numerous references in contemporary records to ornaments of gold, silver. copper etc. afford ample testimony to the flourishing condition of this industry. These

Jewel-makers were also experts in the making of many articles of domestic use such as vases, cups, spittoons, toys, etc, Gold and silver ornaments were often inlaid with precious stones and thus, the art of in laying developed in close connection with Jewel making. This goldsmith is considered to be one of the important members of a village [9].

The contemporary literary works refer to the goldsmiths and their execution and design, we can find some references to the implements used by them in executing their craft. Kamatamu, a portable furnace, which was considered at the most important .implement of the profession, on which they named their God of worship. There are quite a good number of references which mention the goldsmiths among other communities who were necessarily accommodated in every new village. The famous Malkapuram inscription of A.D. 1261,Mentions that goldsmith coppersmith, basket-makers, stonecutters, iron-smiths, potters, barbers, carpenters and sculptors are among the inhabitants of the villages [10].

This is one of the oldest and most important industries which flourished greatly. Particularly during the period of Kakatiyas. An inscription from Inugurti village mentions the following jewels gifted to the temple of G8päla Krishna of Inugurti and one of the inscriptions from Warangal tort (A.D. 1185) records the gift of golden vessels endowed to the temple of Siva.

There are inscriptions belonging to the regin of Käkatīya Gaṇapati which record the gifts of makaratõrana, aureola, throne, palanquin and a flower necklace, all of gold and ally-whisk with golden handle to the god Bhimesvara and the Pingali village (Guntur) inscription states that Alladi-Nayaka son of Sabbi Nāyaka put up a golden pot on the top of the temple of Sri Rāmanātha deva of Pingali [11].

The raw material which they needed in their work either gold or silver was supplied by the consumers and only making charges were paid to the smiths. As the people offered very low rates for making the ornaments, it seems, the goldsmiths used to adulterate the precious yellow metal to take a bit of it for themselves in lieu of their services. Almost all the contemporary literary works of the period blamed the goldsmiths for the dishonesty and adulteration".

Mitāksara laid down a set of rules to avoid adulteration and to ensure that the same quality of raw material was given to the Smith should be returned with the finished article allowing legitimate reduction for loss of the metal by melting. In case of gold, Mitäksara lays down that articles of the same weight should be returned to the consumer as gold is not reduced even after heating in fire! proficiency in to his master and his place where his father/family which practiced the same craft. Above all we can see the influence of the guild on their community regulating their socio-economic and cultural life [12].

4. Cosmetics and Perfumery Industries

Perfumery and cosmetics were flourishing industries during the period of Kākatīyas, many of the contemporary sources mention about many varieties of cosmetics and perfumes, like Rasavāda, gandhavāda also developed to a large extent by the Siddhās and the medical scientists. In the works on Materiamedica, we find a record of many aromatic substances used in the manufacture of perfumes and cosmetics, mainly the perfumeries and cosmetics were used to powders, pastes and Dhupas, some perfumes were used for sprinkling on the floor [13].

5. Diamond-Mining

This was one of the oldest and the most profitable industries of the Andhra country. The richness of the diamond mines of Andhra had become proverbial and can be seen reflected in the fiction of Sindbad, the Sailor. Many of the world famous diamonds like the Kohinoor are of Andhra origin. Until the discovery of diamond mines in Brazil and South Africa in the eighteenth and nineteenth centuries, Andhra déśa was the diamond mart of the east. There was hardly a Medieval monarch-oriental or accidental, whose diadem was not adorned by these 'stones of fire' from the mines of Andhradesa.

Marco Polo, the Venetian traveler, who visited Kakatiya Kingdom in the last decade of the thirteenth century, mentions three different ways in which diamonds were obtained In this country. "There are certain lofty mountains in those parts and when the winter rains fall, which are very heavy, the waters come roaring down the mountains in great torrents, when the rains are over and the waters from the mountains have ceased [14].

Marco Polo in the thirteenth century and by Nicolo conti and possibly these hills are the scenes of the marvelous legends of Sindbad the sailor. Krishna District manual were worked more than a hundred years before Taveriors date (1605 -89) and may be the mines described by Marco polo and Nicolo conti. There are very large numbers of very old diamond pits in the gritty quart site beds in the jungles east of pulichintala ranges" [15].

6. Leather Industry

The Leather industry also occupied a prominent place among the cottage Industries during the Kakatiya period, a variety of goods manufactured with tattering all regions in Kakatiya Kingdom. They are: (a) footwear, (b) agriculture goods, to dress, (d) Industrial goods. Instruments of art and music, domestic antices.com goods in military camps, etc.

The village cobbler got his raw material from the farmers and the temples of the guardian deities of villages. During the festive occasions such as annual Jataras and

Mahanavami celebrations a large number of animals were sacrificed. The cottiers took these dead animals peeled the skins and processed them to make leather. He gave in return to the farmers the prepared shoes and other agricultural leather goods. The remaining was considered as his adayam or income. This was the usual practice of the day. To produce leather from a large number of animals at a time especially during the festive occasions, a number of tanneries of large size must have been existed in the vellvādas [16] (hamlets outside the village or towns).

From the ancient days the medical scholars advised the people to wear shoes to protect their feet from heat and dirt "Carucarya a work of Health and Hygiene, suggests decoration Mainly to put on footwear not only for good health and hygiene, but also for the contemporary literary sources clearly described the leather shoes (cheppulu) wom by the people in various designs and the Navanattecaritra refers to the color shoes.

Some of the sandals produced while walking great creaking sound while some were noiseless. In Kridabhiramam there is a reference to Malakavalla kircheppulu, the creaking shoes of malakas or farmers. The farmers preferred to wear kirruchepullu, perhaps to protect themselves from poisonous insects or snakes while moving in the fields, women belonging to rich families used to weak shoes with straps embroidered with silk and golden threads [17].

The common people used ordinary shoes made of a single sheet of the hide without fold or double layer. These were called as Ekavaruceppulu or Omtiatta ceppulu were made to protect the front part of the feet from the sum and served as umbrellas on the feet. It seems that they were the most favorite variety throughout the Medieval period. Leather played an important role in the domestic economy of farmers and artisans also. It was shaped into a large number of articles such as Bokkenas for drawing water, (done) straps for festering to the plough, warts, for making hide ropes, leather bags for holding agricultural implements, whiplashes, baskets, belting the bulls while drawing water and pulling the warts, etc [18].

Farmers also used leather straps while undertaking the offering and curing methods in their gardens. Leather was used in place where a soft, flexible and strong thing was to be used as we use rubber in modem days, water bags and handbags made of leather were also used by the farmers and the agricultural laborers. Farmers used leather in the decoration of their animals also. Belts which were decorated with in lay work were tied to the necks or in the middle of the bulls [19].

Scope to lead a life satisfaction and if necessary, gave courage to migrate to some other place of opportune to improve their earnings. But socially, the leather workers were considered as outcastes. As the industry was considered as unclean causing pollution, they were allowed to live only in the hamlets outside the village or town. Thus, the above observation reveals the fact that the leather industry in the Kakatiya Kingdom was in a flourishing condition and there was a great demand for leather goods in the society.

7. Sculpture

Sculpture art was also developed as an industry. Temples employed silpis (sculpture) to make images in stone or chistle frescos on temple walls. The beautiful sculpture in popular temples of Andhradēša speak volumes of their dexterities and workmanship. Their names had suffixed of achari and Ojju. The courtesans and public women also patronized this industry by purchasing good pieces of art [20].

8. Fisheries

Fish were, as they still are, an important article of section of the community. Therefore the industry of fisheries was in a flourishing condition and add much to the economic resources of the Kakatiya state. A comprehensive account of the growth of fisheries cannot be given here due to the fact that only a few scattered references occur in the sources of this period. The state did not bestow its patronage on the fishing industry. Castly, the foundation of agraharas, the austere life of the Brahmins and the strict injunctions of the dharrmasastras regarding diet and drinks would have discouraged it. Basavapurānamu refers to fish as an item of diet. During the early stage of this period, Kings and princes took to fishing as a pastime [21].

9. Bamboo-Works

Many articles were made out of bamboo, mats, baskets, carts etc. were largely made out of it. Mëdaras were engaged in this industry. They set up their industry at the activist of villages or towns. Kridabhiramam refers to their habitation outside the entrance gate (mogerale) of the central City of Warangal. The Mēdaras used to sell their finished goods with roaming as street hawkers [22].

10. Ivory

This was yet another flourishing industry. The references in contemporary records the exquisitely carved ivory articles like boxes, etc., It played important role along with the Jeweler in supplying the needs of the nobles. The requirements of the industry were largely met by import from Karnataka and Ceylon [23].

11. Pottery

The porter was an important servant of the village Pottery was a common industry during the Kakatiya period. He received remuneration for his services either in

allotments ol land or in fees from the inhabitants of the villages. Pots, jars, vessels and pans were 61 manufactured in almost all the villages in the Kingdom. The pots were used for different purposes like carrying water for storing grains etc. There is no epigraphically or literary evidence to show that the potters had any guild of their own. The reason for this may be that pottery was never either imported or exported as it was breakable [24].

Thus the above study makes it clear that the inscriptions are containing very valuable historical information about the growth of different industries during the period of Kakatiyas of Warangal. Further these sources made it clear that considerable efforts of the kings and their ministry, for the development of various industries in their kingdom. Therefore we saw the sound economy of Kakatiya kingdom, the name of the Kakatiyas is symbolically associated with irrigation system. The tanks and lakes of the period are still serving the farmers of Andhradēša.

References

[1] Inscription of Andhrapradesh Kn-24

[2] Inscription of Andhraprdesh Warangal district DNV Ramanarao.

[3] South Indian Inscriptions IV

[4] Epigraphia AndhricaVol-1

[5] Palkuri Somanatha:Basavapuranam P.160.

[6] Hyderabad Archaeological serious

[7] M. Rama Rao, Kakatiya Samcika, p. 238.

[8] Marco polo Traveiar, Vol. 1

[9] Panditärādhya - cartra parvata prakaranam - 229

[10] Dr.Hymavathi. P, Goldsmith - His industry and Technology in medieval Andhra dēsa PA. H.C. 1999.

[11] Pratapa Reddy S. Andhrula Sangikacaritra, Navaratha Caritra, Rama Rao, Kakatiya Samcika. p. 239

[12] Bhaskara Ramayana, V. 201.

[13] Dr. Hymavathi.P Cosmetology and perfumery in Medieval Andhra Proceedings , V. 261. of S.I.H.C. 1995 p. 123.

[14] Kridäbhirămamu. 160.

[15] Ibid. 235.

[16] I.A.P. wg. ins. No. 59.

[17] Ibid, wg. No. 41.

[18] Kridabhirāmamu.

[19] Mānasöllasa. Vol. II. p. 24. Ibid, p. 30.

[20] IAP wg. ins. No. 68.

[21] Ibid, No. 83.

[22] Foreign notices of south india, p. 193.

[23] Panchtantra, p. 173.

[24] Marco-polo. travelar, 1.p. 108.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 198 – 205

http://www.islamiahcollege.edu.in

HISTORICAL IMPORTANCE OF ALWARTHIRUNAGARI IN THOOTHUKDI DISTRICT

Muthu Santhana Kumar and P. Basith Assarani

Department of History,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
(Affiliated to Thiruvalluvar University, Serkkadu,632115,
Vellore (D.T), Tamil Nadu)

Abstract

Alwarthirunagari is situated in the southern corner of Tamil Nadu in India. It is one of the ancient town in South India and situated between the two ancient seaports of Ancient Tamilagam, Korkai and Adichanallur in the direction of south east and north respectively. It is familiar Vaishnavite centre in Southern India from Ancient period. A plenty of ancient monuments and remains were found here and nearby of this town during the excavations was carried out by Archaeological Survey of India (ASI). It was under the administrative division of Tirunelveli for a long period and now it was annexed with Thoothukudi district, at the time of bifurcation of Thoothukudi from Tirunelveli. It is the taluk head quarter under the district administration of Thoothukudi. Alwarthirunagari have its glorious past history from the prehistoric time onwards. The history of this place can traced from the pre-historic times through the remains were discovered by the excavations took place in this town. This town gained its popularity by Vaishnavism throughout India but apart from Vaishnavism it has a lot of historical importance within it. The works of Bishop Caldwell, G. H. Bate and other foreign accounts were speaking a lot about the glorious past of this town.

Keywords: Alwarthirunagari, Tirunelveli, Thoothukudi, Adhinathan Temple, Vaishanavism, Nammalvar, Kurugur, Kurugoor, Thenkarai, Kulothunga I, Muhammed Yousuf Khan, Khan Sahib, Regional History.

Introduction

Alwarthirunagari town is situated in modern Thoothukudi district of southern Tamil Nadu and familiar for its Vaishnava Cult. Buddhism, Jainism and Saivism were also

practiced in this town. It is located in the south-east of Tirunelveli and south-west of Thoothukudi [1] and lies on the highway between Tiruchendur and Tirunelveli. The southern railway line from Tirunelveli to Tiruchendur passes through this town and the Railway station is also functioning here. The Buddhism and Jainism were evacuated from this land slowly. But the idols of Buddha found in this region during excavations. It is believed to be the largest town in southern India during the times of Pandyas and was fertile. The biggest annual cattle-fair held here at the banks of the river Thamirabarani coincide with the Vaikasi festival from the ancient past [2]. It was the shuttlecock between the Dutch and British during 17^{th} century. It might be one among the trade posts situated between the two ancient sea ports Korkai and Adichanallur. Ancient burial urns were found here [3]. The available sources said that the Dutch established their trading post here. It is confluence of all religions like, Vaishnavism, Saivism, Christians and Muslims etc., from time immemorial. Plenty of historical documents are speaking about the religious importance of this town, but only a meagre amount of records only speaks about the historical importance of this town. The purpose of this paper is an attempt to carve out the outline history and other importance of this town, which are diminishing in the flow of history.

Etymology

The name 'Alwarthirunagari' is the combination of the two words 'Alwar' and 'Thirunagari', 'Alwar' denoted the Nammalvar and 'Thiru' means honour 'nagari' means the people. Sometimes it was referred as 'Thenkarai' in some of the historical records and inscriptions, which means south bank. It is situated in the southern bank of the river Thamirabarani and frequently was flooded.

Ancient Period

The puranas and oral history brings the history of this town to before the birth of Christ that leads to two thousand years ago, but the written records are available to construct the history from eighth century onwards. Ancient burial urns have been found at Alwarthirunagari and its surrounding areas like Alagiyamanavalapuram, Malavarayanattam, Tirukkalur, Thentirupperai, Poraiyur, Angamangalam, Sugantalai, Nallur, Kayalpatinam and Virapandiyanpatinam by Archaeologists through excavations from 1899 to 1906 and 1914. The artefacts excavated in these areas were red and black pottery wares of various dimensions, Iron weapons, skulls etc. The Arabians had a trade contact with this town before Marco polo. The coins belong to Islamic countries were also found here and most of them belongs to Arabians. All these coins were found very near proximity of Alwarthirunagari nearby Thenthirupperai, which belong to 13^{th} century. The Ancient texts sometimes refers the community of

vessel (Kappalkara Jaathiyar) as Usilampadiyar, might be the derivation of the term Muslimpadiyar. Arab traders on board in a Vessel is depicted at the Vishnu temple in Alwarthirunagari shows that they have a cordial relationship with the foreigners from time immemorial. 14 important inscriptions were found in this town which contains the political and endowments information about various kings [4]. A sizable Muslim and Christian population are also living here even today with Mosques, Dargahs and Church. Most of the mosques were constructed in this region with stones and depicted Dravidian style of Architecture. The same Dravidian Architectural style was followed in Adhinathan temple at Alwarthirunagari. Muslims are served as a mahouts and kavadi for a generation in Athinathar Alwar temple at Alwarthirunagari [5].

Krishnadasa Kaviraja mentioned in his work Chaitanya Charithamrita that, the famous Vaishnava saint Chaitanya of Bengal visited the Nammalvar temple in this town during his pilgrimage in Southern India between April, 1510 and January 1512. An ancient choultry named as Govindappayyan choultry built by stone was existed was administered by the local board [6] not knowing its history. It was ruled by Pandyas, Madurai Sultanates, Vijayanagras [7], Mughals, Portuguese, Carnatic Nawab's and the British.

Temple Architecture

Sri Adhinathar Temple

Sri Adhinathar temple is ancient one and situated in the middle of this town. The town might be established around the temple. The temple is decorated with the colourful paintings, grand structure of architecture, exquisite sculpture and Mandapas with carved pillars. Most of the sculptures in temples at Alwarthirunagari was carved out of stone and depicted the Dravidian style of Architecture. In Adhinathan temple, the pillars at hall near the sanctum is decorated with the sculptures of saints and sages. The pillars at hall near the Gopuram is decorated with the beautiful designs along with the sculptures.

The endowments and renovation works of Pandyas, Cholas, Rayas, and Nayaks are engraved in the inscriptions of this temple. The stalapurana of this temple is engraved in the southern side of the wall.

Sri Kurugur Nangai Mutharamman temple situated here is also ancient one. Thiruvengadamudaiyan temple, Thiruvaranganathan temple, Pillai Logachariyar, Azhagar, Desikar and Andal temple, Udaiyavar temple, Uyankondan temple, Periya Nambi temple, Krishnan temple, Thirukachi Nambi temple, Kurathazvan temple are the other temples situated in this town.

Inscriptions

Inscriptions of the Kumudam in Adinathan temple mention the name of this town as Thirukurugur in Thiruvazuthi Valanadu [8]. The inscriptions here can be dated from 1215 A.D. Most of the inscriptions are referred the name of the Pandya king

'Maravarman Sundara Pandyan' and mentioned the endowment of the temple land towards the worship of Thiru Nadudaya Piran or Polindu Nindra Piran. Inscriptions belongs to Pandyas, Cholas, Rayas and Nayaks were also found in the northern side of the temple wall of Adinatha temple at Alwarthirunagari. The inscription dated on 1252 A.D refer the name of the king Kulothunga I. The Inscription of the fourth year of Kulasekara Devar in 1272 A.D, praises him as "Sri Ko Maravarman Thirubhuvana Chakravarthi Sri Kulasekara Devar".

Stone Nadhaswaram

Nadhaswaram is a traditional musical instrument generally made out of wood but Nadhaswaram is found here was made out of stone. This stone made Carnatic vocal musical instrument called as Nadhaswaram in Adinathan temple at Alwarthirunagari. It is a standing example for the artistic skilled work of the artisans of ancient Tamilagam. The history of this stone vocal musical instrument is not mentioned. Only two such stone made musical instruments were found in Tamil Nadu. The another one is found in Adi Kumbeshwarar temple in Kumbakonam. The size of this musical instrument is 1and $\frac{1}{4}$ feet length (1 feet length upper part, $\frac{1}{4}$ feet lower part), and 1-inch breadth. A copper sleeve is attached in the lower side of this Nadhaswaram. It is called as '*moha veena*' and Donated by the Nayaka ruler Krishnappa Nayak before 350 years. This musical instrument was played while performing the classical dance Bharatham during the raapathu and the pagal pathu utsavam [9].

Musical Stone Pillars

Musical pillars are found in South Indian Architecture. Suchindaram Thanumalayan temple at Kanyakumari district, the Nellaiappar temple in Tirunelveli and the Polinthunindrapiran temple in Alwarthirunagari have such musical pillars in Tamil Nadu. The musical stone pillar is situated in Polinthunindrapiran temple at Alwarthirunagari, which produces the seven ragas sa, re, ga, ma, pa, tha, ne, while tapping the pillars.

Drawings

The Adhinatha temple is decorated with the colourful drawings depicted the story of Ramayana. A faded mural in this temple depicted Nammalvar, Nathamuni, scenes from Ramanuja's life and shown Vishnu is embracing Madura Kavi Alvar. The accompanying Tamil inscription with this mural states that the Lord of Vaikunta teaches Madura Kavi upadesham here [10].

Medieval and Modern period

Dr. L. A. Prins sent the pages from Bishop Caldwell's work to *The Journal of the Dutch Burger Union of Ceylon*, Galle in SriLanka, which was published in Volume IX, Part IV, page No.137, in the year 1917, mentioned that the Dutch captured Thoothukudi from Portuguese in 1658 and set up factories at Vembar, Vaippor, Punnaikayal, Palayakayal, Manappad and Cape Comorin and made Alwarthirunagari was also one of their interior trading out-station for warehouse purpose to store textiles, but they did not exercised any civil jurisdiction over the inhabitants [11]. Markus Paulus Maria Vink mentioned in his work Cross-cultural Contacts that the Dutch Pepper sold at Alwarthirunagari for 23 rix-dollars [12] per pahar [13] in the year 1680. Dutch records in this period deals with the meagre information about the places of this region.

During the time of trade rivalry with British, the Dutch made a secret alliance with the poligars and the King of Travancore against British in 1760 and a large number of Dutch forces with field Guns from Batavia landed and despatched to Thoothukudi and Tirunelveli sea coast and they captured Manapad. After capturing Manapad, Dutch troops marched towards the inlands and stationed at Alwarthirunagari. Muhammad Yusuf Khan, the employee of British East India Company asked the explanation for their action from Dutch chief at Tuticorin, but nothing explained from Dutch side. Muhammad Yusuf Khan appeared before them with his troops and in the same night the total Dutch army vacated from Indian sea shore silently. Thus Muhammad Yusuf Khan saved the people and ancient temples of Alwarthirunagari from the ravages of Dutch invasion and who was hanged to death by British in the year 1764 [14]. According to the oral history the only surviving son of Mohammed Yusuf Khan was taken to Alwarthirunagari after his death. The town which was saved by Muhammad Yusuf Khan became shelter for the life of his only surviving son. His decedents migrated to Palayamkottai afterwards.

By terms of the treaty of 1783 with British in European soil, Dutch restored this town till 1785. After a decade, again the British recaptured the trading outstation in Alwarthirunagari and retained with them till 1818. In between Captain Hamilton was appointed as a commander of the military station here by Nawab in the year 1793. "Ambaldan Chavadi", a commercial complex was existed in the eastern side of the town was the derivation of the name of this captain Hamilton [15], now the place is called as Ambattan Chavadi by locals. Sivasubramanya Pillay, the employee of Kattabomman was charged as he plundered Alwarthirunagari and Srivaikuntam on the night of the 30th January 1798 [16]. Kattabomman was asked to send the enquiry report about the dacoits act of his employ by Jackson [17]. The Dutch made another failed attempt to recapture their trading outstation during the last poligar wars in the year 1801 formed an alliance with, Kattabomman and the ruler of Travancore [18]. Alwarthirunagari was the head quarter of this taluk and lost its status in the year 1838.

Father of Nazareth, Arthur Margoschis visited Alwarthirunagari from 1876 to 1877. He reached Alwarthirunagari from Palayamkottai about 8 p.m in the evening. He was

affectionately welcomed by the peoples of Alwarthirunagari regardless of caste and religion. Brahmins and Sudras were also met Margoschis and honoured him with torches and tom-toms, and by bringing temple elephant decorated with howdahs and organised a procession to the east of this town [19]. The following passage from the Church Bells shows that Christianity was also vogue in this town:

"*Nearly every day a party of three or four of them go together to the bank of the river at Alvar-Tirunagari, and there in the dusk of the evening they join together in prayer .... The following is another noteworthy passage in the Bishop's report: You will remember Jothiyanayagam Pillai of Alvar-Tirunagari. Long before he was baptized, he organized a Sunday class in connexion with his day-school. His Brahman and Vellala pupils attended the Sunday class, and Jothiyanayagam himself instructed them in Christianity, At that time he had no official connexion with the Mission, and the Sunday school he organized was purely his own idea. God has called him away to Himself, but the seed sown in the hearts of his forty pupils has remained. All the boys and young men who were instructed by Jothiyanayagam have learnt the custom of offering private prayer*" [20].

During the time of freedom struggle V.O.C, Subramaniya Bharathi etc., were inspired the masses of the peoples of Alwarthinagari. D. Nellaiappan Chettiyar, V. Nelliappa Chettiyar, M.A. Iyemperumal, T. Maharaposhanam, N. Chinnakannu Nadar, K. Ponniah, A. Thayammal [21] were the eminent personalities actively took part in our freedom struggle and some of them were undergone a rigorous imprisonment by the British. K. Ponniah involved in the W. Loane's Murder case otherwise called as Kulasekarapattinam episode.

Conclusion

The history of Alwarthirunagari is diminishing in the flow of ages and the scholars and researchers should come forward to dig the real history and document it in a proper way for their future generations. The Captain Hamilton complex in this place changed as Ambaldan Chavadi, Ambattan Chavadi and now it was vanished and the oral history only lives. The recent oral history among the Muslims says that all Muslims in this town were converted from the cast Mudaliar and for instance there is a complex bearing the name Vengu Mudaliar and there is no Mudaliar population here now. some of the Muslim saint's memorial places are also here and the street named as thaikka street is also situated here. The Muslims in this area had a business with SriLanka from time immemorial and the lost their economic wealth due to the outburst of ethnic problem in SriLanka. Jainism and Buddhism was also vanished from here but the Buddha statue was found and now preserved in Alwarthirunagari temple. So the young scholars and researchers should concentrate on the regional history for the sake of their future generation.

References

[1] Stuart, A.J. (1879), Manual of the Tinnevelly District in the Presidency of Madras, Madras, p.6.

[2] Jagadeesa Iyer, P.V. (1925), District History of Tinnevelly(Tamil), Chennai, p.17.

[3] R. Sinnakani., M.A. (2007), Gazetteers of India Tamil Nadu State Thoothukudi, Appendix-2, Vol-I, Chennai, p.174.

[4] Ibid., p.175.

[5] Wilson Thomas (2018), A Muslim family endears itself to temple elephants, The Hindu, Coimbatore, 14th December, 2018.

[6] Stuart, A.J. op. cit, p.272.

[7] Kuruguthasapillai, S. (1981), Thirunelveli Seemai Charithiram, (Panchalankurichi sandaigalutpada), Chennai, p. 10 – 11.

[8] Sinnakani, R., op.cit, p.177.

[9] V. Alagar Ramanujam, M.A., M.Phil., Sri Alwarthinagari Sri Arulmigu Adhinathar Alwar Thirukovil Varalaru (Tamil), World Tamil Research Centre, Chennai, 1983, p.22.

[10] Anna Lise Seastrand, Guruparampara in the murals of Alvar Tirunakari, *Journal of Vaishnava Studies*, 2013.

[11] Stuart, A.J. op.cit. 44.

[12] A name given to large silver coins current, chiefly during the eighteenth and the beginning of the nineteenth century, in several European countries (Germany, Sweden, Denmark, etc.). The value varied between $ 1.15 and 60 cents United States money, but was usually a little over $ 1. Rixdollars were used throughout 17th century America in most Dutch colonies. The same term was also used of currency in Cape Colony and Ceylon.

[13] 1 pahar = 3 hours.

[14] H. R. Pate, I.C.S, Madras District Gazetteers, Tinnevelly, Vol. 1, Madras, 1917, p.75-76.

[15] Ibid., p.499.

[16] Ganapathy, W.E., Ettaiyapuram: Past and Present, Madras, 1890. p.42.

[17] Kearns, J.F., Introduction to Panjalmkurichi Palaiyakkarar and the State of Tinnevelly, Palayamkottai, 1873. p.6.

[18] Pate, H.R., op.cit, p.443.

[19] Halcombe and John Joseph, Mission Life Home and Foreign Church Work, Wells Gardner, Darton & Co, Vol. XIV, Part 1, London, January 1883, p. 277-278.

[20] Church Bells, Vol.14, (Bells and Bell Ringing), March 24, 1882, p.307.

[21] Government of Tamilnadu, Who, s Who of Freedom Fighters (Tamil Nadu), Vol.III, Madras, 1973, pp.53-159.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 206 – 210

http://www.islamiahcollege.edu.in

EDUCATIONAL POLICIES FOR THE UPLIFTMENT OF TRIBALS IN TELANGANA STATE – A STUDY

Mohammad Osman Pasha[a] **and Bhukya Ushan**[b]

[a]*PG & Research Department of History,*
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India
[b]*Department of History & Tourism Management*
Kakatiya University ,Warangal ,Telangana.

Abstract

The Telangana state government introduced special programs for socio-economic development of the tribes in the state. Education is considered as one of the important components in their total development. Besides free education, various facilities, incentives and concessions are offered to motivate and help them overcome their economic hardships. Such efforts to some extent, proved useful to bring them into the fold of formal education. To equalize the literacy rate of Scheduled Tribes on par with the general category, a number of schemes and programs' were introduced by the State Government in Telangana.

Keywords: Gurukulam, Overseas, Vidya Nidhi, Ashram, Sanna Biyya.

1. Introduction

In India, tribal culture has to be understood in terms of its uniqueness. Warm hospitality, simple ways of living, and a high degree of respect for the elders and consideration for women are some of the traits that mark the tribal culture of India. "Their culture is a depiction of their belief in leading simple lives. Most of the Tribal groups in India have their own gods and goddesses that reveal their close linkages with nature. Most of the tribes in India are friendly, outgoing, fun loving and are very close-knit units [1].

This paper focus on the development activities undertaken by the Telangana Government for the benefit of tribes in the Telangana region. There are 32 recognized tribes all over the state. Tribal's account for 10 percent of the total population of the state and 8.6 percent of the national population of Scheduled Tribes [2].

"The major tribes living in the state are: Lambadi or Banjara, Chenchu, Gond, Jatapu, Kammara, Kolams, Konda Dora, Konda Reddy, Konda Kapu, Khond, Kotia,

Koya, Konda Khammara, Kotia, Mali, Manne Dora, Nayak, Pardhan, Paroja, Savara, Valmiki, Yanadi and Yerukala etc. The tribes in Telangana are mostly found in hilly tract areas of Adilabad, Khammam, Warangal, Nalgonda, Mehboob Nagar and Medak etc [3].

All the tribes found in Telangana are marked for their unique and distinguishing cultures. They have their own living styles, beliefs, festivals, dances and folk customs. But one thing which is universal in all the tribal groups is that their cultures demonstrate a lot of authority, pleasure, liveliness and eagerness. Their festivals are exclusively marked for their generosity and a strong bond of love for each other [4].

The state and central governments implementing special programs for socio-economic development of the tribes. Education is considered as one of the important components in their total development. Besides free education, various facilities, incentives and concessions are offered to motivate and help them overcome their economic hardships. Such efforts to some extent, proved useful to bring them into the fold of formal education [5]. To equalize the literacy rate of Scheduled Tribes on par with the general category, a number of schemes and programmers' were introduced by the State Government in Telangana as follows.

Educational Policies

For Scheduled Tribes education is an input not only for their economic development, but also for promotion in them self-confidence and inner strength to face new challenges . It is worthwhile to note that the education increased at a faster rate amongst Scheduled Tribes than in the general population. Various educational programs which are they implemented by the Government of Telangana are given in the following lines:

Tribal Welfare Hostels

Scheduled tribe student who are studying 3rd to 10th classes in the schools run by different managements both under government and quasi-government are being admitted into tribal welfare hostels. These hostels are opened in 1977 and 65 special hostels for scheduled tribe boys and girls studying in intermediate and higher courses are opened during 1994-95. These hostels are called as Post Metric Hostels. At present, there are 1778 hostels running 33 districts of Telangana. Out of 1778 hostels, 1195 for boys and 583 for girls are functioning in Telangana. In these hostels, accommodation and boarding are provided to the students free of cost.

Pre-Post Metric Scholarships

The schemes focused on the financial condition of the applicants and provide them with financial assistance. The scheme is to provide scholarships to scheduled tribe students studying post- matriculation or post-secondary state to enable them to complete their education and also provide books to scheduled students studying professional courses

under Book Banks Scheme. The Telangana e pass scholarship is for students who face financial difficulties in carrying their Education. Under this schemes mess charges and fees will be sanctioned to tribal students studying in post-metric courses in various collages.

Under Pre Metric Scholarships bright scheduled children are identified and provided opportunity to receive quality education in reputed institutions and institutions of excellence. Under this schemes will be sanctioned 3rd to 10th class tribal students for boys 100/-, girls 150/- per month.

Best Available Schools

Telangana state Tribal Welfare department would give the opportunity to tribal students. Bright children among Scheduled Tribes are selected by district selection committee under the chairmanship of Collector in each district and the selected scheduled tribe children are being admitted in the best available schools.

The government has introduced and provides corporate school education to the poor children of illiterate tribal families duly sanctioning corporate fees i.e. 30,000/- per annum for to the selected students.

Coaching and Allied Schemes for Tribal Students

Coaching is provided to tribal children for competitive examinations through Pre-Examination Training Centers. Part of the coaching cost is provided by Government of India under coaching schemes. Coaching is being provided to tribal youth for competitive examinations like Civil Services, Group-I etc., through State level "Telangana IAS Study Circle for STs" at Rajendra Nagar Hyderabad and for exams like Group-II, RRB, Banking, Police, DSC etc., through (4) Pre-Examination Training Centers (PETCs) at Hyderabad, Warangal, Utnoor and Bhadrachalam.

Residential Schools for Tribal Communities

A separate society in the name of Telangan Tribal Welfare Residential Educational Institutions (Gurukulam) was established in 1999 for managing these institutions. More than 158 residential institutions running by the government of Telangana. This society is maintaining residential education institutions for tribal's communities, from 5th class to Degree. The objective of the gurukula society is to provide quality residential education to the tribal students. It is also maintained quality food by providing the best menu [7].

B.R Ambedkar Overseas Vidya Nidhi

Government has issued orders in G.O. Ms.No. 36 providing financial assistance of Rs. 10.00 lakhs each to tribal students (whose parental income is below Rs. 2.50 lakhs) aspiring to pursue post graduate studies in reputed foreign universities. Accordingly, during 2016-17, it is proposed to extend benefit under the scheme to (50) candidates

proportionate to population of tribal communities and an amount also extent of Rs. 20 lakhs is allocated [8].

E-Learning Class Rooms in Tribal Ashram Schools

In 2018, the Tribal Welfare Department established an advanced learning facility in 50 Tribal Ashram Schools to help students enhance subject learning. Through the e-Learning Classrooms program, supplemental education is being provided in schools. The goal is to empower every student to be a connected, creative, and engaged learner. Students get to learn Mathematics, Science, Social Science, and English from some of the talented teachers of the State from a broadcasting studio (e-School Studio) established at Hyderabad. All the sessions are LIVE and interactive.

That means - students get to watch and listen to the teacher (as well as e-content) and also they can ask questions with the expert. Micro-Assessment is embedded in each session. Students are given assessment tools that help in collecting learning data at the classroom level. These have created a participatory environment in these classrooms. With enough data, remedial teaching plans will be developed for district-level operations.

Sanna Biyyam (Super Fine Rice) Scheme

State Government is providing Super Fine Rice (Sanna Biyyam) for students studying in Government Schools, Government Residential Schools and Hostels in the state, during 2015-16 academic year, about 29,86,010 students in 34,319 schools and 5,39,315 boarders in 3,069 hostels benefited under the Sanna Biyyam scheme. The amount of 662.23 crore was spent on this scheme during the financial year 2015-16. The objective of this programs is to supply "super fine rice "i.e., Sanna Biyyam benefiting (182282) number of Tribal students studying in Tribal welfare institutions.

2. Conclusion

For the boost of Tribal the most important source is increase or enhancement of financial assistance which can be corpse up by the government through allotting the financial resources to implement various tribal development programs. The authority's main objective is to ensure an orderly development and growth of the tribal areas development which is witnessing bewildering changers on socio-economic and political fronts. The achievements of the authority are mostly of developmental nature for which tribes are the prime factor. Tribes are required in quantities and in different places to carry out developmental programs.

References

[1] Ekka Nancy, Impact of Modernisation on Tribal Religious Customs and Traditions : A Case Study of Rourkela; Unpublished Thesis submitted to NIT, Rourkela, Odisha, May 2013, p 1.

[2] Census of India, 2011, Ministry of Home affairs.

[3] Reddy, M., Gopinath and Anil Kumar, K., Development : A Case Study of Andhra Pradesh, Working Paper No. 85, Feb, Centre for Economic and Social Studies (CESS), Hyderabad, p. 9.

[4] Rao, L. Deshingkar, S.P. and Farrington, J., Tribal Land Alienation in Andhra Pradesh Processes, Impacts and Policy Concerns, *Economic and Political Weekly*, Vol. XLI, No (52), December 30, 2006, p. 15.

[5] Jain, P.C., Planned Development Among Tribals, Prem Rawat for Rawat Publications, New Delhi, 1999.

[6] Sudhakara Reddy, P., Displace Population and Social Change, Deep and Deep Publications, New Delhi ,1995. Bhujendra Nath Panda, Tribal Education, A.P.H. Publishing Corporation, Delhi, 1996.

[7] Vijaya Laxmi and Milcah paul, Sociao-Economic Conditions of Tribal Communities in Telangana and Adhra Pradesh, Acta Scientific Agriculture, vol.3, Issue-8, august 2019.

[8] Ramesh, B., Tribal Development Policies and their impact on the Socio-Economic Condition of the Tribal of Telangana state,IJMR, vol.1, Issue-37, March 2018.

International Journal of Science and Humanities
ISSN 2394 9236 Volume 7, Number 1 (2021), pp. 211 – 216

http://www.islamiahcollege.edu.in

STATUS OF WOMEN IN ISLAM - A STUDY

Firdoss Banu and K. Murugan

Department of History,
Islamiah College(Autonomous), Vaniyambadi - 635 752,
Tirupattur Dt, Tamilnadu, India

Abstract

Contrary to the widespread misconceptions about the status of women in Islam, this paper will reveal the most honoured and dignified status of women in different stages of life. A most sincere attempt has been made in this presentation about the status of women in Pre-Islamic Era and later during the times of Prophet Mohammed (PBUH). Most of the references are taken from the two primary sources of Islamic Law; the Holy Quran and the *Hadith**. Islam offers undoubtedly a higher position to women than men for their undaunted devotion towards the responsibility as a mother, for her obedience as a daughter and her sacrifice as a wife and as a sister. It was the advent of Islam that came as a protection to the life of girl children putting an end to female infanticide. Later it recognized the rights of the women in all walks of life.

Keywords: Islam, Women, Quran, Hadith, Education, Rights.

1. Introduction

The status of women in the society has always been a sensational issue of all time and it cannot be denied that the women have been the victim of impartiality, discrimination and exploitation during all the periods in one way or the other. Since past two centuries a deep consent has been adapted, universally to upraise the status of women and implementations of measures have been planned. The most challenging factor of this issue is, the more they try to improve it, the worse it becomes. And as a result the weaker sex remains to be oppressed. A sincere attempt has been made in this paper to highlight the status of women in Islam which is incomparable with respect to some other systems that consider women to be inferior to men in all the aspects. Islam offers the highest position to women as a mother, a sister, a wife and as a daughter. Infact it has been narrated by Prophet Mohammed (PBHU) that a Muslim will find his Paradise under his mother's feet. Through this it is quite obvious that Islam gives more respect and importance to women than men. Inspite of the misconceptions that are widely spread,

against Islam, the status of women remain dignified and incomparable to men as she owes a greater position as a mother, daughter, sister and wife. The objective of this paper is to focus on the real Islamic position and not to insinuate her status in Islamic societies which indeed doesn't require any programme of equality and freedom to claim justice.

2. Status of Women before Islam

During Pre-Islamic ages the status of women was miserable and pathetic one, in most of the countries women were not even considered as a living being with a soul and emotions, rather, she was degraded as a mean and base soul and a source of bad luck cruelty and sin.

During the ancient days, Greece was considered one among the most developed and civilized nations, yet the women in Greece were not provide a respectable position as women. Athens was called the country of wisdom, knowledge and philosophy, but failed to acknowledge the position of a women in the society. Unto them women were just commodities which can be sold or brought or used for making money. The birth of a female baby was considered as an insulting issue and also regarded as if it was devil's work to beget a female child. The Spartan women in the past practised polyandry, and married to more than one husband which was the most detestable custom.

Before the advent of Islam, even the Arabs degraded the women as a symbol of disgrace and futile thing. Women were the victim of some cruel customs like burying alive or burning alive when her husband dies. In Arab countries when the husband died, the widow would be covered with the garments of the deceased and she had no right to remarry until his guardian permitted to do so, or until she ransomed herself. Her matrimonial guardian had the right whether to allow her to remarry or he himself wanted marry her, if the widow of the deceased is his mother, he would not marry her.

Moreover women had no share in her ancestor's property. They were not allowed to own or possess anything except being a poor victim of humiliation and disgrace.

In Arab country during Pre-Islamic period women were deprived from inheriting any wealth or property and in fact they had no right over their own life. The most horrible and monstrous deed during this period was 'Digging hole and burying the girl child alive'. Begetting a girl child was considered a curse and cause of humiliation among Arabs. The girl's father himself would take the daughter to the far away land and dug a hole to bury her. His stone heartedness will reach to its peak, when the child screamed and begged for sympathy and mercy. Despite hearing the groans and cries of his own daughter he would heap the sand over her head and bury her alive. Depriving women from their rights was far better than this unkind act of burying a girl child alive. This was the era of illiteracy that men could not realize the importance of daughters, and considered them a curse rather than a blessing.

3. Status of Women in Islam

As a Daughter

The Holy Quran and the *Hadith* are the two primary sources of Islamic Law which place Muslim Women on the same level as men. Even though they have to play different roles, and fulfil different responsibilities, the women in Islam enjoy an exalted position of honour and dignity.

Jabir-Ibn-Abdullah (May Allah be pleased with him) reported that the Prophet Mohammed (PBUH) Said, "Whoever has three daughters and accommodates them, shows mercy toward them, and supports them - Paradise is definitely guaranteed for him". Thus someone asked the Prophet, what if they are two daughters only? He replied, "He gets that reward even if they are (only) two". Some of those who were present believed that, had the Prophet been asked about only one daughter, he would have answered that the reward was applicable in case of one daughter too". (Source: Al-Albani)

This is how women are considered as a blessing in Islam. In several *Hadith* protection of daughters is reported by the Prophet Mohammed. It is evident through the following *Hadith*, the Prophet Mohammed (PBUH) said, "If anyone has a female child and doesn't bury her alive, or slight her, or prefer his male children to her, Allah will bring him into Paradise. (Source: Ahmad, authenticated by Al-Hakim - graded Hasan by Ahmad Shakir). Islam cares for the girl children, and commands the fathers to be affectionate, loving, patient and supportive to them and fulfil their physical, emotional and mental needs.

As a Wife

Islam grants the right of accepting or rejecting the marriage as a right of women. Without the consent of women one cannot force her to marry a person with whom she doesn't want to.

Women are created to complement men, not to subdue unto them. Allah says, "*And women have rights similar to those of men, but men are a degree above them*". (Al-Quran, 2:228)

Man has been given the responsibility to protect women and shelter them; in no way it grants any superiority to them over women. Islam gives the leadership of the family to men, not the dictatorship over his wife. In fact Islam suggests the importance of counselling and mutual agreement in family matters. In the Holy Quran it is clearly indicated that marriage is a bond between the two important halves of the society (men and women) for an indefinite period of time, so that they could live in peace by fulfilling the needs of one another.

"*And among His signs is that He created mates from among yourselves that you may live in tranquillity with them, and He was put love and mercy between your hearts*". At

the same time women have the right to invalidate a marriage on justifiable grounds by following certain terms of Islamic Law.

As a Mother

Out of all the positions motherhood occupies a supreme status in Islam. Kindness towards parents is considered next to the worship of Allah. The Holy Quran indicates, "*The Lord hath decreed that you worship none save Him and that you show kindness to parents. If one or both of them attain old age in your life, say not to them a word of contempt, nor repel them, but address them in terms of honours, And out of kindness, lower to them the wing of humility and say: My Lord! Bestow on them Your mercy even as they cherished me when I was little*". (Al-Quran, 17: 23, 24)

The responsibility as a mother enhances their dignity and status as women. The company of mother is described to be the best company with reference to the following *Hadith*:

A man came to Prophet Mohammed (PBUH) asking: O messenger of Allah! Who among the people is the most worthy of my good company? The Prophet said, "Your mother!" The man asked again, "Then who else?" The Prophet said, "Your mother!" For the third time the man asked the same question, then Prophet answered, "Your father!" (Al-Bukhari & Muslim Shareef).

In another *Hadith*, **The Prophet Mohammed has mentioned**, "**Paradise is at the feet of mothers**".

Mother's lap is regarded as the first school of the child. Thus mother's role in Islam is a divinely responsibility entrusted upon women.

4. Women and Education

The Holy Quran insisted about acquiring knowledge, to read, to think deeply over signs of Allah in about 750 verses for both men and women. Nowhere in the Holy Quran or in *Hadith* the education of women is prohibited, neither in any single verse was it decreed that only men are capable of acquiring knowledge. It can be rightly observed through the example of Ayesha - the wife of Prophet Mohammed and mother of all believers of Islam, the most honoured woman in Muslim's community for her religious knowledge. It was her knowledge that made her the tower over all other women. She was not a saint but a scholar and she is the inspiration and ideal role model to other women scholars in Islam. In the early periods of Islam, Ayesha (May Allah be pleased with her) was one of the most important sources of oral information about Prophets saying which evolved into the *Hadith*. Prophet Mohammed has asserted, "*Acquiring knowledge is compulsory for every Muslim man and woman*". Islam renders a great importance on seeking knowledge for both men and women and in fact women can be better appreciated in the light of philosophy of knowledge through the Holy Quran, because it is she who nurtures her children in the right path as being the first school of the children.

5. Women and Their Rights

According to Islamic Law, woman's right to her money, land, jewellery or other properties is fully acknowledged, and this right doesn't vary whether she is single or married or a widow. She is eligible to buy or sell or pledge any of her possessions as per her own will. It is Islam which came as a protector of women's right during the time when the whole mankind deprived her of her rights even of her life. Islam declared the right of inheriting parent's property. As Islam and its law spread starting from Arab and to the remotest corners of the world it brought along a new momentum of a desert storm, challenging the existing traditions, customs and discriminations, and this promoted and supported a complete change in cultural revolution for women - the weaker sex. Women's life in Islam is more protected and secured financially as she doesn't have to shoulder any economical responsibility. This might be the justification that women's share in parent's property is one half of man's share. This variation in inheritance could be fair and quiet consistent if we deeply ponder over the financial responsibilities of men over women. According to Islamic Law, man is fully responsible for the maintenance of his wife, children and his needy and poor relatives. Women are entailed to receive '*Mahr*' from her husband at the time of marriage, and she has full right to spend it at her will. Also she has no obligations to take care of the family expenditure, though she has possessions to spend. Even if she claims divorce, she is entitled to get Alimony from her husband. On the whole women's life is a sheltered and secured one in Islam.

6. Conclusion

Islam promotes the value of human brotherhoods irrespective of the gender variation. It regards men and women as created for differing but mutually complementary to one another. Both men and women are equalled in front of Allah, just their functions and roles vary. Women undertake the responsibility of motherhood, home care, children's upbringing where as fatherhood undertakes earning of livelihood, home protection and overall responsibility of his family. Islam blesses the differentiation of the male and female for the self fulfilment of both of them. Though both have the dignified roles to be fulfilled, women are honoured more in Islam for their supreme sense of sacrifice and their grit to bear the pain while undergoing a child birth. In fact Prophet Mohammed has said, "*If a woman dies in child birth, she is counted as a martyr, and the reward for martyrdom is Paradise*".

End Notes

Hadith*: A collection of traditions containing sayings of the Prophet Mohammed which, with accounts of his daily practice, constitute the major source of guidance for Muslims apart from the Holy Quran.

References

[1] Abdullah Yusuf Ali, The Holy Quran (translated into English with notes and commentary) Riyadh.

[2] Latif Khalid Gauba (1992), *The Prophet of the Desert*, Delhi.

[3] Ziauddin Ahman (1996), *Influence of Islam on World Civilization*, Delhi.

[4] Jamal A. Badawi (1996), *The status of Women in Islam*, New Delhi.

[5] Bernard Lewis, *The Arabs in History*, Essex, UK.

[6] Naila Minai (1981), *Women in Islam*, New York.

[7] Muhammad Abdul Rauf (1977), *The Islamic View of Women and the Family*, New York.

[8] Dr. Ali Shariati (1990), *Women in the Eyes and Heart of Muhammad*, (translated from Persian into English by N.P. Nazareno and M. Mekoodast), Arecode, Kerala.

[9] Dr. Parveen Shaukat (1995), *Human Rights in Islam*, Delhi.