AQUINAS JOURNAL OF MULTIDISCIPLINARY RESEARCH

Volume I

April 2015 ISSN 2395-7751



AQUINAS COLLEGE EDACOCHIN, COCHIN-682010 KERALA, INDIA

AQUINAS JOURNAL OF MULTIDISCIPLINARY RESEARCH

Peer Reviewed Research Journal



Aquinas College

Edacochin, Cochin-682010

Kerala, India

www.aquinascollege.co.in

Email: aquinascollegemail@gmail.com

Advisory Board

Rev. Fr. Johnson Chirammel Manager, Aquinas-Avila-Siena Colleges Former Vice Chancellor, Dr. Babu Joseph CUSAT, Kochi Dr. V. P. N. Nampoori Emeritus Professor, ISP, CUSAT Dr. Thomaskutty Mathew Reader, STAS, MG University Regional Centre, Edappally Academic Director, Dr. V. S. Antony Aquinas-Avila-Siena Colleges Dr. John Vineetha Mareeta Vice Principal, Aquinas College, Edacochin

Editorial Board

Chief Editor

Prof. Johnson Gomez

Editor

Joseph John

Associate Editors

Sivaraj K. S.

Alicen Roshiny Jacob

Athira Prakash

Berry Holaday M. G.

Mary Jemima Sebastian

Principal, Aquinas College

Associate Professor, Department of Physics, Aquinas College

Assistant Professor, Department of Physics Assistant Professor, Department of English Assistant Professor, Department of Physics Assistant Professor, Department of Economics Assistant Professor, Department of English

DECLARATION

I, Prof. Johnson Gomez, Principal, Aquinas College, Edacochin, hereby declare that I am the printer and publisher of the journal entitled **Aquinas Journal of Multidisciplinary Research** to be printed and published at Edacochin and particulars in respect to the said journal given hereunder are true to the best of my knowledge and belief.

1. Title of the Journal **Aquinas Journal of Multidisciplinary Research** 2. Registration Number **ISSN** 3. Language English 4. Periodicity Yearly Rs. 300/-5. Retail selling price of the Journal per copy 6. Publisher's Name Prof. Johnson Gomez Nationality Indian Address Principal, Aquinas College, Edacochin, Cochin-682010, India 7. Place of Publication Aquinas College, Edacochin, Cochin-682010, India 8. Printer's Name Johnson Gomez Nationality Indian Address Principal, Aquinas College, Edacochin, Cochin-682010, India Little Flower Press, Perumpadappu, 9. Name of Printing Press Cochin-682006, India 10. Editor's Name Joseph John Indian Nationality Address Associate Professor, Dept. of Physics, Aquinas College, Edacochin, Cochin-682010, India 11. Owner's Name Rev. Fr. Johnson Chirammel Indian Nationality Address Manager, Aquinas-Avila-Siena Colleges, Edacochin, Cochin-682010, India

ISSN 2395-7751

All Rights Reserved

© Aquinas College, Edacochin, Cochin- 682010, India

EDITORIAL

We are proud to present the first issue of the Aquinas Journal of Multidisciplinary Research, a pioneering attempt to mark our contribution to the ever expanding horizons of knowledge. In this era where pen stays mightier than the sword and knowledge remains the key contributor to human existence, we must accept the relevance of introducing new sources of information to the layman as well as our peers in order to constantly replenish the existing knowledge with new theories and inventions.

In this fast advancing world which brings in its wake changes in culture and attitude, it becomes pertinent that we face the challenges posed by the new age. This call for new perspectives in higher education and qualitative improvement is clearly the only answer that every institution must live up to in order to keep up with the changing times.

Following the footsteps of our patron St. Thomas Aquinas, a scholar and theologian with unparalleled insight, we too believe that knowledge is what helps us to actualize the potentialities of the human self. It is with this in mind that we have ventured into the challenging area of research and its publication.

The present issue of Aquinas Journal of Multidisciplinary Research incorporates research findings from various disciplines. The editorial board shares its anxiety and hope with the academic community and is deeply grateful to all the contributors who have generously shared their expertise with us. We thank all our well-wishers for their whole hearted support and co-operation in making the publication of this issue a reality.

Editors:

Prof. Johnson Gomez, Principal Joseph John, Associate Professor

Contents

Science			
1	A Study on the Optical Properties of Dye Doped Polycaprolactone Microstructures Krishnakumar G., Parvathy Radhakrishnan, E. I. Anila, K. S. Sreelatha, U. S. Sajeev	1	
2	Dual band Fractal Antenna for RFID Applications Parvathy A. R., Thomaskutty Mathew	9	
3	Synchronization of Hyperchaotic Lü, Lorenz, and Chen Systems Mary Vinaya, Meenu M. George, Reshma Rajan, Rose P. Ignatius	18	
4	Phase Synchronization Effects in a Lattice of Coupled, Non-identical Rössler Oscillators. Mineeja K. K., Mary Vinaya, Rose P. Ignatius, Anju Claranel Thomas	29	
5	Synthesis and Characterization of Silver Substituted Cobalt Ferrite Nanoparticles Sheena Xavier, Rintu Mary Sebastian, E. M. Mohammed	41	
6	Regulatory Sequence Analysis computational studies on Human Homeobox Genes in T Cell Lymphocytic leukemia and the Potential Effect of Plumbagin; a Plant Derived Naphthoquinone as an Anti-proliferative Agent. Roopa P. Namboothiri, Dani Joseph	50	
7	Molecular Docking Analysis of Natural Ligands Against Infectious Proteins of Human Immunodeficiency Virus and Hepatitis B virus Dani Joseph, Roopa P. Namboothiri	60	

Humanities			
8	Farmers' Suicides and Agrarian Crisis in India Nitheesh Kumar P. K.	69	
9	Demystifying Science: A Study of Humour in Bill Bryson's A Short History of Nearly Everything Alicen Roshiny Jacob	84	
10	Unculturing the self: The Strange Case of Billy Biswas – An Ecodimensional Evolutionary saga Joby Mathew	92	
11	Sports and Religion Shaji Jose	100	
Commerce			
12	Entrepreneurship – An Alternative for Unemployment Dr. Rajagopala Nair	107	
13	Inflation Indexed Bonds as an Investment Alternative in Indian Capital Market: A Comparative Analysis Mahmood Aslam	117	
14	Financial Inclusion: An Overview in Indian Context Devina Mohan	133	

A Study on the Optical Properties of Dye Doped Polycaprolactone Microstructures

Krishna Kumar G.¹, Parvathy Radhakrishnan^{1, 2}, E. I. Anila², K. S. Sreelatha¹, U. S. Sajeev¹

¹Government College Kottayam, ²Union Christian College Aluva, ussajeev@gmail.com

ABSTRACT

Doping of dyes into polymer matrices leads to the effective tuning of the polymer properties. Such polymer structures have applications in Lasers, Photo detectors, Optical sensors and also have photonic & biomedical applications. In this study aligned polymer microfiber of Polycaprolactone (PCL) is fabricated by electrospinning. Organic dyes are incorporated into this aligned polymer microfiber. Scanning Electron Microscopy (SEM) analysis was conducted for the study of morphology of micro fiber under electrospinning technique. The composite structures (presence of the solvents) can be analyzed by FTIR technique. From the UV and Fluorescence spectroscopy analysis the optical properties of the polymer are analyzed. The results are compared and correlated.

Keywords: Polycaprolactone, Dye Doped polymer, Electrospinning, band structure, fluorescence spectroscopy.

INTRODUCTION

A polymer is macromolecule, which is composed of repeating units called monomers. Biopolymers are polymers that are generated from natural sources. They can be produced from biological systems or chemically synthesized from biological starting materials. Synthetic biopolymers are polymers whose source is not natural but synthetic and also biodegradable. Synthetic biopolymer based

composites are of special interest due to their biocompatibility and biodegradation kinetics. Polycaprolactone (PCL), a fully biodegradable synthetic biopolymer has a wide range of applications in biomedical field. It is used in tissue engineering, drug delivery and wound healing ... etc. Most of the applications are using the nanostructure composites of polymers. Electrospinning is a useful technique to fabricate continuous ultrathin micro/nano fibers from polymer composites [1]. The versatility of the applications can be improvised by tuning the polymer properties. Tuning of properties can be achieved by various methods. Doping is a conventional method of manipulating the mechanical, optical and structural properties of a polymer. Dopants like organic and synthetic dyes can be easily doped in to the polymer. They can host a variety of functional dopants including quantum dots and fluorescent dyes that can be used to tailor their properties with greater versatility [2]. Recently, lasing action and single wavelength conversion been realized by incorporating fluorescent dyes have into polymer nano/microfibers. The emitting frequency and intensity of emission from a polymer can be tuned by doping. PCL has been successfully electrospun into desired sizes ranging from nano to micro scales. Doping PCL fibers with fluorescent organic dyes can improve its use as a tracer in drug delivery and other biomedical application. Organic dyes like curcumin, rosebengal, alizarin etc are non-toxic and at the same time show fluorescence which can be doped into PCL matrix. Fluorescent polymer nano/micro composite structures have applications in optical sensors [3]. The biocompatibility and dye hosting capability of PCL makes it significant and the study of optical properties of dye doped PCL micro structures is very important.

MATERIALS AND METHODS

Commercially available PCL (Sigma Aldrich) pellets (Mn=42,500; Mw=65,000) were used as the matrix for preparing the samples. Chloroform (Universal Chemicals and Scientific Industries) and Methanol (Prowess Lab Chemicals) in the ratio 3:1 was chosen as the solvent. Homogenous solutions of the polymer were obtained by magnetically stirring for 24 h at room temperature. The concentration of PCL in the solution was 40 wt%. A plastic syringe (BD Discardit II -10 mL) with a metallic needle of 0.8 mm inner diameter was set horizontally on the syringe and the high voltage power supply (Zeonics Systech India) was set to a voltage of 12 kV. The distance of the needle tip from the collector (Mandrel) was 15 cm. The mandrel was set to rotate at 300 rpm. From the electrospun fibrous mat, five square pieces were cut and was dipped in five different dyes for 10 minutes. The dyes used were Alizarin, Curcumin, Lawsone, Crystal Violet and Rosebengal. PCL fibers doped with five different dyes were synthesized.

Scanning Electron Microscopy (SEM) [JEOL Model JSM - 6390LV] analysis was conducted for the study of morphology of dye incorporated polymer composite structures obtained by electrospinning technique [4]. From the SEM, the morphology and the fiber diameter distribution have been analyzed. As a preliminary characterization the dye doped ES fibers are irradiated with UV. The FTIR image of the dye doped PCL are charted using FTIR Spectrometer (The rmo Nicolet, Avatar 370 at SAIF CUSAT, Cochi-22).

RESULTS AND DISCUSSIONS

The fibers synthesized through electrospinning analyzed using Scanning electron microscopy (SEM) and is given in figure 1.



Fig.1 Images of the crystal violet doped polymer microfiber of PCL produced by electrospinning

It can be found that the formed fibers are bead free and are in the micrometer scale. The fibers are of an average diameter 4.7 μ m. FTIR spectrum in figure 2, give an idea about the chemical structure of PCL, doped with different dyes. The FTIR spectrum is analyzed using standard charts.



Fig.2 FTIR image of the PCL doped with (a) Curcumin (b) Rose Bengal (c) Lawsone (d) Crystal Violet and (e) Alizarin

It is found that the peaks at 2929.74 cm⁻¹ in PCL doped with lawsone and crystal violet is due to the C-H stretching of alkane groups. A peak at 1726.26 cm⁻¹ for all others except that doped with alizarin is due to C=O stretch. Peaks at 1236.89 cm⁻¹ and 369.71 cm⁻¹ correspond to C-N stretching respectively. The 921.01 cm⁻¹ peak in PCl doped with lawsone and Rosebengal is due to the C-H stretching of alkenes. Again in PCL doped with curcum in the C-H stretching is due to alkenes.

From FTIR spectra it is found that the chemical structure of the poly caprolactone fibers is not much affected by the doping of dyes due to the very small concentration of dyes. But the optical properties of the polymer fibers prepared by electrospinning are modified by the doping with organic dyes.

The synthesized fibers were observed under UV lamp .The photographs are given in figure 3.









Fig.3 Fluorescing images of PCL fiber doped with (a) Lawsone (b) Rosebengal (c) Alizarin (d) Curcumin (e) Crystal violent

The fluorescent spectroscopy results are given below. It is observed that new energy levels which are photonically active are formed as a result of doping.





Fig.4 The energy level spectrum of PCL doped with (a) Lawsone (b) Rose Bengal (c) Curcumin (d) Crystal violet and (e) Alizarin

The fluorescent spectra of dye doped PCL fibers are shown in figure 4. The doping of dyes introduced new photonically active energy levels. PCL doped with Lawsone has emissions from 248.84 nm, 308.125 nm and 389.83 nm. Doping of rosebengal creates two energy levels with emissions from 341.658 nm and 558.653 nm. In the alizarin doped PCL 3 energy levels are formed, having emissions from 210.120 nm, 243.086 nm and 346.85 nm. For Curcumin doped samples the emission observed at 241.057 nm and 363.076 nm. PCL with crystal violet showed emissions from 308.125 nm, 341.859 nm and 518.26 nm.

CONCLUSIONS

It is found that the fluorescent spectra of PCL got strongly modified when dyes are incorporated with the samples. The structural analysis of the samples shows that the chemical structure of the polycaprolactone is not much affected by the doping of dyes. By the incorporation of dyes, PCL become photonically active, this makes it suitable for advanced targeted drug delivery, tracing and sensing application in biomedical field.

ACKNOWLEDGEMENTS

Authors acknowledge University Grants Commission (UGC) for financial support through a major research project: "Development of Composite Nanofibers by Electrospinning for Photonic Applications" F.No 41-895/2012(SR).

REFERENCES

- [1] Zheng Ming Huang, Y. Z. Zhang, M. Kotaki, S. Ramakrishna, A review on polymer nanofibers by electrospinning and their applications in nanocomposites, *Composites Science and Technology*, 2003, *63*, 2223.
- [2] Huaqing Yu & Baojun Li, Wavelength-converted wave-guiding in dyedoped polymer nanofibers, *Scientific Reports*, 2004, *3*, 469.
- [3] Pan Wang, Yipei Wang and Limin Tong, Functionalized polymer nanofibers: a versatile platform for manipulating light at the nanoscale, *Light: Science & Applications*, 2013, 2, 102.
- [4] Brian C. Smith, *Infrared Spectral Interpretation: A Systematic Approach*, CRC Press, 1998.

Dual band Fractal Antenna for RFID Applications

Parvathy A. R.¹, Thomaskutty Mathew²

^{1,2}Department of Electronics, School of Technology & Applied Science Mahatma Gandhi University Regional Centre, Edappally, Kochi, drtkmathew@gmail.com

ABSTRACT

The design and development of a dual band antenna operating at RFID bands of 868 MHz (UHF Band) and 2.45 GHz (Microwave Band) are presented. Minkowski fractal geometry is employed in the design of the dual band microstrip patch antenna which results in the miniaturization of the antenna. The radiation characteristics were studied experimentally and found to be in good agreement with the simulation results. The proposed antenna may find applications in the design of multi-band RFID readers and tag antennas.

Keywords: Radio Frequency Identification (RFID), Fractals, Microstrip patch, Minkowski fractal.

INTRODUCTION

Radio frequency identification (RFID) is an automated wireless data collection technology which is widely being used as a substitute for barcodes in industries such as access control, parcel tracking, distribution logistics, automotive systems and people or live stock tracking [1-2]. RFID system is composed of a tag (transponder), reader (interrogator) and middleware. In a passive RFID system, the reader transmits a modulated RF signal to the tag consisting of an antenna and a chip (IC). The chip receives power from the antenna and responds by varying its input impedance and thus modulating the backscattered signal. RFID tags can be passive or active and come in a wide

variety of sizes, shapes, and forms. Communication between the RFID reader and tags occurs wirelessly and therefore does not require a line of sight between the devices.

Fig.1 shows the block diagram of an RFID system. The RFID Reader emits a low-power radio wave field which is used to power up the tag so as to pass on any information that is contained on the chip. In addition, readers can be fitted with an additional interface that converts the radio waves returned from the tag into a form that can then be passed on to another system, like a computer or any programmable logic controller. Passive tags are generally smaller, lighter and less expensive than those that are active and can be applied to objects in harsh environments, are maintenance free and will last for years. These transponders are only activated within the response range of an RFID reader.



Fig.1 The block diagram of RFID basic operation

Radio waves are the carriers of data between the reader and tags. The approach generally adopted for RFID communication is to allocate frequencies depending on application. The frequencies used for RFID cover a wide spectrum. These specified bands are: Low Frequency (LF) 125 - 135 kHz, High Frequency (HF) 13.56 MHz, Ultra High Frequency (UHF) 860-960 MHz and Microwave

Frequency 2.45 and 5.8 GHz. The allocation of frequency bands are regulated by government agencies, require care in considering RFID applications in different countries. Efforts at standardization should avert these problems. The various applications will work their best at different frequencies; therefore, it is important to understand the requirements before selecting a particular type of RFID system. The most common uses of low frequency systems are in security access, asset tracking and animal identification. They generally have short reading ranges and lower system costs. High-frequency systems are used for such applications as railroad, car tracking and automated toll collection.

Recently there has been intense research on RFID technology in the UHF band (860-960 MHz) and microwave bands (2.45 GHz). RFID systems in these bands are getting popular in the identification of objects in the various supply chains around the world [2-3]. One way to achieve greater reading distances is the improvement of the antenna on the tags. Since a passive tag does not have its own power supply, it is important that the tag can absorb as much energy as it can, from the radiated power of the reader antenna. As a solution to minimize the antenna size, while keeping high radiation efficiency is through implementing the fractal structure to the antenna [4].

The application of fractal geometry to conventional antenna structure optimizes the shape of the antennas in order to increase their electrical length, which reduces their overall size. Because fractal geometries have two main features in common, space-filling and self-similarity properties, fractal shape antenna elements present various advantages: wide bandwidth [5], multiband [6], and reduced antenna size, among others. Fractal antennas have shown the possibility to miniaturize antenna size and to improve input matching. Also, certain classes of fractal antennas can be configured to operate effectively at various frequency bands.

OBJECTIVE

The main objective of the work is the design and development of a dual band antenna intended for RFID applications. For the sake of simplicity and ease of fabrication, a compact planar microstrip patch antenna based on fractal geometry is selected for the antenna construction. The fractal concept can be used to reduce antenna size [8] or it can be used to achieve multiple bandwidths and increase bandwidth of each single band due to the self-similarity in the geometry. The antenna is designed to operate at multiple bands of 868 MHz (UHF Band) and 2.45 GHz (Microwave Band)). These two frequencies are used as RFID frequencies in India. This is the reason for concentrating on these two frequencies.

DESIGN METHODOLOGY

The Minkowski fractal antenna is designed based on a square generator structure as described in [7] [8]. Self-similarity of the pre-fractal topology has been iterated to introduce a multi-resonance characteristic as shown in the Fig.2.



Fig.2 Iteration of the square patch to produce Minkowski Pre-Fractal (MPF) radiator

When iterated to a smaller scale, estimation of the initial size has been carried out using the following equation [8]:

$$W_1^{(n+1)} = a_1 x L_n \tag{1}$$

$$W_2^{(n+1)} = a_2 x L_n$$
 (2)

where, n is the iteration number, W_1 is the middle segment width and W_2 the indentation width. a_1 is the W_1/L_0 ratio and a_2 is the W_2/L_0 ratio. The initial value of the square length is found from a typical microstrip patch calculation formula [9]. The indentation ratios, a_1 and a_2 values may get changed depending upon the resonant frequencies. It is also estimated that the fractal perimeter length, L_F is given by:

$$L_F = 2L_{(n+1)} + W_1^{(n+1)} + 2W_2^{(n+1)}$$
(3)

where, **n** is the iteration number, $W_I^{(n+1)} = a_I L_n$; is the width of the middle segment, and $W_2^{(n+1)} = a_2 L_n$; is the indentation width. Parameters a_I and a_2 , which determine the efficiency of the size reduction, are ratios of middle segment width, and indentation width, both with respect to the iteration length (L_n) .

The Minkowski fractal antenna is designed based on a square generator structure. Fig. 3 shows the geometry of the proposed Minkowski fractal antenna based on a square generator structure. In this structure L_0 is the initial value of the square length and is found from a typical microstrip patch calculation formula. W_I is the middle segment width and W_2 is the indentation width. The proposed Minkowski fractal radiator is made on an FR-4 dielectric substrate with \mathcal{E}_r =4.4 and an electromagnetic coupling using a microstrip feed line is employed as shown in the Fig. 3. The Minkowski geometry is simulated using Computer Simulation Technology Microwave Studio (CST MWS) Suite and the parameters are optimized for dual band operation. After the design process is done, and satisfied with the simulation result, the antenna has been fabricated and tested experimentally.



Fig.3 Geometry of the Minkowski Pre-Fractal Radiator with electromagnetic coupling.

RESULTS & DISCUSSIONS

Fig.4 shows the measured and simulated return loss plot for the Minkowski fractal microstrip antenna with dimensions $L_0 = 66$ mm, $a_1 = 0.15$, $a_2 = 0.287$, $W_1 = 10$ mm, $W_2 = 19$ mm. It can be seen that the Minkowski fractal antenna is suitable for dual band operation at 0.868 GHz and 2.45 GHz.





Figures 5(a) & 5(b) shows the 2D view of measured E and H plane radiation pattern of the Minkowski fractal for 0.868 GHz and 2.45 GHz respectively. The radiation pattern shows a wide coverage over the azimuth and elevation angular ranges. This behavior makes the antenna suitable for RFID applications where wide coverage over azimuth and elevation angular ranges is needed for efficient operation in an RFID environment.



Fig.5 Measured Radiation Pattern of Minkowski Fractal Antenna (a) 0.868 GHz (b) 2.45 GHz.

(a)

As per the relation between the antenna length and the operating frequency, for an antenna to operate in 0.868 GHz, the antenna length should be 82 mm. But due to the introduction of fractal geometry, the main patch length gets reduced to 66 mm. Therefore a 20% reduction in size is achieved due to the introduction of the fractal geometry. As a result, miniaturization of the antenna is also achieved.

CONCLUSIONS

A dual band microstrip antenna based on Minkowski Fractal has been developed for the two RFID frequency bands in India. The simulated and measured results are found to be in good agreement. This antenna may find applications in the design of multi-band RFID readers and other wireless communication systems operating in these bands.

REFERENCES

- [1] K. Finkenzeller, *RFID Handbook*, 2nd edition, John Wiley & son, England, 2003.
- [2] C. Diugwu, J. Batchelorand, Thomaskutty Mathew, Complementarity in the optimization RFID dipole tag antenna, *IEEE International symposium on Antennas & Propagation Digest*, San Diego, 2008, 5-12.
- [3] Thomaskutty Mathew, M. A. Ziai and J. Batchelor, RCS and Read Range of UHF RFID tag, *Proceedings of APEMC*, Beijing, 2010, 467-469.
- [4] I. K. Kim, J. G. Yook, H. K. Park, Fractal-shape small size microstrip patch antenna, *Microwave Optical Technology Letters 34, Issue 1*, 2002, 67-70.
- [5] P. E. Mayes, Frequency-independent antenna and broad-band derivatives thereof, *Proceedings IEEE, Issue 1*, 1992, *Vol. 80*, 103-112.
- [6] Puente Balliarda C., Romeu J., Pous R. and Cardama A., On the behavior of the Sierpinski multiband fractal antenna, *IEEE Trans. Antennas Propagation.*, 1998, *Vol. 46, No. 4*, 517-524.
- [7] E. C. Lee, P. J. Soh, N. B. M. Hashim, G. A. E. Vandenbosch, V. Volski, I. Adam, H. Mirza, M. Z. A. A. Aziz, Design and Fabrication of a Flexible Minkowski Fractal Antenna for VHF Applications, *Proceedings of the 5th European Conference on Antennas and Propagation (EUCAP)*, 2011, 545-548.

- [8] E. E. C. de Oliveira, P. H. da F. Silva, A. L. P. S. Campos, Sandro Goncalves da Silva, Overall size antenna reduction using fractal elements, *Microwave and Optical Technology Letters*, 2009, Vol. 51, No. 3.
- [9] J. R. James, P. S. Hall, Handbook of microstrip antennas, Peregrinus on behalf of the Institution of Electrical Engineers, 1989.

Synchronization of Hyperchaotic Lü, Lorenz, and Chen Systems

Mary Vinaya, Meenu M. George, Reshma Rajan, Rose P. Ignatius

Dept. of Physics, St. Teresa's College, Ernakulam maryvinaya@gmail.com.

ABSTRACT

The finite time stochastic combination synchronization of three different hyperchaotic systems, Lü, Lorenz, Chen systems are investigated via the adaptive control method and Lyapunov stability theory. The hyperchaotic systems in the master-slave synchronization models are described by deterministic ordinary differential equations and the stochastic effects in the system model has been taken into account. A secure communication scheme based on adaptive combination synchronization of the above three different systems with uncertainties, arbitrary parameters, stochastic perturbation and random noise is presented. For the numerical simulations, the equation of 4-D hyperchaotic system is solved with the adaptive control law and formulated the parameter update law.

Keywords: Chaos, Hyper Chaos, Synchronization, Adaptive control.

INTRODUCTION

Chaos, a complex, unpredictable phenomenon which is highly sensitive to the initial conditions can be found in a diverse array of research fields, including electrical engineering, electronics, communications, biology, mathematics, physics, chemistry, and economics. Recently, the study of synchronization in hyperchaotic systems has become a hot topic. A hyperchaotic system is defined as a chaotic system with at least two positive Lyapunov exponents, implying that its dynamics expand in several different directions simultaneously. Hyperchaotic systems have more complex dynamical behaviours and could possibly be used in many fields such as chaos-based encryption, secure communication, biological systems, neural networks, etc. The proposed secure communication scheme utilizes chaotic systems to encrypt the transmitted data by an encryption function, followed by modulation by a chaotic signal to increase the complexity and security of such transmitted signals. Adaptive nonlinear control is used to obtain synchronization in hyperchaotic systems like Chen system, Lü system and Lorenz system.

Synchronization of Hyperchaotic Lü and Lorenz systems with Chen system

In the usual drive-response synchronization model, there is one drive system and one response system, which can be seen as one-to-one system. Here, combination synchronization [1] is used which has two drive systems and one response system. We investigate the combination synchronization of three classic hyperchaotic systems: Lorenz, Chen, and Lü systems by using adaptive control method. Lorenz and Lü systems are considered as master systems and Chen system as the slave system and sufficient conditions for combination synchronization are derived. As the first drive system, we consider Lü system described by,

$$\dot{x}_1 = a (y_1 - x_1) + w_1$$

$$\dot{y}_1 = -x_1 z_1 + c y_1$$

$$\dot{z}_1 = x_1 y_1 - b z_1$$

$$\dot{w}_1 = x_1 z_1 + dw_1$$
(1)

where, x_1, y_1, z_1, w_1 are the state variables and a, b, c, d are positive, constant parameters of the systems.

The second drive system be the Lorenz system is described by,

$$\dot{x}_{2} = e (y_{2}-x_{2})$$

$$\dot{y}_{2} = fx_{2}-y_{2}-w_{2}-x_{2}z_{2}$$

$$\dot{z}_{2} = x_{2}y_{2} -g z_{2}$$

$$\dot{w}_{2} = hy_{2}z_{2}$$
(2)

where, x, y, z, and w are state variables and e, f, g, h are parameters of the hyperchaotic Lorenz system.

As the response system, we consider hyperchaotic Chen system described by,

$$\dot{x}_{3} = p(y_{3} - x_{3}) + y_{3}z_{3} + u_{1}$$

$$\dot{y}_{3} = q x_{3} - x_{3} z - y_{3} - w_{3} + u_{2}$$

$$\dot{z}_{3} = x_{3}y_{3} - rz_{3} + u_{3}$$

$$\dot{w}_{3} = x_{3} + sy_{3} - w_{3} + u_{4}$$
(3)

where, x, y, z and w are state variables and p, q, s and r are real constants. Let the synchronization error is defined as [1].

$$e_1 = x_3 - x_2 - x_1$$
, $e_2 = y_3 - y_2 - y_1$, $e_3 = z_3 - z_2 - z_1$, $e_4 = w_3 - w_2 - w_1$ (4)

The error dynamics is obtained as,

$$\dot{\mathbf{e}}_1 = \mathbf{p}(\mathbf{y}_3 - \mathbf{x}_3) + \mathbf{y}_3 \mathbf{z}_3 - \mathbf{e}(\mathbf{y}_2 - \mathbf{x}_2) - \mathbf{a}(\mathbf{y}_1 - \mathbf{x}_1) - \mathbf{w}_1 + \mathbf{u}_1$$

$$\dot{e}_{2} = q x_{3} - x_{3} z - y_{3} - w_{3} - (fx_{2} - y_{2} - w_{2} - x_{2}z_{2}) - (-x_{1}z_{1} + cy_{1}) + u_{2}$$

$$\dot{e}_{3} = x_{3}y_{3} - t z_{3} - (x_{2}y_{2} - gz_{2}) - (x_{1}y_{1} - bz_{1}) + u_{3}$$

$$\dot{e}_{4} = x_{3} + s y_{3} - w_{3} - (hy_{2}z_{2}) - (x_{1}z_{1} + dw_{1}) + u_{4}$$
 (5)

Let us now define the adaptive control functions [1]

$$u_{1}(t) = \hat{a}(y_{1} - x_{1}) + \hat{e}(y_{2} - x_{2}) - \hat{p}(y_{3} - x_{3}) - w_{1} - y_{3}z_{3} - k_{1}e_{1}$$

$$u_{2}(t) = \hat{c}y_{1} - x_{2}z_{2} - x_{1}z_{1} - y_{2} - w_{2} + \hat{f}x_{2} + w_{3} + y_{3} + x_{3}z_{3} - \hat{q}x_{3} - k_{2}e_{2}$$

$$u_{3}(t) = x_{1}y_{1} - x_{3}y_{3} + \hat{r}z_{3} + x_{2}y_{2} - \hat{b}z_{1} - \hat{g}z_{2} - k_{3}e_{3}$$

$$u_{4}(t) = x_{1}z_{1} - x_{3} - \hat{s}y_{3} + \hat{h}y_{2}z_{2} + \hat{d}w_{1} - k_{4}e_{4}$$
(6)

where, \hat{a} , \hat{b} , \hat{c} , \hat{e} , \hat{f} , \hat{g} , \hat{h} , \hat{d} , \hat{p} , \hat{q} , \hat{r} , \hat{s} are estimates of a, b, c, r, p, q, e, f, g, h, d, s respectively and k_i (i=1, 2, 3, 4) are the positive constants.

Substituting (6) into (5), the error dynamics simplifies to

$$\dot{e}_{1} = (p-\hat{p}) (y_{3}-x_{3}) - (e-\hat{e})(y_{2}-x_{2}) - (a-\hat{a}) (y_{1}-x_{1}) - k_{1}e_{1}$$

$$\dot{e}_{2} = (q-\hat{q})x_{3} - (c-\hat{c})y_{1} - (f-\hat{f}) x_{2}-k_{2}e_{2}$$

$$\dot{e}_{3} = -(r-\hat{r})z_{3} + (b-\hat{b})z_{1} + (g-\hat{g}) z_{2}-k_{3}e_{3}$$

$$\dot{e}_{4} = (s-\hat{s})y_{3} - (d-\hat{d})w_{1} - (h-\hat{h})y_{2}z_{2} - k_{4}e_{4}$$
(7)

Let us now define the parameter estimation errors as

$$e_{a} = (a - \hat{a}), e_{b} = (b - \hat{b}), e_{c} = (c - \hat{c}), e_{d} = (d - \hat{d}), e_{e} = (e - \hat{e}), e_{f} = (f - \hat{f}),$$

$$e_{h} = (h - \hat{h}), e_{p} = (p - \hat{p}), e_{q} = (q - \hat{q}), e_{r} = (r - \hat{r}), e_{s} = (s - \hat{s})$$
(8)

Substituting (8) into (7), we obtain the error dynamics as

$$\dot{e}_{1} = e_{p} (y_{3} - x_{3}) - e_{a} (y_{1} - x_{1}) - e_{e} (y_{2} - x_{2}) - k_{1}e_{1}$$

$$\dot{e}_{2} = e_{q} x_{3} - e_{c} y_{1} - e_{f} x_{2} - k_{2}e_{2}$$

$$\dot{e}_{3} = -e_{r} z_{3} + e_{g} z_{2} + e_{b} z_{1} - k_{3}e_{3}$$

$$\dot{e}_{4} = e_{s} y_{3} - e_{b} y_{2} z_{2} - e_{d} w_{1} - k_{4}e_{4}$$
(9)

For the derivation of the update law for adjusting the estimation of the parameters the Lyapunov approach is used. We consider the quadratic Lyapunov function defined by,

$$V = \frac{1}{2}(e_1^2 + e_2^2 + e_3^2 + e_4^2 + e_a^2 + e_b^2 + e_c^2 + e_d^2 + e_e^2 + e_f^2 + e_g^2 + e_h^2 + e_p^2 + e_q^2 + e_r^2 + e_s^2)$$
(10)

which is a positive definite function. Differentiating (10) and using updated estimated parameters, we obtain

$$\dot{V} = -k_1 e_1^2 - k_2 e_2^2 - k_3 e_3^2 - k_4 e_4^2 - k_5 e_5^2 - k_6 e_6^2 - k_7 e_7^2 - k_8 e_8^2$$

$$-k_9 e_9^2 - k_{10} e_{10}^2 - k_{11} e_{11}^2 - k_{12} e_{12}^2 - k_{13} e_{13}^2 - k_{14} e_{14}^2 - k_{15} e_{15}^2 - k_{16} e_{16}^2$$
(11)

which is a negative definite function. Thus by Lyapunov stability theory, it is immediate that the synchronization error and the parameter estimation error decay to zero exponentially with time

Hence we proved the following result.

"The non-identical master systems and the slave system with unknown parameters are synchronized via adaptive control law (9). Also the parameter estimates $\hat{a}(t), \hat{b}(t), \hat{c}(t), \hat{d}(t), \hat{e}(t), \hat{f}(t), \hat{g}(t), \hat{h}(t), \hat{p}(t), \hat{q}(t), \hat{\tau}(t), \hat{s}(t)$ are exponentially converge to the original values of the parameters a, b, c, d, e, f, g, h, r, p, q, s respectively, as $t \rightarrow \infty$ ".

Analysis with various initial parameters

Numerical simulations are performed using the 'ODE method' to solve the 4D system equations with the adaptive control law and the parameter update law. Taking the arbitrary values for k_i , the parameters for the Lü system are taken as a = 36, b= 3, c = 20, $-0.35 \le d \le 1.3$, parameters of the Lorenz system is taken as, e= 10, f = 8/3, g = 28 and h =0.1, parameters of the Chen system is taken as, p = 36, q = 8/3, r = 28, s = 17.17.

Suppose the initial values of the parameter estimates are $\hat{a}(0)=1, \hat{b}(0)=2, \hat{c}(0)=1$, $\hat{r}(0)=2, \hat{r}(0)=1, \hat{f}(0)=2, \hat{g}(0)=1, \hat{h}(0)=2, \hat{p}(0)=1, \hat{q}(0)=2, \hat{t}(0)=1, \hat{s}(0)=2.$

The initial values of the drive system are taken as $x_1(0) = y_1(0) = z_1(0) = w_1(0) = 2$ and the initial value of the second drive system be $x_2(0) = y_2(0) = z_2(0) = w_2(0) = 3$ and the initial values of the response system be $x_3(0) = y_3(0) = z_3(0) = w_3(0) = 4$

Figures (a), (b), (c), (d) show the error response and we can see that the synchronization error decays to zero.

Error Dynamics of synchronization

Following figures shows the error response of the master and the slave synchronization process when it is controlled by an adaptive process. Adaptive control forces the slave system to follow the master system completely.



Hence it can be concluded that the slave system follows the master system completely after a small time interval when the slave is controlled by adaptive control technique. For the synchronization of three systems, the summative behavior of the two masters is controlling the slave Chen dynamics to follow the masters. Numerical simulations given above show the effectiveness of this design of combination synchronization which has more potential applications in physics, electrical engineering, communication theory, and many other fields.

In the usual drive-response model, the signal is transmitted by one drive system. However, in our combination synchronization model of secure chaotic communication, the signal can be transferred by two different chaotic systems, thus the signal transmitted by our model may have stronger anti-attack ability than that transmitted by the usual model.

Sending message signal with two master systems-the hyperchaotic L*ü* and Lorenz systems

The idea of using chaos to design analog secure communication systems and digital ciphers has provoked a great deal of research efforts since the early 1990s [2]. Most chaos based analog secure communication systems are based on chaos synchronization technique [3], where the receiver (response or slave) chaotic system synchronizes with the transmitter (drive or master) system via a signal transmitted over a public channel. After the chaos synchronization is achieved, the message signal can be recovered in different ways corresponding to different structures of the masking algorithms.

In our work, the method of combination synchronization in secure communication is adopted. Here, the transmitted signals are split into several parts, each part loaded in different drive systems. This ensures that the transmitted signals have stronger anti-attack ability and anti-translation capability than that transmitted by the usual transmission model. Random noises are also added to both transmitter and receiver systems.

Assuming m (t) = $m_1(t) + m_2(t)$ are the message signals which should be send to the receiver, we add $m_1(t)$ to the first equation for the first transmitter and $m_2(t)$ to the second transmitter. Thus the two drive systems can be written as,

$$\dot{x}_1 = a (y_1 - x_1) + w_1 + 0.1 \sin x_1 + m_1(t)$$

$$\dot{y}_1 = -x_1 z_1 + c y_1 + 0.2 \sin y_1$$

$$\dot{z}_1 = x_1 y_1 - b z_1 + 0.3 \sin z_1$$
(12)

$$\dot{w}_1 = x_1 z_1 + d w_1 + 0.4 sin w_1$$

where, x_1 , y_1 , z_1 , w_1 are the state variables and a, b, c, d are positive, constant parameters of the hyperchaotic L*ü* system and $m_1(t) = 0.1 \sin(t)$.

$$\dot{x}_{2} = e (y_{2}-x_{2}) -0.1 \cos x_{2} + m_{2}(t)$$

$$\dot{y}_{2} = fx_{2} - y_{2} - w_{2} - x_{2}z_{2} - 0.2\cos y_{2}$$

$$\dot{z}_{2} = x_{2}y_{2} - g z_{2} - 0.3 \cos z_{2}$$

$$\dot{w}_{2} = hy_{2}z_{2} + 0.4 \cos w_{2}$$
(13)

where, x_2 , y_2 , z_2 , and w_2 are state variables and e, f, g, h are parameters of the hyperchaotic Lorenz system and $m_2(t) = 0.1 \cos(t)$.

Then the receiver hyperchaotic Chen system can be constructed as,

$$\dot{x}_{3} = p(y_{3}-x_{3}) + y_{3}z_{3} + u_{1} + 0.1 \sin x_{3} + s(t) + e_{1}(t)$$

$$\dot{y}_{3} = q x_{3} - x_{3} z - y_{3} - w_{3} + u_{2} + 0.2 \sin y_{3} + e_{2}(t)$$

$$\dot{z}_{3} = x_{3}y_{3} - r z_{3} + u_{3} + 0.3 \sin z_{3} + e_{3}(t)$$

$$\dot{w}_{3} = x_{3} + s y_{3} - w_{3} + u_{4} + 0.4 \sin w_{3} + e_{4}(t)$$
(14)

where x₃, y₃, z₃ and w₃ are state variables and p, q, s and r are real constants.

Using the adaptive control method mentioned earlier, parameter estimates are updated and the non-identical master systems and the slave system with unknown parameters are synchronized. Also the parameter estimates $\hat{a}(t)$, $\hat{b}(t)$, $\hat{c}(t)$, $\hat{d}(t)$, $\hat{e}(t)$, $\hat{f}(t)$, $\hat{g}(t)$, $\hat{h}(t)$, $\hat{p}(t)$, $\hat{q}(t)$, $\hat{r}(t)$, $\hat{s}(t)$ exponentially converge to the original values of the parameters a, b, c, r, p, q, t, s respectively as t $\rightarrow\infty$.

Error response

Following figures show the error response of the master and the slave system undergoing combination synchronization process.



CONCLUSIONS

It is verified that the proposed study is well suited for secure communication scheme. Since chaotic signals are characterized by their random nature and broad power spectra, it is possible to enhance the data security substantially by embedding information in chaotic signals. Being broad band, chaotic signals when used for transmission inherit the advantage of conventional spread spectrum signals such as low probability of detection, anti-jamming, mitigation of multipath, etc. In addition, chaotic signals are easy to generate in theoretically infinite quantity, thus providing a comparatively low cost solution to the spread spectrum system construction in usual communication model.

REFERENCES

- [1] Luo Runzi, Wang Yinglan and Deng Shucheng, Combination synchronization of three classic chaotic systems using active back-stepping design, *Chaos*, 2011, *Vol. 21, Issue 4*, 3114.
- [2] T. Yang, A survey of chaotic secure communication systems, *Int. J. Computational Cognition*, 2004, 2, 81–130.
- [3] L. M. Pecora and T. L. Carroll, Synchronization in chaotic systems, *Phys. Rev. Lett.*, 1990, *64*, 821–824.

Phase Synchronization Effects in a Lattice of Coupled, Non-identical Rössler Oscillators.

Mineeja K. K., Mary Vinaya, Rose P. Ignatius, Anju Claranel Thomas

Dept. of Physics, St. Teresa's College, Ernakulam, kkmineeja@gmail.com rosgeo@gmail.com

ABSTRACT

The Chaos theory studies the order in the complex, deterministic, nonlinear and unpredictable systems. Rössler oscillator is an example of chaotic system. Phase synchronization of 25 non-identical, coupled Rössler oscillators in a 1-dimensional lattice is studied. Averaged partial frequency* and beat frequency** of oscillators are employed for studying the synchronization. The results observed are as follows. Control parameters 'a' and 'c' regulated the global synchronization in the lattice. The lattice is found to get globally synchronized as any one of the control parameters accepts a particular value. At some situations clusters of synchronized oscillators also is observed. Even for negligibly small frequency separation between adjacent oscillators the lattice doesn't exhibit global synchronization. When a Gaussian noise term is introduced in the system, at a particular combination of parameters, noise enhanced the synchronization in the lattice. Change in the natural frequency of oscillators also affected the synchronization in the lattice.

* Averaged partial frequency- $\Omega = \langle d\varphi/dt \rangle$, where φ is the phase of the oscillator at time t.** Beat frequency- Averaged partial frequency separation between adjacent oscillators.

Keywords: Chaos, Phase synchronization, Lattice of Oscillators, Cluster synchronization.
INTRODUCTION

Nonlinear dynamical systems having degrees of freedom greater than or equal to three are found to exhibit a completely unpredictable, deterministic and complex behaviour. These types of irregular systems are called chaotic systems. One such chaotic system is the Rössler oscillator. This system is one of the simplest systems exhibiting chaos, simple in the sense that there is only one coupled term in its differential equation. The Rössler system can be applied in techniques of cryptography and can be used as a theoretical model for chronotherapy [1] and for modelling the onset of chaos in various networks.

Chaos and synchronization are two contradicting phenomena. Even then synchronization can be generated among chaotic systems especially in Rössler oscillators either by coupling [2] or by forcing [3]. Here coupling is employed to generate synchronization. There are four different types of synchronizations. They are generalized synchronization, complete synchronization, lag synchronization and phase synchronization. In this paper phase synchronization alone is studied. This is the situation where two coupled chaotic oscillators keep in step with each other while their amplitudes remain uncorrelated [4].

The inspiration for this work is from the work done by Grigory V. Osipov, Arkady S. Pikovsky, Michael G. Rosenblum, and Jurgen Kurths in 1997 [6]. Here in this work, the initial displacements of the oscillators along the x, y and z directions are assumed to follow a sinusoidal variation.

Lattice of Rössler Oscillators

The basic model is the chain of coupled non-identical Rössler oscillators [5] with a nearest-neighbour diffusive coupling. It can be written as a set of ordinary differential equations,

$$\begin{aligned} \dot{x}_{j} &= -\omega_{j} y_{j} - z_{j}, \\ \dot{y}_{j} &= \omega_{j} x_{j} + a y_{j} + \varepsilon (y_{j+1} - 2y_{j} + y_{j-1}), \\ \dot{z}_{j} &= b + (x_{j} - c) z_{j}. \end{aligned}$$
(1)

Here the values of the parameters are assumed as a=0.15, b=0.4, and c=8.5 [6]. The index j=1...N is the position of an oscillator in the lattice and ' ϵ ' is the coupling coefficient. The parameter 'a' determines the topology of the attractor. y_j , y_{j+1} , and y_{j-1} are the varied displacements of the jth, (j+1)th and (j-1)th oscillators in the lattice of non-identical Rössler oscillators. The parameter ' ω_j ' corresponds to the natural frequency of the jth oscillator [6].

To study synchronization in the lattice of non-identical oscillators, a linear distribution of natural frequencies ' ω_i ' is introduced as,

$$\omega_{j} = \omega_{1} + \delta(j-1) \tag{2}$$

where, ' δ ' is the frequency mismatch between neighbouring systems [6]. Boundary conditions of the form,

$$y(t) = 0 \text{ and } y_{N+1}(t) = 0,$$
 (3)

are assumed in this case for the lattice of non-identical Rössler oscillators.

The phase here can be introduced in a simple way namely, as

$$\varphi = \arctan(y/x)$$
 (4)

The amplitude correspondingly can be defined as,

$$A = (x^2 + y^2)^{1/2}$$
(5)

As the phase of a chaotic system is well defined, the phase difference between neighboring oscillators can be calculated as $\phi_j - \phi_{j-1}$ [6]. A weaker condition of synchronization is the coincidence of the averaged partial frequencies ' Ω_i ', defined as,

$$\Omega_{j} = \langle \frac{d\Phi_{j}}{dt} \rangle = \lim T \to \infty[(\varphi_{j}(T) - \varphi_{j}(0))/T]$$
(6)

The frequency mismatch ' δ ' between the adjacent oscillators is defined as,

$$\delta = \omega_{j} - \omega_{j-1} \tag{7}$$

In analogy to the case of periodic oscillators, the frequency

$$\Omega_{\rm b} = |\Omega_1 - \Omega_2| \tag{8}$$

is defined as a 'beat frequency' [6].

In the present work the cooperative behaviour in a 1- dimensional lattice of 25 non-identical Rössler oscillators is studied. The initial displacements of the oscillators along the x, y and z directions are assumed to follow a sinusoidal variation. It comes under the interest of this study to examine whether the phenomena usually encountered in the networks of periodic oscillators can be observed for chaotic systems as well [6]. The main effect is the existence of a regime of global synchronization, i.e., all elements of the chain are synchronized, or the existence of several clusters of synchronized oscillators. The Fourth-Order Runge–Kutta method is employed to solve the differential equations governing the Rössler lattice.

Variation of Beat Frequency (Ω_b) With Natural Frequency (Ω_j)

The parameter 'a' is fixed at 0.15, 'b' at 0.4, 'c' 8.5 ' ϵ ' at 0.001, ' ω_1 ' at 1, and the frequency mismatch parameter ' δ ' is very small (10⁻¹⁰), the behavior of the Rössler oscillators in the lattice is as shown in Fig. 1. Although complete synchronization among oscillators is expected, what is observed are regions of synchronization separated by peaks and dips occurring at regular intervals. It is observed that stretches of perfect synchronization appear periodically in the lattice. The Beat frequency ' Ω_b ' of the adjacent oscillators is almost close to zero in these regions of synchronization, which implies that the oscillators have approached a phase locked state at this value of ' δ '.

When the value of parameter 'a' is made 0.308 as shown in Fig.2, with the frequency mismatch parameter ' δ '=0.0002 and natural frequency of first oscillator ω_1 =0.01, again highly synchronized regions exist at the expense of others. As 'a' is increased beyond 0.308, clusters with same beat frequency ' Ω_b ' begin to grow. When 'a' reached the critical value 0.778, Fig.3, a large group of oscillators with same beat frequency ' Ω_b ' is observed. At this point for example when coupling ' ϵ ' is made 100 percent, the large cluster gets disappeared as shown in Fig.4. This is true for variation of any other parameter.



 a=0.308; b=0.4; c=8.5; δ=0.0002; c=0.001; ω=0.01 0.25 0.2 0.15 0.15 0.15 0.05 0.

Fig. 1Regular variation of beat frequency, At $\delta = 10^{-10}$.

Fig.2 Two clusters of almost same size Formed in the lattice, at a=0.308



Fig.3 At a=0.778, most of the oscillators in the Lattice attained the same beat frequency which marks the onset of global synchronization.

Fig.4At a=0.778, when coupling between adjacent oscillators is made 100%, Synchronization is lost.

Small Frequency Mismatch: Study of Averaged Partial Frequency (Ω_i)

In this section, the synchronization effects in the lattice is analyzed by calculating the averaged partial frequency ' Ω_j ' of the oscillators, for different values of the parameters 'a', 'c' and ' ω_1 '. Here the case of relatively small frequency mismatch is considered, that is, $\delta /\omega_1 <<1$, in the lattice of 25 non-identical Rössler oscillators. The variation of averaged partial frequency ' Ω_j ' along the lattice, with change in the oscillator number 'j' is plotted for various values of the parameters.

In the first case, the parameters 'b', 'c', ' δ ', ' ϵ ' and ' ω_1 ' are kept fixed and the topology parameter 'a' alone is varied. In figures 5 and 6, we have b=0.4, c=8.5, δ =0.0002, ϵ =0.1, ω_1 =0.01 and 'a' is varied from 0.1to 0.21211.It is observed that when a=0.1 in Fig.5, the oscillators from 4 to 9 are found to oscillate with approximately the same averaged partial frequency, ' Ω_j '. Similarly oscillators 15 to 22 also show the same behaviour, but with a different averaged partial frequency ' Ω_j '. When 'a' takes the value 0.21211, Fig. 6, the averaged partial frequency, ' Ω_j ', follows a step variation. At this point (Fig. 7) a very small change in 'c' of the order of 10⁻⁴ is introduced. A drastic change in the size and phase of the clusters, and a very sharp and tall peak suddenly appeared, resulting in loss of synchronization in the first cluster.



Fig. 5 Two perfectly synchronized regions in he lattice, at a=0.1.



Fig.6 At a=0.21211two clusters of different Averaged partial frequency ' Ω_j ' formed in Lattice.

Fig.7 Loss of synchronization in the first the cluster, when 'c' is changed by a value 2×10^{-4} .

In figures 8 and 9 'c' is increased rapidly from 1 to 100. The change in 'c' considerably affects the size and phase difference between clusters. When the parameter c=1, infigure8, the averaged partial frequency ' Ω_i ', follows a sinusoidal variation. When 'c' reaches the critical value 100, a large single cluster of almost same averaged partial frequency ' Ω_i ' is observed in the lattice (Fig.9). Thus one infers that in the case of small frequency mismatch, most of the oscillators in the lattice form clusters of synchronization. The clusters differ in their value of averaged partial frequencies.



Fig.8 Sinusoidal variation of averaged partial Fig. 9 Onset of global synchronization at requency ' Ω_j ', at c = 1. c=100.

In figure 10, when a=0.15, b=0.4, c=8.5, δ =0.0009, ε =0.2 and ω_1 =1 the lattice is found to be divided into two clusters of synchronization. The oscillators from 1 to 10 are grouped in the first cluster, and those from 13 to 25 appear in the second cluster, both clusters having the same value of averaged partial frequency ' Ω_j '. It is interesting to note that doubling ' ω_1 ' resulted in the destruction of clusters as given in Fig.11.



Fig.10 Synchronization penetrating the lattice Fig.11 Loss of synchronization when $\omega_1 = 2$. From the edges, at $\omega_1 = 1$.

Study of Averaged Partial Frequency (Ω_j) - Large Frequency Mismatch

In this section, the behaviour of the oscillators in the lattice is analyzed, when a large frequency mismatch ' δ ' is introduced between them, that is $\delta/\omega_1 > 1$. The variation of averaged partial frequency (Ω j), with the oscillator number 'j', as the parameters are varied is studied. In figure 12 (a=0.15, b=0.4, c=8.5, ε =0.2, ω =0.01), frequency mismatch between adjacent oscillators in the lattice ' δ ' is 0.1and no synchronization is observed in the lattice, instead the more or less periodic variation of averaged partial frequency (Ω_j) is observed with increase in the oscillator number 'j'. The averaged partial frequency ' Ω_j ' is found to follow a saw tooth pattern as the oscillator number 'j' increases.

In Fig. 13, as ' δ ' is increased to a value 11.7, the averaged partial frequency ' Ω_j ' shows an approximately saw tooth/sine variation in the first half of the lattice. But a stretch of perfect synchronization is found to exist in the regions of higher oscillator numbers, where all the oscillators from 11 to 23 are synchronized to a value of averaged partial frequency around -0.24. Even with such a very high frequency mismatch (11.7) between adjacent oscillators, it is quite surprising to observe such stretches of complete synchronization in the lattice. Such stretches of perfect synchronization amidst unsynchronized states may appear periodically in the lattice, if the number of oscillators is further increased.



Fig.12 Saw tooth variation of averaged partial frequency, at δ =0.1.



Fig.13 Oscillators from 11 to 24 form a cluster, when δ =11.7.

Effect of Gaussian Noise

In order to study the effect of noise on the lattice of non-identical coupled Rössler oscillators, a noisy Gaussian term is introduced, which is exp $(-cx_j^2)$, to

the right hand side of equations for x_j and y_j in the system of equations (1) so that the equations are,

$$\dot{x}_j = -\omega_j y_j - z_j + \exp\left(-cx_j^2\right)$$
(9)

$$\dot{y}_{j} = \omega_{j} x_{j} + a y_{j} + \varepsilon (y_{j+1} - 2y_{j} + y_{j-1}) + \exp(-c x_{j}^{2})$$
(10)

$$\dot{z}_j = b + (x_j - c)z_j \tag{11}$$

In order to understand the effect of noise, the system is analyzed for the same parameters as in the case of small frequency mismatch. The changes brought about by the external noise are studied by comparing the results with that of the noise free cases in the small frequency mismatch regime. The variation of averaged partial frequency ' Ω_j ', along the lattice with increasing values of the oscillator number 'j' is plotted and analyzed. The results obtained are as follows:

Initially the parameters b, c, δ , ε and ω_1 are kept fixed at 0.4, 8.5, 0.0002, 0.1 and 0.01 respectively. And the value of 'a' is varied from 0.1 to 0.19.From the figures 14 and 15 it is clear that the noise term didn't completely destroy clusters of same averaged partial frequency ' Ω_j ' or regions of synchronization. But synchronization effects are found to increase compared to those in figure 5, representing the noise free case, with more number of oscillators occupying the clusters of same averaged partial frequency ' Ω_j '.



Fig. 14 Lattice having a single cluster at a=0.1. Fig. 15 The large cluster grown in size at a=0.19





Fig.16 At ω_1 =1 a narrow synchronized region is created in the lattice.

Fig.17Averaged partial frequency, Ω_j , follow an irregular pattern at $\omega_1 = 2$.

In figures 16 and 17 all parameters except ω_1 are fixed. When $\omega_1=1$ or 2 no periodic pattern is visible. In the noise free case for small frequency mismatch, there were two large clusters of synchronization (fig. 10) for $\omega_1=1$. Here when ' ω_1 ' is increased to the value 2 synchronization is completely lost (fig17).

CONCLUSIONS

Beat frequency plots indicated that, for very small values of frequency mismatch, synchronization is present in the lattice. Cluster formation and strong tendency towards global synchronization is the predominant feature in small frequency mismatch regime. For a large frequency mismatch, the averaged partial frequency had a saw tooth variation along the lattice. Even then at some points stretches of complete phase synchronization are identified in the lattice amidst unsynchronized regions.Control parameters 'a' and 'c' regulated the global synchronization in the lattice. The general effect of noise was to completely or partially destroy the states of phase synchronization, even though, many cases of exceptions are observed in which, the inclusion of noise effectively increased and reinforced the phase synchronization in the lattice.

REFERENCES

- [1] Juvencio Alberto Etal, J. of Physics, Conf. ser, 2005, 23, 58.
- [2] Rosenblum M., Pivosky A. and Kurthus J., Europhys. Lett., 1996, 34, 165.
- [3] Rosenblum M., Pivosky A. and Kurthus J., Phys. Rev. Lett., 1996, 76, 1804.
- [4] Rosenblum M., Pivosky A., Osipov G. and Kurthus J., *Physica D: Nonlinear Phenomena*, 104, 219–238.
- [5] Rössler O. E., Phys. Lett. A., 1976, 57, 397.
- [6] Osipov, Grigory V., Pikovsky, Arkady S., Rosenblum, Michael G., and Kurths, Jurgen, Phase Synchronization effects in a lattice of non-identical Rössler oscillators, *Phys. Rev. E*, 1997, 55, 2353.

Synthesis and Characterization of Silver Substituted Cobalt Ferrite Nanoparticles

Sheena Xavier¹, Rintu Mary Sebastian² and E. M. Mohammed²

¹Department of Physics, St. Xavier's College for Women, Aluva, Kerala 683101, India ²Department of Physics, Maharaja's College, Ernakulam, Kerala 682011, India emmohammed_2005@yahoo.com

ABSTRACT

In the present study, silver substituted cobalt ferrite nanoparticles (Co_1 . $_xAg_xFe_2O_4$, x=0.0, 0.025, 0.05, 0.075, 0.1) have been synthesized by sol-gel technique. The X-ray diffraction analysis shows the formation of the spinel structure in all the samples. The crystallite size of the samples was calculated from the prominent diffraction peak using Scherrer formula and it was found to be in the 14 to 20 nm range. The lattice parameter increases initially for x=0.025 and decrease thereafter. The infrared spectra show two prominent absorption bands which are characteristic of spinel ferrites. Transmission electron micrograph reveals the spherical shape and narrow size distribution of the nanoparticles.

Keywords: Nanoparticles, Cobalt ferrite, silver doping, magnetic properties

INTRODUCTION

Nanocrystalline ferrites have been the focus of intense research for more than a decade due to their unusual structural, magnetic and electrical properties. A resurgence of interest in magnetic nanoparticles is observed in recent years due to their promising applications in biomedicine. Ferrite nanoparticles offer potential applications in a variety of biomedical fields such as magnetically guided drug delivery, magnetic hyperthermia and magnetic resonance imaging [1-3]. Several physical and chemical

methods are available for the synthesis of ferrite nanoparticles. The sol – gel technique allows good control over stoichiometry and produce nanoparticles with small size and narrow size distribution [4, 5]. Hence this method is selected for the synthesis of cobalt ferrite nanoparticles. Cobalt ferrite is an important magnetic material and is characterized by its high coercivity, moderate saturation magnetization and very high magneto-crystalline anisotropy. These properties along with their physical and chemical stability make them suitable for several technological applications [6, 7].

The application of magnetic nanoparticles as antimicrobial agents is gaining importance due to the fact that they can be easily manipulated by an external magnetic field. The iron oxide nanoparticles have been synthesized and tested for various applications in medicine such as magnetic hyperthermia, targeted drug delivery and bactericides [8 - 10]. Among the different ferrites, cobalt ferrite has special magnetic and physical properties which lead to its wide applications in medicine. The biomedical and clinical applications of silver nanoparticles are well established in the literature [11 - 13]. Okasha et al. [14] studied the effect of silver substitution in magnesium ferrite and observed an enhancement in its thermal and electrical conductivity. Further, silver nanoparticles have a broad spectrum of antibacterial activity against several pathogens. Hence they are incorporated into various matrices to extend their utility in biomedical applications. The addition of silver to cobalt ferrite will provide a new composite material with good magnetic behaviour and enhanced antimicrobial activity.

MATERIALS AND METHODS

Nanoparticles of silver substituted cobalt ferrite were synthesized by a facile and rapid sol-gel technique. Stoichiometric ratio of cobalt nitrate, silver nitrate and ferric nitrate (AR grade MERCK) were dissolved in minimum amount of ethylene glycol using a magnetic stirrer. The solution was heated at 333 K until a wet gel of the metal nitrate was obtained. Further heating of the gel at 473 K resulted in the self ignition and a highly voluminous and fluffy product is obtained. This powder was ground well using an agate mortar. These synthesized powders were labelled as CA0, CA1, CA2, CA3 and CA4 based on the amount of silver in it.

The silver substituted cobalt ferrite samples were characterized by using X-ray powder diffractometer (XRD, Bruker AXS D8 Advance) using Cu-K α radiation (λ = 1.5406A0) at 40 kV and 35 mA. The morphology of the nanoparticles was analyzed by using transmission electron microscope (TEM, Philips-CM200).The Fourier transform infrared (FTIR) absorption spectra of the samples were recorded using FTIR spectrometer (Thermo Nicolet, Avatar 370) in the wave number range 900-400 cm⁻¹ with potassium bromide (KBr) as binder.

RESULTS AND DISCUSSIONS

The XRD patterns of $Co_{1-x}Ag_xFe_2O_4$ nanoparticles are depicted in Fig. 1. The results obtained from XRD data agrees well with the standard values of cobalt ferrite (JCPDS PDF Card No.22-1086).

Sample	Lattice parameter, <i>a</i> Å	Crystallite size, D (nm)
CA0	8.3247	15.12
CA1	8.3791	16.59
CA2	8.3141	18.04
CA3	8.3095	18.77
CA4	8.2969	20.32

Table 1. Lattice parameter and Crystallite size of Co_{1-x}Ag_xFe₂O₄



Fig.1 XRD pattern of Co_{1-x}Ag_xFe₂O₄

The diffraction peaks corresponding to (220), (311), (400), (422), (511) and (440) reflection planes show that all the samples have attained cubic spinel structure. But, from x=0.05 onwards additional peaks are emerged which indicates the presence of metallic silver (JCPDS PDF Card No.04 - 0783). The lattice parameter a for all the samples has been calculated using the following equation [15]

$$a = d_{hkl}\sqrt{h^2 + k^2 + l^2},$$
 (1)

where, d_{hkl} is the interplanar spacing for the prominent peak indexed with (311). The lattice parameter of all the samples is given in Table 1. Though coarse grained cobalt ferrite exhibits inverse spinel structure, in the Nano regime it is reported that they adopt partially inverse structure. Therefore, both the divalent (Co) and trivalent (Fe) ions occupy the tetrahedral and octahedral sites of the spinel lattice. The lattice parameter of silver substituted cobalt ferrite is observed to increase initially and then it decrease for higher silver concentrations. An increase in lattice parameter with increase in silver content is expected because of the large ionic radius of Ag^{2+} (0.108 nm) compared to that of Co^{2+} (0.072 nm) ion. The unit cell of the spinel cobalt ferrite expands to accommodate larger silver ions so that lattice parameter increases. A possible explanation for the decrease in the lattice parameter for x > 0.025 can be the compression of the spinel lattice by the secondary phase formed on the grain boundaries. Similar observation was reported in the case of gadolinium doped lithium nickel ferrites [16]. Due to large ionic radius, silver ions cannot diffuse in the spinel lattice and hence they form secondary phases on the grain boundaries. For smaller concentration of silver such as x=0.025, it can be presumed that the cobalt ions in the octahedral sites are replaced by silver ions. However, when the concentration increases, the aggregation of silver occurs on the grain boundary and further expansion of the spinel lattice is hindered. Beyond x=0.025, most of the silver remains as metallic silver and this is evident in the XRD pattern. The study on silver doped MgFe₂O₄ nanoparticles showed the formation of metallic silver phase and suggested that iron ions change their valence from Fe^{3+} to Fe^{2+} to achieve charge neutralization [14]. Further investigations are needed to confirm the factual distribution of cations in silver doped cobalt ferrite samples. The crystallite size D of the samples has been estimated from the broadening of XRD peaks using the Scherrer equation [17].

$$D = \frac{0.9\lambda}{\beta\cos\theta},\tag{2}$$

where, λ is the X-ray wave length, β is the full width at half maximum (FWHM) and θ is the Bragg angle. It can be seen from Table 1 that the crystallite size of the samples increases with silver ion concentration.



Fig.2 TEM image of Co.95Ag.05Fe2O4

TEM image of the $Co_{.95}Ag_{.05}Fe_2O_4$ is shown in Fig. 2. Most of the nanoparticles are almost spherical in shape; however, a slight agglomeration is noticed. The size of more than 200 nanoparticles is determined from different TEM images of the same sample using *Image J* software. The most probable diameter of the nanoparticles was determined by modelling the data with log normal distribution.

In the wave number range $1000 - 300 \text{ cm}^{-1}$, the infra-red bands of solids are usually assigned to vibration of ions in the crystal lattice. Infrared spectra of the several spinel ferrites are reported by Waldron [18]. Two prominent metal-oxygen bands are seen in the IR spectra of spinel ferrites. The highest one v_1 generally observed in the range $600 - 550 \text{ cm}^{-1}$, corresponds to intrinsic stretching vibrations of the metal at the tetrahedral site. The lowest band v_2 , usually observed in the range $450-400 \text{ cm}^{-1}$, is assigned to octahedral-metal stretching [19]. FTIR spectra of the investigated samples in the wave number range $900 - 400 \text{ cm}^{-1}$ are shown in Fig. 3.



Fig.3. FTIR spectra of Co_{1-x}Ag_xFe₂O₄

It can be seen from the figure that the vibrational frequency band position (v_2) shift to higher frequency side with increasing silver content. This may be an indication of the substitution of Co²⁺ ions on the octahedral site by silver ions. The frequency band position v_1 initially increases and then decrease for higher concentrations of silver. This decrease may be attributed to the formation of secondary phase in these samples.

CONCLUSIONS

Silver substituted cobalt ferrite nanoparticles, $Co_{1-x}Ag_xFe_2O_4$ have been successfully synthesized by sol-gel technique. The XRD analysis reveals that the prepared samples exhibit a spinel structure with sizes varying from 14 to 20 nm. The FTIR spectra corroborate the formation of spinel ferrite structure in all the samples. The addition of silver ions shifts the absorption band v_2 towards the higher frequency side which suggests the occupancy of silver ion on octahedral site. Thus the silver substituted cobalt ferrite nanoparticles with good magnetic and antibacterial properties can offer great promise in biomedical and pharmaceutical applications.

ACKNOWLEDGEMENTS

SX acknowledges the University Grants Commission for providing teacher fellowship under the faculty improvement programme.

REFERENCES

- [1] Goldman, Modern Ferrite Technology, Van Nostrand, New York, 1990.
- [2] S. Amiri, H. Shokrollahi, The role of cobalt ferrite magnetic nanoparticles in medical science, *Mater. Sci. Engg. C*, 2013, *33*, 1–8.
- [3] N. Sanpo, C. C. Berndt, Cuie Wen, James Wang, Transition metal substituted cobalt ferrite nanoparticles for biomedical applications, *Acta Biomaterialia*, 2013, 9, 5830 – 5837.
- [4] B. P. Jacob, S. Thankachan, S. Xavier, E. M. Mohammed, Dielectric behaviour and AC conductivity of Tb³⁺ doped Ni_{0.4}Zn_{0.6}Fe₂O₄ nanoparticles, *J. Alloys compd*, 2012, 541, 29 35.
- [5] S. Thankachan, B. P. Jacob, S. Xavier, E. M. Mohammed, Effect of samarium substitution on structural and magnetic properties of magnesium ferrite nanoparticles, *J. Magn. Magn. Mater*, 2013, *348*, 140 145.
- [6] I. H. Gul, A. Masqood, Structural, magnetic and electrical properties of cobalt ferrites prepared by the sol gel route, *J. Alloys compd*, 2008, 465, 227 231.
- [7] Z. Zi, Y. Sun, X. Zhu, W. Song, Synthesis and magnetic properties of CoFe₂O₄ ferrite nanoparticles, *J. Magn. Magn. Mater*, 2009, *321*, 1251 1255.
- [8] B. Chudasama, A. K. Vala, N. Andhariya, R. V. Upadhyay, R. V. Mehta, Enhanced antibacterial activity of bifunctional $Fe_3O_4 Ag$ core shell nanostructures, *Nano Research*, 2009, *2*, 956 965.
- [9] S. Arokiyaraj, M. Saravanan, N. K. Udaya Prakash, M. Valan Arasu, B. Vijayakumar, S. Vincent, Enhanced antibacterial activity of iron oxide magnetic nanoparticles treated with Argemone mexicana, L. Leaf extract: An in vitro study Mater. Resear. Bulletin, 2013, 48, 3323 – 3327.

- [10] C. H. Liu, Z. D. Zhou, X. Yu, B. O. Lv, J. F. Mao, D. Xiao, Preparation and characterization of Fe₃O₄/Ag composite magnetic nanoparticles, *Inorganic Materials*, 2008, 44, 291 – 295.
- [11] M. Gao, L. Sun, Z. Wang, Y. Zhao, Controlled synthesis of Ag nanoparticles with different morphologies and their antibacterial properties, *Mater. Sci. Engg. C*, 2013, 33, 397 404.
- [12] I. Sondi, B. S. Sondi, Silver nanoparticles as antimicrobial agent: a case study on E.coli as amodel for Gram – negative bacteria, J. Coll. Inter. Sci., 2004, 275, 177 – 182.
- [13] R. Das, S. Gang, S. S. Nath, Preparation and Antibacterial Activity of Silver Nanoparticles, *Journal of Biomaterials and Nanobiotechnology*, 2011, 2, 472 475.
- [14] N. Okasha, Influence of silver doping on the physical properties of Mg ferrites, J. *Mater. Sci*, 2008, 43, 4192 4197.
- [15] B. D. Cullity, Elements of X-Ray Diffraction, Addison Wesley, California, 1978.
- [16] J. Jing, L. Liangchao, X. Feng, Structural analysis and magnetic properties of Gddoped Li – Ni Ferrites prepared using rheological phase reaction method, J. Rare Earth, 2007, 25, 79 – 83.
- [17] B. P. Jacob, S. Thankachan, S. Xavier, E. M. Mohammed, Effect of Gd³⁺ doping on the Structural and Magnetic Properties of nanocrystalline Ni-Cd mixed ferrite, *Phys. Scr.* 84, 2010, 045702.
- [18] R. D. Waldron, Infrared spectra of ferrites, Phy. Rev., 1955, 99, 1727 1735.
- [19] K. B. Modi, M. K. Rangolia, M. C. Chhantbar, H. H. Joshi, Study of infrared spectroscopy and elastic properties of fine and coarse grained nickel-cadmium ferrites, *J. Mater. Sci.*, 2006, 41, 7308 – 7318.

Regulatory Sequence Analysis computational studies on Human Homeobox Genes in T Cell Lymphocytic leukemia and the Potential Effect of Plumbagin; a Plant Derived Naphthoquinone as an Anti-proliferative Agent

Roopa P. Namboothiri¹, Dani Joseph²

¹Post Graduate Department of Bioinformatics, Union Christian College, Aluva, Kerala. roopanamboothiri@gmail.com ²Post Graduate Department of Biotechnology, Aquinas College, Edacochi danialphonsa@gmail.com

ABSTRACT

Plumbagin, exists in the medicinal plant Plumbagozeylenicahas been proved to exert anti-proliferative effect in cell cultures as well as animal tumor models. Even though there is emerging evidences that plumbagin have the potential as a chemotherapeutic agent, their exact growth regulatory mechanisms remain poorly understood. Microarray gene expression analyses of T cell leukemic lymphocytes have revealed the activation of a set of proto oncogenes belong to the HOX gene family which encodes nuclear proteins that undergoes cell cycle dependent regulations. As transcription factors, HOX proteins regulate target genes by specifically binding to DNA on cis-regulatory elements. Only a few of these target genes have been identified so far. The redundancy in HOX function is based upon their ability to bind to similar DNA sequences, and also on the interaction of HOX proteins with a common set of co-factors such as PBX (Pre-B-cell leukemia transcription factors). PBX modifies the DNA binding specificity of HOX proteins and influences the regulation of transcription. HOX-PBX interaction therefore represents a novel and highly promising target for anti-cancer therapeutics. Further, molecular docking analysis with plumbagin using Hex (V.6.3) was conducted on PBX so as to find potential PBX binding peptides which could selectively interrupt the PBX-dependent transcriptional regulation of the HOX gene.

Keywords: Plumbagin, HOX gene, Microarray, Nuclear proteins, PBX

INTRODUCTION

Since the identification of the human homeobox (HOX) genes there is a significant and ever increasing amount of evidences that suggests the involvement HOX in the regulation of hematopoiesis [1, 2]. Homeobox genes code for transcription factors, affecting developmental processes during embryogenesis and in the adult. Homeobox genes also code for transcription factors which exhibit strong impacts on cellular behavior, including differentiation, proliferation, and survival. Therefore, upon deregulation, these genes may turn into potential oncogenes, contributing substantially to oncogenesis and other malignancies. Among hematopoietic malignancies, including leukemia and lymphomas, several homeo-oncogenes have been described. Many of them have been identified in hematopoietic cell lines, which serve as useful tools for oncogene -hunting and characterization. In humans about 200 homeobox genes have been identified and many of these are implicated in cancer because of ectopic expression [3].

Recent Microarray gene expression analyses of T cell leukemic lymphocytes have revealed the activation of a set of proto-oncogenes belong to the *HOX* gene family which encodes nuclear proteins that undergoes cell cycle dependent regulations [4]. Although the function of each individual gene has not been clearly defined there is strong evidence for cooperatively among homeoproteins indicating that regulatory combinations of homeobox genes may play a pivotal role in controlling survival, proliferation and differentiation of leukemic lymphocytes. Being regular transcription factors, *HOX* proteins regulate target genes by specifically binding to DNA on cis-regulatory elements. Only a few of these target genes have been identified so far. To achieve this high-regulatory specificity, it has been postulated that Hox proteins co-operate with other transcription factors to activate or repress their target genes in a highly context-specific manner. The context dependency also allows a single Hox protein to affect on distinct sets of target genes in the same cells during the course of development [5]. This particular feature makes Hox proteins ideal candidates for elucidating

the mechanisms employed by transcription factors to achieve tissue-specific functions in multicellular organisms.

Plumbagin, a quinonoid constituent isolated from the root of *Plumbagozeylanica* L., has been shown to exert anticarcinogenic, anti-atherosclerotic, and antimicrobial effects [6, 7]. It exhibits an inhibitory effect on carcinogenesis in the intestines, causes cytogenetic and cell cycle changes in mouse Ehrlich ascites carcinoma, and possesses anti-proliferation activity in human cervical cancer cells [7]. Even though there is emerging evidences that plumbagin have the potential as a chematherapeutic agent, their exact growth regulatory mechanisms remain poorly understood. The present study aims at detecting *HOX* cis-regulatory elements in genomic sequences using Regulatory Sequence Analysis Tools (RSAT). Further, molecular docking analysis with plumbagin was conducted on the retrieved regulatory sequences so as to detect the potential effect as an anti-proliferative agent in T cell lymphomas.

A central role for HOX genes in hematological malignancies is supported by the frequently observed elevation of HOX and MEIS2 gene expression in AML Patient samples. The suppression of Pbx1 expression enhanced in vivo Hoxb4-mediated HSC expansion 20- to 50-fold greater than HOXB4 alone [8]. Pbx1 and Meis1 mutant animals are embryonic lethal and recapitulate the HSC defects observed in Hox knockout models, indicative of a role for these genes in HSC self-renewal/proliferation [9].

MATERIALS AND METHODS

The structure of plumbagin was obtained from Molecules Structural Archive and Gallery (http://molecules.gnudarwin.org/mod/hydroxy/hydroxy-naphthoquinone-more.html) and converted to PDB format and opened in RASMOL. The structure of HOX-B1, PBX1 complex, and Meis2 was obtained from RCSB Protein Databank (fig.1 & fig.2). Molecular docking analysis with plumbagin using Hex (V.6.3) was conducted on HOX- PBX-Meis2, pdb files (fig.3), so as to find potential PBX1 binding peptides. Comparative binding analysis and

position of specific binding of the molecule was visualized using Rasmol and Swiss PDB Viewer.

Classificati Structure V	on: Protein/dna Veight: 33783.67	9		
Molecule: Polymer: Chains:	DNA (5'-D(*AP*CP*1 1 Type: D	rP*CP*TP*AP*TP*GP*Al dna	D*TP*TP*GP*AP*TP*CP*GP* Length:	GP*CP*TP*G)-3') 20
Molecule: Polymer: Chains:	DNA (5'-D(*TP*CP*A 2 Type: E	P*GP*CP*CP*GP*AP*TP dna	*CP*AP*AP*TP*CP*AP*TP*A Length:	AP*GP*AP*G)-3') 20
Molecule: Polymer: Chains: Fragment: Mutation: Organism UniProtKB:	PROTEIN (HOMEOBO) 3 Type: A HEXAPEPTIDE, HOME 1 RESIDUE (MET) ADD Homo sapiens 𝒫 ■ Protein Feature V	X PROTEIN HOX-B1) protein ODOMAIN SED TO N-TERMINUS fiew P Search PDB P	Length: P14653 ਯੋ	97
Molec. Pro Molec. Pro Secstruc 1872.A	Cocessing Homeobox pro	tein Hox-B1	 Homeobox 	
Molecule: Polymer: Chains: Fragment: Organism UniProtKB:	PROTEIN (PBX1) 4 Type: B HOMEODOMAIN Homo sapiens P Protein Feature V	protein Yiew우 Search PDB우	Length: P40424 중	87
Molec. Pro	Pre-B-cell leuk	emia transcription factor 1 ®	Homeobox;) 	

Fig.1 RCSB-PDB entry of Human homeobox (HOX) - Pre B Cell leukemia transcription factor

For detecting Hox –Cis regulatory elements in human genomic sequences, Regulatory Sequence Analysis Tool (RSAT). (http://rsat.ulb.ac.be/) was used. The FASTA sequences of HOX-B1, PBX was retrieved from NCBI (http://www.ncbi.nlm.nih.gov/) and Meis 2 was obtained from Gene cards (http://www.genecards.org). The oligo-analysis was done using RSAT, keeping in perceptive that a set of genes are co-expressed i.e. they show similar expression profiles, and some elements are shared by their upstream regions. Thus, a single analysis was performed to reveal binding sites for multiple transcription factors.



Fig.2 RCSB-PDB entry of Meis 2

RESULTS AND DISCUSSIONS

Docking result was obtained from Hex and viewed in RASMOL which showed complete docking of PBX, HOX-B1-Meis2 complex with plumbagin which revealed a protein-

Aquinas Journal of Multidisciplinary Research

DNA interaction(Fig:4). The protein site of action as assumed was the binding region of molecule docked. The energy was calculated in SPDV _4.10_PC energy field (Table: 1). The results revealed comparative binding energy levels for HOX- PBX-Plumbagin (-7618.205) and HOX-PBX-Meis-Plumbagin (-13562.57) complexes which shows plumbagin is a good anti leukemic drug as it shows lower energy levels on computing force field. The results of Regulatory Sequence Analysis studies are given in table 2. The expected frequency of sequences, frequency of occurrence, P value (probability of occurrence), E value (expected frequency of sequences) was also calculated. Based on the results, the best consensus sequences were identified. The sequences with low E value are highly multiple transcription factor binding sites in co-expressed genes.



Fig.3 Hox-Pbx-Plumbagin



Fig.4 Hox-Pbx-Meis1-Plumbagin

Protien	Energy(KJ/mol)
HOX- PBX- Plumbagin	7368.205
HOX-PBX- MeisPlumbagin	13562.57

Table 1. The Swiss- PDB Veiwer- energy field results

The oligo analysis using RSAT result :

Column headers

1	seq	oligomer sequence
2	identifier	oligomer identifier
3	exp_freq	expected relative frequency
4	occ	observed occurrences
5	exp_occ	expected occurrences
6	occ_P	occurrence probability (binomial)
7	occ_E	E-value for occurrences (binomial)
8	occ_sig	occurrence significance (binomial)
9	rank	rank
10	ovl_occ i	numbers of overlapping occurrences (discarded from the count)
11	forbocc	forbidden positions (to avoid self-overlap)

Aquinas Journal of Multidisciplinary Research

seq	identifie	exp_freq	0	exp_	occ_	occ	occ_	ra	ovl_	Forb
	r		cc	осс	Р	_ E	sig	nk	occ	occ
cata	cataga tc	0.00168677	2	0.05	0.00	1.9	1.72	1	0	10
ga	tatg	82829			120	e-				
						02				
atag	atagag ct	0.00223124	2	0.07	0.00	3.3	1.48	2	0	10
ag	ctat	18660			208	e-				
						02				
ctat	ctatga tc	0.00429716	2	0.13	0.00	1.2	0.93	3	0	10
ga	atag	87008			742	e-				
						01				
actc	actcta ta	0.00059872	1	0.02	0.01	2.8	0.55	4	0	5
ta	gagt	52273			781	e-				
						01				
aatc	aatcat at	0.00834516	2	0.25	0.02	4.2	0.38	5	0	10
at	gatt	97269			595	e-				
						01				
ccga	ccgatc ga	0.00868012	2	0.26	0.02	4.5	0.35	6	0	10
tc	tcgg	20983			790	e-				
						01				
atca	atcata tat	0.00897715	2	0.27	0.02	4.7	0.32	7	0	10
ta	gat	88635			968	e-				
						01				
cgat	cgatca tg	0.00960166	2	0.29	0.03	5.4	0.27	8	0	10
са	atcg	89247			357	e-				

seq	identifie	exp_freq	0	exp_	occ_	occ	occ_	ra	ovl_	Forb
	r		сс	осс	Р	_ E	sig	nk	осс	occ
						01				
cagc	cagccg c	0.01064400	2	0.32	0.04	6.5	0.19	9	0	10
cg	ggctg	91225			047	e-				
						01				
agcc	agccga tc	0.01277152	2	0.38	0.05	9.0	0.05	10	0	10
ga	ggct	78529			604	e-				
						01				

Table 2. RSAT Results

CONCLUSIONS

In the present study, an attempt has been made to identify, the Hox-cis regulatory elements using RSAT, further, molecular docking analysis with plumbagin was conducted on the retrieved regulatory sequences in order to find out their regulatory effects. The regions of the co expressed genes and their transcription factor binding sites where also analyzed. The successful docking of the ligand with receptor provides the evidence for binding and blocking of plumbagin with PBX1, HOX-B1. Thus anti-proliferative action of plumbagin can be demonstrated *in silico*. Results of the present study highlights the potential of plumbagin as a novel plant derived chemotherapeutic against T-cell lymphocytic leukemia which is seen prevalent even in newborns and also in adults.

REFERENCES

- [1] Kehrl J. H., Homeobox genes in hematopoiesis, Crit Rev Oncol Hematol, 1994, 16, 145.
- [2] Lawrence H. J., Sauvageau G., Humphries R. K., Largman C., The role of HOX homeobox genes in normal and leukemic hematopoie- sis., *Stem Cells*, 1996, *14*, 281.
- [3] Garcia-Fernàndez J., The genesis and evolution of homeobox gene clusters, *Nat. Rev. Genet.*, 2005, *6*, 881–892.
- [4] Stefan Nagel and Hans G. Drexler, *Expression Analysis of Homeobox Genes in Leukemia/Lymphoma Cell Lines Cancer Cell Culture*, 2011, 731, 371-380.
- [5] Hueber S. D., Bezdan D., Henz S. R., Blank M., Wu H. et al., Comparative analysis of Hox downstream genes in *Drosophila*, *Development*, 2007, *134*, 381–392.
- [6] Mossa J. S., El Feraly F. S., and Muhammad I., Antimycobacterial constituents from Juniperusprocera, Ferula communis and Plumbagozeylanica and their in vitro synergistic activity with isonicotinic acid hydrazide, *Phytother Res*, 2004, 18, 934-937.
- [7] Srinivas P., Gopinath G., Banerji A., Dinakar A., and Srinivas G., Plumbagin induces reactive oxygen species, which mediate apoptosis in human cervical cancer cells, *Mol Carcinog*, 2004, *40*, 201-211.
- [8] B. Argiropoulosand, R. K. Humphries, Hox genes in hematopoiesis and leukemogenesis, *Nature, Oncogene*, 2007, 26, 6766–6776.
- [9] Nicki R. Colledge, Brian R. Walker, Stuart H. Ralston, *Davidsons Principles and practices of Medicine*, 2010, 1031-1037.

Molecular Docking Analysis of Natural Ligands Against Infectious Proteins of Human Immunodeficiency Virus and Hepatitis B virus

Dani Joseph¹ and Roopa P. Namboothiri²

¹Post Graduate Department of Biotechnology, Aquinas College, Edacochin Kerala and ²Post Graduate Department of Bioinformatics, Union Christian College, Aluva, Kerala. danialphonsa@gmail.com; roopanamboothiri@gmail.com

ABSTRACT

The molecular docking studies of ligands derived from Phyllanthusniruri with proteins involved in most common retroviruses including HIV and HBV is an upcoming area to determinate the ligands of Phyllanthusniruri to their potential targets. We report an in silico approach for the evaluation of novel ligand inhibitors of natural origin against infectious proteins involved in retroviral infections, as promising natural plant products for controlling HIV and HBV infections. Docking studies reveal that extracts of Phyllanthusniruri including geraniin and ellagic acid inhibits human immunodeficiency virus reverse transcriptase (HIV-RT), HIV integrase, Hepatitis B Virus transactivator X (HBV-X) and HBV-RNA polymerase. The ligands from Phyullanthusniruri were downloaded from RCSC PDB and the inhibitors were identified by molecular docking studies with the software Hex (V.6.3) and by energy calculations using swiss PDB Viwer.

Keywords: Molecular docking, Hex, Swiss PDB Viwer

Abbreviations used: HIV - Human Immunodeficiency Virus, HBV – Hepatitis B Virus, HBV X - Hepatitis B Virus transactivator X

INTRODUCTION

Recent statistical studies provide information that HIV/AIDS is responsible for over 2 million deaths annually across the globe [1]. It is predicted that by year 2020, AIDS would

become the deadliest of all the pandemics in human history. Various chemical substances of phyto medical herb extract have been found to act on the reverse transcriptase enzyme of HIV [2]. It is estimated that 500 million people are infected with hepatitis B or C virus worldwide [3]. These and many other human and zoonotic viral agents, therefore, pose a continuous threat to human health and economy.

Molecular docking studies are gaining popularity in drug discovery analysis with the development of molecular docking softwares. With the structural information of various organic and inorganic molecules in popular databases such studies provide great opportunities for developing drug molecules against various diseases. Docking is the process in which two molecules fit together in 3D structural space. Docking is a tool which predicts the preferred orientation of one molecule to another molecule when bound to each other to form a stable complex. Docking is frequently used to predict the binding orientation of small molecule drug candidates to their protein targets in order to predict the affinity and activity of the small molecule to the receptor proteins. Hence docking plays a very prominent role in the rational design of drug molecules. Molecular docking can be defined as an optimization problem, which would represent the "best-fit" orientation of a ligand that binds to a particular protein of interest. The aim of molecular docking is to gain an optimized and desired conformation for both the protein and ligand and an appropriate orientation between protein and ligand such that the free energy of the overall system is minimized [4]. The computing methods to find the probable target proteins for active compounds, natural products or old drugs and this type of drug target finding is called "Insilico Target fishing" or "Inverse Virtual Screening". There are a number of drug target databases developed for the purpose of performing target fishing [5]. These tools generate a tractable set of receptor proteins for experimental validation. Many molecular docking studies have been reported in the literature and many more are being performed. Most of them are drug discovery based studies and use software such as Hex. Such softwares have the advantages that it is easy to handle docking and that results have relatively high power when analyses are carried out properly.

For our study we have selected ligand molecules from the medicinal herb *Phyllanthusniruri*. This medicinal herb is known as good for HBV infections including jaundice, and from literatures it is evident that this herb is also acting against HIV proteins. Therefore we have chosen two viruses and their infectious proteins for their susceptibility in the presence of our selected phyto ligands include geraniin and ellagic acid from the medicinal herb *Phyllanthusniruri*. It is the purpose of this study to evaluate the inhibitory binding of phyto ligands to target infectious proteins.

MATERIALS AND METHODS

Target preparation and validation:

3D structure of HIV-RT, HIV integrase, Hepatitis B Virus transactivator X (HBV-X), HBV-RNA polymerase and such target proteins were downloaded from Protein Data Bank [6]and prepared them for docking with phytomedical ligands from *Phyllanthusniruri*. The phytomedical ligands in the present study are geraniin and ellagic acid. The 3-D structures of ligands were downloaded from various sites. The structures of ligands were in SDF format and they are converted to PDB format for docking using Hex.

Molecular Docking:

The ligand receptor interactions were studied for HIV-RT, HIV integrase, Hepatitis B Virus transactivator X (HBV-X) and HBV-RNA polymerase with different phytomedical ligands such as geraniin and ellagic acid. Hex software was used for the purpose of docking [7]. Both the receptor and ligand structures are uploaded as '.pdb' file and are prepared for docking.

Docking using Hex

Hex is an interactive molecular graphics program for calculating and displaying feasible docking strategies of protein and DNA molecules. Hex can also calculate protein - ligand docking, assuming the ligand is rigid, and it can superpose pairs of molecules using only the knowledge of their 3D shapes. Default parameters were used for the docking process and Energy values of each docking were obtained.

RasMol Visualisation of Hex Result

Docked structures are viewed in protein visualisation software RasMol in and the result should be in .pdb format. In RasMol we have visualised the ligand molecule is bound tightly to the receptor protein in its pocket. For each structure like geraniin - reverse transcriptase, geraniin - integrase, ellagic acid - reverse transcriptase, ellagic acid - integrase, geraniin - HBV RNA polymerase, geraniin - HBV X, ellagic acid - HBV RNA polymerase and ellagic acid - HBV X are viewed in RasMol. In RasMol, protein and ligand can be viewed either by separate color or by separate structure and so on. So the binding between receptor and ligand is very much clear.

Swiss PDB Analysis of Hex Result

Hex result can also be analysed in Swiss PDB Viewer for energy calculation, analysis of Ramachandran plot and so on. By calculating the energy of docked structure or the Hex result further steps in the drug discovery process can be taken. We can also determine whether the docked structure is stable or not by Swiss PDB Viewer.

RESULTS & DISCUSSIONS

In RasMol we have visualised Hex results of each structure- geraniin - reverse transcriptase, geraniin - integrase, ellagic acid - reverse transcriptase, ellagic acid - integrase, geraniin - HBV RNA polymerase, geraniin - HBV X, ellagic acid - HBV RNA polymerase and ellagic acid - HBV X, and these were as ligand molecules were bound tightly to the receptor proteins in their pockets. In RasMol, proteins and ligands are viewed by separate colour and by separate display models. The bound structures are added here in figure 1 and figure 2. The structures are again viewed in Swiss PDB Viewer and Swiss PDB Viewer gave energy level of the bound structures.

Lower binding energy values of the selected phytochemical constituents when docked with retroviral enzymes revealed that the compounds can exist at lower energy levels and found to be more stable than their original forms.

RasMol Visualisation of Hex Result

a. Geraniin – HIV Reverse transcriptase



c. Ellagic acid – HIV Reverse transcriptase





d. Ellagic acid – HIV Integrase



Fig.1 Hex Result of Geraniin and Ellagic acid with HIV receptor proteins a. Geraniin – HIV Reverse transcriptase, b. Geraniin – HIV Integrase, c. Ellagic acid – HIV Reverse transcriptase and d. Ellagic acid – HIV Integrase. The ligands are represented by red colour and in spacefill model. The target proteins are represented as Wireframe model.

a. Geraniin – HBV RNA polymerase

b. Geraniin – HBV X

- c. Ellagic acid HBV RNA polymerase
- d. Ellagic acid HBV X

Fig.2 Hex Result of Geraniin and Ellagic acid with HBV receptor proteins a. Geraniin – HBV RNA polymerase, b. Geraniin – HBV X, c. Ellagic acid – HBV RNA polymerase and d. Ellagic acid – HBV X. The ligands are represented by red color and in spacefill model. The target proteins are represented as Wireframe model.
Protein	Energy (Kj/mol)
Reverse Transcriptase	451134752
RT Ellagic acid	435278912 (-15855840)
RT Geraniin	467804512 (16669760)
Integrase	-12125
Integrase Ellagic acid	-12161 (-36)
Integrase Geraniin	-12097 (28)

The Swiss- PDB Veiwer- energy field results

Table1: Energy level of compounds in single state and in bound state

Figures in the parenthesis show the difference in binding energy from the original compound.

The two compounds namely geraniin and ellagic acid are proven to have anti-retroviral activity. These compounds, geraniin and ellagic acid are promising anti-retroviral agents and can be used as drugs for HIV and HBV infections. Insilico evaluations of geraniin and ellagic acid are considered as inhibitors having antiretroviral effects. The phytochemical ligands bind tightly to the active sites of the receptor proteins and this binding process is the preliminary step to the drug discovery process. In this present study Geraniin and ellagic acid has lower energy level while bound with receptor proteins such as HIV Reverse transcriptase, HIV integrase, HBV RNA polymerase and HBV X than they exist freely in unbound state. Molecules are stable in their lower energy state and the ligands in the present study are in lower energy state while docking with target proteins. Molecular docking using Hex and further analysis with Swiss PDB Viewer has shown that the binding energies of the compounds are fairly less and are known retroviral inhibitors. This work shows that the two alkaloid extracts namely geraniin and ellagic acid has the potential to become druggable candidate molecules or leads for anti-retroviral therapy.

CONCLUSIONS

The development of novel chemotherapeutic agents would play a key role in the treatment of HIV and HBV patients. Nowadays, the chemical, biological and ecological diversity of the ecosystem has contributed immensely potent antiretroviral compounds. In this study we have demonstrated that the alkaloid extracts of phytomedical herb *Phyllanthusniruri* are potential leads to evolve novel anti-retroviral drugs and they are found to target many of the experimentally validated targets relating to various retroviral infections. This study indicates the importance of alkaloid extracts from phytomedical herb *Phyllanthusniruri* in regards to their use as anti-retroviral agents. Further work can be extended towards experimental studies and evaluation of their antiretroviral activity as the findings suggest that these compounds could be developed as lead compounds for designing of anti-retroviral drugs with novel targets and mechanisms of action.

ACKNOWLEDGEMENTS

We thank Rev. Fr. Pradeep Vazhatharamalayil [Principal, Mar Athanasios College For Advanced Studies, Tiruvalla (MACFAST), Kerala], Mr. Stephen James [Head, Post Graduate Department of Bioinformatics at Mar Athanasios College For Advanced Studies, Tiruvalla (MACFAST), Kerala], Mr. Hareesh R. and Mrs. Betsy M. Baby [Faculty Members of the Post Graduate Department of Bioinformatics at Mar Athanasios College For Advanced Studies, Tiruvalla (MACFAST), Kerala], for their valuable guidance.

REFERENCES

- [1] Bokazhanova A., Rutherford G. W., The epidemiology of HIV and AIDS in the world, *Coll Antropol*, 2006, *30*, 3-10.
- [2] Choi K. T., Botanical characteristics, pharmacological effects and medicinal components of Korean Panax ginseng, C. A Meyer. Acta Pharmacol Sin, 2008, 29, 1109-1118.

- [3] WHO, WHO's role and responsibilities in health research: Draft WHO strategy on research for health: Report by the Secretariat, World Health Organization, Geneva, 2010.
- [4] Maria Antony, Dhivyan J. E. and Anoop M. N., *Virtual Screening And Lead Optimization To Identify Novel Inhibitors For Hdac-8*, School of Health and Life Sciences, Edinburgh Napier University, Edinburgh, United Kingdom, 2012.
- [5] Rong Zheng , Tuan-Sheng Chen and Tun Lu, A Comparative Reverse Docking Strategy to Identify Potential Antineoplastic Targets of Tea Functional Components and Binding Mode, *International Journal Of Molecular Sciences*, 2012, *12*, 5200-5212
- [6] H. M. Berman, J. Westbrook, Z. Feng, G. Gilliland, T. N. Bhat, H. Weissig, I. N. Shindyalov and P. E. Bourne, *The Protein Data Bank Nucleic Acids Research*, 2000, 28, 235-242
- [7] Ritchie D. W., *Hex 6.3 User Manual Protein Docking Using Spherical Polar Fourier Correlations*, Copyright 1996-2010.

Farmers' Suicides and Agrarian Crisis in India

Nitheesh Kumar P. K.

S.N. College, Cherthala, nitheeshkumarpk@gmail.com

ABSTRACT

Poor returns from cultivation and absence of non-farm opportunities are indicative of the larger socio-economic malaise in rural India. This is accentuated by the multiple risks that the farmer faces yield, price, input, technology and credit among others. The increasing incidence of farmers' suicides is symptomatic of a larger crisis, which is much more widespread. Risk mitigation strategies should go beyond credit. Long term strategies requires more stable income from agriculture, and more importantly, from non-farm sources. Private credit and input markets need to be regulated.

Keywords: Suicides, Indebtedness, Kaivaipa, Credit burden, Crop loss/yield uncertainty, Market vulnerabilities (price shocks and increasing input costs), Returns to cultivation, Suicide Mortality Rate (SMR).

INTRODUCTION

Agriculture is an important sector of Indian economy as it contributes about 17% to the total GDP and provides employment to over 60% of the population. Indian agriculture has registered impressive growth over last few decades. The food grain production has increased from 51 million tons (MT) in 1950-51 to 250 MT during 2011-12 highest ever since independence. The production of oilseeds (nine-major oilseed) has also increased from 5 MT to28 MT during the same period. The rapid growth has helped Indian agriculture mark its presence at global level. India stands among top three in terms of production of various agricultural commodities like paddy, wheat, pulses, groundnut, rapeseeds, fruits, vegetables, sugarcane, tea, jute, cotton, tobacco leaves, etc (GOI, 2008-09).

However, on marketing front, Indian agriculture is still facing the problems such as low degree of market integration and connectivity, accessibility of reliable and timely information required by farmers on various issues in agriculture. Also, the agricultural marketing sector is characterized by fragmented supply chain. Huge post harvest losses, multiple market intermediaries, higher transaction cost, lack of awareness and several other socio-economic factors are some of the acute problems being faced by the Indian agriculture. But due to some severe the share of agriculture and allied sectors in India's GDP has declined to13.7 per cent in 2012-13 due to shift from traditional agrarian economy to industry and service sectors. Suicide rates among Indian farmers were a chilling 47 per cent higher than they were for the rest of the population in 2011. In some of the State's worst hit by the agrarian crisis, they were well over 100 per cent higher. The new Census 2011 data reveal a shrinking farmer population. And it is on this reduced base that the farm suicides now occur.

A popular peasant saying that "abundance of water destroys life; paucity of water destroys life" signifies agriculture's link with monsoon. The vagaries of nature have been associated with ups and downs in cultivation. In addition, disease and pests can also affect crops. When the produce is good, a glut in the market can through low prices lead to poor returns from cultivation. Increasing cost can also adversely affect returns. Spurious inputs could also leave the farmer in a quandary. The increasing dependence on inputs from the market has also brought about greater demand for credit, which adds another important dimension to the difficulties.

There are multiple risks in agriculture – income, yield, price, input, technology and credit among others. In recent years, one observes an increasing incidence of farmers' suicides. Suicide being a multifaceted and complex phenomenon, the risks are identified either in the neurobiological or socioeconomic domain. The former are predisposing in nature and are internal to the individual whereas the latter are the precipitating ones and are external to the individual. A relatively higher suicide among a particular sub-group is

indicative of a larger socio economic malaise. All the above factors lead to the problem of agrarian crisis in India.

The features of the current agrarian crisis are briefly elaborated as follows. First, there has been a decline in the trend growth rate of production as well as productivity for almost all crops from the mid-nineties. Further, the value of output from agriculture has been declining from late nineties. Second, there is an excessive dependence of a large section of the population on agriculture (in 2004-05 nearly 64 per cent of the rural persons were from households whose members major activity status was either self-employed in agriculture or agricultural labour). This also indicates that rural non-farm employment opportunities are limited. Third, with declining size-class of holding and an increasing preponderance of marginal holdings (63 per cent as per 2000-01 agricultural census) along with poor returns from cultivation indicates that income for farm households is very low.

Fourth, the much talked about green revolution had a greater focus on rice and wheat under irrigated condition by passing crops and regions under rain fed or dry land conditions (which is three-fifths of the141 million hectares of net sown area in the country during 2003-04). There has been failure to capitalize on the vast network of institutes to provide and regulate new technology (including the usage of biotechnology), and a virtual absence of extension service. Fifth, the neglect of agriculture in plan resource allocation has led to a decline of public investments in irrigation and other related infrastructure. Sixth, supply of credit from formal sources to the agricultural sector is inadequate leading to greater reliance on informal sources at higher interest burden. Last, but not the least, with changing technology and market conditions the farmer is increasingly being exposed to the uncertainties of the product as well as factor markets.

OBJECTIVES

- 1. To know the place of farmers in Indian economy.
- 2. To find out the reasons for farmers suicides in India.
- 3. To recognize what happens to the families after a farmer commit suicides.
- 4. Give some preventive measures.

METHODOLOGY

This study is based on secondary data; the data was collected from different sources like journals and articles, news papers, books, periodicals, websites etc.

Farmers' Suicides

Poor agricultural income and absence of non-farm avenues of income is indicative of the larger malaise in the rural economy of India. One manifestation of this has been the increasing incidence of farmers' suicides. The suicide mortality rate (SMR, suicide death for1,00,000 persons) for male farmers in India increased from 12.3 in 1996 to 19.2 in 2004 and then reduced to 18.2 in 2005 whereas SMR for male non-farmers increased from 11.9 in 1996to a peak of 14.2 in 2000 and thereafter declined to 13.4 in 2005.

During 2001-05, there were 86,922 farmers' suicide, of which, 86 per cent were males. Across major states, the states where SMR for male farmers is higher that of the national average of 17.5 and SMR for male non-farmers in that state are Kerala, Maharashtra, Chhattisgarh, Karnataka, Tamil Nadu and Andhra Pradesh Among smaller states/union territories the incidences are high in Pondicherry, Dadra & Nagar Haveli, Delhi, Goa and Sikkim. Public policy and media attention have already highlighted the farmers 'suicides in parts of Kerala, Maharashtra, Karnataka and Andhra Pradesh .In selected districts of these states, the central government and the respective state governments have announced measures to deal with distress.

Aquinas Journal of Multidisciplinary Research

What is intriguing is that the relatively higher incidence of farmers' suicides in Chhattisgarh and Tamil Nadu seems to have gone unnoticed. Chhattisgarh scenario is worrying because cultivators form nearly 45 per cent of its workers, as per 2001 census. Tamil Nadu situation is serious because some recent studies based on verbal autopsies point out that suicides as per police records are underestimates (Gajalakshmi and Peto 2007; Josephet al 2003). Further probing is required in these states. Studies in the other four states have identified multiple risk factors that co-exist and reinforce each other.

The most common thing was indebtedness (96 out of 111 cases, 87 per cent). From all those indebted, 44 per cent were harassed for repayment of loan and in 33 per cent of cases the creditor insisted on immediate repayment. Next in importance is fall in economic position (74per cent). Indebtedness may leads to economic downfall, when repayment is difficult and the household may resort to sale of assets. Similarly, a fall in economic position can also leads greater reliance on credit, and thereby increasing the debt burden. Not discussing one's problem with others (55 per cent) leads to closing an avenue for letting out ones pent up feelings and frustration. Crop failure is mentioned in 40 per cent of the cases and most of these also mentioned about loss in second or third sowing due to delay in rainfall.

There were a few cases which mention fire or theft. Crop loss can also happen due to excessive untimely rain, say, during the time of harvest. Crop failure can lead to economic downfall and make it difficult to repay existing loans. This will also increase the need for additional credit. Crop failure leading to fall in economic position is quite straight forward, but the causal links can also be the other way round. A house that had some fall in economic position or was heavily indebted could not take additional loans for investing in agriculture (say, during a pest attack) and this can lead to a reduction in yield or total crop failure. Incidentally, the year of survey when pockets witnessed crop loss, the overall scenario was a glut in the market and as a result many individuals faced yield and price shock simultaneously. Change in social status was identified in 36 per cent of the cases. This can be associated with a fall in economic position. Harassment by creditors or their agents due to non-payment of loans can also lead to a loss of face in the community. Crop failure due to unsuccessful experimentation by a farmer who was recognized as successful entrepreneur may find a change in his social status – people who earlier came for advice are now providing solace. A socially important role of a brother/father is to get one's sister/daughter married. Communities have norms in terms of age and expenditure. A farmer is largely dependent on a good return from his produce to fulfill this obligation. Thus, crop failure, greater credit burden or a fall in his economic position can come in his way of fulfilling this obligation. Inability to conduct sister's/daughter's marriage can be socially humiliating. It can also increase in the household conflicts. To complete this social obligation a farmer may also take loans thinking that he can repay the amount after the harvest

Recent marriage of a sister/daughter or inability to get one's sister/daughter married has been identified as a risk factor in 34 per cent of the cases. Recent suicides in a nearby village are identified as an additional risk factor (32 per cent). There could be an imitation effect because an individual who is facing some similar socioeconomic problem can relate to the earlier incident and contemplate suicide. Under addiction (28 per cent – mostly alcohol) an individual may indulge in an act of self-harm without being aware of the consequences. Alternatively, getting intoxicated could be a reaction to get out of depression that can be associated with some socio-economic problem. Change in the individual's behavior (26 per cent) including disputes with neighbors/others (24 per cent) could be indicating the need for some psychosocial help. Personal health problem of the deceased was identified in 21 per cent of the cases. From these, 26 per cent (6 cases) were those with some mental health problem. Illness gets aggravated due to poor economic condition because it makes care seeking difficult.

Similarly, ill health can lead to a loan to meet medical expenses and also reduce the ability to work aggravating the economic condition. If the sick person is some other member

(3 per cent of the cases) then the breadwinner has the added frustration and helplessness in not being able to provide appropriate care for an ailing parent/spouse/child. Death of another member in the family before the incident was identified in 10 per cent of the cases. The near ones death could have been because of not receiving appropriate health care. Inability to provide care is largely because of the poor economic condition rooted in the larger agrarian crisis. Suicide history in the family could be identified in 6 per cent of the cases. This could be indicative of a genetic factor. However, as mentioned earlier such Individual factors are predisposing in nature and they can be intensified with some additional risk factors.

The Global Perspective

1. The suicide rate for farmers throughout the world is higher than for the non-farming population.

2. In the Midwest of the U.S. suicide rates among male farmers are twice that of the general population.

3. In Britain farmers are taking their own lives at a rate of one a week.

4. In India, one farmer committed suicide every 32 minutes between 1997and 2011.

All over the world the impact of an industrial approach to boosting crop yields has stripped many small farmers of their self-sufficiency and thrown them into despair.

Numbers and Trends in Farm Suicides in India

In the ten year period between 1997 and 2006 as many as 166,304 farmers committed suicide in India. If we consider the 12 year period from 1995 to 2006 the figure is close to 200,000: the exact figure (190,753) would be an underestimation since a couple of major states like Tamil Nadu and Rajasthan and a number of smaller states like Pondicherry did not report any farmers' suicides for one or the other – or both - of these two years. Thus, going by the official data, on average nearly 16,000 farmers committed suicide every year over the last decade or so.

We would believe that even this number, shocking as it is, is in fact an underestimation of the actual number of farm suicides in the country during this period. The data published by the National Crime Records Bureau, as we have noted above, are put together from the police records from different states. Our experience during our field visits in Andhra Pradesh as a member of the Farmers' Commission set by the state government in 2004 was that the police often adopted a rather strict and stringent definition of a farmer in identifying a farm suicide. The title to land was taken as the criterion for identifying the farmer and this often left out a genuine farmer from the count. For example, a tenant farmer who leased in land and hence did not have a title to the land could be denied the status of a farmer; so also a farmer if the title was in his father's name.

Gender Composition of Farm Suicides in the Country

Farm suicides, according to official data, take place overwhelmingly by the male farmers. Considering the period 1997-2006 as a whole, close to 85 per cent of all the farm suicides are by male farmers, and every fifth male suicide in the country is a farm suicide. Suicides in general, among the population as a whole, are also largely concentrated among males, but the degree of concentration here is significantly lower than in the case of farm suicides: male suicides in the general population account for nearly 62 percent of all suicides in the country. It is also worth noting that the number of male suicides among farmers has increased quite rapidly, at around 3 percent per annum during this period, 1997-2006; the number of female farm suicides in sharp contrast has remained almost static during the period. Consequently the extent of concentration of farm suicides among males has witnessed a steady increase over the period up to 2012-13.

In sum, four significant facts behind the farm suicides in the country as a whole are as follows:

 A large number of farmers - close to 17,000 per year – commit suicide today in the country; a number we believe is unacceptably large.

- 2) The rate of suicide among farmers is also likely to be very high in comparison with the rate for the general population
- 3) An overwhelming proportion (nearly 85 percent) of farm suicides is by male farmers; and the number of farm suicides by young farmers, accounting for nearly 30 percent of the total, is not small
- 4) The trends in both the number of suicides and the rate of suicides are distressing: while the number seems to jump to a higher level in certain years – as in 1998 and 2002 – in the subsequent years after these sharp jumps, there is no reverting back to older numbers; they in fact seem to stabilize at this higher level till the next jump occurs. As for the farm suicide rates, there is reason to believe that they are increasing over time, at least from the year 2001 onwards; the contrast in this regard with general suicide rates which have remained more or less stable is noteworthy.

Distressing as these numbers and trends are, a disaggregated analysis of the data show that there are certain regions in the country where these problems – of the numbers, trends and rates of farm suicides – are much more acute. Let us turn a discussion of these regional patterns now.

FACTORS UNDERLYING FARMERS' SUICIDES

As with any suicide, mono-causal explanations for farmers' suicides would be totally inadequate. And they cannot be explained purely in terms of behavioral patterns and personal, psychological motivations; they have to seen as social phenomena and one has to unearth the underlying social causes. It is worth emphasizing this simple point because there have been attempts at late, especially by state functionaries – particularly in the most affected states like Maharashtra – to delink farm suicides from the agrarian crisis. The claim often made is that a number of farm suicides are not attributable to agrarian crisis and are due to factors like unsustainable life styles of farmers, alcoholism, large expenses on

marriages, or due to some incurable diseases etc. And these types of explanations, we believe, are seriously flawed, since they do not view suicides as a social phenomenon.

Why Farmer Suicide Rates Are So High?

- * Financial Stress constant financial pressure related to the "Farm Crisis"
- * Drought and flood which add to the economic problems
- * Loss of independence and control many of the issues are not within the farmer's
- * Control disease, weather, government policy, but the debts are personal
- * Sense of Loss: repeated sense of hopelessness, loss of crops, loss of land, loss of income, loss of community, loss of family farm, loss of a way of life
- * Geographical remoteness and the potential for social isolation
- * Untreated Mental Illness: Lack of access to mental health services in rural areas.
- * Depression arising from exposure to agricultural chemicals/pesticides may increase the risk for mood disorders and ultimately suicide.

What happens to the families after a farmer commits suicide?

- Farms are confiscated due to inability to payback high interest loans.
- Harassment of the family by corrupt moneylenders.
- Widows burdened with the new responsibility of the family.
- Children sometimes lose both parents to suicide. Forcing their education to a halt, especially if they have to work in order to provide for their needs.

Farmer Suicides - how can we prevent them?

1. The dependency of agriculture on nature should be reduced. This calls for effective management of water during seasons of good monsoons. Prevention of crop failure should be the primary aim of the Government.

- 2. Making institutional finance available to every farmer is another important solution to save to the farmers from debt traps of money lenders. Where institutional finance is available, it should be made easily accessible to the poorest farmers.
- 3. Farmers need to be advised and guided on economical methods of cultivation which would save finances for them.
- 4. The government could also explore the possibility of pooling of the lands of small farmers and making a bigger chunk of economically cultivable land. Through pooling of lands, the small farmers can avail the economies of cultivating on a larger scale.
- 5. Small farmers should be encouraged to develop alternative sources of income and the government should take up the responsibility of providing training to the farmers to acquire new skills.
- 6. Provision of relief facilities alone is not sufficient as it has been observed in the case of Andhra Pradesh where farmers committed suicides just to avail the benefits of relief packages.

Theoretical frame work of the study

Emile Durkheim theory of individual and society

Durkheim argued that economic affluence, by stimulating human desires, carries with it dangers of anomic conditions because it "deceives us into believing that we depend on ourselves only," while "poverty protects against suicide because it is a restraint in itself." Since the realization of human desires depends upon the resources at hand, the poor are restrained, and hence less prone to suffer from anomie by virtue of the fact that they possess but limited resources. "The less one has the less he is tempted to extend the range of his needs indefinitely."

Durkheim distinguished between types of suicide according to the relation of the actor to his society. When men become "detached from society," when they are thrown upon their own devices and loosen the bonds that previously had tied them to their fellow, they

are prone to egoistic, or individualistic, suicide. When the normative regulations surrounding individual conduct are relaxed and hence fail to curb and guide human propensities, men are susceptible to succumbing to anomic suicide. To put the matter differently, when the restraints of structural integration, as exemplified in the operation of organic solidarity, fail to operate, men become prone to egoistic suicide; when the collective conscience weakens, men fall victim to anomic suicide.

In addition to egoistic and anomic types of suicide, Durkheim refers to altruistic and fatalistic suicide. The latter is touched upon only briefly in his work, but the former is of great importance for an understanding of Durkheim's general approach. Altruistic suicide refers to cases in which suicide can be accounted for by overly strong regulation of individuals, as opposed to lack of regulation. Durkheim argues in effect that the relation of suicide rates to social regulation is curvilinear--high rates being associated with both excessive individuation and excessive regulation. In the case of excessive regulation, the demands of society are so great that suicide varies directly rather than inversely with the degree of integration.

For example, in the instance of the Hindu normative requirement that widows commit ritual suicide upon the funeral pyre of their husbands, or in the case of hara-kiri, the individual is so strongly attuned to the demands of his society that he is willing to take his own life when the norms so demand. Arguing from statistical data, Durkheim shows that in modern societies the high rates of suicide among the military cannot be explained by the deprivations of military life suffered by the lower ranks, since the suicide rate happens to be higher for officers than for enlisted men. Rather, the high rate for officers can be accounted for by a military code of honor that enjoins a passive habit of obedience leading officers to undervalue their own lives. In such cases, Durkheim is led to refer to too feeble degrees of individuation and to counterpoise these to the excesses of individuation or de-regulation, which account, in his view, for the other major forms of suicide.

Aquinas Journal of Multidisciplinary Research

Durkheim's discussion of altruistic suicide allows privileged access to some of the intricacies of his approach. He has often been accused of having an overly antiindividualistic philosophy, one that is mainly concerned with the taming of individual impulse and the harnessing of the energies of individuals for the purposes of society. Although it cannot be denied that there are such tendencies in his work, Durkheim's treatment of altruistic suicide indicates that he was trying to establish a balance between the claims of individuals and those of society, rather than to suppress individual strivings. Acutely aware of the dangers of the breakdown of social order, he also realized that total control of component social actors by society would be as detrimental as anomie and deregulation. Throughout his life he attempted to establish a balance between societal and individual claims. Here we can connect the farmer's suicides with Durkheim altruistic approach of suicide. The farmers are commit suicides for different reasons, after they borrow money from banks and money lenders that may also leads to suicides of the farmers. They may commit suicide for save their identity in front of the society but they will not think about the consequences after their suicide. That will create lots of problems in the victim family and society.

CONCLUSIONS

As has been mentioned earlier, there cannot be one single and most effective solution to prevent the suicides of farmers. The trend can be reversed through active participation of the Government in addressing the real issues of the farmers that are driving them to suicides. Social responsibility also goes a long way to help the farmers. The big land owners in most places do not lend a helping hand to struggling farmers, in most cases, they grab the benefits which are otherwise meant for the poor farmers. General public, NGOs, Corporate and other organizations too can play a part in helping farmers by adopting drought affected villages and families and helping them to rehabilitate. The solution to the farmer's plight should be directed towards enabling the farmers to help themselves and sustain on their own. Temporary measures through monetary relief would not be the solution. The efforts should be targeted at improving the entire structure of the small farmers wherein the relief is not given on a drought to drought basis, rather they are taught to overcome their difficulties through their own skills and capabilities. The Government needs to come up with pro-active solutions and the nation has to realize that farmers' suicides are not minor issues happening in remote parts of a few states, it is a reflection of the true state of the basis of our economy.

Give a man a fish, he will eat for a day but teach him how to fish, he will eat for the rest of his life", so goes the popular saying, the case of our Indian farmers is similar to this, what they need is a means to sustain throughout their lives without having the face the desperation that adversity drives them to. If India has to shine, it is these farmers that need to be empowered.

REFERENCES

- [1] IHME, *GBD Profile: India*, Washington DC: Institute for Health Metrics and Evaluation, University of Washington, 2010.
- [2] PRB, 2010 World Population Data Sheet, Washington DC: Population Reference Bureau, 2010.
- [3] NCRB, Accidental Deaths and Suicides in India, New Delhi: Ministry of Home Affairs, Various Years.
- [4] Patel V., Ramasundarahettige C., Vijayakumar L., et al. Suicide mortality in India: a nationally representative survey, *Lancet*, 2012, *379*, 2343–2351.
- [5] Mishra S., Suicide mortality rates across states of India 1975-2001: a statistical note. *Economic and Political Weekly*, 2006, *41(16)*, 1566-1569.
- [6] Nagaraj K, *Farmers' Suicides in India: Magnitudes, Trends and Spatial Patterns*. Chennai: Bharathi Puthakalayam, 2008.

- [7] Government of India, *Report of the Expert Group on Agricultural Indebtedness*. (Chair: R. Radhakrishna), New Delhi: Ministry of Finance, 2007.
- [8] Reddy D. N., Mishra S., *eds. Agrarian Crisis in India*, New Delhi: Oxford University Press, 2009.
- [9] Deshpande R. S., Arora S., eds. Agrarian Crisis and Farmers' Suicides. New Delhi: Sage, 2010.
- [10] Vasavi A. R., *Shadow Space: Suicides and the Predicament of Rural India*, New Delhi: Three Essays Collective, 2012.
- [11] Gruère G., Sengupta D., *Bt cotton and farmer suicides in India: an evidence-based assessment. Journal of Development Studies*, 2011, 47, 316–337.
- [12] Mayer P., Suicide and Society in India, London and New York: Routledge, 2010.
- [13] Establet R., Suicide in India in the early twenty-first century (in French), *Sociologie*, 2012, *3*(2), 117-143.
- [14] Plewis I., *GM Cotton and suicide rates for Indian farmers, Working Paper,* Manchester: The Cathie Marsh Centre for Census and Survey Research, University of Manchester, 2014.
- [15] Plewis I., Indian farmer suicides: is GM cotton to blame?, *Significance*, 2014, *11(1)*, 14-18.
- [16] Gajalakshmi V., Peto R., Suicide rates in rural Tamil Nadu, South India: verbal autopsy of 39000 deaths in 1997–98, *International Journal of Epidemiology*, 2007, 36, 203-207.

Demystifying Science: A Study of Humour in Bill Bryson's A Short History of Nearly Everything Alicen Roshiny Jacob

Department of English, Aquinas College, rocha0610@gmail.com

ABSTRACT

Most books explaining concepts relating to science as well as scientific writing always adopts a straight forward, simple language, interspersed with scientific jargon, carrying a matter of fact tone. Although this might be interesting to people who passionately feel about science, to a layman who is trying to gain an understanding of the mysteries of science it may seem boring and uninteresting. The attempt to make it better by using rhetoric often falls short and only helps in making it more complex and esoteric. But in the book A Short History of Nearly Everything, the writer Bill Bryson, who is best known for his travelogues, presents an almost "quick read" history of science in a very humorous way. Besides the use of hyperboles and metaphors, he juxtaposes the life of scientists, often people with eccentric characters, and their unbelievable scientific discoveries and inventions, thereby catching the attention of the readers rather than putting them to sleep. He in fact subverts the myth that science can be interesting for only those with a scientific inclination and proves that any man, even those without any scientific background, can actually enjoy science and what it offers. This paper will attempt to study Bill Bryson's work as an endeavour to bring science down from the pedestal. It will throw light on how he uses Bakhtin's notion of Carnivalesque to achieve his ends.

Keywords: Humour, Carnivalesque, Contextualisation, Science writing

In France, a chemist named Pilatre de Rozier tested the flammability of hydrogen by gulping a mouthful and blowing across an open flame, proving at a stroke that hydrogen is indeed explosively combustible and that eyebrows are not necessarily a permanent feature of

Aquinas Journal of Multidisciplinary Research

one's face. Most books explaining concepts relating to science, as well as scientific writing, always adopt a straight forward and simple language interspersed with scientific jargon, carrying a very matter of fact tone. This might seem interesting to people who passionately feel about science but to a layman who is trying to gain an understanding of the mysteries of science, this might seem boring and uninteresting. The use of rhetoric often falls short and only helps in making it more complex and esoteric. Is there any other way to make it more exciting and surprising? Of course the use of a narrative might help to arouse interest. What about humour? Science and humour? They are literally like two opposing magnetic fields which are never expected to go hand in hand. However, Bill Bryson in his *A Short History of Nearly Everything* presents a totally new way of looking at science. John Waller in his review of Bryson's book notes: "The anaemic, lifeless prose of standard science textbooks, he argues, smothers at birth our innate curiosity about the natural world. Reading them is a chore rather than a voyage of discovery. Even books written by leading scientists, he complains, are too often clogged up with impenetrable jargon" (Rev. Gaurdian).

Therefore Bryson say's "I grew up convinced that science was supremely dull"(23). But later in his life felt an extreme urge to know about the earth and everything on it and spent about four years doing nothing but understanding science and its achievements. He travelled to about eleven countries on five continents and read loads of books, journals, transcripts and monographs and met experts from various disciplines asking them "enormous amount of dumb questions"("An Even Shorter Hist."). The result was this very humorous *quick read* history of science which leaves the audience in peals of laughter rather than putting them to sleep. By means of this book, Bryson proves that science and its history can be enjoyable to any man by means of humour.

Definitions of humour vary from the quality of being amusing to the ability to appreciate or express that which is humorous, to situations, speech, or writings that are thought to be humorous, a state of mind; temper; mood etc. Similarly many writers and philosophers have come up with different definitions on how humour arises in writing. For instance, according to Immanuel Kant "Laughter is an affectation arising from the sudden transformation of a strained expectation into nothing" (Kant 172). "Aristotle reasoned that laughter arises in response to weakness and ugliness" (Ruch 29-30). Now how does Bryson bring humour into his writing especially when he is talking about something as serious as science?

Very often he begins his discussion with a narrative and presents information in a very simple *sitting across the table and talking* style, thereby catching the attention of his audience. Time and again while describing he compares the object of discussion to something totally not thought of. He arouses, to use McGhee's term, "humour response" as Willibald Ruch notes in his essay by drawing a comparison "…between objects, elements of an object, or between an event and an expectation" (20),which are often incongruous. For instance while talking about neutrinos and the difficulty involved in detecting them Bryson says, "What it really takes to find particles these days is money and lots of it. There is a curious inverse relationship in modern physics between the tininess of the thing being sought and the scale of the facilities required to do the searching" (208).

Again when he explains about the expenditure involved in dividing an atomic nuclei into subatomic particles called Quarks Bryson comments, "But these numbers [\$1.5 billion and 14 trillion volts of energy] are as nothing compared with what could have been achieved by, and spend upon, the vast and now unfortunately never-to-be Superconducting Super collider, which began construction near Waxahachie, Texas, in the 1980s, before experiencing a super collision of its own with the United States Congress" (209).

Therefore Bryson's humour "involves the bringing together of two normally disparate ideas, concepts or situations in a surprising or unexpected manner" (Ruch 25) and the laughter results while perceiving something in one sense (often serious), is looked at in a totally different (usually improbable) perspective, thus falling under the head of incongruity theory of humour. For example, Bryson notes that while Einstein's colleagues believed him

to have wasted the second half of his life, "Elsewhere, however, real progress was being made. By the mid-1940's scientists had reached a point where they understood the atom at an extremely profound level – as they all too effectively demonstrated in August 1945 by exploding a pair of atomic bombs over Japan" (192).

Sometimes humour can be used to express negative or hostile attitudes. According to superiority/disparagement theory of humour, humour is often used to belittle individuals or social groups; it can as "Suls suggested" notes Ruch result from "… an incongruity relating to some misfortune befalling a victim, and this incongruity can only be recognized or resolved (and therefore found funny) if one has a negative or unsympathetic attitude toward the victim"(31). This aspect can be recognised when Bryson talks about Thomas Midgley, Junior, the inventor of the "extravagantly destructive" chlorofluorocarbons or CFCs:

Midgley never knew this because he died long before anyone realized how destructive CFCs were. His death was itself memorably unusual. After becoming crippled with polio, Midgley invented a contraption involving a series of motorized pulleys that automatically raised or turned him in bed. In 1944, he became entangled in the cords as the machine went into action and was strangled. (196)

Bryson develops his humour not merely by the employment of narrative about how things were discovered or invented, but also through the inclusion of the lives of scientists which our not habitually found in our books on science. He often in very personal tones juxtaposes the life of scientists, often people with eccentric characters and their unbelievable scientific inventions. This in itself might result in laughter as the audience who till now have never been exposed to the scientists lives and character (who actually would have expected them to be gifted beings unlike them) would be suddenly struck by the incongruity of the image of the scientist they have in mind and their actual life presented by the writer. In a way laughter here arises from, to use Arthur Koestler's term, "bisociation" in which humour can result from "the juxtaposition of two normally incongruous frames of reference or the discovery of various similarities or analogies implicit in concepts normally considered remote from each other" (Ruch 25).

Although this book by Bryson is instantly categorized under the genre of non-fiction, it can be further narrowed down to science writing or popular science, which actually bridges the gap between scientific literature and popular cultural discourse. "The goal of the genre is often to capture the methods and accuracy of science, while making the language more accessible. Many science-related controversies are discussed in popular science books and publications... ("Popu. Sci."). " Since this is aimed at a wider audience who may have formal learning but no specific scientific training, the writers of such books unlike other science books are expected "to sufficiently explain difficult topics to people who are totally new to the subject" ("Popu. Sci.") which often demands the writer to be creative. Bryson in this book achieves this by blending the technique of storytelling with humour. He discusses the history of various disciplines such as astronomy, geology, palaeontology, physics, chemistry etc. not by tracing the whole history of one and moving on to other but by tracing the progress of each in a particular age or period in time. Very often he ends his chapters by telling the audience that he will be discussing the remaining part in a later section which leaves them in eager expectation. This type of plot construction and the use of various techniques of humour serve not only to maintain the attention of his readers but also lend it a kind of literariness.

As evident popular science writing gains currency because it is accessible as well comprehensible to the common man. But is this the only reason for its appeal? As Bryson himself notes in his introduction, as a child he found science books weren't

...actually altogether comprehensible. Above all it didn't answer any of the questions that the illustration stirred up in the normal enquiring mind: How did we end up with a Sun in the middle of our planet and how did they know

how hot it is? And if it is burning away down there why isn't the ground under our feet hot to touch? (22)

Thus science writing serves to fill in the gaps which we come across in the usual science books - like textbooks, which are at many times our only exposure to science. It even provides a clarification for the doubts that may happen to arise in the reader's mind. In a way it is recontextualizing the information given in scientific books in a more deconstructed and digestible form by defamiliarizing the things the reader may already know by presenting it in a new light. To put it in a different way, what different literary devices does to lend poetry the effect of defamiliarization is what popular science writing does to scientific writing (in Bryson's case with his use of narrative and humour) by means of recontexualization.

Bryson's attempt to present science and what it offers in a totally new angle can be seen as an attempt to subvert the myth that science can be only interesting to those with a scientific inclination. In fact to use Mikhail Bakhtin's term, he carnivalizes the kind of relation which exists between scientific world and the world of ordinary men. Just as in a carnival where there is free interaction between normally separated people, in the realm of popular science writing we can find a non- scientist (like Bryson) interacting with scientists and other experts in the field. Similarly as in the case of carnival where "eccentric behaviour that is otherwise unacceptable is legitimate and human nature's hidden sides are revealed" ("Mik. Bakhtin : Carnival and Carnivalesque"), here too Bryson presents the personal lives of many scientist and their eccentric characters which has been unknown till now which might be quite contrary to the expectation that a reader may have about scientists. According to Bakhtin, carnival is also a site where there is a free interaction between "the sacred and the profane, the new and the old between the high and the low etc." ("Mik.Bakh.") and often turns out to be the space for sacrilege which involves "ungodliness, of blasphemy, profanity and parodies on things that are sacred" ("Mik. Bakh"). In fact Bryson's book can be approached from this angle. Popular science can be seen as a site where an ordinary man

gets to interact with science which till now he may have believed to be the sole prerogative of people in the scientific field, a site where science no longer exists on a pedestal but down there with ordinary men. In other words through means of humour and normal prosaic language Bryson employs a unique technique of writing that constitutes a realm of language where barriers dissolve. His writing therefore emerges as a practical demonstration of Bakhtin's carnivalesque where the social distinctions blur.

Early criticisms on writing hailed the tripolarity – the author, text and the reader emphasising the superiority of the author over the text and the reader. Later there occurred a shift that brought the attention of focus on to the text. However, modern criticisms on writing as well as our present critical scenario uphold the reader forcing him/her into the limelight of prominence. Despite of standing in such a scenario Bryson initiates a move that brings back the author once again into prominence by introducing a new realm of writing in which the author doubtlessly overpowers his readers with his repertoire of information rather than involving reader in the production of the text and its meaning.

Thus, A Short History of Nearly Everything proves how with the use of humour and narrative, Bryson is able to bring science to a level of an ordinary man's reach. Besides the use of different varieties of humour which also lends it creativity and in turn literariness, a close analysis reveals the use other techniques like defamiliarization, carinivalesque and a move back-to-the-author.

REFERENCES

- [1] "An Even Shorter History of Nearly Everything- Bill Bryson." Youtube.Gresham College. 22 Aug. 2011. Web. 27 Oct 2013.
- [2] Bakhtin, M. M., *The Dialogic Imagination: Four Essays*. Ed. Michael Holquist. Trans. Caryl Emerson and Holquist. Austin: U of Texas P, 1981. Print.
- [3] Bryson, Bill. A Short History of Nearly Everything. London: Blackswan, 2003. Print.

- [4] Kant, Immanuel. *Critique of Judgement*. Trans. J. H. Bernard. New York: Hafner, 1951. Print.
- [5] "Mikhail Bakhtin: *Carnival and Carnivalesque* Summary and Review." The Cultural Studies Reader. 22 July 2011. Web. 28 Oct 2013.
- [6] "*Popular Science*."*Wikipedia, The Free Encyclopaedia*. Wikipedia foundation, Inc. 13 July 2004.Web. 10 Aug 2004.
- [7] Ruch, Willibald, "*Psychology of Humour*" *The Primer of Humour Research*, 2008, 8, 17-100. Print.
- [8] Waller John .Rev. of *A Short History of Nearly Everything*, by Bill Bryson. Gaurdian. 21 June 2003. n.pag.web.27 Oct. 2003.

Unculturing the self: *The Strange Case of Billy Biswas* – An Ecodimensional Evolutionary saga

Joby Mathew

Department of English, St. Thomas College, Pala, joby29mathew@gmail.com

ABSTRACT

In a globalized world, with its monologic narrative of development characterized by materialism and mechanization, The Strange Case of Billy Biswas offers a countercultural reading of development and progressive teleology in a different dimension. The story of Billy, a 'cultured' anthropologist going 'primitive' may appear to be a regressive step or a cultural aberration of a perverted genius, but a world steeped in grave ecological crisis, Billy's evolution or metamorphosis can be read as a step of progress in an ecodimensional mode. Interpreted chiefly along existential lines The Strange Case of Billy Biswas has a deeper layer of an ecosophicaldimension. This paper is an attempt to reread the text with special emphasis on the latent ecosophical ethos in the text.

Keywords: ecosophy, metanarrative, progress, nature, culture.

In a very strict poststructuralist discursive paradigm with its underpinning notion of textuality, it is always difficult to draw the line of bifurcation between nature and culture. Cultural critics like Donna Haraway and poststructuralist feminists like Judith Butler have argued that no nature exists as a prediscursive facticity untainted by the matrix of representation. Thus the nature/culture debate is an insoluble one.

Ecocritics and ecophilosophers have challenged the extreme textual claims of structuralists and poststructuralists. But what should be borne in mind is that it is not a pretheoretical naïve clamour for protecting nature with an anthropocentric teleology, but a 'strategic essentialist' stand as Gayathri Chakravorthy Spivak has adopted in the post colonial emancipatory discourse.

Confronted with the global ecological crisis, we are compelled to reconsider our paradigms of culture and progress and to regauge the nature of the relationship between man and his phenomenological reality. The imminent ecological disasters gaping at us persuade us to redefine our narrative of progress. It is in this regard that a new ecophilosophical outlook gathers momentum.

Since philosophical studies in the West have often ignored the natural world (mainly because of the scriptural subjugation of nature to man), and since most studies have focused on human values, those approaches which emphasize ecocentric values have been referred to as ecophilosophy. Arne Naess has defined it thus:

By an ecosophy I mean a philosophy of ecological harmony or equilibrium. A philosophy as a kind of sofia (or) wisdom, is openly normative, it contains both norms, rules, postulates, value priority announcements and hypotheses concerning the state of affairs in our universe. Wisdom is policy wisdom, prescription, not only scientific description and prediction. The details of an ecosophy will show many variations due to significant differences concerning not only the 'facts' of pollution, resources, population, etc. but also value priorities. (A Drengson and Y Inowe 8)

Thus an ecosophical imperative calls for a redefinition of our paradigm of progress.

Progress has always been interpreted as a cultural evolution along the anthropocentric project of appropriating nature and reality according to human-centered discursive paradigms. Hence in a strict deep ecological sense it is a departure from nature to culture where the former is considered to have inferior connotations in the representative matrix of development. Anthropocentric narratives of 'development' represent nature as

dead and passive to be dominated and controlled by humans. This mechanistic world view is founded on the fragile notions of human agency.

Our metanarrative of progress is always one dimensional. It is a journey from ' inferior' nature to 'superior' culture. The parameters with which we gauge progress indicate this prejudice. The progress of a man from a thatched house to a concrete building is a basic indicator of development. The change from wearing a dhothi to a pair of trousers is an indicator of progress or development. The plan to tile the yard of your house rather than keeping it 'natural' is also an indicator of progress. The decision to travel in a vehicle instead of walking a small distance is also a sign of progress. Thus all these small gestures of development constitute the metanarrative of progress – that is 'culture' bound and antinatural.

All that is still 'natural' is said to be 'un'developed and not progressive. This onedimensional notion of development makes us frown with contempt at the primeval and natural ways of life and habits, be it the tribal, adivasi or any other nature bound ontic reality. There are some problems with our epistemology of progress.

The Strange Case of Billy Biswas by Arun Joshi published in 1971 is the story of a highly 'cultured' and successful, city-centered anthropologist shedding his cultural façade and going to live among the tribals on the Maikala hills.

The story of Billy Biswas is narrated by Ramesh (called Romi) a civil servant. Romy meets Billy for the first time in Ney York at a party and he invites Romi to share his abode which is in Harlem. He was living in Harlem for

White America, he said was

much too civilized for him (Joshi 9)

Romi noticed that 'he came from the upper-upper crust of Indian society'. Their friendship flourishes there.

Coming back to India, Billy takes up teaching anthropology at Delhi University and Romi enters the civil service. Both get married. Billy marries Meena Chatterjee and they have a child. Romi's description of Billy indicates his cultured life:

> He had put on weight, rather as a woman does, on his face and around his lips. He was dressed in a very expensive suit. His conversation was nonchalant, at times almost rude. When he drank, he showed it. (Joshi 50)

Once Billy takes a group of students to central India and one day he disappears into the saal forests of the Maikala hills leaving the 'so called organized world' behind.

The narrator meets him accidently after ten years during the visit to a drought ridden village.

I looked at him as, his eyes narrowed, he surveyed the devastated plain. He wore a loin cloth and nothing else... The impression he gave, however, was one of great vitality. (Joshi 75)

Billy Biswas speaks of his transformation:

Layer upon layer peeled off me until nothing but my primitive self was left trembling in the moonlight. (Joshi 88)

The narrator makes a futile attempt to bring Billy back to 'civilization' (back home), but he is shot dead by a havildar during the operation.

Instead of going for the traditional existential reading of *The Strange Case of Billy Biswas*, I attempt to read the novel as a representation of a counternarrative of evolution.

Tribal life has always been represented in the aura of primitivism from which cultural progress evolved. Our paradigm of progress is heavily marked by materiality couched in industrial culture and economic growth gauged in market terminology. Industrial culture represents itself as the only acceptable model for progress and development. Application of this model and its financial and technological systems to all areas of reality results in the destruction of all other models of life on the planet. It is not at all ecofriendly. Our narrative of progress is epistemologically formed in the globalized metadiscourse of market determined consumerism.

The tangible sign of progress in the post modern era is the purchasing and possession of material goods. Consumption as Jean Baudrillard has pointed out is treated as a socially valuable activity in its own right. The result of this change was the massive proliferation of objects whose purpose is no longer justified by need, but instead catered solely to want.

In such a consumerist postmodern ontic mode, we haven't totally disowned our primitive or primeval past. The 'ayurvedic' and 'adivasi' tag attached with market products, especially cosmetic products, show a corporate pastiche which effects a complex mix of primitive 'goodness' with the progressive era.

Our narrative of cultural evolution and progress is not at all ecodimensional. An ecoaesthetic sense is actually blended into our so called cultural existence in a simulated form. We have cultured nature by maintaining costly lawns, fences and by tending tamed gardens—all of which work together to form a 'natural' background to our highly cultured existence as critic. Michael Bunce has clearly observed:

In the process of realizing their own particular version of a country ... they have profoundly altered the character and meaning of the rural landscape. They have fabricated a landscape which has transformed both natural environments and productive spaces into areas which conform to the idealization of countryside as a place of leisure, refuge and alternative living. For the most part it is an amenity landscape, designed to provide pleasure rather than economic sustenance. It is also a predominantly private landscape controlled by the power and exclusivity of property ownership. (Bunce 110)

Thus we know that the progress narrative relies heavily on the active human agent who appropriates the mechanic nature to his cultural ends.

The story of Billy, rather the 'strange' case of Billy offers us an alternative paradigm of progress. The case of Billy is strange. For Billy's desire to unculture himself by going to live among the tribals cannot fit our discursive paradigm of progress or development.

Billy is not an occasional 'cultured' visitor who at times makes a curious peep into the 'natural' ('primitive') life of the tribals to furnish academic needs or cultural irk. That is what we expect from a Delhi based anthropologist who has an elite aura in all his reality of life - a graduate from Columbia, the only son of a Supreme Court judge, husband of a beautiful woman, the father of a handsome child.

Billy's is not a case of a retreat to nature (a Rousseauian mode). It is much more. He actually metamorphoses into a new being. He actually transmigrates. He becomes a new self. Billy describes the night of his transformation:

... it was as though I were not at all this, but the first man on earth facing the earth's first night. A furry little animal came out of a bush...and said, " come to our primitive world that will overcome the works of man. (Joshi 88)

Billy seems to be undergoing a deep ecological realization in which the traditional anthropocentric notion of the human self as an active agent in determining and shaping the non-human world gets dissolved. Deep ecology conceives self in a pantheistic fashion. Deep ecologist Arne Naess conceives it as an extension of identification. He prefaces this by saying that he assumes one is well integrated and has a healthy ego which enables us to connect with a much larger sense of self, transcending ego, by extending our sense of identification beyond the usual narrow focus on ego to a wider sphere of relationships.

Culture with its globalised norms has actually diverted our evolution to a mechanistic and techno-centered technology. Industrialization has served the ecological bond of the human self. Ecological mode of existence began to be viewed with cultural contempt. Our sense of self gradually transformed into a cultural cocoon. Billy Biswas is actually unculturing his self, thereby attaining an encountered liberation. He wears only a loin cloth, he marries a tribal woman Bilasia, he leads a less organized life.

CONCLUSIONS

In the wake of the imminent ecological disaster gaping at us, we need to reconsider our paradigm of cultural evolution. We need to seek a new dimension of progress .our narrative of progress has to be redefined in a greater ecological framework in which the natural should not be regarded as an inferior background to highlight our cultural existence.

The primitive/progress binary has to undergo a conceptual and perceptual deconstruction. Tribal and adivasi existence must be viewed not as 'inferior' primeval ontic modes from which civilizations made its cultural journey of progress. The paradigm of progress should not be a one dimensional material and technocentered linearity.

The story of Billy Biswas depicts a break with our linear narrative of progress from primeval 'coarseness' to cultural 'sophistication'. It represents an attempt to redefine our sense of self not as a cultural entity endowed with active agency to dominate and determine the course of the cosmos, but as an ecological entity whose existence does not make sense apart from the ecological wholeness.

REFERENCES

- [1] Abrams M. H. and Geoffery Galt Harpham, A Glossary of Literary Terms, New Delhi: Cengage Learning, 2012.
- [2] Barry, Peter, *Beginning Theory: An Introduction to Literary and Cultural Theory*, New Delhi: Viva Books, 2010.
- [3] Bunce M., *The Countryside Ideal: Anglo American Images of Landscape*, London: Routledge, 1994.
- [4] Garrard, Greg, *Ecocriticism*, New York: Routledge, 2007.
- [5] Joshi, Arun, The Strange Case of Billy Biswas, New Delhi: Orient Paperbacks, 1971.

Sports and Religion

Shaji Jose

Department of Physical Education, Aquinas College, Edacochin shjosev@gmail.com

ABSTRACT

The purpose of this study is to analyse the attitude among different kinds of sports towards religion. Similarities between sport and religion have times of significant importance and meaning (religious holidays, playoffs, drafts, etc.). Also, there are differences between sport and religion. Religion is non-competitive, whereas sport exhibits a competitive lifestyle. As with sport, rituals and superstitions, athletes and coaches use religion in the sport for a variety of reasons. To cope with uncertainty or failure, to stay out of trouble, to give meaning to sport participation etc.

Key words: Sports, religion.

INTRODUCTION

Sport and religion are two of the oldest social institutions in history. They have been forever linked since the times of the ancient Greeks to the contemporary athlete thanking God for victory.

"The mixing of sport and religion has been in place at least since the Greek athletes offered ritual sacrifices to the gods in the hope of enhancing their performance in events. In my Catholic childhood making the sign of the cross before a free throw was fairly common practice. Today the presence of the deity in sporting events seems, dare we say, omnipresent." Religion and personal belief continue to be important in the lives of most people. Large majority say that they belong to a religious tradition and there is broad agreement with three statements about religious belief and practice. About eight-in-ten world population say they have no doubt that God exists, that prayer is an important part of their lives, and that "we will all be called before God on the Judgment Day to answer for our sins" (William, 2007).

In its most general sense, discipline refers to systematic instruction given to a disciple. This sense also preserves the origin of the word, which is Latin "disciplina" "instruction", from the root discere "to learn," and from which discipulus "disciple, pupil" also derives (Epstein, 2001). School, family, and community partnerships: *Preparing educators and improving schools*. To discipline thus means to instruct a person or animal to follow a particular code of conduct, or to adhere to a certain "order." Consequently, "in the field of child development, discipline refers to methods of modeling character and of teaching self-control and acceptable behavior. Stevenson & Baker (1987).

Human history - Sports and Religion

Throughout human history, sports and religion have been closely linked. Like religion, sports convey important lessons about values and culturally appropriate behavior. The lessons they teach are similar, and both religion and sports use symbols as their primary means of communication. In most of the contemporary world, however, religion and sports occupy separate but complementary conceptual realms. Religion focuses on the idea that, as one anthropologist put it, "there is something more to the world than meets the eye" (Bowen, p. 4). In religion, that "something" is the domain of the divine or of spirit beings; in sport, that "something" is the triumph of the human spirit.

• Scholars from a variety of disciplines typically describe religion as operating in the realm of the sacred and as addressing the relationship of human beings to the supernatural or the transcendent. In modern terms, sport is seen as a secular
pursuit, concerned with the relationship of human beings to each other. In fact, sport and religion are closely related on a number of levels:

- •Historically, many sports developed as part of religious festivals;
- •Sport is often used as a metaphor for religious striving;
- •Sporting events evoke passionate commitment similar to that of religious festivals;
- •Religion and sport are symbolic systems that emphasize similar values and goals, including transcendence of limited personal desires in favor of nonmaterial achievements or experiences and an emphasis on cooperation and personal sacrifice for the good of the group;
- •Both religion and sport convey their message by means of powerful symbols.

Native Americans and Ancient Greeks

The Central American ball game, played by both the Aztec and Maya before the arrival of Spanish conquistadors in the sixteenth century, was associated with the ritual of human sacrifice. Ball courts were commonly located in the temple complex near the racks where skulls of human sacrificial victims were displayed. Players were sacrificed as food for the gods. The divine origins of the ball game are recounted in the Mayan creation myth *Popol Vuh*, which describes the defeat in a ball game of the underworld gods of sickness and death of the hero twins Hunter (Hun Hunahpu) and Jaguar Deer (Xbalanke). In *The Blood of Kings* (1986), Linda Schele and Mary Ellen Miller suggest that, among the Maya, the ritual ball game provided a conquering ruler with a means of validating his reign and a defeated rival with an opportunity to achieve an honorable death.

The four great games of ancient Greece—the Olympian, the Pythian, the Isthmian, and the Nemean—were associated with the worship of the gods. The

Olympian games were held in honor of Zeus, ruler of the sky, whose worship was centered on Mount Olympus, also the site of his marriage to Hera. The Pythian games were held at Delphi, the site of Apollo's oracle, and were said to have been established by the god as compensation for his killing of the great serpent Python. The Pythian games eventually came to include both physical and intellectual competitions, including musical, literary, and dramatic events. The stadium at Delphi was also the site of religious rituals.

The Isthmian games, held at the Isthmus of Corinth every second year, included poetic and musical competitions as well as athletic events. According to one legend, the Isthmian games were initiated by the Greek hero Theseus, who slew the Minotaur. Theseus was fabled to be the son of Poseidon, and the Isthmian games were dedicated to this god. The legendary origins of the Nemean games are traced to an event in which an army led by Polynices, a son of Oedipus, slew a serpent that had killed the infant Opheltes (Snake Man). The Nemean games, held in honor of Zeus, also included poetry and music competitions in addition to athletic contests.

Greek athletes were sometimes accorded the status of gods. Theogenes excelled both in boxing and the Pankration, a virtually no-holds-barred sport that combined elements of boxing and wrestling. He was the son of a priest at a temple dedicated to Herakles in Thasos, on an island in the Aegean Sea. Theogenes, whose name means "god-born," claimed that he was the son of Herakles rather than the priest. Statues of Theogenes were erected at Olympia, Delphi, and Thasos. By all accounts, Theogenes was an arrogant and unpleasant man who earned the wrath of a number of enemies. During his lifetime his enemies were powerless against him, but after his death, one of them sneaked out at night and flogged his statue at Thasos. The statue fell on the man and killed him. Since the statue was guilty of the man's death, it was taken out to sea and thrown overboard. Soon afterwards, Thasos was plagued by crop failures resulting in famine. A consultation with the oracle at Delphi resulted in the order that Thasians should recall their political exiles.

All living political exiles were duly recalled, but the famine continued. Another consultation with the oracle at Delphi produced the reminder that Theogenes remained at large. The statue of the athlete was restored to its base, and the famine ended.

Foot races were part of religious rituals among a number of Native American groups, and there were secret running societies throughout the Americas. Prior to the introduction of the horse by the Spanish, swift runners were important for carrying messages between groups and during times of battle. Within twenty-four hours of the landing of Hernán Cortés (1485–1547) on the east coast of what is now Mexico in May 1519, local runners had described his ship, men, horses, and guns to Moctezuma (1466–1520) at Tenochtitlán, 260 miles away. Ceremonial runners among the Mesquakie in Iowa took a vow of celibacy, adhered to strict dietary rules, and dedicated their lives to running. In many cases, runners represented their clans in races and in religious rituals. Zuni runners painted the symbol of their matrilineal clan on their chests and the symbol of their father's clan on their back. The ball was believed to hold magical power that pulled the runner along with it.

This link between sport and religion has created many similarities between the two institutions.

Similarities between Sport and Religion

- Both have places and buildings for their events.
- Both are controlled by hierarchical organizations/associations.
- •Both have times of significant importance and meaning (religious holidays, playoffs, drafts, etc.).
- Rituals surround events before, during and after.
- Both are historically dominated by men.

- Both have heroes, stories and legends about accomplishments.
- Both can evoke intense excitement and emotional commitment.
- Both can give deep personal meaning to people's lives.
- Both give a sense of belonging.
- Both stress discipline, repetition and the development of character.
- As with any two different institutions, despite the number of similarities, there will always be differences.

Differences between Sport and Religion

- Religious beliefs are grounded in the supernatural realm. Sport is grounded in the material/physical realm.
- •The purpose of religion is to transcend material life pursuing spiritual goals. Sport focuses on material issues.
- Religion is rooted in faith. Sport is rooted in rules and relationships.
- Religion is non-competitive, whereas sport exhibits a competitive lifestyle.
- As with sport rituals and superstitions, athletes and coaches use religion in the sport for a variety of reasons.

How Athletes and Coaches use Religion

- •To cope with uncertainty or failure
- To stay out of trouble
- To give meaning to sport participation
- To put the sport into perspective
- To establish team solidarity
- To reaffirm the rules of coaches

CONCLUSIONS

There are some similarities between sport and religion. Both have places and buildings for their events. Both are controlled by hierarchical organizations/ associations. Coaches use religion, to cope with uncertainty or failure, to stay out of trouble, to give meaning to sport participation and to establish team solidarity.

REFERENCES

- [1] Religion focuses on the idea that, as one anthropologist put it, "there is something more to the world than meets the eye", *Bowen*, ridgent, 1978, 4.
- [2] Linda Schele & Mary Ellen Miller, The Blood of Kings, 1986.
- [3] Dong-Sik Chung, Jong-Kak Lee, Young-Soo Kim, Dong-Ho Park, Bong-Ju Sung, Nam-Hong Cho, & In-Seok Oh, Effects of Intermittent Normobaric Hypoxia on Oxidative Stress during a Period of Endurance Training, *International Journal of Applied Sports Science*, 2005, 17(2), 59-71.
- [4] Epstein J. L., School, family, and community partnerships: Preparing educators and improving schools, *Boulder*, 2001, CO: Westview Press.
- [5] William Francis & G. D. Koppal, Trends in Attitudes Toward Religion, 2007.
- [6] Ajzen I. & Fishbein M., Understanding attitudes and predicting social behaviour, Englewood Cliffs, 1992.
- [7] Stevenson D. & Baker D., *The family-school relation and the child's school performance. Child Development*, 1987, 58 (5), 1348-1357.

Entrepreneurship – An alternative for Unemployment

Dr. Rajagopala Nair

Albertian Institute of Management, Ernakulam, Kochi, rajagopalanair@rediff.com

Study, get a degree, go through campus recruitment, work for a couple of years, get MBA or such other professional degree, write bank test and get a stable job (usually rendering earlier degree useless in process), and work for the rest of your life. This sounds very familiar nowadays. Those who are hanging on in industries will resort to become Professors in engineering colleges or in B-Schools at the age of 40 or 45 for earning some easy money. The present education and social system in India tends to create more unemployed persons in the country, especially unemployed graduates. Among the BRIC countries, Russia with a population of 143 million, 43 per cent are employed, while Brazil with a population of 198 million, 70 per cent are in regular employment. Seventy four per cent of Chinese are employed with a huge population of 1.35 billion. In India, the second largest country in population, mere 39.8% are employed. Most of the resource rich regions the world over are poor and resource poor regions are rich. We call it the 'Resource Curse' phenomenon. Underdevelopment is not because of the lack of natural resources but because of the deficiency in the combining process itself that is undertaken by entrepreneurs. Capital and technology are futile till the absorptive capacity of the country is inadequate because of the shortage of skills and attitude (entrepreneurship).

The World's Population report of the UN reveals that 356 million Indians are of the age between 10 and 24 years, while the same in China is 269 million. In the US, 65 million people are at the age group of 10-24 years, while it is only 15 million in SA. This unique position does not last longer for India. India is ageing faster than global average and by 2050 the world will have a larger proportion of youth population than India. The UN Population projection shows that by 2065, the absolute number of young population will begin to decline. This indicates that, at present India is a 'Young Country' with potential to grow as

Industrial Super power. We have men and resources, but we lack entrepreneurship. The youth of India present an enormous opportunity to transform the future of this country. Young people are the innovators, creators, builders and leaders of the future. But they can transform the future only if they have skills, health, and decision making capacity. The youth of India may have positive or negative impact on the country. This depends on how well Govt. responds to young people's needs, enable them to engage fully and meaningfully in civic and economic affairs

Unemployment rate in India is showing an increasing trend since 2011 when it was 3.5%. The same rose to 3.6% in 2012 and climbed to 3.7% in 2013. In 2014, jobless rate has reached at 3.9%. In China, the unemployment rate is stagnant at 4.1 % from 2010 to 2014. India was experiencing 'jobless growth' due to the fact that total employment grew by only 1.1 million from 2004-05 to 2009-10 (based on the National Sample Survey), representing an employment elasticity of almost zero. A large pool of youth in the age group of 18-25 years, despite being skilled are facing unemployment issues since there are not enough opportunities for them. In India, ILO report shows 21.2% of working men and women (aged 18-59) have a regular salaried job. It says, one out of every three persons in the age group 15 to 29 years who have completed at least their graduates and above for the age group 15-29 years was estimated to be at 36.6 per cent. In urban areas, the same was 26.5 per cent.

As per the data by Reserve Bank of India, in the past four years, outstanding education loan in the category of personal loan has almost doubled. It means India is creating more 'unemployed post graduates and skilled laborers'. According to Labor Bureau's "Third Annual Employment & Unemployment Survey 2012-13", "unemployment rate amongst illiterate youth is lower than educated youth". Unemployment rate among the persons who cannot read and write any language are considered illiterate, was the lowest with 3.2 per cent in the 15-29 age group.

108

National Sample Survey Office (NSSO)

Employment rate

2004 - 05	-	42%
2009 - 10	-	39.2%
2011 – 12	-	38.6%

Unemployment in rural India is 4.4% whereas in urban India it is 5.7%. Economic growth in 2009–10 was 9.3%, whereas in 2011–12 it came down to 6.2% and in 2013-14 it is around 5%. Jobless youth is left with no other option but to go for self employment, and if he/she does not possess required skills then the youth has to do low paying jobs.

Reverse Swing					
Educational Unemployment rate					
Level	Urban	Rural	All		
Illiterate	1.3	1.1	1.2		
Primary	2.1	1.6	1.7		
Secondary	4.4	5.8	5.4		
HSC	7.3	7.8	7.3		
Graduate	8.2	11.0	9.4		
PG	7.7	13.9	10.0		
All	5.1	3.5	3.8		

It is surprising to note that 8.2 per cent of the urban graduates are unemployed while 13.9 per cent of the Post Graduates in the rural India are unemployed. The rate of unemployment among the rural graduates is 11 per cent and 7.7 per cent of the urban post graduates are unemployed.

The report from Labour Ministry for 2012-13 states that Sikkim has the maximum number of unemployed people whereas Chhattisgarh has the minimum number of unemployed people in the country. Overall unemployment rate of the country is 4.7%. In Northern India, Jammu and Kashmir has the maximum unemployment rate followed by Himachal Pradesh, Delhi, Chandigarh, Punjab and Haryana. Unemployment rate in rural area is 4.4% whereas in urban area it is 5.7%.

Gender-wise classification:

Number of employed men between 2009 and 2012 remain almost same but number of employed women dropped from 18% to 16%. Though in terms of percentage it looks small but the actual figures are really daunting. In rural sector about 90 lakh women lost their jobs in the period of three years. On the other hand 35 lakh women were added to the workforce in urban areas. Overall unemployment rate in females was more as compared to males. For females it was 7.2% whereas for male the unemployment rate was 4%.State of Kerala being the most literate state in India had the highest rate of unemployment, i.e., close to 10%, whereas rate of unemployment in West Bengal was 4.5% and in Assam it was 4.3%.



Sector-wise classification:

Number of workforce in agriculture sector has gone down and for the first time it is below 50%. The farm sector now has 49% of the workers whereas manufacturing sector has 24% and services sector has 27% workforce. As per the Govt. of India estimates, 13 million young people enter labour force every year. Simultaneously 113 million people reported to the census that they were seeking work

McKinsey findings:

- # The young people entering the job market lacks skills; less than 3 per cent of young people in high school received vocational education.
- # India's higher education enrolment is just over 20 per cent and the quality of higher education is poor.
- # Skills shortage was a leading reason for entry level vacancies in India.
- # Fifty per cent of the students at secondary school are not employable.
- # Employers, education providers and youth live in parallel universe.
- # India needs to create over one million jobs annually for its unemployed youths.

The only solution is to find an alternative for unemployment and that is "Entrepreneurship"

WHAT ENTREPRENEURS DO?



"If you want the business to succeed, solve the unsolved problem and identify each and every opportunity. Most successful businesses are building upon the study of deep customer insight. To be a successful entrepreneur one must know the customers desires, their mind and observe them keenly. 30-40% of your business depends upon this study only". Mr. Sanjeev Bikhchandani (CEO, Naukri.com) told that one must not wait for an opportunity to come; rather he/she must recognize the opportunities around him/her. The first and foremost quality in becoming the entrepreneur is "persistence". Entrepreneurship is all about taking the risk; the motivation level in starting a new venture must be very strong. The thinking of "Never Quitting" is a key to success. With his own experiences Mr. Bikhchandani also shared that great companies are build by great teams. One must have to be honest and sincere with his team to gain respect and trust from them.

ECONOMIC FR	EEDON	I OF TO)P 10 S	STATES
STATE	RANK		*SCORE	
	2013	2005	2013	2005
Gujarat	1	5	0.65	0.46
Tamil Nadu	2	1	0.54	0.57
Andhra Pradesh	3	7	0.50	0.40
Haryana	4	4	0.49	0.47
Himachal Pradesh	5	3	0.47	0.48
Madhya Pradesh	6	2	0.47	0.49
Rajasthan	7	12	0.46	0.37
Chhattisgarh	8	16	0.44	0.33
Karnataka	9	13	0.43	0.36
Kerala	10	10	0.42	0.38
(*Index score on a scale from 0-10; the Economic Freedom of the States of India, 2013, estimates economic freedom using a methodology adapted from the Fraser Institute's Economic Freedom of the World annual reports)				

Growth has averaged 12 per cent in Gujarat, 10.6 per cent in Chhattisgarh and 10.4 per cent in Andhra Pradesh between 2005 and 2013. "Gujarat is not only the freest state, but it has also registered the fastest rate of improvement in the index (from 0.46 in 2005 to 0.65 in 2013).

States in India which are economically more free are also doing better in terms of a higher per capita growth for its citizens; unemployment levels are lower in these states, sanitary conditions are better and the states also attract more investment.





State – Wise Contribution of GDP: 2013-14

Maharashtra	1248452.80	14.95%
Uttar Pradesh	687836.28	8.23%
Andhra Pradesh	675798.00	8.09%
Tamil Nadu	639024.60	7.65%
West Bengal	541585.56	6.48%
Gujarat	513172.84	6.14%
Karnataka	458902.74	5.49%
Rajasthan	368319.52	4.41%
Kerala	326692.89	3.91%
Madhya Pradesh	315386.66	3.78%

Rs in Crores %

Small and Medium Enterprises play a vital role for the growth of Indian economy by contributing 45% of the industrial output, 40% of exports, 42 million in employment, creating one million jobs every year and produces more than 8000 quality products for the Indian and international markets. As a result, MSMEs are today exposed to greater opportunities for expansion and diversification across the sectors. Economic growth is effect, entrepreneur is the cause. Entrepreneurs explore opportunities, convert ideas into viable business proposition and provide new products and services to the society by bringing together and combining various factors of production.

Roles of entrepreneurship in the new economic order and national growth:

There are three dimensions:

1) In the West (i.e. Developed countries):

From 1970 to 2000, these countries largely depend on big business and mass production and thus they paved the way for 'Entrepreneurship'. Later, they identified that 'Knowledge' driven goods and services can be more efficiently provided by small firms. They developed a creative class known as 'Entrepreneurs', with more facilities from the Govt.

2) In developing countries (like BRIC countries):

The need was a sustained growth through sustainable access to resources, knowledge and market. Hence the answer is "Innovative Entrepreneurship".

3) In least developed countries (under developed):

Where the dependency on Govt. aid is high, development of Entrepreneurship in private sector has become a vital objective of the Govt.

Startups and Incubation centers for promoting Entrepreneurship:

"In order to promote entrepreneurship in IT, the central government has come up with the concept of electronic development fund with the government partnering with angel funds to fund startups in IT, electronics and manufacturing," said Ravi Shankar Prasad, Union Minister for IT.

"India has got 90 crore mobile phones and 300 crore internet connections. We have to make them more effective and more accessible and promote entrepreneurship in this field." He said India can have dozens of Silicon Valleys as many Indians are doing well in IT professions abroad and many of them are coming back.

REFERENCES

- [1] www.economicshelp.org, SOURCE: ONV-YBVQ-MGSX
- [2] The Fraser Institute's Economic Freedom of the World annual reports.

Inflation Indexed bonds as an Investment Alternative in Indian Capital Market: a Comparative Analysis

Mahmood Aslam K.

Department of Commerce, WMO Arts & Science College, Muttil mahmoodaslamk@gmail.com

ABSTRACT

This paper attempts to explain the inflation linked bonds as an innovative product that can be introduced in Indian debt market (both for the retail and the institutional buyers). The study makes an attempt to compare the bonds in the rising inflation scenario. We have analyzed that for an Inflation Indexed Bond, bond value increases with increase in the Inflation and vice-versa but for a Normal Bond it remains unaffected by rising inflation levels. It also proved the superiority of Inflation Indexed Bonds over other investment avenues such as especially on normal bonds and also the securities like gold, property (real estate), commodities and fixed deposits. The study goes through the historic inflation (CPI) in Indian market and its workings on Indian debt market.

After making detailed analysis by making comparison of performance of various securities to hedge against inflation, it is very clear that the inflation linked bonds allow investors to hedge the purchasing power (inflation) risk than any other investment opportunities like gold or fixed deposits or nominal bonds.

Keywords: Inflation; inflation-linked bonds; nominal bonds; real interest rate; real return; inflation indexation; consumer price index (CPI); Wholesale price index; Treasury inflation-protected securities(TIPS), IINSS-C.

INTRODUCTION

Capital market system in any country develops only when both equity and debt markets assume depth and liquidity. World over, debt markets (especially corporate bond segment) has become much larger in size compared to traditional banking and equity sources of financing. Traditionally, the Indian capital markets are more synonymous with the equity markets - both on account of the common investors' preferences and the huge capital gains it offered - no matter what the risks involved are. On the other hand, the investor's preference for debt market has been relatively a recent phenomenon - an outcome of the shift in the economic policy. If we talk about the Indian debt market, bond market has formed its own place in the financial systems. All the recent developments are accrued to bonds market in India.

It would be expected for the less risky debt market to develop before the more risky equity market, however, with a strong and growing equity market, the time seems ripe to develop the corporate bonds market. Although debt financing can be obtained as a bank loan, it would be cheaper to obtain financing by issuing debt in an active bond market. Currently, the corporate bond market forms 2% of India's Gross Domestic Product (GDP) in contrast to the equity market capitalisation which forms 56% of GDP. This is in sharp contrast to developed countries where the corporate bonds market is larger, or at least as large as the equity market.

In India, Fixed-income investors are the hardest hit by inflation. They are facing severe threats while making investments in securities. In the past RBI has been concerned about the fact that a common man does not have any protection against rising prices, Vis No Inflation Hedge. The common man has to rely on traditional but inefficient methods to hedge the real inflation risks, such as Gold and real assets such as commodities or real estate or even excessive stocking of goods.

118

Recently, Reserve Bank of India in consultation with Govt. of India launched Inflation Indexed National Savings Securities-Cumulative (IINSS-C) for retail investors in the second half of December 2013. In developed markets like US, the government has issues "Treasury Inflation Protected Securities" known as TIPS.

REVIEW OF THE LITERATURE

Meaning: Inflation linked bonds (ILBs) Inflation linked bonds (ILB) securities give an opportunity to market participants and investors to hedge against inflation. The coupon (interest rate) of ILB is fixed but the underlying principal would move in tandem with the inflation levels in the country. At redemption of the securities the higher of the value (adding inflation) thus arrived or face value is paid off. Banks and Financial Institutions usually buy wholesale and create retail market for such securities. With right access retail investor can easily buy such securities to protect himself from inflation. Inflation Linked Bonds take an account of Consumer Price Index (CPI). Inflation indexed bonds take an account of Wholesale Price Index (WPI)

<u>**Historic inflation India (CPI)**</u> - This page features an overview of the historic Indian inflation: CPI India. The inflation rate is based upon the consumer price index (CPI)





annual inflation (dec vs. dec)	inflation	annual inflation (dec vs. dec)	inflation
CPI India 2013	9.13 %	CPI India 2003	3.72 %
CPI India 2012	11.17 %	CPI India 2002	3.20 %
CPI India 2011	6.49 %	CPI India 2001	5.16 %
CPI India 2010	9.47 %	CPI India 2000	3.48 %
CPI India 2009	14.97 %	CPI India 1999	0.47 %
CPI India 2008	9.70 %	CPI India 1998	15.32 %
CPI India 2007	5.51 %	CPI India 1997	6.29 %
CPI India 2006	6.53 %	CPI India 1996	10.41 %
CPI India 2005	5.57 %	CPI India 1995	9.69 %
CPI India 2004	3.78 %	CPI India 1994	9.47 %

Table - historic inflation India (CPI) - by year

Also let me clarify that CPI for the Inflation Linked Bonds will not be the same as it is today. There is new formula coming to monitor the consumer price inflation. It may be less than current CPI. But certainly it will be more than WPI.

Working of IIBs

Here is how IIBs work. Interest will be paid twice a year over the 10 year tenure. Principal will be indexed to the final wholesale price index (WPI) rate. The coupon rate will remain constant.

Let us say Rs. 1000 crore are invested in IIBs. The first issue of IIBs was at a WPI level of 170 and a coupon rate of 1.44%. A year later, let's say the WPI is 190. The principal

will be revised to Rs 1,000 crore x (190/170), or about Rs 1,118 crore. The interest will amount to 1.44 % of Rs 1,118 crore, or about Rs 16 crore. If the WPI becomes negative, the principal would be revised down. Practically, this recalculation will be done and interest will be paid every six months.

To ensure that investors do not suffer a loss if WPI becomes negative, higher of original base value and adjusted principal value will be paid at maturity. However, the probability of it happening is practically nil in an emerging economy like India.On maturity, the investor would get back the higher of the adjusted principal or the face value.

The table showing the calculations and indexation concerned with the Wholesale Price Index (WPI) will be shown in detail in the analysis part of the study.

Advantages of inflation linked bonds to the investors.

- 1. It allows investors to hedge the purchasing power (inflation) risk. The capital is inflation risk protected and the income (coupon) can be structured that way too.
- Inflation linked bonds universally are regarded as a separate asset class & would provide diversification benefits to a portfolio due to its negative co relation with returns from traditional asset classes.
- 3. Such bonds provide positive risk reward relationship too.
- 4. Inflation linked bonds are effective vehicle for hedging risks for institutional investors, where the long term liabilities are inflation linked or linked to future wage levels or banks who face the inflation risk on their assets side due to their GOI Bond holdings.
- Access of FIIs to the inflation linked bonds can allow them to hedge their inflation risks in India which are currently expressed in the currency markets. The USD/INR (currency) volatility can hence come down hence.

OBJECTIVES OF THE STUDY

- 1. To address the only IIB in India issued by RBI "Inflation Indexed National Savings Securities-Cumulative (IINSS-C)"in 2013.
- 2. It helps to make comparison of different investment alternatives like normal bonds, gold and fixed deposits as hedge against inflation.
- 3. To find out the solutions to the following question
 - Why should you invest in Inflation Linked Bonds?
 - Why Inflation Linked Bonds are Better than Gold?
 - Why Inflation Linked Bonds are Better than Normal bonds?
 - Why Inflation Linked Bonds are Better than Fixed deposits?

METHODOLOGY

Collection of secondary data:

- Tables and Diagrams
- Historical data from sites of RBI, SEBI etc
- Websites- inflation.eu, plan money taxmarkretscientists.in, etc.
- Getting data from the Various Research papers published, Inflation indexed bonds take an account of Wholesale Price Index (WPI)
- Collecting data from various Books like "hand book on IIBs" by john bryjolfsson, Frank J. Fabozzi etc.

DATA ANALYSIS

• Why inflation indexed bonds are attractive than normal bonds?

Inflation Indexed Bond

Reserve Bank of India issues 3%, 5-year Inflation Indexed Bond on 1st December 2005 redemption on 2010 (1st December 2010) linked to Wholesale Price Index (Table 4) (Base year 2004-2005=100) with a face value of Rs.1000, Semi-Annual compounding with reset dates as per the changing WPI figures from the "Office of the Economic advisor, MCI"

Nominal Fixed Coupon Bond

XYZ ltd Issues, 5 year, 9% bond with face value of Rs. 1000 on 1st December 2005 at par, redemption on 1st December 2010.

Steps in computing the Nominal Rate of Return for Inflation Indexed Bond:

Formulas used:

1) Index Ratio Set Date = (Ref WPI Set Date)/(Ref WPI Issue Date)

2) Indexed Principal/Inflation Compensation Set Date = (Principal × Index Ratio Set Date)

3) Coupon = (3%/2) * Indexed Principal

Reference Wholesale Price Index (WPI) Figures:

For June, "Ref WPI" will be taken as February and for December it would be August (refer to Table 4 for WPI figures).

Table- 1.

Wholesale Price Index (WPI, Monthly data from 2005-2010) with semi-annual coupon payments, Index Ratio, Indexed Principal (Inflation Compensation) and Coupon calculation on reset dates (Interest payment dates) based on 3% per annum (with semi-annual compounding i.e. 1.5%) times Indexed Principal

Year	Month	WPI	Index Ratio	Inflation Compensation	Coupon
		(lagged 4mon	ths)		
2005	December	104.1			
2006	June	105.4	1.01249	1012.49	15.18731
2006	December	111.3	1.06916	1069.16	16.03746
2007	June	112.4	1.07973	1079.73	16.19596
2007	December	115.9	1.11335	1113.35	16.70028
2008	June	118.8	1.14121	1141.21	17.11815
2008	December	128.9	1.23823	1238.23	18.57348
2009	June	122.9	1.18060	1180.60	17.70893
2009	December	129.3	1.24207	1242.07	18.63112
2010	June	134.8	1.29491	1294.91	19.42363
2010	December	140.7	1.35159	1351.59	20.27377

Calculation of Nominal Rate of Return with the help of Inflation (WPI) and Real Rate of Return (Coupon Rate) in order to compare it with a Nominal Fixed Coupon Rate Bond (Table 2) :

 $1 + I = (1 + r)^*(1 + E(I))$

Where: I = Nominal Interest Rate;

R = Real Interest Rate;

E(I) = Expected Inflation Rate.

For Example: Nominal (Six monthly) Rate of Return for 1st June 2006 can be computed as:

Nominal Rate June 2006 = ((1 + 1.5 %) * (1 + 5.400%)) - 1 = 6.981%

Nominal Rate December 2006 = ((1 + 1.5 %) * (1 + 5.598%)) - 1 = 7.181%

Nominal (Yearly) Rate of Return for the year 2006 can be computed as:

Nominal Rate of Return 2006 = Nominal Rate June 2006 + Nominal Rate December 2006 = 6.981% + 7.181% = 14.1627%.

<u>Table 2.</u>

Wholesale Price Index (WPI, Monthly data from 2005-2010 with Base year as 2004-05: 100) with Semi-annual inflation, Coupon rates (as fixed by the government) and Nominal Rate of return (both semi-annually and yearly)

Year	Month	WPI	Inflation	(WPI) Coupon	Nominal Rate Semi-Annual)	Nominal Rate (Yearly)
2004-05	100					
2006	June	105.4	5.400%	1.50%	6.9810%	
2006	December	111.3	5.598%	1.50%	7.1817%	14.1627%
2007	June	112.4	0.988%	1.50% 2.5030%		
2007	December	115.9	3.114%	1.50%	4.660%	7.163%
2008	June	118.8	2.502%	1.50%	4.0397%	
2008	December	128.9	8.502%	1.50% 10.1292%	6 14.1689%	
2009	June	122.9	-4.655%	1.50% -3.225%		
2009	December	129.3	5.207%	1.50%	6.785%	3.561 %
2010	June	134.8	4.254%	1.50%	5.8175%	
2010	December	140.7	4.377%	1.50%	5.9425%	11.76%
				10.1633%		

Aquinas Journal of Multidisciplinary Research

Hence, the Average yearly Nominal Rate of Return, of an "Inflation Indexed Bond" with 3% real rate of coupon (Semi-Annual compounding), issued for the period of 5-years i.e. on 1st December 2005 redemption on 2010 (1st December 2010) linked to Wholesale Price Index with a Face Value of Rs.1000 with reset dates as per the changing WPI figures is coming out to be 10.1633%.

Steps in computing the Nominal Rate of Return for a "Nominal Fixed Coupon Bond":

XYZ ltd Issued, 5 year, 9% bond with face value of Rs. 1000 on 1st December 2005 at par, redemption on 1st December 2010. We can calculate the Coupon for "Nominal Fixed Coupon Bond" with semi-annual compounding with the help of the following formula:

Coupon = (9%/2) * Principal or Face value of the Bond

I.e. Coupon June 2006 = (9%/2) * 1000 = Rs. 45

At the time of Redemption (December 2010) = Principal + Coupon December 2010 = 1000 + 45 = 1045

Table 3.

Nominal Fixed Coupon Bond that pays 9% per annum (4.5% semi-annual compounding) issued on 1st December 2005 at par (Rs.1000), redemption on 1st December 2010 for 5 years

Year	Coupon Date	Cash Inflow (Rs.)
2006	June	45
2006	December	45
2007	June	45
2007	December	45
2008	June	45
2008	December	45
2009	June	45
2009	December	45
2010	June	45
2010	December	1045

We can say that at the time of redemption i.e. on 1st December 2010 (after 5 years) an investor for such bonds will get the Principal repayment along with the coupon. The Cash Flow in our case would be (Table 3): 1000 (Redeemed at par) + 45 (Coupon) = 1045 but it would be as high as Rs.1371.8587 in the case of an 'Inflation Indexed Bond''.

Hence, the Nominal Rate of Return, of an "Nominal Fixed Coupon Bond" with 9% Nominal rate of coupon (Semi-Annual compounding), issued for 5-years i.e. with a Face Value of Rs.1000 is coming out to be 9% (as the bond is issued and redeemed at par) is so inferior to inflation indexed bond with return of 10.1633%. It may be the reason why the investors choose inflation indexed bonds than normal bonds.

• Why investors prefer Inflation Indexed Bonds than Fixed Deposits?

Since, last two years inflation for you stay at about 10%. It means that your cost is increasing 10% every year. While if you put your money in fixed deposit you will earn only below 10% return. That means that your money is not growing fast enough to beat inflation. Actually value of your money is decreasing. So, would you not like to have such fixed deposit which always gives more return than inflation. Will you not be happy that return of your fixed deposit should be more than 10% (or whatever the inflation rate is). Inflation Linked Bonds are to fulfill this need. By investing in these bonds you can be sure that the value of your money will never decrease. It will be always grows at 1.5% more than the inflation. Because, RBI has set the rate of return inflation +1.5%.

We prefers to Invest in Inflation Linked Bonds because inflation will not eat up your savings. You have not to worry for rising inflation. It will give long-term protection against inflation. Government of India issues these bonds. This means that it is more secure than fixed deposit. Fixed Deposit will give fixed return irrespective of inflation. Suppose FD gives you 8% return and inflation Indexed Bond has Interest rate of 3%.Let us calculate the Real Return, The return after considering the inflation is 5%.

Real Return from FD – $\{(1+.08)/1+.05)-1\} = 2.85\%$

Real Return from IIB – 3%

Inflation rises to 12%

Real return from FD – $\{(1+.08)/(1+.12)-1\} = -3.57\%$

Real Return from IIB – 3%

No Inflation (For India it is a distant dream)

Real Return from FD - $\{(1+.08)/(1+0)-1\} = 8\%$

Real Return from IIB -3%

From the above discussion, it is evident that Inflation Indexed bond gives constant return irrespective of the inflation. While Fixed Deposit's real return fluctuates with the inflation, even it becomes negative in high inflation period. But if inflation comes down to zero then fixed deposit will have more real return.

At present, India has an inflation rate of 7.8% (August 2014), and IIBs provides a rate of 7.8%+1.5% i.e;9.3%) rate of return on investment which is more than the rate of return of Fixed deposits of any of the commercial banks in India whether it is private or public. (Highest interest rate provided by BANK OF INDIA AND CANARA BANK is 9.03%, SBI is 8.5%, and SBT is 8.75% for a period of more than 5 years).

• How Inflation Linked Bonds are Better than Gold?

Many of us purchased gold because its value increases with time. Sometimes it gives more return than any other investment. During 2005-2012 price of the gold trebled. This type of performance attracts many. But historically gold did not performed in such way. Actually since 1925 gold gave the return of mere 9%. This is not bad but not very good either. During 1982 -2005 gold gave only 3% annual return. Since last year it is giving negative return. What I want to prove that return of gold is not consistent. It may

happen that after meteoric rise after 2005 gold cycle has reversed and you have to wait for another 5-10 year for the rise of gold. If you are comfortable with this up and down and glitter of gold attracts you then you can still invest in gold. But if you want constant and return over and above the inflation and no risk, then you should put your money in Inflation Linked Bonds. Also you will not lose your sleep about the theft of gold. Neither you have to spend for maintaining locker.

YEAR FD of 1-3 Years FD of 3 -5 Year Sensex Returns Gold Returns 12-13% 258% 25.04% Mar-92 13.00% Mar-93 11-11% 11.00% -48.03% -4.48% 10-10% 63.49% Mar-94 10.00% 11.60% Mar-95 11-11% 11.00% -13.75% 1.78% Mar-96 12-13% 13.00% 1.51% 10.26% Mar-97 11-13% 12.5-13% -1.43% -8.43% Mar-98 10.5 - 12% 11.5-12% 9.36% -14.39% Mar-99 9 - 11.5% 10.5-11.5% -5.78% 4.67% 10-10.5% Mar-00 8.5-10.5% 35.67% 3.92% 8.5-10% Mar-01 9.5-10% -28.67% 2.27% Mar-02 7.55-8.5% 8-8.5% -2.72% 16.05% Mar-03 4.3-6.3% 5.5-6.25% -12.90% 12.22% 5.25-5.50% Mar-04 4-5.5% 81.46% 4.46% 5.3-6.3% 13.10% Mar-05 5.75-6.25% 19.66% 6-7% Mar-06 6.25-7% 70.78% 20.00% 7.75-9% Mar-07 7.5-9 % 70.78% 28.57% Mar-08 7.5-9 % 7.75-9% 25.60% 15.74% Mar-09 7.75-8.5% -37.87% 16.00% 7.8-8.8% 6-7.5% 6.5-7.5% 77.01% 27.59% Mar-10 Mar-11 7.8-9.5% 7.75-9.5% 9.91% 42.70% Mar-12 9.25% 9.25% -10.50% 3.41%

That chart shows annualised returns of Fixed deposits, the Sensex and Gold.

From above table, if we take the data for the last 5 years it is clear that returns from the gold is 21% approx. It is to be noted that returns are 16%, 22%, 42%, 3% etc. shows a significant variation. But if we invest in IIBs not only we expect more returns but also consistency is ensured

FINDINGS

- IIBs are best investment vehicle for fixed or middle income groups.
- The IIBs allows investors to hedge the purchasing power (inflation) risk than any other investment opportunities like gold or fixed deposits or nominal bonds.
- We have analyzed that for an Inflation Indexed Bond, bond value increases with increase in the Inflation and vice-versa but for a Normal Bond it remain unaffected by rising inflation levels.
- Real return of inflation indexed bonds are higher than fixed deposits.
- Fixed Deposit's real return fluctuates with the inflation, even it becomes negative in high inflation period. But if inflation comes down to zero then Fixed deposit will have more real return. But Inflation Indexed bond gives constant return irrespective of the inflation.
- From the analysis it is evident that the return of gold is not consistent. If you want constant and return over and above the inflation and no risk, then you should put your money in Inflation Linked Bonds.

CONCLUSIONS

We have compared the Normal Bond with an Inflation Indexed Bond as guided by the Reserve Bank of India about the instrument. In our comparison based on *Nominal Rate of Return and Future Cash Flow* at the time of repayment keeping in mind the investor's perspective, we have found out that the Nominal Yield on an Inflation Indexed Bonds linked to Wholesale Price Index (Table 4) (Base year 2004-2005=100) with a face value of Rs.1000, Semi-Annual compounding (3% real return per annum) with reset dates as per the changing WPI figures resulted in superior return of 10.1633% as compared to the Nominal Fixed Coupon Bond with Nominal Yield of 9%. The Cash Inflow for investors of these bonds at the time of repayment of their principal along with the coupon (Rs.) will be Rs.1045 in the case of 'Nominal Fixed Coupon Bond' but it would be as high as Rs.1371.8587 in the case of an 'Inflation Indexed Bond''. So that people choose to invest in IIBs. After going through the Gold and fixed deposits it is very clear that the rate of return on gold is not consistent and does not always provide higher return than IIBs. As in the case of fixed deposits for any term, 3-5 or above 5 years IIBs provides more and consistent returns than the latter. So in nutshell we could say that *Inflation Indexed National Savings Securities-Cumulative (IINSS-C)* is the most attractive innovative financial instrument in capital market even though which is of recent origin in India.

REFERENCES:

- [1] Articles.econ, market scientists.in, plan money tax etc.
- [2] Omictimes.indiatimes.com/2013-05-29/news/39602390_1_iibs-inflation-indexed-bonds-inflation-linked-bonds.
- [3] http://www.business-standard.com/article/finance/first-inflation-indexed-bond-auction-subscribed-4-times-113060401204_1.html.
- [4] Deacon, Mark, Andrew Derry, and Dariush Mirfendereski, *Inflation-Indexed Securities: Bonds, Swaps and Other Derivatives,* Wiley Finance, 2004.
- [5] Bhansali, Jayesh D., "Inflation-indexed U.S. Treasury Bonds: An Analysis.", *Journal of Investing Barclays Capital*, 1998.

Financial Inclusion: an Overview in Indian Context

Devina Mohan

Department of Commerce, Aquinas College, Edacochin, devina49@gmail.com

ABSTRACT

Access to finance by the poor and vulnerable group is a prerequisite for poverty reduction and equality. In fact, it was this concept which led to the emergence of Financial Inclusion- The process of ensuring access to appropriate financial products and services needed by all sections of the society in general and empower the vulnerable. The objective of this study is to discuss the various aspects of Financial Inclusion, measures taken by RBI and other banks for promoting it and challenges faced by India for strengthening Financial Inclusion.

INTRODUCTION

India, the land of diversity is also blessed with vast and diverse population. A recent survey in 2001 shows that about 7.4% of the total population in India is the elderly. Let us begin the study to trace the key notes of Financial Inclusion among them. Distressed senior citizens of India, especially farmers, who struggle with the rest of the population to cop up with the new mode of easy transaction is a pathetic plight with which modern India is inflicted with. Even though distressed, most of them are blessed with well to do NRI sons and grandsons who try to comfort their poor Indian parents with their foreign money send via banks or other financial service providers. Once their financial transaction with India is over, they take no pains to ensure whether their parents are really "comforted" or not. They are never aware of the fact that, even though their parents own a bank account, seldom do they operate it. Thus, their virtually rich parents (at least in bank records), still work to earn their livelihood only because their knowledge about the banking products is limited. The government of India as well as the banking industry has recognized this imperative and has

imparted fundamental changes over the last two decades. In order to address the issues of financial inclusion, the Government of India constituted a "Committee on Financial Inclusion" under the Chairmanship of Dr. C. Rangarajan which tried to build an inclusive financial sector which has gained growing global recognition to bring to the fore the need for development strategies that touch all lives instead of a selected few.

"Financial Inclusion is the process of ensuring access of financial services and timely and adequate credit when needed by vulnerable groups such as weaker sections and low income groups at affordable cost" – C. Rangarajan, Chairman of Committee on Financial Inclusion. The term has gained importance since the early 2000's, when it was found that there is a direct correlation of financial exclusion to poverty.

By Financial Inclusion we mean delivery of banking services and credit at an affordable cost to the disadvantaged and low income groups. The various financial services include insurance, payments, remittance facilities, savings, loans, and financial counseling/advisory services by the formal financial system. An efficient society is always defined by the unrestrained access to public goods and services. As banking services are in the nature of public goods, financial inclusion should therefore be viewed as availability of banking and payment services to the entire population without discrimination of any type.

The term Financial Inclusion was first used by UN in 2003 when they realized that India – a land with a historic & well-structured banking system had taken such steps way ahead of the world but could not succeed due to proper covering of the world and the failure to device necessary reforms and continuous monitoring. The concept can be traced back to 1904 when co-operative movement took place in India. It gained momentum in 1969 when 14 major commercial banks of the country were nationalized and lead bank scheme was introduced shortly thereafter. Branches were opened in large numbers across the country and even in the areas which were hitherto being neglected. Bank nationalization in India marked a paradigm shift in the focus of banking as it was intended to shift the focus from "class banking" to "mass banking". Our childhood "Bachat Khal" reminds us of the bank with high grills giant solid wall, iron gates & long queues, either to deposit or withdraw the cash in bank, contrary to present day banking of open offices, ATM counters and net banking. Banking in early 70's in India, was solely the prerogative of the rich and urban people and the socially under privileged people could seldom use the banking facilities. Thus the basic objective of nationalization was not achieved and till date remains in India as what BS Mumbai has reported on 20th Aug 2012 **"Financial Inclusion India scores poorly on global stage".**

A report published by WB in April'12 shows half of the world's population held accounts with formal financial institution. In India only 35% have formal account against an average of 41% in developing countries. Also in India Financial Inclusion remained as an unfinished agenda.

Perhaps, this became a hot talk in India, when the finance minister has emphasized inclusion in the budget sheet. At various fora, the RBI and senior Government officials had been hinting at a "big-bang" action plan for Financial Inclusion to be announced by PM Narendra Modi in his Independence Day address to the nation. There were reports of the authorities getting ready with a **Comprehensive Financial Inclusion plan** (CFIP) or **Sampoornvittiyasamaveshanyojana** which will be breath taking in scope & extremely ambitious. Another path breaking event was the launch of Prathan Manthri Jandhan Yojna which heralded a new plan of action.

OBJECTIVES:-

- 1) To discuss about the conceptual aspects of Financial Inclusion.
- To evaluate the role of banks and highlight the measures taken by RBI towards Financial Inclusion.
- 3) To identify the challenges.

METHODOLOGY OF THE STUDY

Secondary data was conducted to review the present status of Financial Inclusion in India. The data was collected through secondary sources i.e. Published articles, journals, reports, books and websites.

PROBLEMS WITH THE CURRENT SYSTEM

Currently, the RBI is following a large scale program for Financial Inclusion. At the same time, many Government departments are under various PAPs' like the Swarnajayanti Gram Swarojgar Yojna (SJGSY), Jawahar Gram Samriddhi Yojana Employment assurance scheme. Despite these giant initiatives targets are left unmet and poverty level is too high. Currently the sole stress is laid on opening of a bank Account. Actual usage & activity of the account remains limited. A recent study at Paanch Kula village, clearly substantiate that the current strategy of Financial Inclusion is inadequate. For the 3 villages included in the study had 90% of the households with bank account. But why 38.2% of them had not made even a single transaction since the opening of bank account – Is a serious question we are encountered with.

It is quite clear that the task of covering a population of 1.27 billion with bankers is a difficult task. Both demand side factors (customers) & supply side factors (banks & other Financial Institutions) are responsible for Financial Inclusion

Demand side challenges

- Low literacy in banking.
- Lack of awareness.
- Irregular income.
- Lack of trust institutions.

Supply side challenges

- Non availability of branches in rural sides.
- High rules & regulations.
- Limited number of financial service providers.

RBI initiatives for financial inclusion

- Opening of no-frills accounts
- Relaxation on Know your customer (KYC) norms.
- Use of technology.
- Simplified branch authorization.
- Opening of branches is unbanked rural centers.

An approach with certain vital modification such as

- Integration for Financial Inclusion with PAP's
- Financial literacy & awareness generation.
- Customization
- Licensing of new banks etc.

CONCLUSIONS

Today while India may record a GDP growth rate over 8%, about 50% of Indian population lives below Rs.150 a day. Financial Inclusion is a road which India needs to travel for becoming a global player. Today less than half of India's population is a part of India's economic growth. This scenario has to be changed. The Indian focus of the Financial Inclusion at present is confined to ensure a bare minimum access. Out of 19.9 crore households in India 6.62 crore households has access to banking services. RBI's vision for 2020 to open nearly 600 million new customers' accounts and service them through a variety of channels by leveraging on IT should become a reality. Thus challenges pervasive
at every level of the chain have led to the system getting evolved on the principle of compliance & not transaction hitting it at the very foundation level.

And also it is further aggravated by the low quality infrastructure and the absence of financial literacy to the rural population. Thus, it has to be realized by RBI and other bodies working for this course that unless the issue is addressed at the grass root level, the performance of this initiative cannot be optimized. So the need of the hour is to ponder on these basic issues before building the edifice.

REFERENCES

- [1] Chakrabarty K. C., "Financial Inclusion and Banks: Issues and Perpectives, 2011.
- [2] The Institute of Cost & Works Accountants of India, "The Management Accountant", 2012, 47 no: 1.
- [3] Rangarajan C., *Report of the Committee on Financial Inclusion*, Ministry Of Finance, Government of India, 2008.
- [4] Shabna Mol T.P., Financial Inclusion: Concepts and Overview in Indian Context, Abhinav International Monthly Refereed journal of research in Management & Technology.
- [5] Damodaran Akhil, Financial Inclusion: Issues and Challenges.

AQUINAS JOURNAL OF MULTIDISCIPLINARY RESEARCH

AQUINAS JOURNAL OF MULTIDISCIPLINARY RESEARCH is an annual journal with a wide spectrum of multidisciplinary research activities in the science, humanities and commerce. As a journal of multidisciplinary studies, it intends to cater to the needs of all who are committed to the cause of higher learning.

SUBSCRIPTION RATES

Individual Annual (one issue) Rs. 150/-*Institution* Annual (one issue) Rs. 300/-

Payment must be made through demand draft in favour of Principal, Aquinas College, Edacochin, Cochin-682010, payable at State Bank of Travancore, Thoppumpady, Cochin, Kerala.

CALL FOR PAPERS

Next Issue:Last Date for submission of Research papers :Address for Communication

Volume 2, April 2016 December 31, 2015 Editor Aquinas Journal of Multidisciplinary Research Aquinas College, Edacochin, Cochin, Kerala-682010, India Mob: 9847430489 Email:aquinasjournal@gmail.com

Guidelines for submission of research paper

- 1. The soft copy should be emailed to aquinasjournal@gmail.com and the hard copy should be sent to the Editor, Aquinas College, Edacochin, Cochin, Kerala-682010, India.
- 2. The manuscript should be prepared using text processing software such as Microsoft Word for Windows (or equivalent package provided that a similar font and size are provided). Manuscript should be within 4-7 pages (A4 size); Title 16 point Times New Roman, main text 12 point Times New Roman, 1.5 spacing. Papers from humanity category should follow the MLA style of documentation. (For other categories see instruction No.6 below).
- 3. Centered title should be brief, followed by centered name, affiliation and address of author(s). Indicate to whom correspondence should be sent, including e-mail address.
- 4. Manuscript should be in this order: less than 200 word abstract, brief introduction followed by the main text documentation and 200-250 word conclusion summarizing the findings of the paper.
- 5. Illustrations
 - a. Computer generated graphics should be in jpeg format, in 300 dpi resolution.
 - b. Graphs should not be larger than 20x25 cm. Measurements should be indicated in SI units. Grids should not be shown in the graph.
 - c. Photographs should be supplied as glossy prints of the same size as they are to appear in the journal.
 - d. Illustrations should be referred to as Fig.1, Fig.2 etc followed by a caption at the bottom of the figure.
- 6. Journal and book references should be identified in the text using the Vancouver system (numbered throughout the text and numbered list at the end of the article). Reference should be listed by number at the end of the manuscript as reference number, Author(s), title of the article, Journal name, year of publication, volume, page. The journal title and the volume number should be in italics.

Eg.1. Name A. A., Name B. B., Metallic transport in polyaniline, *Nature*, 2006, 441, 65-68.

7. Figures, tables and equations should be inside the text near/after where they are referred in the text. Tables should be numbered consecutively with a heading.

- 8. Contributors' assurance in the prescribed format that the paper is original in nature and has not been published/accepted for publication elsewhere is needed.
- 9. The copyrights of the contributions published in the journal lie with the publishers of the journal.
- 10. The author alone will be liable in respect of any dispute involving violation of the copyright in respect of the material given by him or her for publication in the journal.
- 11. The manuscript that meets the guidelines will be acknowledged by the editor. It will then be sent for peer review.
- 12. The editor reserves the right to make required editing of the manuscript.
- 13. The articles featured in the journal reflect the opinion and findings of authors and do not represent the opinion of Aquinas College.
- 14. The journal is published annually in April.

