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# Essays in Contemporary Science

ശാസ്ത്ര പ്രബന്ധങ്ങൾ

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# Foreword

I take pleasure in writing the foreword to *Essays in Contemporary Science*, the 7th issue (No 2) of the research journal of our college. This is a collection of articles with sensitive and unique perspective on findings and issues in contemporary science. The authors attempt to identify the gaps in present day knowledge and discuss how the gaps can best be filled through research. Let this journal stir further study and research. I take this opportunity to praise all those hands and hearts that worked behind this journal.

**Prof. Sivaramakrishnan. P.A**
Principal
Govt. Arts and Science College

30.7.2016

# Preface

This volume, the 7th issue of Research Journal, Government Arts & Science College, Kozhikode, contains the research manuscripts related to variety of fields of Statistics, Physics, Materials Science, Psychology, Chemistry, Botany, Food safety etc. The journal is the research journal managed by the Research Journal Committee of the college that caters to the factual and informational needs of researchers by providing them a platform where they can do much for satisfying their enthusiasm to research. This is the third journal in the series of journals published by the college and provides access to research thoughts, innovations and original discoveries by publishing them online in or college website for public reading and views.

This volume is an outcome of co-ordinated efforts of a team of a number of people including authors, reviewers, co-ordinators and the research journal committee. A total of fifteen manuscript submissions were selected for publishing in this volume after proper reviews.

In this special issue, we included fifteen research articles of high standard. The first article in this issue is on 'Non-linear time series analysis of human ECG and EEG data' describes the phase plots in normal and disordered states of human heart and brain. From the analysis of the ECG data, the authors of the article conclude that only the normal human ECG show properties that are typical of deterministic chaotic systems. The article on 'MnO2

nanoparticles for dielectric applications' narrate the synthesis and characterization of MnO2 nanoparticles in pure crystalline states with emphasis on their dielectric applications. Another article on 'Anatomical studies on the Genus Zingiber in south India makes a comparative anatomical study of Zingiber Boehm so as to identify correctly the tax. In the article on 'Time series modeling of the silver price data', the authors propose a time series model for the silver price data that can be extended to economic forecasting, stock market analysis etc. The paper titled 'Tuning the basic hydrolysis of Malachite green in CTAB/KBr/alcohol micelles' describes the basic kinetics of the reaction using spectophotometric method. They studied the change in micellar structure with different parameters like alcohol addition, viscosity, rheology etc. The article on 'Genoprotective activity of Barleria prionitis L' evaluates the genotoxicity of the organo-phosphorous insecticide methyl parathion (MP) and genoprotective effect of Barleria prionitis L. using Allium cepa assay. It is reported that the synthetic pesticide possesses severe mito-depressive and genotoxic effects on the samples.

The next article on 'Foot and mouth disease-A case study' is a study that observes the occurrence of the disease in cattle of selected localities of Thrissur district. The authors report that the quality of milk from infected cattle is unaffected and that the milk is suitable for human consumption after boiling. The article titled 'Achievement motivation and stress tolerance among Kerala Police' is a study that explores the achievement and tolerance of Kerala police through a sample of 120 policemen in the age group of 20 to 50 years. The paper concludes that factors like alcohol consumption, non-vegetarian food habits, age etc. affects the achievement motivation and stress tolerance. The article on 'Water sorption studies on poly cellulose composites' elaborates on the sorption characteristics of EAA/micro/nanocellulose

composites using water as the probe liquid. The studies suggest selection criteria for materials to be used for food packaging, controlled drug release, electro-dialysis etc. The next article is on 'Synthetic food colours', in which the authors analyzed different permitted and non permitted food colours used in confectionary items sold in the market. They reiterate the need of relentless campaign to improve awareness in consumers, particularly children. The article on 'Generalizations of the exponential distributions and its applications in lifetime data analysis' explores various generalizations of the exponential distributions and their applications in life time data analysis and illustrates the applications of the exponential distributions with resilient and titled parameters using R package. The paper titled 'Tracing roots of Scientific Psychology - A critical evaluation' describes the evolution of the branch of study 'Psychology' and compares it with other sciences.

We gratefully acknowledge all the supports from the Principal, Prof.P.A.Sivaramakrishnan, for his relentless support, college PTA for the financial support and all staff members for their direct or indirect involvement in the journal publication. We are indeed grateful to all the authors for their efforts and to the reviewers who have provided timely review of the papers.

**Remesh Babu M.K**
(Dept. of Physics)

Kozhikode
30.7.2016

# Nonlinear Time Series Analysis of the Human Physiological Data

■ Rajan Nambiar A, Soorya P.P, Maneesha C

## Abstract

Nonlinear dynamics is concerned with the study of the system whose time evolution equations are nonlinear. Some sudden and dramatic changes in nonlinear systems may give rise to the complex behavior called chaos. The most direct link between chaos theory and the real world is the analysis of time series data in terms of nonlinear dynamics. We analyze human electrocardiogram and electroencephalogram with simple nonlinear time series analysis techniques. Disorders that may occur to heart and brain functioning were also considered during the study. In this study we construct phase plot of the nonlinear time series. The mutual information and false nearest neighbour method are used for finding delay time (τ) and embedding dimension (m). Subsequently, the time series is tested for stationarity and determinism. After positively establishing the presence of determinism and stationarity in the studied time series, then calculate the maximal Lyapunov exponent, thus providing interesting insights into the dynamics

of the human heart and brain. Due to the long time segment of EEG series the criteria of stationarity is impossible to satisfy. Consequently, if the time series are non-stationary, the metric algorithms cannot be used, in other way the calculated magnitudes will be wrong. For further analysis, abstracted those segments of EEG time series have met with the criteria for stationarity and evaluated the features.

## Introduction

A chaotic system is a nonlinear dynamical system which exhibits sensitive dependence on initial conditions. Linear dynamical systems never show sensitive dependence on initial conditions. Some nonlinear dynamical systems show sensitive dependence with initial conditions and need not be chaotic always. These systems are sometimes chaotic and sometimes not chaotic depending on their state, and can be changed from a non–chaotic regime to a chaotic regime and back again by external manipulations of their variables. There has been a large amount of work done over the past few years which has dealt with methods for determining whether a system exhibits dynamical properties, leading to chaotic behavior [16].

The basic principle of almost all nonlinear time series analysis techniques is the reconstruction of the observed system dynamics in a so called state space. If the system is governed by nonlinearity, a simple cause-effect relationship cannot be expected. Rather, nonlinear systems are characterized by a rich variety of dynamics including bifurcations that indicate abrupt state transition or intermittent behavior [2].

We start the analysis of physiological time series by reconstructing the phase space. Physiological recordings are

contaminated by various types of noises which creates problems in the proper analysis of the signals. So in order to eliminate noise, we have to use a simple noise reduction algorithm. For reconstructing phase space we have to find embedding delay ($\delta$) by mutual information method and embedding dimension (m) by false nearest neighbour method. As a prelude to the application of a classical determinism [5] and stationarity [6] test, we apply the method of recurrence plots [3]. After positively establishing the stationarity and determinism we calculate the maximal lyapunov exponent. Due to the long time segment of EEG series the criteria of stationarity is impossible to satisfy. Consequently, if the time series are non-stationary, the metric algorithms cannot be used, in other way the calculated magnitudes will be wrong. For further analysis, abstracted those segments of EEG sleep time series have met with the criteria for stationarity and evaluated the features. The same procedure was used for comparison of normal and abnormal physiological data. Human ECG signals of patients with Apnea, arithmeaya and sudden cardiac death were subjected to study. EEG signals of awake, sleep stages and epilepsy patients were examined.

## Data Analysis

We analyse a short, densely sampled electrocardiographic recording of human heart which can be obtained by the publically accessible MIT polysomnographic data base, although 1minute recordings are available during which the subject was normally asleep (sample 1) with- out any significant movement or apnea attacks. This is our normal sample and also we analyses other three samples with apnea (sample2), sudden cardiac death (sample3) and arithmeaya (sample4). All the

studied time series consists of 15000, 6000, 15000 and 15000 respectively and all data points was sampled at dt =.004s. The studied EEG time series consist of normal human EEG in awake state (11000 data sampled at dt =0.004s thus a total of 44s brain activity is available for study.), normal sleep and epilepsy data (6000 data sampled at dt = 0.002s. thus a total of 12s. brain activity is available for study).

The embedding theorem states that for a large enough embedding dimension m, the delay vectors

$p(i) = (x_i, x_i+\iota, x_i+2\iota,...,x_i+(m-1)\iota)$ .....(1)

yield a phase space that has exactly the same properties as the one formed by the original variables of the system. In equation (1), variables $(x_i, x_i+\iota, x_i+2\iota,...,x_i+(m-1)\iota)$ denote values of the electrocardiographic signal at times t = i dt, t = (i + ι)dt, t = (i +2ι)dt,..., t = (i + (m-1)ι)dt, respectively, where ι is the so-called embedding delay and m is the embedding dimension[7-8]

Before reconstructing the phase space we have to use simple noise reduction algorithm, according to Schreiber , the noise level in an examined time series can be reduced simply by replacing the middle coordinate, i.e. $x_i+(m+1)/2)\iota$ for even or $x_i+((m+1)/2\iota$ for odd m, of each embedding vector p(i) by the average value of the middle coordinate obtained from all those embedding vectors p(k) that are closer to p(i) than some chosen ε. Obviously, the method requires three input parameters, which are ι, m and ε[3-4].

As a first step to the reconstruction, let us use the mutual information method to find embedding delay (ι). Fraser and Swinney [11], who proposed to use the ?rst minimum of the mutual information between $x_t$ and $x_t+\iota$ as the optimal embedding delay.

First minimum of the mutual information calculated for normal electrocardiographic signal obtained as ι=8 (see fig 1)

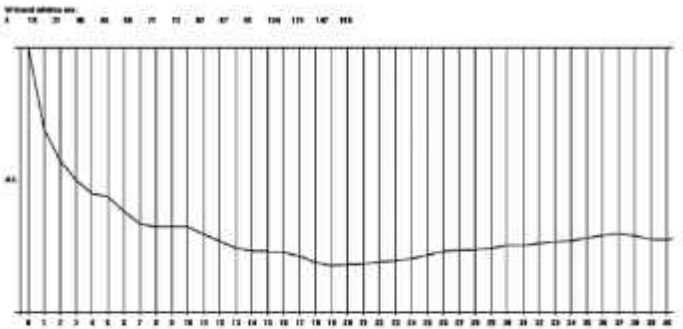


*Fig 1: determination of time delay of sample 1, t=8.*

| State | Signal | Time delay |
|---|---|---|
| 1. Normal | ECG | 8 |
| 2. Apnea | ECG | 9 |
| 3. Arithmeaya | ECG | 52 |
| 4. Sudden cardiac death | ECG | 36 |
| 5. Normal awake | EEG | 4 |
| 6. Normal sleep | EEG | 8 |
| 7. Epilepsy | EEG | 6 |

*Table below shows the time delays of other samples of ECG and EEG data.*

The next step is to find embedding dimension. We use false nearest neighbour method. The false nearest neighbour method was introduced by Kennel et al [10]. as an e?cient tool for determining the minimal required embedding dimension m in order to fully resolve the complex structure of the attractor. Again note that the embedding theorem by Takens guarantees a proper embedding for all large enough m, that is also for those that are larger than the minimal required embedding

dimension. In this sense, the method can be seen as an optimization procedure yielding just the minimal required m. The method relies on the assumption that an attractor of a deterministic system folds and unfolds smoothly with no sudden irregularities in its structure. The false nearest neighbour method can also be used to determine the presence of determinism in a time series [9].

The embedding dimension m is chosen sufficiently large, the fraction of points that have a false nearest neighbor (fnn) converges to zero. Result obtained with the fnn method for m=1-12 are presented (normal ECG). It is evident that at least for m=10 the fraction of points that have a false nearest neighbour drops convincingly to zero (<1%). Hence, the underlying system that produced the studied human electrocardiogram has approximately ten *active degrees of freedom [3]*.

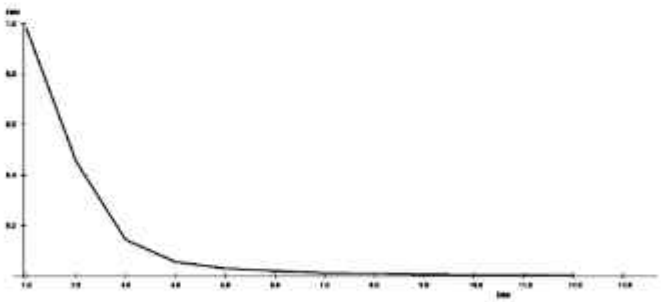


*Fig 2 :determination of embedding dimension m=10 for normal ECG data( τ=8).*

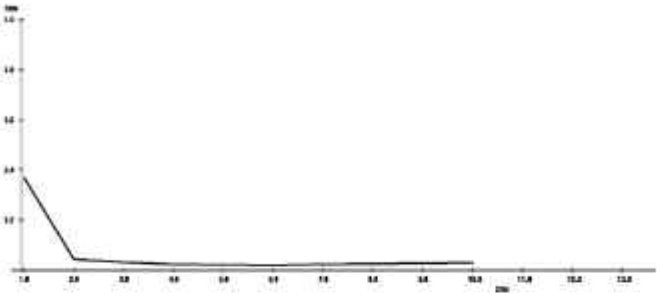


*Fig 3: determination of embedding dimension m=6 for normal awake EEG data (t=4)*

| State | Signal | Embedding dimension |
|---|---|---|
| 1. Normal | ECG | 10 |
| 2. Apnea | ECG | 8 |
| 3. Arithmeaya | ECG | 10 |
| 4. Sudden cardiac death | ECG | 7 |
| 5. Normal awake | EEG | 6 |
| 6. Normal sleep | EEG | 8 |
| 7. Epilepsy | EEG | 5 |

*Table-2*

Now we are in a state to reconstruct the phase space, since we have obtained with proper embedding delay and dimension. Two dimensional projection of the reconstructed phase space of each sample are hown below.

Recurrent behaviour is an inherent property of oscillating systems. Depending on the application, there also exist several variations of recurrence plots. The most important feature of each recurrence plot is its large- and small-scale structure, later being termed typology and texture, respectively. By visually inspecting the typology and texture of a recurrence plot,

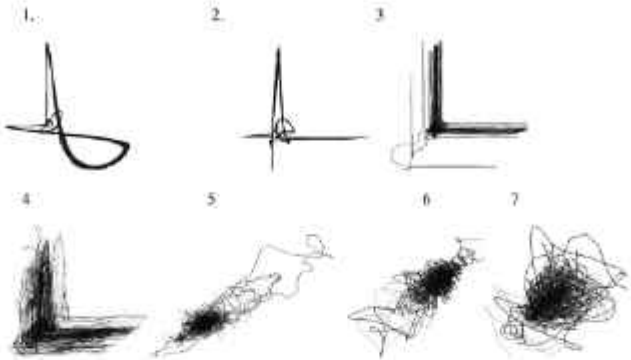



*Fig:4 Phase plotes of various time series. 1.normal human ECG, 2. Apnea ECG, 3.Arithmeaya ECG, 4.Sudden cardiac death ECG 5.normal awake EEG, 6.sleep EEG, 7.epilepsy EEG*

properties of the system such as stationarity and determinism can be assessed. In particular, a homogenous typology is an indicator that the studied data set originated from a stationary process. In contrast, a non-homogenous or disrupting typology indicates non-stationarity in the system. Texture, on the other hand, can provide information regarding deterministic versus stochastic origin of the signal, as well as give insights into the complexity of oscillations. Lack of texture, i.e. solely isolated recurrence points, often indicates stochastic origin of the examined time series (this is especially true for time-continuous-like recordings as is the studied electrocardiogram), while diagonal lines indicate deterministic oscillations, which depending on the complexity of emerged small scale patterns can be further classified into simple, complex or chaotic oscillations. The recurrence plot of the studied electrocardiographic signal can be obtained with the program *recurrplot.exe*.

For $\tau = 8$, $m = 10$, $\varepsilon = 0.065$ and the 'clean' series as input in the case of normal human ECG data (sample1), the typology is homogeneous whilst the small-scale structure is characterized by diagonal lines of variable .But in all other samples the structure is not uniform. Which prove sample 2, sample 3 & sample4 shows poor determinism and stationarity [20].

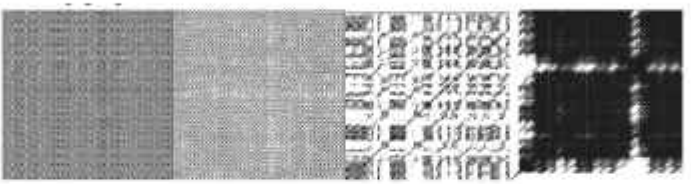


Fig :5 Fig 6 Fig 7 Fig 8

*Figures shows the recurrence plot of ECG data having sta*$\varepsilon/2 = 0.065$ *(sample1)* $\varepsilon = 0.1276$ *(sample2),* $\varepsilon = 0.1659$ *(sample3)* $\varepsilon = 0.1893$ *(sample4)*

Now we apply the determinism test which was proposed by Kaplan and Glass [5]. Deterministic time series always originates from a deterministic process which can always be described by a set of more or less complex first-order ordinary differential equations. But we have with only a time series. From which we have to develop a vector field. The idea is that neighbouring trajectories in a small portion of the embedding space should all point in the same direction, thus assuring uniqueness of solutions in the phase space, which is the hallmark of determinism.

Next we have to verify the stationarity of both of the time series under study. The terms "stationarity" mean that characteristic of a time series, such as mean, variance, and spectral characteristics, don't change with time. The cross prediction

| State | Signal | K |
|---|---|---|
| 1. Normal | ECG | 0.9682 |
| 2. Apnea | ECG | 0.9024 |
| 3. Arithmeaya | ECG | 0.6484 |
| 4. Sudden cardiac death | ECG | 0.5064 |
| 5. Normal awake | EEG | 0.6473 |
| 6. Normal sleep | EEG | 0.8725 |
| 7. Epilepsy | EEG | 0.7630 |

*Table 3*

error statistics which was proposed by Schreiber [12] provides an appropriate tool for testing the stationarity of data. For a stationary process the maximal cross prediction error should not be even one time larger than the average cross prediction error and all the cross prediction errors differ maximally a factor of two.

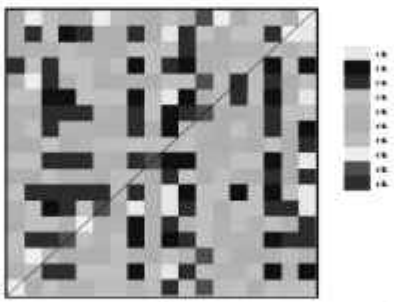


*Fig:9 Statinarity test for normal human ECG. Minimal cross prediction error=0.3344, maximal RMS cross prediction error =0.6411, average RMS cross prediction error=0.4606.*

Since the maximal cross-prediction error is not even one time larger than the average and all cross-prediction errors

differ maximally by a factor of 2, we can clearly refute non-stationarity in the normal human ECG time series. The other ECG samples were also in agreement to the above result. In the case of sample2 the average value of all $\delta_{ij}$ is 0.7560, while the minimum and maximum values are 0.5007 and 0.9530, and in sample 3 the average value of all $\delta_{ij}$ is 0.7590, while the minimum and maximum values are 0.0839and 1.7748and for sample4 The average value of all $\delta_{ij}$ is 0.8736, while the minimum and maximum values are 0.2130 and 0.8736.

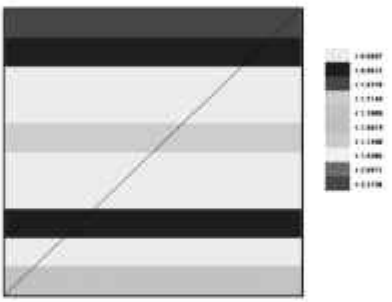


*Fig:10 Stationarity test for normal awake human EEG. Minimal cross prediction error=0.5081, maximal RMS cross prediction error =2.2736, average RMS cross prediction error=0.8761*

The minimal RMS cross-prediction error is 0.5081, the maximal RMS cross-prediction error is 2.2736 and the average RMS cross-prediction error is 0.8761. The above results indicate that non-stationarity is strictly true for awake states. The methods of nonlinear time series analysis can be successfully applied only if the studied data set originates from a deterministic stationary system. Hence further analysis cannot be done. The terms "non-stationarity" or "time-varying" mean that characteristic of a time series, such as mean,

variance, and spectral characteristics, change with time. Statistical tests of stationarity have revealed a variety of results, depending on conditions, with estimates of the amount of time during which the EEG is stationary ranging from several seconds to several minutes. Then, in order to assure the stationarity of the EEG zones to be used for the dynamical analysis, we use the following procedure, based in the weak stationarity criteria[13]. That is, the time series divided in to bins with a length of 1000 data points (about 4 s of digitalized EEG signal). The mean and variance were evaluated for each bin, and we looked for zones where these values did not change significatively for at least five consecutive bins. constructed the corresponding histogram for this zone, and verified the normality of the obtained distribution. This procedure was successful only in EEG sleep signals and the Epilepsy signal, since in the time series of normal awake EEG no consecutive bins were found with nearly equal mean and variance. From a time series of 30000 points, we abstracted a 6000 points satisfied with the above criterion and subjected to study, that is the studied Sleep and Epilepsy signals were a result of 12s. brain activity. These segments were given a positive result in stationarity test also.

In order to determine the Lyapunov exponent we use the algorithm developed independently by Kantz and Rosenstein *et al* [14]. The algorithm tests the exponential divergence of nearby trajectories directly and thus allows a robust estimation of the maximal Lyapunov exponent [3].

The results obtained for $\varepsilon = 0.01–0.065$ are presented in figure. We find that the linear slope of the graph equals $\approx .013$, from which we conclude that the studied short stationary data segment of the human electrocardiogram possesses properties typical of deterministic chaotic signals. Similar analysis

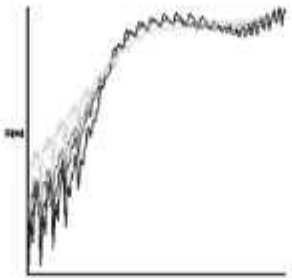


*Fig:11 Calculation of the maximal Lyapunov exponent for normal EEG signals*

on sleep EEG and Epilepsy EEG also obtained with positive maximal lyapunov exponents 0.0176 and 0.00506 respectively.

## Discussion

We analysed the human electrocardiogram and human electroencephalogram using methods of nonlinear time series analysis. From the analysis of ECG data, only the normal human ECG show properties that are typical of deterministic chaotic systems. Remaining samples (abnormal ECG) shows poor determinism and stationarity of signal. The result was conferred by plotting recurrence plot also. Among the three types of EEG time series analysed, the normal human brain activity in awake state is a non-stationarity process. Further analysis was not done over it. In signals of sleep cycle and patient with epilepsy the stationarity lasts for several seconds. The maximal Lyapunov exponent found for these two time series was greater than zero. This is an indication of deterministic chaos.

**References**

1. www.PhysioBankATM.com
2. Physical review E, volume 64, 061907 Indication of nonlinear deterministic and finite dimensional structures in time series of brain electrical activity : Dependence on recording region and brain state.
3. Eur. J. Phys. 26 (2005) 757–768 Nonlinear time series analysis of the human electrocardiogram Matjaz¡Perc.
4. Kantz H and Schreiber T 1997 Nonlinear Time Series Analysis (Cambridge: Cambridge University Press).
5. Kaplan D T and Glass L 1992 Direct test for determinism in a time series *Phys. Rev. Lett.* 68 427–30.
6. Schreiber T 1997 Detecting and analyzing non-stationarity in a time series with nonlinear cross-predictions *Phys.Rev. Lett.*78 843–6.
7. Takens F 1981 Detecting Strange Attractors in Turbulence (Lecture Notes in Mathematics vol 898) ed D A Rand and L S Young (Berlin: Springer) p 366.
8. Sauer T, Yorke J A and Casdagli M 1991 Embedology J. Stat. Phys 65 579–616.
9. Introducing nonlinear time series analysis in undergraduate courses Matja¡z perc1 Online ISSN 1333–9125.
10. Kennel M B, Brown R and Abarbanel H D I 1992 Determining embedding dimension for phase space reconstruction using a geometrical construction Phys. Rev. A 45 3403–11.
11. Fraser A M and Swinney H L 1986 Independent coordinates for strange attractors from mutual information Phys. Rev. A 33 1134–40.
12. Schreiber T 1997 Detecting and analyzing non-stationarity in a time series with nonlinear cross-predictions *Phys.Rev. Lett.***78** 843–6.
13. Stationarity of EEG signals S.Blano ,H.Garcia National Research Council, Argentina Departomento de Fisica, Uniienidad de Buenos Aires instituto de Investigaciones Neuro-

logicos instituto de Calculo, Universidad de Buenos Aires.
14. Kantz H 1994 A robust method to estimate the maximal Lyapunov exponent of a time series Phys. Lett. A 185 77–87.
15. All results presented in this project report can be easily reproduced with the set of programs that can be downloaded from http://?zika.uni-mb.si/~matjaz/ejp/time.html.
16. G Aruldas Classical Mechanics.
17. Low-dimensional chaos in an instance of epilepsy :Babloyantz and A. Destexhe Proc. Nail. Acad. Sci. USA Vol. 83, pp. 3513-3517, May 1986 Neurobiology.
18. Nonlinear EEG Analysis in Epilepsy: Journal of Clinical Neurophysiology 18(3):209–222, Lippincott Williams & Wilkins, Inc., Philadelphia © 2001 American Clinical Neurophysiology Society.
19. A survey on different noise removal techniques of EEG signals Priyanka Khatwani, Archana Tiwari, International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 2, February 2013.
20. Reccurence plot for the analysis of complex system mcarmen Romano.

# $MnO_2$ Nanoparticles for Dielectric Applications

■ Abdul Gafoor A.K, Divya M, Sanju Raj N

## Abstract

Manganese Dioxide ($MnO_2$) nanoparticles in pure crystalline phase were synthesised by a low temparature hydrothermal process at 383K. The crystalline nature is investigated by X ray diffraction(XRD). The topology, morphology and the structure of the sample were studied by Scanning Electron Microscopy (SEM) and Tran-smission Electron Microscopy (TEM). Selected Area Electron Diffraction (SAED) pattern is used to confirm the crystalline Phase. Dielectric properties of the samples were analyzed by LCR Hi-Tester in the frequency range 40Hz to 2MHz. These properties of samples can be used for optical and dielectric applications.

## Introduction

During recent decade's metallic nanoparticle have been found very interesting due to their unique characterizations which make them suitable for different applications. Magnesium oxide (MgO) is widely used in the industry as a scrubber

for air pollutant gases ($CO_2$, NOX, SOX) and as a catalyst support. The principal use for $MnO_2$ is for dry-cell , such as the and the . $MnO_2$ is also used as a and as a precursor to other manganese compounds, such as $KMnO_4$[1] . $MnO_2$ is a blackish or brown solid occurs naturally as the mineral SS, which is the main ore of and a component of . It have various polymorphs, including β, γ, δ, λ and å form among them, β–$MnO_2$ is the most stable in thermodynamics and is very easy to prepare. Like many other dioxides $MnO_2$ crystallizes in the (polymorph called β-Mn $O_2$).

Hydrothermal method has the potential to synthesize one-dimensional nanomaterials which is demonstrated recently. It is environmentally benign, inexpensive and allows for reduction of free energies for various equilibrium. Advantages of the hydrothermal method over other types of crystal growth include the ability to create crystalline phases which are not stable at the melting point. Also, materials which have a high vapour pressure near their melting points can be grown by the hydrothermal method. The method is also particularly suitable for the growth of large good-quality crystals while maintaining control over their composition.

## Experimental Procedures

5.44 g of $K_2S_2O_8$ is dissolved in 40 ml of distilled water and stirred vigorously for 15 minutes to form the first solution. 3.40 g $MnSO_4.H_2O$ is dissolved in 30 ml of distilled water and stirred vigorously well for 15 minutes to form the second solution. These two solutions are mixed in proportion and stirred vigorously well for 30 minutes. pH of the mixture is noted as 3. The resulting transparent solution was transferred in to a teflon lined stainless steel autoclave and treated

hydrothermally at $110^0$C for 5 hours. After the reaction was completed, the sample is washed well by using water and ethanol to remove impurities. It is then dried at $80^0$C.

The synthesized samples were characterized by XRD, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Selected Area Electron Diffraction (SAED). The crystal structure of synthesized nanoparticle was investigated by X-ray diffraction patterns using a Rigaku Miniplex 800 X-ray diffractometer fitted with CuK$\alpha$ radiation ($\lambda$=1.5406 $A^0$) at a scan speed of $0.02^0$ per minute, at room temperature. The intensity data was recorded by continuous scan of $2\theta$ mode from $10^0$ to $80^0$. The morphology and crystalline structure of sample were determined by HITACHI SU800 SEM instrument and Transmission Electron Microscopy. Dielectric studies of the sample were carried out with HIOKI 3532-50 LCR HITE STER set up.

## Results and Discussion

### X-Ray Diffraction

Figure 1 shows the X-ray diffraction patterns of synthesized samples .The prominent peak obtained were successfully assigned and indexed by JCPDS file 24-72 confirmed the crystalline structure of $MnO_2$. No other phase was detected in the pattern, indicating high purity of synthesized sample.

The mean particle diameter was calculated from the XRD pattern according to the line width of prominent peaks using Debye-Scherrer forumula,

$D = 0.9\lambda / \beta Cos\theta$

Where $\beta$ is the full width at half maximum (FWHM) value of XRD diffraction lines, wavelength $\lambda$=1.5406 $A^0$ and $\theta$ is

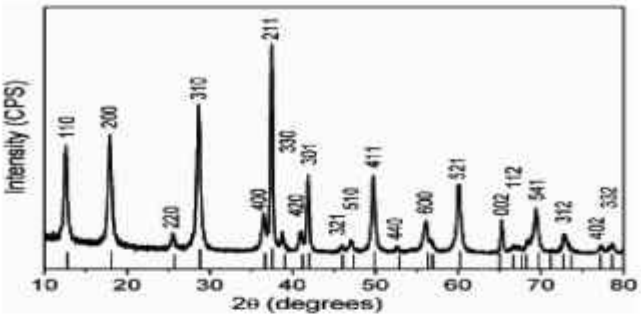



*Figure1. XRD spectrum of MnO2 nanoparticle*

the half diffraction angle of 2θ. The particle size is determined by taking the average of the size at the peaks.

## Scanning Electron Microscopy

The SEM image of synthesized sample is shown in Figure 2. SEM micrograph is found agglomerated and the particle sizes are found in the order of nanometer scale. The particles are almost spherical with varying sizes, might be due to non uniform distribution of temperature during synthesis. It can be observed that product aggregation is constituted by many irregular particles with a variety of pores and voids due to the evolution large amount of gases that are formed as by product during synthesis. Highly porous nature of $MnO_2$ facilitates and enhances the adsorption characteristics.

## Transmission Electron Microscopy [TEM]

The morphology and particle size of the product were also determined from transmission electron microscopy. The observed results are given in Figure.3 for freshly prepared

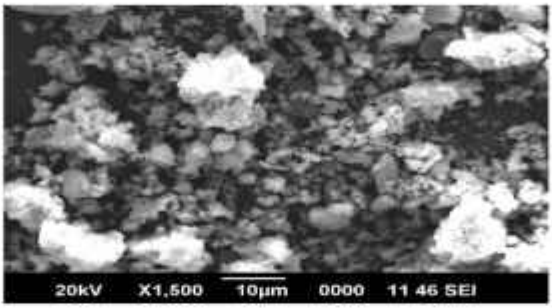



*Figure 2. SEM image of MnO2 nanoparticles*

manganese dioxide nanoparticles. Because of the random nature of aggregate formation, the synthesized $MnO_2$ nanoparticle aggregates have a broad distribution of sizes and shapes. This variety of sizes and shapes are apparent from the TEM images. The $MnO_2$ formed has a particle size in nanometer range. The corresponding SAED pattern is shown in Figure 4.

The SAED pattern reveals the $MnO_2$ particles are crystalline in nature and the crystalline planes are determined. The results obtained are in agreement with the findings from XRD peaks. The size of nanoparticle according to the image was found to be consistent.

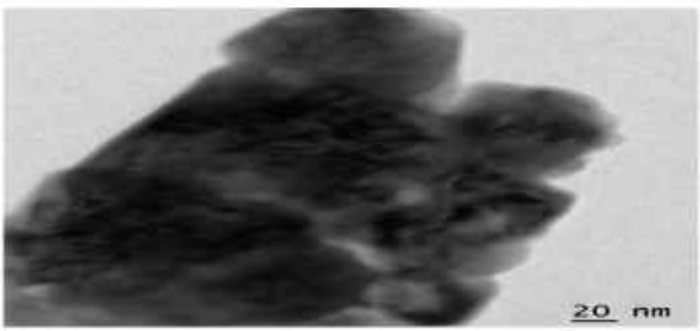



*Figure 3. TEM image of MnO2*

*Figure 4. SAED pattern of MnO2*

## Dielectric Studies

Dielectric studies of the prepared pellet of synthesized $MnO_2$ nanoparticle were carried out with the aid of HIOKI 3532-50 LCR HITESTER set up. The dielectric properties are influenced by grain size, cation distribution, synthesis method etc.. Figure 5 shows the variation of dielectric constant ($\varepsilon_r$) with respect to frequency for the sample at room temperature.

The dielectric constant ($\varepsilon_r$) of the synthesized sample is calculated using the following equations, $\varepsilon_r = C\,d/\varepsilon_0 A$

where C is the capacitance, d is the thickness, A is the area of the sample and $\varepsilon_0$ is the absolute permittivity of free space($8.854\times10^{-12}$F/m).

From the graph, it is clear that the dielectric constant has a high value in the low frequency region of the sample. This is due to existence of various types of polarization mechanisms like electronic, ionic, orientation and space charge polarization. Due to the application of an electric field the space charges are moved and dipole moments are created. this is called as space charge polarization. In addition to this, these

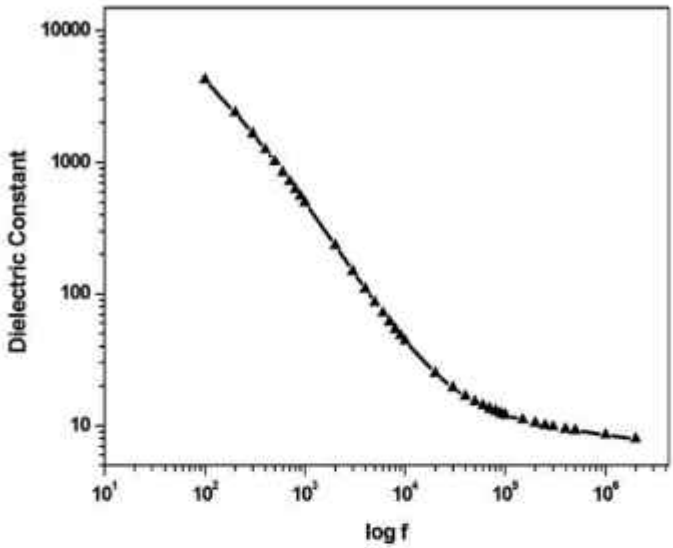



*Figure 5 . Variation of Dielectric constant with frequency*

dipole moments are rotated by the field applied resulting in rotation polarization which is also contributing to the high values. Whenever there is an increase in the temperature, more dipoles are created and the value increases. In the high frequency region, before the field reversal occur the charge carriers may have started to move and dielectric constant fall to a small value.

## AC Conductivity Analysis

The ac conductivity versus frequency graph is shown in figure 6.

The AC conductivity of the sample is determined by using the formula

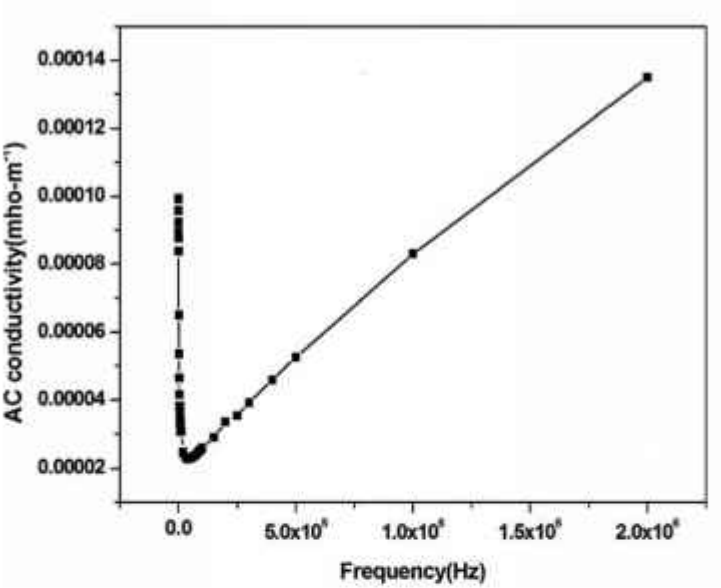



*Figure 6. AC conductance with frequency*

$\delta_{a,c} = 2\pi\varepsilon_r.\varepsilon_0 \tan\delta f$ ,

Where, $\varepsilon_0$ is the permittivity of free space, $\varepsilon_r$ is the dielectric constant, $f$ is the frequency and tan $\delta$ is the loss factor. From the graph it is clear that AC conductivity increases as frequency increases. It is the common behavior shown by nanomaterials. At lower frequency the AC conductivity is minimum and it increase as the frequency increases

## Conclusions

In the present work, $MnO_2$ nanoparticles in pure crystalline phase were synthesized by a low temperature hydrothermal process. The temperature maintained for the synthesis is $110\ ^0$C. The crystalline nature and phases were inves-

tigated by XRD, SEM and TEM It is observed that the sample showed high dielectric constant in the low frequency region and found decreased with frequency. The AC conductivity of the sample is found increasing with frequency. The present work could be utilized for synthesizing nano $MnO_2$ particle for various applications. Other properties like magnetic behavior and optical absorbance etc. are scopeful and demands research.

**References**


1. X.K. Huang, D.P. Lv, H.J. Yue, A. Attia, Y. Yang, Nanotechnology 19 (2008) 225606.
2. N. Pradhan, H. Xu, and X. Peng, Nano Lett. 6, 720 (2006).
3. T. Gao, H. Fjellvag, and P. Norby, Nanotechnology 20, 055610 (2009).
4. X. K. Huang, D. P. Lv, H. J. Yue, A. Attia, and Y. Yang, Nanotechnology 19, 225606 (2008).
5. M. Wei, Y. Konishi, H. Zhou, H. Sugihara, H. Arakawa, Nanotechnology 16 (2005).

# Anatomical Studies on the Genus *Zingiber Boehm* (Zingiberaceae) in South India

■ Vasantha V.A, M. Sabu

## Abstract

A comparative anatomical study of South Indian species of *Zingiber* Boehm. is attempted with reference to the leaf, leaf margin, pulvinus, midrib, stem and root to provide some information which will help in the correct identification of taxa. Anatomical studies of about 9 species of *Zingiber* were carriedout. A key based on their anatomy is provided.

***Key words***: *Zingiber*, Zingiberaceae, South India, Leaf anatomy, Midrib, Pulvinus, Leaf sheath.

## Introduction

The genus *Zingiber*, the type genus of the family, belongs to Zingiberaceae. The family includes about 53 genera and more than 1200 species, distributed mainly in tropics and sub tropics with the centre of distribution in the Indo-Malayan region but extending through tropical Africa to Central and South America (Kress *et al.*, 2002). The genus *Zingiber* is represented by 141 species (Theilade, 1999; Theilade & Mood 1999) distributed mainly in tropical Asia. Sabu (2003) revised the genus

*Zingiber* in South India and recorded the occurrence of 8 species.

Nine species of *Zingiber* occur in South India *viz*., *Z. capitatum* Roxb. var. *elatum* Roxb., *Z. cernuum* Dalzell, *Z. montanum* (K. D. Koenig) Link ex. Dietr., *Z. neesanum* (J. Graham) Ramamoorthy, *Z. nimmonii* (J. Graham) Dalzell, *Z. officinale* Roscoe, *Z. roseum* (Roxb.) Roscoe, *Z. wightianum* Thwaites, and *Z. zerumbet* (L.) Smith.

*Zingiber* species are perennial rhizomatous herbs with tuberous sympodial rhizomes. *Zingiber* is distinct from other

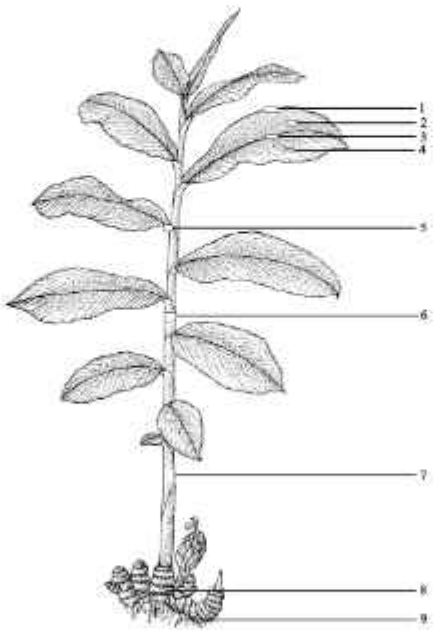



*Fig.01: Diagrammatic representation of a typical Zingiber plant showing the portions of various parts taken for study. 1. Margin, 2. Lamina, 3. Midrib, 4. Epidermis, 5 Pulvinus, 6. Sheath, 7. Aerial Stem, 8. Rhizome, 9. Root.*

genera of the family by the presence of a single anther with a beak or horn-like appendage, which embraces the upper part of the style. Aerial shoot is often covered by sheathing leaf bases, inflorescence is usually a spike or raceme, which usually arises at the base of the leafy stem on a short or long, aerial or subterranean peduncle and rarely terminal. The bracts are overlapping; each subtends a non tubular bracteole and a single flower. In many species the bracts are green when young, turning to red in the fruiting stage. The flowers are very delicate and fragile, they wither and crumble forming a gummy mass, soon after collection, making it difficult to study floral morphology, unless fresh flowers are readily available. The genus can be recognised in the vegetative stage by the presence of a pulvinus between the base of the petiole and ligule.

Anatomical evidences can be useful in various ways, such as identification of fragmentary materials, identification of herbarium materials when morpholological characters are misleading and they can be used to infer evolutionary trends and inter-relationships of taxa at and above species level (Paliwal and Anand, 1978; Hussin *et al.* 2001).

## Material and Methods

Plant parts like epidermis of leaves, foliar anatomy of stem, rhizome, and root were taken from live plants growing in Calicut University Botanical Garden, which were collected from different parts of South India. Free hand sections of were cut invariably from $5^{th}$ leaf from the tip. Epidermal peels were prepared by mechanical scratching or boiling with KOH. Sections were stained with safranine and observed under microscope for details. To study the xylem elements, maceration of stem, root, petiole, and rhizome were done

according to Jeffrey's method (Johansen, 1940). Photographs were taken with the help of Nikon Trinocular Microscope Eclipse-E- 100. Image analyzer and Sony Digital camera (DSC 7.6) attached to Zeiss stemi DV4 Stereo microscope. For the study of stomatal development young leaves, which were rolled inside the concentric layers of leaf sheaths, were dissected out after slashing the stem into longitudinal halves. Small portions of the young leaves were cut and fixed in alcohol-acetic acid-mixture (3:1) for six hours. The leaves were crushed on a slide and mounted in 1% acetocarmine solution and warmed on a hot plate. When cooled, the slides were sealed with nail varnish and observed after 4-6 hours. Drawings were made using camera lucida attached to a trinocular compound microscope (Olympus CX21FS 1 model).

## Observations

A comparative account of anatomical features of different species of *Zingiber*is provided.

*Stomata*: Stomata observed in all species posses a similar fundamental structure. Tetracytic stomata are prevalent and much more frequent in abaxial surface than adaxial (Olatunji, 1970). Guard cells are dumb-bell shaped, two lateral and two terminal subsidiary cells associated with each pair of guard cells are distinct in size from other epidermal cells. They are generally absent in the costal region. The orientation of stomata is unidirectional; the guard cells lie more or less parallel to the long axis of the veins. Size of guard cell in abaxial epidermis is smaller than that of adaxial surface. The longest stomata are present in *Z. capitatum* var. *elatum* 50-63 µm, while the smallest in *Z. officinale* (30-36.9 µm). In *Z. cernuum* 36-41 µm, *Z. montanum* 48-53 µm, *Z. neesanum* 38-40 µm, *Z. nimmonii* 40-

46 µm, *Z. officinale* 30-36.9 µm, the smallest, *Z. roseum* 44-48 µm, *Z. wightianum* 47-49.2 µm, and *Z. zerumbet* 39-43 µm. According to Dunn *et al.* (1965) stomatal patterns and size of stomata in each species of monocotyledons are much more consistent than in dicotyledons and can be used as a reliable character. The study of stomatal development shows that tetraperigenous development is predominant in genus *Zingiber* of South India.

Stebbins and Khush (1961) suggested that the variation in the organization of the stomatal complex in the leaf epidermis has a role in phylogeny. Olatunji (1970) suggested a tetraperigenous development of stomata in the genus *Zingiber*.

## Stomatal development

The stomata are amphistomatic, and more frequent on abaxial side than adaxial surface in *Zingiber* species. Tetracytic stomata are present in all species of genus *Zingiber* in South India. The stoma is surrounded by four cells; two of which are parallel and the other two at right angles to the long axis of the guard cells. Olatunji (1980) reported stomatal development as tetraperigenous in Zingiberaceae. In the present study all species of *Zingiber* of South India have been worked out for stomatal development. Tender unopened leaves were taken for the study. Initially the cells in the epidermis are very small, with dense cytoplasm and prominent nucleus. The initial cell 'meristemoid' is usually distinguishable from other differentiating protodermal cells by its rounded corners, dense cytoplasm, relatively large nucleus, and deep staining contents. Surrounding each meristemoid are four neighbouring cells, two lateral neighbouring cells and two terminal neighbouring

cells. They are smaller than the guard cell mother cell (GCMC). Both lateral and terminal neighbouring cells divide to cut off small cells surrounding the GCMC. Later GCMC divides and gives rise to two guard cells. Guard cells are long, dumb-bell-shaped with a prominent nucleus. A pore is developed in between the guard cells. Thus two parallel and two terminal subsidiary cells are formed around guard cells. This gives rise to tetracytic stomata with two guard cells and four subsidiary cells; two laterals and two terminals **(Fig. 05).**

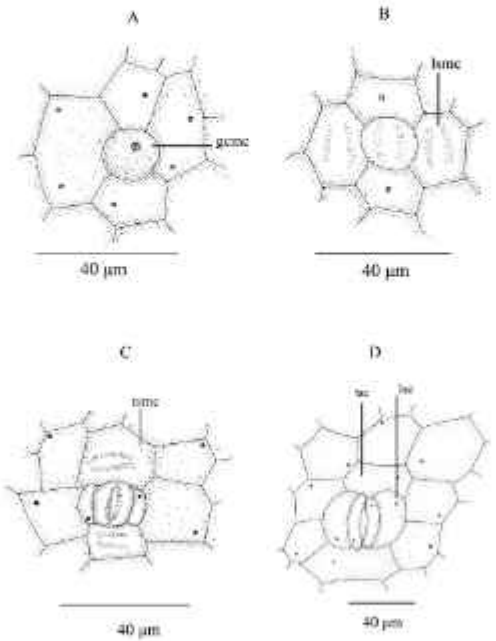



*Fig: 05. Stomatal development in Zingiber cernuum: Gcmc- guard cell mother cell; Lsmc- lateral subsidiary cell mother cell; tsmc- terminal subsidiary cell mother cell; Lsc- lateral subsidiary cell; tsc- terminal subsidiary cell.*

*Trichome*: These are unicellular hairs with pointed tips, base of the trichome is swollen, lumen is narrow and the walls are thick due to cuticularisation. Hairs upto 1 mm long are seen on the midrib, petiole, sheath and leaf margins and the type of hair is 'Borte" bristle type. Delicate hairs 'Weichhaarre' type are seen on the abaxial surface of *Z. officinale* (Tomlinson, 1956), *Z. nimmonii*, *Z. zerumbet* and *Z. wightianum*. Length varies from 500 m to 1.3 mm. Smallest trichome are seen in *Z. capitatum* var. *elatum* 551-896 µm and largest in *Z. montanum* 790 µm-1.3 mm and *Z. officinale* 800 µm-1.3 mm. Trichomes are present only on lower epidermis.

*Leaf epidermis*: The epidermal cells of intercostal region of adaxial surfaces are rectangular, more or less hexagonal in shape with straight walls, size range from 44-48 x 56 m in *Z. roseum* and 80 x 32-64 µm in *Z. capitatum* var. *elatum*. Intermediate size is observed in others *viz.*, 75-95 x 42 µm in *Z. nimmonii;* 58-84 x 48-64 µm in *Z. cernuum;* 56-76 x 40-52 µm in *Z. neesanum;* 52-72 x 44-52 µm in *Z. officinale;* 68-80 x 22-56 µm in *Z. wightianum;* 68-92 x 30-46 µm in *Z. zerumbet* and 45-52 x 64-78 µm in *Z. montanum*. Cell walls are with thickened corners, cell files are regularly arranged in adaxial epidermis, but the cells are smaller on abaxial epidermis and stomata are more in this layer. In the costal region, cells are smaller, slightly thick walled and bear a thin cuticle. Thickness of the leaf and hyaline area on leaf margin are different among different taxa. **(Plate. 23)**.

*Thickness of lamina*: Among the species studied, the thickest lamina, 340 µm is observed in *Z. capitatum* var. *elatum* and thinnest 140 µm in *Z. roseum*. It is 288 µm in *Z. cernuum*, 160µm in *Z. montanum*, 176 µm in *Z. neesanum*, 260 µm in *Z. nimmonii*, 176 µm in *Z. officinale*, 280 µm in *Z. wightianum*, and 272 µm in *Z. zerumbet*. The portion beyond last bundle in lamina

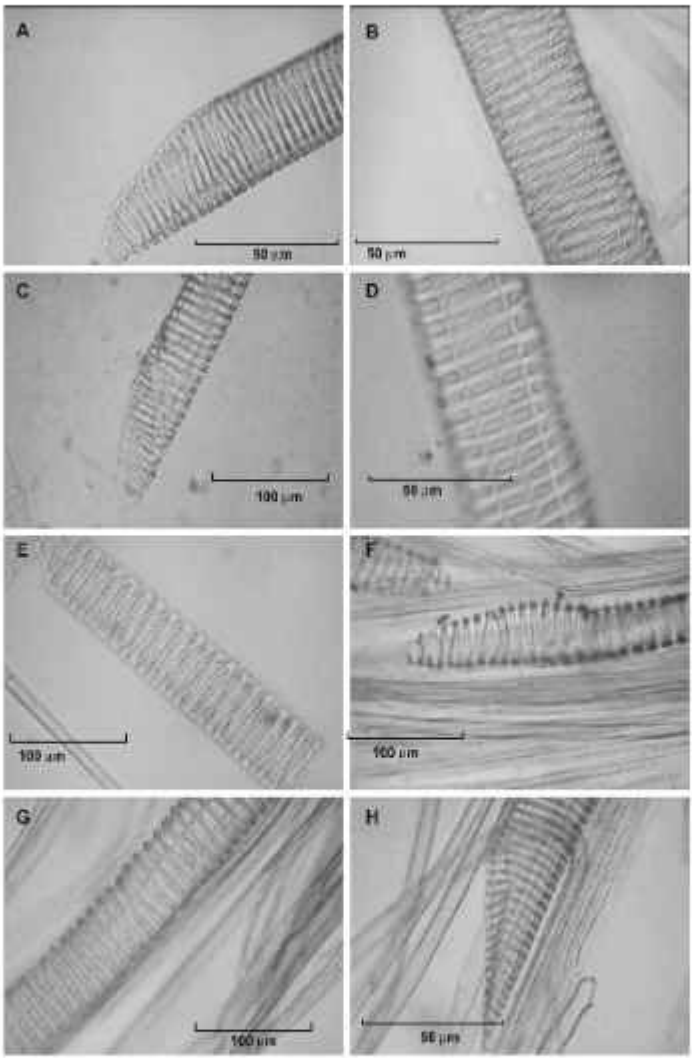



*Plate 20. Xylem elements of various parts: A&B. Zingiber capitatum var. elatum; C&D. Z. cernuum, E&F. Z. montanum; G&H. Z. Neesanum*

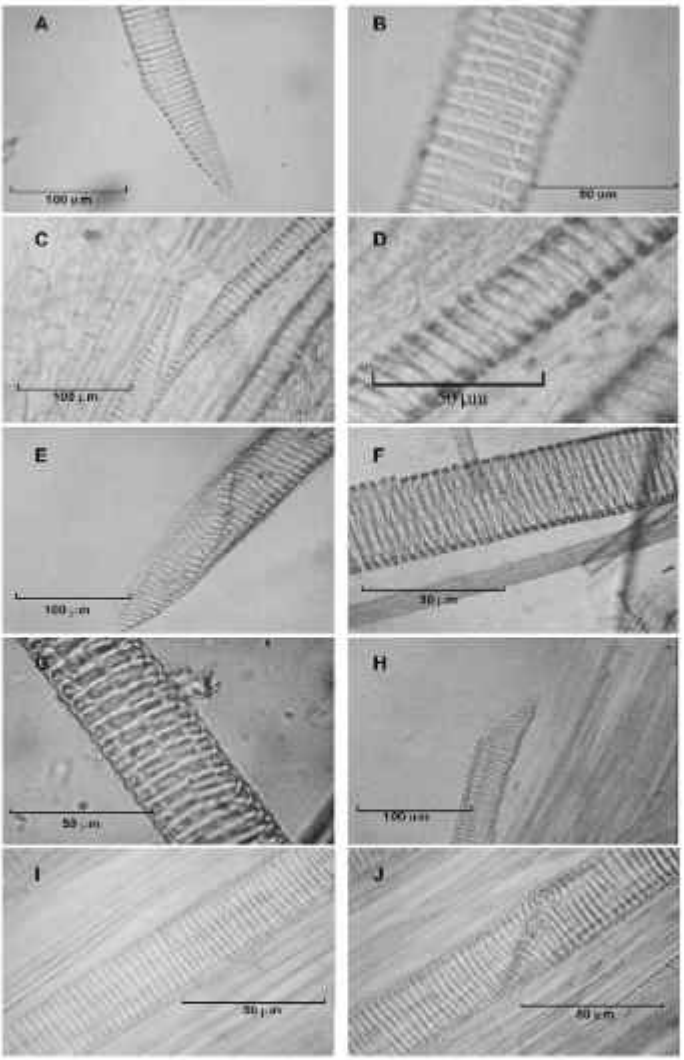



*Plate 21: Xylem elements of various parts: A&B. Zingiber nimmonii, C&D. Z. Officinate, E&F. Z. roseum; G&H. Z. Wingtinaum, I&J. Z. zerumbet*

consists of mesophyll or colourless parenchyma cells only. **(Plate. 22)**.

*Hypodermis*: Adaxial hypodermis is generally absent in all South Indian *Zingiber* species. A single layer of hypodermis is present on abaxial region in all species execpt in *Z. roseum*, which possess two layers. Solereder & Meyer (1930) suggested the hypodermis as water storage in function. The cells are large, colourless and transversely stretched. Largest cells are are present in *Z. capitatum* var. *elatum* 45-56 x 42-52 µm, and in *Z. cernuum* 44-52 x 42-51 µm. Size of hypodermal cell is 38-44 x 28-32 µm in *Z. zerumbet*, 32-48 x 36-44 µm in *Z. wightianum*, 44-48 x 32-36 µm in *Z. nimmonii*, 36-40 x 32-36 µm in *Z. montanum*, 28-32 x 24-28 µm in *Z. officinale*, and smallest 20-28 x 32-48 µm in *Z. neesanum*, and 24-28 x 26-32 µm, in *Z. roseum*. In *Z. cernuum* and *Z. nimmonii*, Calcium oxalate crystals are more confined to the hypodermal layer. The abaxial hypodermis is interrupted by large sub-stomatal chamber at the region of stoma.

*Mesophyll*: The mesophyll comprises parenchymatous tissue internal to the epidermis. It usually undergoes differentiation to form the photosynthetic tissues and contains chloroplasts with distinct adaxial palisade and abaxial spongy parenchyma. The layer of columnar chlorenchyma cells below the epidermis is called palisade parenchyma. The tissue is mostly responsible for photosynthesis and the structure is well suited for the same due to the presence of chloroplast. The number of palisade and spongy layers vary from species to species. A single layer of palisade is present in *Z. cernuum*, *Z. nimmonii*, *Z. neesanum*, *Z. montanum Plates-*, where as three layers of spongy parenchyma is present in *Z. officinale*. In *Z. roseum* one layer of palisade is present. In *Z. capitatum* var. *elatum*, *Z. wightianum* and *Z. zerumbet* two or more layers of palisade

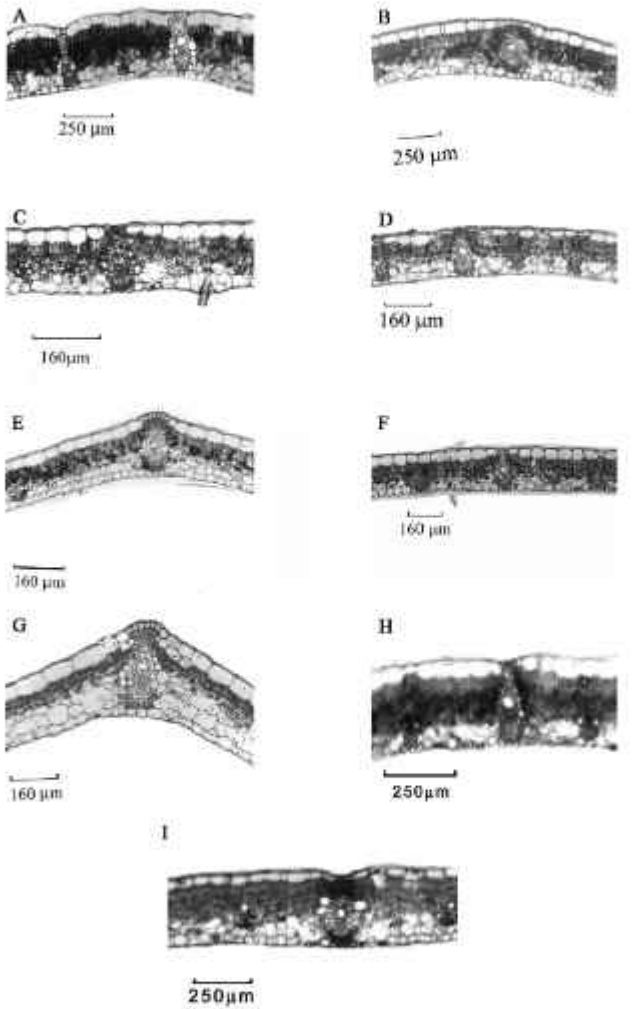



*Plate 22. Comparison of T.S. of lamina: A. Zingiber capitatum var. clatum; B. Z. cernuum; C. Z. montanum; D. Z. neesanum; E. Z nimmonii; F. Z. officinale; G. Z. roseum; H. Z. wightianum; I. Z. Zerumbet.*

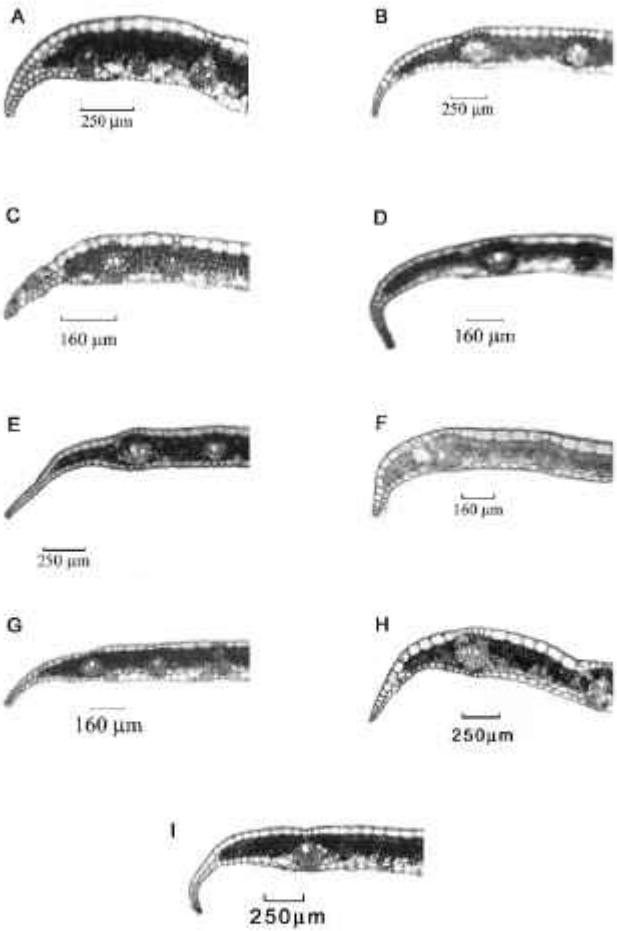



*Plate 23: Comparison of T.S. of Leaf margin: A. Zingiber capitatum var. clatum; B. Z. cernuum; C. Z. montanum; D. Z. neesanum; E. Z nimmonii; F. Z. officinale; G. Z. roseum; H. Z. wightianum; I. Z. Zerumbet.*

parenchyma are seen in the mesophyll. In these species transition from palisade to spongy is not very distinct. A centric leaf structure is recorded in *Z. capitatum* var. *elatum* (Solereder and Meyer, 1930) where as Tomlinson (1956) described as dorsiventral structure. Oil cells are distributed in lower epidermal cells of all species but they are abundant in *Z. officinale*. This agrees with the observation of Tomlinson (1956)

*Leaf margin*: In *Zingiber* leaf, margin consists of a hyaline region extends into a beak, which can be long or short, curved or hooked. Smallest beak is found in *Z. officinale*, 82 µm, whereas longest, in *Z. nimmonii*, 292 µm. It is 290 m in *Z. zerumbet*, 224 µm in *Z. neesanum*, 198 µm in *Z. wightianum*, and 192 µm in *Z. montanum*. Medium sized beak is present in *Z. capitatum* var. *elatum* (166 µm), *Z. cernuum* (170 µm) and *Z. roseum* (160 µm). The hyaline area is 3-4 celled in thickness near the vascular bundle, but two celled thickness in the end region in all, but 3-celled in *Z. montanum*. The shape and length of the hyaline region differ in different species.

*Mid rib*: The mid rib is more or less semicircular in outline with a curve of V or U at the adaxial and abaxial region. Adaxial side is U-shaped in *Z. neesanum*, wide U-shaped in *Z. montanum*, *Z. officinale* and *Z. zerumbet*. It is V-shaped in *Z. roseum* and wide V-shaped in *Z. cernuum*, and *Z. wightianum*. Adaxial side is concave in *Z. capitatum* var. *elatum* and *Z. nimmonii*. Abaxial side is U-shaped in *Z. roseum*, wide U-shaped in *Z. montanum*, *Z. neesanum*, *Z. nimmonii*, *Z. officinale*, wide V-shaped in *Z. capitatum* var. *elatum*, *Z. cernuum* and *Z. wightianum*. In *Z. zerumbet* the abaxial side in U-shaped and ribbed at the region of the arc-I bundles. The epidermal cells are smaller in size and thick walled. The epidermis is followed by ground parenchyma where the bundles are arranged towards abaxial epidermis . **(Plate. 24)**.

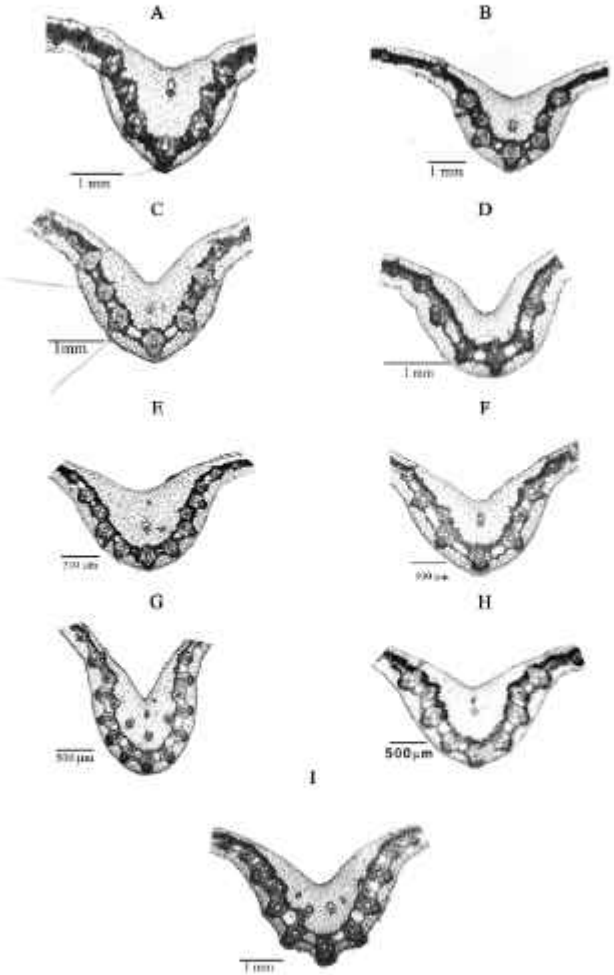



*Plate 24: Comparison of T.S. of Midrib: A. Zingiber capitatum var. clatum; B. Z. cernuum; C. Z. montanum; D. Z. neesanum; E. Z nimmonii; F. Z. officinale; G. Z. roseum; H. Z. wightianum; I. Z. Zerumbet.*

The bundles of the midrib belong to several different systems which are longitudinally continuous through out the sheath, petiole and lamina. These systems are seen as distinct arcs. The main arc is arranged near to the abaxial epidermis. Bundles are pear-shaped in section and some what constricted across the centre. In the mid rib, bundles arcs I and III are present. In *Z. neesanum* only arc-I is present. Bundle arc-I is represented by 1-5 bundles. The individual bundles of the main arc are designated as Musa-type (Solereder & Meyer, 1930). A large metaxylem is present in each bundle. A single layer of conjunctive parenchyma separates the xylem from the abaxial phloem group. They are arranged around the metaxylem in very regular and concentric manner. The phloem consists of sieve tube elements, companion cells and parenchyma.

The bundle sheath is separated into an upper and lower fibre cap by the presence of parenchyma in the median part of the bundle. At the level of the metaxylem elements the lateral parenchyma cells are colourless and contain Calcium oxalate crystals, starch and silica. In *Z. officinale* the shape of the crystal is like an opened book. Various shapes of crystals such as cuboid, pentagonal and rectangular are also present. Laterally, the bundles of the main arc of the midrib show a gradual transition in structure to those of the lamina. A single tracheal element is present in small bundles and protoxylem is generally absent. In between the main arc–I bundles air canals are seen. The air canals are in turn surrounded by chlorenchyma tissue. In *Z. capitatum* var. *elatum* the air spaces between the bundles are occupied by spongy parenchyma cells.

*Pulvinus*: The lamina is separated from the sheath by a distinct petiole. The petiole is colourless, swollen and has the appearance of the pulvinus. This character makes the genus dif-

ferent from other genera of the family. The epidermal cells are smaller in size and the thickening of the wall is confined to the outer region. There is a gradual transition from smaller to the larger cells from the peripheral region to the centre. Air canals and chlorenchyma cells are alternating with the main arc bundles. Air canals are in turn surrounded by chlorenchyma cells. The chlorenchyma resembles mesophyll cells in their round shape and short prolongations are seen towards the intercellular spaces. The chlorenchyma band and air space system shows a maximum development in the petiole. Tomlinson (1956) stated that air canals are absent in pulvinus of *Zingiber*. But present studies revealed that it is well present in all South Indian taxa.

Adaxial side of pulvinus is concave in *Z. capitatum* var. *elatum*, *Z. cernuum*, *Z. nimmonii*, *Z. officinale*, and *Z. zerumbet*. It is U-shaped in *Z. wightianum*, and wide V-shaped in *Z. montanum*, *Z. neesanum*, and *Z. roseum*. Abaxial side is U-shaped in *Z. capitatum* var. *elatum*, *Z. officinale*, *Z. roseum*, *Z. wightianum* and *Z. zerumbet* and it is wide U-shaped in *Z. cernuum*, *Z. montanum*, *Z. neesanum*, and *Z. nimmonii*. Bundle arcs I, II, and III are present in *Z. neesanum*, *Z. officinale*, *Z. wightianum* and *Z. zerumbet*, where as in *Z. capitatum var. elatum*, *Z. cernuum*, *Z. nimmonii* and *Z. montanum* bundles arcs I, III, and IV are present. In *Z. roseum bundle* arcs I and III are present. In *Z. neesanum* and *Z. capitatum* var. *elatum* the parenchyma tissue around the two or three bundles in the median region become radially elongated and gave a specific appearance to the bundles. In these species more growth is confined around the region of these bundles. **(Plate. 25)**.

Arc-I bundles are same size in the median region and gradually becoming smaller towards the margin. Arc-III and IV bundles are arranged irregularly in the adaxial side of the arc-

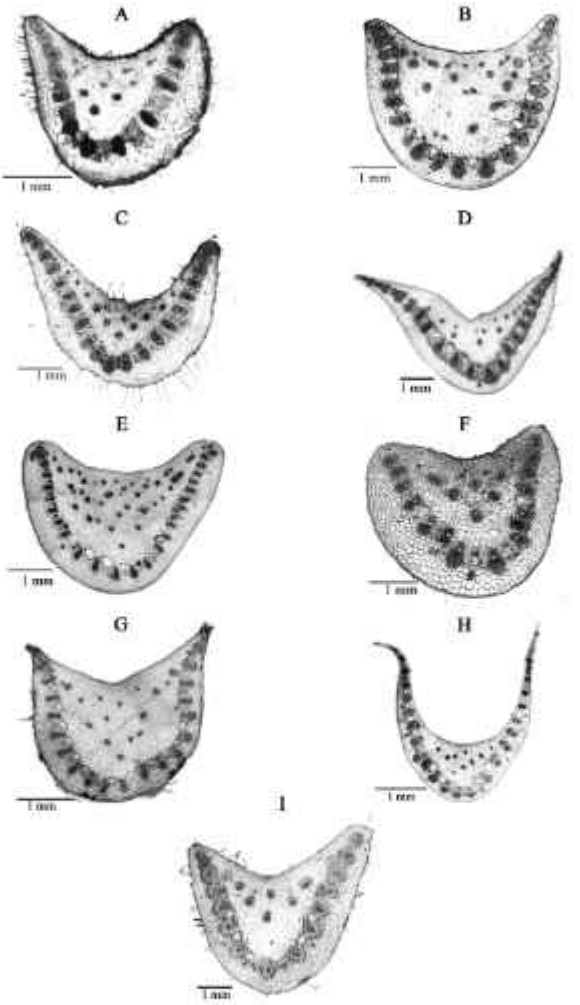



*Plate 25: Comparison of T.S. of Pulvinus: A. Zingiber capitatum var. clatum; B. Z. cernuum; C. Z. montanum; D. Z. neesanum; E. Z nimmonii; F. Z. officinale; G. Z. roseum; H. Z. wightianum; I. Z. Zerumbet.*

I bundles. The arc-III bundles show maximum development in the petiole and the number decreases gradually towards the base of the leaf sheath. In the leaf sheath only a single row or arc-III bundles are present. The structure of the bundles of the pulvinus is similar to that of the midrib. Bundle sheath is well developed and collenchymatous (Tomlinson, 1956). A single large tracheal element and several smaller elements are present. Protoxylem lacunae are not seen in these bundles. The bundles of arc-IV are arranged near adaxial epidermis. The bundles are very much reduced and a well developed mechanical sheath is present around them

*Leaf sheath*: The epidermal cells in the adaxial side are larger, thin walled and transversely stretched, hairs absent. The epidermal cells of the abaxial surface are smaller in size and the wall is slightly thickened. There is a gradual transition to larger central cells, from the epidermis to centre and these central cells are associated with intercellular spaces, hairs present. **(Plate. 26)**.

Adaxial and abaxial sides are U-shaped except in *Z. zerumbet*, in which adaxial side is V-shaped and abaxial side is flat. Bundle arcs I, II, and III, are seen in the leaf sheath and the arc- I constitutes the main bundle arc. Arc-I bundles are arranged close to the abaxial surface and bundles are same size at the median region and gradually decreases towards the margin. Arc-II bundles are much smaller in size and alternate with arc-I bundles. Adaxial to arc-I, intermediate sized bundles of arc-III are arranged irregularly. Arc-I, II and III bundles are present in *Z. capitatum* var. *elatum*, *Z. cernuum*, *Z. neesanum*, *Z. nimmonii*, *Z. roseum*, *Z. wightianum* and *Z. zerumbet*. In *Z. officinale* and *Z. montanum* only bundle arcs I and II are present.

Arc-I bundles are similar in structure of the bundles in the mid rib. Each bundle of the arc-II shows a well developed fi-


*Plate 26: Comparison of Leaf Sheath: A. Zingiber capitatum var. clatum; B. Z. cernuum; C. Z. montanum; D. Z. neesanum; E. Z nimmonii; F. Z. officinale; G. Z. roseum; H. Z. wightianum; I. Z. Zerumbet.*

brous sheath, but it is not well developed as the bundle sheath of arc-III. A simple large xylem tracheid and several smaller elements are present. Arc-I, II, III bundles become reduced towards the margin and the bundles are represented by a fibre strand only in *Z. nimmonii*, *Z. neesanum*, *Z. wightianum*, and *Z. capitatum*. Air canals are seen in between the main arc bundles and they are in turn surrounded by a band of chlorenchymatous tissue. Spongy parenchyma is present in air canals. According to Bell (1980), the bundles of the main arc-I of the sheath passes gradually into the central cylinder. The bundles of the outer arc-II do not enter into cortical system and no fusion takes place between the bundles of the two different systems.

*The stem*: The epidermal cells are smaller in size and the outer wall is slightly thickened. A continuous cylinder of fibre strand separates cortex from central cylinder. The cortical bundles are arranged in 3 or 4 rows and specific number of rows is seen for a particular species. According to Tomlinson (1969), the tissue present between cortex and central cylinder is meristematic and this region eventually differentiates into thin walled fibres. Petersen (1899) used the term intermediate zone to the undifferentiated region between these two. It separates vascular tissue into two regions. Bell (1980) described it as an inner system and an outer system for the cortex and central cylinder respectively.

Vascular bundles are collateral, and those of the cortex being wider with a well developed fibrous sheath but variable in diameter (Bell, 1980). The outermost row of bundles of the cortex is seen in the epidermis and it resembles those of the arc- II bundles of the bundle sheath. The xylem consists of a single large element and several smaller ones. The xylem is separated from the fibres of the bundle sheath and from the small group by parenchyma.

The fibrous thickening is complete around central cylinder in *Z. capitatum* var. *elatum*, *Z. cernuum*, *Z. neesanum*, *Z. nimmonii*, *Z. officinale Z. roseum* and *Z. wightianum*. In *Z. montanum* and *Z. zerumbet* fibre thickening is incomplete and parenchyma patches are seen at certain regions. Elongated bundles are seen in the cortex of *Z. zerumbet*, near the fibrous thickening. In these regions lower portions of elongated bundles extend to the central cylinder. Fibrous thickenings are absent in these regions. In *Z. cernuum*, cortical bundles are in three rows but in *Z. nimmonii*, they are arranged in two rows. The central cylinder contains numerous bundles scattered irregularly in a uniform ground parenchyma **(Plate. 27)**.

*Rhizome*: According to Tomlinson (1956) rhizome is morphologically equivalent to the aerial stem, and there is a fundamental similarity in the anatomy of the two organs. The outer cortical cells of the rhizome are suberised, and a periderm is seen in older rhizomes and several successive layers are present. A distinct cortex and central cylinder are separated by an endodermis. Cortex contains scattered vascular bundles. The central cylinder also contains numerous scattered vascular bundles. Xylem and phloem are less developed in central cylinder. Starch grains are present in cortex and central cylinder, and generally absent in endodermis. Oil cells and crystals are also seen in cortex and central cylinder. **(Plate. 28)**.

*Root*: Numerous roots are developed from the lower portion of the node of rhizome. The cortex is wide and outer layers are radially arranged and suberised. Inner layers are loosely arranged with intercellular spaces. Protoxylem vessels are present at the poles of the xylem, and phloem groups alternate with them. Metaxylem vessels are 10-32 in number with wider lumen and arranged towards centre. Pith is large in *Z. neesanum* and *Z. nimmonii*, *when* compared to other species. Generally the

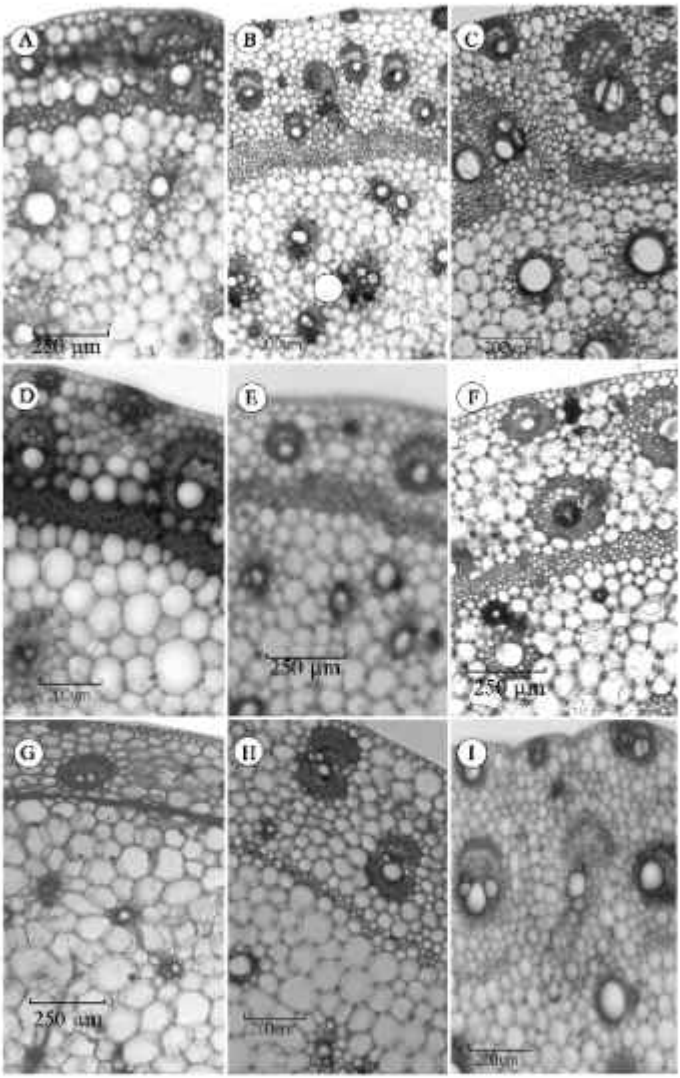
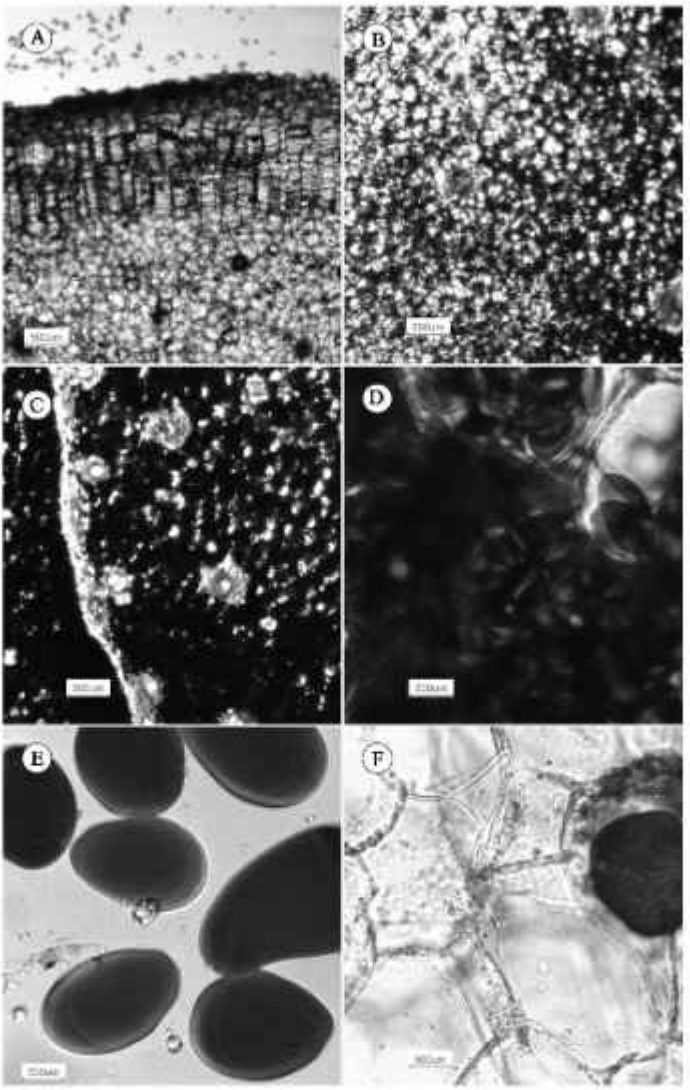



Plate 27: *Comparison of T.S. of Stem: A. Zingiber capitatum var. clatum; B. Z. cernuum; C. Z. montanum; D. Z. neesanum; E. Z nimmonii; F. Z. officinale; G. Z. roseum; H. Z. wightianum; I. Z. Zerumbet.*




*T.S of Rhizome: A. Periderm; B. Cortex; C. Centre cylinder, D. Starch grains; E. Strach grains enlarged; F. Silica granules.*

roots show same anatomical characters but differ in the number of metaxylem vessels, among the South Indian taxa. The number of metaxylem varies from 8-12 in *Z. capitatum* var. *elatum*, 14-18 in *Z. cernuum*, 12-16 in *Z. montanum*, 17-20 in *Z. neesanum*, 20-23 in *Z. nimmonii*, 28-34 in *Z. officinale*, 15-18 in *Z. roseum*, 10-14 in *Z. wightianum* and 13-16 in *Z. zerumbet*.

*Xylem*: The structure and distribution of xylem elements were studied by maceration method. Xylem tissues from midrib, pulvinus, leaf sheath, stem and root were taken for the studies. In *Zingiber*, vessels are confined to the roots only, in all other parts only tracheids were present **(Plate. 20)**.

Vessels are with wide lumen, and scalariform thickening**(Plate. 21)**. The end walls are oblique, and perforation plates are seen at end walls and it is not bordered. Perforation plates are convex and its corresponding part may concave with few to many bars and perforation plates of two ends may vary. They often encroach into the lumen of the adjacent vessels. The perforation plate can be recognised because of the absence of primary membrane, and the bars are supported only at their ends and evenly placed. The first formed xylem elements are very long and narrow. The later formed xylem vessels are larger, with wide lumen seen towards centre. Perforation plates showed variation in length, nature of end wall and width. According to Cheadle and Tucker (1961) scalariform perforation with many bars are considered primitive and with few bars as advanced. Cheadle (1953) classified the monocot families based on the presence of vessels in different organs and the family Zingiberaceae is included in families having some species with vessels in roots only.

Maceration studies showed that xylem vessels are confined only to the roots. Vessels in the Protoxylem elements are very long and narrow with very oblique imperforate end wall.

The later formed xylem vessels are larger with wide lumen. The end wall of perforation plates showed variation in length, nature of end wall and in width. In metaxylem, vessels are seen with scalariform thickening, and the end walls with scalariform perforation plates.

According to Tomlinson (1956) the occurrence and distribution of tracheids and vessels are of considerable phylogenic interest. Dahlgren and Clifford (1982) stated that Zingiberaceae have vessel less leaves and roots have vessels with scalariform perforation vessel types. According to Wagner (1977) Zingiberaceae possess more advanced vessel types in roots than do the other families of monocotyledons.

Cheadle (1968) pointed out that vessels originated in roots and then upward in the plant and that specialisation of vessels followed the same sequence, and in a given organ the origin and specialization of vessels occurred in first in late-formed metaxylem and then successively in the earlier formed xylem. Based on vessel characters Cheadle and Tucker (1961) stated the possible origin of Zingiberales from Commelinaceae, because in Commelinaceae, the vessels are highly specialised than Zingiberaceae.

Based on these anatomical characters anatomical key is prepared for identification of different species studied.

## Key to the species based on anatomical characters

1. Thickness of lamina 140-180 µm ..... 2
1. Thickness of lamina 260-340 µm ..... 3
2. Adaxial and abaxial midrib U-shaped, hypodermis single layered. ..... 4
2. Adaxial midrib V-shaped and abaxial U-shaped, hypodermis two layered.....*Z. roseum*

3. Palisade 2 or more layered ..... 5
3. Palisade 1 layered ..... 6
4. Adaxial epidermal cells higher than broad, 45-52 x 64-78 µm, fibrous band not complete in stem..... *Z. montanum*
4. Adaxial epidermal cells longer than broad, 52-76 x 40-52 µm, fibrous band complete in stem ..... 7
5. Bundle arcs I, III, and IV are present in pulvinu.... *Z. capitatum var. elatum*
5. Bundle arcs I, II, and III are present in pulvinus..... 8
6. Width of the leaf margin c. 170 m, adaxial and abaxial midrib wide V-shaped ..... *Z. cernuum*
6. Width of the leaf margin c. 292 m, adaxial side of midrib concave, and abaxial wide V-shaped ..... *Z. nimmonii*
7. Arc III bundle of Midrib present, leaf margin c. 82 m broad..... *Z. officinale*
7. Arc III bundle of Midrib absent, leaf margin c. 224 m broad..... *Z. neesanum*
8. Adaxial and abaxial side of Leaf sheath U-shaped ..... *Z. wightianum*
8. Adaxial side of Leaf sheath V-shaped and abaxial side flat ..... *Z. zerumbet*

## Discussion

From the present study it is evident that anatomical characters along with morphological characters are helpful in the taxonomic delimitation and identification of the *Zingiber* species. Anatomical studies shows that the genus *Zingiber* bears certain common characters like swollen pulvinus with collenchymatous bundle sheath, tetracytic stomata, hyaline region of lamina, and presence of vessels in the xylem of root, but each taxon is peculiar with specific characters. The size of epidermal

cell, thickness of lamina and hyaline region in the leaf margin are specific for each taxon. Thickest leaf, with a thickness of 340 im is present in *Z. capitatum var. elatum* and thinnest (140 µm) in *Z. roseum*. Palisade layer is two or more in *Z. capitatum* var. *elatum*, *Z. wightianum* and *Z. zerumbet*. The adaxial side of midrib of *Z. roseum* is very peculiar with V-shaped and abaxial side of *Z. zerumbet* is V-shaped and ribbed, and abaxial side of leaf sheath is boat-shaped. In *Z. neesanum* arc-III bundle is absent but in all others it is present. Bundle arc I, III, and IV are present in the pulvinus of *Z. capitatum* var. *elatum*, *Z. cernuum*, *Z. montanum* and *Z. nimmonii*. Arc-II and IV are absent in *Z. roseum*. ArcIV is absent in *Z. neesanum*, *Z. officinale*, *Z. wightianum* and *Z. zerumbet*. In *Z. nimmonii* leaf margin is 292 µm broad and that of *Z. cernuum* is 170 µm broad. In *Z. cernuum* cortical bundles in stem are arranged in 3–4 rows but in *Z. nimmonii* they are arranged in two rows. The adaxial and abaxial side of midrib of *Z. cernuum* is wide V–shaped but in *Z. nimmonii* concave and wide U-shaped respectively. Shape and size of starch grains present in rhizome and root tubers are charecteristic to each taxon. Ramamoorthy (1976) combined *Z. nimmonii* with *Z. cernuum* with an assumption that leaf pubescence in *Z. nimmonii* and absence of it in *Z. cernuum* are not enough to treat them as distinct species. However, detailed studies on these plants have revealed that they are distinct.

As the *Zingiber* species produces flowers for a short period, the anatomy can be used for the identification of the taxa. It is concluded from the present study that anatomy of the petiole, number of bundle arcs, shape of midrib, nature of the hyaline portion, etc are more reliable taxonomic characters. Herbarium materials can also be used for anatomical studies.

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**References**

- Bell A (1980) The vascular pattern of a rhizomatous Ginger (*Alpinia speciosa* L. - Zingiberaceae). 1. The arial axis and its development. *Annals of Botany* **46**, 203-212.
- Cheadle VI (1953) Independent origin of vessels in the Monocotyledons and Dicotyledons. *Phytomorphology* **3**, 23-43.
- Cheadle VI (1963) Vessels in Iridaceae. *Phytomorphology* **13,** 245-248.
- Cheadle VI (1968) Vessels in Haemodorales. *Phytomorphology* **9**, 412–420.
- Cheadle VI and Tucker JM (1961) Vessels and phylogeny of Monocotyledoneae pp. 161-165 In Recent Advances in Botany. Univ.Toronto Press.
- Dahlgren RMT and Clifford HT (1982) *The Monocotyledons. A comparative study*. Springer-Verlag Academic press–London.
- Dunn DB *et al* (1965) Stomatal patterns of Dicotyledons and Monocotyledons. *The American Midland Naturalist.* ***74,*** *185-195.*
- Fischer CEC (1928) Zingiberaceae. In: J. S. Gamble ed., *Flora of Presidency of Madras. Pt. 1-11.* ***8,*** *1478-1493. London.*
- *Hussin KH et al (2001) Anatomical variations in leaves in Ginger*

*(Zingiber officinale Rosc.) Journal of Spices and Aromatic Crops* **8**, *163 – 170.*

- Johansen DA (1940) *Microtechnique.* Mc Graw-Hill, New York.
- Kress WJ *et al* (2002). The phylogeny and a new classification of the gingers (Zingiberaceae): Evidence from molecular data. *American Journal of Botany* **9**, 1682–696.
- Olatunji OA (1980) The structure and development of stomata in some Zingiberales. *Notes from Royal Botanical Garden Edinburgh* **38**, *499-516.*
- *Paliwal GS and Anand SK (1978) Anatomy in relation to taxonomy: some recent trends. Acta Botanica Indica* **6**, *1-20.*
- Petersen OG (1899) *Zingiberaceae.* In: A. Engler & K. Prantl, Naturlichen Pflanzenfamlien, 2, 10-30. Verlag von Wilhelm Engelmann, Leipzig, Berlin.
- Sabu M (2003) Revision of the genus *Zingiber* in South India. *Folia malaysiana* **4**, 25-52.
- Solereder H and Meyer FJ (1930) Zingiberaceae. In Systematische Anatomie der Monokotyledonnen. **6**, 27-56.
- Stebbins L and Khush GS (1961) Variation in the organization of the stomatal complex in the leaf epidermis of Monocotyledons and its bearing on their phylogeny. *American Journal of Botany* **48**, 51-59.
- Theilade I (1999) A synopsis of the genus *Zingiber* (Zingiberaceae) in Thailand. *Nordic Journal of Botany* **19**, *389-410.*
- *Theilade I and Mood J (1999) A new species of Zingiber (Zingiberaceae) from Vietnam. Nordic Journal of Boany* **19**, *525-528.*
- Tomlinson PB (1956) Studies in the systematic anatomy of Zingiberaceae. *Journal of Linnaean Society (Botany* **55**, 547 – 592.
- Tomlinson PB (1969) Commelinales - Zingiberales in: C. R. Metcalfe ed. *Anatomy of Monocotyledons* **3**. Oxford.
- Wagner P (1977) Vessel types of Monocotyledons; A survey. *Botanical Noticer* **130**, 383-402.

# Time Series Modelling of the Silver Price Data

■ Anusha A, Bindu Punathumparambath

## Abstract

Time series analysis has become one of the most important and widely used branches of mathematical statistics. Application of this branch of statistics includes neurophysiology, astrophysics, economic forecasting, stock market analysis, study of biological data and vibrations engineering. In the present study we propose the Marshall-Olkin asymmetric Laplace distribution for silver price data and develop a suitable time series model for the silver price data. Finally, we illustrate the applications of the Marshall-Olkin asymmetric Laplace distribution for the silver price data. The analysis is carried out using R Package and SPSS.

## 1. Introduction

Most of the real life datasets are time dependent and are auto-correlated. Such datasets are called time series data. A time series is a realization of a stochastic process. It is a sequence of observations taken sequentially in time. For analysis of time series, we regard it as a realization of a stochastic

process. It is a very special case of stochastic process based on the assumption that the process is in a particular state of statistical equilibrium.

A discrete-time series is one in which the set $T_0$ of times at which observations are made is a discrete set. If the data is continuous then it is continuous time series. Continuous time series are obtained when observations are recorded continuously over some time interval. Daily returns on a stock, the annual crop yield of sugar-beets and their price per ton, Daily maximum and minimum temperatures and annual rainfall are examples of time series data.

The major problems in time series analysis are those relating to model identification, parameter estimation, diagnostic checking, forecasting etc. The history of time series modelling begins with Gaussian processes. A detailed description of linear Autoregressive Integrated Moving Average (ARIMA) models along with good many illustrations are given in Box et al. (2004).

Many real life time series are non-Gaussian and have structure that change over time. Several authors introduced non Gaussian process with specified marginals. Tavares (1980) introduced the exact distribution of extremes of a non-Gaussian process, Gaver and Lewis (1980) developed first order autoregressive gamma sequences and point processes. Jayakumar and Kuttikrishnan (2006) developed an autoregressive model for Asymmetric Laplace distribution.

Marshall-Olkin (1997) has introduced a new method of adding a parameter to a family of distributions with applications to the exponential and Weibull families. Jayakumar and Kuttykrishnan (2006) expanded the family of asymmetric Laplace distributions by introducing new parameter using the method of Marshall and Olkin (1997). Bindu and Kannan

(2013) proposed Marshall-Olkin asymmetric Laplace (MOAL) as the error distribution for microarray gene expression data. In this paper we use Marshall-Olkin asymmetric Laplace (MOAL) to model the silver price data and develop suitable time series models for the silver price data.

The paper is organized as follows. Section 2 describes different types of time series models. A review of Marshall-Olkin asymmetric Laplace distribution and its properties were described in section 3. Section 4, is devoted to the analysis of silver price data using R package and SPSS. Finally, various conclusions obtained from the time series data were given in section 5.

## 2. Time Series Analysis

The term "univariate time series" refers to a time series that consists of single observations recorded sequentially over equal time increments. A Time series models usually represents a stochastic process and can have many forms. An important class of stochastic models for describing time series, which has received a great deal of attention, is the so called stationary models which assume that the process remains in equilibrium about a constant mean level. The three important models mainly used are autoregressive models(AR), the integrated models(I) and the moving average model(MA). These three models combined to get autoregressive moving average(ARMA) and autoregressive integrated moving average(ARIMA) models.

### 2.1 Autoregressive Model

Autoregressive model is a type of random process which

is often used to model and predict various types of natural phenomena. The autoregressive model is one of a group of linear prediction formulae that attempt to predict an output of a system based on the previous observations. The notation AR (p) indicates an autoregressive model of order p. The AR (p) model is defined

$X_n = \alpha_1 X_{n-1} + \alpha_2 X_{n-2} + \cdots + p\, X_{n-p} + \varepsilon_n, \alpha p \neq 0.$

Where $\alpha_1, \alpha_2, \ldots, \alpha p$ are parameters of the model and {?n} an innovation process of independently and identically distributed random variables to ensure that {Xn} is a stationary Markov process with a specified marginal distribution function F(x). In the literature most processes are assumed to have Gaussian distribution. This is widely preferred, since most parameter estimation techniques can lead to analytically tractable solutions under this assumption.

Many real life time series are non-Gaussian and have structure that change over time. Several authors introduced non Gaussian process with specified marginals. Tavares (1980) introduced the exact distribution of extremes of a non-Gaussian process, Gaver and Lewis (1980) developed first order autoregressive gamma sequences and point processes. Gaver and Lewis(1980) considered the usual linear, additive autoregressive equation,

$X_n = \alpha X_{n-1} + \varepsilon_n\ \alpha \varepsilon [0; 1); n = 0, \pm 1, \pm 2, \ldots$

## 2.2 Moving average model

The process {Xt, t ε Z} is said to be a moving average model of order q if

$X_t = Z_t + \theta_1 Z_{t-1} + \theta_2 Z_{t-2} + \ldots + \theta_q Z_{t-q}$

where, $\theta_1$, $\theta_2$..., $\theta_q$ are constants Moving-average processes.

The theoretical autocorrelation function $\{\rho T\}$ of a pure moving-average process of order q has $\rho T = 0$ for all $T \geq q$. The corresponding partial autocorrelation function $\{\pi T\}$ is liable to decay towards zero gradually. To judge whether the corresponding sample autocorrelation function $\{\gamma T\}$ shows evidence of a truncation, we need some scale by which to judge the signi?cance of the values of its elements.

## 2.3 Autoregressive Moving average model

Moving averages MA(q) and autoregressive AR(p)-processes are special cases of so called autoregressive moving averages (ARMA). Let $\{\varepsilon_t, t \varepsilon Z\}$ be a white noise, $p,q \geq 0$ integers and $a_0,\ldots,a_p, b_0,\ldots, bq \varepsilon R$. A real valued stochastic process $\{Y_t, t \varepsilon Z\}$ is said to be an autoregressive moving average process of order p,q, denoted by ARMA(p,q), if it satisfies the equation

$$Yt = a_1Y_{t-1}+a_2Y_{t-2}+\cdots+a_pY_{t-p}+\varepsilon_t+b_1\varepsilon_{t-1}+\cdots+bq\,\varepsilon_{t-q}$$

An ARMA(p,0)-process with $p \geq 1$ is obviously an AR(p)-process, whereas an ARMA(0,q)-process with $q \geq 1$ is a moving average MA(q). The polynomials

$$A(z) := 1-a1Z-\cdots-apZ\,p$$

and

$$B(z) := 1 + b1Z+\cdots+b_qZ_q$$

are the characteristic polynomials of the autoregressive part and of the moving average part of an ARMA (p, q)-process {Yt}, which we can represent in the form

$$Y_t-a_1Y_{t-1}\cdots-apY_{t-p} = \varepsilon_t + b_1\varepsilon_{t-1}+\cdots+ b_q\varepsilon_{t-q}.$$

In the case of a mixed ARMA(p,q) process, neither the theoretical autocorrelation function not the theoretical partial autocorrelation function have any abrupt cut offs.

The particular values for the order (p, q) are to be determined in identification procedures of the process, with different aspects to be considered, for the data of interest. A gamma point process with an ARMA correlation structure is proposed in Linhart and Zucchini (1972). Lawrance and Kottegoda (1977) suggested one potential application of non-normal ARMA models in stochastic hydrology, since the river flow series are naturally positive and non-normal for most data. ARMA models with Laplace distributed noise is generated in Damsleth and El-Shaarawi (1989).

## 2.4 Autoregressive Integrated Moving average model

ARIMA is an acronym for Auto Regressive Integrated Moving-Average. The order of an ARIMA model is usually denoted by the notation ARIMA(p,d,q).

The ARIMA(p, d, q) model can be expressed as

$X_t = \theta_0+\varphi_1 X_{t-1}+\varphi_2 X_{t-2}+\ldots+\varphi_p X_{t-p}+e_t-\theta_1 e_{t-1}-\theta_2 e_{t-2}\ldots\theta_q e_{t-q}$

Where, p is the order of the autoregressive part

d is the order of the differencing

q is the order of the moving-average process

If no differencing is done (d = 0), the models are usually referred to as ARMA(p,q) models

The ARIMA procedure analyzes and forecasts equally spaced univariate time series data, transfer function data, and intervention data using the Autoregressive Integrated Moving-Average (ARIMA) or autoregressive moving-average (ARMA) model. An ARIMA model predicts a value in a response time series as a linear combination of its own past values, past errors (also called shocks or innovations), and cur-

rent and past values of other time series.

The ARIMA approach was ?rst popularized by Box and Jenkins, and ARIMA models are often referred to as Box-Jenkins models. The general transfer function model employed by the ARIMA procedure was discussed by Box and Tiao (1975). When an ARIMA model includes other time series as input variables, the model is sometimes referred to as an ARIMAX model.

## 2.5 Autocorrelation Functions

Autocorrelation is the internal correlation of the observations in a time series, usually expressed as a function of the time lag between observations. A plot of the sample values of the autocorrelation against the lag is known as the autocorrelation function and is a basic tool in the analysis of time series particularly for indicating possibly suitable models for the series. This technique of model identi?cation is proposed by Box and Jenkins (1972). Their basic tools were the sample autocorrelation function and the partial autocorrelation function.

Given a sample y1, y2... $y_{t-1}$ of T observations, we de?ne the sample autocorrelation function to be the sequence of values

$\gamma_t = CT/Co$, $\tau = o,1...,T-1$

Where in

$$c_\tau = \frac{1}{T}\sum_{t=\tau}^{T-1}(y_t - \bar{y})(y_{t-\tau} - \bar{y}),$$

is the empirical autocovariance at lag T and is the sample variance. One should note that, as the value of the lag increases, the number of observations comprised in the empirical

autocovariance diminishes until the ?nal element,

$$c_{T-1} = T^{-1}(y_0 - \bar{y})(y_{T-1} - \bar{y})$$

is reached which comprises only the ?rst and last mean-adjusted observations. In plotting the sequence {rT}, we shall omit the value of r0 which is invariably unity. Moreover, in interpreting the plot, one should be wary of giving too much credence to the empirical autocorrelations at lag values which are signi?cantly high in relation to the size of the sample. The ACF lies between -1 and +1.

ACF = corr($X_t$, $X_{t+k}$),

i.e. relationship between each other. Here Xt is the current observation and Xt+k is observation after k period.

## 2.5.1 Partial autocorrelation function (PACF)

The sample partial autocorrelation pT at lag T is simply the correlation between the two sets of residuals obtained from regressing the elements y and yt-T on the set of intervening values $y_1,_,\ldots,y_{T-1}$. The partial autocorrelation measures the dependence between yt and yt-T after the effect of the intervening values has been removed. The sample partial autocorrelation pT is virtually the same quantity as the estimated coefficient of lag T obtained by ?tting an autoregressive model of order T to the data. Indeed, the difference between the two quantities vanishes as the sample size increases. The Durbin-Levinson algorithm provides an efficient way of computing the sequence $\{p_T\}$ of partial autocorrelations from the sequence of $\{c_T\}$ of auto-covariances. It can be seen, in view of this algorithm, that the information in $\{c_T\}$ is equivalent to the information contained jointly in $\{p_t\}$ and c0.

Therefore the sample autocorrelation function $\{r_t\}$ and the sample partial autocorrelation function $\{p_t\}$ are equivalent in terms of their information content.

A partial autocorrelation function (PACF) which is conditional correlation of $X_{t+k}$ with $X_t$. PACF is defined for positive lag only, their value also lies between -1 and +1.

The Partial Autocorrelation Function (PACF) is similar to the ACF. It measures correlation between observations that are k time periods apart, after controlling for correlations at intermediate lags. Both the sample ACF and PACF are approximately normally distributed about their population values, and have standard deviation $\frac{1}{\sqrt{T}}$

Where, T is the length of the series.

## 3. Marshall-olkin Asymmetric Laplace Distribution

Marshall-Olkin (1997) has introduced a new method of adding a parameter to a family of distributions with applications to the exponential and Weibull families. Jayakumar and Kuttykrishnan (2006) expanded the family of asymmetric Laplace distributions by introducing new parameter using the method of Marshall and Olkin (1997). If $\Phi(t)$ is the Characteristic function (*cf*) corresponds to the random variable X then the generalized family of distribution will have a Characteristic function $\psi(t)$,

$$\psi(t) = \frac{\alpha\,\Phi(t)}{1-(1-\alpha)\Phi(t)}\ ,\ \alpha > 0. \qquad (3.1)$$

For $\alpha=1$, $\psi(t)=\Phi(t)$.

In particular, when X has the asymmetric Laplace distribution with parameters $(\alpha, k)$, denoted by $X \sim AL(\alpha,K)$, with probability density function

$$f(x)=\frac{1}{\sigma}\frac{\kappa}{(1+\kappa^2)}\begin{cases} e^{\frac{-\kappa}{\sigma}x}, & for\ x\geq 0 \\ \sigma e^{\frac{1}{\sigma\kappa}x}, & for\ x<0 \end{cases} \tag{3.2}$$

where $X \varepsilon R$, $\mu \varepsilon R$ and $\sigma > 0$. The *cf* of asymmetric Laplace distribution is given by

$$\Phi(t)=\frac{1}{1+\sigma^2t^2-i\mu t}, \sigma>0, -\infty<\mu<\infty, \tag{3.3}$$

where $\mu = \mu = \sigma(\frac{1}{\kappa}-1)$. From (1) and (3) the *cf* of the Marshall-Olkin asymmetric Laplace (MOAL) is given by

$$\psi(t)=\frac{1}{1+\frac{1}{\alpha}(\sigma^2t^2-i\mu t)}\ \sigma>0, -\infty<\mu<\infty \tag{3.4}$$

The Marshall-Olkin asymmetric Laplace (MOAL) distribution introduced by Jayakumar and Kuttykrishnan (2006) can be given as follows

$$f(x)=\frac{\sqrt{\alpha}}{\sigma}\frac{\kappa}{(1+\kappa^2)}\begin{cases} e^{\frac{-\kappa\sqrt{\alpha}}{\sigma}x}, & for\ x\geq 0 \\ e^{\frac{\sqrt{\alpha}}{\kappa\sigma}x}, & for\ x<0. \end{cases} \tag{3.5}$$

Now we define the Marshall-Olkin asymmetric Laplace (MOAL) distribution with parameters $(\theta, \alpha, \sigma, k)$

Definition 2.1 A random variable X is said to have a Marshall-Olkin asymmetric Laplace (MOAL) distribution with parameters $(\theta, \alpha, \sigma, k)$, denoted by $X \sim MOAL(\theta, \alpha, \sigma, k)$ if its probability density function is given by

$$f(x) = \frac{\sqrt{\alpha}}{\sigma}\frac{\kappa}{(1+\kappa^2)}\begin{cases} e^{\frac{-\kappa\sqrt{\alpha}}{\sigma}(x-\theta)}, & for\ x \geq \theta \\ e^{\frac{\sqrt{\alpha}}{\kappa\sigma}(x-\theta)}, & for\ x < \theta, \end{cases} \quad (3.6)$$

where $\theta \varepsilon R$, $\alpha > 0$, $K > 0$, $\sigma > 0$ and

$$\kappa = \frac{2\sigma\sqrt{\alpha}}{\mu + \sqrt{4\sigma^2\alpha + \mu^2}}.$$

The cdf of MOAL $(\theta, \alpha, \sigma, k)$ is given by

$$F(x) = \begin{cases} 1 - \frac{1}{(1+\kappa^2)} e^{\frac{-\kappa\sqrt{\alpha}}{\sigma}(x-\theta)}, & for\ x \geq \theta, \\ \frac{\kappa^2}{(1+\kappa^2)} e^{\frac{\sqrt{\alpha}}{\kappa\sigma}(x-\theta)}, & for\ x < \theta. \end{cases} \quad (3.7)$$

The qth quantile of MOAL distribution is,

$$\xi_q = \begin{cases} \theta + \frac{\kappa\sigma}{\sqrt{\alpha}} log\left[\frac{q(1+\kappa^2)}{\kappa^2}\right], & for\ q \in (0, \frac{\kappa^2}{(1+\kappa^2)}] \\ \theta - \frac{\sigma}{\kappa\sqrt{\alpha}} \log\left[(1-q)(1+\kappa^2)\right], & for\ q \in \left(\frac{\kappa^2}{(1+\kappa^2)}, 1\right). \end{cases} \quad (3.8)$$

The cdf and qf can be useful for goodness-of-fit and simulation purposes

For $q = \frac{\kappa^2}{(1+\kappa^2)}$, the qth quantile is given by $= \xi q = \theta$. Hence, for given K an estimate of the location parameter is given by

$$\hat{\theta} = \xi_{\left[\frac{\kappa^2}{(1+\kappa^2)}\right]}.$$

Density plots of Marshall-Olkin asymmetric Laplace distribution for for $\theta = 0$, $\alpha = 1.5$, $\sigma = 2$ and $\kappa = 0.5$, 1 and 1.5 is given in figure 3.1.

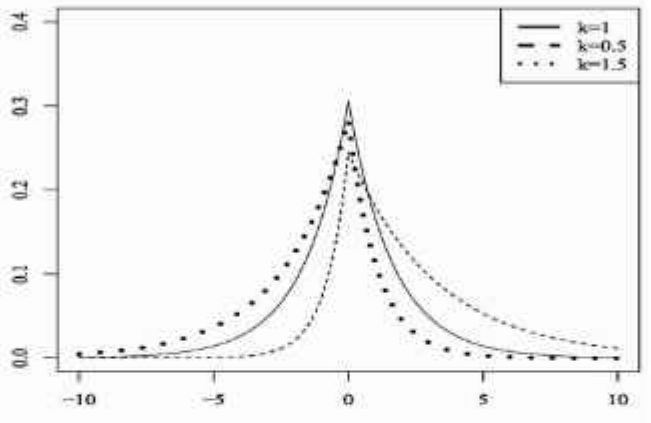



*Figure 3.1: Marshall-Olkin asymmetric Laplace density function for various values of $\kappa$ and for fixed ($\theta = 0$, $\alpha = 1.5$, $\sigma = 2$).*

## 3.1 Likelihood and estimation

In this section, we estimate remaining three unknown parameters $\theta_1 = (\alpha, \sigma, \kappa)$ using the maximum likelihood estimation. Let $X = (X_1, X_2 ..., X_n)$ be independent and identically distributed samples from MOAL distribution. The log-likelihood function takes the form

$$\log_{(\theta_1;X)} = \frac{n}{2}\log\alpha + n\log\kappa - n\log(1+\kappa^2) + n\log\sigma - \sqrt{\alpha}\,S(\sigma,\kappa),$$

where, $S(\sigma,\kappa) = \sum_{i=1}^{n} S_i(\sigma,\kappa) = \sum_{i=1}^{n} \frac{\kappa}{\sigma}(x_i-\theta)^{+} + \sum_{i=1}^{n} \frac{1}{\kappa\sigma}(x_i-\theta)^{-}$.

$(x_i-\theta)+(x_i-\theta)$ if $x > \theta$, and = 0 otherwise, and $(x_i-\theta)^{-} = (\theta - x_i)$ if $x \leq \theta$, and = 0 otherwise.

Existence, uniqueness and asymptotic normality of maximum likelihood estimators (MLEs) can be derived on the same lines as described in detail for an asymmetric Laplace distribution in Kotz et al. (2001).

The MLEs of $(\alpha, \sigma)$ for given $= \theta$, $\theta$ and $\kappa$ are obtained by solving the score equations for and .
This leads to the following equations which are solved iteratively.

In our illustrations, the maximization of the likelihood is implemented using the optim function of the R statistical software, applying the BFGS algorithm (See R Development Core Team, 2006). Estimates of the standard errors were obtained by inverting the numerically differentiated information matrix at the maximum likelihood point.

## 4. Analysis of Silver Price Data

Developing a forecasting model should always begin with graphical display and analysis of available data. In graphical display many of the general features can be identify. The weekly price of silver per gram for the period from 04-Jan-2013 to 28-Nov-2014 is collected from the Agricultural Statistics reports of Department of Economics and Statistics, Govt. of Kerala. We analyzed the data sets using R and SPSS package. First we fitted the normal and asymmetric Laplace distribution to the log ratio of the transformed data using R package.

Then the silver price in Kerala for the period from 04-Jan-2013 to 28-Nov-2014 is fitted with ARIMA(0,1,1) model.

| Table:4.1: Silver price in Kerala | | | | | | | |
|---|---|---|---|---|---|---|---|
| DATE | SILVER PRICE | DATE | SILVER PRICE | DATE | SILVER PRICE | DATE | SILVER PRICE |
| 4-Jan-13 | 61 | 28-Jun-13 | 39.8 | 20-Dec-13 | 44 | 13-Jun-14 | 41 |
| 11-Jan-13 | 58 | 5-Jul-13 | 40.6 | 27-Dec-13 | 45 | 20-Jun-14 | 44 |
| 18-Jan-13 | 58 | 12-Jul-13 | 41.4 | 3-Jan-14 | 45 | 27-Jun-14 | 44 |
| 25-Jan-13 | 58 | 19-Jul-13 | 40.5 | 10-Jan-14 | 45 | 4-Jul-14 | 44 |
| 1-Feb-13 | 58 | 28-Jul-13 | 41.4 | 17-Jan-14 | 45 | 11-Jul-14 | 46 |
| 8-Feb-13 | 58 | 2-Aug-13 | 41.1 | 24-Jan-14 | 45 | 18-Jul-14 | 45 |
| 15-Feb-13 | 58 | 12-Aug-13 | 44 | 31-Jan-14 | 44 | 25-Jul-14 | 44 |
| 22-Feb-13 | 58 | 16-Aug-13 | 50 | 7-Feb-14 | 45 | 1-Aug-14 | 44 |
| 1-Mar-13 | 56 | 23-Aug-13 | 53 | 14-Feb-14 | 46 | 8-Aug-14 | 44 |
| 8-Mar-13 | 56 | 30-Aug-13 | 55 | 21-Feb-14 | 48 | 14-Aug-14 | 45 |
| 15-Mar-13 | 56 | 6-Sep-13 | 54 | 28-Feb-14 | 48 | 22-Aug-14 | 43 |
| 22-Mar-13 | 54 | 11-Sep-13 | 51 | 7-Mar-14 | 47 | 29-Aug-14 | 42 |
| 27-Mar-13 | 54 | 20-Sep-13 | 51 | 14-Mar-14 | 47 | 5-Sep-14 | 42 |

**Table:4.1: Silver price in Kerala**

| DATE | SILVER PRICE | DATE | SILVER PRICE | DATE | SILVER PRICE | DATE | SILVER PRICE |
|---|---|---|---|---|---|---|---|
| 5-Apr-13 | 52 | 27-Sep-13 | 49 | 21-Mar-14 | 46 | 12-Sep-14 | 42 |
| 12-Apr-13 | 52 | 4-Oct-13 | 49 | 28-Mar-14 | 44 | 19-Sep-14 | 41 |
| 19-Apr-13 | 46 | 11-Oct-13 | 48 | 4-Apr-14 | 44 | 26-Sep-14 | 40 |
| 26-Apr-13 | 47 | 18-Oct-13 | 49 | 11-Apr-14 | 44 | 4-Oct-14 | 40 |
| 3-May-13 | 46 | 25-Oct-13 | 50 | 19-Apr-14 | 44 | 10-Oct-14 | 40 |
| 10-May-13 | 46 | 1-Nov-13 | 49 | 25-Apr-14 | 44 | 17-Oct-14 | 40 |
| 17-May-13 | 43.9 | 8-Nov-13 | 49 | 2-May-14 | 43 | 24-Oct-14 | 39 |
| 24-May-13 | 44 | 15-Nov-13 | 48 | 9-May-14 | 42 | 31-Oct-14 | 39 |
| 31-May-13 | 45.1 | 22-Nov-13 | 46 | 16-May-14 | 42 | 7-Nov-14 | 39 |
| 7-Jun-13 | 45.2 | 29-Nov-13 | 45 | 23-May-14 | 41 | 14-Nov-14 | 39 |
| 14-Jun-13 | 44 | 6-Dec-13 | 44 | 30-May-14 | 41 | 21-Nov-14 | 38 |
| 21-Jun-13 | 42 | 13-Dec-13 | 44 | 6-Jun-14 | 41 | 28-Nov-14 | 38 |

Source: Economics and Statistics Department, Govt. of Kerala


*Figure 4.1:Plot of Silver price in Kerala*

## 4.1 Fitting of Silver price dataset

The basic assumption of financial modelling has been the normality assumption for log log $(X_{t+1}/X_t)$. However, to make the modelling more appropriate, the focus of the basic assumption should have been shifted to the non-normality for log $(X_{t+1}/X_t)$.

Here we fitted the normal and asymmetric Laplace distribution. The histogram of the transformed silver price data (n log $(X_{t+1}/X_t)$ ) is plotted along with pdfs of normal and asymmetric Laplace and Marshall-Olkin asymmetric Laplace distributions were given in figure 3.2. The maximum likelihood estimators of the parameters of Normal and asymmetric Laplace istribution for the data is given below in Table 3.3. The Q-Q plot is given in figure 3.3 and their KS test is given below in Table 3.3.

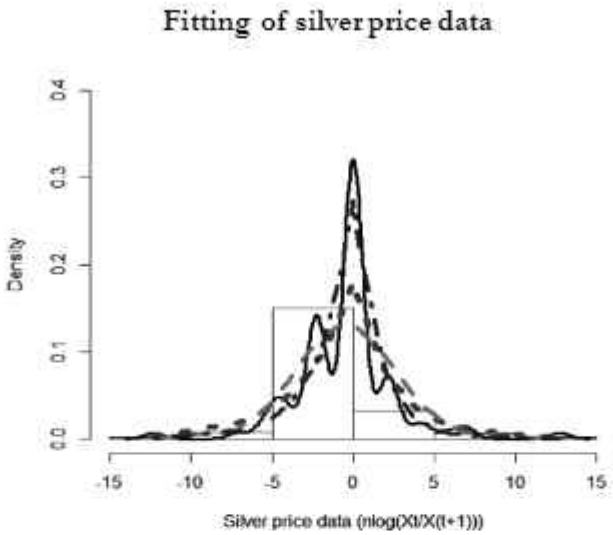



*Figure 4.2 Fitted Normal (dash), asymmetric Lapalce ( dash dot line), empirical (black line) distribution and Marhall-Olkin asymmetric Laplace distribution(dot) for the transformed silver price data.*

***Table 4.2 Gold price data analysis: maximum likelihood estimates for normal and Laplace.***

| Parameter | Normal | Asymmetric Laplace | Marhall-Olkin asymmetric Laplace |
|---|---|---|---|
| $\mu$ | -0.473 (0.001) | 0.01 (0.006) | 0.001(0.005) |
| $\sigma$ | 3.301 (0.019) | 1.814 (0.182) | 2.65(0.231) |
| $\kappa$ | ----- | 1.139 (0.081) | 1.131(0.105) |
| $\alpha$ | ----- | ----- | 3.501(0.891) |

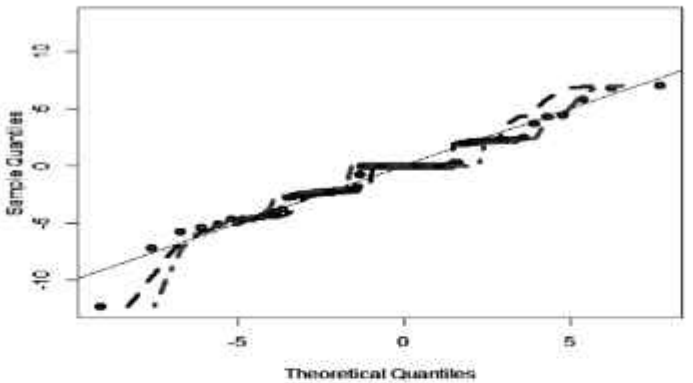



*Figure 4.3 Q-Q plot of Normal ( dash dot), asymmetric Laplace (dash line), empirical (black line) and Marhall-Olkin asymmetric Laplace distribution ( circles) for the transformed silver price data.*

| Table 4.3: K-S Test | | |
|---|---|---|
| Distribution | K-S distance (D) | p-value |
| Normal | 0.2442 | 0.0001 |
| Asymmetric Laplace | 0.0949 | 0.0253 |
| Marhall-Olkin asymmetric Laplace | 0.0341 | 0.0552 |

*Figure 4.3 Q-Q plot of Normal (green dash dot), asymmetric Laplace (blue dash line), empirical (black line) and Marhall-Olkin asymmetric Laplace distribution (red circles) for the transformed silver price data.*

## 4.2 Analysis of silver price data Using SPSS

We analyzed the silver price in Kerala for the period from 04-Jan-2013 to 28-Nov-2014 is fitted with simple model and the silver price in Kerala for the period from 04-Jan-2013 to 28-Nov-2014 is fitted with ARIMA(0,1,1) model.

**Table 4.4: Autocorrelation**

| Lag | Autocorrelation | Std. Error | Box-Ljung Statistic | | |
|---|---|---|---|---|---|
| | | | Value | df | Sig. |
| 1 | .923 | .099 | 87.857 | 1 | .000 |
| 2 | .843 | .098 | 161.890 | 2 | .000 |
| 3 | .755 | .098 | 221.778 | 3 | .000 |
| 4 | .660 | .097 | 268.130 | 4 | .000 |
| 5 | .573 | .097 | 303.424 | 5 | .000 |
| 6 | .486 | .096 | 329.102 | 6 | .000 |
| 7 | .409 | .095 | 347.448 | 7 | .000 |
| 8 | .337 | .095 | 360.075 | 8 | .000 |
| 9 | .264 | .094 | 367.913 | 9 | .000 |
| 10 | .193 | .094 | 372.148 | 10 | .000 |
| 11 | .119 | .093 | 373.773 | 11 | .000 |
| 12 | .041 | .093 | 373.965 | 12 | .000 |
| 13 | -.019 | .092 | 374.007 | 13 | .000 |
| 14 | -.066 | .092 | 374.520 | 14 | .000 |
| 15 | -.102 | .091 | 375.765 | 15 | .000 |
| 16 | -.096 | .091 | 376.883 | 16 | .000 |

| Table 4.4: Autocorrelation | | | | | |
|---|---|---|---|---|---|
| Lag | Autocorre-lation | Std. Errora | Box-Ljung Statistic | | |
| | | | Value | df | Sig. |
| 1 | .923 | .099 | 87.857 | 1 | .000 |
| 2 | .843 | .098 | 161.890 | 2 | .000 |
| 3 | .755 | .098 | 221.778 | 3 | .000 |
| 4 | .660 | .097 | 268.130 | 4 | .000 |
| 5 | .573 | .097 | 303.424 | 5 | .000 |
| 6 | .486 | .096 | 329.102 | 6 | .000 |
| 7 | .409 | .095 | 347.448 | 7 | .000 |
| 8 | .337 | .095 | 360.075 | 8 | .000 |
| 9 | .264 | .094 | 367.913 | 9 | .000 |
| 10 | .193 | .094 | 372.148 | 10 | .000 |
| 11 | .119 | .093 | 373.773 | 11 | .000 |
| 12 | .041 | .093 | 373.965 | 12 | .000 |
| 13 | -.019 | .092 | 374.007 | 13 | .000 |
| 14 | -.066 | .092 | 374.520 | 14 | .000 |
| 15 | -.102 | .091 | 375.765 | 15 | .000 |
| 16 | -.096 | .091 | 376.883 | 16 | .000 |

*Figure 4.4: Autocorrelation plot for silver price data*

| Table 4.5: Partial Autocorrelation | | |
|---|---|---|
| Lag | Partial Autocorrelation | Std. Error |
| 1 | .923 | .100 |
| 2 | -.063 | .100 |
| 3 | -.102 | .100 |
| 4 | -.086 | .100 |
| 5 | -.004 | .100 |
| 6 | -.051 | .100 |
| 7 | .003 | .100 |
| 8 | -.019 | .100 |
| 9 | -.071 | .100 |
| 10 | -.053 | .100 |
| 11 | -.079 | .100 |
| 12 | -.093 | .100 |
| 13 | .062 | .100 |
| 14 | .033 | .100 |
| 15 | .003 | .100 |
| 16 | .223 | .100 |

Table:4.6 ARIMA (p,d,q) model parameters

The graph of fitted model is given below in figure 4.5.

| Table:4.6 ARIMA(p,d,q) model parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| model | | | | | Estimate | SE | t | Sig |
| Silver price ARIMA(0,1,1) model | Silver price | No Transformation | Difference | 1 | | | | |
| | | | MA | Lag 1 | -.224 | .099 | -2.264 | .026 |

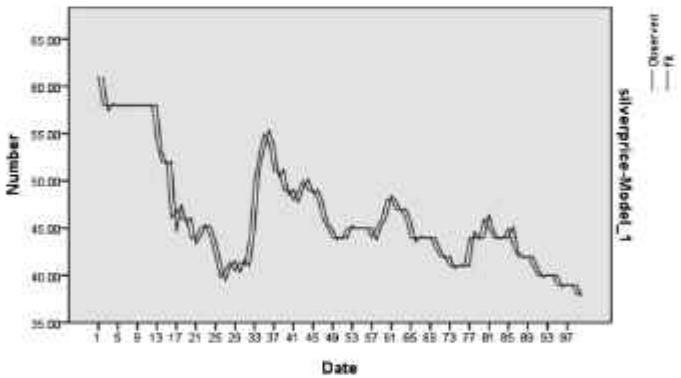



*Figure:4.5 Fitted Graph of ARIMA(0,1,1) Model*

ARIMA(0,1,1) is best fit to the data and the R-square value is 0.934. The fitted model is the ARIMA (0, 1, 1) model is given by,

$X_t = X_{t-1} + e_t + \beta e_{t-1}$, $e_t$ is a pure random process with mean 0 and variance $\sigma^2$.

Here $\beta = -0.224$, $X_t = X_{t-1} + e_t - 0.224\, e_{t-1}$

### 4.2.1 Forecasting of silver price

Forecasting of silver price in this volatile market is a difficult task. Time series ARIMA model, is most authentic and provide more accurate forecasting of silver price, which may be very useful for investor and industry to understand present and future value of this commodity. The forecast of Silver price in Kerala are given in the following table,

**Table:4.6: Silver price forecast**

| Model | | 04-01- 2015 | 28-06-2015 | 10-11-2020 |
|---|---|---|---|---|
| silverprice-model ARIMA(0,1,1) | Forecast | 38.05 | 38.05 | 38.05 |
| | UCL | 40.87 | 42.51 | 43.69 |
| | LCL | 35.23 | 33.59 | 32.41 |

## 5. Conclusion

Time series analysis has become one of the most important and widely used branches of statistics. Application of this branch of statistics includes economic forecasting, stock market analysis, study of biological data, astrophysics and engineering. In present study we analyzed weekly price per gram of silver from 4th January 2013 to 28th November 2014 using SPSS and R package. We found that Marshall-Olkin asymmetric Laplace distribution is good fit to the data compared to asymmetric Laplace and normal distribution. We used Box-Jenkins methodology to find the best model. ARIMA(0,1,1)

model is best fit to the silver price data since R2 value is 0.934. Hence 93.4% of the variability in silver price data was described by ARIMA(0,1,1) model. The fitted model is $X_t = X_{t-1} + e_t - 0.224\, e_{t-1}$, which can be used to estimate the price of silver in the future.

**References**


1. Box, G., Jenkins, G.M., Reinsel, G. (2004). Time Series Analysis: Forecasting & Control 3rd ed., Pearson, New York.
2. Brockwell, P.J., Davis, R.A. (2006). Introduction to Time Series and Forecasting 2nd ed., Springer, Berlin.
3. Damsleth, E., El-Shaarawi, A.H. (1989). ARMA models with double-exponentially distributed noise, J. Roy. Statist. Soc. Ser. B., 51(1), 61-69.
4. Gaver, D. P. and Lewis, P. A. W. (1980) First order autoregressive gamma sequences and point processes. Adv. Appl. Pro. ,12, 727-745.
5. Jayakumar K., Kuttikrishnan A.P. (2006) Time series model using asymmetric Laplace distribution. Statistics and Probability Letters, 76,813-820.
6. Kotz, S., Kozubowski, T.J. & Podgorski, K., (2001). Maximum likelihood estimation of asymmetric Laplace parameters. Ann. Inst. Statist. Math., 50(4), 816-826.
7. Lawrance, A.J. (1978). Some autoregressive models for point processes, In Proceedings of Bolyai Mathematical Society Colloquium on point processes and queuing problems, 24, Hungary, 257-275.
8. Lawrance, A.J., Kottegoda, N.T. (1977). Stochastic modelling of riverflow time series, J. Roy. Statist. Soc. Ser. A, 140(1), 1-47.
9. Lawrance, A.J., Lewis, P.A.W. (1981). Generation of some first order autoregressive Markovian sequence of positive random variables with given marginal distributions, Appl.

probab. Computer Science, The Interface, (Edited by R.L.Disney and T.J.Ott), 1, 353-379.
10. Linhart, H., Zucchini, W. (1972). Parametric models for point processes, S. Afr. Statist J., 6, 19-26.
11. Marshall, A.W. & Olkin, I., (2001). A new method for adding a parameter to a family of distributions withapplications to the exponential and Weibull families. Biometrika, 84, 641652.
12. Tavares V. L. (1980). An exponential Markovian stationary process. J. Appl. Prob. 17, 1117-1120.

# Tuning the Basic Hydrolysis of Malachite Green in CTAB/KBr/alcohol micelles

■ Jasila K, Lisa Sreejith

The basic hydrolysis of malachite green (MG) in CTAB/KBr/alcohol ($C_9OH$-$C_{12}OH$) mixed micelles has been studied. Kinetics of the reaction was studied using spectrophotometric method. The rate of reaction showed noticeable dependence on the concentration and chain length of added alcohols in the reaction medium. The pseudo first order rate constant ($k'$) has been found to increase with concentration of alcohol. The enhancement of reaction rate with concentration of alcohol was interpreted on the basis of alcohol triggered structural transition, which was well supported by viscosity, rheology, DLS and Cryo TEM analysis. Kinetic results showed that CTAB/KBr/nonanol micellar medium catalyses the reaction better than other medium and is attributed to the change in solubilisation site of added alcohol with chain length. The nonanol ($C_9OH$) produces a favour condition for micelle growth as its located in the palisade layer of micelles. However, on increasing the hydrophobicity of alcohol, the alcohol will locate deeper to the core and is less effective to induce micellar elongation. Hence, CTAB/nonanol medium having larger micelles can solubilise large amount of MG, and consequently leads to high rate.

*Keywords*— *Surfactants; Long Chain Alcohols; Micellar Catalysis*

## Introduction

The structural characteristics allow micelles to solubilise both polar and non polar molecules and hence act as a unique media to catalyze numerous organic reactions [1]. Micelle catalyzed reactions are highly sensitive to various factors such as the nature and concentration of surfactant, presence of co-surfactant, electrolyte etc [2-4]. Tuning the reaction rate can thus be achieved by the wise choice of surfactant and reaction conditions. Research in micellar catalysis has noticeably increased during the past few decades, as it provides a simple way to tailor organic reactions in aqueous media and eliminate the use of environmental hazardous organic solvents. Malachite green (MG) is a triphenylmethane dye. The name of the dye just comes from the similarity of its color. It is used to dye materials like silk, leather, cotton and paper. Due to the vast applications of MG, its interactions with other compounds, such as surfactants, are of great importance [5].

The kinetic studies of alkaline fading of malachite green have been extensively developed [6,7]. The reaction of malachite green with hydroxide ions in surfactant media follows a pseudo first order kinetics in excess of $HO^-$. Previous studies indicate that the rate of alkaline hydrolysis of $MG^+$ increased in cationic surfactants [7, 8] and inhibited by anionic ones [7]. In the present paper we try to explore catalytic action of alcohol tuned surfactant organized assemblies on basic hydrolysis of MG. The effect of concentration and chain length of alcohol on the reaction kinetics of MG hydrolysis were also investigated.

## Materials and methods

### Materials and sample preparation

CTAB (Merck, 99% assay), was purchased and used as received. All the additives used KBr (Himedia, 99% assay) and n-alcohol, n-decanol, n-undecanol, n-dodecanol (Merck, 99% assay) were of high purity chemicals and were used without further purification. The dye malachite green was A.R. grade and sodium hydroxide was procured from Merck. The water used to prepare the solutions was Millipore Water of conductivity 18.2 MΩ cm. The stock solution was prepared by dissolving a weighed amount of solid CTAB and the respective amount of KBr in malachite green solution ($2\times10^{-5}$ M). The alcohols of varying concentration were added to this solution using glass microsyringe (Hamilton) and were heated to 50°C under continuous stirring until the solution becomes homogeneous.

### Kinetic measurements

The progress of the reaction was measured spectrophotometrically (Systronics, 2202 UV–visible spectrophotometer) by observing the change in absorbance as a function of time at 630 nm. The observed pseudo-first-order rate constants, $k'$, were obtained from slopes of $\ln(A_t - A_\infty)$ versus time using the equation (1):

$$\ln(A_t - A_\infty) = -k't + \ln(A_0 - A_\infty) \quad (1)$$

where $A_t$, $A_0$ and $A_\infty$ are the absorbances of MG at time t, initial and equilibrium, respectively.

### Viscosity Measurements

The absolute viscosity of samples under conditions of defined shear rate and shear stress were determined by a programmable Brookfield DV-II + cone and plate viscometer (Brook-

field Engineering Laboratories, Inc - USA) thermostated in the temperature range 25°C. Prior to the measurement samples are mounted at least 30 minutes to attain thermal equilibrium.

## DLS measurements

Measurements were performed with a Malvern 4800 Autosizer employing a 7132 digital correlator at a scattering angle of 130°C. A vertically polarized light of wavelength 514.5 nm from an argon laser was used as the incident beam. All solutions were filtered with a 0.2 mm membrane filter before the measurements to avoid interference from dust. The measured intensity correlation functions were analyzed by the method of cumulants33 where unimodal distribution of relaxation time is considered. The size distribution is obtained using the CONTIN algorithm wherever needed.

## Results and Discussions

### a. Effect of concentration of alcohol

The experimental pseudo-first-order rate constants ($k^{\psi}$) for basic hydrolysis of MG in micellar media, 0.1MCTAB/0.1MKBr/xM alcohol are represented in Figures 1. From the results, one can see that the incorporation of alcohol in CTAB/KBr micelles causes a significant enhancement of reaction rate. The variation of reaction rate with $C_0$ reflects the strong dependence of the rate constant on the micellar morphology

In order to rationalize the effect of $C_0$ on the experimental kinetic data, we have performed the viscosity measurements. The variation of viscosity with $C_0$, (fig 2) thus indicates alcohol induced structural transitions.

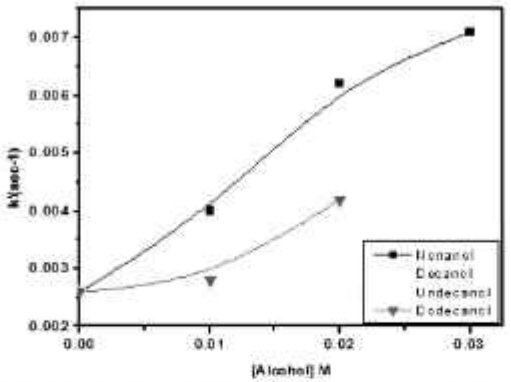



*Fig 1: Variation of pseudo-first-order rate constant for the reaction of MG with OH- (0.01M) as a function of the concentration of C0*

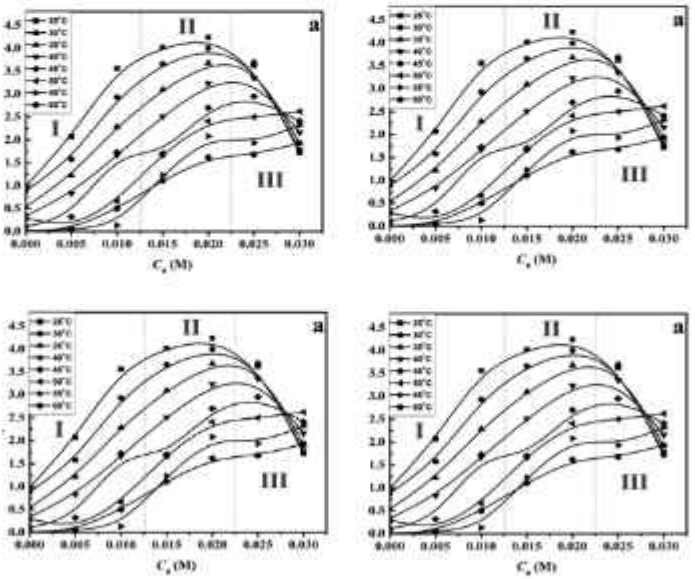



*Fig 2: Zero shear viscosity, log (cP) of 0.1MCTAB/0.1M KBr for (a) Nonanol (b) Decanol (c) Undecanol (d) Dodecanol at temperatures ranging from 25-60°C.*

To better understand the rich variation in viscosity, we have performed rheological measurements. The steady shear viscosities obtained for the samples (>0.01 M $C_0$) showed non-Newtonian behaviour (Fig. 3) i.e., the viscosity decreases drastically with an increase in shear rate (shear thinning behaviour). Upon increasing the concentration of alcohol the viscosity increases promptly: an indication of the formation of rigid rods of medium length, which slowly converts in to flexible wormlike micelles. Here the samples are clear and viscoelastic. However, at higher $C_0$ (0.03 M) shear thinning becomes less prominent (deviation from non-newtonian behaviour). The non-viscous and bluish nature of the sample solution reflects the presence of unilamellar vesicles.

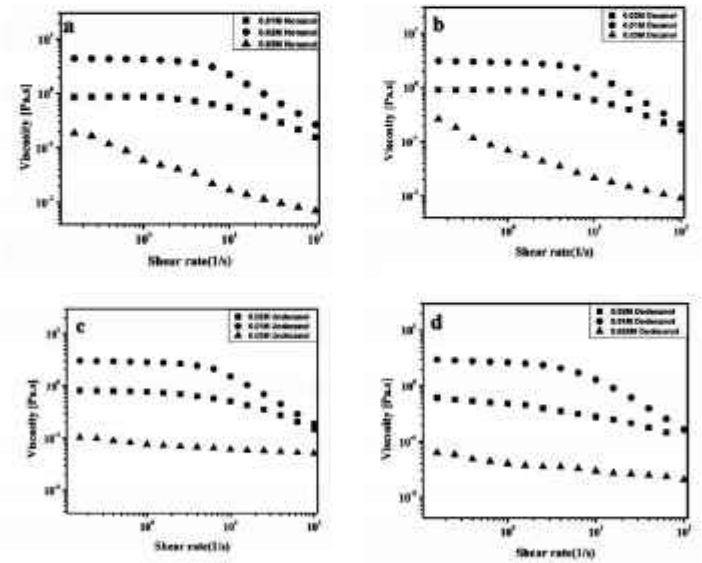



*Fig 3: The Steady shear rheological response of 0.1M CTAB / 0.1M KBr as a function of alcohol concentration.*

To further elucidate alcohol induced micellar growth, DLS analysis was done. DLS data for MG in 0.1CTAB / 0.1MKBr micelle media as a function of $C_0$ is given in Fig. 4 a, b, c, and d and is very much complementary to the viscosity results. It is observed that the average hydrodynamic radii of CTAB micelle increase with $C_0$ (scheme 1), confirming alcohol induced micelle growth. Thus, larger, more hydrophobic micelles can solubilise relatively large amount of MG, leading to an increase in dye-micelle interaction.

Cryo tem image of CTAB/0.02M nonanol and CTAB/0.03M nonanol samples were shown in fig 5a & b. At 0.02M of alcohol, the sample shows the presence of wormlike

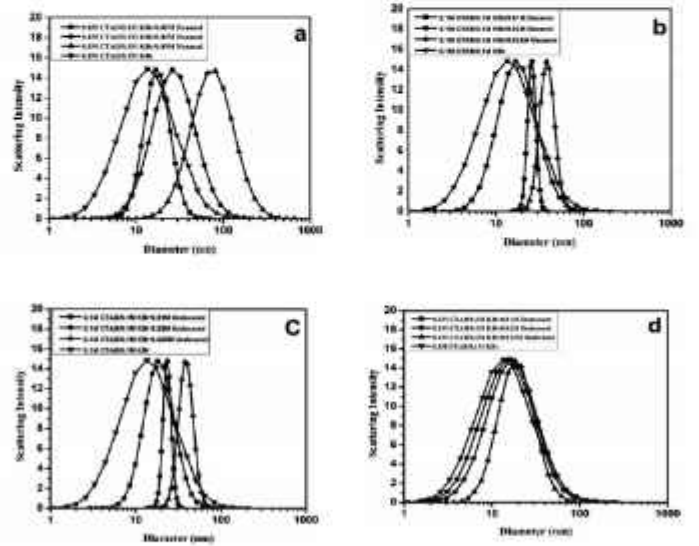



*Fig.4. The diameter of CTAB/KBr/ alcohol micellar solutions as a function of C0 at 25°C. a) nonanol b) decanol c) undecanol and d) dodecanol. x=0.005-0.03M alcohol.*


*Scheme 1: Possible structural growth of CTAB micelles with concentration of alcohol. Larger, more hydrophobic micelles can solubilise large amount of MG.*

micelles. However, upon increasing the alcohol concentration to 0.03M, the structure is changed to vesicles. Presence of unilamellar and multilamellar vesicles is clearly visible in fig 5b. Thus increase in concentration of alcohol cause a noticeable growth of micelles.

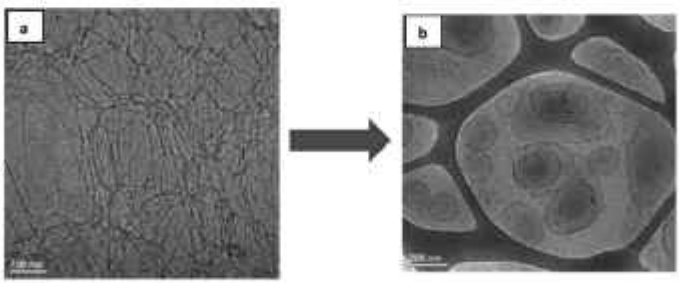
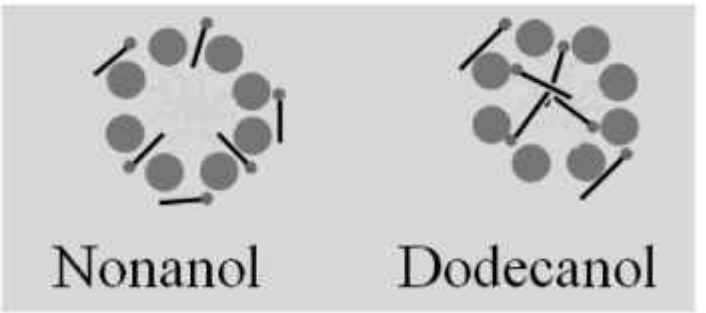



*Fig 5 Cryo-TEM images of the a). CTAB/KBr/0.02M nonanol b) CTAB/KBr/0.03M nonanol*

## Effect of chain length of alcohol

The chain length of alcohol is found to play a crucial role in MG hydrolysis. A noticeable decrease in the reaction rate was observed on varying the chain length of alcohol from $C_9$ to $C_{12}$ (fig1). As can be clearly seen in fig 1, the CTAB/nonanol system catalyses the reaction more effectively than CTAB/dodecanol system.

The variation of reaction rate with chain length of alcohol may be due to change in morphology and change in dye-surfactant interaction with chain length of alcohol. The DLS data show that the hydrodynamic diameter of the CTAB/KBr/nonanol micelles is greater than CTAB/KBr/dodecanol micellar system (fig 4). The expansion of the hydrophobic core volume of CTAB in presence of nonanol enables it to solubilise relatively large amount of MG than dodecanol system. Further, the hydrophobic interaction between dye-micelle will be greater in nonanol sample, since the preferable location of nonanol will be in palisade layer, where MG is usually located. However, the more hydrophobic dodecanol tend to solubilise deeper to the micelles, and interact weakly with MG (scheme 2). Thus MG concentration in CTAB/dodecanol system could have decreased and accordingly rate constant decreased.




*Scheme 2: Proposed solubilsiation site of nonanol and dodecanol*

## Conclusion

In summary, we have shown that the addition of alcohol to CTAB micelles increase its catalytic efficiency for MG hydrolysis . With increases in $c_0$, the reaction rate increases, which is ascribed to the change in micellar structure (micelle growth) with $c_0$ . Viscosity, rheology, DLS and Cryo- tem studies supports alcohol induced morphological transitions. Besides $c_0$, the chain length of alcohol was found to play a crucial role in the reaction kinetics. On increasing the chain length of alcohol, the rate of MG hydrolysis is found to decrease, probably due to the change in the micellar morphology and dye-micelle interaction with chain length of alcohol.

**References**


1. Christian, S. D. and Scamehorn, J.F. (1995) Solubilization in Surfactant Aggregates, Science, New York.
2. Samiey, B. and Toosi, A. R. (2009) Bull. Korean Chem. Soc, 30: 2051-2056
3. Valiente, M. and Rodenas, E.(1990) J.colloid. interface sci, 138: 299-306.
4. a) Bunton , C.A., Minch, M. J., Hidalgo , J. and Sepulveda, L. (1973) J. Am. Chem. Soc, 95: 3262–3272. b) Bunton, C. A., Minch, M. and Sepulveda, L.,(1971) J. Phys. Chem, 75: 2707–2709.
5. D.F. Duxbury, 93 (1993), Chem. Rev. 381–433.
6. S. Dasmandal, H.Kumar Mandal, A.Kundu, A. Mahapatra, (2014) Journal of Molecular Liquids 193, 123–131
7. B. Samiey and A. R. Toosi, (2009), Bull. Korean Chem. Soc. 30,2051-2056
8. S.Oladega; O.Olarenwaju; O.Akinola, (2008), Acta Chimica Slovenica . 55, 3, 613-616.

# Genoprotective activity of *Barleria prionitis* L. (Family: Acanthaceae)

■ **Dr. Renjana P.K**

## Abstract

The present study aimed to evaluate the genotoxicity of the organophosphorus insecticide methyl parathion (MP) and the genoprotective effect of *Barleria prionitis* L. using *Allium cepa* assay. The roots of *A. cepa* were pre-treated with different concentrations of the aqueous leaf extract of *B. prionitis* (0.01%, 0.05 % and 0.1 %), for 12 h, and then exposed to sub-lethal concentration (0.01%) of MP for 3 h. Distilled water and Methyl Parathion (MP) were used as the negative and positive controls respectively. The slides were scored for mitotic index (MI) and percentage of chromosome aberrations (CA). The exposure to MP elicited statistically significant ($P < 0.05$) increase in frequency of CA and caused a significant inhibition of MI in the root meristematic cells of *A. cepa*. Pre-treatment with the extracts at different concentrations produced significant decrease in the frequency of MP induced aberrations and increase in MI in a dose and time dependent manner ($P<0.05$). This study, therefore, confirmed the genoprotective effect of the extract of *B. prionitis* leaves.

***Keywords:*** *Allium cepa, Barleria prionits,* Chromosomal aberrations, Genoprotective, Mitotic index.

## Introduction

Medicinal plants constitute a very important natural resource of India, making it one of the richest plant based ethno-medical traditions in the world (Rajasekharan and Ganesan, 2004). Throughout the centuries, herbalists have used specific herbs or combinations of herbs to treat various diseases and to promote general health. Natural products, their derivatives and aalogs represent over 50% of all drugs in clinical use (Balandrin *et al.*, 1993). Although synthetic drugs and antibiotics brought about a revolution in controlling different diseases, the popularity and acceptability of herbal medicines are mainly due to the toxicity and undesirable side effects of the synthetic allopathic medicines. The plant-based formulations have been found to be effective against mild or chronic ailments and have proved biologically more compatible with human system.

The advent of the industrial revolution has caused the release of several new chemical entities, posing serious threat to the ecosystem and public health. Majority of them affect the functioning of specific bio-molecules and thereby damage health at various levels. Some of these chemicals, *e.g.*, pesticides, may be genotoxic to the sentinel species and to non-target species, causing deleterious effects in somatic or germ cells. Since DNA is the carrier of inherited information, any change in its structure may potentiate serious biological changes.

Organophosphates are a group of pesticides that have historically been in use, which act by inhibiting acetylcholine

esterase, resulting in acetylcholine accumulation in neuromuscular synapses. More recently, it has been reported that organophosphates produce oxidative stress in different tissues, such as liver, blood and brain through the formation of reactive oxygen species (Sharma *et al.*, 2005; Ranjbar *et al.*, 2002). Methyl parathion (O, O–dimethyl O-4-nitrophenyl phosphorothioate) is an organophosphorous insecticide, classified as extremely toxic by the WHO. According to Vidyasagar *et al.* (2004), methyl parathion can enhance capacity for alkylation of informational macromolecules like DNA due to its extra methyl group.

Although there are a multitude of instances where agrochemicals including pesticides pose adverse impact on human health, their role in agriculture is undeniable. Antimutagenesis is considered as one of the most feasible ways for inhibiting or minimizing the genotoxic effects of mutagens during their inevitable exposure by physiological detoxification. Many naturally occurring compounds with genoprotective activity are known to protect cellular components from genetic damage. Recent studies have revealed the presence of natural bioactive materials in many different plant species and the antimutagenicity of these materials is currently under active investigation.

The Acanthaceae family is a large group of plant species used as traditional or folk medicines, containing substantial amounts of phenolic and flavonoid compounds which have been reported to exhibit a broad range of biological activities including antioxidant, anti-inflammatory, antimutagenic, and antitumour effects. *Barleria prionitis* L., belonging to the family Acanthaceae, commonly known as 'Porcupine flower' or 'Vajradanti' in India, is widely distributed throughout Africa, India, Sri Lanka and tropical Asia has long been used as a folk

medicine for the treatment of several ailments. The plant extract has also shown its potential applications as diaphoretic and expectorant (Sing *et al.*, 2005). The plant has been reported to have anti-respiratory syncytial virus (Chen *et al., 1998*), anti-arthritic, anti-inflammatory and anti-fertility properties (Sing *et al.*, 2003; Gupta *et al.*, 2000). Recent phytochemical studies on the extracts of the aerial parts of *B. prionitis* have resulted in the isolation of several new phytochemicals with promising free radical scavenging and antioxidant activity (Ata *et al.*, 2009), that contributes to the wide range of pharmacological properties which could also include protecting tissues against genotoxic effects of environmental toxicants.

A great variety of tests and test systems based on microbes, plants and animals have been developed in order to assess the genotoxic effects of xenobiotic agents, including pesticides. Mitotic cell division inhibition and chromosome aberration induction have been widely used as indicators of cytotoxicity and genotoxicity. *A. cepa* assay is considered as one of the most efficient and cost effective approaches to determine the toxic potential of chemical compounds in the environment because of its high sensitivity and good correlation with the results of mammalian test systems (Fiskesjo and Levan, 1993). Study of the effect of several chemicals on plant mitosis may provide valuable information in relation to possible genotoxicity in mammals and especially in humans (Rank, 2003; Kuras *et al.*, 2006) and so could be used as an alternative to laboratory animal in toxicological research. In light of the above facts, the present investigation was carried out to assess the potential genoprotective effect of aqueous leaf extract of *B. prionitis* against the mutagenic effects of MP using *Allium* root tip cells as a test system.

## Materials and methods

Plant materials from the campus, University of Calicut were collected, identified, catalogued and preserved in the herbarium, Dept. of Botany, University of Calicut (CALI-123737). Plant leaves were weighed and masticated using mortar and pestle and various concentrations (0.01% (Extract 1), 0.05 % (Extract 2) and 0.10 % (Extract 3)) were prepared. Onion bulbs were purchased freshly from the local market. Old roots and dry scales were removed and placed on top of test tubes filled with distilled water and allowed to germinate in the dark at 27±2°C. After 48 h, healthy onion bulbs in water were used for treatments in various concentrations of *B. prionitis* leaf extract. Germinated onion bulbs were incubated for 12 h on top of test tubes filled with different concentrations of the three extracts (Extract 1, 2 and 3). A second set of similar sized onion bulbs were also treated in the same way in the three extracts for 12 h after allowing them to germinate on distilled water for 48 h. To perform the third experiment, another set of equal sized onion bulbs were used. They were carefully unscaled, placed on top of the test tube, which contained distilled water, and allowed to germinate at 27±2°C for 60 h. In the fourth set, onion bulbs treated in the similar way, were allowed to grow and produce new roots on top of the test tube filled with distilled water for 60 h in the dark at 27±2°C.

After incubation, the germinated onion bulbs of the first treatment were exposed to 0.01% of MP solution prepared in distilled water at its peak mitotic time at 27±2°C for another 3 h period. Half of the third set of bulbs was exposed to 0.01% and the other half to 0.1% MP respectively. The second and the fourth set of bulbs were not exposed to MP and were al-

lowed to produce new roots on top of the test tubes filled with distilled water only. The roots from all the three sets of onion bulbs, after treatments were fixed in freshly prepared Carnoy's fluid (3 alcohol : 1 acetic acid). After an overnight fixation, mitotic preparations were carried out by aceto-carmine squash technique (Sharma and Sharma, 1990).

The third set of treatment, where bulbs germinated in distilled water alone and then transferred to 0.01% and 0.1% solutions of MP served as positive control, whereas bulbs of the fourth set (those germinated in distilled water alone for 60 h) served as negative control to compare the effects of the various extracts on *A. cepa* root tip. Two slides were made for each treatment and scoring was done from five sites that were randomly selected from these slides to determine the mitotic index (MI) and the percentage of chromosomal aberrations (CA). The MI was calculated for each treatment as the number of cells in mitosis / total number of cells counted and expressed as percentage. The cells were also scored for chromosomal abnormalities and the percentage of chromosomal aberrations was measured as the ratio of number of aberrant cells to total number of cells observed. For photo graphic documentation, Leica DM 500 microscope with an attached image analyzer was used. The most frequent abnormalities are shown in photomicrographs (Fig. 1).

## Statistical Analysis

The data of MI and CA are represented in percentage mean ± SE of five scorings. For statistical analysis, one-way analysis of variance (ANOVA) and Duncan's multiple range test (DMR) (Duncan, 1995) were used. All statistical analyses were performed by using the computer software SPSS 20.0

for Windows. Results with $P < 0.05$ were considered to be statistically significant.

## Results

The genotoxicity of the three aqueous leaf extracts (extracts 1, 2 and 3) of *B. prionitis* was analyzed and the results obtained were compared with that of negative control group (distilled water treated root tips). As such, the onion root tip cells treated with extracts 1, 2 and 3 showed normal mitotic behaviour and significantly high MI values that are comparable to the negative control group (Table 1). The values of MI of various extracts ranged from 22.72 to 25.34. As the concentration of the extract increased, the value of MI was not affected, whereas MP (0.01%) treated cells showed around 50% inhibition of cell division. Treatment in low concentration (0.01%) of the pesticide itself resulted in significant (p ? 0.05) reduction in MI (13.14%) compared to negative control and the leaf extracts.

**Table 1. Effect of methyl parathion and aqueous leaf extracts of *B. prionitis* on the mitotic behaviour of *A. cepa* root tip cells. Each value represents mean of five replicates.**

| Treatment | Mitotic index ± S. E. | Abnormality % ± S. E. |
|---|---|---|
| **Distilled water** (Negative control) | 24.91 ± 0.94 [a] | 0.89 ± 0.13 [a] |
| **Methyl parathion (0.01%)** | | |

| | | |
|---|---|---|
| (Positive control) | $13.14 \pm 1.14^{d}$ | $58.43 \pm 2.64^{e}$ |
| **Methyl parathion (0.1%)** | | |
| (Positive control) | $3.71 \pm 0.62^{e}$ | $94.88 \pm 0.24^{f}$ |
| **Extract 1** | $25.34 \pm 1.13^{a}$ | $0.64 \pm 0.88^{a}$ |
| **Extract 2** | $22.72 \pm 0.92^{ab}$ | $1.13 \pm 0.27^{a}$ |
| **Extract 3** | $24.88 \pm 0.86^{a}$ | $0.92 \pm 0.27^{a}$ |
| **Extract 1 + Methyl parathion (0.01%)** | $15.20 \pm 1.15^{cd}$ | $45.91 \pm 0.61^{d}$ |
| **Extract 2 + Methyl parathion (0.01%)** | $17.24 \pm 1.37^{c}$ | $36.69 \pm 1.57^{c}$ |
| **Extract 3 + Methyl parathion (0.01%)** | $20.71 \pm 1.36^{b}$ | $28.77 \pm 0.52^{b}$ |

S. E. – Standard error. Means in a column followed by the same superscript letters are not significantly different ($P < 0.05$, one-way ANOVA, DMR test).

The MP (0.01%) treated root tips were also characterized by a high percentage of aberrant cells (Table 1). On the other hand, percentage abnormality of the extract treated root tips was recorded as significantly ($p < 0.05$) low, similar to the negative control (Table 1). The highest percentage (94.88%) of abnormal stages was scored in 0.1% MP treated root tips. Both clastogenic and non-clastogenic abnormalities were observed in MP treated cells. The frequently observed aber-

rations in the pesticide treated cells were chromosome bridges, stickiness, disturbed metaphase and anaphase, scattering, nuclear lesions, mis-orientations, chromosome fragments *etc.* (Fig. 1).

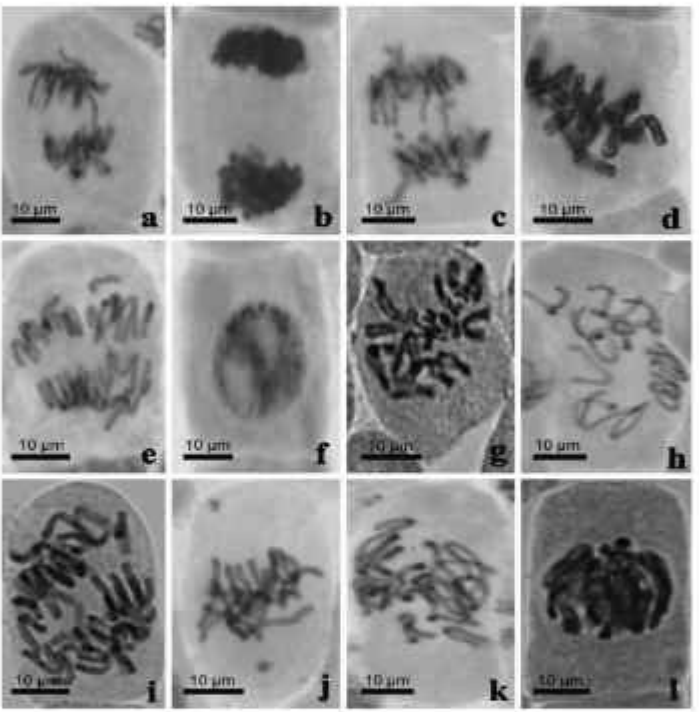



*Fig. 1. Chromosome aberrations in A. cepa root tip cells induced by methyl parathion.*

a. Chromosome bridge b. Sticky anaphase c. Chromosome bridge and fragments d. Chromosome lesions e. Scattered anaphase f. Nuclear lesions g. Fragmentation h. Scattering i. Mis-orientation j. Chromosome fragments at the poles k. Disturbed metaphase l. Sticky metaphase

All three extracts at the doses mentioned had no significant effect on inducing CA or decreasing MI in root tip cells of *A. cepa*, rather pre-treatment with the leaf extracts of *B. prionitis* exhibited inhibitory activity against the MP-induced CA and decrease in MI in a dose dependent manner (Table 1). The lowest frequency of CA was observed with treatment with the highest concentration of the extract, *i.e.*, extract 3. Extracts 1 and 2 also showed good reduction in the percentage of CA compared to that of the MP treated groups. Thus the assay results clearly proved the genoprotective potentiality of *B. prionitis* compared with distilled water and MP.

## Discussion

The *A. cepa* test proved the non-cytotoxic and genoprotective effects of *B. prionitis* aqueous leaf extracts. It is in consensus with the biological activity of other natural metabolites that are proved to be least harmful to biological systems. In the present study it is evident that a much lower concentration (0.01%) of MP could cause severe mitotic abnormalities in the dividing cells. The study also proves that *B. prionitis* extract did not induce chromosome aberrations and thus had no cytotoxic effect on *A. cepa* root tip cells.

The ability of organophosphates to react with DNA by transalkylation may reasonably explain their mutagenecity (Epstein and Legator, 1971). Wild (1975) focused attention on the electrophilic activity as the fundamental cause of the toxicity of these compounds and considered DNA alkylation as one of the reasons for the production of chromosomal aberrations. PO-C is the common structural group of all organophosphates, where phosphorous and carbons are electrophilic sites which offer insight into the understanding

of the reactions of organophosphates with nucleophiles. A nucleophile can preferentially attack either phosphorous or carbon atom with subsequent cleavage of P=O or C=O bonds and undergo phosphorylation or alkylation, as the case may be. Such reactions of nucleophilic substitution constitute the primary chemical lesions, resulting ultimately in cytotoxic or genotoxic effects (Jayashree *et al.*, 1992). Benke and Murphy (1975) found that liver microsome oxidase in the liver of rat oxidizes methyl parathion, containing phosphorothioate (P=S), to oxon (P=O) and subsequently to methyl paroxons. Vijayraghavan and Nagarajan (1994) consider these oxons, which are highly toxic compounds, to account for the profound cytotoxic effect of methyl parathion.

Methyl parathion after entering the body of an organism is metabolized, either by glutathione dependent detoxification or by oxidation to form toxic methyl paraxon. It may also react with cholinesterase to cause subsequent toxicity. Detoxification is achieved by degradation reactions that involve either demethylation or dearylation. The resulting desmethyl compounds and dimethyl phosphoric acids are essentially nontoxic. These detoxification reactions are due to the glutathione-dependent alkyl and aryl transferases. The toxic methyl paraoxon may be inactivated within the living organisms by the very same transferases, during which a superoxide radical, which can initiate a chain of reactions is formed.

The relationship between presence of phytochemicals and biological properties of plant extracts have been investigated by many authors. There have been many previous reports indicating the high antioxidant properties of *B. prionitis*. Khobragade and Bhande (2012) reported the presence of reactive oxygen scavenging agents in the leaf extract of *B. prionitis*. Many have detected the presence of phenolics, glycosides,

flavonoids, proanthocyanidins and tannins from the leaves and stems of *B. prionitis*. Phenoilics and flavonoids have been shown to possess significant antioxidant activites (Van *et al.*, 1996). The health promoting functions of such phytochemicals is by virtue of their ability to scavenge hydroxyl and lipid peroxy radicals by which they can prevent diseases associated with oxidative damage of membranes, proteins and DNA (Fergusion, 2001). Ruch *et al.* (1984) proved that phenolic compounds are very good electron donors, which may accelerate the conversion of hydrogen peroxide to water. According to Lima *et al.* (2007), phenolic compounds have direct effects on genotoxicants which would include the antiradical scavenging activity, hydrogen-donating activity and the ability to chelate metal ions. Rice-Evans *et al.* (1996) also have proved the ability of phenolic compounds to chelate metal ions.

According to Chetan *et al.* (2011), the aqueous extract of *B. prionitis* possess significant antioxidant activity and the observed antioxidant activity is ascribed to the presence of high levels of phenolic compounds. Jaiswal *et al.* (2010) carried out a comparative study on the total phenolic content, reducing power and free radical scavenging activity of aerial parts of *B. prionitis*. Their study proved that the leaf of *B. prionitis* possesses high phenolic content, potential antioxidant activity and reducing power & radical scavenging activity in comparison to flower and stem.

Maji *et al.* (2011) carried out phytochemical analysis of hydro-methanolic extract of *B. prionitis* whole plant which revealed the presence of glycosides, flavonoids, steroids and tannins. Ata *et al.* (2007) carried out detailed phytochemical analysis of the crude ethanolic extract of *B. prionitis* that led to the isolation of six natural products *viz.*, balarenone,

pipataline, lupeol, prioniside A, prioniside B and prioniside C. Among these lupeol is a highly potent chemopreventive and chemoprotective agent against many disorders. Ragasa *et al.* (2003) and Saleem (2009) have reported the antimutagenic property of lupeol. Such studies have presumed that flavonoids, iridoids, tannins *etc.* present in the extracts might be responsible for the observed genoprotective activitiy.

Degenerative diseases, such as cancers, cardiovascular diseases, osteoporosis *etc.* are associated with aging. Oxidative damage to cell components, DNA, proteins, and lipids accumulates with age and contributes to the degeneration of the somatic cells and to the pathogenesis of these diseases. Antioxidants present in food can help limit this damage by acting directly on reactive oxygen species or by stimulating endogenous defence systems. The phenolic groups in polyphenols can accept an electron to form relatively stable phenoxyl radicals, thereby disrupting chain oxidation reactions in cellular components. (Kehrer and Smith, 1994). Antioxidant, cyto/DNA protective potentials are known to offer significant protection against free radical induced injury to cells or tissues and cellular damages that are envisaged in various diseases including chronic diseases (Kapoor and Dharmesh, 2016). Another study conducted by Malaveille *et al.* (1996) found that smokers ingesting dietary phenolics, probably flavonoids, are partially protected against the harmful effects by tobacco carcinogens. They strongly suggest that such protective effect of dietary phenolics against diverse types of cancers should be verified and explored as a part of a chemoprevention strategy.

Mitotic cell division inhibition and chromosome aberration induction have been widely used as indicators of cytotoxicity and genotoxicity. Treatment with MP induced a

decrease in MI but abnormality percentage was on a high which revealed its toxic effect. The major aberrations observed include chromosome bridges, nuclear budding, lesions, stickiness, shift in microtubule organizing centre, misorientations, pole to pole arrangement, scattering and early movement of chromosomes. All values were found to be statistically significant at $p < 0.05\%$. The cytotoxicity of MP recorded in the present study needs follow-up research including further tests using cell lines and animal systems. The present results warrant the hazards of illegal and indiscriminate use of such agrochemicals.

The current study also suggests that some intrinsic components of the extracts could act as nonspecific redox agents, free radical scavengers, or ligands for binding metals or toxic principles, which could possibly explain the record of the least mitotic abnormalities in root tips treated with *B. prionitis* extract. According to Fiskesjo and Levan (1993), *Allium* test has been found to have high correlation with other test system (MIT-217cell test with mice, rats or humans *in vivo*) and could be used as an alternative to laboratory animal in toxicological research.

## Conclusion

The current study points out that synthetic pesticide MP possesses severe mito-depressive and genotoxic effects on onion tips. Experiments conducted to check the non mutagenic nature of *B.prionitis* extracts alone at the said concentrations showed positive results. Combination treatments of *B.prionitis* extracts followed by MP revealed the protective effects of the extracts. These results emphasize the judicious use of MP as an agrochemical on a long term basis. The manifestation of antimutagenic nature of *B. prionitis* extracts, observed in

the present study may be due to the presence of phenolic compounds, which, when given as pre-treatment, could scavenge the MP induced superoxide and other reactive oxygen metabolites. A positive result in *Allium* test should be taken to indicate a potential biological hazard and thus the occurrence of the wide variety of mitotic abnormalities is an indication of the high mutagenic potential of MP. The present investigation suggests that attention should be paid to estimate the toxic potential of the regularly used agrochemicals and other mutagens and that *A. sepa* assay can be recommended as a practical and reliable cytogenetic assay for such toxicity assessments.

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**References**


- Ata, A., Kalhan, K. S. and Samarasekara, R. 2009. Chemical constituents of *Barleria prionitis* and their enzyme inhibitory and free radical scavenging activities. Phytochem. Lett. **2**: 37-40.
- Balandrin, M. F., Kinghorn, A. D. and Farnsworth, N. R. 1993. Plant-derived natural products in drug discovery and development- An overview. In: Kinghorn, A. D. and Balandrin, M. F. (eds) Human Medicinal Agents from plants. ACS Symposium Series, A. C. S., Washington D. C., vol. 534, pp. 2-12.
- Benke, G. M. and Murphy, S. D. 1975. The influence of age on the toxicity and metabolism of methyl - parathion in male and female rats. Toxicol. Appl. Pharmacol. **31**: 254-269.
- Chen, J. L., Blance, P., Stoddart, C. A., Bogan, M., Rozhon, E. J., Parkinson, N., Ye, Z., Cooper, R., Balick, M., Nanakorn, W. and Kernan, M. R. 1998. New iridoids from the medicinal plant *Barleria prionitis* with potent activity against respiratory syncytial virus. J. Nat. Prod. **61**: 1295-1297.
- Chetan, C., Suraj, M., Maheshwari, C., Rahul, A. and Priyanka, P. 2011. Screening of antioxidant activity and phenolic content of whole plant of *Barleria prionitis* Linn. Int. J. Res. Ayu. Pharm. **2**: 1313-1319.

- Ragasa, C. Y., Samantha, E., Javier, E. C. and Irene, G. T. 2003. Antimutagenic Terpenes and Sterol from *Vitex parviflora*. Philipp. J. Sci. **132**: 21-25.
- Duncan, D. B. 1995. Multiple range and multiple *F* tests. Biometrics **11**: 1-42.
- Epstein, S. S. and Legator, M. S. 1971. The Mutagenicity of pesticides: concepts and evaluation. Cambridge MIT Press.
- Fergusion, L. R. 2001. Role of plant polyphenols in genomic stability. Mutat. Res. **475**: 89-111.
- Fiskesjo, G. and Levan, A. 1993. Evaluation of the first ten MEIC chemicals in the *Allium* test. Altern. Lab. Anim. **21**: 139-149.
- Gupta, R. S., Pramod, K., Dixit, V. P., Dobhal, M. P., 2000. Antifertility studies of the root extract of the *Barleria prionitis* Linn in male albino rats with special reference to testicular cell population dynamics. J. Etnopharmacol. **70**: 111-117.
- Jaiswal, S. K., Dubey, M. K., Das, S., Verma, A. R. and Rao, C. V. 2010. A comparative study on total phenolic content, reducing power and free radical scavenging activity of aerial parts of *Barleria prionitis*. Int. J. Phytomed. 2: 155-159.
- Jayashree, I. V., Vijayalaxmi, K. K. and Rahiman, A. 1992. Genotoxicity of Hinosan, an organophosphorous pesticide in the in vivo mouse. Mutat. Res. **332**: 77-85.
  and Dharmesh, S. M. 2016. Physiologically induced changes in bound phenolics and antioxidant, DNA/cytoprotective potentials in pectic poly/oligosaccharides of Tomato (*Solanum lycopersicum*). doi: 10.1002/jsfa.7696. [Epub ahead of print].
- Kehrer, J. P. and Smith, C. V. 1994. Free radicals in biology: Sources, reactivities and roles in the etiology of human diseases. In: Frei, B. (ed.) Natural antioxidants. Academic Press, San Diego, pp. 25-62.
- Khobragade, C. N. and Bhande, R. M. 2012. *In vitro* antibacterial, membrane damage, antioxidant and anti-inflam-

matory activities of *Barleria prionitis* L. extract on UTI causing multidrug resistant *E. coli*. Int. J. Curr. Pharm. Res. 4: 64-69.

- Kuras, M., Nowakowska, J., Sliwinska, E., Pilarski, R., Ilasz, R., Tykarska, T., Zobel, A. and Gulewicz, K. 2006. Changes in chromosome structure, mitotic activity and nuclear DNA content from cells of *Allium* test induced by bark water extract of *Uncaria tomentosa* (Willd.) DC. J. Ethnopharmacol. **107**: 211-221.
- Lima, C. F., Valentao, P. C., Andrade, P. B., Seabra, R. M., Fernandes-Ferreira, M. and Pereira-Wilson, C. 2007. Water and methanolic extracts of *Salvia officinalis* protect HepG2 cells from t-BHP induced oxidative damage. Chem. Biol. Interact. **167**: 107-115.
- Maji, A. K., Bhadra, S., Mahapatra, S., Banerji, P. and Banerjee, D. 2011. [RTF bookmark start: }886797_ja[RTF bookmark end: }886797_jaMast cell stabilization and membrane protection activity of *Barleria prionitis* L. Pharmacog. J. **3**: 67-71.
- ., ., ., ., . and . 1996. Dietary phenolics as anti-mutagens and inhibitors of tobacco-related DNA adduction in the urothelium of smokers. **17**: 2193-200.
- Rajasekharan, P. E. and Ganesan, S. 2004. Biotechnology and Conservation of Medicinal Plants in India. In: Govil, J. N., Kumar, P. A. and Singh, V. K. (eds). Recent Progress in Biotechnology and Genetic Engineering. Vol. 4. Studium Press, USA. pp. 1-3.
- Ranjbar, A., Pasalar, P. and Abdollahi, M. 2002. Induction of oxidative stress and acetylcholinesterase inhibition in organophosphorous pesticide manufacturing workers. Hum. Exp. Toxicol. **21**: 179-182.
- Rank, J. 2003. The method of *Allium* anaphase-telophase chromosome aberration assay. Ekologia **1**: 38-42.
- Rice-Evans, C. A., Miller, N. J. and Paganga, G. 1996. Structure–antioxidant activity relationships of flavonoids and

phenolic acids. Free Radic. Biol. Med. **20**: 933-956.
- Ruch, R. J., Chung, S.U. and Klaunig, J. E. 1984. Spin trapping of superoxide and hydroxyl radical, Methods. Enzymol. **105**: 198-209.
- Saleem, M. 2009. Lupeol, A Novel Anti-inflammatory and Anti-cancer Dietary Triterpene.
- Sharma, A. K. and Sharma, A. 1990. Chromosome Technique – Theory and Practices. 3rd ed. London: Butterworth.
- Sharma, Y., Bashir, S., Irshad, M., Gupta, S. D. and Dogra, T. D. 2005. Effects of acute dimethoate administration on antioxidant status of liver and brain of experimental rats. Toxicology **206**: 49-57.
- Sing, B., Bani, D.K., Gupta, D.K., Chandan, B.K., Kaul, A., 2003. Anti-inflammatory activity of 'TAF' an active fraction from the plant *Barleria prionitis* Linn. J. Ethnopharmacol. **85**: 187-193.
- Sing, B., Chandan, B. K., Prabhakar, A., Taneja, S. C., Sing, J., Qazi, G. N. 2005. Chemistry of Hepatoprotective activity of an active fraction from *Barleria prionitis* Linn. in experimental animals. Phytother. Res. **19**: 39-404.
- Van, A., Van, D. B., Tromp, M. N., Griffoen, D. H., Van, B. W., Vader, V. and Bast, A. 1996. Structural aspects of antioxidant activity of flavonoids. Free Radical Biol. Med. **20**: 331-342.
- Vidyasagar, J., Karunakar, N., Reddy, M. S., Rajnarayana, K., Surender, T. and Krishna, D. R. 2004. Oxidative stress and antioxidant status in acute organophosphorus insecticide poisoning. Ind. J. Pharmacol. **36**: 76-79.
- Vijayraghavan, M. and Nagarajan, B. 1994. Mutagenic potential of acute exposure to organophosphorous and organochlorine compounds. Mutat. Res. **321**: 103-111.
- Wild, D. 1975. Mutagenicity studies on organophosphorus insecticides. Mutat. Res. **32**: 133-150.

# Analysis of Morphotypes of Premna Serratifolia from Selected Habitats of Kannur District

■ Shijina.C.P, Sreeja . P

## Introduction

The genus Premna was described by Linnaeus (1771) for two species, *P. integrifolia* and *P. serratifolia*, which were collected by Paul Hermann in Ceylon. It was placed in "Didynamia Angiosperma", where it was retained by Murray (1774), Gmelin (1791), Schreber (1791), and a few others. In 1806, De Jussieu referred it to the family Verbenaceae where it has been retained by the majority of botanists. *Premna* Linnaeus (1771: 587) has been transferred from the family Verbenaceae to Lamiaceae (Harley *et al.* 2004, Bramley *et al.* 2010, Olmstead 2010, 2012). The genus is mainly distributed in Old World tropics and subtropics, and comprises 50 (Mabberley 2008) to 200 species (Verdcourt 1992) in the world. The type species of the genus (generic type) for the genus *Premna* is *Premna serratifolia* L. The nomenclature and identity of this widespread and very polymorphic species has been subjected for much heated discussions and negotiations among taxonomists..According to Kok (2013), *Premna serratifolia* shows significant variation across a wide geographical distribution, especially in leaf shape, leaf margin, inflorescence size and

calyx form. All *Premna* species are used as ayurvedic drug . Plants that belong to *Premna* genus are known to have medicinal uses like carminative, diuretic, hypoglycemic, stomach disorders, oedema, constipation, piles, cardiac diseases, expectorant etc. The present study was an attempt to evaluate the morphology, leaf area index, stomatal index and total chlorophyll content of the *Premna serratifolia* from different habitats of Kannur district.

## Material and Methods

Randomly selected 5 areas ,Vellikkeel, Edappara, Payyannur college(Edattu), Keezhara and Thekkumbad by treating them into midland (Vellikkeel,Edappara, Payyannur college Edattu) and wetland (Keezhara, Thekkumbad) regions .From the selected area plants and soil samples were collected. From each area 3 to 4 fresh samples with leaf, flower, fruit (if available) collected. Taxonomic studies where done. Leaf area , Stomatal Index, Quatitative estimation of chlorophyll (Arnon,1949) etc )where determined the collection day itself

The collections were made at the blooming period of plants. Area was thoroughly visited and *Premna serratifolia* L. with leaf, flower, fruits were collected. Plant specimens collected from various sites were tagged on spot with significant date, location and other characteristics .The local name was also reported. Herbarium specimen were prepared for further study. The collected specimens were identified with the help of Flora and already determined herbarium specimens of Centre for Medicinal Plants Research (CMPR) herbaria, Arya Vaidya Sala, Kottakkal. After identification the voucher specimen (CMPR 8673) were submitted in the same herbarium. Illustrations and descriptions were made using fresh

specimen. The stomatal index was determined as the number of stomata per square millimeter divided by the number of stomata plus number of epidermal cells per square millimeter multiplied by 100.The stomatal index (SI) was intended using the equation described by Salisbury (1927). Chlorophyll estimation was done according to Arnon (1949)

## Results and Discussion

In the present investigation , four morphotypes of *Premna serratifolia* .L identified. The four of them includes, *Kozhi munja, Mara munja, Cheru munja, Chemparathy munja* with deep leaf serrations. From this, both Kozhi munja and Mara munja were collected from various habitas, including laterite soil and wet lands, and further variations along with their habitat difference is given below;

In the case of kozhi munja shown morphological variation, mainly in stem and leaf characteristics. Kozhi munja shown variation in lenticels pattern and number on the stem that helps in aeration. And more number of lenticels noted from wetland morphotype which is an adaptation. While comparing the leaf shapes, Obovate, or elliptic leaves seen in Edappara morphotypes. Round or ovate seen in Thazhekkavu morphotypes. Leaf base round and acute apex observed in Thazhekkavu. In Edappara which shows the presence of leaves with base acute and apex round. Leaf margin in morphotypes shown serrations which restricted to apex in both morphotypes from Edappara and Thazhekkavu. Inter nodal length also show variations. intermodel length which is higher than that of from Edappara observed. Wavy leaves observed in all the morphotypes. 3-4 pairs of veins observed from the leaves of Edappara morphotypes. Where as 4-5 pairs of veins

noted from the morphotypes of Thazhekkavu. Length of petiole shown variations, Thazhekkavu morphotype with higher length, and In Edappara it is highly reduced. Breadth of the leaves shows significant variation. Reduced leaf breadth shown by leaf from Edappara (2.1667±1.0769) and from Thahekkavu noted almost double (4.5±0.9354). Length of lamina is highly reduced in morphotype from Edappara (3.6667±1.7795). Where Thazhekkavu, with 5.8333±1.3385 in length. Floral characters show more similarity as the inflorescences observed as corymbs.

In the case of *Mara munja*, morphotype ,from the selected area we found from Vellikkeel, Payyannur college area, which treated as laterite soil collections and from Thazhekkavu and Keezhara as wetland collections. The specified variations discussed below; In Vellikkeel morphotype young stem were with green or light brown color, white spots on brownish stem appeared during maturity. In the morphotype from Payyannur college area green or brown when young, and dark brown stem with light white spots when mature observed. Thazhekkavu morphotype shown Light brown (young) stem and dark brown stem with light white or brown spots (mature). The prominent spots, which represents lenticels, were present along wetland morphotypes in the case of *mara munja* also. While comparing the leaf shapes, Ovate, round or elliptic leaves observed in both Vellikkeel and Keezhara morphotypes. Morphotype from Vellikkeel may also show cordate leaves. In Keezhara, leaves and petiole shows pubescent nature. Round or ovate seen in morphotype collected from Payyannur college area. Thazhekkavu morphotype shown elliptic or ovate to oblong leaves. Leaf base round and acute apex observed in all the morphotypes. Leaf margin in morpho-types of Vellikkeel and Payyannur college area shows

slight serrations. Such serrations are restricted to apex in morphotypes from Thazhekkavu . Highly serrated leaf also observed from Keezhara morphotypes. Thazhekkavu, shows maximum petiole length. The lower petiole length observed from Payyannur college area with . Breadth of the leaves shows significant variation. Higher leaf breadth observed in Payyannur college area. Reduced leaf breadth found in Thazhekkavu. Length of lamina was higher in Payyannur college area morphotype collection. Lamina from Vellikkeel morphotype shows lower length. In the case of khozhi munja,

Leaf area shown significant variation, leaf collections from Edappara shown 10 $cm^2$. In Thazhekkavu 19 $cm^2$ were the noted leaf area. In *mara munja* Leaf area shown significant variation, leaf collections from Keezhara shown higher (38$cm^2$) leaf area. From payyannur college area lowest (21 $cm^2$) leaf area found. Stomatal index of leaf (kozhi munja )surface shows that the minimum number stomata were found in the morphotype collected from Edappara, and also recorded maximum stomatal index 36.59%. In the other hand, maximum number of stomata and minimum stomatal index 32.20% is recorded from the wetland Thazhekkavu collection. In *mara munja* stomatal index of leaf surface shows that maximum number of stomata and minimum stomatal index recorded from the ecotype collected from Vellikkeel (31.96%). Higher stomatal index observed from Thazhekkavu(33.24%),with respect to number of stomata. Higher amount of total chlorophyll observed in Thazhekkavu (PT2),near the water content. but there exist a marginal difference in the same area away from the water content(PT2) .the lowest chlorophyll content was shown in Keezhara(PK) than Edappara(PI) ,Vellikkeel (PV) and payyannur college area (PPC).The results are shown in Table -1.

**Table -1**

| | SI | LA | Cha | Chb | Total Ch | Cha/Chb ratio |
|---|---|---|---|---|---|---|
| PV | 31.9659±0.5048 | 37.7625±2.9801 | 0.4029±0.0500 | 0.2574±0.0700 | 0.6610±0.1090 | 1.8011±0.5533 |
| PI | 36.5920±1.1991 | 10.5625±1.4991 | 0.1507±0.0037 | 0.1131±0.0593 | 0.2130±0.0390 | 1.3324±0.2356 |
| PPC | 32.2968±0.1096 | 21.1500±1.4592 | 0.0860±0.0081 | 0.2378±0.0095 | 0.3259±0.0138 | 0.3619±0.0322 |
| PT1 | 32.2045±0.0643 | 19.6000±1.2265 | 0.1871±0.0106 | 0.1391±0.0591 | 0.3261±0.0400 | 1.7803±0.0231 |
| PT2 | 33.2465±0.0557 | 24.3125±1.0561 | 0.5785±0.0310 | 0.3250±0.0200 | 0.9035±0.0400 | 1.6631±0.5000 |
| PK | 32.2611±0.2995 | 38.9500±2.1077 | 0.1616±0.0138 | 0.0865±0.0100 | 0.2047±0.0200 | 1.8752±0.0542 |

PV; Vellikkeel, PI;Edappara, PPC;Payyannur college, PT1; Thazhekkavu 1, PT2; Thazhekkavu 2, PK;Keezhara. SI;Stomatal index, LA;leaf area index, Ch;Chlorophyll

**Figure showing morphotypes of Premna serratifolia**

PK (Keezhara)

PI(Edappara)

PPC (Payyannur college)

PT 1 (Thazhekavu -1)

PV (Vellikkeel)

PT 2 (Thazhekavu -2)

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**References**


- **Arnon D.I**. 1949. Copper enzymes in isolated chloroplasts , polyphenoxidase in beta vulgaris. Plant physiology 24:1-15.
- **Bramley, G.L., Forest, F. & de Kok, R.P.J**. (2010) Troublesome tropical mints: re-examining generic limits of *Vitex* and relations (Lamiaceae) in South East Asia. *Taxon* 58: 500–510. *Bulletin.* 68: 1-30.
- **Gmelin, J. F.** (1791). *Caroli a Linne… Systema Naturae per regna tria naturae,*
- **Harley, R. M., Atkins, S., Budantsev, A. L., Cantino, P. D., Conn, B. J., Grayer, R., Harley, M. M., de Kok, R. P. J., Krestovskaja, T., Morales, R., Paton, A. J., Ryding, O. & Upson, T.** (2004). Labiatae. In: K. Kubitzki & J. W. Kadereit (eds), The Families and Genera of Vascular Plants vol. VII:167 – 275. Springer- Verlag, Berlin
- **Jussieu, A. L. de** (1806). Sur la famille des Plantes Verbenacees. *Ann. Mus. Hist. Nat.,*
- **Kok, R. de** (2013). The genus *Premna* L. (Lamiaceae) in the Flora Malesiana area. *Kew*
- **Linnaeus, C.** (1771). *Mantissa Plantarum Altera Genrum* editionis VI & *Specierum Manila. P*: 484-519.
- **Murray, J. A.** (1774). *Caroli a Linne……Systema Vegetabilium Secundum Classes Ordines Genera Species cum Characteribus et Differentiis.* J. C. Dietrich, Gottingen. Paris.7: 63-77.
- **Olmstead, R.G**. (2012) *A Synoptical Classification of the Lamiales.* Version 2.4..Paris.7: 63-77.
- **Salisbury, E.J**., 1927.On the causes and ecological signifi-

cance of stomatal freequency , with special reference to the woodland flora. Philos.Trans. R. Soc. London B 216, 1-65.

- **Schreber, J.C.D.** (1791). "Caron a Linne Genera Plantarum " Edito Octava. Post Reichhardianam, Secunda, prioribus longe auctior atque emendatioe'. (Warrentrapp et Wenner: Frankfurt a/ M).*secundum classes, ordines, genera, species*.... B.E.Beer, Leipzig.
- **Verdcourt, B.** (1992) Verbenaceae. *In*: Polhill, R.M. (ed.) *Flora of tropical east Africa*. Balkema, Rotterdam, pp. 1–156.

# Achievement Motivation and Stress tolerance among Kerala Police-A Study

■ Divysree R, Dilshad Bin Ashraf

## Abstract

The aim of the study was to explore the achievement motivation, and stress tolerance of Kerala Police. The variables in the study were achievement motivation and stress tolerance. The total sample consists of 120 policemen. The sample was selected using simple random sampling within the age range of 20 to 50, including drinkers and non drinkers, vegetarians and non vegetarians and married and unmarried. The statistical techniques used for analyzing the data were t-test, one way ANOVA, and post- hoc Scheffe test. The results indicate that there were significant difference in achievement motivation and stress tolerance between drinkers and non drinkers and between vegetarians and non vegetarians. No significant difference in either of these two variables found between married and unmarried. In stress tolerance, significant difference found among different age groups indicating that high stress tolerance among 40-50 age group followed by 30-40 and 20-30.there were no significant difference between 30-40 and 20-30.

*Key Words: Achievement motivation, Stress tolerance, Kerala Police*

## Introduction

The very name 'police' or 'policing' brings a negative or more of a cruel image in the laymen's mind – may be an embarrassing reaction for those in this job – as many instances make them say this. Even though only a minority in the force triggers such a reaction in the common man, there should be many studies which could outline the problems related to the job – psychological, physiological or any other problems. In this scenario a study was much needed among the Kerala police force which focuses on their level of achievement motivation and stress tolerance. These variables were selected as each represents how well a person would get along in the force. The empirical studies on Kerala police and the problems faced by them are surprisingly very few. Many a times the morale of the police force is also at stake – a bundle of reasons may be there. The undeniable facts being this, there is no one making any effort to find what might went wrong with our protectors, other than just collectively accusing – including all political parties – them for all the troubles in the state of Kerala. The study is also undoubtedly significant as the results may give how well the policemen cope up in their daily job situations. The results may also project to what extent any further intervention is needed to enhance the entire force in relation to the selected variables of achievement motivation and stress tolerance.

Achievement motivation may be defined as the energization and direction of competence-relevant behavior or why and how people strive toward competence (success) and away from incompetence (failure) (Andrew, 2007). Over the years, behavioral scientists have noticed that some people have an intense desire to achieve something, while others may not

seem that concerned about their achievements. This phenomenon has attracted a lot of discussions and debates. Scientists have observed that people with a high level of achievement motivation exhibit certain characteristics. Achievement motivation is the tendency to endeavor for success and to choose goal oriented success or failure activities. Achievement motivation forms to be the basic for a good life. People who are oriented towards achievement, in general, enjoy life and feel in control. Being motivated keeps people dynamic and gives them self-respect. They set moderately difficult but easily achievable targets, which help them, achieve their objectives. Achievement motivated people prefer to work on a problem rather than leaving the outcome to chance. So it is clear that those working as police personnel need a certain level of achievement motivation in their life to excel in their profession as law enforcers.

Stress tolerance is the ability to handle emotionally charged situations and to resist burn out in demanding environments. A good way to discover our stress tolerance level in a given situation is to be sensitive to the different cues our body gives us. Such cues as a headache, upset stomach, painful joint or aching muscle indicate we have probably surpassed our tolerance level and need to reduce the stress we are experiencing. Stress and its tolerance is also a major concern with the police force. The most stressed out lot in Kerala are probably our local police officers, who with the rising theft, terror threats, and all-night duty, have plenty on their plate. However, what happens when a police officer is forced to pull that trigger and kill a perpetrator? Low social support from coworkers, little decision-making authority, imbalances between effort and reward, and other such negative job features may trigger stress intolerance in many of the police personnel.

Apart from the long hours of duty, a major cause for concern is that few policemen spend enough time with their families — a problem that is especially felt on festive occasions, where, more often than not, they have been roped in for extra duty. The police personnel feel a state of powerlessness, as reported by many. They have greater responsibilities but less decision making power. This causes a major cause for their stress intolerance.

## Hypotheses

1. There will be significant difference among police personnel in their scores on achievement motivation and stress tolerance with respect to drinking habit.
2. There will be significant difference among police personnel in their scores on achievement motivation and stress tolerance with respect to food habit.
3. There will be significant difference between married and unmarried police personnel in their scores on achievement motivation and stress tolerance
4. There will be significant differences among police personnel in their scores on achievement motivation and stress tolerance with respect to age

## Method

A brief methodology adopted for the study is as follows

**Sample**

The sample of the study was collected by random sampling method consists of 120 subjects, which are police personnel of Kerala Armed Police Battalion IV. It includes

police personnel of different age groups, marital status, food habit, drinking habit.

**Variable**

The variables under study are achievement motivation, and stress tolerance.

**Tools**

The tools used for the present study are

1. Achievement Motivation Scale developed by Johnson& Dhamodharan (1993)
2. Stress Tolerance Scale developed by Reshmi&Sam Sananda Raj(1999).
3. Personal Data Sheet

## Administration and Scoring

The subjects were individually met by going to various police stations and police camps in Kannur District. They were briefed about the nature and subject of the study along with the need and significance of the study. Personal data sheet and questionnaires were distributed to them and instructions for responding were explained. The responses were scored and tabulated along with the socio demographic variables.

The data obtained are statistically analyzed using independent samples t-test, one way ANOVA and post hoc Scheffe's test to test the hypothesis.

## Results and Discussions

When the subjects were classified on the basis of drinking habit, food habit, marital status there were two groups. Mean

and standard deviation of the two groups were found out. Since there were two groups, t-test was done to find out whether there exists any significant difference between each group. In the case of age wise classification there were three age groups. Since there are three groups, one way ANOVA was done to find out whether there was any significant difference among police personnel of different age groups on achievement motivation and stress tolerance. To find out which group significantly differed from other, further analysis were done using a post-hoc test of Scheffe's tests. The results of t-test conducted for each variable are given below.

### Comparison of police personnel based on drinking habit

**Table-1**
**Results of t-test: Comparison between drinkers and non-drinkers on achievement motivation, and stress tolerance.**

| Sl. No | Variable | Drinking (N=46) | | Nondrinking (N=74) | | t-value |
|---|---|---|---|---|---|---|
| | | M1 | SD1 | M2 | SD2 | |
| 1. | Achievement motivation | 106.48 | 9.21 | 125.26 | 8.70 | -11.243** |
| 2. | Stress Tolerance | 90.89 | 12.99 | 99.08 | 11.09 | -3.680** ** |

** Significant at 0.01 level

Table I shows that the mean score in achievement motivation and stress tolerance of police personnel who consumes alcohol were 106.48and 90.90 respectively, and corresponding standard deviation were 9.21 and 12.99. Similarly for non-drinkers the mean value for achievement motivation and stress tolerance were 125.26 and 99.08 respectively. The standard deviation for achievement motivation and stress tolerance in non drinking police personnel were 8.7and 11.09 respectively.

The t-values indicate that there was significant difference in achievement motivation and stress tolerance of police personnel with respect to the use of alcohol. The mean value indicates that the achievement motivation and stress tolerance were high for non-drinkers. The mean values also indicate that the achievement motivation was very high among non-drinkers when compared with the mean value stress tolerance. Many people start to drink when they cannot tolerate stress. That means the stress tolerance may be lower for drinkers. Persons with higher level of stress tolerance will be achievement oriented than those who have lower level of stress tolerance.

This results are in conformation with the findings of the following study conducted by Kevin et al. (1990). In their study it was found that those students with low achievement motivation are particularly vulnerable to using alcohol. The study conducted by Andrews, & Judy (1991) suggest that the relation between substance use and achievement motivation is bidirectional. This finding also supports the results of the present study.

## Comparison of police personnel based on food habit

**Table-II**
**Results of t-test: Comparison between non vegetarians and vegetarians on achievement motivation and stress tolerance.**

| Sl. No | Variable | Non-vegetarian (N=98) | | Vegetarian (N=22) | | t-value |
|---|---|---|---|---|---|---|
| | | M1 | SD1 | M2 | SD2 | |
| 1. | Achievement motivation | 116.83 | 12.91 | 123.55 | 10.58 | -2.273* |
| 2. | Stress Tolerance | 94.52 | 12.17 | 102.27 | 12.03 | -2.706** |

Table II shows that the mean value for achievement motivation and stress tolerance scores of police personnel who prefer non-vegetarian food were 116.83 and 94.52 respectively. The standard deviation for achievement motivation, and stress tolerance scores of non vegetarians were 12.91 and 12.17 respectively. Similarly for vegetarians the mean value for achievement motivation, and stress tolerance were 123.55, and 102.27 respectively. The standard deviation for achievement motivation, and stress tolerance in police personnel who consumes alcohol were 10.59 and 12.03 respectively.

The t-values indicate that there was significant difference among police personnel in their achievement motivation and stress tolerance with respect to their food habits. The mean

values show that the vegetarians among police personnel have high achievement motivation and stress tolerance when compared with the mean values for non-vegetarians. This may be due to the reason that vegetarian food is easy to digest. But non vegetarian food is hard or difficult to digest. It affects the body processes. And the body gets disturbed. This will decrease the level of stress tolerance. In the case of vegetarians, their body processes are tuned in the basis of their easily digesting food. These results are in confirmation with the results of the study conducted by Sigel & Sigel (1990). In their study it is found that vegetarian diets can provide an abundant supply of magnesium. Oral magnesium supplementation of magnesium deficit persons can improve brain performance, concentration and stress tolerance.

**Comparison of police personnel based on marital status**

**Table-III**

**Results of t-test: Comparison between married and unmarried police personnel on achievement motivation and stress tolerance.**

| Sl. No | Variable | Married (N=40) | | unmarried (N=80) | | t-value |
|---|---|---|---|---|---|---|
| | | M1 | SD1 | M2 | SD2 | |
| 1. | Achievement motivation | 116.35 | 12.87 | 118.91 | 12.68 | -1.0382 |
| 2. | Stress Tolerance | 96.03 | 12.36 | 95.90 | 12.59 | 0.052 |

Table III shows that, the mean value for achievement motivation and stress tolerance in married police personnel is 116.35, and 96.03 respectively. The standard deviation for achievement motivation and stress tolerance scores of married personnel were 12.87and 12.36 respectively. Similarly for unmarried police personnel, the mean score for achievement motivation and stress tolerance were 118.91, 175.49 and 95.90 respectively. The standard deviation for achievement motivation and stress tolerance of unmarried police personnel were 12.68and 12.59 respectively.

The t-values indicate that statistically there was no significant difference among police personnel in their achievement motivation and stress tolerance scores with respect to their marital status. The mean values indicate that the stress tolerance is slightly high in unmarried individuals than married individuals. In achievement motivation, the mean value shows that the unmarried individuals have a low score in achievement motivation than married individuals.

The results of this research supports the result of Celfa and Bayona's study in which it is found that there is no significant difference between single and married non-teaching personnel on stress tolerance.

## Comparison of police personnel of different age groups.

The police personnel were classified on the basis of their age and were placed into three groups. The first, second, and third group comprised of those in the age group of 20-30 years, 30-40 years and 40-50 years respectively.

**Table-IV**
**Results of one way ANOVA: Age wise comparison among police personnel on achievement motivation and stress tolerance.**

| Sl. No | Variable | Sum of squares | | Mean of squares | | t-value |
|---|---|---|---|---|---|---|
| | | Between | Within | Between | Within | |
| 1. | Achievement motivation | 929.45 | 18411.14 | 464.73 | 157.36 | 2.953 NS |
| 2. | Stress Tolerance | 2057.95 | 16420.64 | 1028.97 | 140.35 | 7.332** |

*Ns denotes F value is not significant. ** denotes .01 level of significance*

Separate one way ANOVA was done for achievement motivation, and stress tolerance and the F value were 2.953and 7.332 respectively. The F value for achievement motivation was calculated as 2.953 which indicate that there were no significant differences among police personals on achievement motivation. This shows that age, as a single factor, doesn't exert any influence on police personnel's achievement motivation. F value obtained for stress tolerance, (F= 7.332, significant at 0.01 level) indicate that there were significant difference among police personnel of different age groups on stress tolerance. To find out which group significantly differed from other further analysis were done using a post-hoc test Scheffe. The results of the post hoc test are given below.

**Table V**
**Result of Scheffe's test: Comparison among police personnel of different age group on Stress tolerance**

| Sl. No. | Age group | N | Mean | Groups | | |
|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 |
| 1 | 20-30 | 60 | 93.40 | () | _ | *0 |
| 2 | 30-40 | 37 | 94.84 | | () | * |
| 3 | 40-50 | 23 | 104.35 | | | () |

**indicates significant difference*

It was found on further analysis by Scheffe's test that the difference was between the first group and third group and also between the second group and third group. In which the third group had significantly higher stress tolerance. Third group consist of police personnel aged 40-50 years. This may be because this group has more experience in life than other two groups. As a group police personnel experiences stress more than any other working group and the experience in handling stressful situation has a great importance in the level of stress tolerance. The first group is the least experienced group those have very low level stress tolerance.

In the present study to assess the achievement motivation stress tolerance of police personnel, the results indicate that drinking habit, food habit and age have its own effect in achievement motivation, emotional intelligence and stress tolerance of police personnel. On the same side no significant differences were seen with respect to marital status. Police personnel who do not consume alcohol had a higher level of achievement motivation and stress tolerance. Police personnel who are vegetarians had a higher level of achievement motivation and stress tolerance than non-vegetarians. Police personnel who aged 40-50 years possess higher level of emotional intelligence and stress tolerance than those who are aged 20-30 years and 30-40 years.

## Conclusion

This study has various implications for organizations, employees and law enforcement agencies such as police. Though there has been guide lines to impart strategies for stress tolerance and become motivated, great obstacles to its effectiveness has been seen. From the present study it is clear that many factors such as alcohol consumption, non vegetarian food habit, age, etc effects the achievement motivation and stress tolerance. The police personnel above the age of 20years and below 40years show significantly low level of achievement motivation and stress tolerance than those of the age above40 years. The problems of the young police personnel behind this result could be explored in other studies and addressed in future.

**References**

- Aldwin, C. *(2007). **Stress, Coping, and Development**,* (2nd Ed). New York: The Guilford Press.
- Andrew,J.(2007). Achievement Motivation. ***Encyclopedia of Social Psychology***, Vol. 1. USA: Rolsa Janke
- Andrews, J. Adolescent Substance Use and Academic Achievement and Motivation. Cited from
- Atkinson, J. W.,& Feather, N. T. (1966). ***A Theory of Achievement Motivation.*** New York: John Wiley & Sons.
- Celfa.,& Bayona. Stress Tolerance of WVCST Non-Teaching Personnel:Its Relationship to Students' Satisfaction. Cited from
- Johnson,J.R.,& Dhamodharan,B (1993). ***Manual for Achievement Motivation Scale.*** Thiruvananthapuram: Department of Psychology, University of Kerala.
- Kevin et al. cited from,
- Reshmi,C.S.,&Sanandaraj,S.H.(1998) ***Manual for Stress Tolerance Scale.*** Thiruvananthapuram: Department of Psychology, University of Kerala.

# Water sorption studies on poly (ethylene-co-acrylic acid)/ cellulose composites

■ Sangeetha Chenampulli, Unnikrishnan.G, Sabu Thomas, Tania Francis

## Abstract

The transport of various solvents through polymeric materials are the basis for a wide variety of applications such as food packaging, controlled drug release, electro-dialysis etc. The sorption characteristics of EAA/ micro/ nanocellulose composites were studied using water as the probe liquid. The sorption of water was found to depend on the cellulose content present in the composites. The water uptake decreased for the composites compared to neat polymer irrespective of the filler dimensions. Sorption studies throw light in to the homogeneity of the polymer system as well as the nature of interactions existing between the composites and the probe liquids.

## 1. Introduction

In order to examine the suitability of a membrane as a barrier material it is essential to acquire a thorough understanding of its interactions with liquids and vapours. The transport properties through a polymer are governed largely by two

factors, polymer chain mobility and the free volume within the polymer. [1] As the segmental mobility and freevolume increases the penetrant molecules find it easier to diffuse through the polymeric system. The mass transport process through a filled polymer system is influenced by factors such as nature of fillers, the degree of adhesion and their compatibility with polymer matrix, crosslink density, temperature, nature of penetrants etc. In composites, transport behaviour depends heavily on the miscibility of the filler within the matrix, interfacial adhesion and the morphology of the system. Conversely, the transport phenomena through a polymer composite can be used as a characterization technique in order to understand the miscibility as well as morphology of the system. If the filler is well distributed within the matrix it can decrease the free volume and thus restrict the permeant diffusion. If the filler is agglomerated within the matrix, it creates voids and leads to enhanced permeability.[2] The diffusion of water through a polymer occurs via three routes. First involves the absorption of moisture into the freevolume within the polymer chains. Second occurs due to the capillary transport of water in to the interfacial region due to poor filler-matrix adhesion. The third mechanism is due to the further transport of water in to the microcracks formed due to water absorption by the filler.[3]

There are numerous studies on the moisture absorption of cellulosic fibres in various polymer matrices.[4-7]Kumar and Siddaramaiah examined the effect of temperature on the water absorption property of NBR latex/Jute fibre composites[8]. Pereda et al. observed an initial increase in barrier properties followed by a decrease with increase in filler loading for sodium caesinate/nanocellulose composites[9]. Khan et al. have reported a decrease in water permeability of

methyl cellulose films in presence of nanocellulose.[10] Transport of organic vapours through a polymer film is important for separation and pervaporation applications. Visakh et al. studied the transport properties of natural rubber/nanocellulose composites using benzene, toluene and xylene as probe liquids.[11]

## 2. Materials and methods

### 2.1. Materials

Poly (ethylene-co-acrylic acid) with 15wt% acrylic acid content was purchased from Sigma Aldrich, India. Microcrystalline cellulose particles were isolated from pandanus plant and converted to nanodimensions by sulphuric acid hydrolysis following the procedure reported elsewhere. Sulphuric acid, chloroform used for solvent casting and all the other chemicals used in the experiment were of analytical purity, obtained from Fischer Scientific, UK.

### 2.2. Experimental

#### 2.2.1. Nanocellulose isolation

Stems of Pandanus plants were cut and immersed in a tank containing pure water for one month for retting out the fibre. The process is called biological natural retting. The stems were taken out and fibres were removed manually, washed many times, dried and were finely ground for further treatments. The ground fibres were treated with 5 % NaOH solution at 70 °C for 30 minutes followed by bleaching by perchloric acid to obtain pandanus microcellulose.

The microcellulose was hydrloysed by 64w/w% sulphuric acid for 30 minutes at $60^0$C followed by centrifugation. The resultant suspension was freeze dried to obtain the nanocellulose in powder form.

## 2.2.2. Composite fabrication

Required quantity of pandanus micro/nanocellulose was weighed out accurately and stirred in chloroform overnight. To this suspension polymer was added so as to form a 6wt% solution. Stirred at $60^0$C for 30 minutes and poured into glass moulds to obtain thin films. The films were dried at $60^0$C and then at room temperature under vacuum till constant weight. The formulation of the composites is given in Table. 1.

**Table:1**
**Formulation of EAA/Cellulose Composites**

| Sample code | Type of cellulose | EAA (g) | Cellulose (wt %) |
|---|---|---|---|
| NCP 0 | Nanocellulose from pandanus | 2.4 | 0 |
| NCP 2.5 | | 2.4 | 2.5 |
| NCP 5 | | 2.4 | 5 |
| NCP 7.5 | | 2.4 | 7.5 |
| NCP 10 | | 2.4 | 10 |
| MCP 2.5 | Pandanus microcellulose | 2.4 | 2.5 |
| MCP 5 | | 2.4 | 5 |
| MCP 7.5 | | 2.4 | 7.5 |
| MCP 10 | | 2.4 | 10 |

### 2.2.3. X-Ray diffractometry

Powder XRD examination was performed on a Rigaku Miniflex X-ray diffractometer with a CuKα radiation source ($\lambda$= 1.5418 A°). The diffracted intensity of CuKα radiation was measured in 2θ range 5° and 80° for neat EAA as well as the composites.

### 2.2.4. Sorption studies

The sorption experiments were carried out following the procedure reported by Aithal et al.[12] The biocomposite samples for diffusion experiments were punched out in circular shape of diameter 1.9 cm from thin films prepared by solvent casting technique. The samples were completely dispersed in 20 ml solvent in diffusion bottles and kept at constant temperature in a thermostatically controlled oven. The swollen samples were taken out from

*Fig. 1. Set up for sorption studies*

the solvents periodically & weighed immediately using an electronic balance. The process was repeated till equilibrium swelling was reached. The time for each weighing was kept to a minimum of 30 to 40 s in order to minimize the errors due to the escape of solvents from the samples. Sorption experiments were carried out with water, glucose and saline as solvents.

## 3. Results and discussion

Fig. 2 gives the water sorption curves of nanocellulose/EAA composites at room temperature. The gravimetric sorption method evaluates the weight gain of the polymer film as a function of time after immersing it in the test liquid under standard conditions of temperature, pressure and pH unlike otherwise specified. The mole percentage uptake was calculated using the following equation [12-13],

(1)

$$M_t\,(\%) = \frac{W_t - W_i}{W_i} X100$$

The factors affecting the absorption water include the presence of polar groups in the material, crosslink density, crystallinity, presence –OH groups that can form hydrogen bonds with water etc. [14]

From the sorption curves it can be seen that there is an initial rapid uptake of water within the first 20 hours followed by a plateau region where the moisture content present in the film get stabilised and does not change with time. This denotes the saturation point beyond which further uptake is quite negligible. In general water uptake of cellulose based

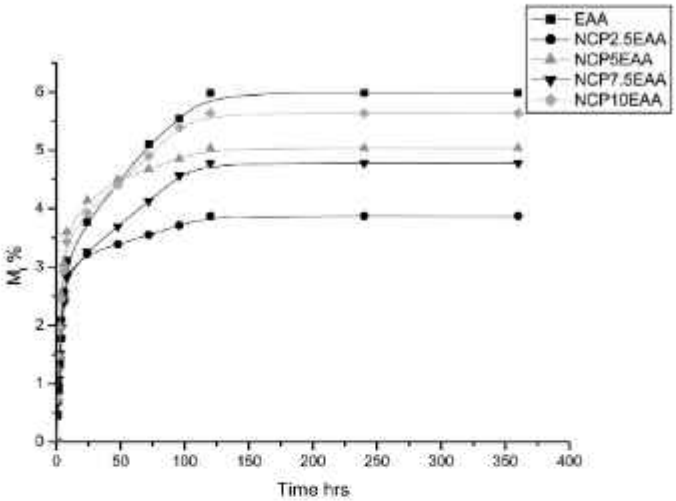



*Fig. 2. Water sorption curves of pandanus nanocellulose(NCP)/ EAA composites*

composites increase with increase in cellulose loading due to enhanced hydrophilicity and poor dispersion of cellulose in hydrophobic matrices leading to the formation of voids. In this case the water sorption of the composite films was found to be lower than that of neat polymer. EAA is a rather amorphous polymer with very low crystallinity as evident from the diffractogram in Fig. 3. So the water uptake may be higher. In the composites the cellulose nanoparticles interact with the polymer chains and form a homogeneous distribution of nanocellulose in the matrix. This fills the voids in the polymer film and thus water uptake is decreased. Many researchers have reported such a decrease in water absorption of polymer films in presence of nanocellulose. [10, 15] The fact that minimum water absorption is shown by NCP2.5EAA further supports this assumption since it is the most homogeneous

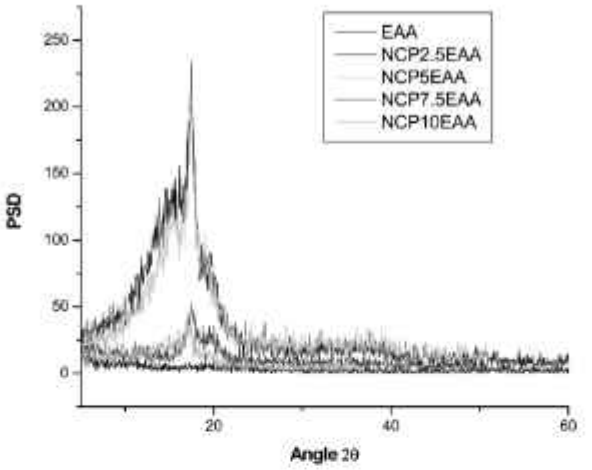



*Fig. 3, X-Ray diffractograms of EAA and NCP/EAA composites*

composite film with optimum filler loading. In general water absorption increases with the increase in cellulose loading due to the increase in number of –OH groups on cellulose that can form hydrogen bonds with water.

The water sorption curves of pandanus microcellulose (MCP)/EAA composites is given in Fig. 4. In this case also the composites show lesser water absorption than neat polymer. The water sorption increases with increase in cellulose loading and at 10wt% become very close to that of neat polymer. This may be due to the larger size of microcellulose particles which has lesser surface area compared to the nanoparticles.

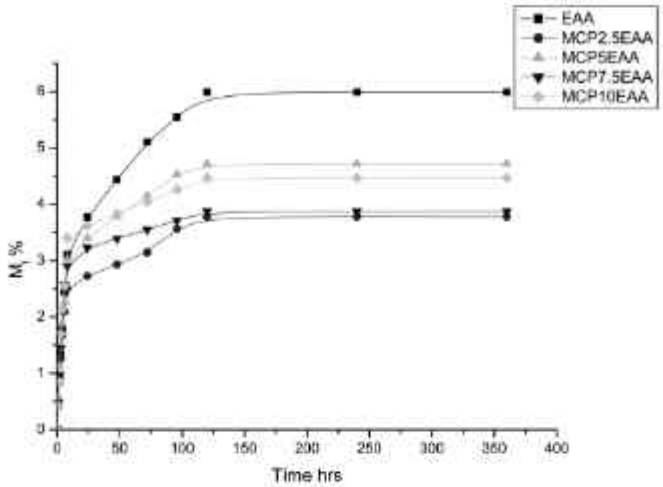



*Fig. 4. Water sorption curves of pandanus microcellulose (MCP)/EAA composites*

## Conclusions

Moisture and gas barrier properties are important for a polymer material to be used for packaging applications. EAA being an inert biocompatible polymer there are possibilities for using it for food packaging applications. Sorption studies using water as the sorbent indicated that the absorption capacity of the composite films decreased compared to neat matrix due to the homogeneous distribution of nanocellulose within the matrix. At 2.5wt% nanocellulose loading the composite film showed considerably lower sorption pointing to the optimum filler loading. Pandanus microcellulose/EAA composites showed higher water sorption than the nanocomposites due to the lesser homogeneity of the composite films.The reduction in sorption for the composite

films compared to the neat matrix is a positive result since, the increase in swelling in presence of fillers usually affects the dimensional stability as well as mechanical properties of the composites.

**References**


1. George, S C and Thomas, S, Transport Phenomena through Polymeric Systems. *Progress in Polymer Science*, 2001. 26(6): p. 985-1017.
2. Park, G S and Crank, J, Diffusion in Polymers. 1968.
3. Merdas, I, Thominette, F, Tcharkhtchi, A, and Verdu, J, Factors Governing Water Absorption by Composite Matrices. *Composites Science and Technology*, 2002. 62(4): p. 487-492.
4. Dhakal, H, Zhang, Z, and Richardson, M, Effect of Water Absorption on the Mechanical Properties of Hemp Fibre Reinforced Unsaturated Polyester Composites. *Composites Science and Technology*, 2007. 67(7): p. 1674-1683.
5. Espert, A, Vilaplana, F, and Karlsson, S, Comparison of Water Absorption in Natural Cellulosic Fibres from Wood and One-Year Crops in Polypropylene Composites and Its Influence on Their Mechanical Properties. *Composites part A: applied science and manufacturing*, 2004. 35(11): p. 1267-1276.
6. Bonniau, P and Bunsell, A, A Comparative Study of Water Absorption Theories Applied to Glass Epoxy Composites. *Journal of Composite Materials*, 1981. 15(3): p. 272-293.
7. Abdul Khalil, H P S, Ismail, H, Ahmad, M N, Ariffin, A, and Hassan, K, The Effect of Various Anhydride Modifications on Mechanical Properties and Water Absorption of Oil Palm Empty Fruit Bunches Reinforced Polyester Composites. *Polymer International*, 2001. 50(4): p. 395-402.
8. Kumar, M, Water Absorption Behavior of Acrylonitrile?Butadiene (Nbr) Latex Impregnated Jute Nonwoven Fabric Composites. *Journal of Applied Polymer Science*, 2006. 101(3): p. 2045-2050.

9. Pereda, M, Amica, G, Rácz, I, and Marcovich, N E, Structure and Properties of Nanocomposite Films Based on Sodium Caseinate and Nanocellulose Fibers. *Journal of Food Engineering*, 2011. 103(1): p. 76-83.
10. Khan, R A, Salmieri, S, Dussault, D, Uribe-Calderon, J, Kamal, M R, Safrany, A, and Lacroix, M, Production and Properties of Nanocellulose-Reinforced Methylcellulose-Based Biodegradable Films. *Journal of Agricultural and Food Chemistry*, 2010. 58(13): p. 7878-7885.
11. Visakh, P, Thomas, S, Oksman, K, and Mathew, A P, Cellulose Nanofibres and Cellulose Nanowhiskers Based Natural Rubber Composites: Diffusion, Sorption, and Permeation of Aromatic Organic Solvents. *Journal of Applied Polymer Science*, 2012. 124(2): p. 1614-1623.
12. Aithal, U S and Aminabhavi, T M, Measurement of Diffusivity of Organic Liquids through Polymer Membranes: A Simple and Inexpensive Laboratory Experiment. *J. Chem. Educ*, 1990. 67(1): p. 82.
13. Dufresne, A, Dupeyre, D, and Vignon, M R, Cellulose Microfibrils from Potato Tuber Cells: Processing and Characterization of Starch-Cellulose Microfibril Composites. *Journal of Applied Polymer Science*, 2000. 76(14): p. 2080-2092.
14. Jacob, M, Varughese, K, and Thomas, S, Water Sorption Studies of Hybrid Biofiber-Reinforced Natural Rubber Biocomposites. *Biomacromolecules*, 2005. 6(6): p. 2969-2979.
15. Azeredo, H, Mattoso, L H C, Avena-Bustillos, R J, Munford, M L, Wood, D, and McHugh, T H, Nanocellulose Reinforced Chitosan Composite Films as Affected by Nanofiller Loading and Plasticizer Content. *Journal of Food Science*, 2010. 75(1): p. N1-N7.

# Synthetic Food Colours

■ Subburaj M, Faseela P.M

## Abstract

Synthetic food colours are added to food materials to catch the attraction of the consumers. Fourteen sugar based confectionery samples were analysed,97% contained permitted colours, 3% contained combination of permitted and non-permitted colours. 82% exceeded 100 ppm, as prescribed by the Food safety and standard Act and 18% were within the prescribed limit. Among the permitted colours, tartrazine was the most widely used colour followed by sunset yellow. Higher concentration was observed in homemade and small scale food manufacturers' products. Non-permitted colour Amaranth, Rhodamine B are commonly used. The prevalent use of non-permitted colours has been considerably reduced, the level or concentration of synthetic permitted colours was noticeably higher than the specifications prescribed under the FSS Act.

## Introduction

The use of permitted and non-permitted colours in foods

in India has been reported previously as has the fact that the use of non-permitted colours are known to cause adverse effects in experimental animals and in humans. Subsequently, the use of non-permitted colours in ready-to-eat foods and other items of daily consumption have been subjected to regulatory scrutiny involving the judiciary. Repeated exposure to even the permitted synthetic colours is hazardous. Based on toxicological evaluation of synthetic food colours the Central Committee for Food standards (CCFS, India) has been constantly updating the food regulations. As a part of these regulations, certain colours such as amaranth and fast red E were banned and the reduction of the synthetic food colour limit from 200 to 100 ppm in all foods except in canned foods, jams and jellies has been recommended.

Different countries permit different synthetic food colours. India permits addition of eight colours, viz. erythrosine, carmoisine, ponceau 4R, tartrazine, sunset yellow, brilliant blue FCF, Fast green FCF and indigo carmine up to specified food items.

## Toxicity of Food Colour

Food dyes are one of the most widely used and dangerous additives. While the European Union has recently placed regulations on labelling food dyes to inform consumers of the health risks, the United States has no such requirement. The use of certain food colours has been banned on their toxicity observations on experimental animals. The use of non-permitted colours and excess of permitted colours generally cause adverse effects on human health. Some of the common after effects of prolonged use of synthetic colours cause hyper acidity, thyroid tumors,

urticaria (hives) dermatitis, asthma, nasal congestion, allergies, abdominal pain, nausea, eczema, liver and kidney damage and cancer. For example, Auramine was found to cause dysfunction of liver and kidney; Rhodomine B was shown to cause retardation of growth and degenerative changes in liver in kidney; Malachite green caused decrease in appetite, growth rate and fertility rate; Yellow G provoked asthma; Allura red caused cancer in mice. In view of above, list of permitted food colours in different countries has some exceptions depending upon the recommendation of their food & Drug Authority Regulations.

## Experimental

### Materials and Methods

Fourteen different coloured sugar based confectioneries such as sweets, sugar candies, toffees, marshmallows are randomly collected from different shops during the period January 2015 and March 2015. The samples are kept in a well packed air tightened container for analysis.

### Extraction of the Colour from the food

Introduce about 20 cm length of woollen thread into a beaker containing about 35 ml of the prepared acidified solution of the sample and boil for a few minutes till the woollen thread is dyed. Take out the woollen thread and wash it with tap water. Transfer the washed woolen thread to a small beaker containing dilute ammonia and heat again. If the colour is stripped by the alkali, the presence of an acid synthetic dye is indicated. Remove the woollen thread. Make the liquid slightly acidic and boil with a fresh piece of woollen thread. Continue boiling until the colour is taken by the woollen thread. Extract

the dye from the woolen thread again with a small volume of dilute ammonia, filter through a small plug of cotton and concentrate the filtrate over a hot water bath. This double stripping technique gives a pure colour extract.

Natural colours may also dye the wool during the first treatment, but the colour is not usually removed by ammonia. Basic dyes can be extracted by making the food alkaline, with ammonia, boiling with wool and then stripping with dilute acetic-acid. At present, all the permitted water soluble synthetic dyes are acidic, hence an indication of the presence of a basic dye suggests that an unpermitted colour is present (Manual Methods of Analysis,1990).

## Identification of the Separated Food Colours by Paper Chromatography

Draw a pencil-line parallel to the bottom edge of the paper (Whatman No.1) at about 2 cm distance. Spot the concentrated solution of the unknown dye on the line together with a series of spots (about 2 cm apart) of aqueous solutions of standard permitted dyes of similar colour and dry. Run the chromatogram, by ascending technique, using a selected solvent. Isobutanol-ethanol-water (1: 2: 1, v/v) is often helpful for general purposes. Identify the colour in the sample by matching its spot with the spot of the standard colour and confirm by co spotting(Manual Methods of Analysis, 1990).

## Determination of Synthetic Food Colours in Food Product

Transfer a known weight of the sample (approximately 5 - 10 gram) into a glass stoppered separator funnel. Extract the

colour with 70% acetone. Shake acetone extract with petroleum ether (40-60°C) in order to remove carotenoids and other natural pigments, if any. Continue extraction with petroleum ether until petroleum ether extract is colourless. Pass the acetone extract containing only coal-tar food colours through a column (2.1cmx 45 cm) containing aluminium oxide acidified with 1% hydrochloric acid. Elute the adsorbed colour with 1% ammonia. Evaporate the eluate to dryness on a hot water bath, dissolve the residue with 0.1 N hydrochloric acid, transfer quantitatively to a 100 ml volumetric flask and make up the volume with 0/1N hydrochloric acid. Determine the optical density of the dye solution at the wavelength of maximum absorption (Manual Methods of Analysis, 1990).

## Preparation of standard curve

### Stock solution

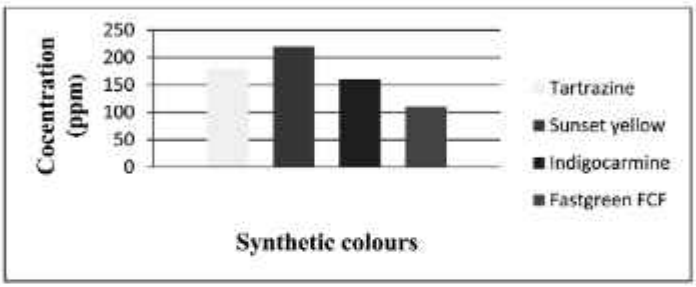
Weigh 0.1 gm of each reference colour and dissolve in 0.1N hydrochloric acid in separate 100 ml volumetric flasks and make up the volume with 0.1N hydrochloric acid in each case.

**Working standard:** Pipette 0.25, 0.5, 0.75, 1.0, 1.25 and 1.5 ml of stock solution of each of the reference colours into series of clean and dry 100 ml volumetric flasks and dilute to volume with 0.1N hydrochloric acid. Determine the optical densities of each of the reference colours at the respective wave length of maximum absorption (refer table) Obtain the standard curve for each colour by plotting optical density against concentration (Manual Methods of Analysis, 1990).

## Result

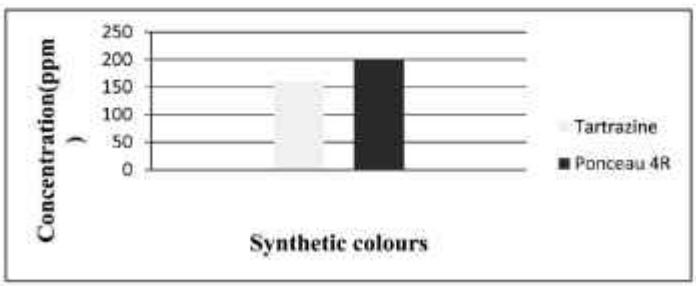
The results show that most of the samples having very high concentrations of colours and very few samples are having non permitted colours.

### Sample -1



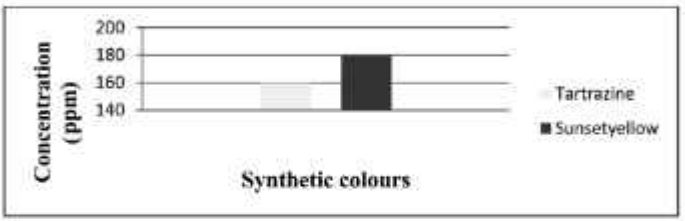

In cumine sweets no natural colours were found. Four type of synthetic food colours were found in the samples. They are individual and mixed colours. All the synthetic colours having concentration more than 100 ppm. Sunset yellow have more than 200ppm and Fast green have least concentration.

### Sample-2



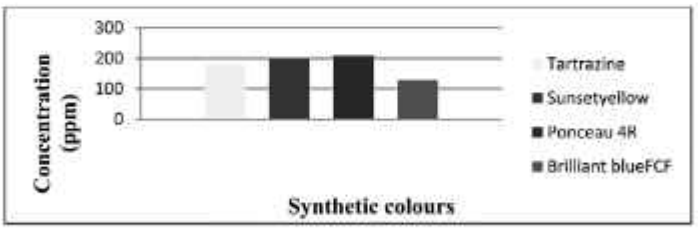
Three types of colours were identified in Peanut sweets one is natural. The other two colours were identified as Ponceau4R and tartrazine. Both colours are more than 100ppm.

**Sample-3**



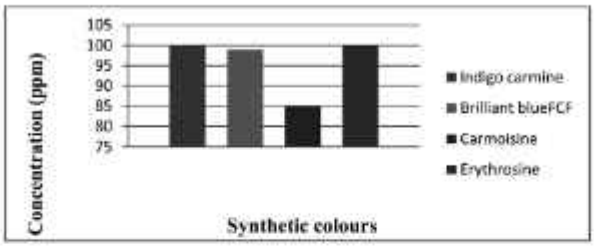

Only two colours were found in lemon sweets. The colours are identified as Tartrazine and Sunset yellow. Sunset yellow is present in more than 180ppm and tartrazine having the concentration 160ppm. No mixed colours and natural colours were identified in these samples.

**Sample-4**



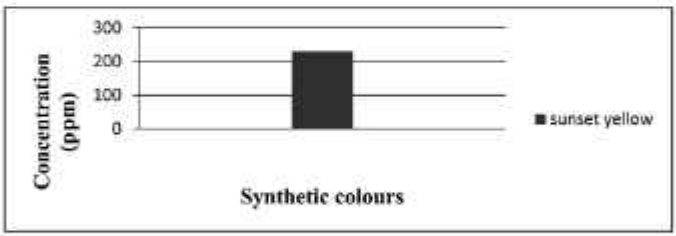

In all jelly sweets individual colour and mixed colours were found in samples. No natural colour or non-permitted colours were found in the samples. Ponceau 4R Present in higher concentration

**Sample-5**




It is interesting to note that the sample Gems sweet having assorted colours containing permitted synthetic colours. No non permitted colours are found in these samples. All the identified colours are below 100ppm.

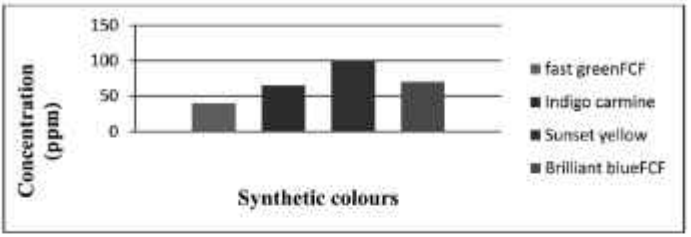
**Sample-6**




The local Lolly pope sample collected having red in colour. Only single colour identified as sunset yellow. The Colour present in higher concentration 230ppm.

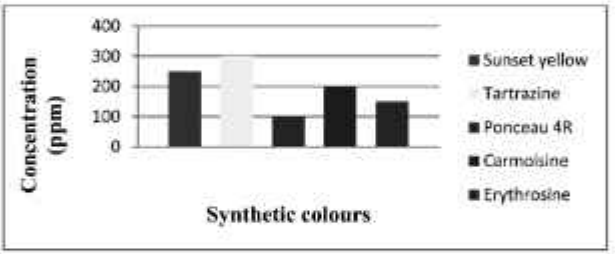
**Sample-7**

The sweet Poppins contains assorted multiples and single colours of permitted synthetic food colours as per the Food Safety Standard level. No natural colours and non-permitted




colours were found in the samples. All the identified colours were less than or equal to 100ppm.

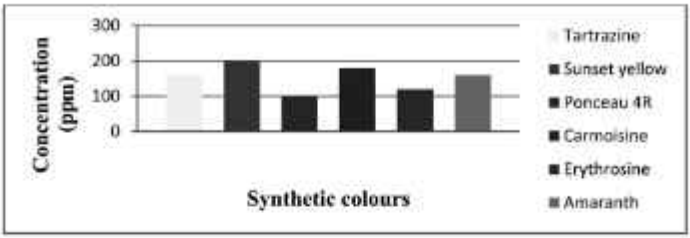
**Sample-8**



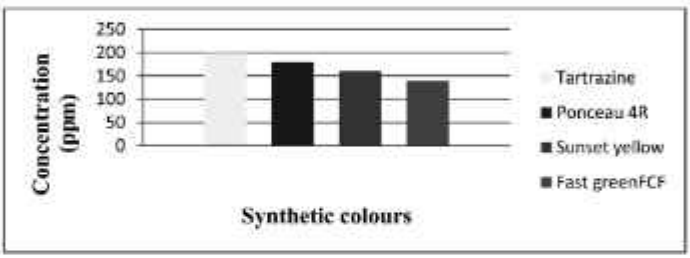

The collected Local sweets are assorted samples of single and multi-coloured sweets. Five types of colours were found in the samples they are mixed and single. Tartrazine is present in highest level followed by sunset yellow and Ponceau 4R. All the colours are above the FSSA prescribed level.

**Sample-9**

The Home made sweets samples having 6 types of colours. They are Individual and mixed colours. Amaranth is mixed with other colours. Ponceau 4R presents in the prescribed level and all other colours are more than 100 ppm.



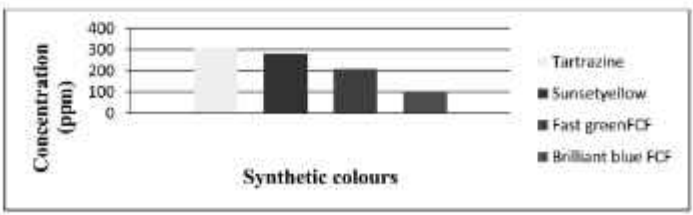

**Sample-10**




Four types of colours were identified in this Local sweet. Assorted sweets having single and multi-colours. All colours were more than 100ppm.

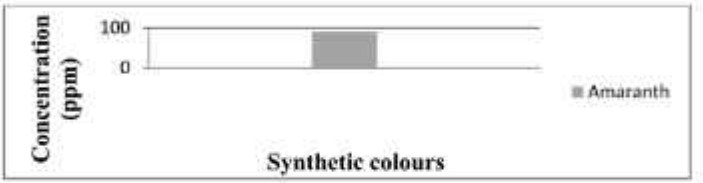
**Sample-11**

In this Local sweets four types of colours were identified in single and multi-coloured. Brilliant blue FCF presents in



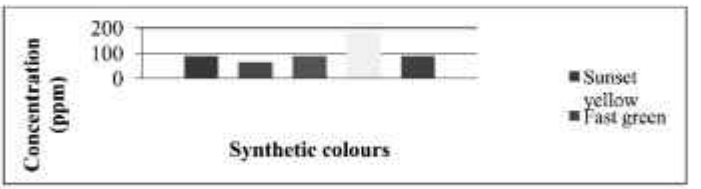
the prescribed level but tartrazine is present in very high concentration followed by sunset yellow and fast green. No natural colour or non-permitted colour were not found in the sample

**Sample-12**



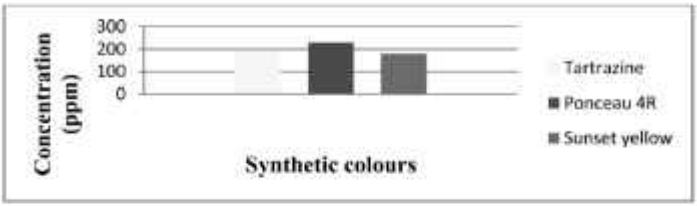

The assorted Local marshmallow collected were having two colours one is white other is pale rose in colour. The non-permitted synthetic colour Amaranth 90ppm was identified.

**Sample-13**




Five colours were identified in the Local sweets containing assorted single and multi-coloured sweets. Tartrazine presents in the higher level and all other colours are present lower level (<100ppm). No natural colour is found in the samples but amaranth is present in the samples. Amaranth is a non-permitted colour.

**Sample-14**




This Local sweet containing three colours of multi-coloured sweets. No non permitted and natural colures were found in this samples.All the colours are above 150ppm. The normal recommended concentration is below 100ppm.

## Discussion

Most of the sugar based confectionary products sold in the market were coloured and it is difficult to find without any colour. Of the fourteen sweet based confectionary samples analysed, 97% contained permitted colours, 3% contained a combination of permitted and non-permitted colours. The analysis shows that, the sweet based confectionary samples with permitted colours, 82% exceeded 100 ppm, as prescribed by the Food safety and standard Act of India and 18% were within the prescribed levels. Among the permitted colours, tartrazine was the most widely used colour followed by sunset yellow. The overall pattern and the frequency of permitted colours in a variety of sugar based confectionary products indicated that tartrazine in blend with sunset yellow is the most widely used colour, followed by sunset yellow. Moreover it was observed that the limit was exceeded most for tartrazine maximum 310 ppm followed by sunset yellow

250ppm, ponceau 4R 230ppm,

It was interesting to note that although the FSSA permits eight colours to be added to specific foods, only six colours were commonly used, i.e. tartrazine, sunset yellow (either individual or in blend with other permitted colours such as carmoisine, ponceau 4R, erythrosine and brilliant blue FCF), carmoisine, ponceau 4R, erythrosine and brilliant blue FCF. However, brilliant blue FCF was mostly used in blends with tartrazine to give a green shade to sugar based confectionary products. The use of individual green colours such as fast green FCF and Indigo carmine were found in company and local sweets.

Among the non-permitted colours found amaranth, Rhodamine B was commonly used. Rhodamine, Orange G, Fast red and Metanil yellow were not found in any sugar based confectionary tested. Reports on earlier studies showed that non permitted colours were used in wide range confectionary products. In contrast, in the present study, the use of non-permitted colours in sugar based confectionary products was found to be considerably less than previously as it was detected in only 4 % in overall and 6.4 % in multi-coloured sugar based confectionary products. This could be due to the awareness of the manufacturers to the hazards of non-permitted colours but could also be because of the stringent action taken by the regulatory authorities.

## Conclusion

It can be concluded from the present investigation that although the prevalent use of non-permitted colours has been considerably reduced, the level or concentration of synthetic permitted colours was noticeably higher than the specifications

prescribed under the FSS Act. The reason is the colours are highly influenced by kids and children. For attracting kids the manufacturers add more quantity of colours instead of looking regulations. The earlier studies clearly reveal that the synthetic colours may carcinogic. Better awareness is necessary for enhancing the quality of synthetic coloured sugar based confectionary prepared in the non-industrial sector. In addition, a relentless campaign needs to be undertaken to improve the awareness amongst consumers of the unscrupulous use of synthetic food colours, particularly concerning vulnerable consumers such as children.

## References


- Achaya, K.T. *Everyday Indian Processed Foods.* Delhi: National Book Trust. P 154–162,1984.
- Adam Burrows, J.D.A *Brief History of Food Colouring and Its Regulation Comprehensive Reviews in Food Science and Food Safety.* (Vol. 8),P 45-55,2009
- Alison Downham and Paul Collins *A review of colours used in our food and drink. International Journal of Food Science and Technology*, 35, p 5-22,2000.
- David Frick(2003),*coloration of foods includes synthetic colour, natural colours regulations,Journal of technology*, vol3,2003.
- Food safety and standards Act-2006, Professional Book Publishers, New Delhi,2013.
- International Journal of Food Science and Technology, 35, p5-22,2000.
- International Journal of Food Science and Technology, 39, p125–131, 2004.
- J. Egypt. Soc. Toxicol. Neveen H. Mahmoud,34,p 77-84, 2000.
- Khanna, S.K., Singh, G.B. & Singh, S.B. *Non-permitted colours in food and their toxicity. Journal of Food Science and Technology*, 10, p 33–36,1973.

- Khanna, S.K., Srivastava, L.P. & Singh, G.B. *Comparative usage pattern of synthetic dyes in yellow orange coloured eatables among urban and rural markets. Indian Food Packer,* 40, p33–37, 1986.
- Manual Methods of Analysis for Adulterants and Contaminants in Food, I.C.M.R p56,1990.
- Meggos, H. Food colours: an international perspective. *The Manufacturing Confectioner,* p 59-65, 1995.
- P.R.Jonnalagadda, PratimaRao, Ramesh V. Bhat and Nadamuni Naidu*Usage of colours in ready-to-eat foods. International journal of Food Science and Technology,*39, p125-131,2004.
- Rao, B.S.N. Food additives – consumer's viewpoint. *Indian Food Industry,* 9, p 14–19,1990.
- The PFA Act & Rules,New Delhi: *Confederation of Indian Industry,*p1–250, 1995.

# Tracing roots of 'Scientific Psychology': A critical evaluation

■ Sheron.K.P.R

Psychology developed as an offshoot of Philosophy (Hergenhahn& Henley, 2013). By the end of the 19th century Psychology evolved into an independent stream like Physics and Chemistry (Koch, S& Leary, 1992). After having separated from Philosophy, Psychology underwent myriads of stages to become a self-sufficient and customary stream. The most prominent stage under William Wundt (1832-1920) took place in 1879 at Germany in the laboratory of University of Leipzig. Psychology gained its present form and shape after that.

What was the primary challenge that Psychology had to face in its initial stage of development? As Lindsay (2013) pointed out, it was the very act of defining Psychology. In the embryonic stage, Psychology was defined as the study of human soul (Corsini, 1994). The etymology of the word 'Psychology' attributed the above meaning to its definition. 'Psychology' comes from the Greek words, *psyche* and *logos* which meant 'soul' and 'study' respectively. It was the assemblage of the word meanings that resulted in this particular definition of Psychology. This definition when put to use cancels out further possibilities of arriving at satisfactory answers to the

questions related to the nature of the soul and its relationship to the body. Soul is an entity diversely perceived by different people. Soul can neither be observed nor studied in an objective fashion. Therefore this definition turns out to be unscientific and unacceptable. This is the point where the problem comes up. The question of how a subject that cannot be defined in terms of science qualify to be a branch of science arises. It was this realisation that spawned yet other definition of Psychology.

## Study of Mind

In the later years Psychology was redefined from the study of the soul to the study of the mind. However the new definition was also not free from the pitfalls of the earlier. A subject in order to be considered a science has to qualify at least the two criteria of observation and objectivity. The subject for scrutiny should be compatible for observation and objectivity. Nevertheless the mind cannot be observed nor defined. As a result of which, the objective and scientific study of mind renders itself to be impractical. What and where is the human mind? How does the mind work? The mind lodges many such obscure questions. The general lack of clarity in the answers disputes the assumption that Psychology is the scientific study of the mind. Moreover this definition tends to negate the role of the body in the behaviour of a person.

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## Study of Conscience

William James (1842-1910) an American Psychologist defined Psychology as the science of the conscience. The existence of conscience unlike the mind cannot be rejected. This is because all human beings are aware of the fact that they are endowed with emotions, intuitions and feelings. Moreover every person has a greater degree of awareness about themselves and his/her emotions, thoughts and feelings. Therefore the above definition proves to be right when people study their own experiences as the access to another person's character and experiences would be limited. Hence in this definition science becomes a personal experience rooted in the individual.

There is yet another short coming to this definition. Not every experience is recorded in the conscience. In other words we do not have the access to or we are not aware of all the experiences we go through. Therefore the study of conscience does not accommodate experiences that occur outside the realm of the conscience or the experiences which are unknown to the conscience. Since the aim of Psychology is not the fragmented study of human beings, this definition also does not fit into the conventions of a scientific study.

## Study of Behaviour

The American Psychologist John BroadusWatson (1878-1958) defined Psychology as the study of human behaviour. He did not believe in the existence of a mind. He argued that

only behaviour which can be observed and analysed by others comes under the scope of Psychology. According to him, mind is only an alternate solution to the at times inexplicable nature of certain human behaviour.

There are also a number of limitations in the definition proposed by Watson. He out rightly dismisses the thoughts, emotions and every other inner experiences of man. This process which focuses on external behaviour alone is highly mechanical as it keeps out the inmost affairs of men reducing him to mere machinery. It is in reality the diverse mental discourses and skills of men which a definition like the above fail to take notice.

## Study of Behaviour and Experience

Many later Psychologists defined Psychology as the study of both behaviour and experience. They argued that human behaviour is of two kinds: the former which can be observed by the others and the latter which is beyond anybody's observation. Activities like running, walking, playing etc can be monitored by others whereas thoughts, memories, imagination etc are purely private in nature and which cannot be observed by others. However they come to the conclusion that such intimate experiences can be speculated from the other observable behavioural patterns of a person. For e.g. during moments of anger a person experiences mental tension, surge in blood pressure, arrhythmic breathing and constriction of pupils. These external changes can be considered as the reflection of the exclusively individualistic intimate emotions. The accommodation of observable characteristics in

its definition can be understood as a move towards incorporating Psychology into the field of science.

## Psychology and Other Sciences

Apart from the changes that were brought about in the definitions of Psychology in order to back the argument that Psychology is a branch of Science and to accommodate the same within the sphere of Science, there were also other significant strategies to accomplish the objective. One such tactic was the conscious effort to frame the method of study in such a manner in which the study of behaviour becomes intricately woven to the functioning of human brain, internal organs and other glands with the assumption that a better understanding of human physiology is essential for the comprehension of human behaviour. The postulations regarding the relationship between body and behaviour arise out of the conviction that when both the body, which can be scientifically studied and behaviour which is less compatible to scientific study are brought together, the study of the latter becomes shaped by the former. Physiology becomes the key to disentangle the ambiguities centred on behaviour. The qualities of Physiology are juxtaposed with that of behaviour. Physiology being a science, Psychology which studies human behaviour and experiences also attain the status of a science. In short, Psychology becomes Science.

In the 19$^{th}$ century, it was the other subjects which were already considered Science that championed the claim that Psychology was also a Science. Earlier, the philosophies and theories of Physics, Chemistry, Biologyetc were considered Science. However, in the present age there has been a shift of focus from philosophies and theorems to their methods of de-

duction. The term Science refers to the collection and arrangement of data through objective methods which can be repeated by others. Science is not restricted to the collection and arrangement of data alone. Analysis and comprehension of data are also its other important duties. Science studies the causal relationship between the collected data. This includes the various reasons behind the occurrence of a phenomenon in a given environment.

The changes which Science makes use of will always be objective. The method of Science is beyond the beliefs, opinions and personal interests as well as bias of the researcher. The studies ought to be fashioned in a manner in which the experiment can be repeated and the observation results examined by others as well. Science aims to accurately explain phenomena, make predictions regarding the future and to thereby regulate its course. The trend to include Psychology under Sciences still continues because in the method of study, Psychology as a subject adheres to at least a few conventions of a science subject.

The logic that only subjects that follow a scientific method would be lodged under Sciences drives most subjects to adhere to scientific conventions. The concern over acceptability is the sole reason behind this as there still exist a degree of uncertainty associated with those subjects which lack a scientific background. There is an age old belief that only Science is regarded favourably in all domains of knowledge. This is because of the reliability and validity of the subject matter which Science deals with. The requirement of acceptability urges most subjects to seek the patronage of Science. During the time of convergence, the qualities of the subject seeking assistance have to be amended in such a manner that it suits the interest of the patron. It is established via scientific

method. The scientific method cultivated from the time of Aristotle to Newton (Betz, 2011) is one of the major factors that determine the status of a subject as a Science.

As Karl Marx (1818-1883) elucidated, Religion was the first agency that clung to the credence that new roads always lead to glory and would carry people to auspicious destinations. If in a multi-religious culture, a religion enjoys an upper hand position after continuous labour, the strategy can be inferred as political. This is analogous to the case of Science and the reliant subjects where Science becomes the religion and scientific method turns into strategy. The change in trend from the $17^{th}$ century employment of theories and philosophies to interpret subjects to the utilization of the scientific method which is obsessed with the procedure of collection of resources substantiates the argument. It was during this method specific and hegemonic period that a laboratory for Psychology became established in Germany. Psychology developed into the scientific subject we see today after it managed to overcome many existential crises such as the lack of a systematic definition or a laboratory. In order to continue as one, Psychology still has to put in conscious efforts to carry along many components (physiological, neurological, cognitive, and experimental) while there exists many other elements which have to be given even greater importance. Culture, Society and the role of history in shaping human conscience etc are a few among them.

## Conclusion

With the intension to remain in the world of Science where empirical evidence outweighs every other thing, the scope of Psychology becomes conditioned in such a way that

it becomes limited to observable facts. Though it can be proven that such a focus carries along with it a systematic approach to the study, this also curbs the growth and ambit of Psychology as a science which studies human mind. It loses the dynamic nature and is forced to remain in a passive state. The growth of cognitive science, neurology, physiology, psycho physics and clinical psychology in the world of Psychology in the last thirty years perfectly proves the argument. The social, cultural and historical aspects of Psychology go unnoticed in its labour to be part of Science. This limits the subject which becomes evident in today's postmodern era when conventional sciences extend its reach to society, culture and history while Psychology in its efforts to remain in the domain of science becomes obsessed with its scientific aspects thereby giving undue importance to some aspects while leaving out many others. This is plainly because of its need to bask in the lap of science. More over the realisation of the celebrated hierarchy, Psychology has to face in order to exist as a non-science subject also adds to its misery. This epiphany is a creation of hegemonic thought.

**References**


- Ackoff, R. L. (1962). Scientific method: Optimizing applied research decisions.
- Benjamin Jr, L. T. (2007). *A brief history of modern psychology*. Blackwell Publishing.
- Betz, F. (2011). Origin of scientific method. In *Managing Science* (pp. 21-41). Springer New York.
- Corsini, R. J. (1994). *Encyclopedia of psychology, Vols. 1–4* . John Wiley & Sons.
- Hergenhahn, B. R., & Henley, T. (2013). *An introduction to*


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*the history of psychology*. Cengage Learning.
- Koch, S., & Leary, D. E. (1992). *A century of psychology as science*. American psychological association.
- Lindsay, P. H., & Norman, D. A. (2013). *Human information processing: An introduction to psychology*. Academic Press.
- Mackenzie, B. D. (1977). *Behaviourism and the limits of scientific method*. Taylor & Francis.
- Popper, K. (2005). *The logic of scientific discovery*. Routledge.
- Popper, K. R. (1972). Objective knowledge: An evolutionary approach.
- Zimbardo, P., &Ebbesen, E. B. (1970). Influencing attitudes and changing behavior: A basic introduction to relevant methodology, theory, and applications.

# Foot and Mouth Disease (FMD)- A Case Study

■ Dr.Petrisia Joseph, Litto Marvel Jose

## Abstract

Foot and Mouth disease (FMD) is an economically devastating viral disease affecting cloven footed animals like cattle. A case study was conducted to observe the occurrence of the disease in selected localities-Ayyanthole, Avanoor and Thanikkudam at Thrissur district. The outbreak of the disease has led to a misconception that the virus may cause health problems to the consumers. Not much study has been conducted in this field. From our studies, more information was collected about FMD and its transmission method .The quality of the milk was tested by analyzing the casein content. The quantity of milk is reduced but the quality remains the same in infected ones also and it was found that this milk is suitable for human consumption after boiling.

*Keywords; FMD-Foot and Mouth Disease, Picorna viridae, Haemorrhagic Septicaemia, Casein*

## Introduction

Livestock contribute significantly to the world economy.

However, animal diseases are a major strain on economic growth, and food security. Among the most significant diseases is Foot and Mouth Disease, highly contagious multi species animal disease with a devastating impact on national economics and trade. Foot and Mouth Disease occur worldwide and is included in the text of disease notifiable to the World Organization for animal health. (Depa P.M.,*et al*)

It is recognized as a significant epidemic threatening the cattle industry since 16$^{th}$ century continues so and till date. It is a major animal health problem. India is endemic to Foot and Mouth Disease and it is indispensable for our country to control this disease to increase productivity of livestock sector.

Livestock and cattle management have been playing an important role in our economy and also form an important part of agriculture, the back bone of our country. Cattle is efficient in converting the farm crops into useful human foods such as milk and milk products which are the main source of animal proteins and people find it hard to think of living without milk.

Numerically, India possesses the largest cattle population in the world. Cattle and buffalo contribute nearly 15% of gross national income. According to recent statistics, India rank third in the world in the field of milk production. This industry fetches more than 100,000 million rupees annually.

Cattle are prone to a large number of diseases. One of the fatal disease in cattle that staked India, especially Kerala is the Foot and Mouth Disease (FMD). It is an infectious and fatal disease that affects cattle, pigs and other cloven – hoofed animals. The virus which causes Foot and Mouth Disease is an aphthovirus of the family *Picorna viridae*. There are 7 immunologically distinct type of FMD viruses, A, O, C, SAT1, SAT3, and Asia 1. Type O virus was found to be the dominant Foot

and Mouth Disease virus type during 1971 to 2010 in North West India except in 1976 and 1984 when Asia 1 overtook other virus types. In the current years serotype O was most prevalent in majority of the outbreaks recorded in different countries (www.fao.org/ag/againfo/commissions/docs/research.../Appl18.pdf).

In the recent outbreaks during 2011 in different countries the majority of species affected were cattle, swine and sheep. Recent outbreak to wildlife species has been reported in South Africa and Namibia (www.oie.int). Larger outbreaks occurred in winter within the higher deer density eco regions, whereas larger outbreaks occurred in summer and fall within the lower deer density eco region. Results of this simulation study suggest that the probability of a Foot and Mouth Disease incursion in a population of wildlife would depend on the density of the population infected and the season in which the incursion occurs. In recent outbreaks in India, the majority of species involved was cattle although diseases reported in buffaloes, pigs, sheep and goats (Annual Report(2010-2011).Project Directorate on FMD,Mukteswar, Nainital, Uttaranchal).

Although Foot and Mouth Disease is known as a disease of cloven hooved animals too, it can occur naturally in other animals, eg. The hedgehog (*Erinaceus* spp.) and infection has been established experimentally in a number of other species. However it is doubtful whether these animals play any part in the epidemiology of the disease (Davies G. (2002) Foot and Mouth Disease. Research in Veterinary Science.73:195-199). Foot and Mouth Disease is not considered zoonotic. Although clinical cases have been proven in human, these are extremely rare when compared to human exposure during outbreaks. Epidemiological studies of Foot and Mouth

Disease in North West India during 2003 – 04 showed that maximum number of outbreaks involved buffaloes and cattle (either simultaneously or alone) followed by goats and sheep. However during 2004 – 05 and 2005 – 06, cattle and buffaloes were involved only simultaneously. It is worthwhile to mention that during 2006 – 07 and 2007 – 08, no other species except cattle were affected with Foot and Mouth Disease outbreaks. Further during subsequent years the number of outbreaks were 1–2 only (Report of Regional Research Centre on FMD, LLRUVAS, Hisar.Illruvas.edu.in/rrc-fmd.php? AM2)

It becomes fatal not because of the Foot and Mouth Disease virus but due to infection Haemorrhagic Septicaemia (HS) which affect the wounds caused due to Foot and Mouth Disease. This disease is caused by certain serotypes of *Pasteurulla multoeida*, a gram negative *cocobacillus* residing mostly as a commensal in the upper respiratory tract of animals. Foot and Mouth Disease along with Haemorrhagic Septicaemia is fatal and causes mortality.

Besides mortality, disease lowers the productive efficiency of the animals and thus results in great economic loss of owner as well as the society. So, it has social dimensions too. In infected animals, the Foot and Mouth Disease blisters usually burst after a few days and the resultant sores generally clear up over a few weeks. During this time, animals experience considerable difficulty in eating and walking. Foot and Mouth Disease therefore cause much suffering and results in loss in production.

The Regional Research Centre on Foot and Mouth Disease, Hisar, India has done a commendable work on epidemiology of Foot and Mouth Disease in north – west India. A total of 1718 Foot and Mouth Disease outbreaks were recorded

by the Regional Centre, Hisar in the Haryana state since inception of the project (1971 - 2010). Maximum number (169) of outbreaks was recorded during 1976 coinciding with heavy rains followed by widespread floods. Likewise, the lowest number of outbreaks recorded during 2004 – 2009 can be attributed to the implementation of Foot and Mouth Disease control programme in Haryana since January 2004. (Depa P.M., *et al*)

In 2010 – 2011, 799 outbreaks were reported from different parts of India (Annual Report (2010-1011) Indian Council of Agricultural Research, NewDelhi, India). Maximum outbreaks were recorded in the eastern region where there was increase in the number of outbreaks compared to the previous year. Drastic reduction in outbreaks was noticed in Southern region. No Foot and Mouth Disease cases were reported from Tamil Nadu whereas Himachal Pradesh and Punjab recorded a single case of Foot and Mouth Disease each (Annual Report (2010-1011) Indian Council of Agricultural Research, New Delhi, India).

If Foot and Mouth Disease outbreak were to occur, our major export markets for meat, dairy product and possibly even 1000 litre would be closed to us immediately. This could devastate our processing industries and rural communities. Thus, it can be said that Foot and Mouth Disease is a serious problem. This issue is very relevant as there was an outbreak of this disease recently in Kerala affecting the production and availability of milk and milk production across the state.

The curiosity to know more about this subject and its effects on society resulted in, choosing this particular subject for the study. As one knows, milk is a significant source of animal protein in our diet. Also, milk is used to produce various by products such as curd, butter, cheese, milk powder etc. the

demand for which is always increasing.

These days, especially after the outbreak of Foot and Mouth Disease, many people were reluctant to use fresh milk and milk products due to the fear of the Foot and Mouth Disease infection and an apprehension misconception that the virus may cause health problems to the consumers. This was the reason for choosing this subject as the project topic.

## Materials and Methods

Foot and Mouth Disease is an infectious disease affecting cloven – hoofed animals, in particular, cattle, sheep, pigs, goats and deer. It is mainly caused by a virus called Picorna. The disease is serious for animal health and for the economics of the livestock industry. Foot and Mouth Disease is normally fatal to adult animals, it is debilitating and causes significant loss of productivity.

For collecting the details of Foot and Mouth Disease, 3 localities were selected randomly. They are as follows: Avanoor, Ayyanthole and Thanikkudam, Thrissur district. Frequent visits were made to Avanoor milk society, and the veterinary hospitals of Ayyanthole and Thanikkudam.

The details of Foot and Mouth Disease in the selected areas were given by veterinary doctors of the respective clinics. A study class was also arranged which helped to look into almost all general aspects regarding Foot and Mouth Disease, its causes, transmission, management and prevention.

The mode of survey was based on veterinary clinics and dispensaries and the observation were recorded based on these reports. The veterinary doctors gave good guidance throughout the project. Previous year records were also checked to know about the pattern of its occurrence and to

check if re-occurrence is reported. A few houses that host Foot and Mouth Disease infected cows were visited and various photographs of the affected cows were taken.

The quality of Foot and Mouth Disease affected and non – affected normal milk collected were tested in the Zoology lab. The test for protein content casein was carried out. The method for casein detection is as follows:

Pipetted out 50 ml of cow's milk in a conical flask. Then about 5 ml of glacial acetic acid was added drop by drop into the conical flask by gently shaking. The contents in the flask were mixed well and allowed to stand for 10 minutes without disturbing the flask. The precipitate accumulated at the bottom and the upper aqueous layer was decanted carefully making sure that the whole precipitate is retained in the conical flask. Then the contents of the flask are filtered using ordinary filter paper. After filtration 5 ml of chloroform was added to the precipitate retained in the filter paper, and was taken out and weighed immediately to get the wet weight of casein. It is dried and the dry weight is taken. Then the amount of casein in milk is calculated.

## Results

Foot and Mouth Disease (FMD) is one of the most economically and socially devastating disease affecting animal agriculture throughout the world. After detailed study of Foot and Mouth Disease and its effect on animals, the following results were obtained.

DR.PETRISIA JOSEPH, LITTO MARVEL JOSE

| Table 1: No. of outbreaks in various years in Avanoor region (2008-2013) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Serial No | Type of animal | Number of animals affected in various years. | | | | | |
| | | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| 1 | COW | 7 | | 4 | | | 145 |
| 2 | CALF | 5 | | | 2 | | 28 |
| 3 | HEIFER | 5 | 1 | | | 3 | 23 |
| 4 | GOAT | 2 | | | | | 7 |
| Total | | 19 | 1 | 4 | 2 | 3 | 203 |

| Table 2<br>No. of outbreaks in 2013 in Ayyanthole locality | | |
|---|---|---|
| Serial No. | Type of animal | Number |
| 1 | Cow | 84 |
| 2 | Calf | 23 |
| 3 | Heifer | 10 |
| 4 | Goat | 9 |
| 5 | Pig | 15 |
| 6 | Buffalo | 3 |
| TOTAL | | 144 |

| Table 3<br>No. of outbreaks in Thanikkudam area in 2013 | | |
|---|---|---|
| Serial No. | Type of animal | Number |
| 1 | Cow | 38 |
| 2 | Calf | 19 |
| 3 | Heifer | 8 |
| 4 | Buffalo | 3 |
| TOTAL | | 68 |

| Table 4<br>Casein content in milk | | | |
|---|---|---|---|
| Milk Type | Casein content (wet weight) | Casein content (dry weight) | Amount of casein |
| Normal milk | 38.86 g | 22.66 g | 16.2 g |
| Infected milk | 36.8 g | 19.7 g | 17.1 g |

## Discussion

Foot and Mouth Disease the most contagious Trans boundary animal disease affecting cloven – footed animals. Significant economic loss is caused by its high morbidity and the export trade restrictions imposed on affected countries. Many studies highlighted the severe impact on national

economics caused by FMD.

The severity of clinical signs will depend on the strain of virus, the age of animal and the species and breed affected. The typical clinical sign is the occurrence of blisters (or vesicles) on the muzzle, tongue, lips, mouth, between the toes, above the hooves, teats and potential pressure points on the skin. Ruptured blisters in inter digital space can result in lameness and reluctance to move or eat due to vesicles in the mouth. Secondary bacterial infection of open blisters can also occur (Plate1-Plate11). An example is Haemerrogeous septicaemia,. Other symptoms often seen are fever, depression, hypersalination, loss of appetite and weight and drop in milk production. The disease is rarely fatal in adult animals, however the disease can weakened and debilitate and can result in severe production losses. The health of young calves, lambs, kids and piglets may be compromised by lack of milk from infected mouth. When young animals are infected with the Foot and Mouth Disease virus, mortality can be high.

The mode of its transmission was also noticed. Cattle are very susceptible to respiratory route requiring as little as 20 TCID of virus to establish infection, but require 10,000 times more virus to become infected by the oral route.

Cattle are mainly infected by inhalation, often from pigs, which excrete large amount of viruses by respiratory aerosols and are considered highly important in disease spread large amount of virus are excreted by infected animals before clinical signs are evident and wind may spread the virus over long distances.

Foot and Mouth Disease virus is found in all excretions and secretions from an infected animal. It can spread easily and rapidly by means of the following.

- Introduction of new animals carrying the virus (saliva, milk, semen etc.) to a herd.
- Use of contaminated pens, buildings or vehicles to house and transport susceptible animals.
- Use of contaminated materials such as hay, feed, ware, milk or biologics.
- Feeding susceptible animals with animal products, raw or improperly cooked food, infected with the virus.
- Dissemination of virus by aerosols transported from an infected property via air currents.
- Accidental release of virus from a laboratory.
- Use of vaccines containing live virus due to production errors in manufacture.

The methods to control and manage the disease were also explained. Countries in different regions of the world adapt Foot and Mouth Disease control policies depending on the epidemiology of the disease. In Foot and Mouth Disease free countries, slaughter of all infected and susceptible in contact animals, quarantine of infected animals, strict animal and animal product import regulation and animal movement restrictions are practiced.

For the effective control of Foot and Mouth Disease about 60 – 80 % animal need to be covered under vaccination so as to control the outbreak of disease. It can be made possible only through implementation of veterinary extension education for livestock owners about the economics of the diseases and by making vaccination services readily available.

Outbreak can also be controlled by one or a combination of two methods. Eg. Stamping (slaughtering of all infected and in contact animals) and routine vaccination of animals. As part of Animal Disease Control Project for Foot and Mouth Disease control in Kerala, outbreaks were controlled by restricting animal movement from and to the foci of infection;

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through disinfection of infected premises and treatment of ailing animals, and conducting ring vaccinations, extending from the periphery to the point of infection within a radius of 5 – 10 kms.

Vaccination for Foot and Mouth Disease was also discussed in our topic. The commonly used vaccines in these areas are Raksha ovac vaccine. It is an adjuvant vaccine.

Revaccination must be carried out every six months. After multiple doses of vaccines in older animals vaccination frequency could be decreased to once a year provided that no new strains not covered by the vaccine formulation emerge or are introduced. There are important short comings of current inactivated vaccines, including shot shelf life, the need for adequate cold chain of formulated vaccines and difficulties of certain serotypes and subtypes to grow in cell culture for vaccine production.

From graph 1 it can be noted that significant infection has occurred to the cows of Avanoor region in all the years. Out of the 203 cases reported, 145 were cows, 28 calves, 23 heifers and 7 goats . The maximum infection is also reported here as compared with other study areas. In Ayyanthole region, a total of 144 cases were reported, out of which 84 were cows, 23 calves, 10 heifers, 9 goats, 15 pigs and 3 buffaloes. Here also cows were the maximum infected ones.

The next area of the study was Thanikkudam. The observation there was also on the same times with other areas. Out of 68 reported cases, 38 were cows, 19 calves, 8 heifers and 3 buffaloes.

Figure 1 shows the Pie – diagram of Foot and Mouth Disease infected animals in Avanoor region in 2013.

- 17.42 % of infected animals were cows
- 13.7 % were calves

- 11.33 % were heifers and
- 3.4 % was goat

Figure 2 shows the Foot and Mouth Disease infection during 6 consecutive years in the same area. The maximum number of cases were reported in 2013. 19 cases were reported in 2008, 1 case in 2009, 4 in 2010, 2 in 2011, 3 in 2012 and 203 in 2013. After 2008, no significant cases were reported in the area till 2012. All regions showed high Foot and Mouth Disease infection in the year 2013.

The reason for increased chances for cows were analysed and its reason were explained to us by Dr. Harish, veterinary doctor of Avanoor clinic. Majority of the breeds of cows in our area are foreign breeds. Foreign breeds are preferred over indigenous breeds for their high milk yielding quality. Indigenous breeds provide only 1 – 2 litres of milk per day whereas foreign breeds can supply 7 – 8 litres per day. These breeds are less resistant to the environmental condition in our area and are more susceptible to attack of pathogens.

Significant infections were also reported to calves in all the study area. Calves are affected as they are the young ones and the juveniles are more susceptible to infections than adults.

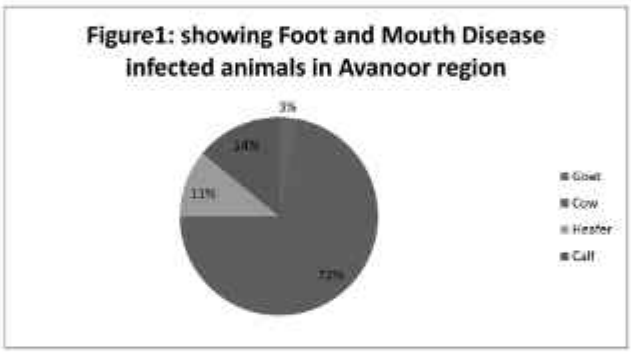
Other animals showed no Foot and Mouth Disease infection since most of them belong to the indigenous breeds. Buffaloes, pigs etc. are indigenous and are highly resistant to the adverse environmental conditions and most strains of viruses or pathogens.

The protein content casein was tested in our zoology lab. Foot and Mouth Disease infected milk and normal milk showed no considerable variation in protein. Thus, it can be inferred that the quality of milk is not affected.

Our study in the Milma milk society showed that quantity of milk in Foot and Mouth Disease infected cows were

significantly reduced and it is a temporary effect. It can be due to mastitis (inflammation of udder). The reduction in milk is due to the inability to take proper food due to blisters in the mouth. Milk is 87% water in composition. So, lack of food intake can cause a fall in milk yield. After the Foot and Mouth Disease is cured the cow produces normal amount of milk as produced earlier. This was observed for over a month.

Since no virus is able to survive very high temperature, using milk of Foot and Mouth Disease infected cows after proper boiling is safe. Although there is heavy economic loss to the society, it no way affects the health of the society.



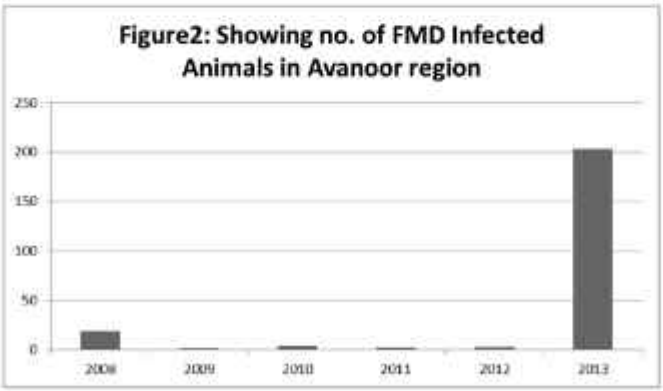



*Plate 1*

*Plate 2*

*Plate 3*

*Plate 4*

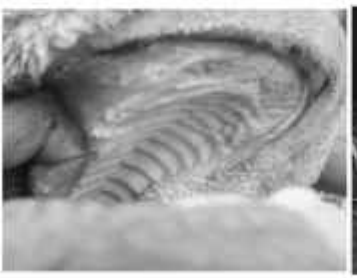


*Plate 5*

*Plate 6*

*Plate 7*

*Plate 8*

*Plate 9*

*Plate 10*

*Plate 11*

## Conclusion

At present, Foot and Mouth Disease is a relevant issue in Kerala. So, this topic was chosen for our project. From the studies, more information was collected about the Foot and Mouth Disease and its transmission method. The major conclusions are:

- Foot and Mouth Disease is a viral disease caused by Picorna belonging to aphtho family of virus.
- No animal die of only Foot and Mouth Disease alone. Majority happens when FMD coupled with other infections particularly caused by bacteria Pasteurella.
- Foot and Mouth Disease infection is mainly infected to cloven footed animals especially cows.
- In calves, mortality rate is high as compared to adults.
- It is a seasonal disease and it occurs mainly due to increased temperature in atmosphere
- Significant reduction in quantity of milk is observed. But it is a temporary phenomenon.
- Quality of milk is not affected by this viral infection and it is safe to use this milk after boiling.
- Vaccination is not proven to be the best method to cure this disease as this virus is fast mutating and new strains are developed very fast even before the vaccine begins to act.

With the timely interference in and interaction with the society, a great awareness regarding Foot and Mouth Disease and its risk factors could be provided to the general public especially the milk producers of the areas surveyed. Many farmers were ready to take their livestock to the nearby veterinary clinics for vaccination and treatment of Foot and Mouth Disease and also were ready to take precautionary methods to prevent its spreading. The message of the immense importance of urgent treatment to the Foot and Mouth Disease af-

fected cattle could be propagated and consequent to this increased understanding, many farmers who were reluctant to admit that their cows have Foot and Mouth Disease, visited the veterinary clinics conceding that their cows were also in need of treatment.

**References**


- Annual Report (2010-2011). Indian Council of Agricultural Research, New Delhi, India.
- Annual Report (2010-2011). Project Directorate on FMD, Mukteswar, Nainital, Uttaranchal.
- Davies. G (2002). Foot and Mouth Disease. Research in Veterinary Sciences. 73:195-199
- Depa P.M., Umesh Dimri, Sharma M.C., Rupasi Tiwari,(2012) 'Update on Epidermology and Control of Foot and Mouth disease – A Menace to international trade and global animal enterprise., Vet. World, 2012, Vol.5(11): 694-704..
- www.oie.int
- www.fao.org/docs/eim/upload/225050/Focus_research.../App/8.pdf.

# Generalisation of the Exponential Distributions and its Applications in Life Time Data Analysis

■ Nihala N. C, Bindu Punathumparambath

## Abstract

The statistical analysis of lifetime or response time data has got more importance in areas such as engineering, medicine, and the biological sciences. Recently there has been lot of research works under going in this area. Lifetime data is a term used for describing data that measures time to occurrence of some event. Lifetime or time to event is usually considered as a positive real valued random variable having a continuous distribution function. In the present paper we study various generalizations of the exponential distribution and its applications in lifetime data analysis. Finally, we illustrate the applications of the exponential distribution with resilient and tilted parameter. The analysis is carried out using R Package.

## 1. Introduction

Lifetime data is a term used for describing data that measures time to occurrence of some event. The event may be death, appearance of some disease, relapse from remission,

equipment breakdown etc. The development of models and methods to deal with lifetimes took place in the second half of the twentieth century. The development proceeded into two main inter mingling streams; through reliability theory and survival analysis. The reliability theory concerns with models for lifetimes of components and systems in the engineering and industrial fields and the survival analysis concerns with medical and similar biological phenomena. Lifetime distribution methodology is widely used in the biomedical and engineering sciences.

Lifetime or time to event is usually considered as a positive real valued random variable having a continuous distribution function. The definition of lifetime includes a time scale and time origin, as well as specification of the event that determines lifetime. In some instances, time may represent age, with the time origin as the birth of the individual. In other instances, the natural time origin may be occurrence of some event such as entry into a study or diagnosis of a particular disease. In some situations, it is difficult to say precisely when the event occurs, for example, the case of appearance of tumour. The time scale is not always real or chronological time, especially where machines or equipments are considered. It could be the number of operations a component performs before it breaks down. Applications of lifetime distribution methodology range from investigations of the durability of manufactured items to studies of human diseases and their treatment.

In present paper, we study two generalizations of the exponential distribution and its applications in lifetime data analysis. Section 2 describes survival function, hazard rate function and cumulative hazard rate functions of exponential distribution. Generalizations of the exponential

distribution were studied in section 3. Section 4 is devoted to the applications of parametric extensions of the exponential distribution to lifetime datasets. Finally, some concluding remarks were given in section 5.

## 2. Exponential Distribution

The exponential distribution is a continuous probability distribution. The exponential distribution was the first lifetime model for which statistical methods were extensively developed. The probability density function of the exponential distribution is,

$$f(x;\lambda)=\begin{cases}\lambda e^{-\lambda x} & x \geq 0,\\ 0 & x<0.\end{cases} \qquad (2.1)$$

Here $\lambda > 0$ is the parameter of the distribution, often called the *rate parameter*. The distribution is supported on the interval $[0, \infty)$.

The distribution function is given by:

$$F(x;\lambda)=\begin{cases}1-e^{-\lambda x} & x \geq 0,\\ 0 & x<0.\end{cases} \qquad (2.2)$$

The quantile function (inverse cumulative distribution function) for exp $(\lambda)$ is:

$$F^{-1}(p;\lambda)=\frac{-\ln(1-p)}{\lambda}, \quad 0 \leq p < 1. \qquad (2.3)$$

The survival function s(t) for the exponential distribution is:

$$s(x;\lambda)=e^{-\lambda x}, \; x>0, \; \lambda>0. \qquad (2.4)$$

The $h$ (or hazard rate) is given by:

$$h(x; \lambda) = \lambda, \quad \lambda > 0. \tag{2.5}$$

The exponential distribution has constant hazard rates, form a baseline for evaluating other families. Because they have only one parameter, they are quite simple to describe and are exceptionally amenable to statistical analysis. One of the drawbacks of exponential distribution is that it is not suitable for modeling datasets with increasing and decreasing hazard rate. The parametric generalizations of exponential distribution can be a suitable model.

## 3. Generalizations of Exponential Distributions

In this section we study the exponential distribution with a resilience parameter and a tilted parameter (Marshall and Olkin (2007)). A useful characteristic of the new distribution is that its failure rate function can have different shapes. We first study certain basic distributional properties of these distributions and provide closed form expressions for hazard functions.

### 3.1 Exponential Distribution with a Resilience Parameter

The two parameter family obtained from the exponential distribution by introducing a resilience parameter was discussed by Verhulst (1838, 1845). A discussion of this and some related distributions has been given by Ahuja and Nash (1967). The hazard rates and the survival functions have explicit expressions, so that these distributions can provide use-

ful models for cases where data are missing.

The exponential distribution with resilience parameter has the distribution function

$$F(x) = (1-e^{-\lambda x})^{\eta}, \eta, \lambda, x > 0 \qquad (3.1)$$

The probability density function is given by

$$f(x) = \lambda\eta e^{-\lambda x}(1-e^{-\lambda x})^{\eta-1} \qquad (3.2)$$

The plot of densities of the exponential distribution with resilience parameter taking values greater than one and less than one are respectively given below in figure (3.1) and (3.2).

**Plot of exponential distribution with resilience parameter**

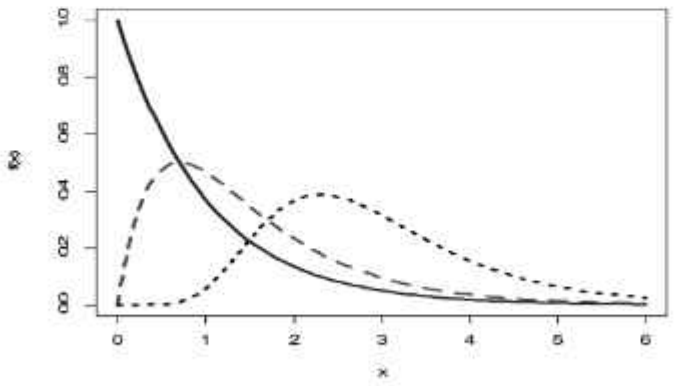



*Figure 3.1: Densities of the exponential distribution with resilience parameter ($\lambda = 1$) and $\eta=1$ (line), $\eta=2$ (dash line) and $\eta=10$ (dot line)*

**Plot of exponential distribution with resilience parameter**

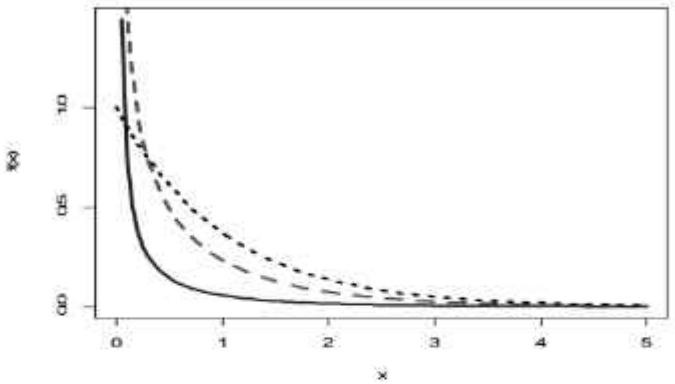



***Figure 3.2:*** *Densities of the exponential distribution with resilience paremeter ($\lambda = 1$) and $\eta$=0.1 (line), $\eta$=0.5 (dash line) and $\eta$=1 (dot line)*

From figure 3.1 and 3.2 we can see that the density exponential distribution with resilience parameter is log concave for $\eta \geq 1$ and log convex for $\eta \leq 1$. The density $f$ is decreasing when $\eta \geq 1$ and is unimodal when $\eta > 1$. If $\eta > 1$, the mode $x_m = [\log \eta] / \lambda$.

The hazard rate is given by,

$$h(x) = \frac{\lambda\eta e^{-\lambda x}(1-e^{-\lambda x})^{\eta-1}}{1-(1-e^{-\lambda x})^{\eta}}, \; x>0. \qquad (3.3)$$

The plot of Hazard rates of Exponential Distribution with a Resilience parameter given below in figure (3.3) and (3.4)

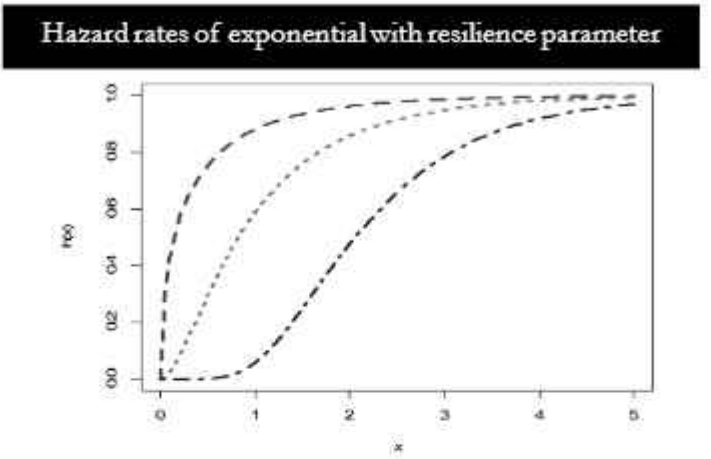



*Figure 3.3: Hazard rates of the exponential distribution with resilience parameter ($\lambda = 1$) and $\eta$=1.5 (dash line), $\eta$=3 (dot line) and $\eta$=10 (dash dot line)*

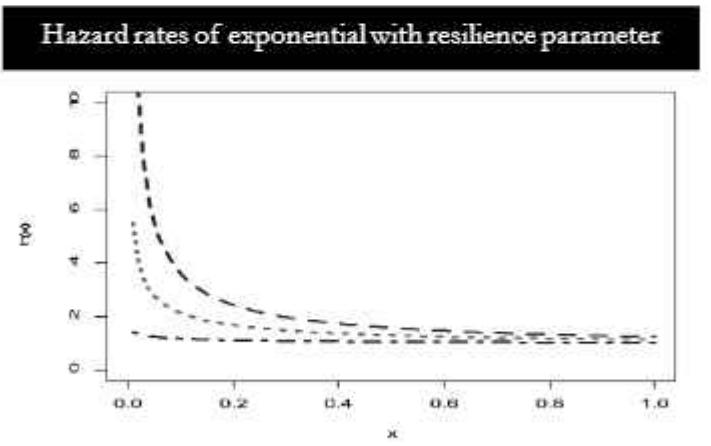



*Figure 3.4: Hazard rates of the exponential distribution with resilience parameter ($\lambda = 1$) and $\eta$=0.1 (dash line), $\eta$=0.5 (dot line) and $\eta$=0.9 (dash dot line)*

From the figure 3.3 and 3.4 we can see that the hazard rate $\gamma$ is increasing for $\eta \geq 1$, and decreasing for $\eta \leq 1$.

## 3.3 Exponential distribution with a Tilt parameter

The survival function exponential distribution with a tilt parameter has been investigated by Marshall and Olkin (1997) and is given by,

$$\bar{F}(x;\lambda,\gamma) = \frac{\gamma}{e^{\lambda x} - \bar{\gamma}} \quad , x \geq 0, \lambda > 0, \gamma > 0, \bar{\gamma} = 1 - \gamma \qquad (3.4)$$

For $\gamma = 1$. it reduces to the exponential distribution.

The probably density function of exponential distribution with a tilt parameter is given by

$$x:\lambda,\gamma) = \frac{\gamma\lambda e^{-\lambda x}}{(1-\bar{\gamma}e^{-\lambda x})^2} \qquad (3.5)$$

$$= \frac{\gamma\lambda e^{\lambda x}}{(e^{\lambda x} - \bar{\gamma})^2}, x \geq 0, \lambda > 0, \gamma > 0$$

The function $\log f(\gamma, \lambda)$ is convex, for $0 < \gamma \leq 1$, and concave, for $\gamma \geq 1$.

This result can be verified by differentiating $\log f(x \mid \lambda,\gamma)$ with respect to $x$. This means that for $\gamma \geq 1$, $f(\cdot \mid \lambda,\gamma)$ is decreasing, and for $\gamma \geq 1$, $f(\cdot \mid \lambda,\gamma)$ is unimodal. By solving $d \log f(\cdot \mid \lambda,\gamma)/dx = 0$, it is readily verified that a random variable $X$ with density $f(\cdot \mid \lambda,\gamma)$ has the mode, mode(X) $\gamma \geq 2$; mode(X) $= \lambda^{-1} \log(\gamma^{-1})$, $\gamma \geq 2$.

$$h(x:\lambda,\gamma) = \frac{\lambda}{1-\gamma e^{-\lambda x}}$$

$$= \frac{\lambda e^{\lambda x}}{e^{\lambda x} - \bar{\gamma}} \quad , x \geq 0, \lambda > 0, \gamma > 0 \qquad = (3.6)$$

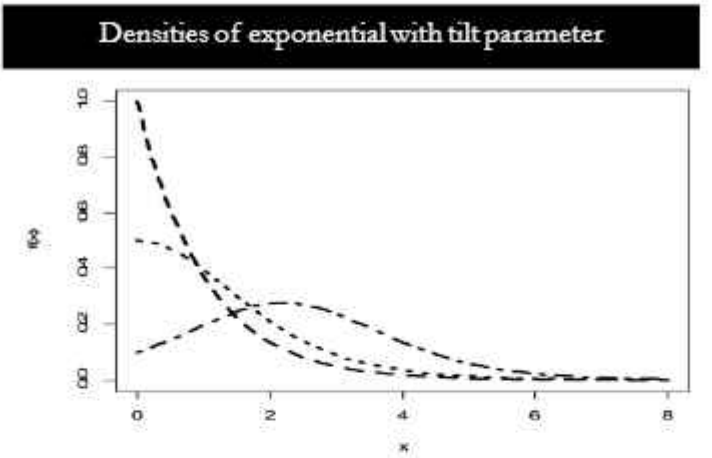



*Figure 3.5: Densities of the exponential distribution with tilt parameter ($\lambda = 1$) and $\gamma$=2 (dot line) and $\gamma$=10 (dot line).*

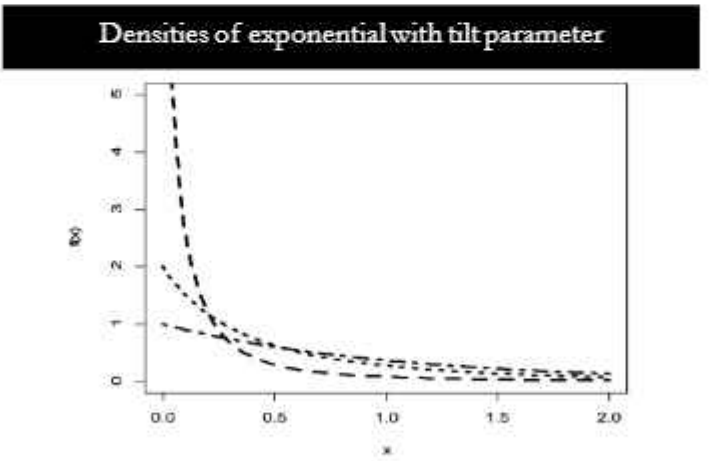



*Figure 3.6: Densities of the exponential distribution with tilt parameter ($\lambda = 1$) and $\gamma$=0.1 (dash line) $\gamma$=0.5 (dot line) and $\gamma$=1 (dash dot line)*

The plot of hazard rates of exponential distribution with tilt parameter given below in Figure (3.7) and (3.8)

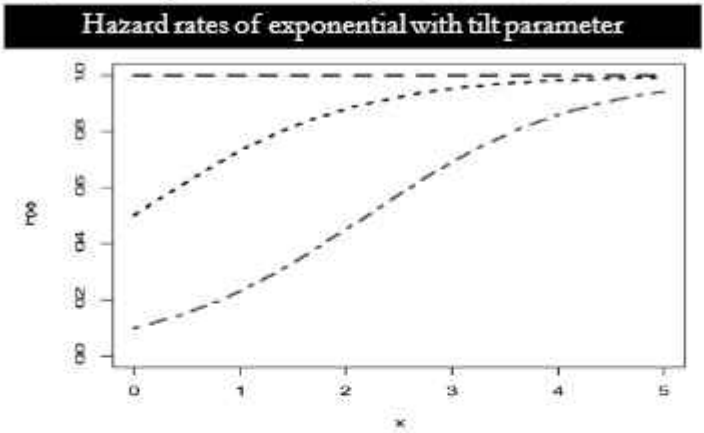



*Figure 3.7: Hazard rates of the exponential distribution with tilt paremeter ($\lambda = 1$) and $\gamma$=1 (dash line) $\gamma$=2 (dot line) and $\gamma$=10 (dash dot line)*

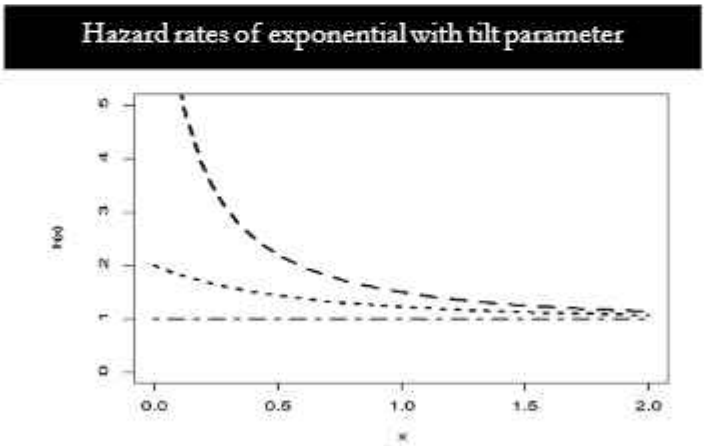



*Figure 3.8: Hazard rates of the exponential distribution with tilt paremeter ($\lambda = 1$) and $\gamma$=0.1 (dash line) $\gamma$=0.5 (dot line) and $\gamma$=1 (dash dot line)*

We can see that $h(x \mid \lambda, 1) = \lambda h(x \mid \lambda, \gamma)$ is decreasing in x for $0 < \gamma \leq 1$, and $h(x \mid \lambda, \gamma)$ is increasing in x for $\gamma \geq 1$.

## 4. Applications

In this section we discuss the applications of resilient and tilted exponential distribution in Lifetime data analysis. We analyzed the Lifetime data using exponential, Weibull, exponential with resilience parameter, exponential with tilt parameter and Lognormal distributions. Estimation of parameters are carried out using Maximum likelihood method of estimation and Kolmogorov-Smirnov goodness of fit test, using the R Package.

### 4.1 Analysis of successive failures of air-conditioning equipment

Proschan (1963) gave data on the time, in hours of operation, between successive failures of air-conditioning equipment in 13 aircraft, taken from Jerald F. Lawless (2003) by John Wiley & Sons. The data for plane number 3 are as follows:

90, 10, 60, 186, 61, 49, 14, 24, 56, 20, 79, 84, 44, 59, 29, 118, 25, 156, 310, 76, 26,

44, 23, 62, 130, 208, 70, 101, 208.

Here we fitted exponential, Weibull, exponential distribution with resilience parameter, exponential distribution with tilt parameter and lognormal distribution for the data and is given in figure 4.1. Maximum likelihood estimators of the parameters for the conditioning equipment time data is given below in Table 4.1 and their KS test is given below in Table 4.2.

## Fitting of successive failures of air-conditioning equipment

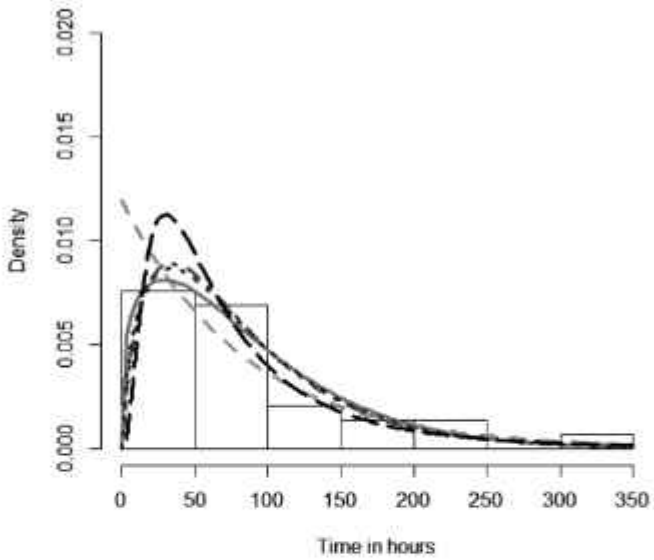



***Figure 4.1:*** *Fitted Exponential (cyan dash), exponential distribution with resilience parameter (green line), exponential distribution with tilt parameter (blue dot),Weibull (red dash dot), and lognormal (black big dash) distribution for failures of air-conditioning equipment time data.*

Table(4.1) : Air-conditioning equipment time data analysis-- maximum likelihood estimates for exponential, exponential distribution with resilience parameter, exponential distribution with tilt parameter , Weibull and lognormal distribution.

| Parameter | exponential | exponential with resilience parameter | exponential with tilt parameter | Weibull | Lognormal |
|---|---|---|---|---|---|
| $\mu$ | --- | --- | --- | --- | 4.097 |
| $\sigma$ | --- | --- | --- | --- | 0.836 |
| $\lambda$ | 0.01197 | 0.644 | 0.021 | --- | --- |
| $\gamma$ | --- | --- | 0.523 | 1.292 | --- |
| $\alpha$ | --- | 0.0197 | 1.799 | 90.655 | --- |
| $\eta$ | --- | 2.237 | --- | --- | --- |

**Table 4.2: K-S Test**

| Distribution | K-S distance (D) | p-value |
|---|---|---|
| exponential | 0.1439 | 0.5851 |
| Weibull | 0.0945 | 0.9582 |
| exponential with resilience parameter | 0.0865 | 0.9761 |
| exponential with tilt parameter | 0.0918 | 0.9602 |
| Lognormal | 0.0961 | 0.9511 |

From table 4.2 we can see that the p-value for the Kolmogorov-Smirnov test for exponential with resilience parameter (0.9761) is greater than that of exponential, exponential with tilt parameter, Weibull and lognormal distribution. Hence from Kolmogorov-Smirnov test and figure 4.1, exponential with resilience parameter is a good fit for the air-conditioning equipment time data.

## 5. Conclusion

In this paper we studied two generalizations of exponential distribution, exponential distribution with resilience and tilt parameter. The hazard rate takes variety of forms; in particular for exponential distribution with resilience parameter the hazard rate $r$ is increasing for $\eta \geq 1$, and decreasing for $\eta \leq 1$. In exponential distribution with tilt parameter hazard rate was decreasing if $0 < \gamma \leq 1$, and is increasing in $x$ for $\gamma \geq 1$. Hence the hazard rates and the survival functions of the generalizations of exponential distribution have explicit expressions, so that these distributions could provide useful models for most of the lifetime data.

In section 4.2 we discussed the analysis of the Lifetime datasets of successive failure times of air-conditioning equipment in 13 aircraft, taken from Proschan (1963) in Jerald F. Lawless (2003). We fitted Exponential distribution, Weibull, exponential with resilience parameter, exponential with tilt parameter and Lognormal distributions for the data set. Maximum likelihood estimation of parameters were carried out using the R Package. For identifying the best model for the data we used Kolmogorov-Smirnov test. For this data set the exponential with resilience parameter has greatest p-value than that of Exponential, Weibull distribution,

exponential with tilt parameter and Lognormal. Hence the exponential distribution with resilience parameter is good fit for the dataset.

**References**


1. Ahuja, J.C. and Stanley W. Nash (1967). The generalized Gompertz-Verhulst family of distributions. *Sankhya* **29**, 141–156.
2. Jerald F. Lawless (2003). *Statistical Models and Methods for Lifetime Data*, Wiley –Interscience, John Wiley & Sons, Inc., Publication.
3. Marshall, Albert W. and Ingram Olkin (2007). *Life distributions*. Springer series in Statistics, Springer Science, Business Media, LLC.
4. Marshall, Albert W. and Ingram Olkin (1997). A new method of adding a parameter to a family of distributions with applications to the exponential and Weibull families. *Biometrika* **84**, 641–652.
5. Proschan, F. (1963). Theoretical explanation of observed decreasing failure rate. *Technomet-Has*, 5,375-383.
6. *Verhulst, P.F. (1838). Notice sur la loi que la population suit dans accroissement. Correspondance math´ematique et physique, publi´ee par L.A.J. Quetelet,* ***10****, 113–121.*
7. Verhulst, P.F. (1845). Recherches math´ematiques sur la loi d'accroissement de la population. *Nouvelles M´emoires de l'Acad´emie Royale des Sciences et Beaux-Arts de Belgique, Series* 2, **20**, 32 pp.

# ഫ്രോൺമേയറുടെ പ്രകൃതിശാസ്ത്രം! ഭാഷയിലെ ആദ്യ ഭൗതികശാസ്ത്ര ഗ്രന്ഥം

■ Sreejith. E

ഭാഷയിലെ ആദ്യത്തെ ഗ്രന്ഥം എന്ന് പ്രൊഫ. ഇളംകുളം വിശേഷിപ്പിക്കുന്നത് തിരുവല്ല ചെപ്പേടിനെയാണ്. എന്നാൽ മലയാളഭാഷയിൽ എഴുതപ്പെട്ട ആദ്യ ഭൗതിക ശാസ്ത്ര പുസ്തകം ഏതെന്ന ചോദ്യത്തിനുത്തരം പ്രകൃതിശാസ്ത്രം എന്ന കൃതിയാണ്. എഴുതിയതാവട്ടെ ജർമൻകാരനായ റവ. എൽ. ജോഹന്നാസ് ഫ്രോൺമേയർ. ബാസൽ ഇവാഞ്ചലിക്കൽ മിഷൻ പ്രതിനിധിയായി 1881 മുതൽ 1905 വരെയുള്ള കാലയളവിലാണ് അദ്ദേഹം ഇന്ത്യയിൽ ഉണ്ടായിരുന്നത്. കോഴിക്കോട് ബാസൽ ജർമൻ ഇവാഞ്ചലിക്കൽ മിഷൻ ഹൈസ്കൂൾ മേധാവിയായിരിക്കെ 1883ലാണ് പ്രകൃതിശാസ്ത്രം രചിക്കുന്നത്. ശാസ്ത്രസാഹിത്യം മലയാളത്തിൽ എന്ന വിശ്രുതമായ ഗ്രന്ഥത്തിന്റെ കർത്താവായ സി.പി. ശ്രീധരൻ ഈ കൃതി പുറത്തുവരുന്നത് 1886ൽ ആണെന്നാണ് രേഖപ്പെടുത്തിയിട്ടുള്ളത്. അന്നത്തെ തിരുവിതാംകൂർ രാജാവായിരുന്ന വിശാഖം തിരുനാൾ രാജാവിന് സമർപ്പിച്ചിട്ടുള്ള പ്രസ്തുത കൃതിയുടെ ഇംഗ്ലീഷിലുള്ള ആമുഖഭാഗം അദ്ദേഹം വിവർത്തനം ചെയ്തു പ്രസിദ്ധീകരിച്ചിട്ടുള്ളതുകൊണ്ട് പുസ്തകം അദ്ദേഹം നേരിട്ട് കണ്ടിട്ടുണ്ടെന്നത് തീർച്ചയാണ്. എന്നാൽ ഈ ലേഖകന്റെ കൈവശമുള്ള പ്രതി 1883 ഫിബ്രവരിലേതായതിനാൽ രണ്ടാം പതിപ്പായിരിക്കണം സി.പി. കണ്ടതെന്ന് കരുതാം. ഒരുപക്ഷേ, അച്ചടിത്തെറ്റോ നോട്ടപ്പിശകോ ആകാനും ഇടയുണ്ട്. പ്രാചീന

ഗണിതം മലയാളത്തിൽ എന്ന ഒന്നാന്തരം ഗവേഷണ ഗ്രന്ഥത്തിന്റെ കർത്താവുകൂടിയായ പ്രൊഫ. സി.കെ. മുസ്സതാണ് ഈ ഗ്രന്ഥത്തെക്കുറിച്ച് ആദ്യമായി രേഖപ്പെടുത്തിയത് എന്നും അദ്ദേഹം പറയുന്നു. സംസ്കൃത സർവകലാശാല മലയാളം അധ്യാപകൻ ഡോ. പി. പവിത്രൻ നല്കിയ കോപ്പിയാണ് ഈ ലേഖകന്റെ കൈവശമുള്ളത്.

ചോദ്യോത്തര രീതിയിൽ സംവിധാനം ചെയ്യപ്പെട്ടിട്ടുള്ള ഈ കൃതിയിൽ 14 അധ്യായങ്ങളിലായി 447 ചോദ്യങ്ങളും 144 ചിത്രീകരണങ്ങളും ഉണ്ട്. ആകെ ടെക്സ്റ്റ് ഭാഗം 292 പേജ് വരെ. എന്നാൽ അനുബന്ധവും Repertory എന്ന വിഭാഗവുമടക്കം 392 പേജുകൾ. ഗുണ്ടർട്ട് രചിച്ച്, ഗാർത്ത് വൈറ്റ് പരിഷ്കരിച്ച മലയാള വ്യാകരണം ചോദ്യോത്തരങ്ങൾ എന്ന കൃതിയുടെ മാതൃകതന്നെയാണിവിടെയും പിന്തുടരുന്നത്. ഗുണ്ടർട്ടിന്റെ വിനീതനായ ശിഷ്യനാണെന്ന് പറയാൻ എനിക്കൊരു മടിയുമില്ലെന്ന് ഫ്രോൺമേയർ തുറന്നു സമ്മതിക്കുന്നുണ്ട്. മംഗലാപുരം ബാസൽ മിഷൻ ബുക് ആൻഡ് ട്രാക്ട് ഡെപ്പോസിറ്ററിക്കുവേണ്ടി മിഷൻ പ്രസ്സിലടിച്ച എല്ലാ പുസ്തകങ്ങളും അച്ചടി മികവുകൊണ്ടും ചിത്രീകരണങ്ങളുടെ തെളിമകൊണ്ടും ആധുനിക സംവിധാനങ്ങളോട് കിടപിടിക്കുന്നതു തന്നെയാണെന്ന് ഉറപ്പിച്ചു പറയാം.

## സമർഷണക്കത്ത്

നമ്മുടെ ഭാഷാ പ്രശ്നത്തിന്റെയും ശാസ്ത്ര സാഹിത്യത്തിന്റെയും മാഗ്നാകാർട്ടയായ ഒരു വിജ്ഞേയനിബന്ധമാണ് ഈ ഗ്രന്ഥത്തിന്റെ സമർപ്പണക്കത്ത് എന്ന് സി.പി. അഭിപ്രായപ്പെടുന്നുണ്ട്. ഇത് സമർപ്പിച്ചിരിക്കുന്നത് ബാസൽ മിഷന്റെ പ്രവർത്തന പരിധിക്കപ്പുറമുള്ള ഒരു നാട്ടിലെ രാജാവിനാണെന്നത് പ്രത്യേകമായി പരിഗണിക്കേണ്ടതുണ്ട്. ഇന്ത്യയുടെ ഇതര പ്രദേശങ്ങളിൽ ശാസ്ത്രത്തിന്റെയും വിജ്ഞാനത്തിന്റെയും പുരോഗതിയുമായി ദൃഢബന്ധമുള്ള പേരാണ് തിരുമേനിയുടേത് എന്ന് വിശാഖംതിരുനാളിനെ അഭിസംബോധന ചെയ്ത്

ഫ്രോൺ മേയർ പറയുന്നു. പാഠപുസ്തക സമിതിയുടെ പുനഃസ്ഥാപനവും ഇന്ത്യൻ ആന്റിക്വറിയിലെ ലേഖനങ്ങളും ലോക സാഹിത്യത്തിലുള്ള ആഴത്തിലുള്ള പാണ്ഡിത്യവും അതിലേറെ മനുഷ്യത്വപരവുമായ വിശാഖം തിരുനാളിന്റെ പ്രവർത്തനങ്ങളാണ് ഈ സംബോധനയിലൂടെ അനാവരണം ചെയ്യപ്പെടുന്നത്. ബ്രിട്ടീഷ് മലബാറിൽ പ്രവർത്തിക്കുന്ന ഒരു വിദേശിക്ക് വിശാഖം തിരുനാളിന്റെ പട്ടുംവളയും ആവശ്യമില്ലെന്ന് ഏതു കൊച്ചുകുട്ടിക്കുപോലും അറിയാം. എന്നിട്ടും മലയാളത്തിൽ ഫിസിക്സിനെക്കുറിച്ച് ഒരു ഗ്രന്ഥമെഴുതുമ്പോൾ തിരുമേനിയുടെ അനുഗ്രഹവും ആശീർവാദവും ഉണ്ടാവണമെന്ന് ഫ്രോൺ മേയർ ആഗ്രഹിക്കുന്നു.

ഈ കത്ത് എങ്ങനെയാണ് ഭാഷയുടെ മാഗ്നാകാർട്ടയാകുന്നത് എന്ന് പരിശോധിക്കേണ്ടതുണ്ട്. ഏതൊരു വ്യക്തിക്കും അമ്മിഞ്ഞപ്പാലിലൂടെ പകർന്നുകിട്ടുന്ന ഭാഷ ക്ലാസിക്കായിരിക്കെ ഏതെങ്കിലുമൊന്നിനെ ക്ലാസിക് എന്നും മറ്റുള്ളവ മോശം എന്ന നിലയിലും പരിഗണിക്കുന്നത് ജനാധിപത്യ സമൂഹത്തിന് ഭൂഷണമല്ല. നമുക്ക് എങ്ങനെയോ ക്ലാസിക്കൽ ഭാഷാ പദവി കിട്ടി. എന്നിട്ടെന്തുണ്ടായി? ഇന്നും കോടതിഭാഷ മലയാളമായിട്ടില്ല. ബിരുദാനന്തരബിരുദതലത്തിൽ പരീക്ഷയെഴുതുവാനോ ഗവേഷണ പ്രബന്ധങ്ങൾ സമർപ്പിക്കാനോ മലയാളം യോഗ്യത നേടിയിട്ടില്ല. ഭരണഭാഷയും ഏതാണ്ടിങ്ങനെത്തന്നെ. ബാലവാടിമുതൽ അങ്ങേയറ്റംവരെ മാതൃഭാഷ തൊടാതെ കഴിക്കാൻ അനുവദിക്കുന്ന ഒരു സമൂഹത്തിന് ഫ്രോൺ മേയറെന്ന ജർമൻകാരനിൽനിന്ന്, പ്രോഗ്രസീവ് ഗ്രാമർ ഓഫ് മലയാളം ഫോർ യൂറോപ്യൻസ് എന്ന കൃതിയുടെ കർത്താവിൽനിന്ന്, ഏറെ പഠിക്കാനുണ്ടെന്ന് ബോധ്യമാക്കുന്നു ഈ സമർപ്പണക്കുറിപ്പ്. ലാഹോർ യൂണിവേഴ്സിറ്റിയിൽ ലാഹോർ ബിഷപ്പ് നടത്തിയ ഒരു പ്രസംഗത്തെ ഉദ്ധരിച്ചുകൊണ്ടാണ് ഫ്രോൺ മേയർ ആരംഭിക്കുന്നത്. വിജ്ഞാനത്തിന്റെ വിശാലതയും നിർമലവുമായ പ്രവാഹം ഈ മഹത്തായ രാജ്യത്തിലെ എണ്ണമറ്റ വീടുകളും ജനഹൃദയങ്ങളിലും എത്തിച്ചേരാൻ നാട്ടുഭാഷകളായ നൂറ് നൂറ് കൈത്തോടുകളിലൂടെ അവ തിരിച്ചുവിടണമെന്നും

ബിഷപ്പ് ആവശ്യപ്പെട്ടിരുന്നു. ഉത്കർഷകമായ കണ്ടുപിടുത്തങ്ങളെയും യുഗങ്ങളായി നേടിയ ഏറ്റവും പൂർണമായ മാനസിക വളർച്ചയുടെ നേട്ടങ്ങളെയും ഇംഗ്ലീഷ് പരിചയമില്ലാത്തവർക്ക് നിഷേധിക്കണമെന്ന് ഒരു ദേശാഭിമാനിയും പൊതുകാര്യ പ്രസക്തനും പറയാതിരിക്കട്ടെ എന്ന് ബിഷപ്പ് പ്രത്യാശിക്കുന്നു.

ഫ്രോൺ മേയർ തുടർന്നെഴുതുന്നു: മലയാളഭാഷയിലും ഈ രാജ്യത്തിലെ വിദ്യാഭ്യാസകാര്യങ്ങളിലും താത്പര്യമുള്ള ആർക്കും ഈ രാജ്യത്തിൽ ഇവ കൈകാര്യം ചെയ്യുന്ന ഔദ്യോഗിക നിലപാടിൽ സംതൃപ്തരായിരിക്കാൻ സാധ്യമല്ല. (133 വർഷങ്ങൾക്കിപ്പുറവും വഞ്ചി തിരുനക്കര തന്നെ). വിദ്യാഭ്യാസവും ശാസ്ത്രജ്ഞാനവും അല്പം പരിശീലനം ലഭിച്ചവർക്കു മാത്രം മനസ്സിലാകുന്ന ഭാഷയിൽ വിനിമയം ചെയ്താൽ ഭാഷയുടെ ചൈതന്യവും നിലവാരവും അപകടത്തിലാകുമെന്ന് അദ്ദേഹം മുൻകൂട്ടി കണ്ടിരുന്നു. ഇനിപ്പറയുന്ന ഭാഗം അതേപടി പകർത്തുന്നു:

## മലബാറിലെ ഇംഗ്ലീഷ് ഭ്രമം

നമ്മുടെ മലബാറിലെ വിദ്യാഭ്യാസത്തിൽ അനർഹമായ പ്രാധാന്യം ഇംഗ്ലീഷിന് നല്കിക്കൊണ്ടുള്ള ആപത്കരമായ ഭവിഷ്യത്തിതാണ്. ഇംഗ്ലീഷ് വിദ്യാഭ്യാസം നേടിയവർക്കുപോലും അവരുടെ വിജ്ഞാനം ഭദ്രമായ അടിത്തറയിലുറക്കുകയില്ല. ഒരാളുടെ സ്വന്തം ഭാഷ ഒരു യാദൃച്ഛിക വസ്തുവല്ല. ഒരു രാഷ്ട്രത്തിന്റെ സ്വഭാവനിർണയത്തിനുതകുന്ന ശരീര ലക്ഷണശാസ്ത്രമാണ് ഭാഷ. ഒരു രാജ്യത്തിന്റെ സവിശേഷതകളുടെ മുഴുവൻ പ്രകാശശക്തിയാണത്. ഭാഷകളെ വസ്ത്രംപോലെ മാറാൻ വയ്യ. അങ്ങനെ ചെയ്താൽ ഒരു രാഷ്ട്രത്തിന്റെ മൗലികതയും അന്തസ്സും നഷ്ടപ്പെടും. മൗലികസത്തയെ രൂപപ്പെടുത്തിയ നാട്ടുഭാഷയെയാണ് (അതാത്മാവാണ്) ആദ്യമായി വികസിപ്പിക്കേണ്ടത്.

ബിരുദാനന്തരതലത്തിലും മറ്റും ഇംഗ്ലീഷ് നിർബന്ധിക്കുന്നവർ ശ്രദ്ധിക്കേണ്ട ഒരു പ്രസക്തമായ ഒരു ചോദ്യം അദ്ദേഹം

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ഉന്നയിക്കുന്നുണ്ട്: ഇംഗ്ലീഷ് ശരിക്കും വശമാക്കിയിട്ടില്ലാത്ത ഒരു കാലഘട്ടത്തിൽ തികച്ചും പുതുതായ ഒരു വിഷയത്തിന്റെ അടിത്തറ നാട്ടുഭാഷയിൽ മനസ്സിലുറപ്പിക്കേണ്ടതല്ലേ? അല്ലാത്തപക്ഷം പഠിപ്പിക്കുന്ന വിഷയം ദഹിച്ചുചേരുകയും ഒരു മാനസിക സിദ്ധിയായി രൂപാന്തരപ്പെടുകയും ചെയ്യുമെന്നതിനെന്താണുറപ്പ്? വാക്കുകൾ മാത്രമല്ല, ചിന്തകളും ആശയങ്ങളും കൂടി നാട്ടുഭാഷയിൽ വിവർത്തനം ചെയ്യുകയും രൂപപ്പെടുത്തുകയും വേണം. വിജ്ഞാനം ഒരാത്മീയ സമ്പാദ്യമായി തീർന്നതിനുശേഷം മാത്രമേ അത് രാഷ്ട്രത്തിന്റെ യഥാർഥ ആന്തരികനേട്ടമായി മാറുകയുള്ളൂ. അതിനുശേഷം മാത്രമേ, ഈ രാജ്യത്തിലെ അഭ്യസ്തവിദ്യരായ ആളുകളിൽനിന്ന് സ്വാശ്രയപ്രേരിതമായ സഹകരണം ശാസ്ത്രീയ ഗവേഷണങ്ങളിൽ ലഭിക്കുകയുള്ളൂ. ഇപ്പോൾ സംഗതികൾ കൈകാര്യം ചെയ്യുന്ന സമ്പ്രദായം ഭാഷക്ക് ആപത്താണെന്നും അദ്ദേഹം ഓർമിപ്പിക്കുന്നു. പുതിയ വിഷയങ്ങൾ ഭാഷയിലേക്ക് സംക്രമിപ്പിച്ചെല്ലെങ്കിൽ, മിക്ക ആത്മീയകാര്യങ്ങളും അന്യഭാഷയിൽ നിർവഹിക്കുകയാണെങ്കിൽ അന്തിമദശയിൽ ഭാഷ ദരിദ്രമായിത്തീരും എന്നതിൽ സംശയമില്ല. ശാസ്ത്രം കുറേക്കാലം നാട്ടുഭാഷയിൽ പഠിപ്പിക്കട്ടെ: എന്നിട്ടു നമുക്ക് ചോദിക്കാം മലയാളത്തിൽ പ്രകാശിപ്പിക്കാൻ കഴിയാത്തത്ര ദിവ്യമായി അതിൽ വല്ലതുമുണ്ടോ എന്ന്! ശാസ്ത്രവിഷയങ്ങൾ മലയാളത്തിലാക്കാൻ കഴിയില്ലെന്ന് വാദിക്കുന്ന പ്രൊഫസർമാരടക്കമുള്ളവർ തീർച്ചയായും വായിച്ചിരിക്കേ ഭാഗമാണിത്. ഗുണ്ടർട്ടിന്റെ നിഘണ്ടു ഉപയോഗിച്ച് പരിഭാഷ നിഷ്പ്രയാസം സാധ്യവുമാണെന്ന് ലേഖകൻ. ഔദ്യോഗിക മലയാളത്തിൽ ടെമ്പററി, റൂൾ, ലോ മുതലായ പദമാതൃകകൾ ഉപയോഗിക്കുന്നതിനേക്കാൾ ഞെട്ടിക്കുന്നതും പരിഹാസ്യമായി മറ്റൊന്നില്ല എന്നുകൂടി അദ്ദേഹം പറയുന്നു. സംസാരഭാഷയിലും മലയാളപത്രങ്ങളിലും ഈ അഭിരുചി കൂടുതൽ കൂടുതൽ വളർന്നുവരുന്നത് അനുകമ്പാർഹമാണ്.

## ജർമൻ ഭാഷയുടെ അഭിവൃദ്ധി

ജർമൻഭാഷ ഉത്തമമായ ഒന്നായി വികസിച്ചതിന്റെ ഉദാഹരണം അദ്ദേഹം നിരത്തുകയുണ്ടായി. ലൂഥർ ബൈബിൾ വിവർത്തനം ചെയ്യുന്നതുവരെ ജർമനിയിൽ ഭാഷ ഉണ്ടായിരുന്നില്ല. സാക്സൻ ചാൻസറിയുടെ സംസാരഭാഷയെ അദ്ദേഹം നൈസർഗികമായി ഗ്രഹണചടുതയോടെ വിവർത്തനത്തിന്റെ ഭാഷയാക്കി. മറ്റുള്ളവർ അതേഭാഷയിൽ എഴുതാൻ തുടങ്ങിയതോടെയാണത് സംഭവിക്കുന്നത്. ഹിറ്റ്ലറെയും നാസിസത്തെയുമൊക്കെ ഉല്പാദിപ്പിച്ച ഒരു രാജ്യമാണെങ്കിലും തത്ത്വചിന്തയിലും സാഹിത്യത്തിലും അടിസ്ഥാന ശാസ്ത്ര വിഷയങ്ങളിലും സാമൂഹിക ദർശനങ്ങളിലും – മാർക്സും ഐൻസ്റ്റീനും ഫ്രോയ്ഡും ഗോയ്ഥെയും – ആ ഭാഷയുടെ ഉത്പന്നങ്ങൾ മഹത്തരമായിരുന്നു. ഇംഗ്ലീഷിൽ ശാസ്ത്രപദങ്ങൾ വേണ്ടിവരുമ്പോൾ ലാറ്റിനെയോ, ഗ്രീക്കിനെയോ ആശ്രയിക്കുന്നതുപോലെ മലയാളം സംസ്കൃതത്തെ സ്വീകരിക്കുന്നതിൽ അസ്വാഭാവികതയൊന്നുമില്ല എന്നും ഫ്രോൺ മേയർ പറയുന്നു.

കൊളോണിയൽ വിദ്യാഭ്യാസത്തിന്റെ വ്യാപനത്തോടെ മലയാളത്തിനു വന്നുചേർന്ന അപചയത്തിൽ ഖിന്നനായി ഇത്രയുമൊക്കെ എഴുതുമ്പോൾ കേവലം 7 വർഷത്തെ പരിചയമേ ഈ ഭാഷയുമായി അദ്ദേഹത്തിനുണ്ടായിരുന്നുള്ളൂ. അയൽപക്കത്തൊരു ഗ്രാമവിദ്യാലയമായിരുന്നു. മലയാളത്തോടുള്ള അവമതിയിൽ മൂന്നോ നാലോ വയസ്സുള്ള കുട്ടികളെയും പിടിച്ച് സ്കൂൾ ബസ് കാത്തുനില്ക്കുന്ന രക്ഷിതാക്കൾ ഒരു തവണയെങ്കിലും ഫ്രോൺമേയറെ വായിച്ചിരുന്നെങ്കിൽ! ഭാഷയും ചിന്തയും തമ്മിലുള്ള അനിഷേധ്യമായ ബന്ധത്തെ വിസ്മരിച്ചതുകൊണ്ടാണ് കേരളത്തിൽ സമീപകാലതലമുറയിൽ ഏതെങ്കിലുമൊരു മേഖലയിൽ മൗലിക ചിന്തകളുണ്ടാകാത്തത്. മാതൃഭാഷയിൽ അവഗാഹമുണ്ടാക്കിയതിനുശേഷം ഇംഗ്ലീഷിനെ മെരുക്കിയെടുത്തവരായിരുന്നു പഴയ തലമുറ. 19-ാം നൂറ്റാണ്ടിന്റെ അന്ത്യ പകുതിമുതൽ ഏതാണ്ട് 1970കളുടെ അവസാനംവരെ അതായിരുന്നു സ്ഥിതി. ചൂണ്ടിക്കാണിക്കാൻ എത്രയോ

SREEJITH. E

സ്തംഭങ്ങളുണ്ട്. ജോർജ് മാത്തനും, വലിയകോയിത്തമ്പുരാനും, ആശാനും, ഉള്ളൂരും, സർ സി. ശങ്കരൻ നായരും, സർദാർ പണിക്കരും ഇ.സി.ജി. സുദർശനും അങ്ങനെ എത്രയോ പേർ.

സമർപ്പണക്കുറിപ്പിനുശേഷം വായനക്കാർക്കുവേണ്ടി മലയാളത്തിൽത്തന്നെ എഴുതിയിട്ടുയുള്ള മലയാളത്തിലുള്ള മുഖവുരയാണ്. കേരള നിവാസികളായുപ്പോരെ, എല്ലാവർ മനുഷ്യർക്കും വായിച്ചറിയുവാൻ കഴിയുന്നതായ വലിയ പുസ്തകത്തിൽ (പ്രപഞ്ചം) അടങ്ങിയിരിക്കുന്ന അധ്യായനങ്ങളിൽ ഒന്നിനെ ഞാൻ നിങ്ങളുടെ ഉപയോഗാർഥം വിവരിക്കാൻ തുടങ്ങുന്നു എന്നാണ് തുടക്കം. എട്ടു ഖണ്ഡികകളിലായി ഈ പുസ്തകത്തിന്റെയും ഉള്ളടക്കത്തിന്റെയും സവിശേഷതകൾ അദ്ദേഹം വ്യക്തമാക്കുന്നു.

## അധ്യായങ്ങൾ

ആധുനിക ഫിസിക്സിലേക്ക് വായനക്കാരനെ കൂട്ടിക്കൊണ്ടുപോകാൻ അന്ന് നിലവിലുണ്ടായിരുന്ന എല്ലാ ബോധന സമ്പ്രദായങ്ങളെയും അദ്ദേഹം ആശ്രയിക്കുന്നുണ്ട്. ലളിതമായതിൽനിന്ന് സങ്കീർണതയിലേക്കാണ് പുസ്തകം പുരോഗമിക്കുന്നത്. ആദ്യ അധ്യായത്തിന് മുന്നോടിയായി പ്രകൃതിശാസ്ത്രം എന്ന സങ്കല്പത്തെ നിർവചിക്കുന്നു. പ്രകൃതി എന്നാൽ എന്ത് എന്ന ഒന്നാമത്തെ ചോദ്യത്തിനുത്തരം പഞ്ചേന്ദ്രിയങ്ങളെക്കൊണ്ട് ഗ്രഹിക്കുന്നതൊക്കെയും എന്നാണ്. പ്രകൃതി വർണന, പ്രകൃതിവിദ്യ എന്നിങ്ങനെ പ്രകൃതിശാസ്ത്രത്തെ രണ്ടായി തിരിക്കാം. ആദ്യത്തേതിൽ നാം ജന്തുക്കളെയും സസ്യങ്ങളുടെയും രൂപം, സ്വഭാവം, ഉപകാരം, ആപത്തുകൾ എന്നിവയെ വിവരിക്കുന്നു. പ്രകൃതിവിദ്യയിൽ എല്ലാ പദാർഥങ്ങളിലും ഉളവാകുന്ന മാറ്റങ്ങളെ നോക്കി ഇവയുടെ സംഗതികളെയും ഫലങ്ങളെയും തെളിയിക്കുകയും ചെയ്യും. ബാഹ്യമാറ്റങ്ങളെ വിചാരിച്ചിട്ടു ഈ വിദ്യക്ക് പ്രകൃതിശാസ്ത്രം (ഫിസിക്സ്) എന്നും ധാതുസംയോഗ വിയോഗങ്ങളെ ഉളവാക്കുന്ന അന്തർമാറ്റങ്ങളെക്കുറിച്ചുള്ള ശാസ്ത്രത്തിന് രസവാദശാസ്ത്രം

(കെമിസ്ട്രി) എന്നും പേർവിളിക്കാം.

പുസ്തകത്തിന്റെ ഭാഷാപരവും സത്താപരവുമായ സവിശേഷതകളെ ചൂണ്ടിക്കാണിക്കാനാണ് ഒരുദാഹരണം മുകളിൽ നല്കിയിട്ടുള്ളത്. മിഷണറി ഗദ്യത്തിന്റെ പോരായ്മകളായി ചൂണ്ടിക്കാണിക്കപ്പെട്ടിട്ടുള്ളതൊന്നും നമുക്കിവിടെ കാണാനാവില്ല. നല്ല മലയാളവും ചീത്തമലയാളവും തമ്മിൽ വേർതിരിക്കാൻ പറ്റാത്തവിധത്തിലുള്ള ഒരു സ്റ്റാൻഡേർഡ് മലയാളമാണിതിൽ ഉപയോഗിച്ചിട്ടുള്ളതെന്ന് ഗ്രന്ഥകർത്താവ് ആദ്യമേ വ്യക്തമാക്കുന്നുണ്ട്. പുസ്തകം കമ്പോടുകമ്പ് വായിച്ച് അഭിപ്രായങ്ങളും നിർദേശങ്ങളും നല്കിയ തിരുവിതാംകൂർ സ്വദേശിയും ബിരുദധാരിയും ഈ വിഷയത്തിൽ പരിജ്ഞാനവുമുള്ള ജി.ടി. വർഗീസ് എന്ന യുവ സിറിയൻ ക്രിസ്ത്യാനി സഹോദരനെ ഫ്രോൺ മേയർ നന്ദിപൂർവം സ്മരിക്കുന്നുണ്ട്. മലബാറിന് തെക്ക് ഭാഗത്ത് പ്രചാരത്തിലില്ലാത്ത മലയാള പദങ്ങളെയെല്ലാം ഒഴിവാക്കാൻ ഇതുവഴി സാധിച്ചു. മാത്രമല്ല അക്കാലത്തെ നാട്ടുകാരെഴുതിയ കൃതികളെക്കാൾ തെളിമയുള്ള മലയാളമാണദ്ദേഹത്തിന് കൈമുതലായിട്ടുണ്ടായിരുന്നത് എന്ന് പുസ്തകം വ്യക്തമാക്കുന്നു.

ഒന്നാമധ്യായത്തിന്റെ പേര് 'പദാർഥങ്ങളുടെ സാധാരണ സവിശേഷതകൾ' (The general properties of bodies) എന്നാണ് വിഷയം ഭൗതികശാസ്ത്രമാണെങ്കിലും അടിസ്ഥാനപരമായി മിഷണറി എന്ന നിലയിൽ ദൈവത്തിന്റെ മഹത്തിലൂന്നിയാണ് പാഠം ആരംഭിക്കുന്നത്. ഉദാഹരണമായി, ദൈവമേ നിന്റെ ക്രിയകൾ എത്ര പെരുകുന്നു! എല്ലാറ്റെയും നീ ജ്ഞാനത്തിൽ തീർത്തു. ഭൂമി നിന്റെ സമ്പത്തിനാൽ പൂർണം. ഇങ്ങനെ ഓരോ അധ്യായത്തിന്റെ തുടക്കത്തിലും ആത്മീയമോ, ഉപദേശപരമായോ ഉള്ള വാക്യങ്ങൾ കാണാം. ആദ്യ അധ്യായം ചോദ്യം 7 മുതൽ 108 വരെ, പതിനൊന്ന് ഭാഗങ്ങളായി ചർച്ചചെയ്യുന്നു. ഓരോ ഭാഗത്തെയും ചോദ്യങ്ങൾ ഒരു ഭൗതികവിഷയത്തെ ഊന്നിക്കൊണ്ടായിരിക്കും. ഉദാഹരണമായി ഒന്നാം ഭാഗം വിസ്തരണം (Extention), പതിനൊന്നാം ഭാഗം ഘനാകർഷണ കേന്ദ്രം (Centre of Gravity). സങ്കീർണവും വിശദീകരണങ്ങളാവ

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ശ്യമായതുമായ ആശയങ്ങൾ മനോഹരമായ ചിത്രീകരണങ്ങളാൽ വ്യക്തമാക്കിയിട്ടുണ്ട്. രണ്ടാമധ്യായം കട്ടിയായ വസ്തുതകളുടെ സമത്തുക്കവും അപാദാനവും ആണ്. 109 മുതൽ 129 വരെ ചോദ്യോത്തരങ്ങൾ. മൂന്നാമധ്യായം വീഴ്ചയും ഊഞ്ഞലും പരിക്രമണവും (Fall, Pendulum ad Central motion) 130 മുതൽ 144 വരെ. താഴേക്ക് വീഴുന്ന ഏതു വസ്തുവിന്റെയും വേഗത വർധിപ്പിക്കുന്നതെന്തുകൊണ്ട് എന്ന ആദ്യ ചോദ്യത്തിന് ഉത്തരം വളരെ വിശദമായി നല്കിയിരിക്കുന്നു. ഘടികാരം കൊണ്ടു നാം സമയമറിയുന്നതെങ്ങനെ എന്നതാണവസാന ചോദ്യം. ദ്രവ്യങ്ങളുടെ സമത്തുക്കവും അപാദാനവും (The equilibrium ad motion of fluids) ആണ് നാലാമധ്യായം. 145 മുതൽ 174 വരെ ചോദ്യോത്തരങ്ങൾ വിശദീകരണത്തിനായി ചിത്രീകരണമൊന്നുമില്ല. മീനുകൾക്ക് ഇഷ്ടംപോലെ വെള്ളത്തിൽ പൊന്തുവാനും താഴുവാനും കഴിയുന്നതെന്തുകൊണ്ട് എന്ന ചോദ്യമാണീ വിഭാഗത്തിൽ അവസാനത്തേത്.

ബാഷ്പങ്ങളുടെ സമത്തുക്കവും അപാദാനവും (Equilibrium and motion of Gases) ആണ് അഞ്ചാമധ്യായം 175 മുതൽ 186 വരെ. വായുവിന്റെ അമർത്തലും ഘനവും ആണ് തുടർ അധ്യായം. (Pressure ad Weight of the Air) 186 മുതൽ 222 വരെ. പക്ഷികൾക്കു പറക്കാൻ കഴിയുന്നതെന്തുകൊണ്ട് എന്നതിന്റെ വിശദീകരണമാണവസാനത്തേത്. വായുവിന്റെ ലക്ഷണവും പ്രയോഗവും (Chemical ad Physiological qualities of the air) ആണ് അടുത്തത്. 223 മുതൽ 241 വരെ. വിറക് ഒടുങ്ങിയാൽ തീ കെടും, നുണയൻ ഇല്ലാഞ്ഞാൽ വഴക്ക് ഒഴിയും, കനലിനു കരിയും തീക്കു വിറകും, വക്കാണം കൊളുത്തുവാൻ വഴക്കുകാരണം വേണം. നിന്റെ ശ്വാസത്തെ അയക്കേ അവ സൃഷ്ടിക്കപ്പെടും. ഇതാണധ്യായത്തുടക്കത്തിലെ ആപ്തവാക്യം. വിശദീകരണത്തിനും മറ്റുമായി ഗുണ്ടർട്ടിന്റെ പാഠമാല, കേരളോപകാരി മുതലായ കൃതികളെ ഉപജീവിച്ചതായി അടിക്കുറിപ്പുകളിൽനിന്ന് മനസ്സിലാക്കാം. എട്ടാമധ്യായം ശബ്ദം (Sound) ആണ്. 242 മുതൽ 257 വരെ. ചെവിടർ ശബ്ദം കേൾക്കാത്തതെന്തുകൊണ്ടെന്നും മനുഷ്യന്റെ തൊണ്ടയിൽ സ്വരമുളവാകുന്നതെ

ങ്ങനെയെന്നുമൊക്കെ വിശദീകരിക്കുന്നു. ഘർമം ആണ് അടുത്ത അധ്യായം. തീക്കൊള്ളിക്കുമേലെ മീറു കളിക്കുമ്പോലെ എന്ന പഴമൊഴി ഉദ്ധരിക്കുന്നു. ചൂടിനെ നിർവചിച്ചുകൊണ്ടാരംഭിക്കുന്നു. 258 മുതൽ 290 വരെ. പത്താമധ്യായത്തിൽ ചൂടിനാൽ ഉളവാകുന്ന മാറ്റങ്ങൾ (effect of heat) ചർച്ച ചെയ്യുന്നു. 201 മുതൽ 353 വരെ. വലിയ അധ്യായങ്ങളിലൊന്നാണിത്. ആവിയന്ത്രത്തിന്റെയും വണ്ടിയുടേയുമെല്ലാം പ്രവർത്തനം വിശദീകരിക്കുന്നു. പതിനൊന്നാമധ്യായത്തിൽ വെളിച്ചം (light) 354 മുതൽ 394 വരെ. നമ്മുടെ സ്വരൂപം കണ്ണാടിയിൽ കാണുന്നതെന്തുകൊണ്ട് നിഴൽ ഉണ്ടാകുന്നതെന്തുകൊണ്ട് മുതലായ ചോദ്യങ്ങൾക്കുത്തരങ്ങൾ നമുക്കീ അധ്യായത്തിൽ ലഭിക്കും. ചിത്രീകരണങ്ങൾ സ്വയം വിശദീകരണത്തിന് കെല്പുള്ളവയാണ് (Self explanatory).

പന്ത്രണ്ടാമധ്യായം വർണം (Colour) ആണ്. 395 മുതൽ 247 വരെ. സാബുൻ കലക്കിട്ട് ഒരു കുഴൽ കൊണ്ട് അതിൽ ഊതുന്നെങ്കിൽ അതിനാൽ ഉളവാകുന്ന പൊക്കുള പല നിറങ്ങളിൽ ശോഭിക്കുന്നതെന്തുകൊണ്ട് എന്നതാണൊരു ചോദ്യം. പതിമൂന്നാമധ്യായത്തിൽ ആയസ്കാന്തശക്തി (Magnatism) ചർച്ച ചെയ്യുന്നു. 411 മുതൽ 417 വരെ മാത്രം ചോദ്യോത്തരമുള്ള ചെറിയൊരധ്യായമാണിത്. കൊല്ലന്മാരുടെ കൈക്കോപ്പുകൾ പല പ്പോഴും അയിരിനെ ആകർഷിക്കുന്നതെന്തുകൊണ്ട് എന്നാണൊരു ചോദ്യം. പതിനാലാമത്തെയും അവസാനത്തെയും അധ്യായം വിദ്യുച്ഛക്തി (Electricity) ആണ്. മേപ്പെട്ടുമിന്നൽ പോലെ പൊങ്ങി ദേഹിയും കിഴ്പ്പെട്ടു മാരുപോലെ വീണു ദേഹവും എന്ന് തുടക്കം. വിദ്യുച്ഛക്തി എന്നതിനെ നിർവചിക്കുന്നു. 418 മുതൽ 447 വരെ. വിദ്യുച്ഛക്തിയെ കൊണ്ടു വർത്തമാനം എത്രയും ദൂരത്തിലേക്ക് അയപ്പാൻ കഴിയുന്നതെന്തുകൊണ്ട് എന്നതാണവസാന ചോദ്യം. കമ്പി ഇല്ലാ കമ്പിയുടെ ശാസ്ത്രം ഇവിടെ അനാവൃതമാകുന്നു. വിദ്യുച്ഛക്തിയുടെ ഗതിവിഗതികൾ വിശദമാക്കുന്ന ഡയഗ്രങ്ങൾകൊണ്ട് സമ്പുഷ്ടമാണ് ഈ അധ്യായം.

SREEJITH. E

## അനുബന്ധം

അധ്യായങ്ങൾക്കൊടുവിൽ ചെറിയൊരു അനുബന്ധമുണ്ട്. ഈ പുസ്തകത്തിന്റെ വായനയിലൂടെ ശാസ്ത്രീയസത്യങ്ങൾ പഠിക്കുന്നതോടൊപ്പം (ദൈവബോധത്തിന്റെ ആദ്യാക്ഷരങ്ങൾ എന്ന് രചയിതാവ്) വെളിച്ചമാകുന്ന ദൈവത്തിന്റെ വസ്ത്രത്തൊങ്ങൾ തൊടുകയും തികഞ്ഞ അറിവിൽ എത്തുവാനും ദൈവത്തിന്റെ ഹൃദയത്തിൽ തന്നെ നോക്കുവാനും ആഗ്രഹിക്കും എന്ന് ഈ പുസ്തകത്തിന്റെ ഗ്രന്ഥകർത്താവ് വാഞ്ഛിക്കുന്നു എന്ന പ്രസ്താവനയോടെ അതവസാനിക്കുന്നു. തുടർന്ന് Repository എന്ന പേരിൽ ഓരോ അധ്യായത്തിലും ചർച്ച ചെയ്യുന്ന വസ്തുതകളെക്കുറിച്ച് ഇംഗ്ലീഷിലുള്ള വിശദീകരണം നല്കിയിട്ടുണ്ട്. നിർവചനങ്ങളും സൂത്രവാക്യങ്ങളും ചിത്രീകരണങ്ങളുമൊക്കെയായി ആ ഭാഗം പുരോഗമിക്കുന്നു. മലയാളത്തിൽ നല്കിയിട്ടുള്ള വസ്തുതകളിൽ കൂടുതൽ വിശദീകരണവും ഉയർന്നതലത്തിലുള്ള ചിന്തയും ഉദ്ദേശിച്ചുകൊണ്ടുതാണി ഭാഗം. മലയാളത്തോടൊപ്പം ഇംഗ്ലീഷുമറിയുന്ന ഒരാൾക്ക് കൂടുതൽ മാനസിക ചിത്രീകരണങ്ങളും പ്രതിനിധാനങ്ങളും ഉണ്ടാക്കാൻ സഹായിക്കുക എന്നതാണ് ഈ Repository യുടെ ഉദ്ദേശ്യം. നിത്യജീവിതത്തിലെ വസ്തുതകളും തത്ത്വങ്ങളും വശമാക്കിയശേഷം കൂടുതൽ വിഷകരമായ വസ്തുതകൾ ചേർക്കുന്നതിനും ആവശ്യമുള്ള ഇംഗ്ലീഷ് പദങ്ങൾ നല്കുന്നതിനും വേണ്ടിയാണ് റിപ്പർട്ടറി നല്കുന്നതെന്ന് അദ്ദേഹം പറയുന്നു.

## കൃതിയുടെ ഉദ്ദേശ്യം

പ്രത്യേക ഉദ്ദേശ്യങ്ങളിലാണ് ഈ കൃതി രചിച്ചിട്ടുള്ളതെന്ന് സമർപ്പണക്കുറിപ്പിൽ അദ്ദേഹം വ്യക്തമാക്കിയിട്ടുണ്ട്. സ്കൂളുകളിലേക്കോ പരീക്ഷയ്ക്കുവേണ്ടിയോ അല്ല ഇതെഴുതിയത്. സ്കൂളുകളിൽകൂടി ജീവിതത്തിനുപകരിക്കാനാണ്. വിദ്യാഭ്യാസത്തിന്റെ ആത്യന്തികലക്ഷ്യം പരീക്ഷ പാസാകൽ മാത്രമല്ലെന്ന്

വിദ്യാർഥികളെ മനസ്സിലാക്കിക്കൊടുക്കേണ്ടതുണ്ടെന്ന് അദ്ദേഹം അടിവരയിടുന്നു. വിദ്യാഭ്യാസത്തിന്റെ തത്ത്വചിന്താപരമായ ലക്ഷ്യങ്ങളെക്കുറിച്ചാണദ്ദേഹം ഭംഗ്യന്തരേണ സൂചിപ്പിക്കുന്നത്. ഒന്നാന്തരം വിദ്യാഭ്യാസ വിചക്ഷണൻ ഇവിടെ പ്രത്യക്ഷപ്പെടുന്നു. പുസ്തകത്തിന്റെ സംവിധാനത്തെക്കുറിച്ച് അദ്ദേഹം തന്നെ പറയുന്നതിതാണ്. ആദ്യം വസ്തുതാപഠനം (mastery of facts) പിന്നെ മാത്രം മാർക്ക്. ആദ്യം പരീക്ഷണം, അതിനുശേഷം മാത്രം ഭൗതിക നിയമങ്ങളെക്കൊണ്ടുള്ള ആശയവത്കരണം. അതുകൊണ്ടുതന്നെ മിക്കവാറും എല്ലാ ഉദാഹരണങ്ങളും നിത്യ ജീവിതത്തിൽനിന്നെടുത്തതാണ്. ക്ലാസ്മുറിയിൽ ഇനിയും ഫിസിക്സ് പഠനം പ്രൊഫഷനലായിട്ടില്ലെന്ന് അദ്ദേഹം നിരീക്ഷിക്കുന്നു.

പ്രകൃതി താത്പര്യം സൃഷ്ടിക്കുന്നതിനും ആത്മീയ ചക്രവാളം വികസിപ്പിക്കുന്നതിനുമുള്ള ഒരു പൊതുവിദ്യാഭ്യാസ പാഠമാണിത്. അതുകൊണ്ടുതന്നെ സ്കൂളിൽപോകുന്ന കുട്ടികൾ മാത്രമല്ല, തങ്ങൾക്കു ചുറ്റിലുമുള്ള പ്രതിഭാസങ്ങളെക്കുറിച്ചറിയാൻ താത്പര്യപ്പെടുന്നവർക്കുകൂടി ഉപകാരപ്പെടണം. ആദ്യമേ ഗണിതശാസ്ത്രപരമായ ക്രിയകളും പ്രശ്നങ്ങളും കൊണ്ടു ബുദ്ധിമുട്ടിക്കുന്നതിനാൽ മിക്ക വിദ്യാർഥികൾക്കും ഫിസിക്സിൽ താത്പര്യം നഷ്ടപ്പെടുന്നതായി അദ്ദേഹം തിരിച്ചറിയുന്നു. അതിനാൽ ഗണിതശാസ്ത്രരീതി ഇതിൽ അദ്ദേഹം അവലംബിക്കുന്നില്ല എന്ന് വ്യക്തമാക്കിയിട്ടുണ്ട്. എന്നാൽ ഉപരിപഠനത്തിന് അതനുപേക്ഷിണീയമാണെന്നദ്ദേഹം അംഗീകരിക്കുന്നുമുണ്ട്. ഈ പുസ്തകത്തിൽ വിവരിച്ചിട്ടുള്ള വസ്തുതകളെക്കുറിച്ചും നിയമങ്ങളെക്കുറിച്ചും നാട്ടുഭാഷയിൽ ചർച്ചകളുണ്ടാകുന്നപക്ഷം അടിത്തറ ഭദ്രമാകുമെന്ന ഉത്തവിശ്വാസം ഗ്രന്ഥകർത്താവിനുണ്ടായിരുന്നു എന്ന് സമർപ്പണക്കുറിപ്പിൽ നിന്ന് നമുക്കൂഹിക്കാൻ കഴിയും.

## വ്യാകരണഗ്രന്ഥം

മലയാളഭാഷയുടെ ഘടനയെയും സവിശേഷതകളെയും

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ക്കുറിച്ച് ആഴത്തിൽ ധാരണയുള്ള ഭാഷാ ശാസ്ത്രജ്ഞനെയാണ് ഫ്രോൺ മേയറുടെ വ്യാകരണ വിശകലനങ്ങളിൽ കാണാൻ കഴിയുക എന്ന് 'A Progressive grammer of Malayalam for Europeans' എന്നകൃതിയെ അപഗ്രഥിച്ചുകൊണ്ട് രവിശങ്കർ എസ്. നായർ നിരീക്ഷിക്കുന്നുണ്ട്. അക്കാലത്തെ പല വ്യാകരണങ്ങളിലേതെന്നുപോലെ നിയമങ്ങൾ വിവരിച്ചു പോകുന്ന ശൈലിയല്ല അദ്ദേഹത്തിന്റേത്. ഓരോ ഘടനയുടെയും അർഥം, പ്രയോഗ സന്ദർഭം എന്നിവയ്ക്കാണദ്ദേഹം ഊന്നൽ നല്കുന്നത്. അർഥത്തിന് പ്രാധാന്യം നല്കുന്നതുകൊണ്ടുതന്നെ ഒരു അർഥം സൂചിപ്പിക്കുന്ന വിവിധ വ്യകാരണരൂപങ്ങൾ വിവരിക്കുകയും ചെയ്യുന്നു. ഓരോ ഘടനയും പല സന്ദർഭങ്ങളിൽ ഉപയോഗിക്കുന്നതും വിവരിക്കുന്നു. തീർച്ചയായും ഈയൊരു ശൈലി അദ്ദേഹം ആദ്യമായി പ്രയോഗിക്കുന്നത് പ്രകൃതിശാസ്ത്രത്തിലാണ്. ശാസ്ത്രീയ രൂപങ്ങളുടെ അർഥത്തിനും പ്രയോഗ സന്ദർഭങ്ങൾക്കും ഊന്നൽ കൊടുത്തുകൊണ്ട് നിത്യ ജീവിതത്തിൽനിന്ന് ഉദാഹരണ സഹിതം ചിത്രീകരിക്കുമ്പോൾ അതികഠിനമായ ഭൗതിക തത്ത്വങ്ങളും നിരീക്ഷണങ്ങളും ലളിതമായി ഇഴവിടർന്നുവരുന്ന ഒരു സുന്ദരദൃശ്യമാണ് അനുവാചകന് അനുഭവവേദ്യമാകുന്നത്.

## മറ്റ് പ്രവർത്തനങ്ങൾ

ഗുണ്ടർട്ടിന്റെയോ മറ്റ് മിഷനറിമാരുടേതോ പോലെയുള്ള വിവരങ്ങൾ ഫ്രോൺമേയറെക്കുറിച്ച് നമുക്ക് ലഭ്യമല്ല. ലിയോനൊർഡ് യൊഹാനസ് ഫ്രോൺ മേയർ ജർമനിയിലെ ആൽതെൻഗ്സ്റ്റെഡ്റ്റ് എന്ന സ്ഥലത്ത് ജനിച്ചു. 1876 മുതൽ 1905 വരെ ഇന്ത്യയിൽ മിഷനറി പ്രവർത്തനം നയിച്ചു. 1909 മുതൽ 1921 വരെ ബാസൽ മിഷനിൽ ഇൻസ്പെക്ഷൻ ഫോർ ഇന്ത്യ എന്ന സ്ഥാനം അലങ്കരിച്ചു. അദ്ദേഹത്തിന്റെ സേവനങ്ങൾ പരിഗണിച്ച് യൂണിവേഴ്സിറ്റി ഓഫ് ബാസൽ ഡി ലിറ്റ് ബിരുദം നല്കി ആദരിച്ചിട്ടുണ്ട്.

1934ൽ പ്രസിദ്ധീകരിച്ച ബാസൽ മിഷന്റെ സെന്റിനറി വാല്യത്തിലാണ് ഫ്രോൺ മേയറെക്കുറിച്ചുള്ള അല്പമെങ്കിലുമുള്ള ഒരു വിവരണം കാണാനാവും. തലശ്ശേരിയിൽ മലയാളികൾക്കായി ക്രിസ്ത്യൻ ഹൈസ്കൂളും മലയാള വൈദികശാലയും സ്ഥാപിച്ചത് മേയർ സായിപ്പാണ്. ഈ രണ്ട് വിദ്യാലയങ്ങളും മലയാളക്കരയിൽ സ്ഥാപിച്ചുകിട്ടാൻ അദ്ദേഹം വളരെ പ്രയത്നിച്ചതായി പഴമക്കാർ ഓർക്കുന്നുണ്ടെന്ന് ഗ്രന്ഥം പറയുന്നു. തലശ്ശേരിയിലെ ആദ്യ എലിമെന്ററി സ്കൂൾ 1887ൽ ഫ്രോൺ മേയർ ട്രെയിനിങ് സ്കൂളാക്കി മാറ്റി. സായ്പിന്റെ കീഴിൽ അഭ്യസിച്ചിട്ടുള്ള യാതൊരുവനും ഒരു നിമിഷമെങ്കിലും അലസനായിരിപ്പാൻ സാധിക്കുമായിരുന്നില്ല. ഒരേസമയം അദ്ദേഹം ഏറ്റെടുത്ത ജോലികൾ ഇവയാണ്. 1. നെട്ടൂർ സഭയുടെ ഉത്തരവാദിത്വമുള്ള ബോധകർ. 2. സെക്കൻഡറി സ്കൂളിന്റെയും വൈദികശാലയുടെയും ഗുരുഭൂതൻ. 3. ബാസൽ മിഷന്റെ ജില്ലാ മേധാവി അല്ലെങ്കിൽ ബാസൽ മിഷന്റെ ഇന്ത്യാ പ്രസിഡന്റ്. 4. മദിരാശി സർവകലാശാലാ സ്ഥിരം അംഗങ്ങളിൽ ഒരാൾ (Fellow of the University of Madras). സഭാംഗമോ വിദ്യാർഥികളോ ആവശ്യപ്പെട്ടാൽ എനിക്ക് സമയമില്ല എന്ന് പറയാതെ കാര്യം നിവർത്തിക്കാൻ എപ്പോഴും അദ്ദേഹം തയ്യാറായിരുന്നു. സംഗീതത്തിലും ചിത്രരചനയിലും അദ്ദേഹം പണ്ഡിതനായിരുന്നു. 1905ൽ തിരിച്ചുപോകുന്നതുവരെ ഒരുദിവസംപോലും വിശ്രമിക്കാതെ കർത്താവിനായി പ്രവൃത്തിച്ചിട്ടുള്ള ദാസനുമായിരുന്നു ഫ്രോൺ മേയർ. ഒരു പ്രാവശ്യം മാത്രം തൊണ്ടയ്ക്ക് ദീനം വന്നപ്പോൾ മൂന്നുമാസം അദ്ദേഹത്തിന് നീലഗിരിയിൽ പോയി താമസിക്കേണ്ടിവന്നു. വിദ്വാനും വിശ്വസ്തതയോടെ തന്റെ സകല പ്രവൃത്തിയും ചെയ്യുന്നവനും ആയിരുന്നതിനാലാണ് ഫ്രോൺമേയർക്ക് ഇന്ത്യയിൽ മിഷനറി ആയി പ്രവർത്തിച്ചിരുന്ന മറ്റൊരാൾക്കും ലഭിക്കാത്ത ഇൻസ്പെക്ടർ ഉദ്യോഗം ലഭിച്ചത് എന്ന് ഗ്രന്ഥം വിലയിരുത്തുന്നു. തീർച്ചയായും പ്രകൃതിശാസ്ത്രവും വ്യാകരണ ഗ്രന്ഥവും ഈയൊരു നിരീക്ഷണത്തെ ബലപ്പെടുത്തുന്നു. (മലയാള ബാസൽ മിഷൻ

സഭയുടെ ചരിത്രസംക്ഷേപം എഴുതിയത് ആരെന്ന് വ്യക്തമല്ല. ഒന്നാം പതിപ്പ് 1934ൽ പുറത്തിറങ്ങി. ഒരു സംഘടിതശ്രമത്തിന്റെ ഫലമായിരിക്കാം അത്. രണ്ടാം പതിപ്പ് 1989ൽ വികൂർ ആന്റണി നൂൺ കോഴിക്കോടുനിന്ന് പുറത്തിറക്കി.) 1850ൽ ജനിച്ച ഫ്രോൺ മേയർ കേരളത്തിനെത്തുന്നതിനുമുൻപ് ജർമനിയിൽ ബാസൽ മിഷൻ ഹൗസിൽ അധ്യാപകനായിരുന്നു. കർമനിരതമായിരുന്ന ആ ജീവിതം. 1921ൽ അവസാനിച്ചു.

# പരിണാമോപനിഷത്ത്

■ Indu. R

റിച്ചാഡ് ഡോക്കിൻസ്, 2012.
*ഭൂമിയിലെ ഏറ്റവും മഹത്തായ ദൃശ്യവിസ്മയം പരിണാമത്തിന്റെ തെളിവുകൾ*, വിവ. സി. രവിചന്ദ്രൻ. കോട്ടയം: ഡി.സി. ബുക്സ്, പേജ് 552.

ഒരുത്തിരുത്തി വ്യാഖ്യാനിക്കുന്നതാണ് ഉപനിഷത്ത്. ഭൂമിയിലെ ഏറ്റവും മഹത്തായ ദൃശ്യവിസ്മയം - പരിണാമത്തിന്റെ തെളിവുകൾ (The greatest show on earth:Evidence for evolution, Bentan press, 2009) എന്ന ഗ്രന്ഥം ഡാർവ്വിന്റെ സിദ്ധാന്തത്തിന്റെ ഏറ്റവും ശക്തമായ വ്യാഖ്യാനമാണ്. പരിണാമ ശാസ്ത്രജ്ഞനും മുൻ ഓക്സ്ഫോർഡ് പ്രൊഫസറുമായ റിച്ചാഡ് ഡോക്കിൻസ് , പരിണാമ സംബന്ധിയായ നിരവധി ബെസ്റ്റ് സെല്ലറുകളുടെ രചയിതാവാണ്. 150 വർഷങ്ങൾക്കുമുമ്പ് ചാൾസ് ഡാർവ്വിൻ രൂപം കൊടുത്ത ആശയങ്ങൾക്ക് 21-ാം നൂറ്റാണ്ടിലും യാഥാസ്ഥിതികരായ മതവാദികളുടെയും സൃഷ്ടിവാദികളുടെയും കടന്നാക്രമണങ്ങൾ നേരിടേണ്ടി വരുന്നുണ്ട്. പരിണാമ സിദ്ധാന്തം തെളിവുകൾ നിരത്തി വ്യാഖ്യാനിക്കുകയും സാധൂകരിക്കുകയും ചെയ്യുന്നതോടൊപ്പം അതിൽ പുലർത്തുന്ന ശാസ്ത്ര പക്ഷപാതിത്വവും ആരമവിശ്വാസവുമാണ് ഈ പുസ്തകത്തിന്റെ കാതൽ.

പരിണാമ സിദ്ധാന്തം പൊതുജനങ്ങൾക്ക് പുസ്തകങ്ങളിലെ അറിവുമാത്രമാണ്. എത്രമാത്രം അതിൽ വിശ്വസിക്കുന്നുവെന്ന് സ്വയം ചോദിച്ചാൽ, സംശയം നിറഞ്ഞ മറുപടികളാവും

ലഭിക്കുക. നമുക്കുമാത്രമല്ല ഈ സംശയം. അമേരിക്കൻ ജനത യുടെ നാൽപ്പതു ശതമാനം പേരും മനുഷ്യൻ മറ്റൊരു ജീവിവർ ഗത്തിൽ നിന്ന് പരിണമിച്ചുണ്ടായതാണെന്നു വിശ്വസിക്കുന്നി ല്ല. ഈ ഭൂമിയുടെ പ്രായം ആയിരക്കണക്കിന് ദശലക്ഷം വർഷ ങ്ങളല്ല, മറിച്ച് ഏതാനും ആയിരം വർഷങ്ങൾ മാത്രമാണെന്നു വിശ്വസിക്കുന്നവരാണവർ . ഡോക്കിൻസ് പറയുന്നു: 'പരിണാ മത്തെക്കുറിച്ചുയരുന്ന ചോദ്യങ്ങൾക്ക് തൃപ്തികരമായി മറുപ ടിനൽകാൻ കഴിയാത്ത, ചരിത്രനിഷേധികളല്ലാത്ത പരിണാമ വാദികളുടെ കരങ്ങൾക്ക് ശക്തിപകരാനായിട്ടാണ് ഈ പുസ് തകം പ്രധാനമായും രചിക്കപ്പെട്ടിട്ടുള്ളത്.' അദ്ദേഹത്തിന്റെ പ്ര തീക്ഷപോലെതന്നെ ,നിഷ്പക്ഷമതിയായ ഒരുവായനക്കാരൻ പോലും ഈ പുസ്തകം വായിച്ചതിനുശേഷം അതിനെക്കുറി ച്ച് സംശയിക്കില്ല.

## യഥാർത്ഥത്തിൽ നാം കുരങ്ങിൽ നിന്നുണ്ടായവരാണോ?

നേർസാക്ഷികളില്ലാത്ത ഒരു കൃത്യം നടന്ന ശേഷം സംഭവ സ്ഥലം സന്ദർശിക്കുന്ന കുറ്റാന്വേഷകനാണ് പരിണാമശാസ് ത്രജ്ഞൻ. പരിണാമത്തിനു വേണ്ടിവന്ന കാലദൈർഘ്യം നമു ക്ക് ഭാവനചെയ്യാൻ സാധിക്കുന്നതിനും അപ്പുറമുള്ളതാണ്. ദ ശലക്ഷക്കണക്കിനു വർഷങ്ങൾ നമുക്ക് വെറും അക്കങ്ങൾ മാ ത്രമാണ്. പ്രപഞ്ചത്തിലെ എല്ലാജീവികളും ഓരോ പൊതുക ണ്ണിയാൽ പരസ്പരം ബന്ധിക്കപ്പെട്ടിരിക്കുന്നു. ഏതു ജീവി യിൽനിന്നും പരിണാമപഥമാകുന്ന ഹെയർപിൻ വളവിലൂടെ പിറകോട്ട് സഞ്ചരിച്ചാൽ ഒരു പൊതുപൂർവ്വികനിലെത്താം; തു ടർന്ന് വളവുതിരിഞ്ഞ് മുന്നോട്ട് നീങ്ങിയാൽ പരിഗണിക്കപ്പെട്ട മറ്റേ ജീവിയിലും. അതുകൊണ്ട് ഒരിക്കലും മനുഷ്യൻ കുര ങ്ങിൽ നിന്നുണ്ടായതല്ലെന്നും, രണ്ടു സ്പീഷീസിനും പൊതു വായി ഉണ്ടായിരുന്ന ഒരു പൂർവ്വികനിൽനിന്നും പരിണമിച്ച് ര ണ്ടു വിഭാഗങ്ങളായി മാറിയവരാണെന്നും വ്യക്തമാകും. ഒപ്പം, പ്രപഞ്ചത്തിലെ ഏതുരണ്ടു ജീവികളും പരിണാമപാതയിൽ

എവിടെയെങ്കിലും ഒരു പൊതുപൂർവ്വികനെ പങ്കിടുകയും ചെയ്യുന്നു.

*ലോകമേ തറവാട് ,തനിക്കീ ചെടികളും പുൽകളും പുഴുക്കളും കൂടിത്തൻ കുടുംബക്കാർ* എന്ന് കവിവാക്യം.

'സ്ഥൂലപരിണാമത്തിലേക്കുള്ള രാജവീഥി' എന്ന മൂന്നാമധ്യായത്തിലാണ് ഡോക്കിൻസ് പരിണാമത്തിന്റെ കാതലായ പ്രകൃതിനിർദ്ധാരണത്തിലേക്ക് (Natural Selection)കടക്കുന്നത്. പ്രകൃതി നിർദ്ധാരണമെന്നത് ലോകമെമ്പാടും ഓരോദിനവും ഓരോമണിക്കൂറും സംഭവിച്ചുകൊണ്ടിരിക്കുന്ന പരിശോധനയും തെരഞ്ഞെടുപ്പുമാണെന്ന് ഡാർവ്വിൻ പറയുന്നു.

ആഫ്രിക്കയിലെ മഡഗാസ്കർ ഓർക്കിഡിന് പതിനൊന്ന് ഇഞ്ച് നീളമുള്ള തേൻകുഴലുണ്ട്. ഇതിന്റെ മധുനുകരാൻ തക്ക ദൈർഘ്യമുള്ള കൊമ്പുള്ള പ്രാണിയെ ഭാവിയിൽ ആരെങ്കിലും കണ്ടുപിടിക്കുമെന്ന് ഡാർവ്വിനും വാലസും പ്രവചിച്ചു. ബഹിരാകാശ ഗവേഷകർ, നെപ്റ്റ്യൂൺഗ്രഹത്തെ അന്വേഷിച്ച അതേ ആത്മവിശ്വാസത്തോടെ പ്രകൃതിശാസ്ത്രജ്ഞർ അത്തരമൊരു പ്രാണിക്കുവേണ്ടി തെരച്ചിൽ നടത്തുകയും 1903-ൽ അന്നേവരെ അറിയപ്പെടാതിരുന്ന അത്തരത്തിലൊന്നിനെ കണ്ടെത്തുകയുമുണ്ടായി. പരിണാമസിദ്ധാന്തം ഭൂതകാല സംബന്ധിയായതിനാൽ ഭാവിയെപ്പറ്റി പ്രവചനം നടത്താൻ അതിനാവില്ലെന്ന വാദത്തെ ഖണ്ഡിക്കാനായി ഡോക്കിൻസ് ആവേശപൂർവ്വമാണ് ഈ ഉദാഹരണം വിവരിക്കുന്നത്. സുന്ദരൻമാരായ ആൺമയിലുകൾ ഉണ്ടാവുന്നതും പാമ്പിന്റെ ഭീഷണരൂപം പുറത്ത് ആലേഖനം ചെയ്യപ്പെട്ട പുൽച്ചാടികൾ ഉണ്ടാവുന്നതും പ്രകൃതിനിർദ്ധാരണമെന്ന ഡാർവ്വിന്റെ ഏറ്റവും മഹത്തായ കണ്ടുപിടിത്തം കൊണ്ടാണെന്ന് ചിത്രങ്ങൾ സഹിതം പുസ്തകം വിശദീകരിക്കുന്നു. ചിലന്തി ഓർക്കിഡുകളും ഹണിട്രാപ്പ് (തേൻകെണി) ഒരുക്കുന്ന ഓർക്കിഡുകളും തേൻ കുരുവികളും കടന്നലുകളും. അങ്ങനെ പ്രകൃതി ഒരുക്കിവെച്ച ഓരോ വിസ്മയക്കാഴ്ചകളും ചൂണ്ടിക്കാണിച്ച് , വായനക്കാരെ ബാല്യത്തിൽ നിന്നുള്ള പരിണാമത്തിൽ നഷ്ടപ്പെട്ട കൗതുകലങ്ങളിലേക്ക് കൈപിടിച്ചുനടത്തിക്കുന്നു ഡോക്കിൻസ്.

INDU. R

## പരിണാമം കൺമുന്നിൽ

വേട്ടക്കാരിൽനിന്നും പിടിക്കപ്പെട്ട ആഫ്രിക്കൻ ആനകളുടെ കൊമ്പുകളുടെ ഭാരം നിരീക്ഷിച്ചതിൽ നിന്നും ക്രമേണ ഭാരം കുറഞ്ഞുവരുന്നതായി അനുഭവപ്പെട്ടു. ഈ പ്രവണത, ആനകളുടെ കാര്യത്തിൽ നീണ്ടകൊമ്പുകളേകാൾ ചെറിയ കൊമ്പുകളെ പ്രകൃതി പിന്തുണക്കുന്നുവെന്ന് ചിന്തിക്കാൻ ഡോക്കിൻസിനെ പ്രേരിപ്പിക്കുന്നു. 1988 ൽ ഇ-കോളി ബാക്ടീരിയകളെ 12 ഫ്ളാസ്കുകളിൽ അടച്ച് 45000 തലമുറകളെ സൃഷ്ടിച്ച് നടത്തിയ ലെൻസ്കിയുടെ പരീക്ഷണം രോമാഞ്ചത്തോടെ മാത്രമേ വായിക്കാൻ സാധിക്കൂ. (രോമാഞ്ചം എന്നത് ഒട്ടുമിക്ക സസ്തനികളും പങ്കുവെക്കുന്ന, ഒരു പൊതുപൂർവ്വികനെ അനുസ്മരിപ്പിക്കുന്ന സഹജമായ ഒരു ഗുണമാണെന്ന് ഡോക്കിൻസ് സ്ഥാപിക്കുന്നുമുണ്ട്) അതിജീവനശേഷിയുള്ളവ പെറ്റുപെരുകുന്നതായും സാഹചര്യങ്ങളെ ഏറ്റവും കൂടുതൽ നിലനിൽപ്പിനായി പ്രയോജനപ്പെടുത്തുന്നവ അതിജീവിക്കുന്നുവെന്നും ഗപ്പി മത്സ്യങ്ങളെ ഉപയോഗിച്ച് നടത്തിയ പരീക്ഷണത്തിലൂടെയും കണ്ടെത്തുന്നു.

ഈ പുസ്തകത്തിൽ ഡോക്കിൻസ് ഉപയോഗിക്കുന്ന ശാസ്ത്രമേഖലകൾ നിരവധിയാണ്. ജനിതക ശാസ്ത്രം (Genetics), തന്മാത്രാജീവിശാസ്ത്രം (Molecular biology), കൃത്രിമ പരിപാലനം(Artificial breeding), ഭ്രൂണശാസ്ത്രം (Embryology), ഭൗമശാസ്ത്രം (Geography) എന്നിങ്ങനെയുള്ള സഹായക ശാസ്ത്രശാഖകളിലും ഡോക്കിൻസിന്റെ പ്രാവീണ്യം അത്ഭുതാവഹമാണ്.

ഗാലപ്പഗോസ് ദ്വീപുകളിലെ ഡാർവ്വിന്റെ പര്യടനം അവതരിപ്പിക്കുന്നിടത്ത് കാൽപനികചാരുതയും ഗൃഹാതുരതയും തെളിഞ്ഞുനിൽക്കുന്നു. പുസ്തകത്തിലുടനീളം വായനക്കാരെ സുഹൃത്തുകളായി കണ്ട് ഒപ്പമിരുന്ന് സംസാരിക്കുന്ന പ്രതീതി ജനിപ്പിക്കാൻ ഡോക്കിൻസിന് കഴിയുന്നുണ്ട് ഉദാഹരണം: 'ഇനിവരുന്ന പേജുകളിൽ അല്പം സങ്കീർണമായ കാര്യങ്ങളായിരിക്കും വിവരിക്കപ്പെടുന്നത്, ദിവസത്തിന്റെ അവസാനം

ജോലിചെയ്ത് ക്ഷീണിച്ചിരിക്കുന്ന വേളയിൽ പുസ്തകത്തിന്റെ ഈ ഭാഗം വായിക്കരുതെന്ന നിർദേശമാണ് എനിക്കുള്ളത്.' മറ്റൊന്ന് : 'രാത്രി ഏറെവൈകിയെങ്കിൽ നാളെ രാവിലെ വായന തുടരുന്നതായിരിക്കും ഉത്തമം.'

കുറിക്കുകൊള്ളുന്ന പരിഹാസശരങ്ങളും ഡോക്കിൻസ് എയ്യുന്നുണ്ട് 'ജീവശാസ്ത്രത്തിലെ നാമകരണപ്രക്രിയയിലെ കണിശത പാണ്ഡിത്യ ഗർവ്വിന്റെ അതിരുകൾ സ്പർശിക്കുന്നതാണ്.' ഇസ്ലാമിക സൃഷ്ടിവാദിയായ ഹാരുൺ യഹ്യയുടെ *അറ്റ്ലസ് ഓഫ് ക്രിയേഷൻ* എന്നപുസ്തകത്തെകുറിച്ച്: 'ഇത്തരമൊരു പുസ്തകം കണ്ടാൽ അത് നിർമ്മിക്കാൻ നിധിവല്ലതും കിട്ടിയിട്ടുണ്ടാകുമോ എന്നു സംശയിച്ചുപോകും, അത്രകനത്തതായിരിക്കും അത്. പുസ്കത്തിലെ തെറ്റുകളും തുല്ല്യനിലയിൽ ഇതിഹാസമാനം ആർജിച്ചവയാണ്!'

ശാസ്ത്രം യാഥാർത്ഥ്യത്തിന്റെ കവിതയാണെന്ന ഡോക്കിൻസിന്റെ തന്നെ നിർവചനത്തെ സാധൂകരിക്കുന്ന അവതരണശൈലിയും ഭാഷാഘടനയുമാണ് ഈ പുസ്തകത്തിനുള്ളത്. സി. രവിചന്ദ്രനാണ് ഡി.സി ബുക്സിനുവേണ്ടി ഈപുസ്തകത്തെ മലയാളത്തിലേക്ക് മൊഴിമാറ്റം ചെയ്തത്. ഡോക്കിൻസിന്റെ കുലീനഭാഷയുടെ സത്ത നഷ്ടപ്പെടാതെയും മലയാളത്തിന്റെ തനിമകൾ ഉൾക്കൊണ്ടുമാണ് അദ്ദേഹത്തിന്റെ പരിഭാഷ.

പുസ്തകത്തിലുടനീളം കാണുന്ന യുക്തിഭദ്രതയുടെയും ചിന്താശേഷിയുടെയും ശാസ്ത്രീയ വീക്ഷണത്തിന്റെയും തിളക്കങ്ങളാണ് ഇതിനെ പ്രകാശപൂരിതമാക്കുന്നത്. പരിണാമസിദ്ധാന്തത്തിന്റെ അപ്രമാദിത്വം തരുന്ന ധൈര്യവും ആത്മവിശ്വാസവും തുളുമ്പുന്ന വാക്കുക്കളാണ് ഡോക്കിൻസിന്റെത്. എങ്കിലും ഏതുശാസ്ത്രസിദ്ധാന്തവും ചോദ്യംചെയ്യപ്പെടാമെന്നും അദ്ദേഹത്തിനറിയാം 'ജൈവപരിണാമം സംബന്ധിച്ച കാലക്രമം തെറ്റിയുള്ള ഏതെങ്കിലും ഒരു ഫോസിൽ ആരെങ്കിലും ഹാജരാക്കിയാൽ അതോടെ പരിണാമസിദ്ധാന്തത്തിന്റെ വെടി തീർന്നു.'

1859 ൽ പ്രസിദ്ധീകരിക്കപ്പെട്ട 'Origine of Species'ന് 150

വർഷങ്ങൾക്കുശേഷം വീണ്ടുമൊരു വ്യാഖ്യാനം ഏഴുതേണ്ടി വരുന്ന സാഹചര്യമാണ് ശാസ്ത്രപഠിതാക്കളിൽ ആശങ്കയുണർത്തേണ്ടത്. ജീവശാസ്ത്രത്തിന്റെ മർമ്മ സ്ഥാനത്ത് നിൽക്കുന്ന ഒരുസിദ്ധാന്തം അനുദിനം ചെളിവാരിയെറിയപ്പെടുകയും ചോദ്യം ചെയ്യപ്പെടുകയുമാണ്. വർദ്ധിച്ചു വരുന്ന മത തീവ്രവാദം ഇതിനുവളക്കൂറുള്ള മണ്ണാണ്. ബഹുസ്വരതയും സാംസ്കാരിക വൈവിധ്യവും പ്രോത്സാഹിക്കപ്പെടേണ്ടതായതുകൊണ്ട് പരിണാമ വിമർശകരെ ചോദ്യം ചെയ്യപ്പെടുന്നതിലൂടെ വംശീയവാദിയെന്ന് ആക്ഷേപിക്കപ്പെടുമെന്ന് ആശങ്കപ്പെട്ടാണ് പലരും മൗനം പാലിക്കുന്നത്.

പരിണാമം ഒരു സിദ്ധാന്തമല്ല, വസ്തുതയാണ്. പരിണാമം അനിഷേധ്യമായ ഒരു യാഥാർത്ഥ്യമാണെന്ന് വിവരിക്കുന്നതോടൊപ്പം അതിന്റെ സ്തോഭജനകമായ ശക്തിയും ലാളിത്യവും സൗന്ദര്യവും അഘോഷിക്കുന്ന ഒരു കൃതിയാണ് റിച്ചാഡ് ഡോക്കിൻസ് രചിച്ചിരിക്കുന്നത്.

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