ISBN: 978-93-88901-41-3

ADVANCES IN SCIENCE AND TECHNOLOGY

VOLUME II

Editors

Dr. Med Ram Verma

Dr. Padmakar A. Savale

Dr. S. R. Shaikh

Mr. Dnyaneshwar P. Maule

Bhumi Publishing

First Edition: 2023

Adavances in Science and Technology Volume II

(ISBN: 978-93-88901-41-3)

Editors

Dr. Med Ram Verma

ICAR-Indian Veterinary Research Institute

Izatnagar,

Bareilly, Uttar Pradesh

Dr. Padmakar A. Savale

Department of Physics,

SES's Arts & Science College,

Bhalod Tal. Yawal Dist. Jalgaon (M.S.)

Dr. S. R. Shaikh

Department of Zoology,

Dr. C. V. Raman Science College,

Sironcha, Dist. Gadchiroli (M.S.)

Mr. Dnyaneshwar P. Maule

Department of Mathematics,

A. V. College of Arts, K. M. College of

Commerce and E. S. A. College of Science,

Vasai Road, Palghar (M.S.)

Bhumi Publishing

2023

First Edition: April, 2023

ISBN: 978-93-88901-41-3

Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: www.bhumipublishing.com

E-mail: bhumipublishing@gmail.com

Book Available online at:

https://www.bhumipublishing.com/book/

PREFACE

Science and technology have been integral to human progress since the dawn of civilization. From the development of basic tools to the advanced technologies we use today, science and technology have enabled us to explore new frontiers and make incredible advancements in our understanding of the world around us.

The purpose of this book, Advances in Science and Technology, is to showcase some of the latest research and innovations in the field. We have gathered contributions from experts in various scientific and technological disciplines to provide a comprehensive overview of the most recent developments.

The topics covered in this book are diverse, ranging from advances in artificial intelligence and robotics, to breakthroughs in medical research and environmental sustainability. The research presented here is at the cutting edge of their respective fields and demonstrates the potential for further advancements in the years to come.

We hope that this book will inspire new ideas and encourage collaboration among researchers and innovators. Our goal is to promote the continued growth and development of science and technology, as we believe that they are essential for addressing the challenges facing our world today.

We would like to thank all the contributors who have shared their expertise and insights in this book. We would also like to thank the editors, reviewers, and everyone else involved in bringing this project to fruition.

We hope that readers will find this book informative and thought-provoking, and we look forward to seeing the impact of the research presented here on the future of science and technology.

Editors

CONTENT

Sr. No.	Book Chapter and Author(s)	Page No.
1.	**VIABILITY ASSAY OF RAT PERITONEAL MACROPHAGES BY ARSENIC TRIOXIDE (ATO): THE POSSIBLE FUTURE PROSPECTS OF NANOMEDICINE DELIVERING ARSENIC TRIOXIDE (ATO) FOR DISEASE THERAPY** Srikanta Guria, Ohidul Middya, Debrina Saha, Asik Billa Hossain and Samar Chattopadhyay	1 – 5
2.	**THEORETICAL INTERPRETATION OF EXCESS VISCOSITY OF POLAR LIQUID MIXTURES FROM 298.15-318.15K** Naveen Awasthi	6 – 13
3.	**AUGMENTED REALITY AND AR CODE USING AI TECHNIQUE** P. Anusha and H. Parveen Begum	14 – 22
4.	**STRENGTHENING THE POWER OF BIOINFORMATICS WITH THE HELP OF ARTIFICIAL INTELLIGENCE** Manoj Patidar	23 – 27
5.	**ROLE OF GREEN CHEMISTRY IN ENVIRONMENT SUSTAINABLITY** Meenakshi	28 – 36
6.	**EVOLUTION OF HEALTHCARE SERVICES IN WORLD** Swarnima Pandey and Pragya Chaudhary	37 – 41
7.	**GRAPHENE BASED INVASIVE AND NON-INVASIVE SENSORS FOR HEALTH CARE MONITORING SYSTEM** Babita, Swati and Hempal Singh	42 – 57
8.	**METAL OXIDES BASED H_2 GAS SENSORS: A REVIEW** S. V. Patil	58 – 62
9.	**GLIMPSE ON THE RISE AND FALL OF MUMBAI DABBAWALA** Abhijeet Deepak Yadav	63 – 70
10.	**NANOTECHNOLOGY – A SUSTAINABLE AGRICULTURAL DEVELOPMENT IN INDIA** Rahul Vasantrao Zade	71 – 79
11.	**VOLUMETRIC ANALYSYS-COMMON INDICATORS AND APPLICATIONS** Rajeev Ramachandra Kolgi	80 – 84
12.	**REVIEW OF RESEARCH TYPES IN CONTEXT TO SCIENCE DISCIPLINE** Shailendra Bhalchandra Kolhe	85 – 89

13.	**LANDSCAPE OF PERSIMMON FRUIT ON ANTI-OXIDANT ACTIVITY** Anamika P. K., Britika Pal, Shanthini Nachiyar and Keerthana Devi M	90 – 93
14.	**UTILIZING DATA ANALYTICS TO UNDERSTAND THE NUTRITIONAL AND MEDICINAL PROPERTIES OF *MORINGA OLEIFERA*** K. Thiyagarajan, T. Parkavi, U. Gomathi and R. Kavitha	94 – 103
15.	**PROTECTIVE EFFECT OF BETULINIC ACID AND FLUVASTATIN ON EXPERIMENTAL ARTHRITIS- AN INVIVO APPROACH** Limi Elizabeth Mathew and A Helen	104 – 124
16.	**A REVIEW ON PHARMACOLOGICAL ACTIVITIES OF *Kedrostis foetidissima (JACQ.) COGN.*** Gayathri S, Muthamizhan V J and Santhi R	125 – 132
17.	**NEED OF BASIC ELECTRONICS FOR TODAY'S TECHNOLOGY** Bhavesh Anant Chavan	133 – 135
18.	**A COMPARATIVE STUDY OF HYDROETHANOLIC EXTRACT OF HYDROPONICS AND SOIL GROWN *SPINACIA OLERACEA* LEAVES: A REVIEW** Praveenraj N, Karan Nikas S and R. Santhi	136 – 140
19.	**FORMATION AND STRUCTURE OF MICROBIAL BIOFILMS** Santosh Vitthalrao Jadhav	141 – 146
20.	**SIMULATION OF THERMAL CONDUCTIVITY OF NANOFLUIDS BASED ON CLASSICAL MODEL** Vijay S. Raykar, Vivek A. Rane and Parshuram B. Abhange	147 – 150

VIABILITY ASSAY OF RAT PERITONEAL MACROPHAGES BY ARSENIC TRIOXIDE (ATO): THE POSSIBLE FUTURE PROSPECTS OF NANOMEDICINE DELIVERING ARSENIC TRIOXIDE (ATO) FOR DISEASE THERAPY

Srikanta Guria*[1], Ohidul Middya[1], Debrina Saha[1],
Asik Billa Hossain[1] and Samar Chattopadhyay[2]
[1]Post Graduate Department of Zoology,
[2]Post Graduate Department of Physics,
Barasat Govt. College, Barasat, Kolkata-700124, West Bengal, India
*Corresponding author E-mail: guriasrikanta@gmail.com, srikantaguria81@gmail.com

Abstract:

Exposure of humans to arsenic is associated with various adverse health effects including immunotoxicity. Arsenic toxicity toward macrophages is complex. In the present study we investigated viability assay of peritoneal macrophages isolated from rat exposed for 2 weeks to Arsenic Trioxide (ATO) in water at 0.5, 5, and 50 mg As/l. Normal saline (0·9% NaCl) was injected into rat peritoneum and the aspirate was taken for macrophage study. Peritoneal fluid was smeared on glass slides. The adherent macrophages were stained by Giemsa. Cells were treated with 50 µl of 0.25 % trypan blue dye solution for 5 minutes and observed under light microscope. Significant number of treated peritoneal macrophages (5 and 50 mg As/l) showed trypan blue (TB) positive response. Arsenic treatment at 0.5mg As/l dose increased cell aggregation. These inorganic arsenicals mainly caused necrotic cell death with partially apoptotic cell death; about 80% of dead cells were necrotic, and 20% were apoptotic. Hence, the arsenic trioxide (ATO) has capacity to kill the cells, it can be used as nano medicine to treat cancer. Different studies reported the role of arsenic trioxide in the implementation of nanotechnology for arsenic trioxide delivery to solid cancer cells. So, arsenic is both poisonous and therapeutically useful. But further study is needed to better understand the relationship between As exposure and macrophage immunotoxicity and therapeutic approaches.

Keywords: Arsenic Trioxide, Macrophages, Immunotoxicity, Nano medicine

Introduction:

Although extensive research has focused on investigating arsenic (As) carcinogenicity, growing evidence indicates that As also has deleterious effects on the immune system (Selgrade, 2007; Vahter, 2008). The specific effects of As on immune function remain poorly understood. Here, we summarize the known toxicological effects of As on macrophage function. Arsenic exposure in animals suppresses macrophage production of NO^- and/or $O2^-$, release of TNF-α and phagocytosis (Sengupta and Bishayi,

2002). Arsenic can also induce apoptosis in macrophages, as seen in 3-fold increased DNA fragmentation in splenic macrophages from As III-exposed mice (Sengupta and Bishayi, 2002). Lemarie *et al.,* 2006 stated As exposure disrupted monocyte/macrophage survival, development and function in vitro. As_2O_3-exposed human blood monocytes and U937 promonocytic cells underwent marked apoptosis during macrophagic differentiation, through inhibition of NF-κB-related survival pathways (Lemarie *et al.,* 2006 a &b).

Further, As reversed macrophage specific features, and impaired phagocytosis leading to macrophagic "de-differentiation" (Sakurai *et al.,* 2006).

Hence the arsenic trioxide (ATO) has capacity to kill the cells, it can be used as nano medicine to treat cancer. Different studies reported the role of arsenic trioxide in the implementation of nanotechnology for arsenic trioxide delivery to solid cancer cells.

Materials and Methods:

In the present study we investigated viability assay of peritoneal macrophages isolated from rat exposed for 2 weeks to Arsenic Trioxide (ATO) in water at 0.5, 5, and 50 mg As/l.

Normal saline (0·9% NaCl) was injected into rat peritoneum and the aspirate was taken for macrophage study. Peritoneal fluid was smeared directly on sterilized glass slides and incubated at 37˚C in a humid chamber for 3 hours. The adherent macrophages were fixed by methanol and stained by Giemsa and observed under light microscope. Cells were treated with 50 µl of 0.25 % trypan blue dye solution for 5 minutes. Cells that have taken up the dye are dead, since the dye is normally excluded by the membranes which maintain their semi permeability intact and therefore, the percentage of blue-stained cells represents a mortality index.

Result:

Dead macrophages were blue in colour whereas the viable cells of controls were white. Mean mortality index was significantly increased in treated group. The result showed, arsenic treatment at 0.5mg As/l dose increased cell aggregation (picture not shown). Significant number of treated peritoneal macrophages (5 and 50 mg As/l) showed trypan blue (TB) positive response (Fig.1, 2, 3 and 4).

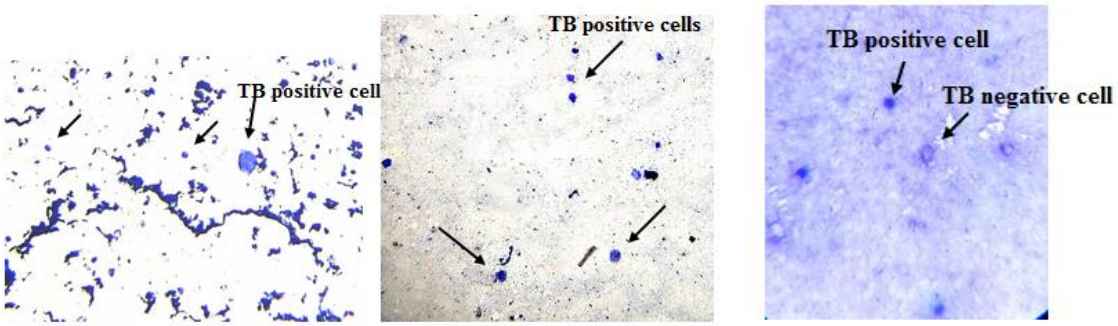


Figure 1: Trypan blue (TB) positive peritoneal macrophages isolated from rat exposed to Arsenic Trioxide in water at 5 mg As/l. (indicated by arrow) (x100)

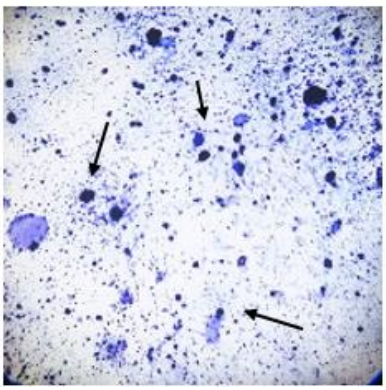


Figure 2: Trypan blue (TB) positive peritoneal macrophages isolated from rat exposed to Arsenic Trioxide in water at 50 mg As/l. (indicated by arrow) (x100)

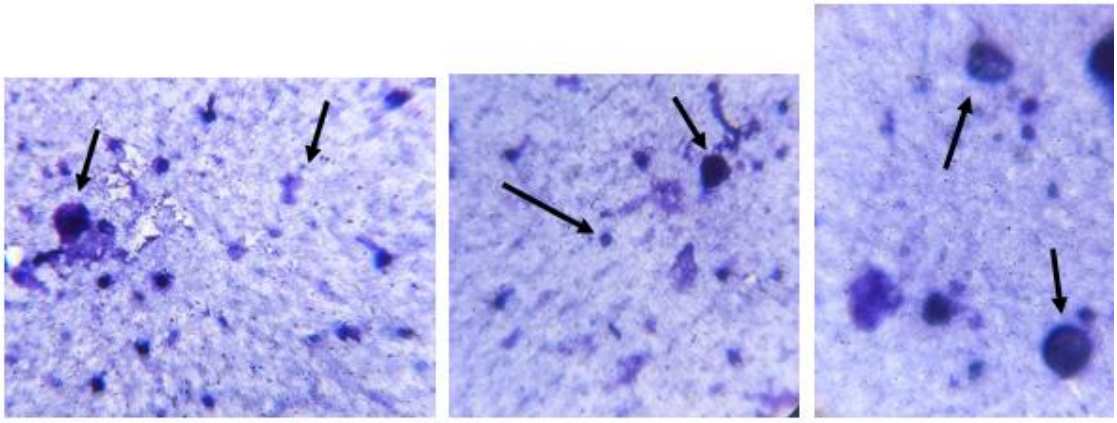


Figure 3: Trypan blue (TB) positive peritoneal macrophages isolated from rat exposed to Arsenic Trioxide in water at 50 mg As/l. (indicated by arrow) (x 400)

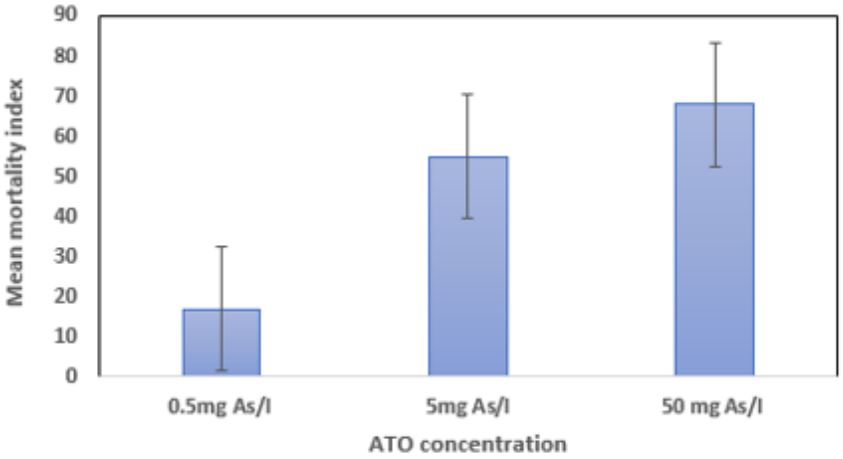


Fig.4

Figure 4: Mean mortality index in peritoneal macrophages isolated from rat exposed to Arsenic Trioxide (ATO) in water at 0.5, 5, and 50 mg As/l. Values are expressed as Mean ± SEM.

Discussion:

Guria *et al.,* 2012 reported clearly that arsenic toxicity adversely affected peritoneal macrophages and spleen cell function. Significant number of peritoneal macrophages and spleen cells were found to be pyknotic and reduced in number. Arsenic treated cells showed membrane blebbing and fragmentation. The cellular death was also confirmed by Trypan blue staining. An increased rate of macrophage death causes a decrease of immune function in arsenic poisoning (Guria *et al.,* 2012; Gardner, 1984; Bustamante *et al.,* 1997). The inorganic arsenicals mainly caused necrotic cell death with partially apoptotic cell death; about 80% of dead cells were necrotic, and 20% were apoptotic.

The present result revealed significant number of treated peritoneal macrophages (5 and 50 mg As/l) showed trypan blue (TB) positive response (Fig.1, 2, 3 and 4).

Hence the arsenic trioxide (ATO) has capacity to kill the cells, it can be used as nano medicine to treat cancer. Different studies reported the role of arsenic trioxide in the implementation of nanotechnology for arsenic trioxide delivery to solid cancer cells. Anti-cancer activity of free ATO has been tested on a variety of solid tumor cell lines. Zhao and co-workers (Zhao *et al.,* 2008) administered direct intra-tumoral injections of ATO to human esophageal carcinoma xenografts in mice. Tumor growth inhibition was observed. Arsenic trioxide has been used alone and in combination as drug therapy for acute promyelocytic leukemia (Teran *et al.,* 2019). The efficacy and mechanism of arsenic trioxide nanoparticles in the treatment of Hepatocellular carcinoma (HCC) were reported by Jian Hu *et al.,* 2019. Arsenic trioxide alone and arsenic trioxide nanoparticles were conveniently administered to mice intratumorally using a needle. Compared with As_2O_3, As_2O_3 nanoparticles (As_2O_3-NPs) showed pyroptosis, a type of programmed necrosis in vitro (Jian Hu *et al.,* 2019). Moon *et al.,* 2002 showed Arsenic trioxide (As_2O_3) to be an effective inducer of apoptosis in patients with relapsed acute promyelocytic leukemia (APL). As_2O_3 was able to induce the apoptotic activity in K562 cells (Human chronic myelogenous leukemia cells), and its apoptotic mechanism was associated with activation of caspase-3 (Moon *et al.,* 2002). So, arsenic is both poisonous and therapeutically useful. But further study is needed to better understand the relationship between As (arsenic) exposure, macrophage immunotoxicity and therapeutic approaches.

Acknowledgement:

The corresponding author is thankful to Head, Post Graduate Department of Zoology and Principal, Barasat Govt. College for necessary support.

References:

1. Bustamante J, Dock L, Vahter M, Fowler B, Orrenius S. (1997). The semiconducter elements arsenic and indicum induce apoptosis in rat thymocytes. *Toxicol.*, 118: 129-36.

2. Gardner DE. (1984). Alteration in macrophage function by environmental chemicals. *Environ Health Perspect*, 55: 343-358.
3. Guria S, Chhetri S, Saha S, Chetri N, Singh G, Saha PB, Sarkar BS, and Das M. (2012). Pulmonary Involvement of Arsenic Poisoning and Effect of Arsenic Toxicity on Peritoneal Macrophages and Spleen Cells in Rat. *Animal Biology Journal,* 3(2): 67-76.
4. Jian Hu, Yi Dong, Li Ding, Yang Dong, Zhihua Wu, Wenping Wang, Ming Shen and Yourong Duan. (2019). Local delivery of arsenic trioxide nanoparticles for hepatocellular carcinoma treatment. *Signal Transduction and Targeted Therapy*, 4: 28.
5. Lemarie A, Morzadec C, Merino D, Micheau O, Fardel O and Vernhet L. (2006 a). Arsenic trioxide induces apoptosis of human monocytes during macrophagic differentiation through nuclear factor-kappaB-related survival pathway down-regulation. *J Pharmacol Exp Ther*, 316: 304–314.
6. Lemarie A, Morzadec C, Bourdonnay E, Fardel O and Vernhet L. (2006 b). Human macrophages constitute targets for immunotoxic inorganic arsenic. *J Immunol*, 177: 3019–3027.
7. Moon Jeong Shim, Hyun Jeong Kim, Seung Ju Yang, In Soo Lee, Hyun Il Choi and Tae Ue Kim. (2002). Arsenic Trioxide Induces Apoptosis in Chronic Myelogenous Leukemia K562 Cells: Possible Involvement of p38 MAP Kinase. *Journal of Biochemistry and Molecular Biology*, 35 (4), 377-383.
8. Sakurai T, Ohta T, Tomita N, Kojima C, Hariya Y, Mizukami A and Fujiwara K. (2006). Evaluation of immunotoxic and immunodisruptive effects of inorganic arsenite on human monocytes/macrophages. *Int Immunopharmacol*, 6: 304–315.
9. Selgrade MK. (2007). Immunotoxicity: the risk is real. *Toxicol Sci*, 100: 328–332.
10. Sengupta M and Bishayi B. (2002). Effect of lead and arsenic on murine macrophage response. *Drug Chem Toxicol*, 25: 459–472.
11. Teran VA, Wilson BB and Guffey DJ. (2019). Flexural eruption associated with arsenic trioxide therapy in a patient with acute promyelocytic leukemia. *JAMA Dermatol.* https://doi.org/10.1001/jamadermatol.2018.5258 .
12. Vahter M. (2008). Health effects of early life exposure to arsenic. *Basic Clin Pharmacol Toxicol*, 102:204–211.
13. Zhao S, Zhang X, Zhang J, *et al.,* (2008). Intravenous administration of arsenic trioxide encapsulated in liposomes inhibits the growth of C6 gliomas in rat brains. *J Chemother*, 20(2): 253– 262.

THEORETICAL INTERPRETATION OF EXCESS VISCOSITY OF POLAR LIQUID MIXTURES FROM 298.15-318.15K

Naveen Awasthi
Department of Chemistry,
Janta College Bakewar (206124), Etawah, India
Corresponding author E-mail: nvn_awsthi@rediffmail.com

Abstract:

Excess volume and Excess viscosity are two important physico-chemical properties for the analysis of molecular interactions present in various liquid mixtures. Excess volume and Excess viscosity were computed for two polar binary liquid mixtures Benzyl alcohol + 2- Propenol, 2-Phenyl ethanol over the entire range of concentration from 298.15-318.15K temperatures and atmospheric pressure from statistical model of Flory. Results were compared and tested with literature values and represented in terms of molecular interactions.

Keywords: Excess viscosity, Binary mixture, Excess Volume, Statistical model

Introduction:

In past few years the knowledge of physico-chemical properties such as density, viscosity, surface tension and refractive index of liquid mixtures has wide range of interest in many pharmaceutical and technological areas. Among these physico-chemical properties, viscosity data play a significant role in process simulations, equipment design and molecular dynamics Wang *et al*. (2005) and Mchawehet *et al.* (2004) and prediction of molecular interaction between the binary liquid system Shukla *et al.* (2011). In the continuation of previously published work Awasthi *et al*. (2017)**,** this paper is concerned with the theoretical evaluation of Excess viscosity for Benzyl alcohol +2-Propenol and Benzyl alcohol+2 -Phenyl ethanol over the entire range of concentration from 298.15-318.15K from the experimental work of Ching-Ta and Chein-Hsiun Tu Ching Ta *et al.* (2007). Flory statistical liquid state model Flory *et al.* (1965) was used for theoretical evaluation of Excess viscosity at three different temperatures. Excess volume Awasthi *et al*. (2019) computed from Flory statistical model for both the binary liquids at different temperatures were used to analyze the extent of molecular interaction between the binary liquid mixtures. The main purpose of this work to analyze the effect of temperatures on intermolecular interactions between polar binary liquid mixtures.

Modeling

1. Flory liquid state model

Flory proposed a model Flory *et al.* (1965) based on non-association concept and the behavior of liquids are additive during the determination of mixing properties. Viscosity of liquid mixtures were computed by the following equation:

$$\ln \eta = x_1 \ln \eta_1 + x_2 \ln \eta_2 - [x_1 P_1^* v_1^* \left\{ \frac{1}{\tilde{v}_1} - \frac{1}{\tilde{v}} \right\} + 3\tilde{T}_1 \ln\{$$

$$(\tilde{v}_1^{1/3} - 1)/(\tilde{V}^{1/3} - 1)\} + x_2 P_2^* v_2^* \{(1/\tilde{v}_2) - (1/\tilde{v})\}$$

$$+ 3\tilde{T}_2 \ln\{(\tilde{v}_2^{1/3} - 1)/(\tilde{v}^{1/3} - 1)\} \quad + x_1 v_1^* \theta_2 X_{12} / \tilde{V}_1] / RT$$

$$+ 1/(\tilde{v} - 1) - x_1 /(\tilde{v}_1 - 1) - x_2 /(\tilde{v}_2 - 1) \qquad (1)$$

Where P*, v*, $\tilde{v}$, $\tilde{T}$, θ and X12 are the characteristic pressure, characteristic volume, reduced volume, reduced temperature, site fraction and interaction parameters respectively. Which are calculated by the following equations:

Reduced volume can be calculated by the help of following expression

$$\tilde{v} = \frac{V}{x_1 v_1^* + x_2 v_2^*} \qquad (2)$$

$$V = \frac{M_1 x_1 + M_2 x_2}{\rho_{mix}} \qquad (3)$$

Where ρ_{mix} is the density of binary liquid mixture.

Characteristic. temperature of binary liquid mixture can be calculated from the following expression.

$$T^* = \frac{P^*}{\frac{\Psi_1 P_1^*}{T_1} + \frac{\Psi_2 P_2^*}{T_2}} \qquad (4)$$

Where P* is the characteristic pressure of binary liquid mixtures.

$$P^* = [\Psi_1 P_1^* + \Psi_2 P_2^* - (\Psi_1 \theta_2 X_{12})] \qquad (5)$$

Where ψ_1 and $\psi_2$is segment fraction, θ_2 is the site fraction of component 2 and X_{12} is the interaction parameters.

$$\psi_2 = \frac{X_2}{X_2 + X_1 (V_1^* / V_2^*)} \qquad (6)$$

$$\psi_1 = 1 - \psi_2$$

site fraction is given by the following expression

$$\theta_2 = \frac{\psi_2}{\psi_2 + \psi_1 (V_2^* / V_1^*)^{1/3}} \qquad (7)$$

$$\theta_1 = 1 - \theta_2 \tag{8}$$

The interaction parameter X_{12} is obtained by adopting familiar Berthelot relationship $\eta_{ij}=(\eta_{ii}\eta_{jj})^{1/2}$ can be expressed as

$$X_{12} = P_1^*[1-(P_2^*/P_1^*)^{1/2}(v_2^*/v_1^*)^{1/6})]^2 \tag{9}$$

Result and Discussion:

Table1 represent the density, experimental and theoretical values of Molar volume, Viscosity, Excess viscosity, and Excess volume computed for binary liquid mixture of Benzyl alcohol +2-Propenol by Flory liquid state model from298.18-318.15K over the entire range of concentration and atmospheric pressure. Whereas Table2 represent the density, experimental and theoretical values of Molar volume, Viscosity, Excess viscosity, and Excess volume computed for binary liquid mixture of Benzyl alcohol +

$$\eta^E = \eta_{Flory} - (X_1\eta_1 + X_2\eta_2) \tag{10}$$

2-Phenyl ethanol by Flory liquid state model from 298.18-318.15K over the entire range of concentration and atmospheric pressure. A perusal of table 1 reveals that the density of binary liquid mixture decreases with increase in temperature whereas the Molar volume increases with increase in temperature. Which means that the molecular interactions become weak as we increase the temperature.Excess viscosity computed from Flory model firstly decreases as molar concentration increases up to certain limit than increases.

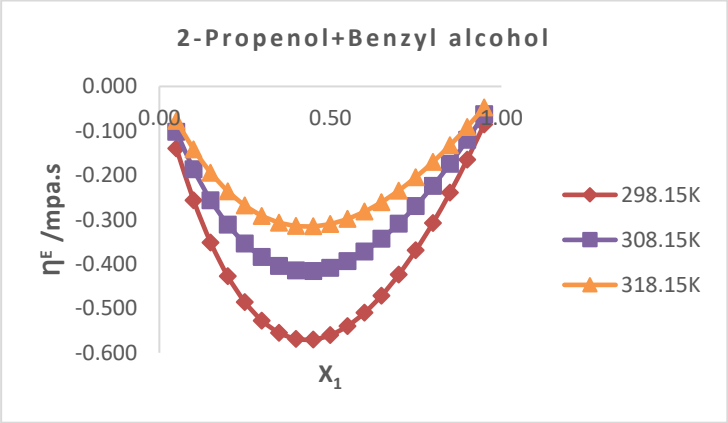


Figure 1: Variation of Excess viscosity from 298.15-318.15K

Similar trades were observed for all the temperatures as shown in Fig. (1). The values of Excess viscosity computed for Benzyl alcohol +2-Propenol decreases with increase in temperature. Which clearly confirm that intermolecular association decreases with increase in temperature Awasthi (2022). A careful observation of table2 reveals that the density of binary liquid mixture Benzyl alcohol+2 -Phenyl ethanol increases with molar concentration while decreases with increase in temperature. Molar volume also increase

with temperature, which indicate that molecular association (dipolar-dipolar) becomes weak and spacing between the components of binary liquid mixture becomes large.

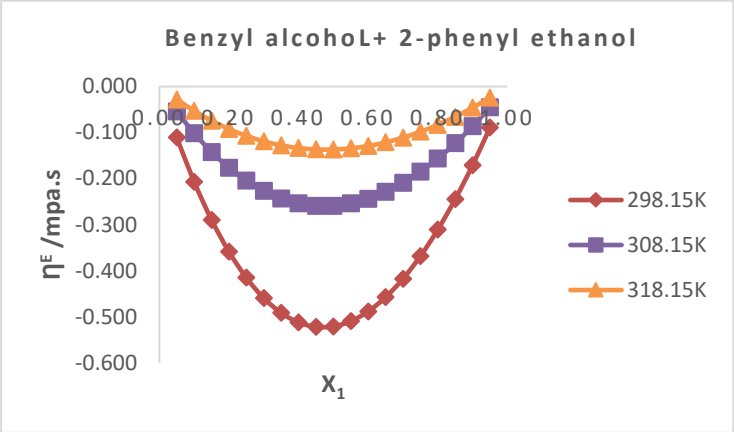


Figure 2: Variation of Excess viscosity from 298.15-318.15K

Excess viscosity decreases in magnitude as temperature increases form 298.15-318.15K as shown in figure 2. Trends are almost similar for all the three temperatures.

Table 1: Excess thermodynamic properties of 2- Propanol +Benzyl alcohol from 298.15-318.15k

X_1	ρ^{MIX}	V_M	η^{EXP}	V^E_{Exp}	V^E_{Theo}	η^E_{Exp}	η^E_{Theo}
			T=298.15K				
0.05	1.03	102.38	5.299	-0.118	-0.118	-0.082	-0.140
0.10	1.02	100.94	5.053	-0.211	-0.211	-0.155	-0.256
0.15	1.01	99.51	4.799	-0.291	-0.291	-0.235	-0.351
0.20	1.00	98.10	4.559	-0.359	-0.358	-0.301	-0.427
0.25	0.99	96.69	4.332	-0.426	-0.426	-0.355	-0.485
0.30	0.98	95.29	4.116	-0.482	-0.481	-0.397	-0.528
0.35	0.97	93.89	3.911	-0.529	-0.529	-0.428	-0.555
0.40	0.96	92.51	3.714	-0.565	-0.565	-0.452	-0.569
0.45	0.95	91.14	3.523	-0.596	-0.596	-0.469	-0.570
0.50	0.94	89.77	3.335	-0.614	-0.614	-0.484	-0.560
0.55	0.92	88.42	3.169	-0.624	-0.623	-0.476	-0.540
0.60	0.91	87.08	3.010	-0.617	-0.616	-0.461	-0.510
0.65	0.90	85.75	2.858	-0.598	-0.598	-0.440	-0.471
0.70	0.88	84.44	2.715	-0.659	-0.568	-0.409	-0.424
0.75	0.87	83.14	2.580	-0.521	-0.521	-0.370	-0.369
0.80	0.85	81.86	2.460	-0.456	-0.455	-0.317	-0.307
0.85	0.84	80.59	2.346	-0.376	-0.376	-0.257	-0.239
0.90	0.82	79.35	2.251	-0.277	-0.277	-0.178	-0.165
0.95	0.80	78.12	2.148	-0.154	-0.154	-0.108	-0.085

T=308.15K

0.05	1.03	103.16	3.910	-0.126	-0.126	-0.056	-0.102
0.10	1.02	101.72	3.730	-0.224	-0.224	-0.109	-0.187
0.15	1.01	100.29	3.558	-0.308	-0.308	-0.154	-0.256
0.20	1.00	98.88	3.389	-0.381	-0.381	-0.195	-0.311
0.25	0.99	97.47	3.230	-0.448	-0.448	-0.227	-0.354
0.30	0.98	96.07	3.076	-0.503	-0.503	-0.254	-0.384
0.35	0.96	94.68	2.921	-0.553	-0.553	-0.282	-0.404
0.40	0.95	93.30	2.772	-0.592	-0.591	-0.304	-0.414
0.45	0.94	91.93	2.631	-0.624	-0.623	-0.318	-0.415
0.50	0.93	90.57	2.490	-0.641	-0.641	-0.332	-0.408
0.55	0.92	89.22	2.370	-0.650	-0.650	-0.324	-0.393
0.60	0.90	87.88	2.256	-0.642	-0.641	-0.311	-0.371
0.65	0.89	86.56	2.145	0.623	-0.623	-0.295	-0.343
0.70	0.87	85.25	2.042	-0.593	-0.592	-0.271	-0.309
0.75	0.86	83.95	1.946	-0.548	-0.548	-0.240	-0.269
0.80	0.84	82.68	1.851	-0.481	-0.481	-0.208	-0.224
0.85	0.83	81.42	1.761	-0.393	-0.393	-0.170	-0.174
0.90	0.81	80.18	1.675	-0.290	-0.290	-0.129	-0.120
0.95	0.79	78.97	1.602	-0.166	-0.166	-0.075	-0.062

T=318.15K

0.05	1.02	103.96	2.989	-0.131	-0.131	-0.034	-0.077
0.10	1.01	102.52	2.864	-0.237	-0.237	-0.062	-0.141
0.15	1.00	101.10	2.745	-0.324	-0.323	-0.084	-0.194
0.20	0.99	99.68	2.628	-0.400	-0.400	-0.104	-0.236
0.25	0.98	98.28	2.513	-0.469	-0.468	-0.122	-0.268
0.30	0.97	96.89	2.400	-0.527	-0.526	-0.138	-0.291
0.35	0.96	95.50	2.285	-0.578	-0.578	-0.156	-0.307
0.40	0.94	94.12	2.172	-0.618	-0.618	-0.172	-0.314
0.45	0.93	92.75	2.059	-0.651	-0.651	-0.188	-0.315
0.50	0.92	91.40	1.953	-0.668	-0.668	-0.198	-0.310
0.55	0.91	90.06	1.858	-0.674	-0.674	-0.196	-0.298
0.60	0.89	88.73	1.769	-0.666	-0.665	-0.188	-0.282
0.65	0.88	87.42	1.680	-0.646	-0.646	-0.180	-0.260
0.70	0.87	86.11	1.594	-0.619	-0.619	-0.169	-0.234
0.75	0.85	84.81	1.511	-0.577	-0.576	-0.155	-0.204

0.80	0.83	83.55	1.434	-0.503	-0.503	-0.135	-0.170
0.85	0.82	82.30	1.359	-0.415	-0.415	-0.113	-0.132
0.90	0.80	81.07	1.295	-0.306	-0.306	-0.080	-0.091
0.95	0.78	79.87	1.228	-0.171	-0.171	-0.050	-0.047

Table 2: Excess thermodynamic properties of 2-Phenyl ethanol +Benzyl alcohol from 298.15-318.15k

X_1	ρ^{MIX}	V_M	η^{EXP}	V^E_{Exp}	V^E_{Theo}	η^E_{Exp}	η^E_{Theo}
			T=298.15K				
0.05	1.02	119.30	11.068	-0.095	-0.095	-0.045	-0.111
0.10	1.02	118.37	10.734	-0.201	-0.201	-0.086	-0.207
0.15	1.02	117.43	10.406	-0.322	-0.322	-0.122	-0.289
0.20	1.02	116.51	10.082	-0.431	-0.431	-0.153	-0.359
0.25	1.03	115.59	9.759	-0.535	-0.535	-0.184	-0.415
0.30	1.03	114.68	9.440	-0.618	-0.618	-0.210	-0.459
0.35	1.03	113.80	9.125	-0.682	-0.682	-0.233	-0.491
0.40	1.03	112.93	8.816	-0.738	-0.738	-0.249	-0.512
0.45	1.03	112.06	8.506	-0.782	-0.782	-0.267	-0.522
0.50	1.04	111.23	8.203	-0.798	-0.798	-0.277	-0.521
0.55	1.04	110.44	7.913	-0.771	-0.771	-0.275	-0.510
0.60	1.04	109.66	7.628	-0.734	-0.734	-0.267	-0.488
0.65	1.04	108.91	7.351	-0.664	-0.664	-0.252	-0.457
0.70	1.04	108.17	7.081	-0.584	-0.584	-0.229	-0.417
0.75	1.04	107.45	6.813	-0.486	-0.486	-0.205	-0.368
0.80	1.04	106.74	6.554	-0.380	-0.380	-0.171	-0.311
0.85	1.04	106.03	6.296	-0.265	-0.265	-0.137	-0.245
0.90	1.04	105.33	6.036	-0.149	-0.149	-0.104	-0.171
0.95	1.04	104.60	5.787	-0.064	-0.064	-0.061	-0.089
			T=308.15K				
0.05	1.01	120.16	7.322	-0.133	-0.133	-0.025	-0.054
0.10	1.01	119.20	7.132	-0.270	-0.270	-0.044	-0.101
0.15	1.02	118.25	6.940	-0.396	-0.396	-0.064	-0.142
0.20	1.02	117.31	6.752	-0.504	-0.504	-0.081	-0.176
0.25	1.02	116.38	6.564	-0.609	-0.609	-0.098	-0.205
0.30	1.02	115.48	6.372	-0.690	-0.690	-0.119	-0.227
0.35	1.02	114.59	6.186	-0.755	-0.754	-0.133	-0.243
0.40	1.02	113.71	5.999	-0.804	-0.804	-0.149	-0.254

0.45	1.03	112.85	5.815	-0.846	-0.846	-0.162	-0.259
0.50	1.03	112.01	5.636	-0.863	-0.863	-0.170	-0.259
0.55	1.03	111.21	5.467	-0.839	-0.839	-0.167	-0.254
0.60	1.03	110.42	5.302	-0.799	-0.799	-0.161	-0.244
0.65	1.03	109.66	5.140	-0.737	-0.737	-0.152	-0.229
0.70	1.03	108.91	4.979	-0.663	-0.663	-0.142	-0.209
0.75	1.03	108.19	4.821	-0.554	-0.554	-0.128	-0.185
0.80	1.03	107.48	4.666	-0.443	-0.443	-0.112	-0.156
0.85	1.03	106.78	4.519	-0.319	-0.319	-0.088	-0.123
0.90	1.03	106.08	4.374	-0.195	-0.195	-0.062	-0.086
0.95	1.03	105.36	4.232	-0.091	-0.091	-0.032	-0.045
			T=318.15K				
0.05	1.00	121.05	5.116	-0.165	-0.165	-0.010	-0.028
0.10	1.01	120.04	5.000	-0.339	-0.339	-0.021	-0.053
0.15	1.01	119.08	4.883	-0.472	-0.472	-0.032	-0.074
0.20	1.01	118.13	4.770	-0.586	-0.586	-0.040	-0.092
0.25	1.01	117.20	4.655	-0.687	-0.687	-0.049	-0.107
0.30	1.01	116.30	4.542	-0.760	-0.760	-0.056	-0.119
0.35	1.02	115.41	4.430	-0.819	-0.819	-0.063	-0.128
0.40	1.02	114.53	4.320	-0.865	-0.865	-0.067	-0.133
0.45	1.02	113.66	4.210	-0.905	-0.905	-0.072	-0.136
0.50	1.02	112.81	4.101	-0.924	-0.924	-0.075	-0.137
0.55	1.02	112.00	3.997	-0.904	-0.904	-0.073	-0.134
0.60	1.02	111.21	3.897	-0.865	-0.865	-0.068	-0.129
0.65	1.02	110.44	3.797	-0.805	-0.805	-0.062	-0.121
0.70	1.02	109.69	3.697	-0.727	-0.727	-0.057	-0.111
0.75	1.02	108.96	3.599	-0.620	-0.620	-0.049	-0.098
0.80	1.02	108.25	3.500	-0.498	-0.498	-0.042	-0.083
0.85	1.02	107.56	3.402	-0.365	-0.365	-0.035	-0.066
0.90	1.03	106.85	3.306	-0.238	-0.238	-0.025	-0.046
0.95	1.03	106.14	3.213	-0.117	-0.117	-0.013	-0.024

Conclusion:

Excess viscosity computed from statistical approach of Flory for two concerned liquid mixtures: Benzyl alcohol +2- Propanol and 2-Phenyl ethanol over the entire range of concentration from 298.15-318.15K temperatures and atmospheric pressure deals a faire agreement with experimental findings at higher temperature up to certain extent because liquid under consideration ispolar in nature while Flory model is based on non-associative

γ- meric spherical liquid system. Negative sign of excess viscosity indicates the intermolecular association between the binary components where as its magnitude indicate the extent of interactions between them.

Acknowledgement:

Author is very thankful to Department of Chemistry, Janta College, Bakewar Etawah for their support and motivation.

References:

1. Wang, L. C., Xu, H. S., Zhao, J. H., Song, C. Y., & Wang, F. A. (2005): Density and viscosity of (3-picoline+ water) binary mixtures from T= (293.15 to 343.15) K. The Journal of Chemical Thermodynamics, 37(5)., 477-483.
2. Mchaweh, A., Alsaygh, A., Nasrifar, K., &Moshfeghiam, M. (2004): A simplified method for calculating saturated liquid densities. Fluid phase equilibria, 224(2)., 157-167.
3. Shukla, R., Awasthi, N., Kumar, A … AS-J of M, (2011): Prediction of associational behaviour of binary liquid mixtures from viscosity data at 298.15, 303.15, 308.15 and 313.15 K. Elsevier.AccessedJuly13,202https://www.sciencedirect.com/science/article/pii/S0167732210003296.
4. Awasthi, N., Gangwar, V. S., Prakash, S. K. S. G., & Shukla, R. K. (2017). Viscosity and Excess Viscosity for Associated Binary Systems at T= (298.15, 308.15 and 318.15). International Journal of Thermodynamics (IJoT), 20(4)., 183-189.
5. Awasthi, N., Kumar, A., Srivastava, U., Srivastava, K., & Shukla, R. K. (2019): Excess volume and surface tension of some flavoured binary alcohols at temperatures 298.15, 308.15 and 318.15 K. Physics and Chemistry of Liquids, 57(6)., 800-815.
6. Awasthi, N. (2022): Viscosity and Excess Viscosity for non-polar systemfrom 298.15 - 323.15K. Research Journal of Recent Sciences, 11(2)., 23-33.
7. Ching-Ta, &Chein-Hsiun Tu. (2007): Density, Viscosity, Refractive Indexes, and Surface Tension for Binary Mixtures of 2-Propenol+Benzyl Alcohol, +2- Phenyl Ethanol and Benzyl Alcohol+2- Phenyl Ethanol at T= (298.15,308.15, and 318.15K). J. chem. Eng. Data, 52, 1760-1767.
8. Awasthi N. (2021): Prediction of molecular interactions in binary system from 288.15 to 318.15K by ultrasonic speed and isentropic compressibility. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 12(6)., 19-27.
9. Flory P.D. (1965): Statistical thermodynamics of liquid mixtures. Journal of the American Chemical Society. 87(9)., 1833-1838.
10. Awasthi N. (2022): Recent trends of innovations in chemical and biological sciences, Bhumi Publishing Transport and thermodynamic properties of associated fluid mixture at various temperatures, Vol-IV, 1-9.

AUGMENTED REALITY AND AR CODE USING AI TECHNIQUE

H. Parveen Begum and P. Anusha
Department of Software Engineering,
Periyar Maniammai Institute of Science and Technology,
Vallam, Thanjavur, Tamil Nadu

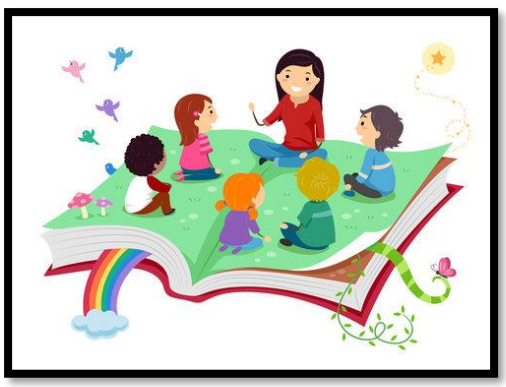
Introduction:

Science is the Latin word "Scientia" which literally means "know something" about anything. Invention and Discovery are the children of science. Technology is adopted from the Greek words techne and logos, techne means some skill of arts or anything and logos means expressing that skill to others. Every invention or discovery is the milestone of science development. Most of the people accept that iron is the first discovery of man. The latest inventions are Augmented Reality, anything possible in the development of science and technology. In this chapter, I assured you that you will get a clear perception of augmented reality especially about AR code.

Augmented Reality:

Augmented Reality is the broaden view of Virtual Reality. The AR user can sense the virtual and real environment concurrently. For example, filters used in Instagram video call is the suitable example for augmented reality which mean you can change the background, you can add the face mask or you can wear some ornaments etc. Like VR user the AR user does not fully immerse in the Virtual world. AR user can feel the real world too. The android phones, tablets, Laptops and smart glasses are the hardware tools used to feel AR

Adobe aero is a contemporary augmented reality tool released by adobe for developing, outlook and give out the instinctive tale-telling. In our childhood we read tale books that contain text and some 2D images to narrate stories, later we watch movies in theatres and tv shows which casted by actors. Nowadays augmented reality gives an opportunity to bring the story book alive around us. It is more helpful for kids to visualize and immerge into the moral stories. In our childhood we first read and then imagine the characters, now the children come across with the story lively.



AR Code – Evolution of Code

We all have basic idea about Uniform Product Code (UPC) which is the machine-readable code that contains some hidden information. Generally designed for denoting some description and price of any product. Initially in 1954, Norman Joseph Woodland developed barcode. It was developed in 1-Dimension and 2-Dimension.

A QR code, or Quick Response code, is also a 2Dimension barcode that encodes data in black and white or contrasting dark and light, cells arranged in a grid format. Like other 2Dimension codes, QR codes are unidirectional meaning that they can be read from any side. The QR code was developed in 1994, by the Denso Corporation of Japan. It reduces the procedural steps of the expecting process, normally when we scan QR code the control took us to corresponding website link for further procedure. But in AR code we can able to do what we need at once. For example if we want to pay money using AR code can directly pay the money without moving to third party website for payment.

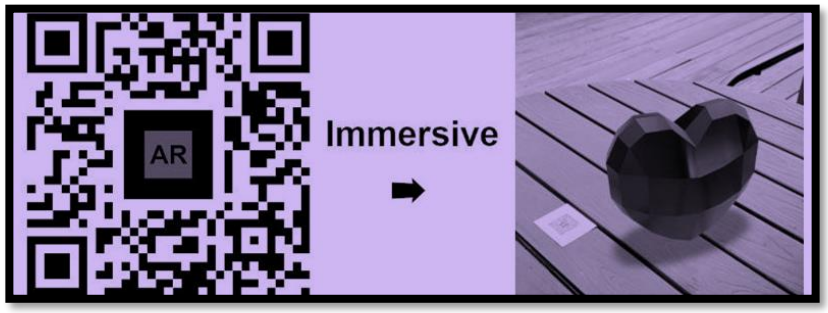
AR(Augmented Reality) code is the expandable variation of QR code usually by Scanning QR code our device directed us to the denoted website. But , the when we scan the AR code the 3Dimensional visuals will be displayed on the device. AR code merge both the physical and virtual world together.

“There are many AR SDKs out there, but ARKit and ARCore are the go-to choices precisely because they are native to market-leading Apple and Google products. However, some of the other tools in the ecosystem can harvest the power of both, depending on the device they’re running on”. **-** Pawel Nikiel - 3D Software Engineering Lead, CGTrader.

Types of AR code

Immersive AR code:

When you scan the AR code with your device camera, you can see one or more 3D animated images on your screen.

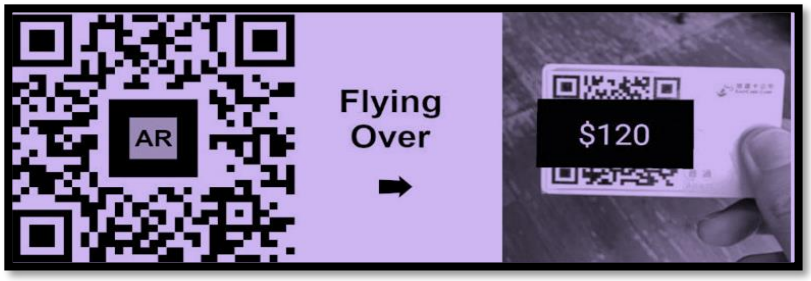


Social media AR code:

Used to change your appearance and background in social media post.

Fly-over AR code:

This type of AR code generates voucher, discounts or any money transaction related features.



Artificial Intelligence:

Artificial Intelligence is the vast researchable area which comprises of many areas like machine learning, deep learning, neural network, Robotics and many more. Basic concept of AI is to make the machine to act like a human being in all occasions. Everyone handles several situation either it is “normal or critical” in different ways; intelligent people handle the situation in a smarter and unique way.

The difference between automation and intelligence like, automation is a routine task which happens periodically either mechanically or electronically. For example, an automatic train signal gate closes and opens periodically, plus red signal also glow in the signal tower on seeing this, the train driver has to stop the train it is normal situation in case when the train is not in control then it will not stop in the gate and it damaged the

gate, as we seen in many movies chasing scene hero's car hit the gate and the gate broken into many pieces.

Here we need an intelligent task to save from getting damage, is that if the gate found that the train is not getting slower at a particular distance then the gate has to open immediately to defend itself. This is the difference between automation and intelligence. Human has ability of "intelligence growth" by birth, human always read something on his experience, but the machine need artificial intelligence to handle the different situations in different manner.

The literal meaning of Heuristic is self-learning that is not learning from previous strategies. Discovering new techniques from the determination of assumption. This is the search to resolve calculations and makes discernment fastly and skilfully. It is the cognitive search of gaining knowledge from thinking and sensing current situation. Heuristic search might not provide best solution every time but it surely helps to find better solution in a negotiable time.

Machine Learning:

Machine Learning is the arm of Artificial Intelligence, It is the study of prediction or classification of data and algorithm in the view of how human will learn and also for improving accuracy of learning. There are many machine learning algorithms are their some of them are

Linear regression:

Linear regression is the mathematical function for predicting data using set of previously available data.

$$Y = a + bX$$

$$b = \frac{N\sum XY - (\sum X)(\sum Y)}{N\sum X^2 - (\sum X)^2} \qquad a = \frac{\sum Y - b\sum X}{N}$$

Where ,

N – is the number of observations

X – is the independent variable

Y – is the dependent variable

For a Sample of 8 employees, a personnel director has collected the following data on ownership of company stock y, versus years in the firm of x . For an employee who has been with the firm 10 years, what is the predicted no of shares of stock owned?

X	6	12	14	6	9	13	15	9
Y	300	408	560	252	288	650	630	522

$$Y = a + bX$$

$$b = \frac{N\sum XY - (\sum X)(\sum Y)}{N\sum X^2 - (\sum X)^2} \qquad a = \frac{\sum Y - b\sum X}{N}$$

X	Y	XY	X2
6	300	1800	36
12	408	4896	144
14	560	7840	196
6	252	1512	36
9	288	2592	81
13	650	8450	169
15	630	9450	225
9	522	4698	81
84	3610	41238	968

$$b = \frac{8 \times 41238 - 84 \times 3610}{8 \times 968 - 84^2} = 38.75, \quad a = \frac{3610 - 38.75 \times 84}{8} = 44.375$$

Substitute x=10,

Y= a + bX

= 44.375 + 38.75 x 10 = 431.875 = 432

When x is 10 years and stock will be 432.

Linear regression algorithm:

Step 1 collect all dataset

Step 2 initialize parameters

Step 3 predict the variable of dependent variable by given independent variable

Step 4 calculate the error predictions to all data sets

Step 5 calculate the partial derivative with respect to a0 and a1

Step 6 calculate cost for each number and add them

Step 7 update the values of a0 and a1

Step 8 repeat the steps until for all data set

Logistic regression

Logistical regression is the analysis of past binary data to predict future binary outcomes. For example to determine a person is affected by some disease based on getting

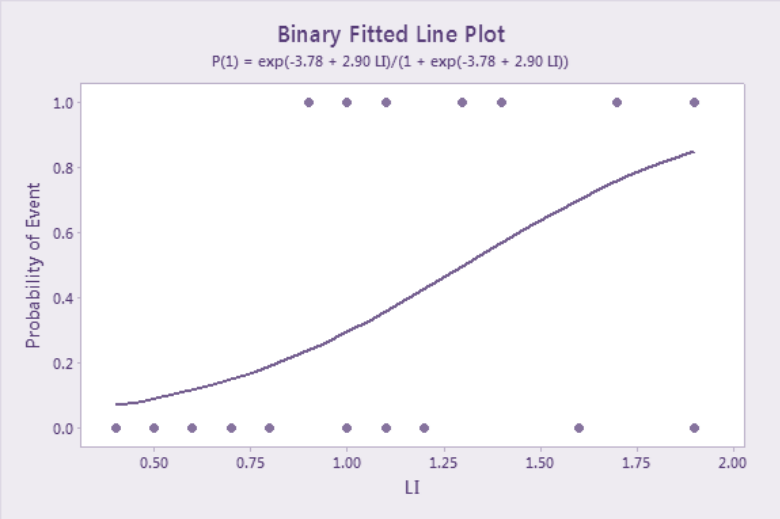
binary(yes / no) type answers from him, like whether he is having headache – yes / no, cough – yes / no, fever – yes / no etc.

$$\ln\left(\frac{P}{1-P}\right) = a + bX$$

$$\frac{P}{1-P} = e^{a+bX}$$

$$P = \frac{e^{a+bX}}{1+e^{a+bX}}$$

Where P is the probability of event "Y" occurs



Robotics:

Robotics is one of the arm of AI, which involves locomotors, manipulators, Programming, sensors and act as many more. Robotics is the inter disciplinary of computer science and AI which is the programmable machine that can finish given task and also take decision for further implementation. Unless like in movies or in serials they built a toy that can walk and talk, robot is the coded machine for automation. If arm like structure that invented for cleaning vessels regularly or whenever needed is a robot. Playing arms, drawing arms are also robots.

Conclusion:

The proliferation of android phones and other mobile devices drive forward the invention to next level. The immersive and interactive situations allow the students to be active more in the class. It enriches the employability and reduces the dangerous conditions on learning; it avoids the accidents happening on lab during practical session. It reduces the teaching, understanding and practicing time. The ability of visualization of interface reduces the dangerous of real class. The spread of affordable technology will impact the education as more entertained and leisure. On mastering in this technology will open a new door to a new universe. AI, Machine Learning, Robotics are the well growing areas.

Bibliography

1. Antonietti, Alessandro, et al. "Virtual reality and hypermedia in learning to use a turning
   lathe." Journal of Computer Assisted Learning 17.2 (2001): 142-155.
2. Baker, Suzanne C., Ryan K. Wentz, and Madison M. Woods. "Using virtual worlds in education:Second Life® as an educational tool." Teaching of Psychology 36.1 (2009): 59-64.
3. Bell, John T., and H. Scott Fogler. "Virtual reality in chemical engineering education." Proceedings of the 1995 Illinois/Indiana ASEE Sectional Conference. 1998.
4. Blasing, Molly Thomasy. "Second language in Second Life: Exploring interaction, identity and pedagogical practice in a virtual world." The Slavic and East European Journal (2010): 96-117.
5. Blum, Tobias, et al. "mirracle: An augmented reality magic mirror system for anatomy education." Virtual Reality Short Papers and Posters (VRW), 2012 IEEE. IEEE, 2012.
6. Botden, Sanne Marius Bernardine Ignatia. "Augmented reality simulation for laparoscopic
   training realistic haptic feedback and meaningful assessment." (2009).
7. Byrne, Christine M. "Water on tap: The use of virtual reality as an educational tool." (1996).
8. Choi, Dong Hwa, ed. Emerging Tools and Applications of Virtual Reality in Education. IGI Global, 2016.
9. Dede, Chris. "Planning for neomillennial learning styles." Educause Quarterly 28.1 (2005): 7-12.
10. Dunleavy, Matt, Chris Dede, and Rebecca Mitchell. "Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning." Journal of Science Education and Technology 18.1 (2009): 7-22.

11. Falah, Jannat, et al. "Virtual Reality medical training system for anatomy education." Science and Information Conference (SAI), 2014. IEEE, 2014.
12. Fang, Te-Yung, et al. "Evaluation of a haptics-based virtual reality temporal bone simulator for anatomy and surgery training." Computer methods and programs in biomedicine 113.2 (2014): 674-681.
13. Huang, Hsiu-Mei, Shu-Sheng Liaw, and Chung-Min Lai. "Exploring learner acceptance of the use of virtual reality in medical education: a case study of desktop and projection-based display systems." Interactive Learning Environments 24.1 (2016): 3-19.
14. Huber, T., et al. "Influence of a camera navigation training on team performance in virtual reality laparoscopy." J Surg Sim 2 (2015): 35-39.
15. Hussein, Mustafa, and Carl Nätterdal. "The Benefits of Virtual Reality in Education-A comparision Study." (2015).
16. Ibáñez, María Blanca, et al. "Design and implementation of a 3D multi-user virtual world for language learning." Educational Technology & Society 14.4 (2011): 2-10.
17. Ibáñez, María Blanca, et al. "Experimenting with electromagnetism using augmented reality: Impact on flow student experience and educational effectiveness." Computers & Education 71(2014): 1-13.
18. Jarmon, Leslie, et al. "Virtual world teaching, experiential learning, and assessment: An interdisciplinary communication course in Second Life." Computers & Education 53.1 (2009):169-182.
19. Jauregi, Kristi, Rick de Graaff, and Silvia Canto. "Integrating Cross-Cultural Interaction through Video-Communication and Virtual Worlds in Foreign Language Teaching Programs: Burden or Added Value?" European Association for Computer-Assisted Language Learning (EUROCALL) (2011).
20. Jonassen, David H., Kyle L. Peck, and Brent G. Wilson. "Learning with technology: A constructivist perspective." (1999).
21. Kamphuis, Carolien, et al. "Augmented reality in medical education?." Perspectives on medical education 3.4 (2014): 300-311.
22. Kerawalla, Lucinda, et al. ""“Making it real”: exploring the potential of augmented reality for teaching primary school science." Virtual Reality 10.3-4 (2006): 163-174.
23. Kinateder, Max, et al. "Virtual reality for fire evacuation research." Computer Science and Information Systems (FedCSIS), 2014 Federated Conference on. IEEE, 2014.
24. Klopfer, Eric, and Kurt Squire. "Environmental Detectives—the development of an augmented reality platform for environmental simulations." Educational Technology Research and Development 56.2 (2008): 203-228.
25. Korolov, Maria. “Report: 98% of VR headsets sold this year are for mobile phones.” Hypergrid Business. Trombly International. 30 Nov 2016. Web. 23 Apr 2017.

26. Lee, Elinda Ai-Lim, Kok Wai Wong, and Chun Che Fung. "How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach." Computers & Education 55.4 (2010): 1424-1442.
27. Lee, Elinda Ai-Lim, and Kok Wai Wong. "Learning with desktop virtual reality: Low spatial ability learners are more positively affected." Computers & Education 79 (2014): 49-58.
28. Martín-Gutiérrez, Jorge, et al. "Augmented reality to promote collaborative and autonomous learning in higher education." Computers in Human Behavior 51 (2015): 752-761.
29. Merchant, Zahira, et al. "Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis." Computers & Education 70 (2014): 29-40.
30. Olsson, Thomas, et al. "Expected user experience of mobile augmented reality services: a user study in the context of shopping centres." Personal and ubiquitous computing 17.2 (2013): 287-304.
31. Ota, David, et al. "Virtual reality in surgical education." Computers in Biology and Medicine 25.2 (1995): 127-137.
32. Pantelidis, Veronica S. "Reasons to use virtual reality in education and training courses and a model to determine when to use virtual reality." Themes in Science and Technology Education 2.1-2 (2010): 59-70.
33. Potkonjak, Veljko, et al. "Virtual laboratories for education in science, technology, and engineering: A review." Computers & Education 95 (2016): 309-327.
34. Ray, Ananda Bibek, and Suman Deb. "Smartphone Based Virtual Reality Systems in Classroom Teaching—A Study on the Effects of Learning Outcome." Technology for Education (T4E), 2016 IEEE Eighth International Conference on. IEEE, 2016.
35. Rosenblum, Lawrence J., and Robert A. Cross. "The challenge of virtual reality." Visualization & modeling (1997): 325-399.

STRENGTHENING THE POWER OF BIOINFORMATICS WITH THE HELP OF ARTIFICIAL INTELLIGENCE

Manoj Patidar
Department of Zoology,
Govt. College Manawar, Dhar, Madhya Pradesh, India
Corresponding author E-mail: manoj1patidar@gmail.com

Abstract:

The combination of biological fields like molecular biology& genetics with computer science, mathematics, and statistics to predict the molecular structures or model the mechanism is known as bioinformatics. Collecting information on biological processes, database development, computational modeling, and testing are the major steps of bioinformatics. On the other side, the correlation of various human thinking patterns with the help of computers to predict human behavior is the base of artificial intelligence. Both bioinformatics and artificial intelligence is tremendously used by researchers as well as common people for their various purposes. Bioinformatics has generated huge data and it is become difficult to analyze such big data, and hence here, artificial intelligence can be useful. A combinational strategy of utilizing the techniques of artificial intelligence with bioinformatics might provide better insights from the huge amount of data for human benefits. This approach can be utilized for novel modeling of protein structure classification, sequencing, retrieving the true information from the databases, and computer-aided drug design.

Keywords: Bioinformatics, Artificial Intelligence, Prediction

Introduction:

Advancement in the fields of computational biology and bioinformatics is well known. These both are interdisciplinary protocols of life sciences and utilized the algorithms of computers, physics, and mathematics. The application of bioinformatics ranges from molecular to personalized medicine, and genome to climate prediction. Computational biology deals with the modeling of molecular medicine, and the analysis of genetics. Both these fields generate huge data and it is out of our mind capacity to understand, analyze and retrieve the wanted information from it. Artificial intelligence is emerging very fast and reached the common people. The power of bioinformatics can be strengthened by the appropriate incorporation of artificial intelligence (1, 2, 3).

- Artificial intelligence can improve the prediction efficiency of bioinformatics such as the prediction of RNA-binding proteins, transcription factors, classifying protein structures, mutations, and localization. Analysis of big genomic data, relation extraction, and entity recognition are a few more examples. With the help of these two

approaches nowadays it becomes easier to sequence the whole human genome in a day (1).

- DeepVariant is a cloud-based tool useful for the comparison and analysis of complex genomics data sets (4).
- Gene editing including CRISPR is attracting researchers worldwide and artificial intelligence can make this process more efficacious, economical, and fast. The prediction of amino acid residues involved in the interaction of Cas9 (genome-editing protein) with the target DNA is a complex and time taking procedure. But artificial intelligence makes it time-saving by reducing the screening burden by around 95% (2).
- Computational biology in association with mass-spectrometry enables proteomics to analyze several proteins. Adding artificial intelligence in proteomics might be useful for protein identification. For example, the Prosit tool is useful for error-free protein pattern recognition.
- In proteomics convolutional neural networks can achieve 84% accuracy in positioning the proteins' amino acids into alpha-sheet, beta-helix, and coil. One more example of the combination of bioinformatics and artificial intelligence is the use of feature vectors for scoring the protein model for prediction accuracy (5).
- Artificial intelligence can enable microarray techniques to read a thousand interactions at a time for a complex experiment. Neural Designer is useful in complex pattern identification and relation retrieval. Understating the gene patterns, mutations, and future stages of a particular gene is useful in disease monitoring, early diagnosis, and modeling preventive medicine (6).
- Text mining is a very useful tool of artificial intelligence. This can be utilized to analyze the thousand research papers to obtain desired data efficiently. One example of text mining is retrieving the protein model scoring from various publications from PubMed. This includes protein-protein dockings data from protein-protein interactions and identification of constrain in time-saving, economic, and laborless processes (7).
- Modern drug discovery processes are entirely dependent on bioinformatics. It can achieve more precision with the inclusion of artificial intelligence. Some of the research and development technologies used precision medicine and next-generation sequencing. They have proven to find alternative options for multifactorial disease therapy (2).
- The field of medicine highly depends on imaginative technologies. Artificial intelligence is making these procedures easy and sensitive. Microsoft’s InnerEye tool is utilized for deeper analysis of 3D medical images. Similarly, the prediction of individual behavior can make the process of personalized medicine more effective. This can remove the limitations of specific procedures of diagnosis. Artificial intelligence can analyze the historical data of a single patient and can provide a wide range of treatment options (8).

- Now it is not difficult to treat different neurological disorders as the combined strategy of bioinformatics and artificial intelligence is helping in the prediction, analysis, diagnosis, and treatment of such complicated issues (9).
- Tools based on 3D Conventional Neural Networks and Support Vector Machines are useful in predicting motor deficits in stroke patients. This makes it possible to treat Acute Ischemic Stroke in a simple manner (10).
- By using the Atomwise tool, one can built 3D pixels from molecules to understand the 3D structure of proteins with maintaining the atomic attributes. This algorithm is useful in drug discovery as it can determine the interactions of molecules with specific proteins (11).
- CellProfiler makes it possible to imagine and measure various parameters in several samples simultaneously instead of measuring a single parameter of similar types of images by old biological image tools (12).
- These tools also increase the power of microscopes. For example, in fluorescence microscopy, artificial intelligence can figure out numerous cell attributes in a single run, and analysis of such parameters is also feasible. It also can make a model from various sets of data (13).
- The approaches including machine learning in bioinformatics algorithms like decision trees, support vector machines, and neural networks are being tested for the prediction and classification of cancer types. The Cancer Genome Atlas project deployed the RNA sequence and found 95.8% accuracy in cancer classification by using a linear support vector machine. Similarly, breast cancer is also classified into triple-negative breast cancer and non-triple-negative by machine learning (14).
- Apart from cancers, various other complicated disorders like coronary artery disease are also being predicted by machine learning-powered bioinformatics tools. Machine learning and Tree-based Pipeline Optimization tools can successfully identify single nucleotide polymorphisms (SNPs) related to coronary artery disease (15).
- Discovery of novel therapeutic is very challenging, time-consuming, costly and laborious. Therefore it is a good idea to find new roles for existing drugs and this concept is known as drug repurposing (reprofiling). Many scientists are exploring currently available databases like DrugBank and BindingDB with the help of artificial intelligence for the novel potential of reported drugs. There are several strategies are being adopted such as finding the binding ability of a particular drug with the target protein, drug-drug interactions, and identification of allosteric sites for protein-protein interactions (3, 16, 17).

Conclusion and future perspective:

Although the combination of bioinformatics and artificial intelligence is attracting researchers worldwide, there are many difficulties in adapting the combination of bioinformatics and artificial intelligence:

- The combination of bioinformatics and artificial intelligence makes the process very costly as it requires high-speed computer facilities, internet access, and software.
- Creation and maintenance of a huge database are also costly, and time-consuming, and receiving the correct information is also challenging.
- Recruitment of trained staff or giving them such training to operate various tools is also a very complicated process.
- The algorithm might vary from disease to disease. A different algorithm should be built for rare diseases, where lack of information might be the challenge. Also, it is difficult to believe in software where human life is concerned. Therefore testing and coincidence levels should be high.
- Adaptation of these technologies among researchers, practitioners, and common people is a serious issue.

Acknowledgment:

The author acknowledges the Department of Higher Education, Govt. of Madhya Pradesh, and Principal, IQAC head, Govt. College Manawar.

References:

1. Jin, S., Zeng, X., Xia, F., Huang, W., and Liu, X. (2021). Application of Deep Learning Methods in Biological Networks. Brief. Bioinformatics 22 (2), 1902–1917. doi:10.1093/bib/bbaa043.
2. Kumar Shukla, P., Kumar Shukla, P., Sharma, P., Rawat, P., Samar, J., Moriwal, R., et al. (2020). Efficient Prediction of Drug-Drug Interaction Using Deep Learning Models. *IET Syst. Biol.* 14 (4), 211–216. doi:10.1049/iet-syb.2019.0116.
3. Pushpakom, S., Iorio, F., Eyers, P. A., Escott, K. J., Hopper, S., Wells, A., et al. (2019). Drug Repurposing: Progress, Challenges and Recommendations. *Nat. Rev. Drug Discov.* 18 (1), 41–58. doi:10.1038/nrd.2018.168.
4. Huang PJ, Chang JH, Lin HH, Li YX, Lee CC, Su CT, Li YL, Chang MT, Weng S, Cheng WH, Chiu CH, Tang P. DeepVariant-on-Spark: Small-Scale Genome Analysis Using a Cloud-Based Computing Framework. Comput Math Methods Med. 2020 Sep 1;2020:7231205. doi: 10.1155/2020/7231205. PMID: 32952600; PMCID: PMC7481958.
5. Mann M, Kumar C, Zeng WF, Strauss MT. Artificial intelligence for proteomics and biomarker discovery. Cell Syst. 2021 Aug 18;12(8):759-770. doi: 10.1016/j.cels.2021.06.006. PMID: 34411543.
6. Raza, Khalid. (2019). Analysis of Microarray Data Using Artificial Intelligence Based Techniques. 10.4018/978-1-5225-8903-7.ch034.
7. D. Rebholz-Schuhmann, A. Oellrich, R. Hoehndorf. Text-mining solutions for biomedical research: enabling integrative biology. Nat. Rev. Genet., 13 (2012), pp. 829-839.

8. Meijering E. A bird's-eye view of deep learning in bioimage analysis. Comput Struct Biotechnol J. 2020 Aug 7;18:2312-2325. doi: 10.1016/j.csbj.2020.08.003. PMID: 32994890; PMCID: PMC7494605.
9. K. Rupabanta Singh, Sujata Dash. Chapter 1 - Early detection of neurological diseases using machine learning and deep learning techniques: A review, Editor(s): Ajith Abraham, Sujata Dash, Subhendu Kumar Pani, Laura García-Hernández, Artificial Intelligence for Neurological Disorders, Academic Press, 2023, Pages 1-24, ISBN 9780323902779.
10. Kamal H, Lopez V, Sheth SA. Machine Learning in Acute Ischemic Stroke Neuroimaging. Front Neurol. 2018 Nov 8;9:945. doi: 10.3389/fneur.2018.00945. PMID: 30467491; PMCID: PMC6236025.
11. Atomwise Artificial intelligence for drug discovery. [(accessed on 24 April 2019)]; Available online: https://www.atomwise.com/
12. Carpenter, Anne & Jones, Thouis & Lamprecht, Mike & Clarke, Colin & Kang, In & Friman, Ola & Guertin, David & Chang, Joo & Lindquist, Robert & Moffat, Jason & Golland, Polina & Sabatini, David. (2006). CellProfiler: Image analysis software for identifying and quantifying cell phenotypes. Genome biology. 7. R100. 10.1186/gb-2006-7-10-r100.
13. Lucas von Chamier, Romain F. Laine, Ricardo Henriques; Artificial intelligence for microscopy: what you should know. *Biochem Soc Trans* 30 August 2019; 47 (4): 1029–1040. doi: https://doi.org/10.1042/BST20180391.
14. Khan J, Wei JS, Ringnér M, Saal LH, Ladanyi M, Westermann F, Berthold F, Schwab M, Antonescu CR, Peterson C, Meltzer PS. Classification and diagnostic prediction of cancers using gene expression profiling and artificial neural networks. Nat Med. 2001 Jun;7(6):673-9. doi: 10.1038/89044. PMID: 11385503; PMCID: PMC1282521.
15. Gaudillo J, Rodriguez JJR, Nazareno A, Baltazar LR, Vilela J, Bulalacao R, Domingo M, Albia J. Machine learning approach to single nucleotide polymorphism-based asthma prediction. PLoS One. 2019 Dec 4;14(12):e0225574. doi: 10.1371/journal.pone.0225574. PMID: 31800601; PMCID: PMC6892549.
16. Wishart DS, Knox C, Guo AC, Cheng D, Shrivastava S, Tzur D, Gautam B, Hassanali M. DrugBank: a knowledgebase for drugs, drug actions and drug targets. Nucleic Acids Res. 2008 Jan;36(Database issue):D901-6. doi: 10.1093/nar/gkm958. Epub 2007 Nov 29. PMID: 18048412; PMCID: PMC2238889.
17. Liu T, Lin Y, Wen X, Jorissen RN, Gilson MK. BindingDB: a web-accessible database of experimentally determined protein-ligand binding affinities. Nucleic Acids Res. 2007 Jan;35(Database issue):D198-201. doi: 10.1093/nar/gkl999. Epub 2006 Dec 1. PMID: 17145705; PMCID: PMC1751547.

ROLE OF GREEN CHEMISTRY IN ENVIRONMENT SUSTAINABLITY

Meenakshi
Department of Chemistry,
University of Rajasthan, Jaipur, India. 302004.
Corresponding author E-mail: meenakshialwaraj@gmail.com

Abstract:

Chemistry plays a key role in our day to day life. World cannot imagine without chemistry. Medicines, food, cloths, construction materials etc. are prepared by chemical substances. During manufacturing of these materials, all the reactants never be 100% converted into products, therefore loss in yield due to formation of by products, which pollute environment. The world is now focusing on green chemistry, also known as sustainable chemistry, which refers to minimizing or reversing environmental damage. Therefore, green chemistry could involve anything from cutting down on waste to properly disposing of it. Utilizing renewable food supplies is another strategy to promote sustainable chemistry and protect the environment. Another smart option is to substitute catalysts for stoichiometric reagents in chemical experiments. Chemical derivatives should be avoided wherever feasible because they frequently turn out to be dangerous. The environment and other living things shall not be harmed in any way during the disposal of any chemical waste. In this chapter, the role of green chemistry and its applications in environment sustainability are briefly discussed.

Keywords: Green chemistry, environment, sustainable development, etc.

Introduction:

In order to provide alternative vision for sustainable development, Green Chemistry must address a wide range of chemical and technological concerns. Meeting current requirements without sacrificing the capacity of future generations to meet their own needs is known as sustainable development. In both goods and processes, green chemistry efficiently uses renewable raw materials, reduces waste, and eliminates the use of harmful or potentially dangerous solvents and reagents. There are two main points to green chemistry. It begins by addressing the issue of effective raw material usage and the corresponding reduction of waste (Dhage and Shisodiya, 2013). Second, it addresses the environmental, health, and safety concerns related to the production, use, and recycling of chemicals. One of the most essential and effective instruments to use on the way to sustainability is green chemistry. In reality, without green chemistry and green engineering, there is no way to sustainability.

Paul T. Anastas and John C. Warner developed the “Twelve Principles of Green Chemistry” in 1991. The two categories (A & B) that best describe these guidelines are "Reducing Risk" and "Minimizing the Environmental Footprint." Some chemical businesses

have left a legacy of risk in the past. New chemical goods were linked to risks of environmental contamination and human exposure to hazardous chemicals, which gave synthetic chemical materials a negative reputation. The climatic problem, energy use, and the depletion of natural resources are more important factors in the environmental footprint.

Green chemical approach focuses on:

A. Green chemistry aims to reduce risk in the laboratory: Use Safer Chemicals, Design Less Hazardous Synthesis Methods, Use Safer Solvents and Reaction Conditions, Accident Prevention (minimize the potential for explosions, fires, etc.).

B. Minimizing the environmental footprint:

i. Waste minimization and prevention – Use of catalysts instead of stoichiometric quantities, Reduce the use of chemical derivatives, Synthetic efficiency (Atom Economy), Taking advantage of chemicals designed for degradation.

ii. Establishment of in process controls for pollution prevention – Use of renewable feedstock, encourages energy efficiency.

The 12 principles of Green chemistry and their applications to basic and applied research are briefly described below (Anastas and Warner, 1998):

1) **Prevention:** This is a key principle. Preventing an issue is preferable to cleaning or treating one afterwards (waste or pollution). The majority of chemical reactions and synthetic pathways result in waste and hazardous byproducts. By designing the feed stocks and chemical processes in advance and with novel modifications, green chemistry can reduce waste and hazardous byproducts (Namienik & Wardencki, 2000).
2) **Maximize synthetic methods (Atom economy):** This concept delves into the chemistry of how items are actually manufactured. To date, all synthetic processes have been wasteful, with yields ranging from 70 to 90 percent. According to green chemistry, it is possible to plan synthetic processes in advance to maximize the incorporation of all reagents employed in the chemical process into the finished product, obviating the need to recycle the byproducts. It is more effective and minimizes waste to select transformations that use the majority of the raw materials.
3) **Less hazardous chemical synthesis:** Green Chemistry must make every effort to create less hazardous compounds and synthesis products, as well as safer synthetic procedures whenever possible (Sato *et al.,* 1998). Substances with little to no toxicity toward the environment and human health should be used and produced via synthetic techniques. For a green technology, some hazardous chemicals are swapped out for less harmful ones.
4) **Designing safer chemicals:** To affect the desired function and features of the

chemical product while minimizing their toxicity to humans and the environment, design must become a core goal of green chemists. Huge number of chemical products and materials are available on the market right now. The majority of these chemicals have been classified according to their physiochemical characteristics and toxicities; however the majority of them lack ecotoxicological data.

5) **Safer solvents and auxiliary substances**: It is necessary to switch out or reduce the amount of harmful compounds employed as solvents, separation agents, and auxiliary chemicals in synthetic chemistry. In a solvent, numerous chemical processes take place (Bardley *et al.,* 2000). Additionally, many of the chemical solvents that have been utilized historically have risks and are quite hazardous. Most syntheses make heavy use of solvents. Toxic and flammable substances like alcohol, benzene (known to cause cancer), CCl_4, $CHCl_3$, perchloroethylene, and CH_2Cl_2 are frequently utilized as solvents in syntheses. Large amounts of solvents are also used in the purification process (such as in chromatography), which increases pollution and poses a serious risk to human health. The advent of "green chemistry" has altered what a solvent is: A perfect green solvent should be inexpensive, readily available, natural, and harmless. This idea focuses on designing goods to make use of less dangerous solvents. Water is undoubtedly the least cheapest and environmentally friendly solvent.
6) **Design for energy efficiency**: Renewable energy sources and energy efficiency are currently in the spotlight. We use energy to power our homes and businesses, as well as for transportation. Traditional energy production techniques have been shown to contribute to global environmental issues like global warming, and the energy consumed can be expensive as well (Romano & Garbassi, 2000). This philosophy emphasizes extremely efficient product and material production while lowering costs and pollution risks. Chemists must acknowledge that until recently, energy requirements in chemical synthetic chemical processes were given very little consideration. Creating more effective processes is essential, and whenever it is feasible, synthetic methods should be carried out at room temperature and pressure to minimize energy requirements.
7) **Use of renewable raw materials and feed stocks:** Petrochemical compounds and refined products make up the majority of the initial raw materials for synthetic processes (Nicholas *et al.,* 2002). Raw materials must be very non-toxic and, if at all feasible, renewable as opposed to decreasing. Locating renewable raw materials presents a number of real-world challenges. Green chemists must find renewable compounds to alter the production process. Development that uses up natural resources is a drawback of economic expansion.

8) **Reduce intermediate derivatives:** In order to reduce needless derivatization in the synthetic routes, chemists must apply blocking groups, protection/deprotection strategies, and temporary modifications of physical and chemical processes. These derivatizations consume resources, generate a lot of trash, and require extra reagents (Stashenko *et al.,* 2000). The principle serves as a reminder to chemists to update their outdated processes for making compounds by incorporating more chemical steps and new materials. It is desirable to create novel chemical synthesis pathways.
9) **Catalytic reagents**: It is well known that the use of catalysts can significantly alter both the yield of products and the efficiency of chemical reactions (Acardi *et al.,* 2003). Stoichiometric reagents may not always be preferable to highly selective catalytic reagents. Another advantage of employing a catalyst is that it typically only takes modest amounts to have an impact. Additionally, if the catalyst is truly "green," it won't produce any toxins throughout the reaction. Wonderful catalysts include enzymes. The fact that biocatalyzed reactions take place in aqueous media makes them beneficial. The future of green chemistry techniques is in the development of new catalysts and a greater focus on catalytic processes.
10) **Design products which degrade easily**: The majority of chemical products and everyday items don't decay very quickly, which is bad for the environment. Green chemistry strives to create products that decompose into harmless materials at the end of their useful lives. Many consumer goods have a negative environmental impact due to their persistence (such as plastic products), however this can be changed by developing goods that decompose quickly. This approach aims to create goods that serve the purpose for which they were created.
11) **Real time analysis for pollution prevention**: To enable real-time, in-process monitoring and control before the creation of hazardous chemicals, analytical methods must be further developed. Everyone is aware that pollution control is preferable to pollution prevention since the former is better than the latter. Utilizing products, procedures, or activities that cut down on or get rid of wastes or pollution at the source is known as pollution prevention.
12) **Inherently safer chemistry for accident prevention:** Raw materials and chemical substances utilized in chemical reactions should be intrinsically safe, meaning that neither their qualities nor the byproducts of their degradation should be harmful or hazardous (e.g. to explode, to be flammable, allergic to humans, cause burns to skin, etc). For the sake of the health and safety of consumers and employees, green chemistry tries to eliminate the usage of hazardous compounds. When creating a product, it is preferable to employ substances and chemicals that won't blow up, catch fire, or ignite in the air.

These principles are obviously very difficult to apply immediately for many chemical processes. After many years of Green Chemistry initiatives and industrial applications it is amazing to see many creative innovations at various scientific and industrial processes. The cooperation of chemists, engineers, material scientists, bio scientists and technologists has achieved interesting results. The interdisciplinary approach has expanded the fields of green chemistry and produced some excellent non-toxic materials and feedstock savings in chemical industries.

For many chemical processes, it is obviously quite challenging to instantly apply these concepts. It is great to witness so many inventive discoveries in different scientific and commercial processes after 20 years of Green chemistry projects and industrial applications. Interactions between chemists, engineers, material scientists, biologists, and technologists have produced some intriguing outcomes. The application of an interdisciplinary approach has broadened the scope of green chemistry, led to the development of top-notch non-toxic materials, and reduced feedstock costs in the chemical industry.

Applications of green chemistry:

- Use of solar energy: Sun is an inexhaustible source of energy. If we fulfill most of energy demand of us by using solar energy then it will be a green and environment friendly approach. The best known example of green technology would be the solar cell (photovoltaic cell). A solar cell directly converts the energy in light into electrical energy through the process of photovoltaics. Generating electricity from solar energy means less consumption of fossil fuels, reducing pollution and greenhouse gas emissions.
- Oxidation reagent and catalysis: historically, many of the oxidation reagents and catalysts have been comprised of toxic substances such as heavy metals. Since these substances were often used in extremely large volumes required to convert millions of pounds of petrochemicals, there was a significant legacy of these metals being released to the environment and having substantial negative effect on human health and environment. It can be changed by the use of benign substances. Now many researches are focused on alternative ways of less chemical uses.
- Metal free synthesis: Many organic and inorganic compounds are synthesized with the help of metal catalyst. The excess use of metal very harmful to life of humans, animals and environment. Bioaccumulation of metals pose a big risk to life for many decades (Minamata disaster).
- Use of green chemical solvents in chemical reactions: Many inorganic and organic compounds are toxic in nature and adversely affect environment. Water is as environment friendly material, hence use of it in many reactions as solvent pose to no risk to environment.

- Proliferation of solvent less reactions: one of the 'solvent alternatives' that is being: it is one of the solvent alternatives that is being developed in green chemistry is that of solvent less reaction system. The carrying of manufacturing process in solvent-less condition utilizes some non-traditional conditions. This helps in development of product isolation, separation and purification that will be solvent-less as well in order to maximize the benefits.
- Find alternative rules of increasing yield of chemical reactions. As the yield percentage increases, amount of byproduct formation decreases, therefore wastage of chemical also decreases.
- Use of green binder: Application of green binder reduces environmental pollution. Sodium silicate is a very good inorganic binder for wood industry instead of harmful organic compounds. In construction industry, Portland cement is widely used. The formation process of Portland cement emits CO_2 in large amount, and also require a large amount of energy. Use of eco-friendly Magnesia cement in place of Portland and other cements is a green route of construction industry.
- Supramolecular chemistry: Research is currently ongoing in the area of supramolecular chemistry to develop reactions which can proceed in the solid state without the use of solvents. The cycloaddition of trans-1,2-bis(4-pyridyl)ethylene is directed by resorcinol in the solid state. This solid-state reaction proceeds in the presence of UV light in 100% yield.
- Super critical fluids: the use of CO_2 as a substitute for organic solvents already represents a tool of waste reduction in chemical industry. Of the wide range of supercritical Carbon dioxide reactions that have been explored, one class of reaction has shown exceptional promise; it was found that asymmetric catalytic reactions, particularly hydrogenation and hydrogen transfer reactions can be carried out in supercritical carbon dioxide with selectivity compared or superior to those observed in conventional solvents.
- Immobilized solvents: With solvents being of extremely high volume and very broad breadth of applicability, their potential for negative impact on human health and the environment is very large. Therefore, the immobilization of such solvents helps in reduction of hazards. Immobilized solvents or solvent molecules tethered to a polymeric backbone follow the same logic as the ionic liquids. By creating a system where a known solvent, e.g., THF, is tethered properly, it can still maintain its solvency but is incapable of manifesting any hazard by exposing humans or the environment. These types of solvents are expensive and difficult to handle.
- Degradable material: Formation of biodegradable material in minimum amount is now the main focus of green chemistry.

- Biometric multifunctional reagents: while synthetic catalysis and reagents for the most part have centered on carrying out one discrete transformation. The manipulations may include activation, conformational adjustments, and one or several actual transformations and derivitizations.
- Halide free synthesis of aromatic amines: Traditional synthesis of aromatic amines involves chlorination of benzene followed by nitration and nucleophilic displacement of the chlorine with a new substituting group. The synthesis of 4-amino-diphenylamine illustrates this process. Monsanto has developed a new synthesis of 4-aminodiphenylamine that utilizes nucleophilic substitution for hydrogen. The process avoids the use of halogenation intermediates. In this process nitrobenzene and aniline are heated in presence of tetramethyl ammonium hydroxides to give tetramethyl-ammonium salts of the condensation products.

Conclusions:

Each industry's main objective is to make money using readily available raw materials and basic capital while engaging in sustainable industrial operations. Chemical processes must use raw materials, water, and energy in a way that does not harm the environment and be commercially viable if they are to be considered sustainable industrial activities, which means that they must meet the needs of the present without endangering the needs of future generations. Through the implementation of a green chemistry method, whose goal is to create chemical processes and products that are safe for both human health and the environment, a balance can be established between the use of natural resources, economic growth, and environmental conservation. The use of the idea of "green chemistry," which brings chemical safety, entails sufficient legal backing through the legislative control of specific processes and activities that are essential for the execution of such a concept. The twelve principles that make up the notion of "green chemistry" speak of minimizing or removing hazardous or dangerous compounds from the synthesis, manufacture, and application of chemical products and, as a result, the use of substances that are detrimental to human health and the environment. While it is impossible to implement all twelve of the process's principles simultaneously while building a green chemistry method, it makes an effort to do so at certain points in the synthesis. Green chemistry works in a number of key ways to fulfill its objectives of economic growth and environmental conservation. These include new photo catalytic processes as well as biocatalysis and catalysis, the use of renewable raw materials (such as biomass), alternative reaction mediums (such as water, ionic liquids, and supercritical fluids), and different reaction conditions (such as microwave activation). With new catalytic reactions and catalyst types, catalysis, the cornerstone of green chemistry, offers a range of advantages in terms of process utilization, selectivity, energy savings, and the use of alternative reaction media. Biocatalysts hold a leading position in the "green" agenda due

to the enormous potential of microorganisms and enzymes in the selective transformation of synthetic compounds. Green chemistry and the creation of circumstances for sustainability are both facilitated by photo catalytic reactions, which represent novel techniques for purifying contaminated air and water.

References:

1. Anastas, P. T., Warner, J. C. (1998). Green Chemistry Theory and Practice, Oxford University Press, New York.
2. Dhage, S.D., Shisodiya, K.K.,(2013). Applications of green chemistry in sustainable development, *International Research Journal of Pharmacy,* 4(7), 1-4. DOI:10.7897/2230-8407.04701
3. Namienik, J., Wardencki, W. (2000). Solvent less sample preparation techniques in environmental analysis, *J. High Resol. Chromatogr.,*23,297.
4. Sato K, Aoki M, Noyori R. (1998). A Green Route to Adipic Acid: Direct Oxidation of Cyclohexenes with 30 percent hydrogen peroxide. *Science*, 281: 1646. http://dx.doi.org/10.1126/science.281.5383.1646 PMid:9733504
5. Bardley D, Dyson P, WeltonT. (2000). Room temperature ionic liquids. *Chem. Rev.* 9(5): 18.
6. Romano, U., Garbassi, F. (2000). The environmental issue. A challenge for new generation polyolefins. *Pure Appl. Chem*., 72: 1383. http://dx. doi.org/10.1351/pac200072071383
7. Nicolas, N., Benvegnu, T., Plusquellec, D. (2002). Surfactants from renewable resources. *Actualite Chimique*, 70, 11-12.
8. Stashenko, E.E., Puertas, A.M., Salgar, W., DelGado, W., Martenez, J.R. (2000). Solid-phase micro extraction with on fibre derivatization applied to the analysis of volatile carbonyl compounds. *J. Chromatogr. A*, 886, 175. http://dx.doi.org/10.1016/S0021-9673(00)00479-9
9. Acardi, A., Bianchi, G., DiGiuseppe, S., Marinel, Li. F. (2003). Gold catalysis in the reaction of 1,3-dicarbonyls with nucleophiles. *Green Chemistry*, 5(1): 64. http://dx.doi.org/10.1039/b210165c
10. Scott, G.(2000). Green polymers. *Polym .Degrad. Stab*.68(1): 1. http://dx.doi.org/10.1016/S0141-3910(99)00182
11. Africo, F., Tundo, P., (2010). Dimethylcarbonate as a green reagent and solvent, Russian Chem. Rev., 79(6),479..
12. Hjeresen, D.L., Schutt, D.L., Boese, J.M. (2000). Green chemistry and education, J. Chem. Educ, 12, 1543. http://dx.doi.org/10.1021/ed077p1543
13. Lancaster, M. (2002). Green Chemistry- An Introductory Text, Royal Society of Chemistry, Cambridge.
14. Gao, F., Bai, R., Ferlin,F., Vaccaro, L., Li, M., Gu,Y. (2020). Replacement strategies for non-

green dipolar aprotic solvents, *Green Chem.*, **22** , 6240 —6257

15. Sherwood , J., Bruyn , M. D., Constantinou , A., Moity , L., McElroy , C.R., Farmer,T.J., Duncan , T., Raverty, W., Hunt, A.J., Clark, J.H. (2014). Dihydrolevoglucosenone (Cyrene) as a bio-based alternative for dipolar aprotic solvents *Chem. Commun.*, 2014, **50** , 9650 — 9652
16. Abouelela, A.R., .Mussa,A.A., Talhami, M., Das, P., Hawari, A.H.(2022). Industrial sludge valorization and decontamination via lipid extraction and heavy metals removal using low-cost protic ionic liquid, *Science of The Total Environment,* 835, 155451. https://doi.org/10.1016/j.scitotenv.2022.155451
17. Cui, J., Zhu, N., Li, Y., Luo, D., Wu, P., Dang, Z. (2020). Rapid and green process for valuable materials recovery from waste liquid crystal displays, *Resources, Conservation and Recycling,* 153,104544. https://doi.org/10.1016/j.resconrec.2019.104544

EVOLUTION OF HEALTHCARE SERVICES IN WORLD

Swarnima Pandey*[1] and Pragya Chaudhary[2]

[1]Apex college of Pharmacy, Bilaspur, Rampur 244943 Uttar Pradesh, India .

[2]Sai institute of Medical Sciences, Jaspur, Uttarakhand, 244712 India

*Corresponding author E-mail: drswarnimat@gmail.com

The early ages of the seventeenth and eighteenth- century witnessed the emergence of colorful pandemics and conditions. There was a great trouble from the public to cover the citizens from contagious conditions at this stage. The 19th century saw a great advancement in the field of public health. There was a huge development in the part of the public in financing public health care during the late 1970s. During the same period, the public sector share of this sum rose from 25 percent to 37 percent. Although health requirements and health services haven't lowered, political and social values of this time encouraged financial constraint. The values during this period emphasized state responsibility for utmost health and weal programs.

The 20th century saw the expansion of the Government's part in public health. During this period. The expansion of state conditioning in health matched the growth in civil conditioning. numerous of the changes on the civil position stimulated or supported state programs. In 2000 the World Health Organization (WHO) performed a ranking to compare the performance of the health systems of the member countries. Since also other health system rankings have been performed and it came an issue of public discussion. By the morning of the 21st century, every existent's access to health care has come to be regarded as an introductory mortal right.

The history of the public health system is a history of bringing knowledge and values together in the public arena to shape an approach to health problems. The task of the public health agency has been not only to define objects for the healthcare system grounded on data about illness and health but also to find means to apply health pretensions within a social structure.

Healthcare services around the world

All health systems are different due to the different combinations of factors they can consider.

USA

Utmost Americans are served by a blend of intimately and intimately funded programs and healthcare systems. Overall, the US healthcare system allows providers to inflate prices and precious services but inadequately compensates for essential services similar as primary care and behavioral advice.

UK

The UK healthcare system covers the whole population via the National Health System (NHS). The UK has public, private profit, and nonprofit hospitals.

European Union

Each country in the EU has its healthcare system. still, EU members generally partake the same thing as the UK model. All healthcare systems in Europe automatically include all citizens irrespective of paying capacity. Secondly, all are substantially funded by levies paid by the employer and by the public. Healthcare is free, except for some optional and specialist services.

Asia

Asian healthcare systems are a mélange of public and intimately managed programs.

Australia

Australia has a duty- funded universal free public health insurance program, called Medicare. All citizens get free care from the public and numerous croaker services and medicines at public hospitals.

Africa

Utmost Africans that are moreover low or middle- income turn to the public health system or traditional healers. Only a many can go high- quality private care, but out- of- fund expenditures are bound to be high in this two- league system.

An introduction to healthcare systems

A Healthcare system is a method of planning, organizing, financing, and delivering health-related facilities to the population. The goal of a health care system is to enhance the health of the population efficiently by proper utilization of the available resources.

Existing health systems all over the world are different due to the different combinations of components that can be considered for their establishment. The extent and form of a specific system are influenced by a variety of factors, including the unique culture and history of a population or country's level of development and social values. Some populations emphasize the prevention of disease, whereas others only care for or cure particular illnesses. Another major factor that influences the health care system of a country is the level of economic resources available.

As the complexity of the healthcare system increases, patients now have an incredible array of choices while choosing to receive care. The choice is often left to decide which kind of health care facility to be available. But this type of facility will widely vary in each country.

Classification of healthcare facilities

Healthcare facilities are classified as primary health care units, secondary health care units and tertiary care units. There are also district units and basic units. The main objective behind establishing these units is to grant access to health care services to patients.

Basic organizational structure

Healthcare organizations not only vary from country to country but also vary within each country as they address access, cost, and quality which are in turn influenced by

social, economic, and political factors. Healthcare organizations are complex and dynamic. The nature of the organizations require that managers provide leadership, as well as supervision and coordination of employees.

Definition

A Healthcare organization is generally defined as " A formal system of interaction and coordination that links the tasks of individuals and groups to achieve organizational goals.

Purpose

The purpose of having a proper organizational structure is generally to

- Channel Information to Managers
- Create Distribution of Authority
- Maintain interrelationships among different units

The organizational design classification

Organizational designs take as many forms as needed to address the uniqueness of a dynamic organization. The designs are usually reflected in an organizational chart that describes the relations, authority, responsibilities, and interactions of the different units and individuals.

- **Functional Design**

They are characterized by a strict chain of command and line of operation. It is advantageous as it provides clear lines of reporting and accountability.

- **Divisional Design**

In this structure, specific service lines, responsibility and accountability staffing, budgeting, and financial control are allocated under an array of service lines. This kind of structural design has proven to be effective in certain cases as they are cost-effective and quality-driven.

- **Matrix Design**

The other organizational structure is the matrix structure which is a combination of the functional and divisional structures. It believes that a strictly functional structure may reduce the flexibility of an organization and a divisional structure is required continually. Here a Functional staff is at times required to perform divisional-specific responsibilities. The advantages of this structure are lateral communication and coordination of services.

The most common organizational structure for a healthcare system is the functional organizational structure, whose key characteristic is a pyramid-shaped hierarchy. The size and complexity of the healthcare system will dictate the structure. Larger organizations like academic medical centers and community hospitals having a vast array of administration support will have deep vertical structures.

Definition of hospital

Hospitals are healthcare institutions primarily offering patient treatment and specialized medical care with the help of nursing staff and medical equipment. Though the

healthcare system and services vary from country to country they can be classified into the following types.

- Based on Services
- Based on Bed Numbers
- Based on Location
- Based on Ownership

Based on services:

Based on the services provided, hospitals are generally classified as:

- General: General Hospitals are designed to care for medical and surgical patients with acute illness and injury. Usually, they are of limited capacity and devoid of super-specialist medical care.
- Specialty: These hospitals limit their services to treat a particular condition. For example, orthopedics, maternity, pediatrics, geriatrics, oncology, etc.
- Teaching cum Research: College is attached for medical/nursing/dental/pharmacy education. The main objective is to provide medical care/teaching and research is secondary.

Based on bed numbers:

Based on the bed numbers available, hospitals are divided into three further categories.

- Small: The capacity of small bedded hospitals is usually up to 100 beds.
- Medium: Medium-sized hospitals consist of 100 to 499 beds.
- Large: Large hospitals are usually those with more than 500 beds.

Based on Location:

Hospitals can further be identified based on the location, but this may vary in each country depending on the way they are structured.

- Rural Hospitals: Rural hospitals are those that are located in rural areas with fewer beds and function in smaller units. They lack advanced technology for providing higher medical support.
- Urban Level: These are mostly community hospitals serving in the cosmopolitan areas. They operate on larger budgets and are well-equipped to treat all sorts of illnesses. The number of beds usually varies from 100 to 500.

Some countries have District level hospitals that provide health facilities to specific localities and Regional hospitals that serve a larger area.

Based on Ownership:

Hospitals are usually owned by governments, individuals, or groups of people. This ownership usually decides the cost of medical services provided by that hospital. The basic types of ownership are:

- Public / Government Hospitals: They are owned/administered and controlled by the government. They usually come under the health ministry and are funded by the

federal government. They usually provide free-of-cost service to the citizens or have a nominal fee for treatment.

- Private Hospitals: They are usually owned by an individual or group of individuals. They are run mostly for-profit and they try to recover their funds through patient fees. They provide world-class amenities and ensure a better doctor-patient ratio.
- Trust Hospitals: They are run by a group of people or trust and offer services at subsidized rates. They are usually preferred by middle-class people.
- Charity Hospitals: These hospitals provide treatment to poor people who cannot afford treatment. They do not charge for the treatment and provide free medical services.

References

1. Ec.europa.eu (2017). European semester thematic factsheet: Health systems.
2. Thorlby, R. (2021). International Health Care System Profiles England. https://www.commonwealthfund.org/international-health-policy-center/countries/england
3. Earn, L. C. (2021). International Health Care System Profiles Singapore. https://www.commonwealthfund.org/international-health-policy-center/countries/singapore
4. Gupta, I. (2021). International Health Care System Profiles India. https://www.commonwealthfund.org/international-health-policy-center/countries/singapore
5. Earn, L. C. (2021). International Health Care System Profiles Singapore. https://www.commonwealthfund.org/international-health-policy-center/countries/singapore
6. World Health Organization. Regional Office for Europe, European Observatory on Health Systems and Policies, Miguel Á González Block, Hortensia Reyes Morales, Lucero Cahuana Hurtado. et al. (2020). Mexico: health system review. World Health Organization. Regional Office for Europe.
7. World Health Organization. Regional Office for Europe, European Observatory on Health Systems and Policies, Miguel Á González Block, Hortensia Reyes Morales, Lucero Cahuana Hurtado. et al. (2020). Mexico: health system review. World Health Organization. Regional Office for Europe. https://apps.who.int/iris/handle/10665/334334
8. Kim, S. Universal Healthcare Systems and Fragmentation in Latin America. https://sites.google.com/macalester.edu/phla/key-concepts/universal-healthcare-systems-and-fragmentation-in-latin-america

GRAPHENE BASED INVASIVE AND NON-INVASIVE SENSORS FOR HEALTH CARE MONITORING SYSTEM

Babita*[1], Swati[1] and Hempal Singh[2]

[1]Department of Physics, Baba Mastnath University Rohtak

[2]Department of Physics, IIT, Roorkee

*Corresponding author E-mail: babitaphy@gmail.com

Abstract:

Graphene as an atom-thick, the two-dimensional, honeycomb-structured material due to its distinctive physicochemical characteristics, has been widely exploited in the sensor detecting industry. These properties include large surface to volume ratio, outstanding mechanical strength, high electrical conductivity, high thermal conductivity, excellent carrier mobility, ability to generate electricity by exposure to sunlight, adjustable optical properties and makes it an ideal candidate for sensing applications. Graphene has been used in various forms including nanoparticles and oxide forms to fabricate various types of sensors. These sensors have incredibly alluring qualities like low cost, great sensitivity, robustness, user friendliness, and quick results. This book chapter gives a detailed overview on preparation and properties of graphene, sensing mechanisms, technological innovations in development and fabrication of sensors and their applications in health monitoring devices. Both invasive and non-invasive graphene based sensors will be discussed in the chapter. In diagnostics field, graphene based invasive sensors can be used for diagnosis of various ailments by detecting viruses, bacteria, disease biomarkers, immune bodies, etc. Non-invasive (Wearable sensors and implantable devices) can measure body temperature, heart rate, pulse oxygenation, respiration rate, blood pressure, blood glucose, electrocardiogram, electromyogram, and electroencephalogram signals in real time have been reported as examples of graphene-based sensors used for human health monitoring. This chapter also provides a brief explanation of the difficulties now experienced by graphene-based sensors, along with some potential remedies and potential future applications.

Introduction:

As the worldwide population is developing quickly and the life anticipation of people is expanding [1] the healthcare framework is confronting expanding costs and burdens, which requires that governments should discover feasible arrangements to render satisfactory restorative care without expanding healthcare costs [2]. Preventive and personalized medical approaches [3], which alter the wellbeing status, can be identified and analyzed early. Disease-risk can moreover be anticipated, and utilized to overcome challenges by expanding the remedy rate and survivability of on-risk population, while minimizing large treatment costs [4,5]. By intermittently or ceaselessly following basic

signs and biomarkers, health checking frameworks are able of comprehensively surveying wellbeing conditions which can amazingly advantage the conclusion and infections treatment together with postoperative restoration, which can altogether decrease the burden of restorative frameworks and make strides quality of life [6] and one need good sensors to do the job. It may be a well-established truth that graphene based biosensors are one of the foremost candidate. Graphene a honey comb like structure formed with single thick planer carbon sheet or a two-dimensional (2D) nanomaterial has made a major role within the sensor and electronic industry. Its properties are comparable to those of semi-metals and are found to be steady beneath appropriate conditions [7]. Graphene has been utilized in biosensors because of its various interesting traits which incorporate a large electron exchange rate, large surface to volume ratio, its capacity to immobilize atoms and expanded electrical conductivity [8]. The bigger surface zone advances dynamic destinations for charge-biomolecular interactions which assists in legitimate functionalization/immobilization [9] which leads to detection of the target particle. Additionally graphene is effortlessly accessible and cost-effective as well. Nanomaterials made up of graphene and its derivatives have contributed to the fabrication of different types of advanced biosensors. Here in this chapter we will discuss about characteristics and fabrication of graphene and its derivatives and various invasive and non invasive graphene based sensors. We will also discuss difficulties experienced by graphene-based sensors, along with some potential remedies and potential future applications.

Properties of Graphene

The extraordinary properties of graphene make it an interesting option for a variety of applications. It is the perfect material for usage in various industries, including electronics, energy, and biomedical engineering, due to its great mechanical strength, electrical and thermal conductivity, flexibility, transparency, chemical stability, and high surface area.

1. High mechanical strength: The strongest substance ever found is graphene. Its tensile strength (130 GPa) makes it roughly 100 times stronger than steel. It can be stretched up to 20% of its original length without breaking and is also incredibly flexible. It is the perfect material for high-stress applications because it can sustain pressures of up to 1 terapascal (TPa) [10,11].
2. High electrical conductivity: A good electrochemical conductor is graphene. Its conductivity is approximately 100 times better than that of copper, the common component of electrical wiring. Due to this characteristic, it is the perfect material to be used in electronics, especially in the creation of high-speed and high-frequency transistors. The unique band structure of graphene is what gives it its electrical conductivity. Moreover, the material has a very high electron mobility, which enables

electrons to travel through it quickly and makes it perfect for use in high-speed electronics.

3. High thermal conductivity: As a heat conductor, graphene performs admirably. More than any other known material, it has a thermal conductivity of roughly 3000 W/mK [12]. It is the perfect material for thermal management applications, such as heat sinks and electronic cooling systems, because of its characteristic.
4. Flexible and lightweight: Thin and malleable graphene may be folded, twisted, and bent without breaking. With a density of only 2.3 grams per cubic centimetre (g/cm3) [13], it is also extraordinarily light, making it the perfect material for thin and flexible electronics.
5. Optical properties: With a visible spectrum absorption rate of about 2.3%, graphene is almost transparent [14]. Also, because to graphene's extremely high refractive index, light passing through it is bent at an acute angle. These characteristics make it the perfect substance for optoelectronic components like solar cells and light-emitting diodes.
6. Chemical stability: A wide variety of substances, including acids, bases, and organic solvents, can be exposed to graphene without harming it because it is chemically inert. Due to this characteristic, it is the perfect material for use in abrasive conditions and in processes requiring high levels of chemical resistance, such as the manufacture of chemical sensors and water filtration systems.
7. High surface area: Due to its large surface area, graphene can be used in a variety of processes, including catalysis, sensing, and energy storage [15].
8. Biological properties: It has been proven that graphene is biocompatible, which means that it does not affect live cells. Due to this characteristic, it is the perfect material for biomedical applications, including the creation of implanted devices and drug delivery systems. One of the most promising applications for graphene based invasive sensors is in biomedical sensing [16]. These sensors can be used to monitor vital signs such as blood pressure, heart rate, and oxygen levels in real time providing valuable data for heath care professionals [17-19]. Additionally, graphene based sensors can be used to detect biomolecules such as glucose which is critical for monitoring conditions such as diabetes. Graphene based invasive sensors can also be used for environmental monitoring such as detecting pollutants in water or air. The high sensitivity of graphene based sensors allows for the detection of even low concentrations of pollutants, making them an ideal tool for monitoring environmental conditions [20-25].

Methods of fabrication of graphene and it's derivatives

The methods listed below can be used to produce graphene derivatives like graphene oxide and reduced graphene oxide. Because graphene oxide may be

functionalized with different chemical groups, it can be used in a wide range of products, including composite materials, energy storage, and sensors. While reduced graphene oxide shares many characteristics with graphene, it is less conductive because of imperfections and functional groups that include oxygen. Top-down and bottom-up approaches are two broad categories that can be used to group together a variety of graphene synthesis techniques.

Top-Down Methods

The process by which graphite, the substance from which graphene is generated, is exfoliated mechanically or chemically is known as the top-down technique. By using these techniques, graphene is created by dissolving the layers of graphite.

a. Mechanical Exfoliation: This method was first demonstrated by Andre Geim and Konstantin Novoselov in 2004, for which they won the Nobel Prize in Physics in 2010. In this method, a piece of graphite is repeatedly peeled with a piece of adhesive tape until the desired thickness is obtained [26]. This process produces small amounts of high-quality graphene but is time-consuming and not suitable for large-scale production.
b. Chemical Exfoliation: Andre Geim and Konstantin Novoselov first presented this technique in 2004, for which they were awarded the 2010 Nobel Prize in Physics. This technique involves continuously peeling a piece of graphite using an adhesive tape until the appropriate thickness is achieved. Little amounts of high-quality graphene are produced using this method, but it takes a lot of time and is not appropriate for mass manufacturing.

Bottom-Up Methods

The bottom-up strategy consists of creating graphene from atomic or molecular building blocks. By using these techniques, the graphene structure is constructed atom by atom.

a. Chemical Vapor Deposition (CVD): The most popular technique for producing significant amounts of graphene is CVD. Over a metallic substrate, such as copper, nickel, or platinum, hydrocarbon gases are catalytically decomposed. In most cases, the substrate is heated to high temperatures (about 1000°C) while being exposed to a carbon source, like methane or ethylene. The carbon atoms then come together to create a layer of graphene on the support. Several techniques, such as wet transfer or dry transfer, can be used to transfer the resultant graphene to a different substrate. The process of large-scale graphene synthesis known as CVD produces high-quality graphene that is simple to transfer to other surfaces.

b. Epitaxial Growth: By this technique, graphene is grown on a material, such as silicon carbide, that has a crystal structure that is comparable to that of graphene. Following the deposition of carbon atoms onto the substrate, the lattice structure of the emerging

graphene is aligned with that of the substrate. High-quality graphene is produced by epitaxial growth, although it is only possible on certain substrates.

c. Chemical Synthesis: This technique uses chemical reactions to create graphene from molecular building blocks. One of these techniques is the reduction of graphene oxide with hydrazine, which yields reduced graphene oxide. Another technique entails reducing graphene oxide with other reducing substances, like sodium borohydride or ascorbic acid.

Graphene based invasive and non-invasive sensors:

Graphene based invasive sensors refer to sensors that are implanted inside the body to monitor various physiological parameters and detect potential diseases. High electrical conductivity, great tensile strength, and exceptional thermal conductivity are just a few of graphene's special qualities. With the ability to detect a variety of analytes, such as gases, liquids, and biological compounds, graphene is an appealing material for sensing applications [27]. Graphene's electrical conductivity, which may be altered by a change in the immediate surroundings, serves as the basis for its sensing mechanism. Target analytes that come into contact with the graphene surface alter the local charge density, which in turn alters the electrical conductivity of the material. Many methods, including resistance measurements, field-effect transistor (FET) measurements, or impedance spectroscopy, can be used to gauge this change in conductivity.

Non-invasive sensors are sensors that do not require penetration of the skin or other body tissues to measure physiological parameters, making them safe, painless, and easy to use [28].

Graphene-based non-invasive sensors have unique properties, such as high sensitivity, fast response time, low power consumption, and high durability, making them an attractive option for various applications, including healthcare, environmental monitoring, and industrial sensing. These sensors can be used to monitor various parameters such as temperature, strain, gas concentration, and biological molecules, without the need for invasive procedures. These sensors have the potential to revolutionize various fields, such as healthcare, by providing patients with real-time monitoring of their health parameters. These sensors can also be used for environmental monitoring and pollution control, as well as for industrial sensing, improving the efficiency and safety of various industrial processes.

Graphene's high surface-to-volume ratio, which enables a high degree of sensitivity to minor changes in the immediate surroundings, is one of the key benefits of employing it as a sensing material. Moreover, graphene is a fantastic material for quick and precise sensing due to its special electrical features, such as its high carrier mobility. There are many uses for graphene-based sensors, including gas detection, biosensing, and environmental monitoring. For instance, graphene-based gas sensors have been created to detect several gases with great sensitivity and selectivity, such as nitrogen dioxide,

ammonia, and carbon dioxide. The local charge density and electrical conductivity change as a result of the interaction between the gas molecules and the graphene surface, which serves as the sensing mechanism. Similar to this, biosensors based on graphene have been created to detect biomolecules like DNA, proteins, and glucose [29]. The biomolecule is immobilised on the graphene surface as part of the sensing mechanism, changing the local charge density and electrical conductivity in the process. Graphene-based biosensors are desirable for a variety of medical and diagnostic applications due to their excellent sensitivity and selectivity. Graphene-based sensors have been created for environmental monitoring applications, such as the detection of contaminants in water and the air, in addition to gas and biosensing. The target pollutant interacts with the graphene surface to modify the local charge density, which in turn changes the electrical conductivity. This interaction is the basis for the sensing process. When it comes to the detection of different pollutants, such as heavy metals, pesticides, and organic chemicals, graphene-based sensors have demonstrated great efficacy [30]. In conclusion, the electrical conductivity of graphene serves as the basis for its sensing mechanism, which can be affected by changes in the immediate surroundings. For a variety of sensing applications, such as gas sensing, biosensing, and environmental monitoring, graphene-based sensors have demonstrated exceptional performance. The high sensitivity, selectivity, and quick response times of graphene-based sensors make them desirable for a variety of applications, including medical diagnostics, environmental monitoring, and industrial process control.

Graphene-based sensors are perfect for wearable health monitoring devices since they can track a variety of physiological variables, such as heart rate, blood pressure, and respiration rate. Due to its great sensitivity and precision, graphene-based sensors can gather and analyse data in real time while continuously monitoring a variety of physiological indicators. Also, because to graphene's exceptional electrical conductivity and flexibility, wearable sensors that can adapt to the surface of the body and provide the highest level of comfort and accuracy are easily developed [31].

Graphene-based sensors have also demonstrated considerable promise for the creation of implantable medical technology. For long-term health monitoring, graphene-based sensors can be included into medical implants like pacemakers and defibrillators to monitor a variety of physiological factors like temperature, pressure, and pH. Graphene's biocompatibility also makes it a desirable material for implantable medical devices because it doesn't trigger an immune reaction or harm tissue. The great stability and sensitivity of graphene-based sensors make them perfect for long-term health monitoring and data collection. Systems for targeted medicine delivery based on graphene have also been created. Graphene is a desirable material for creating drug delivery systems that can precisely and effectively target particular body regions due to its high surface area and strong drug-loading capability. The outstanding biocompatibility, stability, and controlled-

release characteristics of graphene-based drug delivery systems make them the best choice for a variety of medicinal applications [32]. For instance, graphene-based drug delivery systems have been created for the treatment of cancer, allowing for highly precise and effective targeting of cancer cells with the least amount of harm to healthy cells. Graphene scaffolds have also been developed for tissue engineering applications. Graphene's remarkable biocompatibility and mechanical properties make it the ideal material for promoting cell growth and differentiation. Graphene-based scaffolds can aid in the growth and differentiation of several cell types, including those that make up bone, cartilage, and muscles. The greatest option for a range of tissue engineering applications is graphene-based scaffolds due to their better biocompatibility, strength, and conductivity [33].

By providing continuous and accurate monitoring of multiple physiological parameters, targeted drug delivery, and tissue engineering applications, graphene-based health monitoring systems have the potential to revolutionize the healthcare industry. By allowing for early disease detection, real-time data gathering and analysis, and targeted and individualized treatment, these devices have the potential to enhance patient outcomes. Due to its special qualities, graphene is a desirable material for creating health monitoring devices that can be used to a variety of medical conditions, such as cancer, neurological illnesses, and cardiovascular disease. By offering continuous and accurate monitoring of multiple physiological parameters, targeted drug delivery, and tissue engineering applications, graphene-based health monitoring systems have the potential to revolutionize the healthcare industry [34-35]. Due to its special characteristics, graphene is a desirable material for creating health monitoring devices that may be applied in a variety of medical settings. Graphene-based health monitoring devices will be a key tool for enhancing patient outcomes and developing the healthcare industry with sustained research and development.

Graphene based invasive sensor for neural sensing

Graphene-based neural sensing techniques, which include analyzing the electrical impulses of neurons in the brain, are a fast-emerging field of study. Because of graphene's unusual features, such as its high electrical conductivity, biocompatibility, and flexibility, these approaches have received a lot of interest in recent years. These methods have the potential to change the way we identify and treat neurological illnesses including epilepsy, Parkinson's disease, and Alzheimer's disease. Graphene-based electrodes that can be inserted into the brain to monitor neuronal activity are being developed. Because of their great sensitivity and ability to offer real-time information on brain activity, these electrodes are valuable for detecting and treating neurological problems [36].

Traditional neural sensing techniques offer significant benefits over graphene-based neural sensing systems. They are biocompatible, which means they do not harm brain cells, and they have excellent sensitivity and resolution, which allows for more exact

measurements of neural activity. Furthermore, because graphene-based devices are flexible and can adjust to the contour of the brain, they are more pleasant for the patient. We may anticipate to see more improved graphene-based devices that can deliver even more accurate and exact measures of cerebral activity in the future. Neural sensing methods based on graphene have the potential to change neuroscience by giving new tools for understanding the brain and generating novel therapies for neurological illnesses. These methods make use of graphene-based materials such electrodes, FETs, nanomaterials, and MEAs, which offer unique qualities like high conductivity, biocompatibility, and flexibility [37-40]. Although these approaches are still in their infancy, they show immense potential for enhancing our knowledge of the brain and finding novel therapies for neurological illnesses.

Graphene-based electrodes can be created by depositing a thin layer of graphene onto a flexible substrate like polyimide and then patterning the graphene into the desired shape. The graphene layer is then designed to form an array of biocompatible electrodes with excellent conductivity that may be implanted into the brain or other neural tissue. These electrodes can generate high-quality electrical impulses and be used to either stimulate or record brain activity. Graphene-based transistors are made up of a small sheet of graphene sandwiched between two electrodes. The graphene layer serves as a route for electrical impulses. These transistors may be used to measure the electrical activity of nerve cells by altering the electrical characteristics of the graphene layer [41]. Graphene-based optoelectronic devices combine the electrical and optical capabilities of graphene to provide a revolutionary neural sensing approach. A tiny layer of graphene is put onto a substrate, such as a silicon wafer, to create these devices. The graphene sheet is then designed to form an array of electrodes capable of stimulating or recording brain activity. Moreover, the graphene layer may be utilized to transform light into electrical impulses, enabling for visual stimulation or cerebral activity recording [42].

Field-effect transistors (FETs) built on graphene may detect changes in ion concentration near neurons, which are a sign of brain activity. A graphene channel is sandwiched between two electrodes, with the gate electrode isolated from the graphene by a thin insulating layer. As neurons discharge ions, the electrical characteristics of the insulating layer change, which may be sensed by the FET. FETs based on graphene have a high sensitivity and can detect changes in ion concentration in real time. Neuronal activity may be detected and monitored using graphene-based nanomaterials such as graphene oxide and reduced graphene oxide. These nanoparticles have a large surface area and can interact with neurons, causing their electrical characteristics to alter. Graphene-based nanomaterials may be placed onto substrates like glass or silicon before being functionalized with chemicals that interact with neurons. The sensors developed as a result can detect changes in cerebral activity in real time.

Graphene-based microelectrode arrays (MEAs) can detect and record electrical impulses from numerous neurons at the same time. These MEAs are made up of a grid of electrodes, each of which is attached to a single neuron. Graphene is used to make the electrodes, which gives great conductivity and biocompatibility. The generated MEAs can offer a high-resolution map of brain activity, which can aid in the study of neural circuits and the development of innovative therapies for neurological illnesses.

Graphene based invasive sensor for temperature sensing

Graphene-based invasive sensors can also be used to measure temperature inside the body. Graphene-based temperature sensor can be implanted into the body to monitor body temperature. The sensor consists of a thin layer of graphene coated with a polymer that can detect temperature changes. This allows for accurate and continuous monitoring of body temperature, which is important for diagnosing and treating various conditions.

Temperature sensors based on graphene are used to determine the absolute temperature of sample or surroundings. They are made up of a graphene layer placed onto a substrate, such as a silicon wafer, that changes electrical characteristics when subjected to temperature variations. The change in electrical characteristics that results may be observed and used to compute the temperature. Temperature sensors based on graphene have a high sensitivity and can monitor temperatures with great precision. The usage of graphene-based materials, such as thermocouples, temperature sensors, resistance temperature detectors (RTDs), and thermal transistors, with unique qualities such as high thermal conductivity, sensitivity, and adaptability, is one of these fields. Although these approaches are still in the early phases of research, they show considerable potential for a wide range of applications such as temperature sensing in electrical devices, industrial processes, and environmental monitoring. Thermocouples made of graphene are used to monitor temperature variations between two sites. They are made up of two graphene electrodes, each coupled to a different metal, and when subjected to a temperature differential, they create a voltage difference. The voltage that results may be used to compute the temperature difference between the two sites. Graphene-based thermocouples have a high sensitivity and can accurately sense temperature variations.

Graphene-based RTDs detect variations in the resistance of a graphene layer to monitor temperature changes. They are made up of a graphene layer that is put onto a substrate, such as a glass slide, that changes resistance when subjected to temperature variations. The consequent resistance change may be monitored and used to compute temperature. RTDs made of graphene have a high sensitivity and can monitor temperatures accurately [43]. Graphene-based resistive sensors vary their electrical resistance in response to temperature variations. Since graphene has a negative temperature coefficient of resistance, its resistance lowers as temperature rises. Temperature may be estimated by monitoring the change in resistance of a graphene-based sensor. Resistive sensors based

on graphene have a high sensitivity and can function across a wide temperature range. Graphene-based FETs can detect temperature changes by measuring the electrical conductivity of the graphene channel. The electrical conductivity of the graphene channel changes as the temperature changes, which may be monitored by the FET. FETs based on graphene have a high sensitivity and can function across a wide temperature range. Temperature variations are measured using graphene-based fiber optic sensors that detect changes in the refractive index of a graphene-coated fiber optic cable. A tiny coating of graphene is placed onto the surface of a fiber optic cable to form these sensors. The refractive index of graphene changes with temperature, which may be observed by measuring the change in the light signal carried through the cable.

High-sensitivity graphene-based fiber optic sensors may be employed in difficult settings such as high temperatures and radiation. Graphene-based thermistors detect changes in electrical resistance to monitor temperature changes. These thermistors are made out of a thin layer of graphene that has been placed on a substrate and shaped into a certain form. The resistance of graphene changes with temperature, which may be observed by monitoring the electrical current running through the device. Thermistors based on graphene offer excellent sensitivity, rapid reaction times, and can operate at high temperatures. Temperature changes are measured using graphene-based thin film sensors that detect changes in the electrical characteristics of a graphene-coated thin film. These sensors are made up of a thin layer of graphene that has been placed onto a substrate like silicon or glass and shaped into a precise form. The electrical characteristics of graphene vary as the temperature varies, which may be measured by measuring the electrical current passing through the device [44]. Graphene-based thin film sensors offer excellent sensitivity and may be employed in a variety of applications, including temperature mapping of electrical devices and chemical reaction monitoring. Thermal transistors based on graphene are used to measure temperature changes by sensing changes in the electrical current passing through a graphene layer. They are made up of a graphene layer that is placed onto a substrate and a gate electrode that is separated from the graphene by a thin insulating layer. When the temperature varies, the electrical conductivity of the graphene layer changes, which the transistor detects. Thermal transistors based on graphene have a high sensitivity and can sense temperature changes in real time.

Graphene based invasive sensor for pressure sensing

Pressure sensing techniques based on graphene have the potential to transform the sector by giving new instruments for detecting pressure with high accuracy and sensitivity across a large pressure range. These approaches make use of graphene-based materials such piezoresistive sensors, piezoelectric sensors, capacitive sensors, SAW sensors, FETs, and optical sensors, which have unique qualities like high sensitivity, mechanical flexibility, and electrical conductivity. Although these techniques are still in the early stages of

development, they hold great promise for improving our ability to measure pressure and developing new technologies for a variety of applications such as medical diagnostics, automotive, biomedical engineering, aerospace, and environmental monitoring.

A graphene-based pressure sensor that may be implanted into the bladder to assess urine flow pressure. The sensor is made up of a thin sheet of graphene covered with a pressure-detecting polymer. This enables reliable and continuous monitoring of bladder function, which is critical for detecting and treating problems like urine incontinence. Graphene-based pressure sensing methods employ graphene-based materials to detect pressure changes. Piezoresistive sensors adjust their electrical resistance in response to mechanical stress or pressure changes. Graphene has a negative piezoresistive coefficient, which indicates that when subjected to mechanical stress or pressure, its resistance lowers. The pressure may be calculated by detecting the change in resistance of a graphene-based sensor. Piezoresistive sensors based on graphene offer excellent sensitivity, short reaction times, and can work across a wide pressure range. Piezoelectric sensors are mechanically deformed devices that create an electrical charge. Doping graphene with impurities such as nitrogen or boron creates flaws in the graphene lattice that can behave as piezoelectric materials, resulting in graphene-based piezoelectric sensors. As pressure is applied to the sensor, the graphene lattice deforms, resulting in a piezoelectric action that produces an electrical charge that can be detected to calculate the pressure. Because of its high electrical conductivity and vast surface area, graphene may be utilized as one of the components in a capacitive sensor [45]. The resultant graphene-based capacitive sensors can sense pressure accurately throughout a wide pressure range.

Graphene may be embedded into fiber optic sensors to detect pressure changes. Graphene may be placed on the surface of an optical fiber and used to analyze changes in the fiber's refractive index as pressure varies. The intensity of the light passed through the fiber can be used to detect this change in refractive index. Fiber optic sensors based on graphene offer excellent sensitivity, rapid reaction times, and can function across a wide pressure range. Graphene may be used into optical sensors to detect pressure changes. Graphene may be placed on the surface of an optical fiber and used to analyze changes in the fiber's refractive index as pressure varies. The intensity of the light passed through the fiber can be used to detect this change in refractive index. Graphene-based optical sensors are very sensitive and can function across a large pressure range. By monitoring the electrical conductivity of the graphene channel, graphene-based FETs can detect pressure changes [46]. The FET detects variations in the electrical conductivity of the graphene channel as pressure varies. FETs based on graphene offer excellent sensitivity, quick reaction times, and can function across a wide pressure range. Because of its enormous surface area and mechanical qualities, graphene may be employed as a sensing material in surface acoustic wave (SAW) sensors. Graphene is placed on a piezoelectric substrate, and

the variations in surface acoustic waves caused by applied pressure are monitored. They have a high sensitivity, a quick reaction time, and can work in a wide pressure range.

Graphene based invasive sensor for Glucose Monitoring

Graphene-based sensors can also be used to monitor glucose levels in diabetics. Graphene-based sensor that can be implanted beneath the skin and measures glucose levels in real time. The sensor is made up of a thin film of graphene covered with enzymes that can convert glucose into hydrogen peroxide, which the graphene layer detects. This enables for precise and continuous glucose monitoring without the need for unpleasant finger pricks. Graphene-based glucose sensing systems employ graphene-based materials to detect glucose in biological fluids such as blood, saliva, and urine. Diabetes, a chronic condition that affects millions of individuals worldwide, necessitates glucose monitoring. Graphene-based electrochemical sensors detect glucose in biological fluids by using the electrochemical characteristics of graphene. When glucose is present in biological fluid, it combines with an enzyme called glucose oxidase, resulting in the production of hydrogen peroxide. The hydrogen peroxide then interacts with the graphene-based electrode, producing a measurable current. The glucose concentration may be estimated by monitoring the current [47]. Electrochemical sensors based on graphene have a high sensitivity and can function across a wide range of glucose concentrations. Graphene-based FET sensors can detect changes in graphene's electrical conductance when exposed to glucose. When glucose is present in biological fluid, it interacts with the graphene surface, causing the graphene's electrical characteristics to alter. The FET sensor can monitor this change in electrical conductance, allowing glucose detection. Graphene-based FET sensors are very sensitive and can work across a wide range of glucose concentrations [48]. Surface-enhanced Raman spectroscopy (SERS) sensors based on graphene leverage the unique optical features of graphene to detect glucose in biological fluids. When glucose is present in biological fluid, it reacts with a metal nanoparticle bonded to the graphene surface, producing a Raman signal that a spectrometer can detect. The glucose concentration may be estimated by monitoring the Raman signal. SERS sensors based on graphene have a high sensitivity and can function across a wide range of glucose concentrations [49].

Impedance based graphene sensors employ graphene and its derivatives to assess electrical impedance changes induced by glucose levels in biological fluids. The sensors are made up of a graphene working electrode that is functionalized with glucose oxidase enzymes that react with glucose to create a change in electrical impedance. The glucose levels are then determined by measuring the change in impedance [50]. Graphene-based impedance sensors offer great sensitivity, selectivity, and stability and may be used to monitor glucose levels in real time. Graphene-based optical sensors can detect changes in graphene optical characteristics when exposed to glucose. When glucose is present in

biological fluid, it interacts with the graphene surface, causing the graphene's refractive index to alter. This change in refractive index may be monitored by the optical sensor, allowing glucose to be detected. Graphene-based optical sensors are very sensitive and can work over a wide range of glucose concentrations. Graphene-based glucose monitoring sensing methods have the potential to transform the area of glucose monitoring by giving new instruments for detecting glucose with high accuracy and sensitivity over a wide range of glucose concentrations. These approaches make use of graphene-based materials such electrochemical sensors, FET sensors, SERS sensors, and optical sensors, which offer unique qualities like high sensitivity, selectivity, and biocompatibility [51]. Although these approaches are still in their infancy, they show considerable potential for enhancing our capacity to monitor glucose levels and developing new technologies for the management of diabetes and other glucose-related disorders.

References:

1. Vaupel, J.W.," Biodemography of human ageing". Nature 464, 536-542.
2. Pantelopoulos, A. and Bourbakis, N.G.,"Prognosis-a wearable health monitoring system for people at risk: methodology and modeling". IEEE Trans. Inf. Technol. Biomed. 14, 613-621, 2010.
3. Ng, P. C., S, M. S., Levy, S., and Venter, J. C.," An agenda for personalized medicine". Nature 461, 724–726. 2009.
4. Narayan, R. J., and Verma, N.. "Nanomaterials as implantable sensors bt - materials for chemical sensing," in Materials for Chemical Sensing, eds T., 2016.
5. Tricoli, A., Nasiri, N., and De, S. "Wearable and miniaturized sensor technologies for personalized and preventive medicine". Adv. Funct. Mater. 27:160527. 2017.
6. Yao, S., Swetha, P., and Zhu, Y. "Nanomaterial-enabled wearable sensors for healthcare". Adv. Healthc. Mater. 2017.
7. P. Suvarnaphaet, S. Pechprasarn, "Graphene-based materials for biosensors: a review", Sensors 17, 2161, 2017.
8. J. Pen˜a-Bahamonde, H.N. Nguyen, S.K. Fanourakis, D.F. Rodrigues, "Recent advances in graphene-based biosensor technology with applications in life sciences", J. Nanobiotechnol. 16,1–17,2018.
9. C.M. Hussain, "Nanomaterials in Chromatography: Current Trends in Chromatographic Research Technology and Techniques", Elsevier, 2018
10. Vadukumpully, Sajini, et al. "Flexible conductive graphene/poly (vinyl chloride) composite thin films with high mechanical strength and thermal stability." *Carbon* 49.1 (2011): 198-205
11. Zhang, Bingxing, et al. "Cellular graphene aerogel combines ultralow weight and high mechanical strength: A highly efficient reactor for catalytic hydrogenation." *Scientific reports* 6.1 (2016).

12. Balandin, Alexander A., et al. "Superior thermal conductivity of single-layer graphene." *Nano letters* 8.3 (2008).
13. Diaz-Chacon, Lurayni, et al. "Graphite nanoplatelets composite materials: role of the epoxy-system in the thermal conductivity." *Journal of Materials Science and Chemical Engineering* 3 (2015).
14. Zhu, Yu, et al. "Rational design of hybrid graphene films for high-performance transparent electrodes." *ACS nano* 5.8 (2011).
15. Goenka, Sumit, Vinayak Sant, and Shilpa Sant. "Graphene-based nanomaterials for drug delivery and tissue engineering." *Journal of Controlled Release* 173 (2014).
16. Compton, Owen C., and SonBinh T. Nguyen. "Graphene oxide, highly reduced graphene oxide, and graphene: versatile building blocks for carbon-based materials." *small* 6.6 (2010).
17. Song, Zhongqian, et al. "Bioinspired microstructured pressure sensor based on a janus graphene film for monitoring vital signs and cardiovascular assessment." *Advanced Electronic Materials* 4.11 (2018).
18. Zhang, Fan, et al. "A highly accurate flexible sensor system for human blood pressure and heart rate monitoring based on graphene/sponge." *RSC advances* 12.4 (2022).
19. Khan, Yasser, et al. "Monitoring of vital signs with flexible and wearable medical devices." *Advanced materials* 28.22 (2016).
20. Li, Lucy, Mounia Chakik, and Ravi Prakash. "A review of corrosion in aircraft structures and graphene-based sensors for advanced corrosion monitoring." *Sensors* 21.9 (2021).
21. Aragay, Gemma, Josefina Pons, and Arben Merkoçi. "Recent trends in macro-, micro-, and nanomaterial-based tools and strategies for heavy-metal detection." *Chemical reviews* 111.5 (2011).
22. Ramnani, Pankaj, Nuvia M. Saucedo, and Ashok Mulchandani. "Carbon nanomaterial-based electrochemical biosensors for label-free sensing of environmental pollutants." *Chemosphere* 143 (2016).
23. Gutiérrez, Javier, and M. Carmen Horrillo. "Advances in artificial olfaction: Sensors and applications." *Talanta* 124 (2014).
24. Mao, Shun, et al. "Nanomaterial-enabled rapid detection of water contaminants." *Small* 11.40 (2015).
25. Kauffman, Douglas R., and Alexander Star. "Carbon nanotube gas and vapor sensors." *Angewandte Chemie International Edition* 47.35 (2008).
26. Novoselov, Kostya S., et al. "Electric field effect in atomically thin carbon films." *science* 306.5696 (2004).
27. Toda, Kei, Ryo Furue, and Shinya Hayami. "Recent progress in applications of graphene oxide for gas sensing: A review." *Analytica chimica acta* 878 (2015).

28. Vashist, Sandeep Kumar. "Non-invasive glucose monitoring technology in diabetes management: A review." *Analytica chimica acta* 750 (2012).
29. Ji, Guangmin, et al. "Optical biosensor based on graphene and its derivatives for detecting biomolecules." *International Journal of Molecular Sciences* 23.18 (2022).
30. Zahra, Qurat ul Ain, et al. "Graphene based nanohybrid aptasensors in environmental monitoring: concepts, design and future outlook." *Critical Reviews in Analytical Chemistry* (2022).
31. Tang, Danli, et al. "Highly sensitive wearable sensor based on a flexible multi-layer graphene film antenna." *Science Bulletin* 63.9 (2018).
32. Goenka, Sumit, Vinayak Sant, and Shilpa Sant. "Graphene-based nanomaterials for drug delivery and tissue engineering." *Journal of Controlled Release* 173 (2014).
33. Shadjou, Nasrin, Mohammad Hasanzadeh, and Balal Khalilzadeh. "Graphene based scaffolds on bone tissue engineering." *Bioengineered* 9.1 (2018).
34. Gomes, Manuela E., et al. "Tissue engineering and regenerative medicine: new trends and directions—a year in review." *Tissue Engineering Part B: Reviews* 23.3 (2017).
35. Ma, Yinji, et al. "Flexible hybrid electronics for digital healthcare." *Advanced Materials* 32.15 (2020).
36. Huang, Haizhou, et al. "Graphene-based sensors for human health monitoring." *Frontiers in chemistry* (2019).
37. Yang, Wenrong, et al. "Carbon nanomaterials in biosensors: should you use nanotubes or graphene?." *Angewandte Chemie International Edition* 49.12 (2010).
38. Yao, Jun, et al. "Recent advances in graphene-based nanomaterials: properties, toxicity and applications in chemistry, biology and medicine." *Microchimica Acta* 186 (2019).
39. He, Qiyuan, et al. "Graphene-based electronic sensors." *Chemical Science* 3.6 (2012).
40. Chakrabarti, M. H., et al. "Progress in the electrochemical modification of graphene-based materials and their applications." *Electrochimica Acta* 107 (2013).
41. Ma, Yingjie, and Linjie Zhi. "Graphene-based transparent conductive films: material systems, preparation and applications." *Small Methods* 3.1 (2019).
42. Wang, Jingang, et al. "Optoelectronic and photoelectric properties and applications of graphene-based nanostructures." *Materials Today Physics* 13 (2020).
43. Sahatiya, Parikshit, et al. "Graphene-based wearable temperature sensor and infrared photodetector on a flexible polyimide substrate." *Flexible and Printed Electronics* 1.2 (2016).
44. Zheng, Qingbin, et al. "Graphene-based wearable piezoresistive physical sensors." *Materials Today* 36 (2020).
45. Zhu, Shou-En, et al. "Graphene based piezoresistive pressure sensor." *Applied Physics Letters* 102.16 (2013).

46. Yogeswaran, Nivasan, Ensieh S. Hosseini, and Ravinder Dahiya. "Graphene based low voltage field effect transistor coupled with biodegradable piezoelectric material based dynamic pressure sensor." *ACS Applied Materials & Interfaces* 12.48 (2020).
47. Wu, Shixin, et al. "Graphene-based electrochemical sensors." *small* 9.8 (2013).
48. Artiles, Mayra S., Chandra Sekhar Rout, and Timothy S. Fisher. "Graphene-based hybrid materials and devices for biosensing." *Advanced Drug Delivery Reviews* 63.14-15 (2011).
49. Szlag, Victoria M., et al. "Molecular affinity agents for intrinsic surface-enhanced Raman scattering (SERS) sensors." *ACS applied materials & interfaces* 10.38 (2018).
50. Deng, Peihong, et al. "Determination of uric acid in biological fluids by ceria nanoparticles doped reduced graphene oxide nanocomposite voltammetric sensor." *Journal of The Electrochemical Society* 168.12 (2021).
51. Lipani, Luca, et al. "Non-invasive, transdermal, path-selective and specific glucose monitoring via a graphene-based platform." *Nature nanotechnology* 13.6 (2018).

METAL OXIDES BASED H_2 GAS SENSORS: A REVIEW

S. V. Patil
Department of Physics,
Shri Pancham Khemraj Mahavidyalaya, Sawantwadi
Corresponding author E-mail: spkphysics.svp@gmail.com

Abstract:

A sensor is a device that receives a physical, chemical or biological signal and converts it into an electric signal. The sensing mechanism of metals oxide sensor is the change in the metal oxide properties, when the oxidizing or reducing gas comes in contact with metal oxide either at room temperature or at high temperature. The good sensor should have fast response and recovery time. Among the different types of sensor materials, metal oxide based gas sensors are of recent attraction and many researchers are exploring the response of many gases for different metal oxides and other type of materials. Among H_2 gas detection techniques must also be focused with the increased use of H_2 gas in industries. Ready and accurate detection can minimize the risk of a small leak becoming a huge hazard risk. In this book chapter focus is on recent advances in sensing of H_2 gas by different type of metal oxides and their responses.

Introduction:

In Today's era, because of the technological advances, there are many automated systems which makes use of different gas for various purposes. In recent years, several types of gases have been used in different areas of industries. In order to avoid the accidental damages, it is now essential to constantly monitor these gases emitted which developed the need for gas sensors. The various uses of gas sensors vary across a wide range from industries to home applications. The leakage of these gases may cause damage to property and human life.

Among different gases the H_2 gas is highly hazardous because it is odorless and colorless [1]. The lower explosion limit is 4% concentration level of H_2 gas above this limit it is highly explosive and dangerous [2]. H_2 gas molecules are smaller in size that's why they can leak through small holes very easily. Therefore there is need to detect H_2 at lower concentrations to ensure the safety. Many techniques are used by the researchers to monitor H_2 gas. Different types of instruments have been used for the monitoring of trace hydrogen concentrations such as ultraviolet (UV) adsorption spectroscope and gas chromatography columns [3-5].

The use of metal oxides materials for fabrication of H_2 gas sensors with high sensitivity and selectivity is attracting attention of researchers because of their easy synthesis and fascinating tunable electrical and optical properties [6, 7].

Different metal oxides for detection of H_2 gas

1. SnO_2 based thin films

Among the various materials used for detection of H_2 gas, the widely explored metal oxide is SnO_2. Ansari et.al. studied gas response of SnO_2 thin and thick films deposited using various deposition techniques. He found that the thick film SnO_2 along with lead borosilicate glass is more sensitive than others [8]. H_2 gas sensing properties were studied by Md. Shahabuddin et.al. of Pt anchored SnO_2 sensor prepared by sputtering technique and found highly promising for H_2 sensing application [9]. Wu et.al. reviewed the response of SnO_2 nanosensors to H_2, CO, NO_2, and ethanol gas for different ppm levels at various temperatures [10]. The gas sensing properties of SnO_2 varies depending upon its morphology, surface area, grain size and other surface properties [11]. The doping of Pd to SnO_2 improves the H_2 gas sensitivity, Y. Shen et.al. studied the performance of undoped and doped SnO_2 nanowires synthesized by thermal evaporation of tin at 900 ^{0}C and found that Pd-doped SnO_2 shows more sensitivity than undoped SnO_2 nanowires [12]. Another efficient approaches to increase the selectivity and sensitivity of sensors is to use a filtering membrane, X. Meng et.al. studied the effect of thickness of the SiO_2 filtering membrane on sensitivities and selectivity of gas sensors [13]. Polyaniline (PANI)/SnO_2 composite gas sensor were prepared using electrospinning technique by H. J. Sharma for hydrogen (H_2) and carbon monoxide (CO) gas with fast response and recovery times. So, SnO_2 based thin film or thick film sensors is a potential candidate for H2 as well as other types of gases. The main disadvantage of these sensors is operating temperatures.

2. Graphene based Materials

Most of the metal oxides shows gas response at very high temperatures. The high operating temperature over 200 ^{0}C for the detection leads to high power consumption. Along with this metal oxides show low selectivity. Over the last couple of years, Graphene Oxide (GO), with its fascinating properties has been reported to advantageously exhibit room temperature gas sensing. M. Shabana et.al. deposited nanoporous GO sensor using spray pyrolysis technique and studied the gas response for CO_2, H_2 and C_2H_2 at room temperature. Nanoporous GO thin films were more sensitive to CO_2 as compared with H_2 and less sensitive to C_2H_2 at room temperatures [15]. Due to high chemical and physical properties nanomaterials such as graphene and graphene oxide have emerged as potential candidates for the design and fabrication of selective gas membranes. Reinaldo et.al. prepared an efficient H_2-sensor by the hydrothermal microwave exfoliation method with highly-exfoliated-graphene layers by means of palladium nanoparticles [16]. Along with use of graphene/graphene oxide as a membrane, composite materials were also explored by different research groups to sense different gases. K. Anand et.al. prepared nanocomposite of graphene/ZnO through reduction method during refluxing and confirmed that the electron transfer and electrical conductivity is due to the existence of graphene in the composites [17]. Pandey et.al. reported a silicon based gold electrode

coated by graphene oxide the with the help of spin coating. later the graphene oxide was reduced and then Pd sputter coated. The sensors showed selectivity towards the hydrogen even at 50 p.p.m. level [18]. Different deposition techniques with a lot of metal oxide material have been studied and explored as a H_2 gas sensor. P. A. Russo et al reported the performance of hydrogen sensor based on reduced graphene oxide (RGO), tin oxide, and platinum prepared by microwave-assisted methods [19].

3. TiO_2 based Sensors

TiO_2 exists in nature with its three forms generally known as rutile, anatase, and brookite. Rutile and anatase are tetragonal and brookite exist in orthorhombic form. Out of these three first two (rutile and anatase) shows gas sensitivity. The TiO_2 gas sensors can be classified into different types based upon the other elements present alongwith TiO_2.they can be classified as

3.1. Pure TiO_2:

Pure TiO_2 may be in thin or thick form shows gas response at some operating temperature. They show low sensitivity also they responds to the stimulus at particular temperatures. A. Hazra [20] et al. prepared nanocrystalline TiO_2 thin film by sol-gel methods. As-prepared p-type TiO_2 chemiresistor sensor showed a very excellent response for H_2 in air at 100 ^oC with a response time of 1.3 s. A well-designed pristine TiO_2 can be a potential candidate as a high quality hydrogen gas sensor working at room temperature. The sensitivity can be increased with decreasing in the operating temperature by radiating the TiO_2 under the light of specific wavelength. A UV irradiation-assisted room temperature hydrogen gas sensor is reported by X.Y. Peng [21] *et al.,* which exhibited a compact structure composed of uniform TiO_2microspheres.

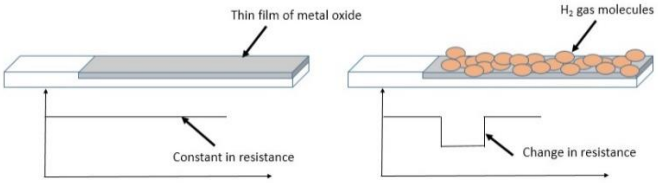
3.2 Doped TiO_2:

Further the sensitivity of the TiO_2 thin films can be increased by doping of different metals. Doping causes surface sensitization, they surface properties gets altered due to doping. P. Gwizdz et.al. reported the response of Cr-doped TiO_2 sensor from 0 to 10 % doping [22]. Patil [23] et.al. deposited Pt-doped TiO_2 thin films by chemical spray pyrolysis and response of H2 gas. The low level detection is possible with these films also the response and recovery time of Pt-doped TiO_2 thin films is very fast near about 14 s.

Gas sensing Mechanism

For most of the metal oxides either in a pure form or doped with other elements, the gas response is at higher temperatures. The basic principle is the surface reactions at high temperature. The adsorbed gas molecules changes the surface properties. The oxidizing or reducing gases either accepts or donates electrons resulting into change in the resistance of the thin film. When reducing gas donates electrons the resistance of the film decreases. The change in the resistance of the thin film indicates the presence of the gas molecules. In order to observe the change temperature may be raised upto 600 ^0C. The room temperature H_2 sensors shows the change in the physical properties at room temperatures.

Srivastava et.al. deposited pure PANI and TiO_2/PANI composite thin films based chemisresistor H_2 gas sensor. The resistance of all composite films decreases rapidly upon introduction of H_2 gas [24].



Gas sensing mechanism

Conclusion:

The SnO_2 thin films shows the gas response towards H_2 gas but detection needs high temperatures in order to show change in the electric properties of sensor film. Graphene oxides in various forms or doped with various metals showed better gas response even at room temperatures. TiO_2 is also a potential candidate for the H_2 detection.

References:

1. C. B. Barbosa Farias , R. C. Santos Barreiros, M. F. da Silva, A. A. Casazza, , A.Converti L.A. Sarubbo (2022): Use of Hydrogen as Fuel: A Trend of the 21st Century, Energies, 15: 311.
2. Sayago I., Terrado E., Lafuente E., Horrillo M., Maser W.K., Benito A., Navarro R., Urriolabeitia E., Martinez M., Gutierrez J. (2005): Hydrogen sensors based on carbon nanotubes thin films. Synth. Metals, 148 :15.
3. Sulaiman Khan, David Newport, Stephane Le Calve(2019): Gas Detection Using Portable Deep-UV Absorption Spectrophotometry: A Review, Sensors, 19:5210.
4. Ahmed I. Osman, Neha Mehta, Ahmed M. Elgarahy, Mahmoud Hefny, Amer Al-Hinai, Ala'a H. Al-Muhtaseb & David W. Rooney(2022) : Hydrogen production, storage, utilization and environmental impacts:a review, Environmental Chemistry Letters, 20:153.
5. Farina L, Boido E, Carrau F, Dellacassa E. (2007): Determination of volatile phenols in red wines by dispersive liquid-liquid microextraction and gas chromatography-mass spectrometry detection. J Chromatogr A, 1157:46.
6. W. Chen, Q. Zhou, FuWan, T. Gao(2012): Gas Sensing Properties and Mechanism of Nano-SnO_2-Based Sensor for Hydrogen and Carbon Monoxide, Journal of Nanomaterials, 612420: 9.
7. Pil Gyu Choi, Noriya Izu, Naoto Shirahata, Yoshitake Masuda (2018): Fabrication and H_2-Sensing Properties of SnO_2 Nanosheet Gas Sensors, ACS Omega, 3:14592.
8. S. G. Ansari, S. W. Gosavi, S. A. Gangal, R. N. Karekar, R. C. Aiyer (1997) : Characterization of SnO_2-based H_2 gas sensors fabricated by different deposition techniques, Journal of Materials Science: Materials in Electronics, 8: 23.
9. Md. Shahabuddin, Ahmad Umar, Monika Tomar, Vinay Gupta(2017): Custom designed metal anchored SnO_2 sensor for H_2 detection, International Journal of Hydrogen Energy, 42:4597.

10. Qi-Hui Wu, Jing Li, Shi-Gang Sun(2010): Nano SnO_2 Gas Sensors, Current Nanoscience, 6:525.
11. S.G. Ansari, P. Boroojerdian, S.R. Sainkar, R.N. Karekar, R.C. Aiyer, S.K. Kulkarni: (1997) Grain size effects on H2 gas sensitivity of thick film resistor using SnO2 nanoparticles, Thin Solid Films, 295:271.
12. Y. Shen, T. Yamazaki, Z. Liu, D. Meng, T. Kikuta, N. Nakatani, M. Saito, M. Mori (2009): Microstructure and H2 gas sensing properties of undoped and Pd-doped SnO2 nanowires, Sensors and Actuators B, 135:524.
13. X. Meng, Q. Zhang, S. Zhang, Ze He (2019): The Enhanced H_2 Selectivity of SnO_2 Gas Sensors with the Deposited SiO_2 Filters on Surface of the Sensors, Sensors 19: 2478
14. H. J. Sharma, M. A. Salorkar, S. B. Kondawar (2017): H_2 and CO gas sensor from SnO_2/polyaniline composite nanofibers fabricated by electrospinning, Advanced Materials Proceedings, 2(1) : 61.
15. Mohamed Shabana, Saber Ali, Mohamed Rabia (2019): Design and application of nanoporous graphene oxide film for CO_2, H_2, and C_2H_2 gases sensing, J Mater Technol., 8(5):4510.
16. R. D. Martínez-Orozco, R. Antano-Lopez, V. Rodríguez-Gonzalez (2015): Hydrogen-gas sensors based on graphene functionalized palladium nanoparticles: the impedance response as a valuble sensor evaluation, New J. Chem., 00:1.
17. K. Anand, O. Singh, M. P. Singh, J. Kaur, R. C. Singh (2014): Hydrogen sensor based on graphene/ZnO nanocomposite, Sensors and Actuators B, 195: 409.
18. P.A. Pandey, N.R. Wilson, J.A. Covington (2013): Pd-doped reduced graphene oxide sensing films for H_2 detection, Sensors and Actuators B 183: 478.
19. P. A. Russo, N. Donato, S. G. Leonardi, S. Baek, D. E. Conte, G. Neri, Nicola Pinna (2012): Room-Temperature Hydrogen Sensing with Heteronanostructures Based on Reduced Graphene Oxide and Tin Oxide Angew. Chem. Int. Ed., 51:11053.
20. Hazra A, Das S, Kanungo J, Sarkar CK, Basu S.(2013): Studies on a resistive gas sensor based on solgel grown nanocrystalline p-TiO_2 thin film for fast hydrogen detection, Sens Actuators B,183:87.
21. Peng XY, Wang ZM, Huang P, Chen X, Fu XZ, Dai WX. (2016): Comparative study of two different TiO_2 film sensors on response to H_2 under UV light and room temperature, Sensors, 16:1249.
22. P. Gwizdz, M. Radecka, K. Zakrzewska (2014): Array of chromium doped nanostructured TiO_2 metal oxide gas sensors, Procedia Engineering 87 : 1059
23. Lalchand A Patil, Dinesh N Suryawanshi, Idris G Pathan, Dhanashri G Patil (2014): Nanocrystalline Pt-doped TiO_2 thin films prepared by spray pyrolysis for hydrogen gas detection Bull. Mater. Sci., 37(3):425.
24. Srivastava, S.; Kumar, S.; Singh, V.; Singh, M.; Vijay, Y. (2011): Synthesis and characterization of TiO_2 doped polyaniline composites for hydrogen gas sensing., Int. J. ydrog. Energy, 36:6343.

GLIMPSE ON THE RISE AND FALL OF MUMBAI DABBAWALA

Abhijeet Deepak Yadav
Department of Mathematics,
Khare Dhere Bhosale College Guhagar, Dist. Ratnagiri,
Mumbai University, (415703)
Corresponding author E-mail: yadav.abhijeet50@gmail.com

Abstract:

Every successful business has a foundation of vision, leadership, management, marketing and money. Mumbai Dabbawala, an army of 5000 people runs a 130 years old tiffin delivery business. Feeding Mumbai's middlemen and contributing to the economy of Mumbai. People from the same community, religion and culture handle nearly 4 crores transactions per day. Every member has an equal share in profit. Due to error free transactions, Mumbai Dabbawala is now Management Guru. Many high profile personalities, prestigious universities, students willing to visit and learn management. Always their priority is to their customers, as they consider customers as Maharaja. They assume that, Technology is to support business and Business is not there to support technology. Natural disasters, calamities do not stop dabbawala from doing their duty. But, the wave of Covid 19 in India, destroyed Dabbawala's business. In this chapter, glimpse on the success story of dabbawala, their ethics in business and fall of their system.

Keywords: Dabbawala, Management Gurus, NMTBSA, Entrepreneur

Introduction:

Mumbai is the Financial Capital of India. Three things play an important role, first Mumbai's Local Train, Second Bollywood, and Third Mumbai's largest and Oldest Linked Chain Business "Dabbawala". Many people believe that Dabbawalla and Caterers are the same. But this is not true, because tiffin and the food contained in tiffin are both yours. Dabbawalla handles only the logistics. In English "dabbawalla" means "one who carries a box"[1]. They deliver your tiffin from your home to your workplace and the same in a reverse manner. In one day, they are organizing two deliveries. As we all know, in Mumbai servicemen use local trains for their travelling and they can't carry their tiffin with them while leaving from home for two reasons. First, local trains are very crowded, so they can't carry their luggage and tiffin box at a time and secondly, servicemen start their journey early in the morning around 06.00 a.m., so it is not possible for housewives to wake up and cook by around 05.00 a.m. So here enters Mumbai Dabbawala to solve the problem of servicemen. As everyone wants hygienic food, the only choice in front of every serviceman is home-cooked food. Now, who is this Mumbai Dabbawala and what is their background?

History:

A Parsi Banker employed a person to bring Homemade Food to the site of work. His office friends also liked this innovative idea and started availing of this service. Hon. Mahadu Havaji Bachhe takes this innovative idea and started working on this [2]. Around 1890, with 100 people he started the service of Dabbawala1. His descendant, Mr. Raghunath Medge is the first professional Dabbawala in Mumbai. He is the President of Nutan Mumbai Tiffin Box Suppliers Association (NMTBSA), a Charitable Trust registered in 1956. Once he said, "People study management books and then practice. But we practiced first and have now we become a subject of case studies". He trusts in Memory more than in Technology. He builds this empire with 5000 employees, who regularly wear white kurta and Gandhi topi [3].

NMTBSA:

There is a 3 tier system in the association. 13 permanent members are at the highest level of NMTBSA, responsible for fine-tuning among dabbawala and the overall transport system. President- Raghunath Medge, Vice President- Sopan Mare, General Secretary, Treasurer, and Directors (9). The second-tier system consists of 800 Mukadams, the group leader of 5-10 dabbawala, and mostly the highest age members in a group. Everyone gets an equal salary, as everyone is a partner in this business, not the employees. The rest are nearly around 5000. Every group tries to find new customers and try to compete with another group. An executive committee of 13 members is elected every five years. Monthly meetings are held to discuss problems in the line of operations. 9 Directors are spread over Mumbai; their workplace is defined by the railway station. When someone started working with dabbawala, he was not a member. He has to buy a tiffin line only if some previous member wants to sell his tiffin line for reasons, then the highest bidder gets this tiffin line and finally, he becomes a member. The price of the tiffin line is not based on the number of tiffins, but on the length of the route for the delivery. The value of the bid depends upon how much the tiffin line earns every month. Mainly there are three routes, first is Virar to Churchgate, Secondly Kalyan/Dombivli to CST, and lastly Panvel to CST. Each Tiffin Basket/Crate weighs 60-65 kgs. They had to carry this much weight on their heads and had to walk a few kilometres. There is no fixed retirement age.

On Average, all 5000 Dabbawalas delivered 2,00,000 tiffins per day and charged nearly Rs. 1000-2000 per month [4]. It means each dabbawala delivers 40 tiffins a day. If we assume the cost of tiffin delivery is Rs. 1500 per month, the monthly average revenue of Dabbawalas is nearly Rs. 30 crores which leads to a 360-crore turnover of this business per year. Each dabbawala could earn Rs. 10,000-15,000 per person per month depending upon a few parameters. Also, they get one month's salary as a Diwali bonus from the customers. There are still some default expenses (in percentage) for each dabbawala such as monthly

urban railway pass (3%), maintenance of bicycles and pushcart (2%), compulsory contribution to the NMTBSCT (1%), and contribution for Puja in railway station (1%) [5].

Some key features of Dabbawalas are as follows:

1. They memorize the names and addresses of 30-40 customers in their minds, so don't require any technological backup [6].
2. Since 1890, there has been no strike and no police/court case on dabbawala. No organization/ industry in the world has such a record.
3. All dabbawala wear white Gandhi topi, and white kurta, and must carry their Identity card.
4. Everyone believes in "Work is Worship"
5. This business runs on zero % of the investment, disputes, fuel, modern technology, 99.99% performance, and 100% customer care and satisfaction .

Everyone follows the Code of Conduct declared by NMTBSA:

1. No alcohol Drinking/Smoking during Business Hours.
2. No, leave Without Prior Notice.
3. Different types of fines, for disobeying the code of conduct
    i. Rs. 500 for Drinking on Duty,
    ii. Rs. 100 Smoking on Duty,
    iii. Rs. 25 Not Wearing White Cap, ID Card,
    iv. Rs. 1000 Leave without Intimation,
    v. sacked if repeated in 2-3 instances

Service Process Structure:

A) Colour Coding system:

When Dabbawallas deliver 2,00,000 Tiffins across Mumbai without an error, it is mandatory to have some unique identification over every tiffin box. But as most of the Dabbawalas are illiterate, there was the only option to use colours, basic numbers, and some short forms. By the end of the 19th century to the mid-20th century, colored threads were used for identification. From the Mid-20th century till the early 1970's colored cloth tags were in practice [7]. But as the population of Mumbai expanded exponentially, this system was not that useful. So, they introduced the Devanagari alphabet, religious allegories, or just geometrical symbols and started to use oil paint on the top of every tiffin box, instead of colored threads and tags [8].

Mainly four codes use in Colour Coding System:

1. Resident Station Pick Up Group Code (1 Digit Alphabet),
2. Resident Station Code (2/3 Digit Alphabets),
3. Destination Station Code (1 Digit Number))

4. Destination Pickup Group Code (1 Digit Number), Destination Address Code (2 Digit Alphabet), Final Destination (Details Specification of Floor/Office/Person Name) (2 Digit Numbers)

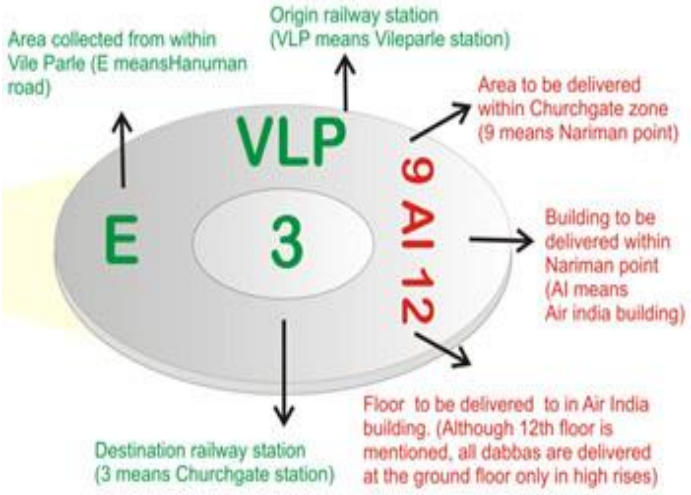


Figure 1: Details of a coding system

B) Distribution Flow:

Whole Day of Dabbawalas: (Nearly 08 hours of work per day)

09.00 a.m. to 10.30 a.m._ Pickup_ Dabba from Residence/ Caterer and Bring it to the nearest stations.

10.30 a.m. to 11.30 a.m._ Journey via Local Train_ This period is travelling time. Dabbawalas load wooden crates filled with Tiffins onto the luggage or goods compartment in the train. Generally, they choose to occupy the last compartment of the train.

11.30 a.m. to 12 p.m._ Downloading and Sorting_ The Dabbas is downloaded from the trains and Sorting is done as per the destination codes.

12.00 p.m. to 01.00 p.m._ Final Delivery_ Tiffins are delivered at the destination address.

01.00 p.m. to 01.30 p.m._ Lunch Time_ Dabbawalas carry their food with them, area wise they sit together and have lunch. Small meetings were also carried out.

01.30 p.m. to 02.30 p.m._ Collection Process_ Dabbawalas have to pick up the Tiffins from the offices where they had delivered almost an hour ago.

02.30 p.m. to 04.00 p.m._ Reverse Journey_ Reverse Travelling by train taking the empty dabbas.

04.00 p.m. to 04.30 p.m._ Sorting at Source Station_ segregation as per the destination suburb and Tea Time.

04.00 p.m. to 06.00 p.m._ Returning Dabba to Residence/ Caterer. At this stage dispatch takes place. Empty dabbas are delivered to the respective residence.

Achievements/ Notable Events:

1. Six Sigma Certification (In 1998): Due to the error rate of one in 16 million transactions. Forbes Global magazine conducted a quality assurance study on Dabbawala and gave it a Six Sigma efficiency rating of 99.999999. No one in the world gets this Certification without an Application [14].
2. Visit of Prince Charles (04 November 2003): Prince Charles III, King of the United Kingdom, visited Dabbawala during his visit to India. Dabbawalas requested King to adjust his schedule according to them, so King had to adjust his visit with them according to their suitable time and Place. The meeting of both was held on the Footpath of ChurchGate Station, from around 11.20 a.m. to 11.40 a.m. [14].
3. Hon. Shri Richard Branson, Chairman of Virgin Atlantic Airways (01 April 2005): Mr. Richard Branson not only visits Dabbawalla but spends his whole day working as a Dabbawalla and also travelling with them on a local train from Andheri to Churchgate [14].
4. Invitation to the Wedding of Prince Charles and Camilla Parker Bowles (09 April 2005): For this Royal wedding only three special guests from India were invited, namely Raghunath Medge (President of NMTBSA), Sopan More (another dabbawala from Mumbai) and Maharani Padmini Devi (From the Royal family in Rajasthan). Dabbawalas sent a nine-yard sari for Camilla and a Maharashtrian Puneri turban for Prince Charles [13].
5. Indian Institution of Ahmedabad (In 2005): IIM Ahmedabad published a case study on the management perspective of logistics of the Mumbai Dabbawala [14].
6. Received ISO 9001:2000 Certificate (29 July 2007): Certified by the Joint Accreditation System of Australia and New Zealand [14].
7. The New York Times (In 2007) Published one report on Dabbawalla that, this industry grows at a rate of 5-10% per year [14].
8. Visit of Gary Locke, U.S. Secretary of Commerce (12 February 2011): During this visit, he tries to understand the colour-coding system and its efficient management model [13].
9. Guinness Book of World Records (21 March 2011): Prakash Baly Bachche carried out 3 crates of tiffin on his head at one time. [13]
10. In 2011, Dabbawalas support Anna Hazare as a part of the Indian Anti-Corruption [13].
11. Certification by World Records India (27 April 2013): For the invention of a unique and effective, 0.999999% errorless Tiffin Delivery system [14].
12. IPSA 2019 (31 May 2019): International Product and Service Award presented to Mumbai Dabbawala for India's Best Tiffin Services Provider of the Year 2019 [14].
13. Recognition from Ripley's "Believe it or not" from the American Franchise [13]

14. Included among DNA's top 50 entrepreneur list of India [13]
15. There are some documentaries by well-known broadcasting channels like BBC, UTV, MTV, and ZEE TV and also the special episode in the British TV Series "Top Gear: India Special" [14]
16. Delivers talks and speeches in various prestigious Universities, in front of well-known personalities all over the world like the Prime Minister of the Netherlands, Prime Minister of Belgium, Mercedes Benz, British Telecom and Oxford University London, Latin America Columbia University, Massachusetts Institute of Technology (USA), Cognizant Technology Solutions (Wharton), Wharton Business School (Pennsylvania), Tuck School of Business (Dartmouth) and all the well-known business schools in India and Asia. [13]

Fundamentals of Dabbawala:

1. Discipline: - If some customer is late by 1 minute only, during pickup time, they walk away as it disturbs their time management and refuses to collect unusual shaped tiffin boxes as it imbalances their crate [9].
2. Internal Promotion: After completing 10 years, Dabbawalas was promoted to Supervisor (supervises a group of 25 people),
3. Ownership: Everyone is a partner in the profit after the completion of 06 months of the probation period [10].
4. Similarity: Most of the Dabbawalla is from Varakari Sampraday and near the villages of Pune. So, there is uniqueness in language, culture, food, and region. So, conflicts among them are negligible [11].
5. Coding System: illiterate people can also understand this system which leads to 0% error in delivery Collection and Distribution of Lunch Boxes with the care of customers is the motto of Dabbawalas.

Fall of System:

Terror attacks (2008), Bomb Blasts (1993, 2011), Communal riots (1992), Floods (2005) and so many other natural calamities did not stop Dabbawalas from their duty, but COVID-19 (March 2020) crushed this whole 130 years food industry [12]. The government started restrictions on travel by local train, a few months of curfew; industries started working online, and a rise of work-from-home culture, really destroyed Dabbawalas, as the demand for Dabbas declined. Most of the Dabbawalas returned to their hometown, and some of them who still live in Mumbai started another business for their two meals in a day. Currently, the 130 year old empire of 5000 employees drops down to 300-500 and serves around only 1000 deliveries a day [12]. Also, the main reason behind the fall of the Dabbawalas era is from the last 130 years, Dabbawalas had focused on only one type of service. They never tried to diversify their business models. As around 80% of Dabbawalas are illiterate, from the start they never tried the technology aspect of their business. Also,

their main focus was only restricted to Mumbai, and never tried to reach out to other towns in Maharashtra or India, so their functional area remained constant which resulted in a drop-down in industry growth.

Action Plan:

As we all know, "After every sunset there is a sunrise. So don't lose hope". Dabbawalas start to try new business ideas, running parallel to the previous food industry. There are some income sources for Dabbawalas by using their own established channels. A list of such business models is as follows:

1. In Mumbai, there are still lots of people who can't get home-cooked food. If Dabbawalas start their catering service, through some cloud kitchens, they can certainly reach such people. This will help to grow their business vertically. Also, the Dabbawalas family will get involved in this business model due to catering services, which will result in an increment in monthly income [12].
2. As Dabbawalas cover all major parts of Mumbai, if they collaborate with advertising companies, there will be another source of income.
3. They can use their channel to implement courier services by increasing their workforce. If they st
4. art delivering tiffin boxes or food to the homes or apartments, just like Swiggy and Zomato, they should never have to turn back.

Conclusion:

There is one proverb, "Don't put all your eggs in one single basket", which means don't put all your resources in one business because if that single business goes wrong due to some circumstances, you might lose everything. If your one business is well established, then start to spread your wings into other businesses. This story of Mumbai Dabbawalas gives a lesson that, no matter how old you are in your Business, how Successful and Safe in your business is, irrespective of all these things if you want to run your business for many years. Then you have to think about new ideas continuously till your last moment.

References:

1. Gauri Sanjeev Pathak, (August 2010): Delivering the Nation: The Dabbawalas of Mumbai, Journal of South Asia Studies, Vol. 33, No. 2, pp. 235-257
2. 'Your Dabbas on Time, Every time', The Times of India (18 July 2004).
3. S.N.M. Abdi, (2 November 2003): Charles to See First Hand how Lunch Carriers Deliver the Goods, South China Morning Post, p.11.
4. Shobhaa De, (17 Apr. 2005): Medge & More, 'Politically Incorrect' column, The Times of India, p.18.
5. Natarajan Balakrishnan and Chung-Piaw Teo, (2008): Mumbai Tiffin (Dabba) Express, International Series in Operations Research & Management Science, Vol.119, pp.271–278

6. Gauri Pathak, (2008): Bridging the Home and the World: Iconic Representation and the Negotiation of Cultural Brand Value in the Dabbawallahs of Mumbai, Master's dissertation, National University of Singapore, pp.13–29.
7. Sara Roncaglia, (2013): Feeding the City: Work and Food Culture of the Mumbai Dabbawalas, Cambridge: Open Book Publishers, 2013
8. Deepak Baindur, Rosario M. Macario, (2013): Mumbai lunch box delivery system: A transferable benchmark in urban logistics?, Research in Transportation Economics, Vol. 38, pp. 110-121.
9. Mumbai Dabbawalas (2012): Yuvakbharati: A Coursebook in English, Standard XI, Maharashtra State Board of Secondary and Higher Secondary Education, Pune.
10. Shobha Bondre (2011): Mumbai's Dabbawala, India International Centre Quarterly, Vol. 38(2), pp. 84–96.
11. Stefan H Thomke, Mona Sinha (February 2010): The Dabbawala System: On-Time Delivery, Every Time (Case 610-059), Harvard Business School.
12. Ahaan Bansali (3 July 2021): A struggle for Mumbai's Dabbawalas: 'Covid-19 has ruined us', Indian Express. https://indianexpress.com/article/cities/mumbai/mumbai-dabbawalas-covid-pandemic-7387162/
13. Wikipedia https://en.wikipedia.org/wiki/Dabbawala#cite_note-28
14. Mumbai Dabbawala Website https://mumbaidabbawala.in/

NANOTECHNOLOGY – A SUSTAINABLE AGRICULTURAL DEVELOPMENT IN INDIA

Rahul Vasantrao Zade
Annasaheb Vartak College, Vasai Road (w),
Dist.-Palghar- 401202 (M.S.)-India
Corresponding author E-mail: ravzade87@gmail.com

Abstract:

Nanotechnology is the study and operation of extremely fragile effects, about 1 to 100 nanometers. Nanotechnology has subsidized the agrarian-grounded business region with a periodic excrescency rate of 25%. The Department of Science and Technology (DST) is the nodal division for enforcing the nano-charge. The Ministry of Agriculture released 'guidelines for evaluation of nano-grounded agri-input and food productions in India'. Nanotechnology in agriculture includes special operations like nano-diseases, nano-fungicides, and targeted use of inputs to boost productivity without decontamination of soil and water. Nanotechnology has immensely contributed to sustainable agriculture by enhancing crop products and repairing and perfecting soil quality. New parentage technologies are essential if global crop production is to redouble by 2050 to meet the rising food demand. Nanomaterials prepared by eco-friendly and verdant styles may boost agriculture eventuality for perfecting the fertilization process, factory excrescency controllers, fungicide quittance of active factors to the asked prey spots, treatment of wastewater and also enhancing the immersion of nutrients in the factory. Nanotechnology provides new quittance mechanisms and new agrochemical instrumentalities for perfecting crop productivity and promises the reduction of fungicide operations and better evolution in sustainable agriculture.

Keywords: Nanotechnology, sustainable agriculture, agrochemicals, nanomaterials.

Introduction:

The agrarian region is dealing with enormous expostulations similar as rapid-fire climatic changes, a drop in soil fertility, macro and micronutrient insufficiency, overuse of chemical diseases and fungicides, and heavy essence presence in the soil. (Planning Commission, 2011). Lately, the Union Minister of Agriculture and Farmers Welfare, grassed about the colourful enterprise taken by the government to espouse agriculture technology. In 2021, a discussion paper on the India Digital Ecosystem of Agriculture (IDEA) from the Ministry of Agriculture and Farmers' Welfare (MoA & FW) was released, which talks about a digital revolution in the agriculture region. The relinquishment of ultramodern technology depends on colourful procurators similar as socioeconomic conditions, geographical conditions, crop grown, irrigation installations etc. Significant advancements in crop gain will come from perfecting the effectiveness of the photosynthetic process.

(Sukirtha and Saranya, 2020). The editors of Nature estimated that any technology takes some 20 times to crop from the laboratory and be capitalized. (Nature, 2011).

Nutrient use effectiveness (NUE) is a measure of how well shops exercise the accessible mineral nutrients. (Sukirtha and Saranya, 2020). Crop complaint discovery nanotechnology bias and tools like nanocapsules, nanoparticles and viral capsids can be exercised for the discovery and treatment of conditions. Nanosensors can be exercised to identify fungicide remainders, excrescency, phytopathogens, and nonentity pest in the field. (Reddy and Chhabra, 2022). Quantum blotches and nanoparticles have substantiated to a natural marker associated with standing delicacy (Sharon *et al.,* 2010). Nutrient operation nanotechnology bias can be exercised for the improvement of nutrient immersion by shops, the quittance of active constituents to special spots and water treatment processes. The use of prey-special nanoparticles can reduce the damage to non-target facfactories the quantum of chemicals released into the terrain. Nanosensors are formed for covering factory fragments, soil and water in the agroecosystem. (Sukirtha and Saranya, 2020).

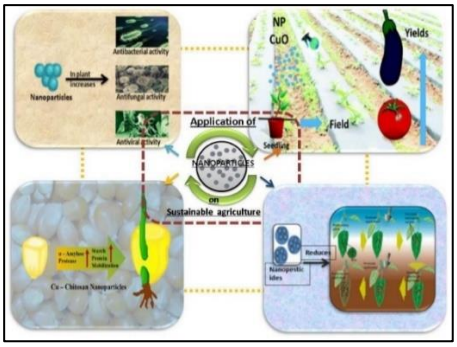


Fig. a) Application on sustainable agriculture.
(Source: https://www.frontiersin.org/articles/10.3389/fmicb.2017.01014/full)

Dr. S. Neethirajan developed a detector by integrating microelectronics and nanotechnology, this helps the planter in the covery of corruption of grain during storehouse, and this detector identifies the corruption of granules grounded on carbon copy dioxide attention and on the base of chemicals which discharge smell. The smell emitted by the organisms varies from species to species; the detector detects and sends signals to growers so that planter can control it as beforehand as practicable (Chen and Yada, 2011). Nanosensors are exercised in detecting fungicide remainders, for case multi-walled carbon copy nanotubes (MWCNT) were exercised to descry methyl parathion (Scognamiglio, 2013), nanogold grounded immunosensors were exercised to descry karnal bunt complaint in wheat (Dong *et al.,* 2013). Nanostructures with a special chemical, physical, and mechanical parcels like electrochemically active carbon copy nanotubes, nanofibers and fullerene can be exercised for soil dissection, ready bio-chemical seeing and control, water operation and quittance, fungicide and nutrient quittance.

As the climate revise is posing serious expostulations for agriculture, there is a want to switch to perfect agriculture. Nanotechnology holds the key for perfect agriculture.

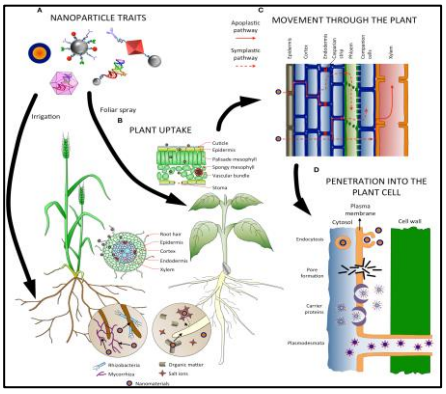


Fig. b) Factors influencing absorption, uptake, transport and penetration of nanoparticles in plants (Source: Alejandro, 2017).

Use Nanotechnology in Agriculture

The want for new parentage technologies is essential if global crop product is to redouble by 2050 to meet the rising food demand. Gain raises of 2.4% are needed to meet the demand without putting further land under civilization. The periodic product of cereals would need to go up by 50% to around three billion tonnes to give for the 2050 population demand. Use of nanoparticles like ZnO, TiO_2, MWCNTs, FeO, Zn, Fe, Cu- oxide, and hydroxyl fullerenes had swelled the crop excrescency and quality (Liu *et al.,* 2016; Joshi *et al.,* 2018; Dubey and Mailapalli, 2016). Perfecting the effectiveness of Rubisco (Amthor, 2007), modifying the chlorophyll antenna size of chloroplast photosystems (Melis, 2009), potentially allowed to wangle briskly growing shops and come the crucial procurator to design and develop artificial photosynthetic systems, an implicit source of clean dynamism (Giraldo *et al.,* 2014; Noji *et al.,* 2011).

Genome-edited crops had the eventuality to lower chemical toxin and fungicide use, reduce post-harvest losses while at the same time producing climate-flexible, nutrient-thick, and advanced-gain crops. Nanotechnology is an arising field of Indian agriculture. The use of nanotechnology for meliorated crop productivity can be a locally feasible program for growers, especially in extremities. The connected use of diseases with the carbon copy nanoparticles swelled the grain works in rice, spring sludge, soybean and downtime wheat (Li *et al.,* 2013). These technologies have inheritable substance to be appended, removed, or remodelled at personal locales in the genome. Its operations carry correcting inheritable blights, treating and precluding the spread of conditions and perfecting crops etc. CRISPR technology is one of the tools exercised in gene editing.

Nanotechnology in agriculture includes special operations like nano diseases, nano fungicides, and targeted use of inputs to boost productivity without decontamination of soil and water etc. Technology in agriculture can be exercised in nonidentical aspects of

agriculture similar as the operation of pesticides, fungicides, toxins, and bettered seed. Through technology, growers are in a situation to exhilarate every process for effectiveness and bettered product. Increases agriculture productivity. Prevents soil declination. Reduces chemical operation in crop products. Effective use of water coffers. Disseminates ultramodern ranch practices to ameliorate the quality, volume and downgraded cost of product. Changes the socio-profitable status of growers.

How can nanotechnology be applied to the field of agriculture?

a. Nanoscale carriers can serve as ' magic pellets ', containing dressings, chemicals, or genes, which target personal factory corridor to release their content. Nano-capsules can enable operative penetration of dressings through cuticles and allow tardy and constant release of the active substances.
b. Nanofabrication is the project and manufacture of bias with confines measured in nanometers. It can enable the study of factory regulation of hormones similar as auxin, which is responsible for root excrescency and seedling establishment. It helps understand how factory fountain heads acclimatize to their terrain, especially to borderline soils.
c. Photocatalysis: It involves the response of catalyst (nanoparticles) with chemical composites in the presence of light. Through this process, nanoparticles can be exercised for the bioremediation of resistant or sluggishly degradable fungicides, as detergents and for wastewater treatment.
d. Nano-barcode technology: Nanobarcodes have been exercised as ID markers for gene expression dissection. Nano patches to be employed in nanobarcodes are fluently encodable, engine-readable, durable, sub-micronsized taggant patches.
e. Nanosensors: Through the use of nano-detectors and GPS with satellite imaging of fields, growers can ever descry crop pests or substantiation of pressure similar as failure. By utilizing electronic detectors, diseases can be placed exactly in the wettish belt, grounded on the spatial variability in native fertility.
f. Smart Dust The 'smart dust' technology can be exercised for covering colourful parameters like temperature, moisture, and maybe nonentity and complaint infestation to produce allotted intelligence in vineyards and vineyards.
g. Nano-accoutrements productions grounded on nano-accoutrements are being developed to absorb soil humidity when it is in redundant and release sluggishly to shops during dry ages.

Government in this instruction:

The government launched a National Nano Mission in 2007. The charge looks at the usages of nanotechnology for safe drinking water, accoutrements evolution, detectors evolution, medicine quittance, etc. The Department of Science and Technology (DST) is the nodal division for enforcing the nano charge.

a. Guidelines apply to Nano-Agri-Input productions (NAIPs), Nano-Agri productions (NAPs) and nano mixes, detectors made from nanomaterials that bear direct connection with crops, food and feed for data accessions. They do not apply to usual productions or phrasings with the incidental presence of natural nanomaterials.
b. Digital Agriculture Mission: This has been founded for 2021-2025 by the government for systems grounded on new technologies like artificial intelligence, block chain, remote seeing and Civilians technology, use of drones and robots etc.
c. In 2007, the Government of India launched Nano Science and Technology Mission (NSTM) for exploration and creation. The Ministry of Agriculture released 'Guidelines for Evaluation of Nano-grounded Agri-input and food productions in India '.
d. Unified Farmer Service Platform (UFSP) UFSP is a combination of Core structure, Data, operations and Tools that enable flawless interoperability of colourful public and private IT systems in the agriculture ecosystem across the country.
e. Nationale-Governance Plan in Agriculture (NeGP-A) A Centrally Sponsored Scheme, it was originally launched in 2010-11, which aims to achieve rapid-fire evolution in India through use of ICT for timely access to agriculture-affiliated information to the growers. In 2014-15, the gambit was farther extended for all the remaining States and 2UTs.
f. Sub-Mission on Agricultural robotization (SMAM) Under this Scheme, subventions are handed for clinch of colourful manners of agrarian outfit and ministry.
g. Other Digital enterprise Kisan Call Centres, Kisan Suvidha App, Agri Market App, Soil Health Card (SHC) Portal,etc.

What are the affiliated challenges?

Education and Training Related Lack of knowledge shy chops Lack of advanced chops Technology and structure Poor structure, Lack of transport. Economic and Policy issues Lack of Money Access to credit, Lack of access to Bank Loans. Climate and Environmental Issues Poor soils, Soil fertility, Unreliable downfall, Natural disasters similar as cataracts, frost, hail storm. sickie-social issues Workers have no interest in agriculture, ranch workshops are not preferred overipelegeng systems (tone-reliance workshop), and Farm jobs are time consuming. Repeated and ferocious use of finagled nanoparticles will lead to the accumulation of these in the terrain, soils, water. This will make the soil physiochemical and natural parcels largely reactive (Nemmar *et al.,* 2001). Human coffers to be successful in the new arising field of agrarian nanotechnology, mortal coffers must be well trained to experiment, introduce, assess, interpret, and successfully assimilate the proposition, tools, and ways of nanotechnology for its operation in husbandry. Enterprises at colourful situations the enterprises related to the vacuity, conflation, position of toxin, health hazards, transportation challenges and contradiction of nonsupervisory structure

circumscribe the broad recognition and acceptance of espousing nanotechnology in husbandry. Lack of Risk Assessment The current exploration trends warrant realistic approach that fail to attain comprehensive knowledge of threat assessment factors and farther toxin of nanoparticles toward agroecosystem factors viz. factory, soil, soil microbiomes after their release into the terrain.

Way forward

The use of technology has defined the 21st century. As the world moves toward amount computing, AI, big data, and other new technologies, India has a tremendous occasion to reap the advantage of being an IT mammoth and revise the agriculture sector. While the green revolution led to an increase in agrarian products, the IT revolution in Indian agriculture must be the coming big step. There need to be immense sweat to ameliorate the capacities of the growers in India–at least until the educated youthful growers replace the being under-educated small and medium growers. Technology in agriculture has the implicit to truly lead India to be "Atmanirbhar Bharat" in all felicitations, and be less dependent on extraneous factors. IFFCO has also sought authorization from the Department of Diseases for the import of Nano Urea
(Liquid) manufactured from its Nano Fertilizer Plant installation set up at Kalol, Gujarat.

At ICAR exploration on different crops were set up agronomically suitable indicating that nano nitrogen (Nano Urea) can enhance crop yields besides saving nitrogen to the extent of 50%. The occasion for the operation of nanotechnology in husbandry is fabulous. Nonetheless, as conventional agricultural practices come decreasingly shy, and requirements have exceeded the carrying capacity of the terrestrial ecosystem, we have little option but to explore nanotechnology in all sectors of agriculture.

References:

1. *(http://planningcommission.gov.in/aboutus/committee/wrkgrp12/sandt/wg_dst2905.pdf).*
2. A. Kumar, K. Gupta, S. Dixit, K. Mishra, and S. Srivastava, "A review on positive and negative impacts of nanotechnology in agriculture," International journal of Environmental Scienceand Technology, vol. 16, no. 4, pp. 2175–2184, 2019.
3. Afsharinejad A, Davy A, Jennings B. Dynamic channel allocation in electromagnetic nanonetworks for high resolution monitoring of plants. Nano Communication Networks. 2016;7:2-16.
4. Alejandro Pérez-de-Luque, Interaction of Nanomaterials withPlants: What Do We Need for Real Applications in Agriculture?, Frontiers in Environmental Science | www.frontiersin.org, April 2017 | Volume 5 | Article 12.
5. Amthor J. Improving photosynthesis and yield potential. In: Ranalli P, editor. Improvement of Crop Plants for Industrial End Uses. Dordrecht: Springer; 2007. pp. 27-58.

6. Aziz HM et al. Nano chitosan-NPK fertilizer enhances the growth and productivity of wheat plants grown in sandy soil. *Span. J. Agric. Res.* 2016;14(1):17.
7. Chen H, Yada R. Nanotechnologies in agriculture: new tools for sustainable development. *Trends Food Sci Technol*. 2011 Nov 1;22(11):585-94.
8. Chhipa H. Nanofertilizers and nanopesticides for agriculture. Environmental Chemistry Letters. 2016;15(1):15-22.
9. D. Thangadurai, J. Sangeetha, and R. Prasad, Eds., Nanotechnology for Food, Agriculture, and Environment, Springer,2020.
10. Dimkpa CO, Bindraban PS. Nanofertilizers: new products for the industry?. Journal of agricultural and food chemistry. 2017 May 24;66(26):6462-73.
11. Ditta A, Arshad M. Applications and perspectives of using nanomaterials for sustainable plant nutrition. Nanotechnology Reviews. 2016;5(2):1-22.
12. Dong J et al. Highly sensitive electrochemical stripping analysis of methyl parathion at MWCNTs–CeO2–Au nanocomposite modified electrode. *Sens. Actuators B Chem.* 2013 Sep 1;186:774-80.
13. Dubey A, Mailapalli DR. Nanofertilisers, nanopesticides, nanosensors of pest and nanotoxicity in agriculture. *InSustainable agriculture reviews* 2016 (pp. 307-330). Springer, Cham. SS Reddy1 and V Chhabra2, Nanotechnology: its scope in agriculture , Journal of Physics: Conference Series 2267 (2022) 012112.
14. FAO. World agriculture towards 2030/2050: the 2012 revision [Internet]. 11/06/212. Available from:http://www.fao.org/docrep/016/ap106e/ap106e.pdf
15. Fellet, G.; Pilotto, L.; Marchiol, L.; Braidot, E. Tools for Nano-Enabled Agriculture: Fertilizers Based on Calcium Phosphate
16. Fraceto LF, Grillo R, de Medeiros GA, Scognamiglio V, Rea G, Bartolucci C. Nanotechnology in agriculture: Which innovation potential does it have? Frontiers in Environmental Science. 2016;4:20.
17. G. N. Rameshaiah, J. Pallavi, and S. Shabnam, “Nano fertilizers and nano sensors–an attempt for developing smart agriculture,”International Journal of Engineering Research and General Science, vol. 3, no. 1, pp. 314–320, 2015.
18. Giraldo JP, Landry MP, Faltermeier SM, McNicholas TP, Iverson MN, Boghossian AA, Reuel NF, Hilmer AJ, Sen F, Brew J, Strano MS.Plant nanobionics approach to augment
19. H. Chhipa, “Nanofertilizers and nanopesticides for agriculture,”Environmental Chemistry Letters, vol. 15, no. 1,pp. 15–22, 2017.
20. Joshi A et al. Multi-walled carbon nanotubes applied through seed-priming influence early germination, root hair, growth and yield of bread wheat (Triticum aestivum L.). *J. Sci. Food Agric*. 2018 Jun;98(8):3148-60.

21. K. S. Subramanian, A. Manikandan, M. Thirunavukkarasu, and C. S. Rahale, "Nano-fertilizers for balanced crop nutrition,"in Nanotechnologies in Food and Agriculture, pp. 69–80, Springer, Cham, 2015.
22. Liu R et al. Use of a new controlled-loss-fertilizer to reduce nitrogen losses during winter wheat cultivation in the Danjiangkou reservoir area of China. *Commun Soil Sci Plant Anal* . 2016 May 14;47(9):1137-47.
23. Mahakham W et al. Nanopriming technology for enhancing germination and starch metabolism of aged rice seeds using phytosynthesized silver nanoparticles. *Scientific reports*. 2017 Aug 15;7(1):1.
24. Mandal, D. Nanofertilizer and its application in horticulture. J. Appl. Hortic. 2021, 23, 70–77. [CrossRef].
25. Manjunatha SB, Biradar DP, Aladakatti YR. Nanotechnology and its applications in agriculture: A review. Journal Farm Science. 2016;29:1-13.
26. Melis A. Solar energy conversion efficiencies in photosynthesis: Minimizing the chlorophyll antennae to maximize efficiency. Plant Science.1774;2009:272-280.
27. Mittal, D.; Kaur, G.; Singh, P.; Yadav, K.; Ali, S.A. Nanoparticle-Based Sustainable Agriculture and Food Science: Recent Advances and Future Outlook. Front. Nanotechnol. 2020, 2, 10. [CrossRef].
28. Mukhopadhyay SS, Sharma S. Nanoscience and nanotechnology: cracking prodigal farming. *Journal of Bionanoscience*. 2013;7:1–5.
29. Nanotechnology in Agriculture:Scope and Current Relevance, NATIONAL ACADEMY OF AGRICULTURAL SCIENCES, NEW DELHI December 2013.
30. Nayyar A, Puri V, Le D-N. Internet of nano things (IoNT): Next evolutionary step in nanotechnology. Nanoscience and Nanotechnology. 2017;7(1):4-8.
31. Nemmar A et al. Passage of intratracheally instilled ultrafine particles from the lung into the systemic circulation in hamster. *Am J Respir Crit Care Med*. 2001;164:1665-8.
32. Noji T, Kamidaki C, Kawakami K, Shen JR, Kajino T, Fukushima Y, Sekitoh T, Itoh S. Photosynthetic oxygen evolution in mesoporous silica material: Adsorption of photosystem II reaction center complex into 23 nm nanopores in SBA. Langmuir. 2011;272:705-713
33. Prasad R, Bhattacharyya A, Nguyen QD. Nanotechnology in sustainable agriculture: Recent developments, challenges, and perspectives. Frontiers in Microbiology. 2017;8: 1014.
34. Qi M, Liu Y, Li T. Nano-TiO 2 improve the photosynthesis of tomato leaves under mild heat stress. *Biological trace element research*. 2013 Dec;*156*(1):323-8.
35. Raliya, R.; Saharan, V.; Dimkpa, C.; Biswas, P. Nanofertilizer for Precision and Sustainable Agriculture: Current State and FuturePerspectives. J. Agric. Food Chem. 2017, 66, 6487–6503.

36. Scognamiglio V. Nanotechnology in glucose monitoring: Advances and challenges in the last 10 years. *Biosens. Bioelectron*. 2013 Sep 15;47:12-25.
37. Sharon, M., Choudhary, A.K., Kumar, R., 2010. Nanotechnology in agricultural diseases and food safety. J. Phytol. 2, 83–92.
38. Siddhartha S Mukhopadhyay, Nanotechnology in agriculture: prospects and constraints,Nanotechnology, Science and Applications 2014:7 63–71.
39. Silicon, and Chitosan Nanostructures. Agronomy 2021, 11, 1239. [CrossRef].
40. Singh, H.; Sharma, A.; Bhardwaj, S.K.; Arya, S.K.; Bhardwaj, N.; Khatri, M. Recent advances in the applications of nanoagrochemicals for sustainable agricultural development. Environ. Sci. Process. Impacts 2021, 23, 213–239. [CrossRef] [PubMed].
41. Subramanian KS, Tarafdar JC. Prospects of nanotechnology in Indian farming. *Indian J Agric Sci*. 2011 Oct 1;81(10):887-93.
42. The long game. *Nature*. 2011;473:419.
43. Thiruvangium Henry Sukirtha, N Saranya, Applications of Nanotechnology in Agricultural Waste–Review Paper, Scholars Academic Journal of Biosciences Abbreviated Key Title: Sch Acad J Biosci, ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online) Journal homepage: https://saspublishers.com/sajb/

VOLUMETRIC ANALYSYS-COMMON INDICATORS AND APPLICATIONS

Rajeev Ramachandra Kolgi
Department of Chemistry and Biochemistry,
Government Science College Bengaluru-01. Karnataka, India
Corresponding author E-mail: rajeevkolgi@gmail.com

Abstract:

Analytical chemistry deals with the methods used in determining the composition of various materials. It can be devided into two main branches i.e. quantitative and qualitative analysis. Qualitative analysis is the process of detecting the various constituents of a substance or substances. Quantitative analysis consists of determining the proportion of each or any of the constituents present in the mixture. So to analyze any substance first it should be subjected to qualitative analysis then to quantitative estimation. The usual method which is followed is the volumetric analysis. In this the volume of a reagent of known concentration required to reduce or oxidize or neutralize the substance under investigation. This article explains the different types of indicators and their applications.

Keywords: Volumetric analysis, indicators, analytical chemistry.

Introduction:

Indicators are necessary to mark the endpoint of reactions in the titration of acids against bases. A proper choice of indicators is necessary to carry out the titration. Acid base indicators used in acidimetry and alkalimetry are either weak acids or weak bases. They show different colours in acid and alkaline medium. In other words, they change their colours with changes in the pH of the solution.

History

Volumetric analysis was first introduced by Jean Baptiste Andre Dumas, a French chemist. He used it to determine the proportion of nitrogen combined with other elements in organic compounds, Potassium hydrogencarbonate, which is still used for standardization in acid–base titrations, was introduced by Than in 1860. Functional group determination of organic compounds can be done by volumetric analysis. The introductory titration in the vicinity was carried out by Vorlander, who, in 1903, resolved aniline by titration with hydrochloric acid in benzene.

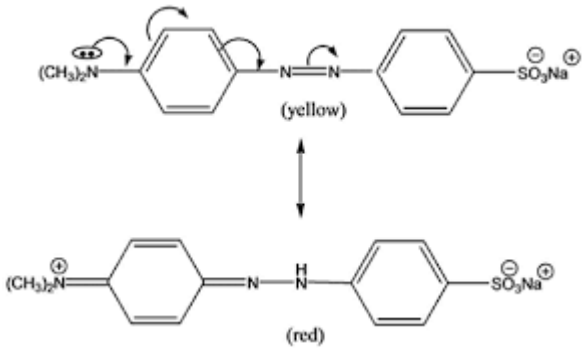
Factors influencing behaviour of indicators

The indicators just as any electrolyte will be ionized in solution. Each indicator dissociates to different extent in solutions, hence their indicator constants will also be different. That is every indicator changes their colour depending on its pH range. For example, methyl orange is yellow in acid medium and orange in alkaline medium. Usually the concentrations of indicator solutions used are 0.5 to 1 gm per litre of the solvent. The most successful of these methods is the titration of acids with bases using luminol, giving

precision of approximately1 part per thousand. Ionic strength of the medium, nature of solvent, temperature, and formation of colloidal particles influences the behaviour of indicators.

The common indicators used in volumetric analysis are

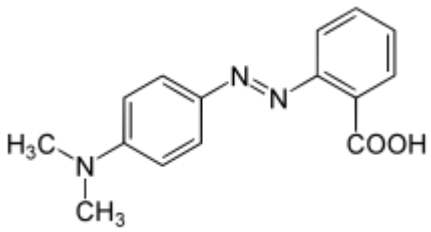
Methyl orange



pH range 3.1 to 4.4. This indicator is yellow in acid medium and red in alkaline medium. Since the colour change of methyl orange occurs at pH less than 5, hence cannot be used for weak acids such as boric acid, carbonic acid. It does not give sharp end points in the titrations of ammonia.

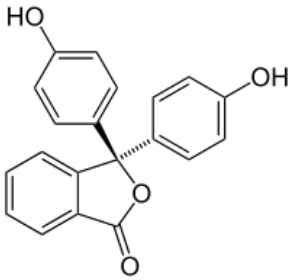
Methyl orange turns red in an acidic medium and yellow in a basic medium. It is routinely used in acid titration since it commutes colour at the pKa of a mid-strength acid. Methyl orange, unlike a universal indicator, does not have a complete spectrum of colour transition, but it does have a sharp end point.

Methyl red



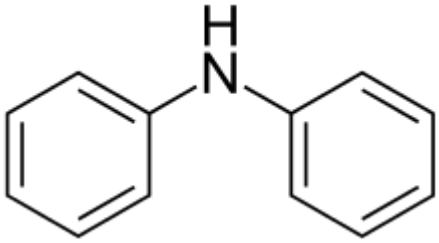
PH range is 4.2 to 6.2. This has red colour in acid medium and yellow in alkaline medium. This indicator can be used for the titrations of ammonium salts. Methyl Red has a unique role in cytogenetics for revealing acidic character of tissue and existence of life forms with acidic natured cell walls.

Phenolphthalein



PH range 8.2 to 10. The indicator is colorless in acids and pink coloured in alkalies. It is best indicator for the titrations of weak acids against strong bases. It is a component of universal indicator along with thymol blue methyl red and bromothymol blue

Diphenyl amine



The instigation of internal redox indicators has markedly broadened the field of oxidimetry by introducing new typical oxidizing agents and intensifying the accuracy of previous ones.

It has been used as an internal indicator in the dichromate titrations. Since it is sparingly soluble in water solution of the compound in sulphuric acid is used. Since diphenyl amine is not oxidized by ferrous ions it can be used as an internal indicator. A sharp colour change can be obtained at the end point by adding phosphoric acid, which lowers the oxidation potential of the ferric ferrous ion system by forming a complex.

A system of indicating the range of oxidation-reduction indicators other than that of the oxidation potential which is sometimes, although infrequently, used is that of sensitivity. When it is said that diphenylamine has a sensitivity of 4 $X10^{-6}$ to potassium permanganate in 1 N sulfuric acid, this means that as soon as the 1 N sulfuric acid containing the indicator becomes 4 $X10^{-6}$ N with respect to potassium permanganate the indicator becomes violet colored. As all oxidizing agents of the same normality lack the same oxidizing power

Starch

Used in iodometric titrations. Forms blue colour with the iodine. Iodine is trapped with the molecule of starch to form tri-iodide. Very sensitive, shows colour even at $2X10^{-7}$ M of iodine. Starch is decomposed by bacteria and oxygen, hence starch indicator should be freshly prepared. It can be used both in direct and indirect iodometric titrations.

Applications:

Several technical, medicinal, and naturally existing samples comprise acids or bases. If the acids or bases in the sample are quantitatively leached out into water or if the sample is soluble itself the acid or base content can be determined by titration with standard titrant. End-point detection can be by color indicator or one of several different instrumental techniques.

Industrial cleaning, paint removal, rust removal, and dip solutions, carbonate content of minerals and ores, HC03~ in antacid tablets such as acetic acid content of

vinegar, orthophosphoric acid in commercial orthophosphoric acid, boric acid and borax, and nitrogen analysis are typically determined by acid-base procedures.

Medical laboratories and hospitals use automated titration equipment for basically knowing the concentration of unknown substance. Beside these, the process has found ample use in analytical laboratories; and drug, food and petrochemical industries. For example, in biodiesel industry, it is used to determine the acidity of a sample of vegetable oil.

In the determination of hardness of water using Erichrome black T indicator and basic buffer. Determination of acidity of vinegar using standard oxalic acid solution. To determines total iron content in water.

Determination of 'Available chlorine' in bleaching powder. Used to determine magnesium and manganese content in a solution by using EDTA.A redox titration may be used to determine the amount of unsaturated fatty acids. Diphenylamine can be used as an indicator in the determination of cobalt by titration with standard potassium dichromate. One of the best methods of determining chromium and vanadium in alloy steels by titrating with ferrous sulfate solution makes use of diphenyl amine as the indicator. Ackermann reports using the indicator satisfactorily in the direct titration of used chrome liquor in the tanning of leather. Knop applied the indicator to the determination of chromium in steel. He found that accurate results could be obtained by dissolution of the sample in 1:1 sulfuric acid, oxidation with ammonium persulfate, removal of the manganese as the oxyhydroxide, reduction of the chromic acid so formed with standard ferrous sulfate solution, and back-titration with standard potassium dichromate.

Furman found the indicator useful in the determination of vanadium in ores or steels even in the presence of ferric iron, quinquevalent arsenic, and hexavalent uranium. He employed various methods and titrated with standard ferrous sulfate after oxidizing with potassium permanganate. Diphenylbenzidine can be used in ceric titrations of iron, even in the presence of arsenious acid; however, it is less satisfactory than diphenylamine. Diphenylbenzidine is also applicable to the determination of vanadium by titration with ceric sulfate.

Methyl red can be used as the indicator in the titration of trivalent antimony with ceric sulfate, and in determining hydroquinone by using ceric sulfate as the titrating agent. Apomorphine indicator is used for the determination of antimony with potassium bromate. Small quantities of the indicator in hydrochloric acid solution are colored rose by free bromine, and the solution is decolorized when potassium antimonyl tartrate is added. The reaction is reversible. The same color change is produced by an antimonite with the indicator and potassiumbromate. The results agree with potentiometric titrations.

Titration is frequently used in the food industry to keep the acid, base and salt content in the food. Some of the everyday food products where quantity is determined by titration are, acetic acid in vinegar, lactic acid in pickles and nitrogen content in proteins can be determined.

Pharmaceutical industry

Purity analysis of pharmaceutically active ingredients used to determine the content of active ingredients in pharmaceutical products. Vitamin C content in multivitamin tablets can be determined. Karl Fischer titration is common analytical method in Chemistry that helps in determining the water content in particular mixture. In Pharmaceutical industry water or moisture content of a product plays a important role as per the activity or storage life time of a product are concerned.

Medical diagnosis

Titration is one of the many practices that lab technicians often across while analyzing blood and urine samples from the patients. Titration can be used to measure glucose levels in the blood. Phenolphthalein and its derivatives structurally similar to 2-APB inhibit SOCE in platelets and other cells. Many phenolphthalein analogues inhibited the ability of thrombin and thapsigargin (a specific activator of SOCE) to increase [Ca]i. Phenolphthalein has an IC50 approximately 10 microM to inhibit thrombin-induced [Ca]i elevation, its active analogues have a similar potency. Several phenolphthalein analogues also inhibited thrombin-induced intracellular Ca mobilization.

Conclusion:

Indicators help us to boost knowledge and comprehending distinct concepts. They deflate and renew facts so that it can be practiced to study different parameters. They are used in almost all fields particularly in all sciences for their particular purposes.

References:

1. Ackermann: Collegium 1933, 828-30.
2. Furman and Wallace: J. Am. Chem. SOC. 62, 1443-7, 2347-52 (1930).
3. Knop: J. Am. Chem. SOC. 46, 263-9 (1924). (35) KNOP: Z. anal. Chem. 77, 111-25 (1929); 86, 253-75 (1931); 87, 234-6 (1932).
4. Knop and Kubelkova: Z. anal. Chem. 100, 161-83 (1935); 86, 401-23 (1931).
5. Kuhn and Franke: Ber. 68, 1528-36 (1935).
6. Lewis, D.: Ind. Eng. Chem., Anal. Ed. 8, 199-200 (1936).
7. Universal Indicator". *ISCID Encyclopedia of Science and Philosophy*. Archived from the original on September 25, 2006.
8. Dobrydneva, Y.; Wilson, E.; Abelt, C. J.; Blackmore, P. F. (2009). "Phenolphthalein as a Prototype Drug for a Group of Structurally Related Calcium Channel Blockers in Human Platelets". *Journal of Cardiovascular Pharmacology*. 53 (3): 231–240.

REVIEW OF RESEARCH TYPES IN CONTEXT TO SCIENCE DISCIPLINE

Shailendra Bhalchandra Kolhe
Department of Physics,
Shivaji Arts, Commerce & Science College Kannad, Dist.-Aurangabad – 431103 (M.S.)
Corresponding author E-mail: kolhe_sb71@yahoo.com

Abstract:

Types of research has been discussed in this review paper. Specially emphasis has been given to science research types intended for research scholars of science stream such as mathematics, physics, chemistry, biology, and computer science etc. Examples have been cited while explaining types of research in this research paper. Specially stress is given to encourage young researchers while performing research work.

Keywords: Research methodology, Types of Research, Fundamental research, Qualitative research, Empirical research.

Introduction:

Research is the term used in searching for knowledge and truth. Here knowledge means information. It is a logical and systematic search for new and useful information on a particular topic. Research work is nothing but collection of data to answer the questions and finding solution to problems. In this paper the prime aim is to provide a brief review of research types. Research work is not only limited to science stream but it has same importance in humanities, social science, and other branches. The research in management and social science are concerned with human beings, whereas research in science and technology is related to experiments, observations. Research paves a way to overall development of human being. It brings prosperity in human life. We can make our life more efficient and faster using research. Research is carried out with the help of study, experiment, observation, analysis, comparison, and reasoning. For example, we know nutritious food and hygiene is very necessary for our health, consumption of alcoholic drink is injurious to our health, solar energy is useful source of non-conventional energy. How did we get all this information? We became aware of all these information only through research. It requires predictions of events, explanations, relationships, and theories for them.

Objectives of research

Objective of research is a sentence or question that summarizes the purpose of our study. The prime objectives or goals of research are to discover, verify and test important facts, to study an individual or situation or phenomenon to find the cause-and-effect relationship, to develop new scientific tools, models, concepts, and theories to diagnose scientific and nonscientific problems, to overcome problems occurring in our everyday life. For example, if you are on vacation and planning for tour, you will make list of your

objectives. You will first think of your budget, search for spots, hotels according to your budget and make time schedule. Like this while doing research we have to make objectives according to our hypothesis. If you want to measure volume of a rectangular solid block, your objective is to measure its length, breadth, and height.

Necessity of research

We know the proverb necessity is mother of invention. Nobody will go for research work unless there is need of it. For research there should be motivating factors. We do research for better position in job, for getting opportunity abroad. To solve unsolved problems, we do research. We go for research to get recognition of society. Some people do it for their curiosity, creativity to find out new things. It is better way to serve society by performing research. Research requires lot of hard work, commitment. Mere getting a degree of Ph.D. is not research. There should be interest in research. Research motivated minds can do miracles either in company field or educational institution or any other area. For example, we have noticed situation like pandemic corona. Because of pandemic, researchers got motivated to invent new vaccine. There was a need to invent vaccine to get rid of corona. Many issues like diseases, environmental disasters encouraged scientists to invent remedies.

Importance of research

Development of society depends on research. Scientists do hard work, make new inventions to serve society. Government makes policies based on the research activities in various fields. Research provides for predicting of prospects of the region. Research has special importance in relation to solving various problems of business and industries. Research has application in socio political sector in order to find out solution to social and political problem of the society. Research is fountain of knowledge to tackle various problems. Research leads to a new style of life and makes it enjoyable and splendid. It leads to the identification and characterization of new materials, new living things.

Research methodology and research method

Research method means all those methods or techniques that are used for conduction of research. Research methods refer to the methods used by researchers in performing research operations (Kothari and Garg, 2014). Research methods are used to collect the information; to establish the relationship between the information and the unknowns; and to evaluate the accuracy of the results obtained. Research methodology is a way to systematically solve the research problem. Research methodology is nothing but the procedures by which researchers do their work of describing, explaining, and predicting phenomena. It is a systematic way to solve a problem. It focuses on the significance of research, defining of research problem, formulation of hypothesis, selection of data collection method, and using of data collection techniques. The scope of research methodology is broader than research method.

Types of research

We will discuss various types of research here.

1. Fundamental research

It is the research carried out to invent new ideas, facts, basic principles for betterment and knowledge of human being. Fundamental research is based on experimentation and observation by following severe ethics and procedures to meet specific objective and ensure reliability of conclusions of research published into peer reviewed journals (Pawar, 2020). This kind of research examines data to find the unknown and fulfill a sense of curiosity. It involves "how," "what" and "why" questions to find out unknown and fulfil curiosity. Information gained from fundamental research often creates a basis for applied studies. For example, research to study what makes up a proton.

2. Applied research

Applied research is a type of research applied to find out practical solution for immediate problems faced by the society. This type uses methods such as experiments, to collect supplementary data in the area of research. Discoveries are applicable and usually applied upon completion of a study. It is a type of research method for applying natural sciences to real life to make human life enjoyable (Basic Research Vs. Applied Research: What's the Difference? 2021). Example, applied physics is the study of physics for a practical purpose, such as the development of electronics for advanced devices useful for society.

3. Descriptive research

This type of research includes surveys and fact-finding investigations of different kinds. In this research researcher has no control over the variables, he has only to report the findings. It does not answer questions about "how," "when," and "why". It addresses the question "what". For example, the periodic table categorizes the elements. Scientists use knowledge about the nature of electrons, protons, and neutrons to devise this categorical scheme. Over time the periodic table is a description of the elements allowed scientists to explain chemical reaction and make sound prediction when elements were combined. Hence, descriptive research cannot describe what caused a situation (Wikipedia contributors, 2023).

4. Analytical research

In this type of research, researcher uses information which is already existing and analyze it to make a critical evaluation of the material (Bhome *et al.,* 2013). Analytical research tells us why something is true. You need critical thinking skills and careful assessment of the facts. It gives new ideas about your data. Thus, it helps prove or disprove hypotheses. Analytical research answer "how" and "why" questions. For example, what makes hand hygiene so essential in hospitals?

5. Quantitative research

Quantitative research implies measurement of quantity or amount. Statistics is mostly used in quantitative research. At first data is collected based on hypothesis. This type of research includes the employment and investigation, analysis of numerical data using specific statistical methods to answer questions like "who," "how much," "what," "where," "when," "how many," and "how." (Apuke, 2017). For example, a teacher wants to know, why some students perform better than other students in Physics test. The teacher may consider two variables, test marks and revision time.

6. Qualitative research

This type of research does not use numerical data. It is concerned with qualitative phenomenon involving quality that cannot be quantified. It intends to understand a complex reality and the meaning of actions in the context (Queirós *et al.,* 2017). Qualitative research applies reasoning. It is used to understand meaning of numbers obtained by quantitative research. It investigates why and how of the decision making. For example, we want to weigh a block, we need not worry about weighing pattern. We will just have to weigh that block.

7. Conceptual research

Conceptual research is conducted based on already present information and observation on topic of research. This type of research can be used in developing theories by abstract concepts and ideas. It does not include any practical experiments. Thinkers have long used conceptual research to develop new theories or interpret existing theories in a different light. In this research, we have to choose the topic, gather appropriate literature, find specific variables, make the outline (Pawar, 2020). For example, Sir Issac Newton observed his surroundings to conceptualize and develop theories about gravitation and motion.

8. Empirical research

Empirical research is research that is based on observation and measurement of phenomena, as directly experienced by the researcher. This type of research depends on experience and observations alone rather than theory or ideas. It is databased research. In this type of research, the researcher should first know the hypothesis to get probable results then he has to collect necessary data to verify or contradict his hypothesis. It is important to plan the steps to conduct the experiment and how to analyze it. This will enable the researcher to resolve complications which can occur during the experiment. Information gathered through empirical research is considered most powerful support for a given hypothesis (Bist, 2014). For example, listening to melodious songs improves mood of the person. The researcher needs to conduct experiment in this regard.

Conclusion:

Various researchers explored different types of research types while performing their research. Research is used for quest of knowledge and truth. Fundamental research is carried out to discover new things. Applied research provides practical solution for instant problems. Descriptive research employs investigative methods. In analytical research analyzes information which is already available. Quantitative research related to quantity or amount. Qualitative research is concerned with quality that cannot be enumerated. Conceptual research is conducted on already present information and observation. In empirical research results are based on real life experience.

References:

1. Kothari, C. R., & Garg, G. (2014). Research methodology methods and techniques (3rd ed.). New Delhi: New Age International (P) Ltd.
2. Neelam Pawar. (2020). Type of Research and Type Research Design. KD publications: Pune.
3. https://www.indeed.com/career-advice/career-development/basic-research-vs-applied-research
4. https://en.wikipedia.org/wiki/Descriptive_research
5. Shraddha Bhome, Nishikant Jha, Vinod Chandwani, Seethalakshmi Iyer, Swati Desai, Archana Prabhudesai, and Suryakant D. Koshti. (2013). Research methodology. Himalaya Publishing House, p. 1-140.
6. Oberiri Destiny Apuke. (2017). Quantitative research methods a synopsis approach, Arabian Journal of Business and Management Review (Kuwait Chapter), Vol. 6 (10), 40-47.
7. André Queirós, Daniel Faria, Fernando Almeida, (2017). Strengths and limitations of qualitative and quantitative research methods, European Journal of Education Studies, Volume 3, Issue 9, 369-387.
8. Resham Bahadur Bist. (2014). Research Procedure: An Introduction, Journal of NELTA Surkhet, Vol. 4, 34-40

LANDSCAPE OF PERSIMMON FRUIT ON ANTI-OXIDANT ACTIVITY

Anamika P. K.*[1], Britika Pal[2], Shanthini Nachiyar[3] and Keerthana Devi M[4]

[1]Faculty of Pharmacy, Sri Balaji Medical College and Hospital campus,
Bharath Institute of Higher education and Research, Chennai

[2]College of Pharmaceutical Sciences, Dayanada Sagar University, Bangalore

[3]School of Pharmacy, Sathyabama Institute of Science and Technology, Chennai

[4]Department of Pharmaceutics, Apollo College of Pharmacy, Chennai

*Corresponding author E-mail: anamikapk2191@gmail.com

Abstract:

Persimmon belongs to the Ebanaceae family, and is widely consumed in Asia but it was only some years ago when it was introduced to the occident. As a consequence, persimmon has showed some interesting properties that could make it a very promising component of every diet. Persimmon has higher anti-oxidant activity as well as high level of bioactive compounds (like polyphenols, carotenoids, etc.)[1].

The anti-oxidant activity of persimmon fruit appears to be mainly due to its high-molecular-weight tannin content. Antioxidant activity is variety specific with some astringent varieties showing very high antioxidant activity, comparable to strawberry and blueberry. In vitro, and limited animal studies, have shown that condensed tannins in the fruit may reduce the risk of cardiovascular disease, hypertension, diabetes and a wide range of cancers. Persimmon has an unusual property in that it appears to alter and reduce the rate of alcohol absorption and metabolism and thus ameliorate the symptoms of a hangover. The health and medicinal benefits of persimmon are considerable and should be further researched and promoted by persimmon industries around the world.[2]

The phytochemical composition of persimmon peel (PP), a waste by product of dried persimmon, and its possible antidiabetic influence in streptozotocin-induced diabetic rats were examined. Dietary fibre was found to be the major component of PP, with a high content of 40.35% (w/w). PP also contains high levels of antioxidants including total carotenoids, vitamin C, and total phenolic. Dietary PP also restored the reduced plasma high-density lipoprotein (HDL) -cholesterol levels in diabetic rats. Although regression of the hypertrophies of liver and kidney was not observed in diabetic rats, dietary PP showed the partial or complete restoration of plasma aspartate amino transferase (AST), and creatinine levels, which serve as indicators of liver and renal dysfunctions, respectively. Therefore, PP containing high levels of dietary fibre and antioxidants with antidiabetic properties represents a potential dietary supplement for improving hyperglycemia and diabetic complications.[3]

Keywords: Persimmon, Dietary, Hyperglycemia

Rationale of the study:

Persimmon fruit are used as antioxidant, antioxidants are potent Anti-cancer agents. Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020, or nearly one in six deaths. The most common cancers are breast, lung, colon and rectum and prostate cancers. I have done this study to prioritize the anti-cancer property of Persimmon fruit which can be used for future studies.

Objectives:

The aim of the above study is to recognize the anti-oxidant property of the persimmon fruit which belongs to Ebanaceae family. Persimmon fruit also contains bioactive compound like polyphenols (regulates cell proliferation) which can also be used as anticancer agents. Here the study aimed at prioritizing the anti- neoplastic activity of Persimmon fruit which is less used currently. It also aims at ranking the use of Persimmon fruit as a potent cancer drug in the upcoming future.

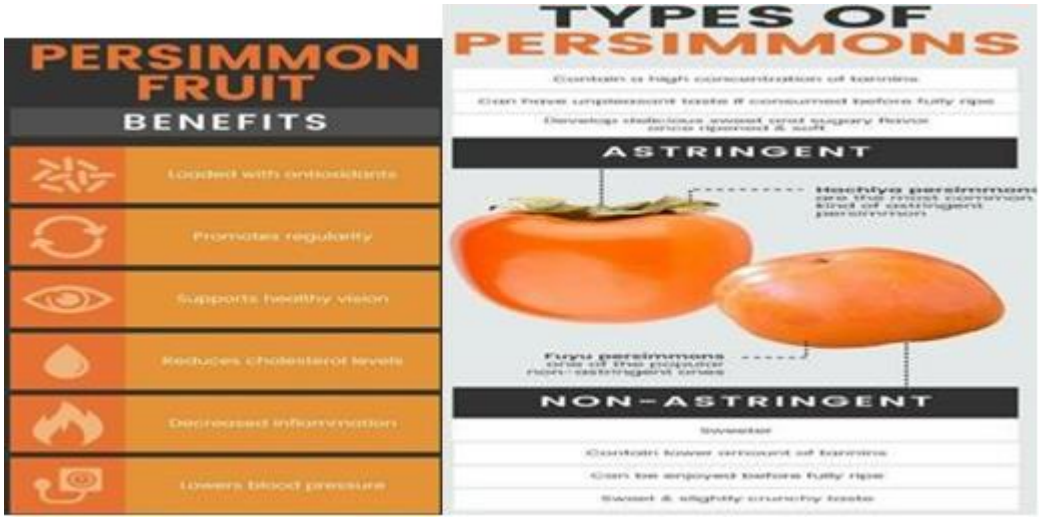
Methodology:

The content of the total antioxidant activity and phenolic compounds from the fruits of the American persimmon (*Diospyros virginiana* L.) of six genotypes were compared. Antioxidant activity (AOA) was measured using three different photometric methods – DPPH (2, 2diphenyl-1-picrylhydrazyl), ABTS (2, 2-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid) and FRAP (ferric-reducing antioxidant power). Total phenolic content (TPC) was evaluated using Folin-Ciocalteu reagent assay.

Results and Discussion:

The phytochemical composition of persimmon peel (PP), a waste by product of dried persimmon, and its possible antidiabetic influence in streptozotocin-induced diabetic rats were examined. Dietary fibre was found to be the major component of PP, with a high content of 40.35% (w/w). PP also contains high levels of antioxidants including total carotenoids, vitamin C, and total phenolic. Dietary PP also restored the reduced plasma high-density lipoprotein (HDL)-cholesterol levels in diabetic rats. Although regression of the hypertrophies of liver and kidney was not observed in diabetic rats, dietary PP showed the partial or complete restoration of plasma aspartate amino transferase (AST), and creatinine levels, which serve as indicators of liver and renal dysfunctions, respectively.

Therefore, PP containing high levels of dietary fibre and antioxidants with antidiabetic properties represents a potential dietary supplement for improving hyperglycemia and diabetic complications.



Conclusion:

The results showed that all fruit extracts exhibited strong antioxidant activities, which generally correlated positively with the total phenolic content. This study demonstrates the potential of the fruits of Diospyros virginiana L grown in Ukraine as a possible source of valuable polyphenol content, with high anti- oxidant activities and health-promoting properties. The high contents of phenolic compounds and significant linear correlation between the values of the concentration of phenolic compounds and antioxidant activity indicated that these compounds contributed to the strong antioxidant activity.

Other activities of persimmon fruit:

In vitro digestion studies of persimmon fruit include the study of gastrointestinal behavior of food in which food digestibility determination is conducted using the concepts like bioavailability, bio accessibility, and bioactivity of food components. Bioavailability involves the ingested fraction of a bio component that reaches the systemic circulation which is distributed to organs and tissues, is determined using in vivo studies. Bio accessibility is determined using in-vitro studies here, the ingested fraction of a bio component that becomes accessible for absorption through the epithelial layer of the gastrointestinal tract. The bioactivity represents the ability of a compound to manifest a biological effect.

In vivo studies of persimmon fruit include the complexity of organisms. The digestion studies included here are evaluating the beneficial effects on lipid metabolism, the regulation of glucose levels, and carcinogenic and anti-inflammatory effects.

The carotenoid and carotenoid ester profile in astringent persimmon (Diospyros kaki Thunb.,var. Rojo Brillante) was composed by 13 free xanthophylls, 8 hydrocarbon carotenes and 17carotenoid esters.

References:

1. Grygorieva O, Kucharska AZ, Klymenko S, Vergun O, Brindza J. Antioxidant activities and phenolic compounds in fruits of various genotypes of American persimmon (Diospyros virginiana L.). Acta Scientiarum Polonorum Technologia Alimentaria. 2018 Jun 30;17(2):117-24.
2. M. González C, Hernando I, Moraga G. In Vitro and In Vivo Digestion of Persimmon and Derived Products: A Review. Foods [Internet]. 2021 Dec 11;10(12):3083.
3. Cano MP, Gómez-Maqueo A, Fernández-López R, Welti-Chanes J, García-Cayuela T. Impact of high hydrostatic pressure and thermal treatment on the stability and bioaccessibility of carotenoid and carotenoid esters in astringent persimmon (Diospyros kaki Thunb, var. Rojo Brillante). Food Research International. 2019 Sep 1;123:538-49.

UTILIZING DATA ANALYTICS TO UNDERSTAND THE NUTRITIONAL AND MEDICINAL PROPERTIES OF *MORINGA OLEIFERA*

K. Thiyagarajan*[1], T. Parkavi[1], U. Gomathi[1] and R. Kavitha[2]

[1]Department Computer Science,

Periyar Maniammai Institute of Science & Technology, Vallam, Thanjavur

[2]Department Computer Applications,

Bharath College of Science & Management, Thanjavur-5

*Corresponding author E-mail: profktr@gmail.com

Abstract:

The *Moringa oleifera* plant, also known as drumstick plant, is a fast-growing tree known for its nutritional, medicinal, and economic benefits. It is grown widely in tropical and subtropical regions of the world. This paper focuses on the use of data analytics to study the medicinal properties of different parts of the Moringa tree and its major growing areas. The study involved the collection of samples from four districts in Tamil Nadu, India, throughout the year. Cluster analysis was used to group the samples based on their chemical composition, and the results were analyzed to identify the major compounds responsible for the medicinal properties of the plant. The study found that different parts of the tree, such as leaves, pods, seeds, and flowers, have different chemical compositions and therefore different medicinal properties. The study also found that the soil type, weather condition, and irrigation method used in different growing areas affect the chemical composition of the plant. The findings of this study can be used to guide the cultivation and harvesting of Moringa trees for optimal medicinal and economic benefits. The study demonstrates the potential of data analytics in agriculture and the use of cluster analysis to analyze large datasets of plant samples

Keywords: *Moringa oleifera*, Moringa tree, Drumstick trees agriculture, Data Analytics, Cluster Analysis, medicinal properties

Introduction:

The drumstick plant, also known as Moringa tree, is a fast-growing tree native to the Indian subcontinent. The drumstick is a vegetable plant farmed for its nutrient-dense delicate pods, leaves, and blossoms. Drumstick trees are softwood trees endemic to India. The trees are cultivated in tropical and subtropical climates all over the world. With its numerous properties, the drumstick tree is known by several English common names, including Moringa, drumstick tree, benzoil tree, and horseradish tree. The tree is a perennial vegetable tree that grows quickly and is drought-resistant. It is grown widely for its nutritious and medicinal properties. The plant can grow up to 10 meters tall and has delicate, fern-like leaves. The drumstick tree is grown in tropical and subtropical regions and can tolerate a wide range of soil conditions.

Key features of the drumstick plant

Nutritional Benefits: The drumstick plant is a rich source of vitamins, minerals, and amino acids. The leaves are high in vitamin C, vitamin A, and calcium, while the pods are a good source of dietary fiber, potassium, and vitamin B6.

Medicinal Properties: The drumstick plant has been used in traditional medicine for centuries to treat a wide range of ailments, including arthritis, digestive disorders, respiratory infections, and skin problems. Modern research has also found evidence of its potential in treating diabetes, hypertension, and cancer.

Culinary Uses: The tender leaves and pods of the drumstick plant are used in a variety of dishes in Indian cuisine. The leaves are often cooked with lentils or used to make soups and stews, while the pods are used in curries, pickles, and chutneys.

Easy to Grow: The drumstick plant is easy to grow and maintain. It can be propagated from seeds or cuttings and requires regular watering and fertilization. The plant can also be grown in containers and is suitable for small gardens.

The drumstick plant, also known as Moringa tree, is a fast-growing tree native to the Indian subcontinent. The drumstick is a vegetable plant farmed for its nutrient-dense delicate pods, leaves, and blossoms. Drumstick trees are softwood trees endemic to India. The trees are cultivated in tropical and subtropical climates all over the world. With its numerous properties, the drumstick tree is known by several English common names, including Moringa, drumstick tree, benzoil tree, and horseradish tree. The tree is a perennial vegetable tree that grows quickly and is drought-resistant. It is grown widely for its nutritious and medicinal properties. The plant can grow up to 10 meters tall and has delicate, fern-like leaves. The drumstick tree is grown in tropical and subtropical regions and can tolerate a wide range of soil conditions.



Medicinal properties

The drumstick plant (*Moringa oleifera*) is known for its various medicinal properties, and almost all parts of the plant are used for various medicinal purposes. Here are some of the medicinal properties of different parts of the drumstick plant:

1. Leaves: The leaves of the drumstick plant are a rich source of vitamins, minerals, and antioxidants. They are known to have anti-inflammatory, antimicrobial, and anticancer properties. The leaves are used in traditional medicine to treat a variety of ailments, including diabetes, hypertension, arthritis, and digestive disorders.
2. Pods: The pods of the drumstick plant are rich in fiber, vitamins, and minerals. They are known to have anti-inflammatory, antimicrobial, and antioxidant properties. The pods are used in traditional medicine to treat various ailments, including respiratory disorders, liver disorders, and skin problems.
3. Seeds: The seeds of the drumstick plant are rich in proteins, vitamins, and minerals. They are known to have antifungal, antibacterial, and anti-inflammatory properties. The seeds are used in traditional medicine to treat various ailments, including asthma, hypertension, and diabetes.
4. Flowers: The flowers of the drumstick plant are rich in vitamins and minerals and have antioxidant and anti-inflammatory properties. The flowers are used in traditional medicine to treat various ailments, including respiratory disorders, digestive disorders, and skin problems.

The *Moringa oleifera* plant is a versatile medicinal plant, and its various parts are used to treat a wide range of ailments. However, it is important to note that while traditional medicine has long used drumstick plant parts for medicinal purposes, more scientific research is needed to fully understand their efficacy and potential side effects.

Economical values

The drumstick plant (*Moringa oleifera*) has various economical values due to its multiple uses. Here are some of the economical values of the drumstick plant:

1. Food: The drumstick plant is widely used as a food source, and almost all parts of the plant are edible. The leaves, flowers, pods, and seeds of the drumstick plant are used in various dishes and cuisines worldwide. The plant is especially popular in South Asia, Africa, and the Caribbean.
2. Medicine: The drumstick plant is widely used in traditional medicine to treat various ailments, including diabetes, hypertension, arthritis, and digestive disorders. The plant's leaves, pods, and seeds are rich in vitamins, minerals, and antioxidants, which makes them beneficial for human health.
3. Cosmetics: The drumstick plant is also used in cosmetics due to its antioxidant and anti-inflammatory properties. It is used in various skin and hair care products to promote healthy skin and hair.
4. Animal feed: The drumstick plant is used as a feed for livestock, and the leaves and pods are especially popular among poultry and cattle farmers. The plant's high protein and mineral content make it a nutritious feed source for animals.

5. Biofuel: The drumstick plant is also being explored as a source of biofuel due to its high oil content. The plant's seeds contain up to 40% oil, which can be used to produce biodiesel.

Finally, the drumstick plant has various economical values, and its multiple uses make it an important plant for food, medicine, cosmetics, animal feed, and biofuel industries.

Pros of growing *Moringa oleifera* plant

1. Easy to grow: The drumstick plant is relatively easy to grow and does not require much maintenance.
2. Nutritious: The plant is highly nutritious, and almost all parts of the plant are edible.
3. High-yielding: The drumstick plant is a high-yielding crop, and a single plant can produce a significant number of pods.
4. Multiple uses: The plant has multiple uses, including food, medicine, cosmetics, and biofuel.
5. Sustainable: The drumstick plant is a sustainable crop that can be grown using organic farming methods.

Cons of growing *Moringa oleifera* plant

1. Susceptible to pests and diseases: The drumstick plant is susceptible to various pests and diseases, including aphids, caterpillars, and powdery mildew.
2. Requires warm climate: The plant requires a warm and humid climate to grow, which can limit its cultivation in certain regions.
3. Short shelf life: The pods of the drumstick plant have a short shelf life and need to be consumed or processed quickly.
4. Labour-intensive harvesting: The harvesting of the pods is labour-intensive, as the pods are attached to long stems and need to be cut off by hand.
5. Limited market: The market for drumstick plant products is limited in some regions, which can make it challenging for farmers to sell their crops.

The *Moringa oleifera* plant has several advantages as a crop, but it also has some drawbacks that farmers need to consider when deciding whether to grow it.

Environmental requirements

1. Soil requirements: The drumstick plant prefers well-drained soil that is slightly acidic with a pH range of 6.0 to 7.0. It also requires soil that is rich in organic matter.
2. Climate requirements: The drumstick plant requires a warm and humid climate to grow. It can tolerate temperatures up to 48°C, but temperatures below 10°C can damage the plant.
3. Planting and spacing: The drumstick plant can be grown from seeds or cuttings. The seeds should be soaked in water overnight before planting. The spacing between the plants should be around 8-10 feet.

4. Irrigation: The drumstick plant requires regular irrigation, especially during the dry season. The plant should be watered at least once a week, and more frequently during hot weather.
5. Fertilizers: The drumstick plant requires regular fertilization to promote growth and increase yield. Organic fertilizers such as cow dung, compost, and vermicompost are ideal for the plant.
6. Harvesting: The pods of the drumstick plant are ready for harvest 6-8 months after planting. The pods should be harvested before they turn yellow and start to dry out. The pods can be harvested every 10-15 days, depending on the yield.
7. Uses: The drumstick plant is used in a variety of dishes in Indian and Southeast Asian cuisine. The leaves, flowers, seeds, and roots of the plant are also used for medicinal purposes. The plant is also used in the production of cosmetics and biofuel.

The drumstick plant is a versatile crop that has many uses and benefits. With proper care and maintenance, it can be a profitable crop for farmers and a valuable addition to any garden.

Methodology

Moringa tree, also known as the miracle tree, is a plant that has been used for medicinal purposes for centuries. Different parts of the tree, such as leaves, pods, seeds, flowers, and roots, are rich in various nutrients and compounds that provide numerous health benefits.

Data Collection

To study the Tree of Moringa (*Moringa oleifera*), samples were collected throughout the year from December 2020 to December 2021. The samples were collected during summer, autumn, winter, and spring seasons. Two stages of regrowth, young and mature with 40 and 80 days, were also considered. The collection was done from four different districts in Tamil Nadu state, India, namely Theni (9.9330° N, 77.4702° E), Dindigul (10.4747° N, 77.8367° E), Karur (10.8855° N, 78.1564° E), and Thoothukkudi (8.9063° N, 78.0195° E).

District	Soil Types	Weather Condition	Irrigation
Theni	Red sandy loam soil	summers and mild winters 22°C to 34°C	Drip Irrigation
Dindugal	Red loamy soil	hot and humid summers and mild winters 21°C to 36°C	Sprinkler Irrigation
karur	Sandy loam soil	hot and humid summers and mild winters 23°C to 36°C	Drip Irrigation
Thoothukudi	Red loamy soil	hot and humid summers and mild winters 26°C to 34°C	Subsurface Irrigation

District	2019-20	acres	Average Productivity	price/kg
Theni	5.45	3424	26.23	36-40
Dindugal	5.3	2645	20.26	32-38
karur	5.25	2070	15.89	31-42
Thoothukudi	5	1465	11.26	30-48

Medicinal properties of moringa tree

Moringa leaves:

Moringa leaves are one of the most nutritious parts of the tree, packed with a variety of vitamins and minerals. They contain high levels of vitamin C, calcium, iron, and antioxidants. Some of the medicinal properties of moringa leaves include:

Anti-inflammatory: Moringa leaves contain compounds that can reduce inflammation in the body, which may help alleviate conditions like arthritis and other inflammatory diseases.

Cholesterol-lowering: Studies have shown that moringa leaves can help lower cholesterol levels in the blood, reducing the risk of heart disease.

Anti-diabetic: Moringa leaves have been shown to help regulate blood sugar levels, making them a useful supplement for people with diabetes.

Immune-boosting: The high vitamin C content in moringa leaves can help boost the immune system and fight off infections.

Moringa Pods:

Moringa pods are another part of the tree that is packed with nutrients. They are a good source of vitamin C, vitamin A, calcium, and potassium.

Some of the medicinal properties of moringa pods include:

Digestive aid: Moringa pods contain high levels of fiber, which can help regulate digestion and prevent constipation.

Anti-inflammatory: Similar to moringa leaves, the pods also contain compounds that can reduce inflammation and alleviate conditions like arthritis.

Anti-bacterial: Moringa pods have been shown to have antibacterial properties, which may help prevent the growth of harmful bacteria in the body.

Moringa Seeds:

Moringa seeds are rich in amino acids, healthy fats, and antioxidants. Some of the medicinal properties of moringa seeds include:

Anti-inflammatory: Moringa seeds contain compounds that can reduce inflammation in the body.

Antioxidant: The seeds are rich in antioxidants, which can help protect the body against damage from free radicals.

Liver-protecting: Studies have shown that moringa seeds can help protect the liver from damage caused by toxins.

Moringa flowers:

Moringa flowers are a good source of vitamin C and antioxidants. Some of the medicinal properties of moringa flowers include:

Anti-inflammatory: Moringa flowers contain compounds that can reduce inflammation in the body.

Respiratory health: The flowers have been shown to have respiratory benefits, making them a useful supplement for people with respiratory conditions like asthma.

Moringa roots:

Moringa roots are also rich in nutrients and contain compounds that provide various health benefits. Some of the medicinal properties of moringa roots include:

Anti-inflammatory: Moringa roots contain compounds that can reduce inflammation in the body.

Digestive aid: The roots have been shown to have digestive benefits, helping to regulate digestion and prevent constipation.

Cardiovascular health: Studies have shown that moringa roots can help improve cardiovascular health by reducing cholesterol levels and regulating blood pressure.

This tree is a versatile plant with various medicinal properties that can provide numerous health benefits. However, it's important to note that while Moringa may offer many health benefits, it should not be used as a replacement for medical treatment or advice from a healthcare professional.

S.No	Disease	Medicinal Properties	Type of Nutrient Content
1	Diabetes	Lowers blood sugar levels	Vitamins B1, B2, B3, B6, C, calcium, potassium
2	Anemia	Increases hemoglobin levels	Iron, vitamins B2, B6, C
3	High blood pressure	Lowers blood pressure	Potassium, calcium
4	Inflammation	Reduces inflammation	Vitamins A, C, E, beta-carotene, quercetin, chlorogenic acid
5	Digestive issues	Aids digestion and relieves constipation	Fiber, calcium, magnesium
6	Malnutrition	Provides essential nutrients	Vitamins A, C, calcium, iron, protein

Data analytics

The collected samples were analyzed using various techniques to determine their chemical composition. Cluster analysis was performed to group the samples based on their

chemical composition. The results were then analyzed to identify the major compounds responsible for the medicinal properties of the plant.

Data analytics for medicinal properties

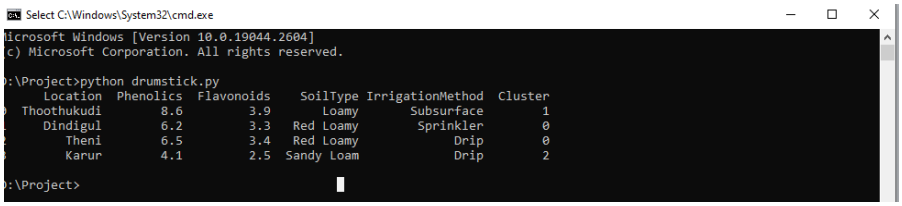
The analysis of medicinal properties data of Moringa tree can be carried out using Python programming language. Python offers several powerful libraries such as Pandas, NumPy, Matplotlib, and Scikit-learn that can be used for data analysis and machine learning tasks. The first step in the analysis process would be to collect the necessary data on the medicinal properties of different parts of the Moringa tree. This data can be obtained from various sources, such as research articles, scientific journals, and online databases. Once the data is collected, it can be cleaned and pre-processed using Python libraries such as Pandas and NumPy. This involves removing any missing or duplicate values, converting the data into a suitable format, and performing any necessary data transformations. After cleaning and pre-processing the data, various analysis techniques can be applied using Python libraries such as Matplotlib and Scikit-learn. For example, we can perform statistical analysis to identify any patterns or correlations between different medicinal properties of the Moringa tree. We can also use machine learning algorithms to build predictive models that can help us identify the most effective parts of the Moringa tree for treating different diseases. Python provides a powerful platform for analyzing the medicinal properties data of Moringa tree. With its rich set of libraries and tools, Python can help researchers and healthcare professionals better understand the potential health benefits of different parts of the Moringa tree.

List the common medicinal properties of different parts of the Moringa tree:

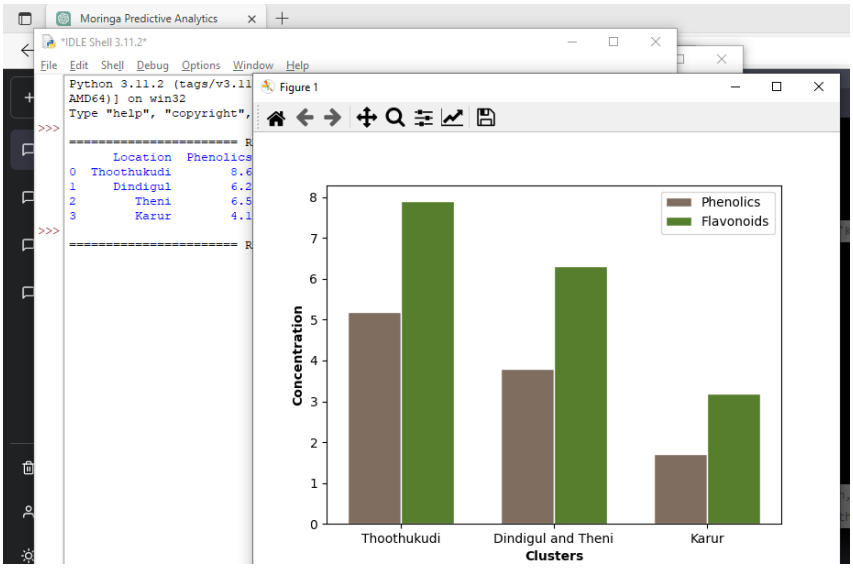
Part of Moringa Tree	Common Medicinal Properties	Common Nutrient Content
Leaves	Anti-inflammatory, cholesterol-lowering, anti-diabetic, immune-boosting	Vitamin C, calcium, iron, antioxidants
Pods	Digestive aid, anti-inflammatory, anti-bacterial	Vitamin C, vitamin A, calcium, potassium
Seeds	Anti-inflammatory, antioxidant, liver-protecting	Amino acids, healthy fats, antioxidants
Flowers	Anti-inflammatory, respiratory health	Vitamin C, antioxidants

Results:

The results of the cluster analysis showed that the samples could be grouped into three clusters based on their chemical composition. The first cluster included samples from Thoothukudi, which had the highest concentrations of phenolics and flavonoids. The second cluster included samples from Dindigul and Theni, which had similar chemical compositions. The third cluster included samples from Karur, which had the lowest concentrations of phenolics and flavonoids.



The analysis of the major compounds in the samples showed that the leaves of the Moringa tree had the highest concentrations of phenolics and flavonoids, followed by the flowers, seeds, and pods. The major compounds responsible for the medicinal properties of the plant were identified as quercetin, kaempferol, and rutin, which are all flavonoids.



The analysis also showed that the soil type, weather condition, and irrigation method used in different growing areas affected the chemical composition of the plant. The samples from Thoothukudi, which had the highest concentrations of phenolics and flavonoids, were grown in loamy soil and irrigated using subsurface irrigation. The samples from Dindigul and Theni, which had similar chemical compositions, were grown in red loamy soil and irrigated using sprinkler and drip irrigation, respectively. The samples from Karur, which had the lowest concentrations of phenolics and flavonoids, were grown in sandy loam soil and irrigated using drip irrigation.

Conclusion:

The study showed that different parts of the Moringa tree have different chemical compositions and therefore different medicinal properties. The study also showed that the soil type, weather condition, and irrigation method used in different growing areas affect the chemical composition of the plant. The findings of this study can be used to guide the cultivation and harvesting of Moringa trees for optimal medicinal and economic benefits. The study demonstrates the potential of data analytics in agriculture and the use of cluster analysis to analyze large datasets of plant samples. Further research can be conducted to study the effects of different growing conditions on the chemical composition and medicinal properties of the Moringa tree.

References:

1. Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. (2007). *Moringa oleifera*: a food plant with multiple medicinal uses. Phytotherapy Research, 21(1), 17-25.
2. Arun Kumar and Rashmi Chandra (2018). "A review of the therapeutic effects of *Moringa oleifera* on various diseases" Journal of Acute Disease, 2018.
3. Ayoola J. T., A. A. Makinde, and A. A. Adeyeye (2016). "*Moringa oleifera*: A review on nutritive importance and its medicinal application."Food Review International, 2016. https://doi.org/10.1080/87559129.2015.1055229
4. Fahey, J. W. (2005). *Moringa oleifera*: A review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part 1. Trees for Life Journal, 1(5), 1-15.
5. Karim S. S., M. A. Rahman, and M. A. Karim(2016). "*Moringa oleifera*: A natural gift - A review." International Journal of Pharmaceutical Sciences and Research, 2019. https://doi.org/10.26452/ijrps.v10i4.1765
6. Kumari, D., & Reddy, K. R. (2016). Drumstick tree (*Moringa oleifera* Lam.): A review of nutritional value and medicinal properties. Journal of Food Science and Technology, 53(2), 732-742.
7. Nighat Yasmin and Faiza Saleem (2021). "*Moringa oleifera*: A review on nutritive importance and its medicinal application" Food Science and Human Wellness, 2021.
8. Siddhuraju F. A. and K. Becker (2013). "*Moringa oleifera*: A review of the medical potential." Acta Horticulturae, 2013. https://doi.org/10.17660/ActaHortic.2013.975.21

PROTECTIVE EFFECT OF BETULINIC ACID AND FLUVASTATIN ON EXPERIMENTAL ARTHRITIS- AN INVIVO APPROACH

Limi Elizabeth Mathew and A Helen*

Department of Biochemistry, University of Kerala, Kariavattom Campus,

Thiruvananthapuram 695581. Kerala, India

*Corresponding author E-mail: helenabiochem@gmail.com

Abstract:

Betulinic acid (BA) is the naturally occurring triterpenoid widely distributed throughout in the plant kingdom and have anti-inflammatory effect. The enzyme HMG CoA reductase inhibitor Fluvastatin, comes under the class of statins, is a water-soluble cholesterol lowering agent. Rheumatoid arthritis (RA) is linked with the increased incidence of cardiovascular risk, but even though considerable advances in disease management, mortality remains high. Cells and cytokines involved in RA pathogenesis may also contribute to the disease condition in atherosclerosis. The activities of phospholipase A_2 and Prostaglandin E_2 was significantly reduced in the treatment group co-administered with betulinic acid and fluvastatin. Expression of CYP3A4 was decreased in drugs alone and in combination therapy when compared to the arthritic rats, shows that the drugs are well metabolized. Combination therapy significantly blocked the expression of matrix metalloproteinases MMP-2, MMP-9 and the pro-inflammatory cytokine TNF-α in the cartilage. The molecular mechanism through which the betulinic acid and fluvastatin mediates this effect was evaluated by studying TLR signaling pathway. It was found that the levels of both TLR-2 and TLR-4 were significantly increased in the cartilage of collagen induced rats. The co-administration of BA and FLU in arthritic rats exhibited a significantly decreased expressions of TLR-2 and TLR-4 than the drugs given individually when compared with collagen induced rats. This study provides a novel therapeutic approach into the molecular mechanism for the anti-arthritic effect of betulinic acid and fluvastatin in collagen induced arthritis.

Keywords: Betulinic acid, fluvastatin, arthritis, cytokines, ADMET, MD2 receptor

Introduction:

Triterpenoids are ubiquitous in the plant kingdom possess many beneficial effects of against numerous types of human diseases including different cancers. Biologically active triterpenoids with their cardioprotective and anti-inflammatory effects are studied earlier (Setzer *et al.,* 2000). There are three main triterpene families: oleane, ursane, and lupane triterpenes. The oleane family consists of are oleanolic acid, erythrodiol and β-amyrin; in the ursane family comprises ursolic acid and uvaol and in the lupane family are lupeol, betulin and betulinic acid. Betulinic acid, (3β-hydroxy-lup-20(29)-en-28-oic acid) (fig.1.9.) is a naturally occurring pentacyclic triterpenoid properties widely distributed throughout plant kingdom – *Bacopa monniera* (L.), *Ziziphus mauritiana*, *Triphyophyllum peltatum* and *Ancistrocladus heyneanus* etc, which exhibits a variety of biological and

medicinal properties such as anti-cancer (Ren *et al.,* 2010), anti-malarial (Santos *et al.,* 2009), anti-retroviral and anti-inflammatory properties (Viji *et al.,* 2011). Betulinic acid protects the neuronal damage in new born rats from isoflurane-induced apoptosis in the developing brain by blocking FASL-FAS signaling pathway (Wang *et al.,* 2017). Betulinic acid is a PPARγ antagonist that improves glucose uptake, promotes osteogenesis and inhibits adipogenesis (Brusotti *et al.,* 2017).

Fluvastatin a statin drug, used to treat hypercholesterolemia through the inhibition of 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase. Fluvastatin sodium is [R*,S*-(E)]-(±)-7-[3-(4-fluorophenyl)-1-(1-methylethyl)-1H-indol-2-yl]-3,5-dihydroxy-6-heptenoic acid, monosodium salt. The empirical formula of fluvastatin sodium is $C_{24}H_{25}FNO_4$•Na, its molecular weight is 433.46 and its structural formula is given in fig. 1.10. Fluvastatin (FLU) is a white to pale yellow, hygroscopic powder soluble in water, ethanol and methanol. LESCOL is taken as tablets inclosing fluvastatin sodium, 20 mg or 40 mg of fluvastatin, orally. LESCOL XL is supplied as tablets containing fluvastatin sodium, equivalent to 80 mg of fluvastatin, for oral administration. Studies in rats demonstrated the potent vascular protective effects in adjuvant induced arthritis (Yoshisuke *et al.,* 2007; Limi *et al.,* 2013) and provide additional scientific rationale for the use of statins to reduce cardiovascular mortality in patients with rheumatoid arthritis. It also upregulates the calcium channel expression in vascular smooth muscle cells via RhoA and ERK/p38 MAPK pathways (Ouyang *et al.,* 2014). Combined effect of telmisartan and fluvastatin was also studied recently on arachidonic acid metabolism in human liver microsomes (Kato *et al.,* 2017).

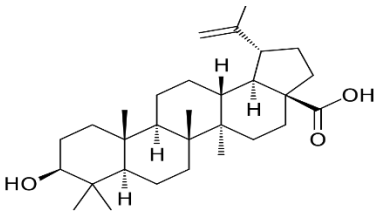


Fig. 1.11. Structure of Betulinic acid - Formula: C30H48O3, Molar mass: 456.7 g/mol, adapted from the wikipedia

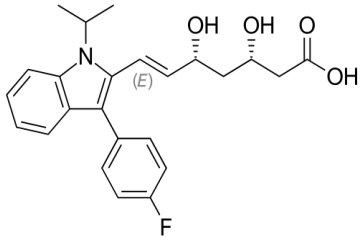


Fig. 1.12. Structure of Fluvastatin: Structural formula C24H25FNO4.Na with a molecular weight of 433.46, adapted from the wikipedia

Synovial tissues of patients with rheumatoid arthritis (RA) have increased expression of COX-2. Cytokines play a key role as therapeutic targets in RA and other inflammatory diseases (Stefan *et al.,* 2015). Upregulated expression of COX-2 in synovial tissues is mediated by the pro-inflammatory cytokines IL-1 and TNF-α (Fattahi *et al.,* 2012; Wojdasiewicz *et al.,* 2014). The pro-inflammatory cytokines TNF-α, IL-1 and IL-6 are shown to play an important role in the pathophysiology of arthritis development in humans and animal models (McInnes *et al.,* 2007). The effects of these cytokines in arthritic joints appear to be multiple which include the expression of adhesion and chemoattractant molecules that facilitates leukocyte influx and activation (Cannnetti *et al.,* 2003). TNF-α is

produced by activated macrophages/monocytes, fibroblasts, mast cells and T cells stimulates the production PGE2 by synovial cells and thus causes joint damage in inflammatory conditions such as rheumatoid arthritis (Brennan *et al.,* 2008). Datas from clinical trial and experimental study revealed that two key pro-inflammatory cytokines IL-1 and TNFα play a characteristic role in the pathogenesis of human RA and collagen induced arthritis (Erik *et al.,* 2013).

Matrix metalloproteinases (MMPs) are the key enzymes responsible for the degradation of collagen and other proteins in the extracellular matrix (ECM) (Jablonska *et al.,* 2016). MMP-2 and MMP-9 expressed by synoviocytes and play an important role in RA progression (Meng *et al.,* 2014). Report by Sandhya *et al.,* 2009 demonstrated that the expression of MMP-2, MMP-3 and MMP-9 in the synovial effusate of type II collagen induced arthritic animals can cause degradation of articular cartilage extracellular matrix. Also findings, including recent studies suggest that serum matrix metalloproteinase-3 is associated with disease activity and joint destruction in rheumatoid arthritis patients (Samia *et al.,* 2016). The previous studies in our laboratory revealed that the inflammation induced by Type II collagen injection was alleviated by BA isolated from *bacopa monniera* (Viji *et al.,* 2010) and fluvastatin proved to possess anti-inflammatory and antioxidant effect in experimental animals (Limi *et al.,* 2013) in addition to the cholesterol lowering effect. But the combination effect of betulinic acid is not elucidated so far. So the next aim is to investigate how both these compounds reduce or decrease the intensity or progression of arthritis in the joint cartilage of collagen induced rats. The aim of the study is to evaluate the protective effect of betulinic acid and fluvastatin on collagen induced arthritis.

Materials and Methods:

Animals

Female albino rats (Sprague-Dawley strain) of body weight 150-200g which were breed and reared in the department animal house were used for this study. They were provided Laboratory chow (Hindustan Lever Lab diet) and water *ad libitum* throughout the experimental period. The rats were housed in polypropylene cages in a room with temperature maintained at 26 $\pm 1^0$C and a 12 hr light and dark cycle. All experimental protocols were approved by the institutional animal ethics committee [IAEC- KU- 16/2013-14- BC- AH (25)].

Reagents and drugs

The biochemicals used in this study were purchased from Sigma- Aldrich Chemicals, Merck, Eppendorf India Ltd and Spectro Chem. Pvt. Ltd. India and the solvents of analytical grade were from SRL chemicals, Mumbai, India. The compounds betulinic acid and fluvastatin were purchased from Sigma-Aldrich and Novartis Pharma (Basel, Switzerland) respectively. The chemicals used for molecular biology works such as ethidium bromide, TRI reagent, RNA isolation kit, monoclonal and polyclonal primary antibodies, secondary antibodies and other biochemicals from Sigma chemicals Co, USA and Cell Signaling Technology. 96 well ELISA plates were obtained from NUNC (Denmark). PCR kit and Revert first stand cDNA synthesis kit were purchased from fermentas. The primer sequences were

custom synthesized from NCBI nucleotide database and were supplied by Biogene, New Delhi, India. RT-PCR kit was purchased from Eppendorf India Ltd, Chennai.

Experimental procedure

Type II Collagen induced arthritis

Rheumatoid arthritis was induced by type II collagen (CII) from bovine nasal septum which was dissolved in 0.1 M acetic acid at a concentration of 4 mg/ml and emulsified in equal volume of incomplete Freund's adjuvant. Each rat was given intradermal injections of 100 µl in divided doses at the base of the tail in two sites on day 0 and then received booster injection on day 7. Paw edema was peaked on day 14. Normal non-immune rats were used as negative control. Betulinic acid and Fluvastatin were dissolved in 1% normal saline and fed orally. The dose of Betulinic acid and fluvastatin were chosen as 2mg and 5mg /kg body weight as per the following reference [15,17] respectively. Duration of the experiment was 60 days. Rats were then sacrificed after overnight fasting by euthanasia. At the end of 60 days, the tissues and blood were isolated for evaluation of biochemical parameters.

Rats were divided into 5 groups each consists of 6 rats:

Group I- Normal rats

Group II- Collagen induced arthritic rats (CIA)

Group III- Rats were given collagen + BA (2mg/ kg body weight)

Group IV- Rats were given collagen + FLU (5mg/ kg body weight)

Group V- Rats were given collagen + BA (1mg/ kg body weight) + FLU (2.5mg/ kg body weight).

Biochemical Estimations

Malondialdehyde (MDA) was estimated by the method of Ohkawa [19]. Catalase enzyme was assayed by the method of Machely and Chance [20]. Superoxide dismutase enzyme (SOD) activity was determined by the method described by Kakkar *et al* [21]. The activity of glutathione peroxidase (GPx) was determined by the method by Agerguard and Jense [22]. Glutathione content was estimated by the method of Benke *et al* [23]. Protein was estimated by Lowry et al method [24]. Activity of SGOT was estimated by the method of Reitman and Frankel, 1957**.** Activity of SGOT was estimated by the method of Reitman and Frankel, 1957. LDH enzyme activity was determined by the method described by Bergmeyer and Bernt, 1974.

Enzyme Linked Immunosorbant Assay (ELISA)

The tissue was lysed in a buffer containing 50mM Tris pH 8.0, 150mM NaCl, 1% Triton X 100, 1mM Na_3VO_4, 2.5mM sodium pyrophosphate, 1mM NaF, 1mM DTT, 1mM PMSF, 1µg/ mL leupeptin. Multiwell ELISA plates coated with the lysates served as the antigen and incubated for 24 hours at 37^0C. Washed the wells with the blocking buffer containing 0.2% gelatin in PBS (0.025M, pH 7.4, 0.15M NaCl) and 0.05% Tween 20. The primary antibodies were diluted in PBS Tween in the ratio of 1:500, were added to the wells (100µL) and incubated for 1h at room temperature. After washing with PBS-Tween 20, the wells were treated with HRP conjugated anti rabbit IgG that served as the

secondary antibody (100µL) for 1h at room temperature. This was followed by washing with PBS-Tween 20 and PBS. Then the wells were treated with the substrate solution (0.5mL of O-dianisidine 10mg/mL methanol + 60mL of 0.1M citrate –phosphate buffer pH5.0 + 12µL of 30% H_2O_2) and incubated for 30 minutes. The reaction was stopped by the addition of 100µL 5N HCl. The optical densities of the samples were determined using microplate (Thermo Multiskan Spectrum) reader set at 405 nm.

RNA Preparation and Reverse Transcriptase Polymerase Chain Reaction (RT-PCR)

RNA was isolated by homogenizing 100mg tissue in 1mL TRI reagent (Sigma Aldrich). After homogenization, centrifuge it at 12000g for 10 min at 2-8^{0}C and stand for 5 min. Added 0.2mL chloroform, covered the sample tightly and shaken vigorously for 15 seconds and allowed to stand for 2- 15 seconds at room temperature. Centrifuged at 12000g for 15 min at 2-8^{0}C. A colourless aqueous phase containing RNA was obtained. Transferred the aqueous phase to a fresh tube and added 0.5mL isopropanol, allowed to stand at 5- 10 min at room temperature. Centrifuged at 12000g for 10 min at 2-8^{0}C, RNA will be precipitated at the bottom and sides of the tube. Removed the supernatant and washed the RNA pellet by adding 1mL 75% ethanol. Vortexed the sample and then centrifuged at 75000g for 5 min at 2- 8^{0}C. Air dried the RNA pellet for 5- 10 min. Added appropriate volume of water to the RNA pellet and facilitated dissolution at 55-60^{0}C for 15 min.

Primers	**Gene sequences**
TLR - 2	Forward 5'-TCTCTGTCATGTGATGCTGCTGGT- 3' Reverse 5'-TCCAAGTGTTCAAGACTGCCCAGA- 3''
TLR - 4	Forward 5'-AGTGTATCGGTGGTCAGTGTGCTT- 3' Reverse 5'-ATGAAGATGATGCCAGAGCGGCTA- 3''
IL-1β	Forward 5′-AACCTGCTGGTGTGTGACGTTC-3′ Reverse 5′-CAGCACGAGGCTTCTTTGTTGT-3′
IL-6	Forward 5'-CCACTGCCTTCCCTACTTCA3' Reverse 5'-TGGTCCTTAGCCACTCCTTC3'
TNF-α	Forward 5'-GTCGTAAACCACCAAGC-3′ Reverse 5'-GACTCCAAAGTAGACCTGCCC-3′
CYP3A4	Forward 5′-TTCAGCAAGAAGAACAAGGACAA-3′ Reverse 5′GGTTGAAGAAGTCCTCCTAAGC-3′
GAPDH	Forward5′-GGAGTCAACGGATTTGGTCGTAT-3′ Reverse 5′AGGTCAGGTCCACCACTGAC-3′

cDNA synthesis was carried out in an Eppendorf mastercycler according to the manufacturer's instruction. The reaction mixture consisted of 5µg DNA as template, oligo dT primer, reaction buffer, RNase inhibitor, dNTPs and reverse transcriptase enzyme. Glyceraldehyde-3-phosphate dehydrogenase (GAPDH) served as the control. The mixture was gently centrifuged and incubated for 5 minutes at 25^{0}C followed by synthesis at 42^{0}C for 60 minutes. The reaction was terminated by heating at 70^{0}C for 5 minutes. The reverse transcription products were directly used for PCR. The reaction mixture for PCR contained

template DNA, PCR master mix and appropriate primers. The reaction mixture was programmed for PCR amplification as follows: incubated in an Eppendorf thermal cycler for an initial denaturation at 105°C for 1 min, template denaturation at 94°C for 30sec, primer annealing at 59°C for 30sec, and final extension at 72°C for 60sec, for a total of 30 cycles. The products of the PCR reactions were electrophoresed on 1.5% agarose gel and stained with ethidium bromide. The bands were quantified by densitometry in a Gel Documenter (BIO RAD) to determine the optical density of each band against an internal standard, GAPDH. The primer pairs for rat TLR – 2, TLR – 4, IL-1β, IL-6, TNF- α, COX-2, CYP3A4 and GAPDH were given above table.

Histopathological analysis of the synovium

The tissue was excised, fixed in 10% formalin, decalcified in 5% nitric acid and processed for paraffin embedding. Sections were cut at 3µm thickness, flattened and adhered to the slides. They were stained with hematoxylin-eosin and viewed under a light microscope for histopathological changes.

Statistical analysis

The results were analyzed using a statistical program SPSS/PC+, version 17.0 (SPSS Inc., Chicago, IL, USA). One-way ANOVA employed for comparison test of significant differences among groups was determined. Pair fed comparisons between the groups was made by Duncan's multiple range tests and $p< 0.05$ was considered significant.

Results:

Effect of BA and FLU on glutamic-oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT)

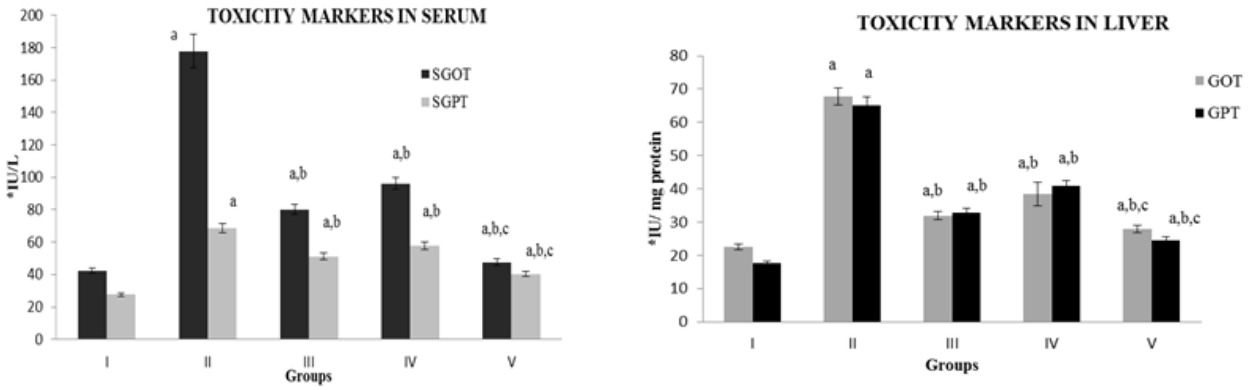


Fig 3.1. Toxicity markers in serum and liver: Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. CIA- collagen induced arthritis, BA- betulinic acid and FLU- fluvastatin. Values expressed as average of 6 values ± SEM in each group, a- Significant difference when group II compared with group I at $p<0.05$, b- Significant difference when group III, IV, V compared with groups II at $p<0.05$, c- Significant difference when group V compared with group III and IV at $p<0.05$. *Unit- pyruvate liberated/min/mg protein.

The toxicity markers GOT and GPT in serum and liver were significantly ($p<0.05$) increased in collagen induced rats when compared with normal rats. Treatment with BA and FLU, alone or in combination showed significant ($p<0.05$) reduction in toxicity markers.

Effect of BA and FLU on lactate dehydrogenase (LDH) in serum

LDH is released during tissue damage, injuries or certain pathologic diseases. The lactate dehydrogenase enzyme in the serum was significantly ($p<0.05$) increased in collagen induced rats when compared with normal rats. Betulinic acid and fluvastatin treatment alone or in combination showed significant ($p<0.05$) reduction in lactate dehydrogenase.

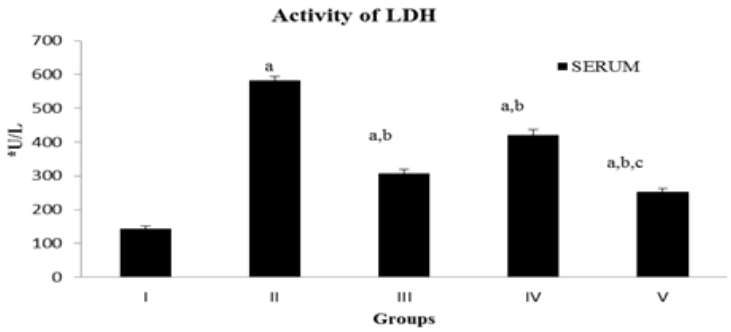


Fig.3.2. LDH enzyme activity in the serum: Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. CIA- collagen induced arthritis, BA- betulinic acid and FLU- fluvastatin. Values expressed as average of 6 values ± SEM in each group, a- Significant difference when group II compared with group I at $p<0.05$, b- Significant difference when group III, IV, V compared with groups II at $p<0.05$, c- Significant difference when group V compared with group III and IV at $p<0.05$. *Units defined as the amount of enzyme that catalyzes the conversion of 1 µmol of lactate per minute under specified conditions.

Expression of Cytochrome P450 3A4 (CYP3A4) in liver

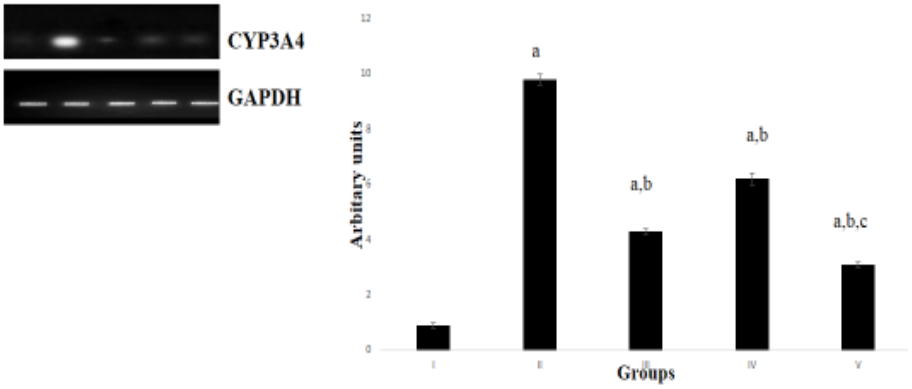


Fig. 3.3. CYP3A4 in the serum: Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. CIA- collagen induced arthritis, BA- betulinic acid and FLU- fluvastatin. Values expressed as average of 6 values ± SEM in each group, a- Significant difference when group II compared with group I at $p<0.05$, b- Significant difference when group III, IV, V compared with groups II at $p<0.05$, c- Significant difference when group V compared with group III and IV at $p<0.05$.

After 60days, the expression of CYP3A4 was analyzed in the liver. The expression of CYP3A4 in liver was significantly ($p<0.05$) increased in collagen induced rats when

compared with normal rats. Combination therapy with betulinic acid and fluvastatin showed a significant ($p<0.05$) reduction in the expression of CYP3A4.

Betulinic acid and fluvastatin mediated reduction of oxidative stress

The concentration of MDA was significantly ($p<0.05$) increased in collagen induced rats when compared with normal rats. Treatment with BA and FLU showed significant ($p<0.05$) decrease in MDA level indicates the reduced level of lipid peroxidation and oxidative stress than the drugs given alone. In the cartilage tissue, the activities of SOD, catalase and GPx were significantly ($p<0.05$) reduced in CIA when compared with normal rats. Combination of BA and FLU treatment significantly ($p<0.05$) increased the activities of these enzymes and restored the concentration of GSH rendering more protection against oxidative damage than the drugs given alone (Table 1).

Table 1: Antioxidant status of the cartilage tissue: Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. Values expressed as average of 6 values ± SEM in each group. a- Statistical difference with group I at P <0.05, b- Statistical difference with group II at P <0.05 and c- Statistical difference with group III and group IV at P <0.05. CAT Units* = velocity constant / second, SOD Units# = Enzyme concentration to inhibit chromogen production (OD 560nm) by 50% in 1 min, GPx Units$= 1µmol NADPH oxidized/min/mg protein.

Cartilage	Normal	CIA	CIA+ BA	CIA+FLU	CIA+BA+FLU
MDA (Mm/ g tissue)	0.97± .07	9.37± 0.89[a]	2± .19[a, b]	3.54 ±0.42[a,b]	1.75± 0.15[a,b,c]
GSH (mmol/ g wet tissue)	129.08± 12.3	30.34 ± 2.89[a]	99.2± 9.5[a,b]	78.6 ± 7.54[a,b]	107.43± 10.28[a,b,c]
CAT (Units*/ mg protein)	5.75± 0.54	1.21± 0.11[a]	3.48± 0.32[a,b]	2.56± 0.24[a,b]	4.83 ± 0.44[a,b,c]
SOD (Units#/ mg protein)	3.80± 0.36	0.77 ± 0.06[a]	2.73± 0.26[a,b]	2.18± 0.21[a,b]	3.02 ± 0.28[a,b,c]
GPx (Units$/ mg protein)	10.62± 1.02	1.65± 0.16[a]	5.12± 0.48[a,b]	3.2 ± 0.29[a,b]	7.6 0± 0.73[a,b,c]

Effect of Betulinic acid and fluvastatin on the release of inflammatory mediators

Since COX-2 is an enzyme responsible for inflammation, protein expression of COX-2 was estimated by ELISA. The expression of COX-2 in the synovium was significantly ($p<0.05$) increased in collagen induced rats when compared with normal rats. Supplementation of betulinic acid and fluvastatin showed significant ($p<0.05$) decrease in COX-2 than the drugs given alone.

Prostaglandin E_2 (PGE_2) is a principal mediator of inflammation in diseases such as rheumatoid arthritis. Arachidonic acid is transformed into PGE_2 via cyclooxygenase (COX) enzymes. The expression of PGE_2 was significantly ($p<0.05$) increased in CIA rats when compared with normal rats. Administration of BA and FLU showed significant ($p<0.05$) decrease in PGE_2 than the drugs given alone. $cPLA_2$ a calcium-dependent phospholipase A_2

that catalyzes the release of arachidonic acid from membrane phospholipids. The expression of cPLA$_2$ was significantly ($p<0.05$) increased in CIA rats when compared with normal rats. Supplementation of betulinic acid and fluvastatin showed significant ($p<0.05$) decrease in cPLA$_2$ than the drugs given alone.

Treatment with BA or FLU significantly decreased the expressions of COX-2, PGE2 and cPLA2 in the synovium thereby have a role in reducing inflammation in the treated group which is more prominent in the combination therapy (Fig. 3.5).

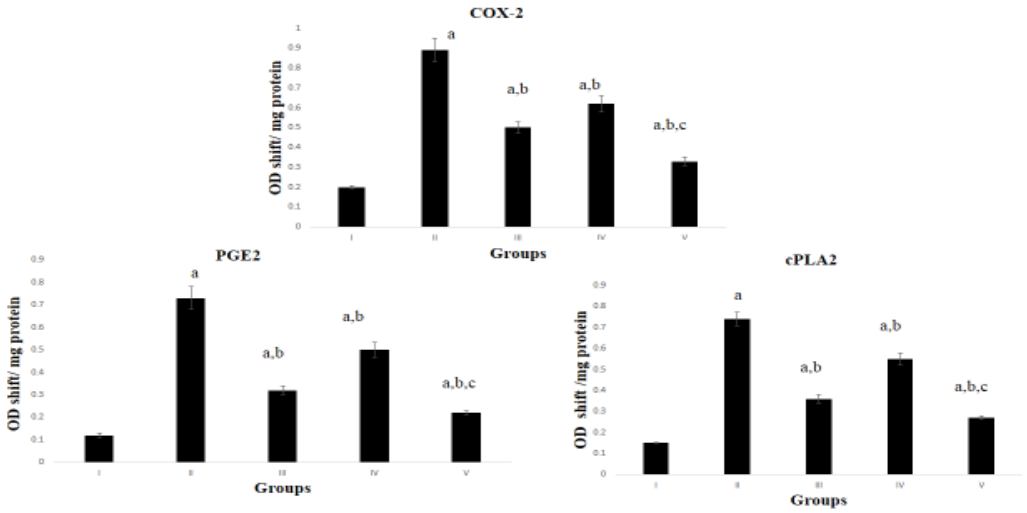
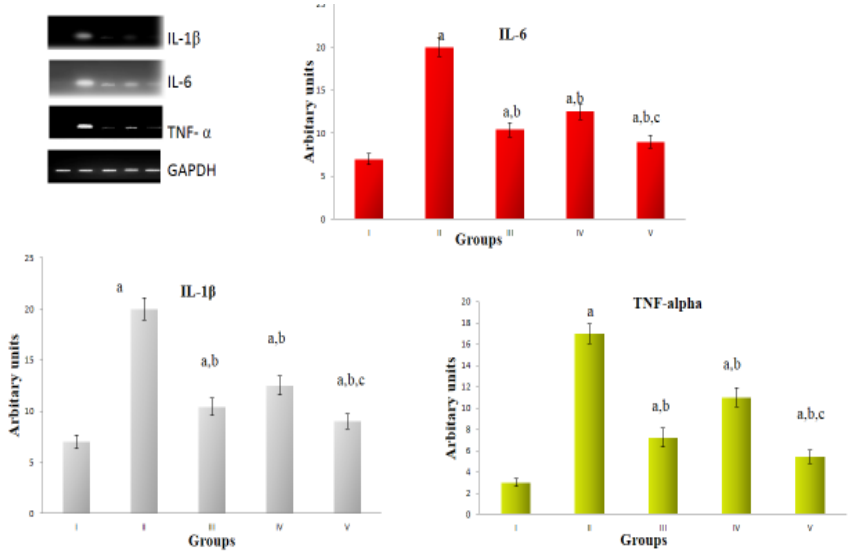


Fig. 3.5. Effect of BA and FLU on inflammatory mediators on COX-2, PGE2 and cPLA2: The expression of COX-2, PGE2 and cPLA2 was assayed by ELISA in the synovial tissue. Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. Values expressed as average of 6 values ± SEM in each group, a- Statistical difference with group I at *P* <0.05, b- Statistical difference with group II at *P* <0.05 and c- Statistical difference with groups III and IV at *P* < 0.05.

Protein and m-RNA expression of pro-inflammatory cytokines

A)



B)

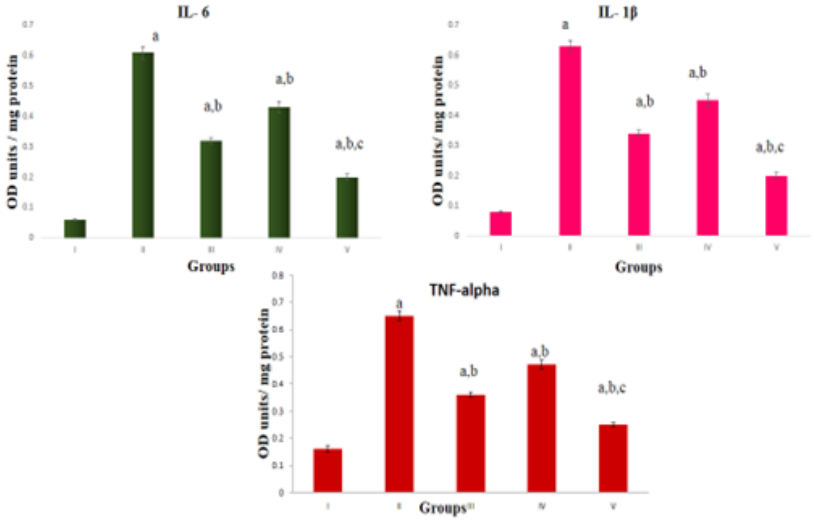


Fig. 3.6. Expression of cytokines in the cartilage: A) The relative amount of mRNA was estimated by semi quantitative RT- PCR. The PCR products were quantified by densitometry and standardized to their respective GAPDH controls. The intensity was measured and expressed as Arbitrary Units. B) Protein level by ELISA. Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. CIA- collagen induced arthritis, BA- betulinic acid and FLU- fluvastatin. Values are expressed as average of 6 values ± SEM in each group**,** a- Statistical difference with group I at *P* <0.05, b- Statistical difference with group II at *P* <0.05 and c- Statistical difference with group III and group IV at *P* <0.05.

Expression of Interferon-γ (IFN- γ)

IFNγ, or type II interferon, is a cytokine that is important for innate and adaptive immunity against viral, some bacterial and protozoal infections. IFNγ is a key activator of macrophages and inducer of class II major histocompatibility complex (MHC) molecule expression. The expression of the pro-inflammatory cytokine, IFN- γ was significantly (p<0.05) increased in collagen induced rats when compared with normal rats. Administration of betulinic acid and fluvastatin showed significant (p<0.05) decrease in IFN- γ than the drugs given alone.

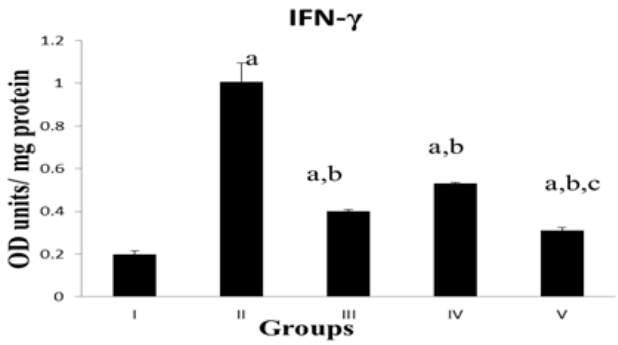


Fig. 5.3.7. IFN- γ in the cartilage: Group Normal, Group II- CIA, Group III- CIA+ E Group IV- CIA+ FLU, Group V- CIA+ BA + FL CIA- collagen induced arthritis, BA- betulir acid and FLU- fluvastatin. Values are express as average of 6 values ± SEM in each group**,** Statistical difference with group I at *P* <0.05, Statistical difference with group II at *P* <0. and c- Statistical difference with group III a group IV at *P* <0.05.

Matrix metalloproteinases, MMP-2 AND MMP-9 in the cartilage

Matrix metalloproteinases (MMPs), hydrolyze components of the extracellular matrix. The level of matrix metalloproteinases MMP-2 and MMP-9 were significantly ($p<0.05$) increased in collagen induced rats when compared with normal rats. Administration of BA and FLU showed significant ($p<0.05$) decrease in MMP-2 and MMP-9 levels than the drugs given alone.

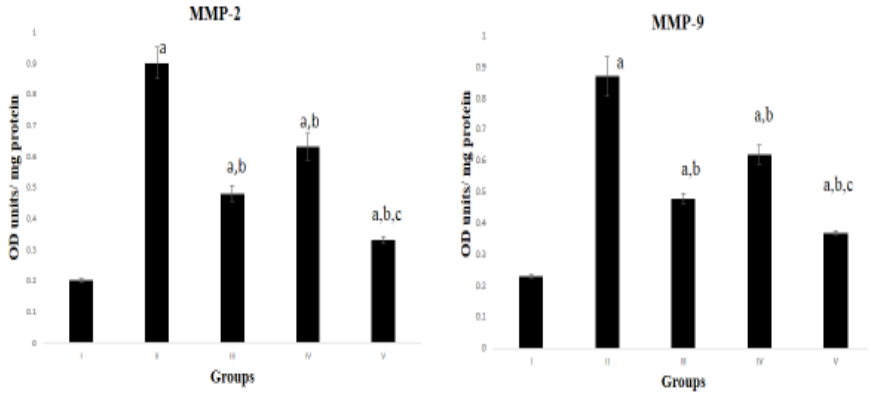


Fig. 3.8. MMP-2 AND MMP-9 level in the cartilage by ELISA: Protein level of MMP-2 and MMP-9 by ELISA. Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. CIA- collagen induced arthritis, BA- betulinic acid and FLU- fluvastatin. Values are expressed as average of 6 values ± SEM in each group**,** a- Statistical difference with group I at *P* <0.05, b- Statistical difference with group II at *P* <0.05 and c- Statistical difference with group III and group IV at *P* <0.05.

Effect of BA and FLU on the expression of TLR-2 and TLR-4 in the cartilage

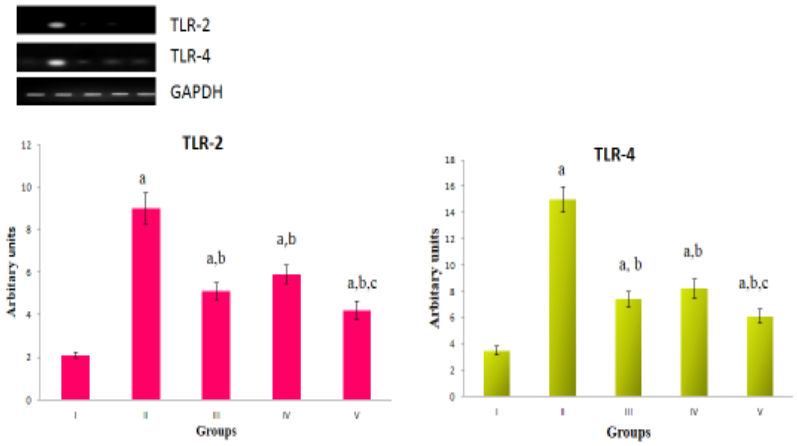


Fig. 3.9. Effect on the expression of TLR-2 and TLR-4 in the cartilage: The relative amount of mRNA was estimated by semi quantitative RT- PCR. The PCR products were quantified by densitometry and standardized to their respective GAPDH controls. The intensity was measured and expressed as Arbitrary Units. Group I- Normal, Group II- CIA, Group III- CIA+ BA, Group IV- CIA+ FLU, Group V- CIA+ BA + FLU. CIA- collagen induced arthritis, BA- betulinic acid and FLU- fluvastatin. Values expressed as average of 6 values ± SEM in each group, a- Significant difference when group II compared with group I at $p<0.05$, b- Significant difference when group III, IV, V compared with groups II at $p<0.05$, c- Significant difference when group V compared with group III and IV at $p<0.05$.

The cell surface receptors TLRs especially TLR-2 and 4 play a major role in the development of autoimmune diseases, so the expression of the toll like receptors TLR-2 and TLR-4 were evaluated in the cartilage. The expression of TLR-2 and TLR-4 were significantly ($p<0.05$) increased in collagen induced rats when compared with normal rats. Combination therapy using betulinic acid and fluvastatin showed significant ($p<0.05$) decrease in TLR-2 and TLR-4 than the drugs given alone.

Histopathology of the synovium

The normal rats showed a synovial membrane without inflammation. Collagen induced arthritic rats showed severe inflammation associated with synovial hyperplasia and accumulation of inflammatory cells in the joint whereas in combination therapy the inflammation and synovial hyperplasia was reduced and showed a histology near to normal. Groups administered with either betulinic acid or fluvastatin showed mild inflammation without synovial hyperplasia.

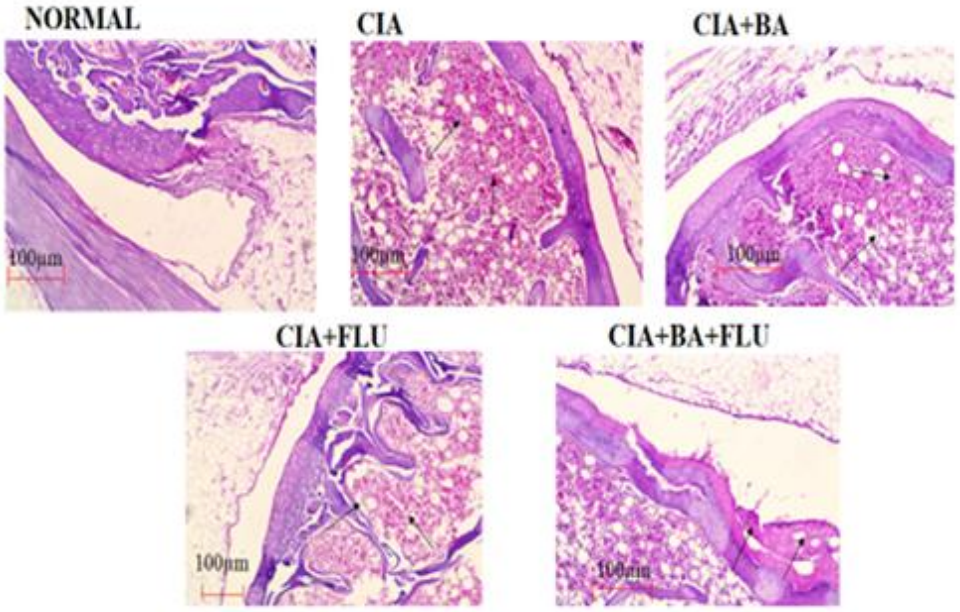


Fig.3. 10. H and E staining of the synovium: Light microscopic appearance of tissue sections obtained using hematoxylin and eosin (H & E) stain with 40X magnification. Scale bar 100µm.

Discussion:

Autoimmune arthritis was induced by immunization with an emulsion of incomplete Freund's adjuvant and type II collagen (CII) (Brand *et al.,* 2007; Viji *et al.,* 2010) which has been widely used as a typical human rheumatoid arthritic model, since the CIA model shares a number of clinical, immunologic and pathologic features with RA (Shou *et al.,* 2006). Collagen antibody induces inflammation via Fc receptor and complement factors involving the infiltration of both neutrophils and macrophages (Hietala *et al.,* 2004). This monoclonal specific antibody activates T cells and B cells which bind the cartilage *in vivo* which is critical for the development of arthritis. Rheumatoid Arthritis is associated with the inflammation of the synovial joints leading to bone destruction. So in the present study,

we have evaluated the role of BA and FLU on various inflammatory mediators and cytokines involved in the disease progression in collagen induced rats. Prostaglandins sustain homeostatic mechanisms and mediate pathogenic processes including the inflammatory reaction (Mohammad and Abbas, 2012). Cytosolic phospholipases A_2 ($cPLA_2$) hydrolyzes the membrane phospholipids resulting in the release of arachidonic acid (AA) which is further converted by COX-2 and prostaglandin synthases to biologically active PGs (Chih-Chung *et al.,* 2009). The activities of $cPLA_2$ and PGE_2 were increased in the cartilage of CIA rats which is in association with the studies that $cPLA_2$ and PGE_2 contributes to the pathological process leading to rheumatoid arthritis (Gheorghe *et al.,* 2011; Leclerc *et al.,* 2013). It was reported that PGE_2 aggravates collagen-induced arthritis in mice via the inflammatory IL-23/IL-17axis (Amir *et al.,* 2007). Our findings showed that the $cPLA_2$ activity in the cartilage was significantly reduced in the treatment group co-administered with betulinic acid and fluvastatin.

COX is an enzyme that catalyzes the formation of prostaglandins that play an important role in promoting the signs and symptoms of rheumatoid arthritis (Smith, 2002; Morita, 2002; Joan, 2003). Here, the collagen induced rats showed an increased activity COX-2 expression due to the increased production of PGE2 characterized by synovial pannus formation and cartilage erosion. The administration of betulinic acid and fluvastatin significantly decreased the total COX and COX-2 activity in the monocytes and synovium reduced the production of lipid mediators. Cytosolic phospholipases A_2 ($cPLA_2$) and cyclooxygenases-1 and 2 (COX-1 and 2) play a pivotal role in the metabolism of arachidonic acid (AA) and in eicosanoid production (Yan *et al.,* 2003). Studies have shown that vascular smooth muscle cells have been shown to express COX-2 and $cPLA_2$, which are tightly regulated by various mediators in several species (Ali *et al.,* 2008). This is in agreement with the previous studies by Sindhu *et al.,* 2012 in adjuvant induced arthritis. This is further confirmed by significantly reduced activity of PGE_2 in the treatment group which is co-administered with BA and FLU.

Cytochrome P450 3A4 enzyme plays a key role in the body, mostly located in the liver and intestine. It oxidizes small foreign organic molecules such as toxins or drugs, so that they can be removed from the body (Ye *et al.,* 2013). Several other members of this family are also involved in drug metabolism, but CYP3A4 is the most common and the most versatile one. It is a hemoprotein, a protein containing a heme group with an iron atom. The mRNA expression of CIA rats showed increased expression of CYP3A4 which is a member of the cytochrome P450 superfamily of enzymes (Sim *et al.,* 2014; Kim *et al.,* 2015). Many reactions involved in drug metabolism, synthesis of cholesterol, steroids and other lipids components are catalyzed by this monooxygenase's cytochrome P450 proteins. The mRNA expression of CYP3A4 was decreased in drugs alone and in combination therapy when compared to the arthritic rats, suggests that the drugs are well metabolized in phase I metabolism. Previous studies have revealed the involvement of different members of this family in Phase I metabolism of xenobiotics by alkaloids and flavonoids (Wang *et al.,* 2015; Dong *et al.,* 2016).

Even though the drugs were metabolized in Phase I metabolism, the toxicity markers such as GOT, GPT and LDH enzymes were analyzed in the liver and serum. GPT and GOT enzymes are associated with the conversion of amino acids to keto acids and the difference is that GPT is found predominantly in the liver, with clinically negligible quantities found in the kidneys, heart and skeletal muscle, while GOT is found in the skeletal muscle, kidneys, brain, liver, heart and red blood cells. As a result, GPT is a more specific indicator of liver inflammation than GOT. In our studies the toxicity markers such as GOT, GPT and lactate dehydrogenase were elevated in collagen induced arthritic rats which was significantly reduced in combination therapy. A previous study revealed that BA have no toxicity even at high concentrations in animal experiments (Pisha *et al,* 1995). But methotrexate (MTX) or leflunomide (LEF) that comes under NSAIDs administration elevated liver enzymes in rheumatoid arthritis patients (Fries *et al.,* 1990; Jeffrey *et al.,* 2010). However, Fluvastatin, which is a statin decreases these toxicity markers than CIA rats, better effect was observed in betulinic acid alone or in combination. Earlier reports also showed that lactic dehydrogenase in the serum and synovial fluid, is a marker of joint damage in rheumatoid arthritis patients (Thompson and Jones, 1987; Pejovic *et al.,* 1992). Thus, the study significantly reduced the toxicity markers in combination therapy, confers a safer therapeutic strategy

Reactive oxygen species (ROS) and nitrogen species (RNS) are potential biomarkers for disease activity in patients with rheumatoid arthritis (Khojah *et al.,* 2016). The most significant method used to assess oxidative stress and an increase in ROS is to check the rise in plasma and tissue levels of SOD, CAT, GPx, GRd, reduced glutathione and MDA, one of lipid peroxidation products (Sivaraj *et al.,* 2011). In the present study, the increased levels of MDA in CIA rats indicate increased lipid peroxidation due to inflammation. The increased concentration of lipid peroxidation product, measured as MDA is most widely used to assess the extent of inflammation (Guerrero-Romero *et al.,* 2006). MDA is a major reactive aldehyde, an end product of the oxidation and decomposition of polyunsaturated fatty acids. In normal physiological conditions a homeostatic balance exists between the formations of ROS and their removal by endogenous antioxidant scavenging compounds. When cellular production of ROS overwhelms its antioxidant capacity, a state of oxidative stress is reached contributing to the pathogenesis of several diseases such as atherosclerosis, diabetes, arthritis, neurodegenerative disease and also in ageing process etc. On treatment with BA+ FLU, a significant decrease in the MDA levels was observed, which indicate the efficiency of these drugs in inhibiting lipid peroxidation effectively than the drugs given alone. RA is often associated with the formation of reactive oxygen species and lipid peroxides as a result of disease activity (Manjunatha *et al.,* 2012; Somaiya *et al.,* 2016). These cytotoxic ROS may cause oxidative damage in the cells (Halliwell, 2007).

Antioxidant enzymes play a major role in reducing the level of ROS generated (Petrozzi *et al.,* 2007). In our study, decreased activity of CAT was observed in collagen induced rats. But BA+ FLU treatment significantly enhanced the catalase activity which indicates the increased decomposition of H_2O_2 to H_2O and O_2 by the enzyme. This is in

agreement with the reports of Karatas *et al.,* 2003. The first enzyme involved in the antioxidant defence, superoxide dismutase is a metallo protein that lowers the steady state level of $O_2^{\cdot-}$. A decreased activity of SOD was observed in collagen induced rats due to increased levels of superoxide anion ((Barazzone & White, 2000) and on BA+ FLU administration significant increase enzyme activity was observed indicating increased conversion of superoxide radicals to H_2O_2. The resulting H_2O_2 is subsequently removed by the enzymatic activity of GPx or CAT. The latter is localized in peroxisomes and converts H_2O_2 with an impressive turnover rate to water and molecular oxygen (Valko *et al.,* 2004).

Previous report has shown that various anti-inflammatory and antioxidant drugs increase the activity of these antioxidant enzymes (Krieglstein *et al.,* 2001). In the present study, administration of BA+ FLU significantly increased the activity of GPx, indicating increased conversion of peroxides to water with simultaneous oxidation of glutathione (GSH) to glutathione disulfide (GSSG) that lessens oxidative stress. GSH is accountable for the maintenance of the complete redox balance in the cell (Masella *et al.,* 2005). The levels of GSH were also increased in the treated group as it serves as a cofactor for detoxifying enzymes like GPx, which in turn prevent lipid oxidative damage by reducing lipid peroxides (Flohe, 1978) and this helps in the regeneration of oxidized forms of antioxidant vitamins C and E. These results evidence that the collagen induction cause an imbalance between oxidants and antioxidant enzymes. This imbalance was brought to near normal levels by the administration of BA+ FLU to arthritis induced rats. Thus, it is concluded that the antioxidant status of CAT, SOD, GPx and GSH was increased and the lipid peroxidation product MDA (TBARS) decreased on combination therapy in the tissues studied. Reports showed that betulinic acid (BA) possess potent antioxidant activity thereby reducing oxidative stress (Julius *et al.,* 2013; Peng *et al.,* 2015; Lee *et al.,* 2015). Previous studies in our lab also demonstrates the antioxidant effect of BA alone and FLU in different studies (Viji *et al.,* 2011; Limi *et al.,* 2013).

Then we evaluated whether BA and FLU had a regulatory role on the expression of cytokines in the joint cartilage of CIA rats. It was found that combination therapy significantly reduced the expression of pro-inflammatory cytokines such as IL-6, TNF-α and IL-1β in the cartilage while in CIA rats, the expression of these cytokines was increased contributing to the pathophysiology of arthritis. Increased concentrations of TNF-alpha and IL-6 were observed in the serum as well as synovial fluid of RA patients correlates with the disease activity and joint destruction in RA (Matsuno *et al.,* 2002; Srirangan *et al.,* 2010; Scheller *et al.,* 2011). Recent studies showed that serum levels of IL-6 and TNF-α may correlate with the severity of rheumatoid arthritis (Shi-Tong Wei *et al.,* 2015) and these cytokines can stimulate the production of PGE2 by synovial cells that contribute to joint damage in inflammatory conditions in RA. Also, the elevated concentrations of IL-1 in the plasma and synovial fluid associate with several factors of disease activity in RA patients (Kay and Calabrese, 2004; Burger *et al.,* 2006) and IL-1 together with TNF-α are considered to be key mediators in RA (Joosten *et al.,* 2010). After 60 days, increased level of IFN- γ was observed in the cartilage of CIA rats. Zhang *et al.,* 2017 have shown that LTB4 stimulates

the expression of interleukins, interferon-γ and chemokines in the synovial cells. IFN-γ level was decreased in combination therapy using BA and FLU which was consistent with the current report by Lee *et al.,* 2017 which showed that IFN-γ regulates inflammatory cell death in experimental autoimmune arthritis since IFN-γ has important effects on endothelial cells, promoting expression of adhesion molecules (Iryna *et al.,* 2014).

Recent findings specified that MMPs have a regulatory role on varied aspects of inflammation and immunity involving the synthesis of pro-inflammatory cytokines and chemokines (Cekici *et al.,* 2014; Robinson *et al.,* 2016; Turner *et al.,* 2014). The activities of MMP-2 and 9 were markedly increased in the cartilage in CIA rats. On 60 days, treatment with BA and FLU significantly reduced the activities of MMP-2 and 9 in the joint cartilage. This is in association to the report of McCawley and Matrisian, 2001 that MMPs repress inflammation by the biologically active molecules such as cytokines, chemokines and growth factor receptor. Reports showed that MMPs contribute to joint destruction in rheumatoid arthritis (RA) by directly degrading the cartilage and bone (Jackson *et al.,* 2001) and synovial fluids from RA patients showed enhanced levels of MMP-2 and MMP-9 (Yoshihara *et al.,* 2000). Expression of MMP-2, 3 and 9 were elevated in arthritis which degrades the non-collagen matrix components of the joints (Burrage *et al.,* 2006, Sandhya *et al.,* 2009). Also, MMP-14 (MT1- MMP) an activator of MMP-2 was found increased in the synovium of RA patients (Yamanaka *et al.,* 2000). Furthermore, MMP-9 from macrophages and neutrophils is thought to play a key role in RA (Jovanovic *et al.,* 2000). Study by Meng *et al.,* 2014 suggest that MMP-2 and MMP-9 expressed by synoviocytes play important role in the angiogenesis in RA progression. Current reports also showed that serum MMP-3 is a specific marker of disease activity and joint damage in RA patients (Samia *et al.,* 2016). Current studies showed that betulinic acid derivative SH479 inhibits arthritis by modulating T cell differentiation and cytokine balance in collagen-induced model (Chen *et al.,* 2017). These results conclude that the synergistic effect of betulinic acid and fluvastatin showed potent anti-inflammatory effect in collagen induced arthritis.

Conclusion:

Collagen induction increases the pro-inflammatory cytokines whereas combination therapy with betulinic acid and fluvastatin decreased cytokine level in the joint cartilage further hinders the production of other pro-inflammatory mediators and enzymes involved in inflammatory response. This is also supported by the histopathological examination of the synovium. Collagen induced arthritic rats showed a severe inflammation associated with synovial hyperplasia and accumulation of inflammatory cells in the joint whereas in combination therapy the inflammation and synovial hyperplasia was reduced, showed a histology near to normal. However, the effect is more prominent in combination therapy than FLU alone. This may be due to the antioxidant effect of betulinic acid.

Acknowledgement:

The authors gratefully acknowledge the help rendered by the Veterinary surgeon, Dr. Ananthalakshmi for assisting in the animal experiments. The authors are also very

thankful to the financial assistance rendered by UGC, New Delhi (UGC BSR RFSMS) in the form of junoir and senior research fellowships.

References:

1. Agerguard N and Jense J. Procedure for blood glutathione peroxidase determination in cattle and swine. Acta Vet Scand**.** 1982; 23: 515–527.
2. Ali K, Lund-Katz S, Lawson J, Phillips MC and Rader DJ. Structure-function properties of the apoE-dependent COX-2 pathway in vascular smooth muscle cells. Atherosclerosis. 2008; 196: 201-209.
3. Asif Husain, Aftab Ahmad, Shah Alam Khan, Mohd Asif, Rubina Bhutani and Fahad A. Al-Abbasi. Synthesis, molecular properties, toxicity and biological evaluation of some new substituted imidazolidine derivatives in search of potent anti-inflammatory agents. Saudi Pharmaceutical Journal. 24, 2016, 104–114.
4. Barata TS, Teo I, Brocchini S, Zloh M and Shaunak S. Partially glycosylated dendrimers block MD-2 and prevent TLR4-MD-2-LPS complex mediated cytokine responses. PLoS Comput Biol. 2011; 7(6): 1-13.
5. Barazzone C and White CW. Mechanisms of cell injury and death in hyperoxia: Role of cytokines and Bcl-2 family proteins. Am J Respir Cell Mol Biol. 2000; 22: 517-519.
6. Benke GM, Cheever KL, Mirer FE and Murphy SD. Comparative toxicity, acetylcholine esterase action and metabolism of methyl parathione (parathione in sunfish and mice). Toxicol Appl Pharmacol. 1974; 28: 97-109.
7. Burger D, Dayer JM, Palmer G and Gabay C. Is IL-1 a good therapeutic target in the treatment of arthritis? Best Pract Res Clin Rheumatol. 2006; 20(5): 879-96.
8. Chen S, Bai Y, Li Z, Jia K, Jin Y, He B, Qiu WW, Du C, Siwko S, Chen H, Liu M and Luo J. A betulinic acid derivative SH479 inhibits collagen-induced arthritis by modulating T cell differentiation and cytokine balance. Biochem Pharmacol. 2017; 15(126): 69-78.
9. Chithra KP, Shalini V, Sindhu G, Parvathy R, Jayalakshmi A and Helen A. Attenuation of atherosclerotic complications by modulating inflammatory responses in hypercholesterolemic rats with dietary Njavara rice bran oil. Biomed Pharmacother. 2016; 83: 1387-1397.
10. Christopher A Lipinski, Franco Lombardo, Beryl W Dominy and Paul J Feeney. Experimental and computational approaches to estimate solubility and permeability in drug discovery and development settings. Advanced Drug Delivery Reviews. 1997; 23(1–3): 3-25.
11. Egan WJ, Merz KM and Baldwin JJ. Prediction of drug absorption using multivariate statistics. Journal of Medicinal Chemistry. 2000; 43(21): 3867–3877.
12. Flohe L. Glutathione peroxidase: fact and fiction. Ciba Found Symp. 1978; 65: 95-122.
13. Gioannini TL, Teghanemt A, Zhang D, Levis EN and Weiss JP. Monomeric endotoxin: protein complexes are essential for TLR4-dependent cell activation. J Endotoxin Res. 2005; 11: 117–123.
14. Guerrero-Romero F and Rodriguez-Moran M. Hypomagnesemia, oxidative stress, inflammation and metabolic syndrome. Diabetes Metab Res. 2006; 22(6): 471- 6.
15. Halliwell B and Gutteridge J. Free Radicals in Biology and Medicine. Oxford University Press. USA. 2007.

16. Iryna Voloshyna, Michael J Littlefield and Allison B Reiss. Atherosclerosis and interferon-γ: New insights and therapeutic targets. Trends Cardiovasc Med. 2014; 24(1): 1-13.
17. Jackson C, Nguyen M, Arkell J and Sambrook P. Selective matrix metalloproteinase (MMP) inhibition in rheumatoid arthritis--targetting gelatinase A activation. Inflamm Res. 2001; 50(4): 183-6.
18. Joan Claria. Cyclooxygenase-2 Biology. Current Pharmaceutical Design. 2003; 9: 2177-2190
19. Joosten LA Netea MG, Mylona E, Koenders MI, Malireddi RK, Oosting M, Stienstra R, van de Veerdonk FL, Stalenhoef AF, Giamarellos-Bourboulis EJ, Kanneganti TD and van der Meer JW. Engagement of fatty acids with Toll-like receptor 2 drives interleukin-1β production via the ASC/caspase 1 pathway in monosodium urate monohydrate crystal-induced gouty arthritis. Arthritis Rheum. 2010; 62: 3237–3248.
20. Jovanovic DV, J Martel-Pelletier, JA Di Battista, F Mineau, FC Jolicoeur, M Benderdour and JP Pelletier. Stimulation of 92-kd gelatinase (matrix metalloproteinase 9) production by interleukin-17 in human monocyte/macrophages: a possible role in rheumatoid arthritis. Arthritis Rheum. 2000; 43: 1134-44.
21. Julius K Adesanwo, Oluwatoyin O.Makinde and Craig A Obafemi. Phytochemical analysis and antioxidant activity of methanol extract and betulinic acid isolated from the roots of Tetracera potatoria. Journal of Pharmacy Research. 2013; 6(9): 903-907.
22. Kakkar P, Das B and Viswanathan PN. A modified spepctrophotometric assay of superoxide dismutase. Indian J Biochem Biophys. 1984; 21: 130-132.
23. Karatas F, Ozates I, Canatan H, Halifeoglu I, Karatepe M and Colak R. Antioxidant status & lipid peroxidation in patients with rheumatoid arthritis Indian J Med Res. 2003; 118: 178-181.
24. Kay J and Calabrese L. The role of interleukin-1 in the pathogenesis of rheumatoid arthritis. Rheumatology (Oxford). 2004; 43 Suppl 3: iii2-iii9.
25. Khojah HM, Ahmed S, Abdel-Rahman MS and Hamza AB. Reactive oxygen and nitrogen species in patients with rheumatoid arthritis as potential biomarkers for disease activity and the role of antioxidants. Free Radic Biol Med. 2016; 97: 285-291.
26. Krieglstein CF, Cerwinka WH, Laroux FS, Salter JW, Russell JM and Schuermann G. Regulation of murine intestinal inflammation by reactive metabolites of oxygen and nitrogen: divergent roles of superoxide and nitric oxide. J Exp Med. 2001; 194: 1207-1218.
27. Kubinyi H. Quantitative Structure-Activity Relations. The Bilinear Model, a New Model for Nonlinear Dependence of Biological Activity on Hydrophobic Character. Journal of Medicinal Chemistry. 1977; 20: 625-629.
28. Lacraz S, Nicod LP, Chicheportiche R, Welgus HG, Dayer JM. IL-10 inhibits metalloproteinase and stimulates TIMP-1 production in human mononuclear phagocytes. J. Clin. Invest. 1995; 96: 2304–2310.
29. Lee K, Yim JH, Lee HK and Pyo S. Inhibition of VCAM-1 expression on mouse vascular smooth muscle cells by lobastin via downregulation of p38, ERK 1/2 and NF-κB signaling pathways. Archives of Pharmacal Research. 2015; 39(1): 83-93.

30. Lee SH, Kwon JY, Kim SY, Jung K and Cho ML. Interferon-gamma regulates inflammatory cell death by targeting necroptosis in experimental autoimmune arthritis. Sci Rep. 2017; 7(1): 10133-10142.
31. Leslie J Crofford. The role of COX-2 in rheumatoid arthritis synovial tissues. Arthritis Res. 2000; 1(Suppl 1): S30-19.
32. Limi Elizabeth Mathew, Vrinda Rajagopal, Chithra K Pushpan and A Helen. Fluvastatin Alleviates Inflammation and Oxidative Stress in Adjuvant Induced Arthritic Rats by the Downregulation of TNF-α and IL-6. Pharmacologia. 2013; 4: 498-506.
33. Loffek S, Schilling O and Franzke CW. Biological role of matrix metalloproteinases: a critical balance. Eur Respir J. 2011; 38(1): 191-208.
34. Lowry OH, Rosebrough NJ, Farr AL and Randel RJ. Protein measurement with folin-phenol reagent. J Biol Chem. 1951; 193: 265-273.
35. Lucia Petrozzi, Giulia Ricci, Noemi J Giglioli and Gabriele Siciliano. Mitochondria and neurodegeneration. Bioscience Reports. 27, 2007, 87–104.
36. Machely AC and Chance B. Assay of catalase and peroxidase, in Glick D Ed: Methods of Biochemical Analysis. NewYork Interscience Publishers. 1954; 1: 357.
37. Manjunatha Goud BK, Sarsina Devi O, Bhavna N, Devaki RN, Deepa K and Niveditha S. Nutritional antioxidants and lipid profile in newly diagnosed rheumatoid arthritis patients. The International Medical Journal. 2012; 11(1): 5-8.
38. Masella R, Di Benedetto R, Vari R, Filesi C and Giovannini C. Novel mechanisms of natural antioxidant compounds in biological systems: involvement of glutathione and glutathione-related enzymes. J Nutr. Biochem. 2005; 16: 577-586.
39. Matthias Pierer, Ulf Wagner, Manuela Rossol and Saleh Ibrahim. Toll-like receptor 4 is involved in inflammatory and joint destructive pathways in collagen-induced arthritis in DBA1J Mice. PLoS One. 2011; 6(8): 1-6.
40. McCawley LJ and Matrisian LM. Matrix metalloproteinases: they're not just for matrix anymore. Curr Opin Cell Biol. 2001; 13: 534-40.
41. Meng Zhou, Si Qin, Yang Chu, Fengming Wang, Lujun Chen and Yahua Lu. Immunolocalization of MMP-2 and MMP-9 in human rheumatoid synovium. Int J Clin Exp Pathol. 2014; 7(6): 3048-3056.
42. Mika Falck-Hansen, Christina Kassiteridi and Claudia Monaco. Toll-like receptors in atherosclerosis. Int J Mol Sci. 2013; 14(7): 14008–14023.
43. Okhawa H, Oshishi N and Yagi K. Assay for lipid peroxides in animal tissues by thriobarbituric acid reaction. Anal biochem. 1979; 95: 351- 358.
44. Peng J, Lv YC, He PP, Tang YY, Xie W, Liu XY, Li Y, Lan G, Zhang M, Zhang C, Shi JF, Zheng XL, Yin WD and Tang CK. Betulinic acid downregulates expression of oxidative stress-induced lipoprotein lipase via the PKC/ERK/c-Fos pathway in RAW264.7 macrophages. Biochimie. 2015; 119: 192-203.
45. Prija Ponnan, Shikhar Gupta, Madhu Chopra, Rashmi Tandon, Anil S. Baghel,Garima Gupta, Ashok K Prasad, Ramesh C Rastogi, Mridula Bose and Hanumantharao G Raj. 2D-QSAR, Docking Studies and In Silico ADMET Prediction of Polyphenolic Acetates as Substrates for Protein Acetyltransferase Function of Glutamine Synthetase of Mycobacterium tuberculosis. Hindawi Publishing Corporation. 2013; 2013: 1-12.

46. Prohinar P Re, F Widstrom, R Zhang D, Teghanemt A, Weiss JP and Gioannini TL. Specific high affinity interactions of monomeric endotoxin.protein complexes with Toll-like receptor 4 ectodomain. J Biol Chem. 2007; 282: 1010–1017.
47. Ren W, Qin L, Xu V, Cheng N. Inhibition of betulinic acid to growth and angiogenesis of human colorectal cancer cell in nude mice. Chinese-German J Clin Oncol 2010; 9: 153–157.
48. Robinson DH, McCall and Facsm GE. The role of matrix metalloproteinase-9 in myofiber hypertrophy of mouse plantaris muscle. International Journal of Exercise Science: Conference Proceeding. 2016; 8(4): 1-10.
49. Samia Fadda, Enas Abolkheir, Rabab Afifi and Mohamad Gamal. Serum matrix metalloproteinase-3 in rheumatoid arthritis patients: Correlation with disease activity and joint destruction. The Egyptian Rheumatologist. 2016; 38(3): 153-159.
50. Sandya S, Achan MA and Sudhakaran PR. Multiple matrix metalloproteinases in type II collagen induced arthritis. Indian Journal of Clinical Biochemistry. 2009; 24 (1): 42-48.
51. Santos M, Costa JF, Krettli AU, Zalis MG, Maia GL and Sette IM. Anti-malarial activity of betulinic acid and derivatives in vitro against Plasmodium falciparum and in vivo in P. berghei-infected mice. Parasitol Res. 2009; 105: 275–279.
52. Scheller J, Athena Chalaris, DirkSchmidt-Arras and StefanRose-John. The pro and anti-inflammatory properties of the cytokine interleukin-6. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research. 2011; 1813(5): 878-888.
53. Shalini V, Jayalekshmi A and Helen A. Mechanism of anti-inflammatory effect of tricin, a flavonoid isolated from Njavara rice bran in LPS induced hPBMCs and carrageenan induced rats. Mol Immunol. 2015; 66(2): 229-39.
54. Shi-Tong Wei, Yong-Hua Sun, Shi-Hua Zong and Yong-Bing Xiang. Serum levels of IL-6 and TNF-α may correlate with activity and severity of rheumatoid arthritis. Med Sci Monit. 2015; 21: 4030–4038.
55. Shobha Bhaskar, Shalini V, Helen A. Quercetin regulates oxidized LDL induced inflammatory changes in human PBMCs by modulating the TLR-NF-κB signaling pathway. Immunobiology. 2011; 216 (3): 367-73.
56. Sindhu G, Ratheesh M, Shyni GL, Bala Nambisan and A Helen. Anti-inflammatory and antioxidative effects of mucilage of Trigonella foenum graecum (Fenugreek) on adjuvant induced arthritic rats. Int Immunopharmacol. 2012; 12 (1): 205-11.
57. Sivaraj A, Vinothkumar P, Sathiyaraj K, Sundaresan S, Devi K and Senthilkumar B. Hepatoprotective potential of Andrographispaniculata aqueous leaf extract on ethanol induced liver toxicity in albino rats. J Appl Pharm Sci. 2011; 01(06): 204-208.
58. Somaiya Mateen, Shagufta Moin, Abdul Qayyum Khan, Atif Zafar and Naureen Fatima. Increased reactive oxygen species formation and oxidative stress in rheumatoid arthritis. Plos one. 2016; 11(4): 1-15.
59. Susnow RG and Dixon SL. Use of robust classification techniques for the prediction of human cytochrome P450 2D6 inhibition. Journal of Chemical Information and Computer Sciences. 2003; 43: 1308–1315.

60. Valko M, Izakovic M, Mazur M, Rhodes CJ and Telser J. Role of oxygen radicals in DNA damage and cancer incidence. Mol Cell Biochem. 2004; 266: 37-56.
61. Vicenova B, Vopalensky V, Burysek L, Pospisek M. Emerging Role of Interleukin-1 in cardiovascular diseases. Physiol. Res. 2009; 58: 481-498.
62. Vijayan Viji, Antony Helen and Varma R Luxmi. Betulinic acid inhibits endotoxin-stimulated phosphorylation cascade and pro-inflammatory prostaglandin E2 production in human peripheral blood mononuclear cells. British Journal of Pharmacology. 2011; 162: 1291–1303.
63. Viji V, Kavitha SK and Helen A. Bacopa monniera (L.) wettst inhibits Type II collagen-induced arthritis in rats. Phytotherapy research. 2010; 24(9): 1377–1383.
64. Volin MV. Soluble adhesion molecules in the pathogenesis of rheumatoid arthritis. Curr Pharm Des. 2005; 11: 633-53.
65. William C Parks, Carole L Wilson and Yolanda S Lopez-Boado. Matrix metalloproteinases as modulators of inflammation and innate immunity. Nature Reviews Immunology. 2004; 4: 617-629.
66. Witztum JL and Lichtman AH. The influence of innate and adaptive immune responses on atherosclerosis. Annual Review of Pathology: Mechanisms of Disease. 2014; 9: 73–102.
67. Yamanaka H, Makino K, Takizawa M, Nakamura H, Fujimoto N, Moriya H, Nemori R, Sato H, Seiki M and Okada Y. Expression and tissue localization of membrane-types 1, 2 and 3 matrix metalloproteinases in rheumatoid synovium. Lab Invest. 2000; 80: 677-687.
68. Yan J Jiang, Biao Lu, Patrick C Choy and Grant M Hatch. Regulation of cytosolic phospholipase A_2, cyclooxygenase-1 and -2 expression by PMA, TNF-α, LPS and M-CSF in human monocytes and macrophages. Mol Cell Biochem. 2003; 246: 31-38.
69. Yoshihara Y, Nakamura H, Obata K, Yamada H, Hayakawa T, Fujikawa K and Okada Y. Matrix metalloproteinases and tissue inhibitors of metalloproteinases in synovial fluids from patients with rheumatoid arthritis or osteoarthritis. Ann Rheum Dis. 2000; 59: 455-461.
70. Yoshisuke Haruna, Yoshitaka Morita, Toyotaka Yada, Minoru Satoh and David A. Fox-2 and Naoki Kashihara. Fluvastatin reverses endothelial dysfunction and increased vascular oxidative stress in rat adjuvant-induced arthritis. Arthritis & Rheumatism. 2007; 56: 1827–1835.
71. Zhang L, Zhu M, Li M, Du Y, Duan S, Huang Y, Lu Y, Zhang J, Wang T and Fu F. Ginsenoside Rg1 attenuates adjuvant-induced arthritis in rats via modulation of PPAR-γ/NF-κB signal pathway. Oncotarget. 2017; 8(33): 55384-55393.

A REVIEW ON PHARMACOLOGICAL ACTIVITIES OF *Kedrostis foetidissima (JACQ.) COGN.*

Gayathri S, Muthamizhan V J and Santhi R*
Department of Biochemistry,
PSG College of Arts & Science, Coimbatore-641 014.
*Corresponding author E-mail: santhi@psgcas.ac.in

Abstract:

Many traditional medicines in current usage are from medicinal plants, minerals and organic matter. Nowadays there is an increased attention towards the usage of medicinal to treat various disease. *Kedrostis foetidissima* (Jacq.) Cogn., is a conventional medicinal plant of the Cucurbitaceae family, which is abundant in India, Sri Lanka, Ethiopia and Western Malaysia. Many members of Cucurbitaceae are browbeaten for their therapeutic and cost-effective values. The entire parts of the plant are used in conventional systems of medicines and suggested that they have medicinal properties in both *in vitro* and *in vivo* studies. Recently wide research work had been carried out using the various extracts, important phytochemicals from *Kedrostis foetidissima* to validate its pharmacological and biological activities. It possesses numerous activities like antimicrobial, antioxidant, anticancer, gastroprotective, cardioprotective, antidiabetic, anti-inflammatory properties. This is due to the presence of various metabolites like phenols, alkaloids, flavonoids, tannins, terpenoids and steroids. The present review gives chemical constituents and pharmacological activities of *Kedrostis foetidissima.*

Keywords: *Kedrostis foetidissima*, pharmacological activity, antiproliferative

Introduction:

In general humans for their food, clothing, shelter and medicine depend on plant resources. Nature will provide food and remedy in the form of herbs for human, animals as well as birds (Hashemi *et al.,* 2012). There has been an increased awareness of the limitations of synthetic drugs and chemicals, as well as the potential for adverse effects and toxicity. This has led many people to seek out alternative approaches to health and wellness, including the use of herbal remedies (Okitoi *et al.,* 2007).

The Cucurbitaceae is basically a tropical plant family which contain 110 genera and 640 species (Kavitha *et al.,* 2015). Throughout India there is 37 genera and 97 species are cultivated. It is widely distributed in the areas of Tamil Nādu, Gujarat, Punjab, Uttar Pradesh, Maharashtra and Andhra Pradesh. The pharmacological evaluation of this plant provides the importance regarding the morphology, microscopical and physical characteristics of crude extract (Raja *et al.,* 2021). The main aim of this review is to give the need, chemical components, their activities and the pharmacological values of this plant.

Vernacular Names (Nirmala *et al.,* 2013)

In Tamil it is called as Appakovai, in Telugu as Kukumadumda /Nagadonda, in Kannada it is named as Kukumadumdarnara.

Synonyms (Heath and Heath, 2009)

- *Kedrostis foetidissima*
- *Trichosanthes foetidissima*
- Zelmeria obtusiloba Sand.
- *Melothira foetidissima*
- *Bryonia foetidissima*

Taxonomical Classification (Kunthavi *et al.,* 2018)

Kingdom: Plantae
Phylum: Tracheophyte
Class: Magnoliopsida
Series: Calyciflorae
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Kedrostis*
Species: *foetidissima*

Figure 1: Whole plant of *Kedrostis foetidissima*

Figure 2: Ripen fruit of *Kedrostis foetidissima*

Figure 3: Tuber of *Kedrostis foetidissima*

Medicinal Values of Various Parts of *Kedrostis foetidissima*

Plant Parts	Medicinal Uses
Leaf	Anti-diarrheal, Antibacterial, Antifungal, Wound healing, Antiinflammatory, Antianemic, Antidiabetic, Antiproliferative, Anti-fouling agents, Gastroprotective and Immune modulator
Stem	Anti-bacterial, Anti-fungal, Wound healing, Immune modulator
Root	Anti-fungal, Anti-bacterial

Pharmacological Activities of *Kedrostis foetidissima*

Plants can often be more cost-effective than synthetic drugs. While some herbs may be more expensive than others, overall, they can be a more affordable option for many people, especially when compared to the high cost of prescription drugs. The various medicinal activities of *K. foetidissima were* given below.

Anti-Diarrheal activity

Kedrostis foetidissima, a traditional remedy for child diarrhoea. The antidiarrheal efficiency of *Kedrostis foetidissima* leaf extract in ethanol was examined in albino mice. Research of the ethanolic extract of this plant reveals the presence of terpenoids, tannins and flavonoids. One of the findings demonstrated a significant decrease in faecal output with *Kedrostis foetidissima* in the number of diarrheal incidents in a castor oil-induced diarrhoea test. According to the findings, it is concluded that *Kedrostis foetidissima* ethanolic leaf extract had antidiarrheal properties (Sengottuvelu, 2015).

Anti-Bacterial activity

The antibacterial activity of chloroform extracts of stem and leaf of *Kedrostis foetidissima* were carried out against various microorganisms using agar disc diffusion technique. The results shown that extract of stem offered the highest zone of inhibition against *Pseudomonas aeruginosa* (Priyavardhini *et al.,* 2012; Vasantha *et al.,* 2012). Another study also supported the above findings and confirmed the antimicrobial properties (Raja *et al.,* 2019).

Antifungal activity

K. foetidissima leaf, stem, and tuber extracts were experienced for antifungal activity using the disc diffusion method with several solvents against *Candida albicans, C. tropicalis, Aspergillus niger, A. flavus, and A. versicolor*. The methanolic extract of the examined plant components are most effective against fungus. As a result, *K. foetidissima* can be utilised to discover its bioactive natural compounds that employed as a starting point for the creation of novel medicines that meet unmet therapeutic needs (Priyavardhini *et al.,* 2012).

The antifungal activity was analysed against few microorganisms on Muller Hinton agar and potato dextrose agar. The result revealed that they have effective activities against *Trichophyton rubrum* and mild effect in *Epidermophyton floccosum* (Subramani and Kamaraj, 2014).

Wound Healing activity

Using an incision wound model on healthy young adult Albino Wistar rats, it was investigated how well *Kedrostis foetidissima* (Jacq.) Cogn. leaf and stem petroleum ether extract treated wounds and its effects compared to control. It exhibits significant wound healing properties and this study confirms the plant's usage in traditional medicine (Amutha and Lalitha, 2013).

Anti-Inflammatory activity

The qualitative phytochemical analysis of *Kedrostis foetidissima* showed the presence of alkaloids, flavonoids, tannins, triterpenoids, phenols, steroids, saponins and glycosides. The plant's widely known for its ability to reduce inflammation since it contains numerous secondary metabolites in large quantities. The recent researches contribute to usefulness of the plant in treating variety of ailments and disorders. The antiinflammatory activity of *Kedrostis foetidissima* leaf extracts were assessed by inhibition of protein denaturation. The methanolic leaf extract was found to have a potent antiinflammatory activity and shows maximum inhibition of 80.25% protein denaturation at the concentration of 800µg/ml (Jagadeeswari and Hemashenpagam, 2019).

Cardio Protective Effect

An isoproterenol (ISO)-induced rat model was used to assess the cardioprotective effects of the partially purified phenolic fraction *of Kedrostis foetidissima* (PFK). After two days of ISO induction, there is a significant increase in the levels of triglycerides, cholesterol, phospholipids, free fatty acids, low-density lipoproteins and cardiac biomarker enzymes, whereas there is a significant decrease in the levels of high-density lipoproteins and antioxidant enzyme activity. Antioxidant enzyme activity significantly increased after 45 days of pre-treatment with phenolic fraction in experimental rats. The study showed that PFK reduced the negative effects of ISO on the cardiovascular system by enhancing the endogenous antioxidant system in the heart and thereby reducing the amount of lipid peroxidation brought on by ISO-induced free radicals (Pavithra *et al.,* 2020).

Free radical scavenging and antioxidant activity

The activity of antioxidant of crude phenolic fraction of *K. Foetidissima* was investigated *in vitro* by Phosphomolybdenum assay. The crude phenolic fraction was found to have high number of phenols followed by flavonoids and tannins. The study also revealed that, as the concentration of the phenolic fraction increase the antioxidant activity increases. The results prove that there is strong correlation with phenolic compounds and antioxidant activity which supports the traditional use of *K. foetidissima* plant as a potent resource of antioxidant compounds that could be utilized pharmaceutically (Pavithra *et al.* 2019; Kalaisezhiyen and Sasikumar, 2012)**.**

Anti-Anaemic activity

Anaemia was induced by administering phenyl hydrazine to evaluate the anti-anaemic properties of the Cucurbitaceae plants *Mukiama deraspatana* (MM) and *Kedrostis foetidissima* (KF). For the study, rats with haemoglobin contents less than 14 mg/dl were chosen. On the first, second, third and fourth weeks of the treatment, animals were punctured in the sinus to obtain blood samples. When compared to the standard drug (Vitamin B12), both the doses of MM and KF extracts considerably increased the RBC content from the first week to the fourth week of treatment. Following treatment with MM

extract, the WBC content did not change significantly. But there was less significant decrease in WBC in Vitamin B12 and KF extract treated groups (Saravanan and Manokaran, 2012).

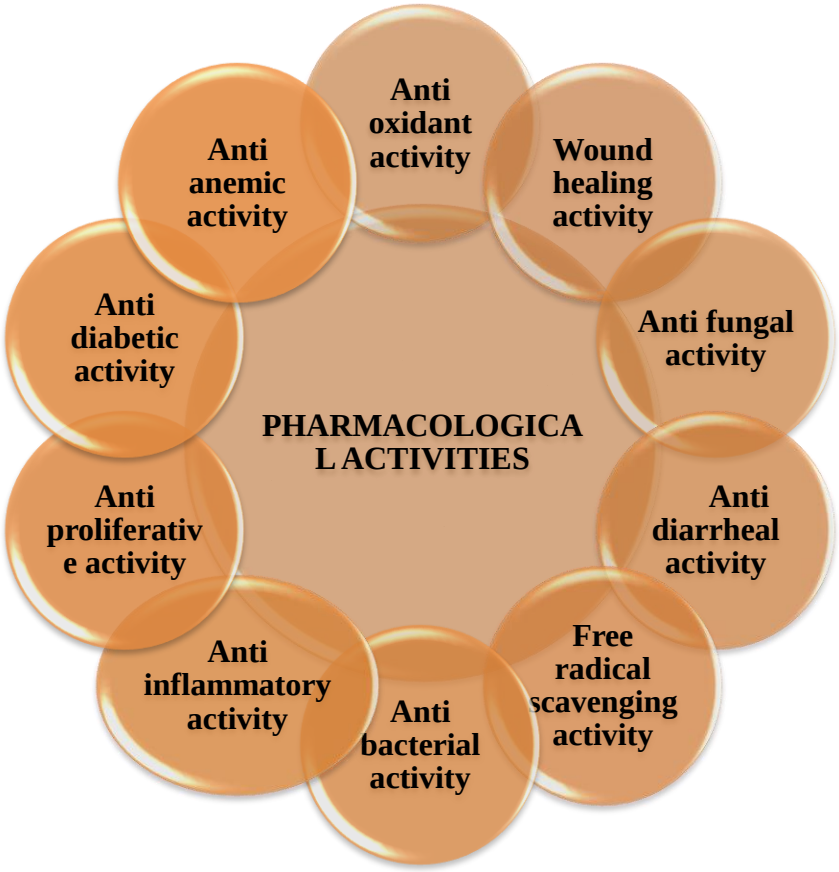


Fig. 4: Various Pharmacological activities of *Kedrostis foetidissima*

Alpha-Amylase Inhibition activity

The ability of *K. foetidissima* (Jacq.) extracts towards the inhibition of alpha-amylase was evaluated by the Dinitro salicylic acid method. All eight extracts exhibit excellent inhibition activity as measured by the IE50. Ethyl acetate extract has an IE50 of 21.02 g/ml, while petroleum ether extract has an IE50 of 37.14 g/ml. When compared to the standard drug Acarbose, ethanol and ethyl acetate extract exhibit excellent inhibition efficiency at 30 g/ml, demonstrating that this plant is an effective, natural treatment for diabetic patients that don't have any negative side effects (Amutha and Lalitha, 2015).

Anti-Proliferative activity

MCF-7 and YMB-1 cell lines were subjected to different concentrations (0-100g/ml) of the methanolic extract in order to assess the anti-proliferative effects of *K. foetidissima,* which are related to the putative anticarcinogenic characteristics in breast cancer. A dose- and time-dependent suppression of cell proliferation was induced by the extract, which was followed by a parallel decline in cell viability. All things considered, the evidence points

to the presence of bioactive substances in the methanolic extract which is useful to treat breast cancer (Choene and Motadi, 2012).

Three different techniques were used to create biogenic nanoparticles that were effective against bone cancer cell lines with the aqueous extracts of *Kedrostis foetidissima*. By using FTIR, relationship between the phytoconstituents and the gold nanoparticles was analysed. The use of XRD, SEM, and TEM analysis was used to confirm the formation of gold nanoparticles. The TEM analysis supported the existence of gold nanoparticles in the form of flowers that were smaller than 25 nm that exhibit 88% cell viability when used to treat bone cancer cell lines (Jannathukl and Lalitha, 2016).

The characteristics and effectiveness of the gold and silver nanoparticles on human lung cancer cell lines (A-549) were studied using *Kedrostis foetidissima* (Jacq.) Cogn. traditional medicinal plant. Using an ethanol extract of the plant *K. foetidissima,* gold and silver nanoparticles were created using the solar irradiation method. The findings show that compared to AuNPs (IC50-106.27 g/mL), silver nanoparticles exhibit significantly less cytotoxicity (IC50-62.16 g/mL) towards A-549 (Amutha and Pottail, 2021).

Conclusion:

In this article, we have collected and reviewed several research articles and reviews. From this, it is clear that *Kedrostis foetidissima* harbors a variety of pharmacological properties.

References:

1. Amutha M and Lalitha P (2013): Evaluation of Wound Healing Activity of Leaf and Stem Extract of *Kedrostis foetidissima* (Jacq.) Cogn., Research Journal of Pharmaceutical, Biological and Chemical Sciences, 4(2); 445-449.
2. Amutha M and Pottail L (2021): Rapid Green Synthesis of Gold and Silver Nanoparticles Using Ethanol Extract of *Kedrostis foetidissima* (Jacq.) Cogn. and its Anticancer Efficacy against A549 Human Lung Cancer Cell Lines. Indian Drugs, 58; 30-40.
3. Amutha M, Lalitha P and Jannathul Firdhouse M (2014): The Biosynthesis of Silver Nanoparticles Using *Kedrostis foetidissima* (Jacq.) Cogn*.,* Journal of Nanotechnology, 2014; 1-5.
4. Amutha Muthusamy, Lalitha pottail (2015): Screening of *Kedrostis foetidissima* (Jacq.) Cogn: Extracts for A-Amylase Inhibition, International Journal of Interdisciplinary Research and Innovations, 3(4); 106-110.
5. Hashemi S R, Davoodi H (2012): Herbal Plants as New Immuno-Stimulator in Poultry Industry, Asian Journal of Animal and Veterinary Advances,7; 105-116.
6. Heath A and Heath R (2009): Field Guide to the Plants of Northern Botswana including the Okavango Delta Kew Publishing; ISBN No. 13: 9781842461839.

7. Jagadeeswari M and Hemashenpagam N (2019): *In vitro* Antioxidant and Anti-inflammatory Potential of *Kedrostis foetidissima* (Jacq.) Cogn. Leaf Extracts, J Pharm Res, 8(5); 360-365.
8. Jannathul Firdhouse M and Lalitha P (2016): Flower-shaped gold nanoparticles synthesized using *Kedrostis foetidissima* and their Antiproliferative Activity against Bone Cancer Cell Lines, International Journal of Indian Chemistry,7; 347-358.
9. Kalaisezhiyen Pavithra and Sasikumar Vadivukkarasi (2015): Evaluation of Free Radical Scavenging Activity of Various Extracts of Leaves from *Kedrostis foetidissima* (Jacq.) Cogn. Food Science and Human Wellness, 4; 42-46.
10. Kavitha R, Chittibabu C V and Subha T S (2015): Pharmacognostic Evaluation of Indigenous Medicinal Plant *Kedrostis foetidissima* (Jacq.) Cogn, Pharmacognosy Journal,7(1); 52-57.
11. Kunthavi B, Malarvizhi M and Poongodi Kandhimathi A S (2018): Retrospective study of leaves of *Kedrostis foetidissima*in siddha medicine. International Journal of Current Research in Biology and Medicine, 3(5); 18-21.
12. Mpho Choene and Lesetja R Motadi (2012): Anti-Proliferative Effects of the Methanolic Extract of *Kedrostis foetidissima* in Breast Cancer Cell Lines, Molecular Biology, 1(2); 1-5.
13. Nirmala J and Pandian R (2013): Morphological and Systematic Studies on *Kedrostis foetidissima* (Jacq.) Cogn, International Journal of Current Microbiology and Applied Sciences, 2(10); 560-571.
14. Nirmala J and Pandian R (2015): Anatomical Studies o*f Kedrostis foeditissima* (Jacq.) Cogn. (Cucurbitaceae), International Journal of Current Research in Biosciences and Plant Biology, 2(7); 217-223.
15. Okitoi LO, Ondwasy HO, Siamba DN and Nkurumah D (2007): Traditional Herbal Preparations for Indigenous Poultry Health Management in Western Kenya, Livestock Research for Rural Development, 19(5); 1-5.
16. Pavithra K, Sathibabu Uddandrao V V, Chandrasekaran P, Brahmanaidu P, Sengottuvelu S, Vadivukkarasi S and Saravanan G (2020): Phenolic Fraction Extracted from *Kedrostis foetidissima* Leaves Ameliorated Isoproterenol Induced Cardiotoxicity in Rats through Restoration of Cardiac Antioxidant Status, Journal of Food Biochemistry, 44(11); 1-9.
17. Priyavardhini S, Shyamalagowri S, Vasantha K and Umadevi M (2008): Antibacterial Activity of Stem and Leaf Extract *of Kedrostis foetidissima* (Jacq.) Cogn., Ancient Science of Life, 28(2); 10-11.
18. Priyavardhini S, Vasantha K, TresinaSoris P and Mohan V R (2012): Antifungal Activity of *Kedrostis foetidissima* (Jacq.) Cogn, International Journal of Pharm Technology Research, 4(1); 44-48.

19. Raja M J, Arivuchelvan A and Jagadeeswaran A (2019): Evaluation of Antibacterial Activity of *Kedrostis foetidissima* (Jacq.) Cogn., Plant Extracts against Pathogens Causing Bovine Mastitis, 8(1); 452-455.
20. Raja M J, Arivuchelvan A and Jagadeeswaran A (2021): Environmental Factors as Quality Determinants on Phytochemistry of *Kedrostis foetidissima* (Jacq.) Cogn. Herb,10(12); 2057-2059.
21. Saravanan V S and Manokaran S (2012): Anti-anaemic Activity of Some Plants in Cucurbitaceae on Phenyl hydrazine Induced Anaemic Rats, Thaij.pharm.sci,36; 150-154
22. Subramani V and Kamaraj M (2014): Trace Metal Concentration and Antimicrobial Efficacy of Selective Medicinal Plants, Southern India, IJPCBS, 4(1); 182-187.
23. Vasantha K, Priyavardhini S, TresinaSoris P and Mohan VR (2012): Phytochemical Analysis and Antibacterial Activity of *Kedrostis foetidissima* (Jacq.) Cogn, Bioscience Discovery,3(1); 06-16.

NEED OF BASIC ELECTRONICS FOR TODAY'S TECHNOLOGY

Bhavesh Anant Chavan
Sant Rawool Maharaj Mahavidyalaya, Kudal, Dist. Sindhudurg (MH)
Corresponding author E-mail: physics.bhavesh@gmail.com

Abstract:

There are a number of basic concepts that form the foundations of today's electronics and radio technology. Electrical current, voltage, resistance, capacitance, and inductance are a few of the basic elements of electronics and information technology. Apart from current, voltage, resistance, capacitance, and inductance, there are many other interesting elements to electronic technology. While some can become quite complicated, it is nevertheless possible to gain a good understanding of them without delving into the complicated depths of these topics. We all are aware of today's technology. Now it is time to evolve quantum technology. Still now base of every technology is electronics. Electronics is key for embedded system which connects software and hardware parts of application system. So it is needed to have basic knowledge of electronics when we work in multidisciplinary subjects. The aim of this chapter is to explain basic and conceptual information about electronic components and their working. With the help of this chapter everyone can interact with electronics components easily and confidently.

Electronics:

Basically, in electronic branch all types of materials (viz conductors, semiconductors and insulators) have their significant roles. Semiconductor devices plays important role in electronic circuits. A circuit is a structure containing passive and active electronics components that directs and controls electric current, to perform specific ad useful task and function. The word 'circuit' implies that the structure is closed, like a loop. An electric current is considered as flow of electric charges within closed loop.

Electric Charge:

Electric charge is the property of subatomic particles that causes them to experience a force when placed in an electric and magnetic field. There are two types of charges; positive and negative charges. Generally, electron is a subatomic particle which also consider as negatively charged particle causes electric current. The flow of electrons within conducting material is called electric current. Free electrons are available in metals. When electric field applied across any conductor then electrons are freely move within the material causing electric current. The SI unit of electric current is Ampere. Ammeter is the device used to measure the amount of current.

Voltage:

Voltage, also known as electric pressure, or (electric) potential difference, is the difference in electric potential between two points. In the International System of Units, the derived unit for voltage is volt.

The voltage between points can be caused by the build-up of electric charge (e.g., a capacitor), and from an electromotive force (e.g., electromagnetic induction in generator, inductors, and transformers). On a macroscopic scale, a potential difference can be caused by electrochemical processes (e.g., cells and batteries), the pressure-induced piezoelectric effect, and the thermoelectric effect.

A voltmeter can be used to measure the voltage between two points in a system. Often a common reference potential points is called ground. A voltage can represent either a source of energy or the loss, dissipation, or storage of energy.

Generally, voltage developed across each point of electrical components (active or passive elements) depends upon their resistance or reactance offered in closed loop circuit. Voltage remains constant when components are connected in parallel mode while voltage divides when connected in series mode.

Direct current (DC):

One directional flow of current is called direct current (DC). All batteries provide direct current that is the form of electricity that flows in one direction. DC is used in many electronic equipment like computer, radios, embedded systems, mobile phones, calculators, toys, etc. With the help of rectifier circuit, we can convert alternating current into direct current. All electronics devices require direct current supply and we can complete this demand with the help of alternating current. Some batteries are present in rechargeable and non-rechargeable format, which all are provides direct current supply. Nowadays, staring from small LED torch we use button type cell, also in wrist watches, AA & AAA types batteries for remotes, and 6V, 12V batteries in vehicles and invertors also. So, the direct current is the backbone of electronic circuits.

Alternating current (AC):

Alternating current is bidirectional current. It flows first in one direction and then the flows in reverse direction with same frequency. Alternating current varies as a sine wave, it is a combination of positive and negative half cycles. We can generate high power ac in large scale. In India the frequency of alternating current is 50 Hz. It means an alternating current waveform competes a complete cycle, that is positive and negative halves 50 times a second.

Batteries:

For the production of voltage separation of charges is needed. A battery uses a chemical reaction to produce chemical energy which can be used to separate the opposite charges on to its two terminals. Basically, batteries are considered as storage elements of electrical charges. When we use such battery in external closed circuit, then the charges move through the circuit following given path and finally returning to the opposite terminal, chemical in the battery react to restore the charge difference hence the voltage. This battery voltage is actually called electromotive force (EMF) that we measure in terms of voltage or potential difference. EMF is the voltage of battery tells us the capacity of sourcing voltage without external circuit or any load connection. EMF is also considered as open loop voltage of battery.

When we use battery in closed external circuit, after sometimes it gets discharged. It means that it's EMF remains constant only internal resistance of battery increases so some EMF is used to overcome that increased internal resistance and hence its output voltage which we called as source voltage is decreases.

The EMF of the battery is determined by the particular type of chemical reaction. For most of the commercial batteries their EMF is about 1.5 volt per cell or chemical section but can be with different electrical power. Power of the battery is the basically product of current and voltage that can source by battery to a load. Also batteries with higher voltages contain multiple cells inside connected in series mode to get desired voltage. So, the commercially available batteries are of 3V, 6V, 9V and 12V etc.

Electronics & Electrical Devices:

Electronic and electrical both are correlated branches. Electrical devices convert electrical energy in to another form of energy like light, sound, mechanical etc. Electronics devices used to control the current to perform specific task.

In general, Electrical and electronics things are separated by AC and DC. All electrical devices or appliances work on alternating current. Transformers, generators, motors are examples of electrical devices. While all electronics devices work on direct current. Diodes, transistors, microprocessors, integrated circuits (ICs), etc., all are examples of electronics devices.

The electrical devices use copper and aluminium wires for the flow of electrical current whereas the electronics devices use the semiconductor material. Most of the time all electronics appliances use electronic devices for receiving electrical energy.

Electronic / Electronics components:

Generally same components use in both branches. So as per the use in specific tasks these components are called electronic or electrical components. Electronics or electrical components are categories in two types: Passive and Active elements.

Passive elements: Passive elements are those elements who does not generate power, but instead dissipates, stores or releases the electrical energy. Resistors, capacitors and inductors (coils) all three components are considered as passive elements.

Active elements: Active elements are actually a part of circuit. Active elements always play active role in working circuit. Active elements sources electrical signals or modify electrical signals as per the demand of task. Diode, transistors, etc., are examples of active elements.

References:

1. VK Mehta, Rohit Mehta. (2020). *Principles of Electronics*, 12th Revised Edition, S Chand and Company limited,.
2. https://en.wikipedia.org/wiki/Electronics

A COMPARATIVE STUDY OF HYDROETHANOLIC EXTRACT OF HYDROPONICS AND SOIL GROWN *SPINACIA OLERACEA* LEAVES: A REVIEW

Praveenraj N, Karan Nikas S and R. Santhi*
Department of Biochemistry,
PSG College of Arts & Science, Coimbatore – 641 014.
*Corresponding author E-mail: santhi@psgcas.ac.in

Abstract:

Spinach is a green leafy vegetable that is native to central and SouthWestern Asia. It is a member of the Amaranthaceae family and is closely related to beets and quinoa. Spinach is widely grown for its nutritious leaves, which are consumed raw or cooked and are a popular ingredient in salads, smoothies and other dishes. Hydroponics is the method of growing plants using a water-based nutrient solution rather than soil, and can include an aggregate substrate, or growing media, such as vermiculite, coconut coir, or perlite. Spinach takes about 40-50 days from seed to harvest. Hydroponic spinach in systems that promote fast growth may be ready to harvest in as few as 35 days. Spinach does best when growing in moist, nitrogen-rich soil. Spinach plants form a deep taproot. Spinach requires *6 weeks of cool* weather from seeding to harvest, so sow seeds directly into the soil as soon as the ground warms to 40°F.In this study we have compare these samples which are grown in soil and hydroponics and we also evaluated the anti-oxidants potential of the hydroethanolic extract of these samples.

Keywords: Hydroponics, Antioxidants, Vermiculite.

Introduction:

Spinach is a rich source of vitamins and minerals, particularly vitamins A and C, iron, calcium, and magnesium. It is also a good source of fiber, protein, and antioxidants such as carotenoids and flavonoids. Due to its nutritional content, spinach has been linked to numerous health benefits, including improved eye health, strengthened bones, and reduced risk of chronic diseases such as heart disease and cancer. Spinach can be grown using various methods, including traditional soil-based agriculture, hydroponics, and aquaponics. Hydroponic and aquaponic systems can produce spinach with faster growth rates, higher yields, and better quality than traditional soil-based methods. These systems also allow for precise control over nutrient delivery and environmental conditions, resulting in consistent and high-quality produce (Tewani *et al.,* 2016).

Spinach contains special defensive carotenoid compounds that are linked with decreasing the risk of many diseases including heart disease (Miller, 1994; Gaikwad *et al.,* 2010; Diet and Health, 2014) diabetes (BMJ 2010), neurodegenerative diseases and obesity (Miller, 1994). Chemical constituents include carotenoids as beta-carotene, lutein, and zeaxanthin, similar to other vegetables like carrots, kale, and broccoli (Hugo *et al.,* 2005). It provides flavonoids, an important antioxidant (Pemberton *et al*. 1991) that protect various

diseases by fighting free radical damage within the body (Miller, 1994). These protective compounds make spinach one of the best anti-aging foods (McKeowyn-Eyssen *et al.,* 1994; Miller, 1994).

Spinach is very helpful in preventing the central nervous system (Lomnitski *et al.,* 2003), reducing inflammation and delaying the aging process by protecting cells (Cruess, 1958). Spinach is useful source for various carotenoids and lipophilic active compounds (i.e., neoxanthin, lutein, zeaxanthin, and chlorophylls).

2. Classification (Kline & Aman, 1969)

Official Latin Name: Spinacia oleracea
Botanical Name: Spinacia oleracea (LINN.)
Scientific Name: Spinacia oleracea
Common name: Spinach
Family: Amaranthaceae, N.O. Chenopodiaceae
Genus: Spinacia
Species: oleracea

Fig. 1: Spinach plant

Pharmacological activities of spinach

Spinach exhibits various pharmacological activities due to its nutrient and phytochemical content. It includes

Antimicrobial activity

Cnidoscolus aconitifolius (Miller) I. M. Johnston's leaves, stem, and root ethanol extracts were tested for their phytochemical composition as well as their antioxidant and antibacterial properties. Secondary metabolites with potential medical use for both prevention and treatment were found through phytochemical screening. The stem displayed the largest spectrum of activity against the various bacterial strains examined, although all plant sections (leaf, stem, and root) shown activity against *Escherichia coli* and *Bacillus subtilis*. Although though the extract's antioxidant activity [as measured by 2,2-Diphenyl-picryl-1-hydrazyl radical (DPPH)] is less effective than that of vitamin C, it nevertheless demonstrated an increase in activity with concentration (Adeniran *et al.,* 2013).

Anti-Alzheimer plant

The diet required achieving healthy brain and neurocognitive function is known as neuro-nutrition. Diets high in vitamins, flavonoids, antioxidants, and polyphenolic substances will slow the progression of Alzheimer's disease. One of the traditional

medicinal plants that is rich in those mentioned minerals is Spinacia oleracea (Family: Amaranthaceae), sometimes known as spinach or Buai Leng (in Thai). Many vitamins and minerals that can help avoid deficiency illnesses and are necessary for healthy physiological function are among the micronutrients found in spinach. Carotenoids, flavonoids, and phenolic compounds, which are its phytochemicals, help prevent chronic illnesses and other aging-related ailments. This article's goal was to analyse the many ethnomedical uses of spinach and how they may have an impact on the pathogenesis of Alzheimer's disease (Jiraungkoorskul, 2016).

Anti-Cancer effect

The extract's antioxidative activity was established by us. The chloroplast membrane of plants contains important glycoglycerolipids such monogalactosyl diacylglycerol (MGDG), digalactosyl diacylglycerol (DGDG), and sulfoquinovosyl diacylglycerol (SQDG). The bioactivities of pure spinach MGDG, DGDG, and SQDG have been well studied. Mammalian DNA polymerases have been demonstrated to be inhibited by MGDG and SQDG, whereas DGDG does not have this inhibitory effect. These glycoglycerolipids may have an impact on cancer cells, angiogenesis, and the development of solid tumours by inhibiting DNA polymerase replication. We examine the mechanism of action of plant chloroplast glycoglycerolipids as anti-cancer therapeutics in light of these discoveries (Ohtani *et al.,* 2008).

Anti-Inflammatory effect

In biological systems, flavonoids, one of the active components of spinach leaves, display antioxidative, antiproliferative, and antiinflammatory activities. Spinach extracts have been shown to offer a wide range of positive effects, including functions that protect against cancer and the ageing process as well as those that protect the central nervous system. In this review paper, we give a collection of research findings from our labs and those of other scientists that describe the chemical makeup of spinach, its health benefits, its general level of safety, and the advice to include it in the diet of people. It was discovered that spinach leaves contain a potent, water-soluble natural antioxidant combination (NAO) that selectively inhibits the lipoxygenase enzyme. When NAO's antioxidative activity was compared to that of other known antioxidants, it was discovered that it was both in vitro and in vivo superior than that of green tea (Lomnitski, 2009).

Anti-Tumor effect

A significant glycolipid component from spinach was successfully purified. Monogalactosyl diacylglycerol (MGDG), digalactosyl diacylglycerol (DGDG), and sulfoquinovosyl diacylglycerol make up the majority of this fraction (SQDG). In a prior work, we discovered that subcutaneous injection of the glycolipid fraction decreased DNA polymerase activity, cancer cell development, and tumour growth. We sought to understand how oral treatment of the glycolipid fraction inhibited mouse colon-26 adenocarcinoma tumour growth. In a tumour graft experiment, oral treatment of 20 mg/kg glycolipid fraction for two weeks resulted in a 56.1% reduction in the solid tumour volume (P 0.05) in mice without causing any negative side effects, such as weight loss or severe

organ failure. The glycolipid fraction resulted in the prevention of colon-26 tumour development (Maeda, 2008).

Antiproliferative activity

This study looked into the potential anti-inflammatory and anti-proliferative properties of organ extracts from water spinach (Ipomoea aquatica Forsk) and 95% ethanol.

Fig. 2: Spinach grown by hydroponic technique

Inhibition of cancer cell proliferation, total phenolic compounds, total flavonoid content, DPPH radical, reducing power method, and FTC method were all used. When diluted to 6.25 mg dry matter/mL, the ethanol extract of the stem had a favourable effect on DPPH staining, whereas the other fractions showed no effect. Moreover, this fraction showed the highest reducing power and FTC activity, as well as the largest amount of all phenolic compounds. The most flavonoids were found in the ethanol extract of the leaf. It was discovered that an ethanol extract of the stem had the colorimetric DPPH technique.

Hydroponics system

Hydroponics is the practise of growing plants without soil. In short, the phrase "hydroponics" is a combination of the Greek terms "hydro" (for water) and "ponos" (labor). The practise of growing plants in a variety of (chemically inert) substrates, such as sand, gravel, or liquid (water), where nutrients are supplied but no soil is used. Because it provides nutrients, water, and air, but more importantly, it gives plants a location to grow successfully, soil is the most accessible substrate for growing plants. Yet, there are many factors that seriously impede plant growth, including unfavourable soil composition, soil erosion, inadequate soil reaction, poor drainage, the presence of disease-causing organisms, and nematodes. To get over these limitations, hydroponic cultivation technology was introduced to agriculture (Dholwani *et al.,* 2018; Abad Syed *et al.,* 2021).

Conclusion:

Spinach is a nutritious vegetable that can provide numerous health benefits. However, it should be noted that individual results may vary and that spinach should not be used as a substitute for medical treatment. The comparison of bio active components presents in spinach plant which is grown both in soil and hydroponic system will show variation. In general, the plant grown in soil system will have some of the bioactive compounds in higher ratio compared to hydroponic system, similarly some of the bioactive compounds present in higher ratio in hydroponic system than that of soil system.

References:

1. Bakhru H K (2014): Healing through Natural Food, Jaico Publishing house, 80, 150, 186, 189.
2. Gaikwad P S, Shete R V, Otari K V, (2010): *Spinacia oleracea* linn: A Pharmacognostic and Pharmacological Overview, International Journal of Research in Ayurveda & Pharmacy, 1 (1); 78-84.
3. Jiraungkoorskul W (2016): Review of Neuro-nutrition Used as Anti-Alzheimer Plant, Spinach, Spinacia oleracea. Pharmacogn Rev. 10(20); 105-108.

a. Kirschner H E (1991): Live Food Juices, H.E. Kirschner Publications, California, 71.

4. Bakhru H K (2001): Food That Heal The Natural Way To Good Health, 17th printing, Orient Paperbacks New Delhi,145-147.
5. Kirschner H E (1980): Nature's Healing Grasses, H C, White Publication California, Chapter two Nature's Green Magic, 21-24.
6. Kline M A, Aman (1969) : Medicinal Secrets of Your Food, Secretary IndoAmerican Hospital N.R. Mohalla, Mysore, India, 373-377.
7. Kumar S, Prasad A, Iyer S V and Vaidya S K (2013): Systematic pharmacognostical, phytochemical and pharmacological review on an ethno medicinal plant, *Basella alba* L. Journal of Pharmacognosy and Phytotherapy, 5(4); 53-58.
8. Laxman Sarma K and Swaminarhan S (2005): Speaking Of Nature Cure, The nature cure Publishing house, Pudukkottai, 66-67.
9. Liat L, Margalit B, Abraham N, Varda BenS, and Shlomo G(2003):Composition, Efficacy, and Safety of Spinach Extracts, Lawrence Erlbaum Associates, Inc., Nutrition and Cancer, 46(2); 222-231.
10. Maeda N, Kokai Y, Ohtani S (2008): Anti-Tumor Effect of Orally Administered Spinach Glycolipid Fraction on Implanted Cancer Cells, Colon-26, in Mice. Lipids 43, 741–748.
11. Mukherjee K R (1983): Protective Foods in Health and Disease, IV edition, 285-288.
12. I Adeniran, Olajide, N C Igwemmar1 and AT Orishadipe (2013): Phytochemical constituents, antimicrobial and antioxidant potentials of tree spinach, Academic Journals, 7(19): 1317-1322,
13. Ramachandran L (1990): Eating for health with emphasis on economy, Laxman sharma Institute of Natural Health Education and Research New Delhi, 285-291.
14. Ramesh Tewani, Jitendra Kumar Sharma, S V Rao (2016): Spinach (Palak) Natural Laxative, International Journal of Applied Research and Technology, 1(2); 140-148.
15. Wigmore A & Weaver D (1984): The Hippocrates Diet and Health Program, Avery publishing group inc. Wayne, New Jersey, 88-90.

Advances in Science and Technology Volume II
(ISBN: 978-93-88901-41-3)

FORMATION AND STRUCTURE OF MICROBIAL BIOFILMS

Santosh Vitthalrao Jadhav

Department of Microbiology,

Khare -Dhere- Bhosale College, Guhagar, Dist. Ratnagiri M.S. 415703

Corresponding author E-mail: jadhavsantoshkdbc@gmail.com

Introduction:

The assembly of microorganisms over a surface and their ability to develop a unique structure, referred to as biofilm. The mechanism of biofilm formation is triggered and regulated by quorum sensing, hostile environmental conditions, nutrient availability, hydrodynamic conditions, cell-to-cell communication, signalling cascades, and secondary messengers. In this chapter, we focus in detail on biofilm formation, its architecture, composition, genes and signalling cascades involved by microorganisms dwelling within biofilms. So, this chapter aims at providing researchers the knowledge regarding recent advances on the mechanisms involved in biofilm formation at the molecular level.

Microorganisms can live in free form or in a consortium of different or same species, called biofilm. Biofilms are an ordered and arranged group of microorganisms living within an extracellular polymeric substance (EPS) matrix produced by them and are adhered to each other on living or non-living surfaces and show variations in terms of growth rate and gene expression when compared to their planktonic form. Biofilms have various pathological manifestations and exist almost everywhere, inhabiting medical implants, living tissues, water channels, pipes, hospital floors, food processing units, and other biotic and abiotic surfaces. As per the reports of the National Institutes of Health (NIH), about 65% and 80% of microbial and chronic infections, respectively, are caused by microbial biofilms, infecting both tissues and medically implanted devices. Breast implants, ventricular shunts, tissue fillers, ventricular-assisted devices, contact lenses, catheters, joint prostheses, urinary catheters, orthopaedic implants, pacemakers, mechanical heart valves, defibrillator, vascular grafts, endotracheal tubes, voice prostheses, etc. are some examples of medically implanted devices often infected by microbial biofilms.

Different sectors of the food industry, viz. poultry, dairy, ready-to-eat, aquaculture, etc., are severely affected by biofilm-producing microorganisms resulting in food spoilage, disease outbreaks, and deaths. So, keeping in view the prevalence of biofilm-associated microorganisms and inefficiency of current antibiotics, the situation requires a transition towards the formation of non-toxic and potent antibiofilm agents targeting signalling pathways regulating quorum sensing (QS), EPS synthesis, biofilm-related genes, microbial motility, adhesion, dispersion, and many more.

Composition of Biofilm:

Biofilm is a heterogeneous structure comprising mainly of microbial cells and self-produced EPS matrix as shown in Table-1.EPS forms a scaffold that holds the biofilm together and, thus, helps in cell-to-cell communication and provides adhesion and cohesion forces required for biofilm formation.

Table 1: Composition of biofilm

Sr. no.	Components	Percentage (%)
1	Microbial cells	2–5
2	Water	Up to 97
3	Polysaccharides	1–2
4	Proteins	< 1–2 (including enzymes)
5	DNA and RNA	< 1–2

The main constituents of Extracellular Polymeric Substance (EPS) could be categorized as follows:

Polysaccharides:

Most of the polysaccharides are heterogeneous while some are homogeneous as well like cellulose, sucrose-derived fructans, and glucans. Various interactions like van der Waals interactions, electrostatic attractive and repulsive forces, ionic attractive forces, and hydrogen bonds promote interaction of polysaccharides with themselves or with proteins and ions required for maintaining structure and stability of biofilm matrix. The role of the polysaccharides is to act as a molecular glue required for bacterial adhesion to each other and to biotic and abiotic surfaces for colonization besides playing a protective role against the immune system, and other external stresses.

Extracellular proteins:

Extracellular proteins in the biofilm matrix are of secreted extracellular proteins, protein subunits of cell appendages such as pili and flagella, cell surface adhesions, and outer membrane vesicle proteins. They interact with exopolysaccharides and nucleic acid components, thus help in biofilm matrix stabilization, surface colonization, and maintaining integrity and architecture of biofilm.

Extracellular DNA:

Extracellular DNA is one of the key constituents of the EPS matrix which is important for microbial aggregation within a biofilm. The mechanism of origin of eDNA is diverse as it is released through bacterial secretion systems, cell death because of phages, autolysis, quorum sensing–regulated DNA release.

Surfactants and lipids:

Some lipids with surface-active properties available in the EPS matrix are surfactin, emulsan, and viscosin. They increase the availability of hydrophobic substances by

dispersing them out. Rhamnolipids, an important class of surfactants studied in *P. aeruginosa*, initiate microcolony formation, help in shaping biofilm, and facilitate biofilm dispersion as well.

Water:

Water is regarded as the largest component of the EPS matrix of biofilm. It keeps the biofilm hydrated and protects it from desiccation even during environmental water content fluctuations. The flow and maintenance of essential nutrients within a biofilm are attributed to the amount of water available.

Biofilm formation:

Biofilm formation is a multi-step and complex process that involves the transition of bacteria from free-swimming planktonic form to biofilm-making sessile form. The whole process of formation is influenced by external conditions like temperature, pH, gravitational forces, hydrodynamic forces, Brownian movements, nature of the inhabiting surfaces, quorum sensing, secondary messengers, and other signalling molecules as well. As shown in Figure-1, different stages of biofilm formation can be divided into following major stages.

Stages of biofilm formation:

1.Attachment,2. Colonization,3. Proliferation,4. Maturation and 5. Dispersion

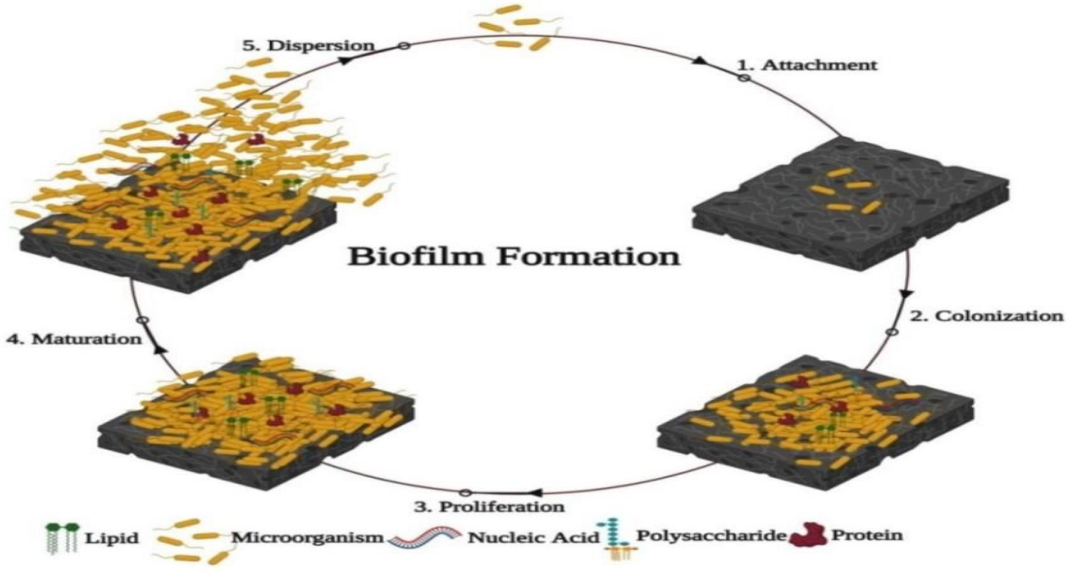


Figure 1: Stages of biofilm formation-1. Attachment, 2. Colonization, 3. Proliferation, 4. Maturation and 5. Dispersion

Bacteria need to be connected to the surface to successfully reach the surface as bacteria approach the surface of liquid environments or suspended media with effective movement or negative. Some species of bacteria show swimming movement to generate active self-driving force but even non-moving bacteria are subject to physical forces that bring them close to the surface in a negative way, the swimming movement is driven by

flagella as the rotation of the flagellum generates the driving force that provides enough energy to reach the surface.

1.Attachment:

Bacterial attachment is the first step in the formation of thin biofilms. The attachment begins with the interaction between a few suspended bacterial cells and the underlying material of the surfaces. This occurs as a result of chemical attraction by a movement of bacterial cells towards the source of nutrients or chemical attractions in moving fluids, when cells reach a surface, the interaction between cell surfaces and surface depends on the total net exuberant or gravitational forces generated between the two surfaces as hydrophobic forces are believed to be the strongest force with a long range of non-covalent reactions in biological systems.

2.Colonization:

Bacterial cells are in retrospectively associated with the surface through strong reactions such as adhesive collagen association proteins, lipopolysaccharides, flagella asses and pili.

3.Proliferation:

As soon as bacterial cells are associated with surfaces and begin to divide and multiply to form 3D clusters called microcolonies.

4.Maturation:

Microcolonies grow and Extracellular Polymeric saccharide (EPS) acts to help cells adhesion to surfaces, bond between cells, stack cells together for the durability of building 3D compositions to protect microcolonies. The maturity of biofilms and the formation of signal molecules lead to structural changes as well as changes in gene expression that encrypt various factors of virulence. Bacterial cells show a complex pattern of cooperative behaviour to demonstrate their ability to communicate with each other as Quorum Sensing (QS) is a generic term used to describe communication between one bacterial cell and another that ensures the survival of species. Bacteria produce many auto-inducers like acyl-homoserine lactone molecule signals to regulate the density of bacterial cell populations.

5.Dispersion:

After the development of the formation of the biofilm is completed, bacterial cells disperse or disintegrate by using active mechanical mechanisms and convert fixed cells into plankton growth pattern, to colonize new sites, to form a new cycle of biofilms.

References:

1. Allesen-Holm, M., Barken, K. B., Yang, L., Klausen, M., Webb, J. S., Kjelleberg, S., Molin, S., Givskov, M., & Tolker-Nielsen, T. (2006). A characterization of DNA release in *Pseudomonas aeruginosa* cultures and biofilms. *Molecular Microbiology, 59*, 1114–1128. doi: 10.1111/j.1365-2958.2005.05008.x.

2. Amankwah, S., Abdella, K., & Kassa, T. (2021). Bacterial biofilm destruction: A focused review on the recent use of phage-based strategies with other antibiofilm agents. *Nanotechnology in Science and Applications, 14*. doi: 10.2147/NSA.S325594
3. Berne, C., Ellison, C. K., Ducret, A., & Brun, Y. V. (2018). Bacterial adhesion at the single-cell level. *Nature Reviews Microbiology, 16*, 616–627.
4. Boles, B. R., Thoendel, M., & Singh, P. K. (2004). Self-generated diversity produces "insurance effects" in biofilm communities. *Proceedings of the National Academy of Sciences USA, 101*, 16630–16635. doi: 10.1073/pnas.0407460101.
5. Cecile Berne, Courtney K. Ellison, Adrien Ducret, Yves V. Brun. (2018). Bacterial adhesion at the single-cell level. *Nature Reviews Microbiology, 16*, 616-627.
6. Flemming, H. C., Wingender, J., Griebe, T., & Mayer, C. (2000). Physico-chemical properties of biofilms. In *Biofilms: Recent Advances in Their Study and Control* (pp. 19–34). CRC Press.
7. Flemming, H. C., & Wingender, J. (2010). The biofilm matrix. *Nature Reviews Microbiology, 8*, 623. doi: 10.1038/nrmicro2415.
8. Fong, J. N., & Yildiz, F. H. (2015). Biofilm matrix proteins. *Microbiology Spectrum*. doi: 310.1038/nrmicro2415.
9. Giaouris, E. E., & Simões, M. V. (2018). Pathogenic biofilm formation in the food industry and alternative control strategies. In *Foodborne Diseases* (pp. 309–377). Elsevier. doi: 10.1016/B978-0-12-811444-5.00011-7.
10. Gupta, P., Sarkar, S., Das, B., Bhattacharjee, S., & Tribedi, P. (2016). Biofilm, pathogenesis and prevention—a journey to break the wall: a review. *Archives of Microbiology, 198*, 1–15. doi: 10.1007/s00203-015-1148-6. Link
11. Ibáñez de Aldecoa, A. L., Zafra, O., & González-Pastor, J. E. (2017). Mechanisms and regulation of extracellular DNA release and its biological roles in microbial communities. *Frontiers in Microbiology, 8*, 1390. doi: 10.3389/fmicb.2017.01390.
12. Jamal, M., Tasneem, U., Hussain, T., & Andleeb, S. (2015). Bacterial biofilm: its composition, formation and role in human infections. *Research Reviews in Journal of Microbiology and Biotechnology, 4*, 1–15.
13. Kjelleberg, S., & Givskov, M. (2007). *The Biofilm Mode of Life: Mechanisms and Adaptations* (1st ed.). Horizon Scientific Press.
14. Lembre, P., Lorentz, C., & Di Martino, P. (2012). Exopolysaccharides of the biofilm matrix: a complex biophysical world. In *The Complex World of Polysaccharides* (pp. 371–392). InTech. doi: 10.5772/51213.
15. Li, X. H., & Lee, J. H. (2017). Antibiofilm agents: a new perspective for antimicrobial strategy. *Journal of Microbiology, 55*, 753–766. doi: 10.1007/s12275-017-7274-x.

16. Limoli, D. H., Jones, C. J., & Wozniak, D. J. (2015). Bacterial extracellular polysaccharides in biofilm formation and function. *Microbiology Spectrum*. doi: 310.1128/microbiolspec.MB-0011-2014.
17. Lu, T. K., & Collins, J. J. (2007). Dispersing biofilms with engineered enzymatic bacteriophage. *Proceedings of the National Academy of Sciences USA, 104*, 11197–11202. doi: 10.1073/pnas.0704624104.
18. Montanaro, L., Poggi, A., Visai, L., Ravaioli, S., Campoccia, D., Speziale, P., & Arciola, C. R. (2011). Extracellular DNA in biofilms. *International Journal of Artificial Organs, 34*, 824–831. doi: 10.5301/ijao.5000051.
19. Muhammad, M. H., Idris, A. L., Fan, X., Guo, Y., Yu, Y., et al. (2020). Beyond risk: Bacterial biofilms and their regulating approaches. *Frontiers in Microbiology, 11*. doi: 10.3389/fmicb.2020.00928.
20. Parrino, B., Schillaci, D., Carnevale, I., Giovannetti, E., Diana, P., Cirrincione, G., et al. (2018). Synthetic small molecules as anti-biofilm agents in the struggle against antibiotic resistance. *European Journal of Medicinal Chemistry, 161*, 154–178. doi: 10.1016/j.ejmech.2018.10.036.
21. Pawar, S., & Lahiri, C. (2018). Quorum sensing: An imperative longevity weapon in bacteria. *African Journal of Microbiology Research, 12*, 96–104.
22. Rather, M. A., Gupta, K., Bardhan, P., Borah, M., Sarkar, A., Eldiehy, K. S., et al. (2021). Microbial biofilm: a matter of grave concern for human health and food industry. *Journal of Basic Microbiology, 61*, 380–395. doi: 10.1002/jobm.202000678.
23. Roy, R., Tiwari, M., Donelli, G., & Tiwari, V. (2018). Strategies for combating bacterial biofilms: a focus on anti-biofilm agents and their mechanisms of action. *Virulence, 9*, 522–554. doi: 10.1007/s12275-017-7274-x.
24. Srinivasan, R., Santhakumari, S., Poonguzhali, P., Geetha, M., Dyavaiah, M., & Xiangmin, L. (2021). Bacterial biofilm inhibition: A focused review on recent therapeutic strategies for combating the biofilm-mediated infections. *Frontiers in Microbiology, 12*. doi: 10.3389/fmicb.2021.676458.
25. Vorkapic, D., Pressler, K., & Schild, S. (2016). Multifaceted roles of extracellular DNA in bacterial physiology. *Current Genetics, 62*, 71–79. doi: 10.1007/s00294-015-0514-x.
26. Wilton, M., Charron-Mazenod, L., Moore, R., & Lewenza, S. (2016). Extracellular DNA acidifies biofilms and induces aminoglycoside resistance in Pseudomonas aeruginosa. *Antimicrobial Agents and Chemotherapy, 60*, 544–553. doi: 10.1128/AAC.01650-15.
27. Zhao, X., Zhao, F., Wang, J., & Zhong, N. (2017). Biofilm formation and control strategies of foodborne pathogens: food safety perspectives. *RSC Advances, 7*, 36670–36683. doi: 10.1039/C7RA02497E.

SIMULATION OF THERMAL CONDUCTIVITY OF NANOFLUIDS BASED ON CLASSICAL MODEL

Vijay S. Raykar*, Vivek A. Rane and Parshuram B. Abhange
G. M. Vedak College of Science,
Tala, Raigad-402111, Maharashtra, India
*Corresponding author E-mail: vijay.raykar@gmail.com

Abstract:

A theoretical model has been proposed that involves four modes contributing to the energy transfer resulting in enhancement of thermal conductivity of Nanofluids. The first mode is collision between base fluid molecules, the second mode is the thermal diffusion in nanoparticles, the third mode is the collision of nanoparticles with each other due to the Brownian motion, and the fourth mode is collision between base fluid molecules and nanoparticles by thermally induced fluctuations. Considering the all the above four modes, the Effective thermal conductivity of Nanofluids has been predicted. The model showed that that the Brownian motion of the suspended nanoparticle is the most important factor in the enhancement of thermal conductivity of Nanofluids.

Keywords: Nanofluids, Brownian Motion, Heat Transfer, Thermal Conductivity

Introduction:

The past few years have witnessed significant advances in our understanding of the effective thermal conductivity (ETC) and related transport properties of Nanofluids (NFs) [1]. Although early theoretical work based on the Effective Medium Theory (EMT) has predicted that the ETC will change nonlinearly with variation in volume fraction, the effect of Brownian motion (BM) on ETC due to nanoconvection diffusion is not considered in this framework [2-4]. In this differential EMT combined with BM induced heat transfer with suitable modification has been explored. The proposed model obtained results has been compared with experimental observations for Ag based NFs. The dispersibility factor related with stability of NFs has been introduced in volume fraction term to quantify the enhancement in ETC [5].

Successful utilization of NFs in any application requires suitable model for predicting ETC, variation in transport properties of NFs with volume fraction of nanoparticles, temperatures and strengths of applied electric and magnetic fields. A large number of NFs has been synthesized using chemical methods and their thermal and rheological properties have been investigated [6]. In this study emphasis has been on the dilute NFs. A transient hot wire (THW) and plane heat source techniques has been developed indigenously and standardized for measurement of thermal conductivity of NFs.

Keeping in view the application of NFs in electrorheological (ER) damper, rheological properties of NFs under electric field has been investigated by researchers.

Overall study of rheological properties of the prepared NFs shows that dilute NFs exhibits Newtonian behaviour [7]. People also studied the effect of magnetic field and its directional variation on the thermal effusivity of synthesized metal oxide-based NFs. It is also observed that doped metal oxide-based NFs shows degraded heat transfer as compared to metal, metal oxide-based NFs. In this study the estimated thermal conductivity of NFs based on silver nanoparticles is compared with the classical effective medium theory model. The dependence of thermal conductivity on various parameters like volume fraction, temperature is shown.

Materials and Methods:

The existing methods of NF synthesis are divided into the single-step and two-step processes. In the single step, NF can be produced during one process cycle. The advantage is reflected by the fact that produced nanoparticles are usually small (2-30 nm), agglomeration is minimized, and the produced NFs are the stable ones. Silver NF was obtained by reduction of silver nitrate with PVP in ethanol under the effect of high temperature [8-10].

Results and Discussion:

For Nonspherical inclusions, the differential effective medium theory gives [6],

Static part: k_{static}

$$\left[\left(\frac{K_m}{K_e}\right)^{\frac{3A}{D}}\left(\frac{K_m+S_+}{K_e+S_+}\right)^{3C_+}\left(\frac{K_m+S_-}{K_e+S_-}\right)^{3C_-}-f+1\right]=0$$

where S_{+-}, C_{+-}, A and D are constants.

From the Jang and Choi model [1], the Brownian term of diffusion can be written as

Dynamic part: $k_{dynamic}$

$$3C_1\frac{d_{bf}}{d_e}K_{bf}\,\mathrm{Re}_{d_{nano}}^2\,\mathrm{Pr}\,f$$

The classical model given by effective medium theory needs to be revised for nanoparticle inclusions. Because NFs shows a fivefold increase in the thermal conductivity as compared to the conventional coolants. From the Figure 1 we can see that the Static Interfacial resistance term negligible at lower volume fraction. Again the effect of temperature is not seen in the classical model. Even if the Brownian motion is considered then one has to look for the scale or size of the particles to which it is applied. Lot of Brownian models one can see in the literature. But the synthesized nanoparticles are also having different shapes and dimensions. So in predicting the effective thermal conductivity we have to look for all these parameters. Considering the Brownian motion it will well predict the thermal conductivity of NFs with variation in the temperature.

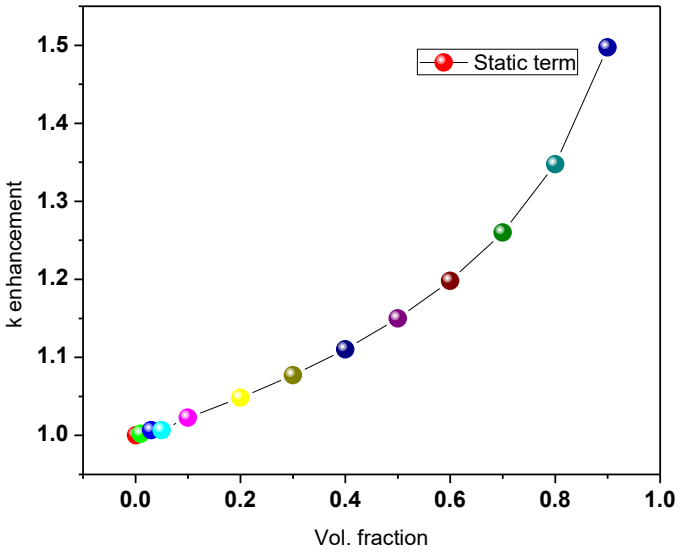


Figure 1: Simulation of thermal conductivity based on classical model

Conclusions:

The effective thermal conductivity has been reported for Ag nanofluids considering static part. The theory for static part has to be revised by taking effect of temperature dependent Brownian motion term.

Acknowledgement:

The authors are obliged to the Chairman and Trustee, Shri. Gopinath Mahadeo Vedak Pratishthan and the Principal, G. M. Vedak College of Science, Tala, Raigad for their support and continuous encouragement.

References:

1. Eastman, J., Choi, S., Li, S., Yu, W., & Thompson, L. (2001). Anomalously increased effective thermal conductivities of ethylene glycol-based nanofluids containing copper nanoparticles. *Applied Physics Letters, 78*(6), 718–720.
2. Das, S. (2006). Nanofluids - The cooling medium of the future. *Heat Transfer Engineering, 27*(10), 1–2.
3. Hosseini, M., & Ghader, S. (2010). A model for temperature and particle volume fraction effect on nanofluid viscosity. *Journal of Molecular Liquids, 153*(2-3), 139–145.
4. Li, C. H., & P. G. (2006). Experimental investigation of temperature and volume fraction variations on the effective thermal conductivity of nanoparticle suspensions (nanofluids). *Journal of Applied Physics, 99*(8).
5. Jang, S., Lee, J. H., Hwang, K., & Choi, S. (2007). Particle concentration and tube size dependence of viscosities of Al2O3 water nanofluids flowing through micro- and minitubes. *Applied Physics Letters, 91*(24).

6. Zhang, X., Gu, H., & Fujii, M. (2006). Effective thermal conductivity and thermal diffusivity of nanofluids containing spherical and cylindrical nanoparticles. *Journal of Applied Physics, 100*(4).
7. Gharagozloo, P., Eaton, J., & Goodson, K. (2008). Diffusion, aggregation, and the thermal conductivity of nanofluids. *Applied Physics Letters, 93*(10).
8. Raykar, V. S., & Singh, A. K. (2011). Photoacoustic method for measurement of thermal effusivity of Fe3O4 nanofluid. *Journal of Thermodynamics, 464368.
9. Cherkasova, A., & Shan, J. (2006). Thermal conductivity enhancement of nanofluids. *Carbon Nanotubes, 222*, 235–237.
10. Xie, H., Lee, H., Youn, W., & Choi, M. (2003). Nanofluids containing multiwalled carbon nanotubes and their enhanced thermal conductivities. *Journal of Applied Physics, 94*(8), 4967–4971.

Advances in Science and Technology Volume II (ISBN: 978-93-88901-41-3)

About Editors

Dr. Med Ram Verma is presently working as a Principal Scientist at ICAR-Indian Veterinary Research Institute Izatnagar, Bareilly, Uttar Pradesh. He passed M.Sc. in Agriculture Statistics in 1998 from Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. He obtained his Ph.D. degree in Statistics in 2005 from Dr. B.R. Ambedkar University, Agra, Uttar Pradesh. He joined Agricultural Research Service in 2003. He guided 4 Ph.D. and 10 M.V.Sc students in the discipline of Biostatistics. He published 227 research papers in reputed journals. He authored/Edited 5 books. He was awarded with Best Teacher Award for the year 2014-15 by ICAR-IVRI Deemed University, Izatnagar, Bareilly, U.P. Dr. Med Ram Verma was awarded with prestigious Bharat Ratna Dr. C. Subramaniam Award for Outstanding Teachers 2018 by Indian Council of Agricultural Research. He is the Fellow of Royal Statistical Society, London (UK) and Elected Member of International Statistical Institute, Netherlands. He is the Editorial Board Member and reviewer of the several journals.

Dr. Padmakar A. Savale (M.Sc., M.Ed., Ph. D.) is presently working as a Head, Department of Physics, SES's Arts & Science College, Bhalod Tal. Yawal Dist. Jalgaon (M.S.) India. He did his Ph.D. in the year 2008 from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S.) India. He has 23 years of teaching experience and 13 years of research experience. He is specialized in Synthesis & Characterization of Conducting Polymers; Conducting Polymer based Bio-Sensors, Gas-Sensors, Optical Fiber Sensors and Crystal Growth. He has 74 National/ International Journal publications, 16 book chapters and 06 Text books publications to his credit. He has handled 01 Minor Research Project with funds from UGC, New Delhi. He is a life member of Indian Science Congress Association, Society for Science and Environment, The Indian Association of Physics Teachers (IAPT) and The International Foundation for Environment and Ecology, Kolkata, India. He is recipient of INSO 'Best Researcher Award', 'Dr. A. P. J. Abdul Kalam Life-Time Achievement International Award 2021" of IRDP Group of Journals, Chennai, 'Young Scientist of the Year 2018 Award' and 'Environment Excellence Award' of International Foundation for Environment and Ecology, Kolkata, West Bengal, 'Best Outstanding Academician National Award 2020' of Kamarajar Institute of Education and Research Theni, Tamil Nadu and prestigious 'Bharat Gaurav Award' from India International Friendship Society, New Delhi.

Dr. S. R. Shaikh is presently working as an Assistant Professor, Department of Zoology, Dr. C. V. Raman Science College, Sironcha. He hs completed his Master degree in Zoology. He got awarded with M. Phil. and Ph. D. from Zoology. He is also working as an Counselor for Yashwantrao Chavan Open University (YCMOU), Nashik, Maharashtra. Dr. Shaik published 22 research articles in reputed International journal, 47 in National and 13 state level journals. He attended, presented and published 39 research papers in various national and international level conferences. He has completed one minor research project on "A Study of Bezor Formation in Goats" funded by UGC, New Delhi. He published a book on "Animal Biotechnolgy" in 2017.

Mr. Dnyaneshwar Prakash Maule is presently working as an assistant Professor at Department of Mathematics, A. V. College of Arts K. M. College of Commerce and E. S. A. College of Science Vasai Road, Palghar, (Maharashtra) India. He has completed M.Sc. in Mathematics from University of Mumbai. He also qualified NET exam in Mathematics. Currently he is pursuing Ph. D. form Mathematics department of Mumbai University. He has an experience of more than 6 years of teaching to under graduate level. He taught various subjects B.Sc. at UG level. He has worked as University Paper setter for one year. He has also delivered invited lecture on NET/SET for M.Sc. students in Mathematics department of Mumbai University.

Bhumi Publishing

ISBN 978-93-88901-41-3

9 789388 901413