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# Editorial Board



Printed and published by Dr. K. B. Manoj, Principal, Sree Narayana College, Cherthala.

# Editorial

*The rising trend of citizen science initiatives have immense potential to revamp the whole research culture in India. The concept of citizen science is nothing but the scientific work undertaken by the public in collaboration with scientists and research institutes for creating scientific knowledge. Not necessarily scientists or even students of science but anyone with a proclivity toward science and with a basic knowledge about data collection can be the part of such initiatives.*

*The citizen scientists are those who come from all walks of life and age groups such as students, teachers, doctors or bankers involved in diverse scientific activities like tracking galaxies, detecting gravitational waves, inspecting numerous images from the celestial bodies and discovering new species. Globally, citizen science saw a swell with projects such as Einstein at Home, Stardust at Home, Moon Zoo and Plant Hunters. The Asian Waterbird Census launched in 1987 was considered as one of the earliest citizen science initiatives in India. Today, in the realm of ecology alone, 25-30 citizen science projects are operational, which includes e-Bird India, Big4mapping, Biodiversity Atlas, Citizen Sparrow etc.*

*The citizen science initiatives in India are exceptional in democratizing science by taking it out of the laboratories and into the masses. It not only improves the transparency and accessibility of science but also fosters scientific temperament among the public at large, particularly among the student community. Their transformation from being merely the receivers of scientific information to the collaborators in the creation of scientific knowledge triggers a positive impact on the scientific research culture of the country.*

*So far, the citizen science projects in India are largely confined to the realms of life and natural sciences, whereas Social Science and Humanities did not receive much attention in this respect. The time is ripe for the diversification of such initiatives into other domains as well.*

***Principal***

***Dr. K. B. Manoj***

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# ACADEMIC SPECTRUM—2018 December

Guidelines to the authors

**Academic Spectrum** is a **Multidisciplinary Peer Reviewed Annual Research Journal** of Sree Narayana College, Cherthala, Alappuzha devoted to the publication of original research papers in all disciplines.
Manuscripts should be submitted through e-mail, addressed to cforresearchsnc@gmail.com as MS Word attachment.

## Preparation of Manuscript

*General style:* Manuscripts must be typed double spaced with margins of one inch at the top, bottom and the sides. Pages should be numbered consecutively, and the matter should be arranged in the following order: title, abstract with keywords, introduction, materials and methods, results and discussion, acknowledgement and references.

*Title:* Manuscript title should be a brief phrase describing the content of the paper.

Author information: Complete name and department of the authors, including those of corresponding authors should be mentioned.

*Abstract:* Abstract should be self-explanatory and should briefly represent the topic.

*Keywords:* Author(s) must give about 4-5 key words which can identify the most important subjects covered by the paper.

*Introduction:* Introduction should be attractive and provide a clear statement of the study.

*Materials and Methods:* For science articles this section should provide an overview of the design of study. The type of analysis should be mentioned.

Methods for articles of other disciplines should provide the main method applied.

*Results and discussion:* Complete details of the experiment that are required to support the conclusion of the study for science articles should be given. Findings and their implications is necessary in the broadest context for articles of other disciplines.

*Acknowledgement:* People, funding agencies and grants should be acknowledged.

Tables and figures if any should be numbered in Arabic numerals and supplied with title.

## References:

In science and social science—use APA style

In literature—conform to the specification of the latest edition of MLA Handbook

Manuscripts for submission should not normally exceed 15 pages of typing. The font shall be Times New Roman and the font size for titles shall be 14, and the font size for the body of the article shall be 12.

# INNOVATIVE TECHNIQUES IN TEACHING

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## Abstract

*This is an attempt is to analyze the main aspects of the traditional methods of teaching as well as modern methods of teaching using multimedia and also to try to suggest some useful teaching methods that can be attempted in imparting knowledge to the students. The two major components of education are sending information and receiving information. The concept of teaching includes providing knowledge to the students and motivating them with the piece of information contained in the lesson being taught to the student. Thus, any communication method that serves this purpose without destroying the objective could be considered as an innovative method of teaching. The use of innovative methods of teaching in educational institutions has the potential not only to improve the quality of education but also to empower the new generation with ideas and solutions to life.*

## Introduction

"Thamasoma Jyothir gamaya" was the Indian cultural motto from ancient times which means "from darkness towards light". Education is a light that shows the mankind the right direction to pursue. Ignorance and fear are always compared to darkness, the development in any field requires a willingness to change. Creativity can be developed and innovations in the field of teaching benefit both students and teachers in

receiving and imparting knowledge. According to Swami Vivekananda "Education is the manifestation of prediction already in man". Any method of teaching should be capable of bringing out the quest for perfection within every man. The students who sit in the classrooms today are the nation-builders of tomorrow. The quality of education provided to the students determines the quality of the nation they build up. The real aim of education is to enrich the future generation with the right raw-materials for life.

## Importance of Education

From ancient times, India had great importance for knowledge and education. Education is the sole tool for inculcating self-discipline and commitment in the students. Education should enlighten the value of life in the minds of students. Education should generate interest in the students and motivate them to know more about what is being taught. Education should be an integral part of the growth of the student and should help them to become very good citizens.

Education is actually an engine for the growth and progress of any society. It not only imports knowledge and skills but is also responsible for building human capital for setting technological innovation and economic growth. Thus, education plays the key role in social reformations, cultural development of the society and advancement of technologies. Any ruler with the right insight will not fail to realize the role of education in the building up of the nation and will definitely take steps towards imparting the right education to the coming generation.

## An evaluation of traditional teaching methods

The Gurukulam was the ancient Indian system of teaching. In the Gurukulam system, both the teacher and student stay together and learn things. The student goes to the teacher in search of knowledge he requires for life. Even princes go and stay with the guru in his residence for education which indicates the great importance given to knowledge in India from ancient times and later Indians erected universities like Nalanda and Thakshasila to bring about innovation in the method of teaching.

When there was a shift from the Gurukulam to the Universities there was a shift and alternation in the method of teaching also. In the universities, several teachers assembled together and the students from various classes came there. Different subjects were handled by different teachers which caused the building up of masters in each subject. Knowledge was imparted not only from books, but also from the experiences of the veteran teachers of each field. According to Nicolaides [1], acquiring life-skills and other information should be given due importance in the curriculum.

The teacher is the source, the student is the receiver and the knowledge is the message or information being transmitted. In ancient days the role of the student was to listen to the words of the teacher. In the Gurukulam system or in platonic dialogues we see that the teacher is the only one who talks and the students simply listen to it. But later this conventional curriculum was subjected to a lot of restructuring or reformation and as a result, learning become an interactive process.

## Influence of traditional classroom

In a classroom the teacher solely decides and designs the structure of the class. The 'talk and chalk' method is more interactive. It experiences more involvement from the part of both the teacher and the student for the advancement of the class. When the teacher attempts to lecture simply about the topic, there is a chance that the class become passive. According to doctors and psychologists, students cannot concentrate to something continuously more than 15-20 minutes. They may get distracted after that interval of time. If the teacher does not plan according to this concept, the students may fail to attend the class after the first 20 minutes. A one-hour class should be planned in such a way that the students should not be exposed to simple lecture throughout the class. A class, which is a one-way flow of information, has all the chances of the students getting bored. In order to avoid the boredom of students the class should be planned innovatively and interactively.

## Mind maps

Mind maps were developed in late 60's by Tony Buzan as a way of helping students make notes that used only keywords and images. But the method can be used by teachers to explain concepts in an innovative way. They are much quicker to make and much easier to remember and review because of their visual quality. They engage much more of the brain in the process of assimilating and connecting facts than conventional notes. The key notion behind mind mapping is that we learn and remember more effectively by using the full range of visual and sensory tools at our disposal. Pictures stories, colour etc. play a big role in storing information in memory for a very long time.

## The use of Sense of humor

Humor is always considered as a very effective medium for the conveyance of ideas. Even veteran film-makers use a humorous environment for narration of their stories. Being sensibly humorous is a very big achievement. If a teacher has this quality, them he can perform wonders is the classrooms. Humor strengthens the relationship between the teacher and the student. Humor has the ability to relax the minds of people, reduce tensions and thereby create an environment which is more apt for learning.

## Linking classes to examples and events

It would be very useful if the teacher links the topic of study with some events to examples familiar to the students. Music, movies, familiar from newspapers or some presently relevant issues may be used to link with the topic that is being taught by the teachers. This type of linking strikes the minds of the students and help them understand, analyse and memorize the topic much better. Even difficult theory and formulae can be learned and remembered by linking them to interesting examples or events.

## Effective use of diagrams and tables

Using proper diagrams and tables to convey an idea helps the teacher to present his ideas in a very effective manner. For example, a pie-chart or a bar diagram can convey a comparative study beyond words. To teach $(a+b)^2 = a^2 +2ab +b^2$ , we can identify a square with side a, a square with side b and two rectangles with sides a and b inside a square

with side (a+b). Computing the composition table for an algebraic system [5] makes the student to understand the binary operation more effectively. When a composition table is complete, no more methods other than inspection is required to check closure property, existence of identity element, existence of inverse element or commutativity. A correlation between variables is best explained by a rough scatter diagram. We can quote numerous examples where the proper use of diagrams and tables increase the effectiveness of the ideas being presented in the class. It is also a fact that a diagram is remembered much easily than a raw data.

## Z to A approach

Another useful method of teaching is Z & A approach. Here the teacher explains the application of a particular concept first and then describe the theory behind it. Knowing about the uses and applications of a concept, students would normally be eager to know much about its theory. From the viewpoint of students, learning a theory without knowing where it has got applications is definitely not interesting. The concepts of group theory in mathematics have got many applications in chemistry. So, if we first explain the applications of group theory in chemistry and then teach the concepts of group theory, it would create a much better environment for the students to learn about the ideas of group theory. According to Saxena [3], Grabbing a useful tool will be much more interesting for a student than acquiring something without knowing its use. Making awareness about the use of the information is the best method to create eagerness in the students to study.

## Drawbacks of conventional classroom teaching

The conventional class room teaching has got many limitations. The main limitation is regarding the effectiveness of the class. The lecture is based on lecture notes or text books prescribed by the university. There are high chances that the information being conveyed become outdated or old. Learners have little role in the learning process. They are supposed to simply listen to the words of teacher throughout the class, but such one-way flow of information has always proved to be less effective than interactive sessions. When discussions happen in the classrooms, it provides freedom for the learners to ask questions on the topic they learn. Generally, the traditional or conventional classroom teaching does not provide a chance or freedom for the students to analyze, compare and investigate on the topic they learn in the classroom. They may understand what is being learned, but perhaps may not believe it. In such cases the information or knowledge acquired through education does not become an integral part of the student, but it remains a passive data in their mind. We should not hesitate to say that such gathering of knowledge is merely useless. Education should be capable of developing a better human within a student by providing knowledge and refining his/her character.

## Incorporation of knowledge is a challenge

The process of teaching, Learning and Evaluation have always been a challenge. When we face challenges, we need innovative ideas and plans to overcome it. The students may forget what they hear, but they believe what they see. They understand what they do. The challenge of a teacher is to plan the classes in such a way that the knowledge he imparts

to the students does not merely become a passive data in the minds of students, but they actively accept the information and the knowledge becomes an integral part of their life. A society requires experts in all fields. So, education should aim to create experts in all fields. The way and the quality of education provided to a generation should not fail to fulfill this aim.

## Multimedia learning process

The use of multimedia in teaching and learning is a new-generation innovation which has got a lot of benefits and advantages over traditional methods. The use of multimedia makes the presentation of facts to appear in a different way. The same information orated by the teacher in the classroom has got more power when presented through slides in front of the students. The use of relevant audio clips, video slips and slides can make the class more colourful, attractive and memorable. It almost evacuates the boredom from the minds of students for a more attention time span, so that they memorize the knowledge imparted better than they do in a traditional lecture class. Thus, the use of multimedia in teaching and learning process can compensate for many inadequacies of traditional learnings. It can not only make the classes colourful, but also increase the interest of the students in attending the classes and increase their duration of effectively attending the classes. The use of PowerPoint slide presentations definitely makes the classes more structured and logical. It also helps the teacher to present all the ideas without losing any minute facts with a clear logical flow.

## Internet and all-knowing Google

In the present era, knowledge is easily accessible through the internet and Google is ready to answer any kind of doubts. The new generation students find internet as the easiest and most dependable way to find answers to their doubts. But we should be very careful while receiving information from the internet. The safety and credibility of the data obtained from the internet should be very carefully scrutinized before accepting them. The information provided by the internet is so vast that it is really a tedious job to select what we need from the information obtained. Also, the data and information we get have less credibility that those we obtain from standard reference books and journals. But a careful selection and use of the internet resources helps very much in teaching and learning.

## The benefits of e-contents

Reading through Mehar [2], we learn that e-learning is an effective method relevant in the present Scenario. The information and communications technology is rapidly advancing and the education field also should be subjected to a lot of changes in order to be in tune with the present trends. Today, the learner needs to learn better and faster and the teacher should teach vaster and more accurate. The Indian National Policy on Education (1986) has laid special emphasis on the special use of computer for improving quality of education.

Electronic content or digital content is defined by those involved in creating, providing and distributing information as the digitalized content

which is viewed on screen and not on paper. The quality and relevance of e-content should be carefully verified and updated so that the students shall receive totally apt and latest information. Audios, videos, animations, slides and appropriate images or graphics shall be included to improve the quality of e-content. In short, a good e-content should be authentic, modular, highly interactive structural multimedia enriched and easily navigated. Creating good e-content requires more attention and efforts from experts in the field of education. In the coming days there are chances that the traditional classrooms may disappear and students will acquire knowledge of their own interest through e-learning.

## Virtual classrooms and e-learning

Like any other field, the field of education is also being subjected to tremendous changes. In the coming days there are chances that the traditional classrooms may disappear and e-learning is popularized. Students can choose what to study, when to study and from where to study. The present scenario requires the teachers to be more and more competent in their relevant field. If a teacher is an expert and if he has created good e-content the he will be much sought after. Creating good e-content requires more attention and efforts. The online courses and virtual classrooms are increasing in a rapid rate so that the traditional classrooms may disappear in future.

## Importance of Research

According to Kothari [4], research is the fountain of knowledge for the sake of knowledge and an important source of providing guidelines

for solving different business, governmental and social problems. It is a sort of formal training which enables one to understand the new developments in one's field in a better way. Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organization. The role of research in several fields of applied economics, whether related to business or to the economy as a whole, has greatly increased in modern times. The increasingly complex nature of business and government has focused attention on the use of research in solving operational problems. Research, as an aid to economic policy, has gained added importance, both for government and business. Education should focus on developing a research-oriented generation for the future times.

## Conclusion

Teaching is a challenge. Learning is also a challenge. Evaluation is yet another challenge. Combining teaching, learning and evaluation effectively is a very big challenge. The advancement of teaching methods and tools is essential in the modern age. The teacher is not the only source of knowledge today, but one of many sources. So, a teacher should be competent enough in all aspects. E-learning and its platforms are being more and more popular day by day. So, teachers should adopt more innovative ideas and techniques in order to attract the interest of the students towards learning.

## References

[1] A. Nicolaides, Innovative teaching and learning methodologies for higher education Institutions, Vaal University of Technology, Educational Research (ISSN: 2141-5161) Vol. 3 (8) pp. 620-626, August 2012.

[2] Mehar. R. E-Learning for Professional Development of Teachers. *Journal of Educational and Psychological Research*, 2 (1), (2012).

[3] Saxena. A., Pedagogical Designs for Generation of contents for the Community. *Community development Theme* pp.01-03. Indira Gandhi Open University Publications, (2011).

[4] Kothari. C. R, Research Methodology-Methods and Techniques, Second Edition, New Age International Publishers.

[5] John B. Fraleigh, A First course in Abstract Algebra, Seventh edition, Pearson Education.

# TRENDS AND PATTERNS OF RURAL INDEBTEDNESS IN INDIA

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## Abstract

*Despite, over three decades of systematic expansion of the banking infrastructure in the country, it is argued that informal sources of credit including usurious money lenders remain important, and often dominant and growing sources of credit for rural and agricultural households in the post reform period. It is true that the formal credit market in India has grown up rapidly since the reforms of 1991 with a variety of financial products. However, the informal market continues to be pervasive, catering to diverse credit requirements of rural India. Bank reforms have led private banks to expand in the urban areas at the cost of poorer rural areas to 'skim the cream' without contributing to long-term growth. It was argued that the banking reforms in India, did not bring rural banking closer to poor, but to cut it back altogether and throw the entire structure of social and development banking over board. In this context, we studied the trends and patterns of rural indebtedness in India with reference to financial reforms. The analysis of trends and patterns of rural indebtedness reveals that the number of indebted households increased significantly in the post reform period. More importantly, the number of indebted households availing loans from non-institutional source of credit is higher than those with institutional source of credit. The increasing indebtedness is one of the challenges the rural masses, especially farmers, face in their livelihood security and it is a clear indication of the distress of farmers. From the discussion in the paper, we arrive at a conclusion that the proportion of indebted households is very large with a large share depending on even informal sources. It is seen that the debt outstanding has been accumulated over the years. The formal credit institutions in rural areas after 1991, showed a lethargic attitude towards the provision of credit. There has been a contraction in rural banking in general and priority lending to the poor in particular. The explicit reversal of the development policy of social banking with the implementation of financial liberalization has a drastic and potential disastrous effect on the debt portfolios of the income-poor. The study points to the fact that the indebtedness has its ramification on the agrarian crisis and the distress among the farmers.*

## 1. Introduction

It is argued that despite strong presence of competitive financial institutions like banks and cooperatives in India, the rural farmer households depended on informal institutions including private money lenders for credit at exorbitant interest rates. In states where both private and public sector banks were present, the farmers had to avail loans from private money lenders which resulted in increase in rural indebtedness due to usurious interest rates charged by the professional money lenders. The belief that in the post reform period, formal sector would serve as a countervailing force to the exploitative informal credit market, was proved to be wrong. Rather competitiveness accentuated credit crunch and pushed farmers to the vicious circle of debt by professional money lenders in the post reform period. The credit flow to rural sector, especially to marginal and small farmers, have declined in the post reform period (Nagaraj, 2008). It is generally opined that lack of agricultural credit has forced the farmers to depend on informal credit in the post reform period resulting in agrarian distress and widespread suicides have become a phenomenon in rural India, especially in states where formal bank lending to farmers was meager. Many studies argued for a better rural credit structure through the expansion of rural institutional credit facilities to effectively release the agricultural sector from the clutches of deflation and indebtedness under the neo liberal regime (Banerjee, 2009; Chandrasekhar and Ghosh, 2004). As pointed out by Narayana (2000), in India, bank reforms have led private banks to expand in the urban areas at the cost of poorer rural areas to 'skim the cream' without contributing to long-term growth. Thus, it was argued that the reforms in the banking

sector were not attempts to bring rural banking closer to the poor, but to cut it back altogether and throw the entire structure of social and development banking over board (Shetty, 1997).

In the recent times, the indebtedness of farmers has been widely debated in the context of declining rural credit, especially agricultural credit in India. One of the reasons attributed to the indebtedness of farmers is the inadequacy of institutional credit. The dependence on informal money lenders (non-institutional sources) at heavy interest rate liability, in the absence of adequate provision for institutional credit, makes it difficult to repay such debt on time under their distress conditions. The cumulated liability with principal and compound interest rate accentuates the debt problem and forces them to mortgage or sell their land resulting in losing their only means of food security and livelihood asset. In many cases, the indebtedness and the inability to repay debt become the major reasons for farmer suicides. The post-1991 period could be characterised as period of suicides as over 250,000 farmers have ended their lives. More importantly between 1995—the year from which occupation-wise classification of suicides was available—to 2015, the farmer suicides in India witnessed a growth over 60 per cent. Studies that analysed the agricultural situation in general and farmers' suicides in particular, authentically argued that the most prominent reason for distress is the indebtedness among rural households, especially farmer households (Assadi, 2000; Jeromi, 2007; Mishra, 2006; Mohanty, 2005). These studies pointed out that the farmers' average debt holding is higher compared to other rural households. It is found that the farmer households, especially households where a member had committed suicide, had not received adequate institutional credit

(Dandekar et al, 2005). This has led farmers to depend on informal financial institutions which pushed them into debt trap (Chavan, 2005a; Mohan, 2006; RBI, 2014). Thus, the nature, extent and magnitude of indebtedness have serious implications on the agrarian crisis, distress and farmer suicides. In the context of increasing distress and suicides among farmers in India in the recent period, there are studies both in favour and against the success of financial reform policies. One stream of thought argues that even after financial liberalisation, the prevalence of incomplete information and imperfections in the rural credit market resulted in unequal accessibility of credit, indebtedness and distress of rural masses, especially farmers (Deshpande et al, 2005).

In the Indian context, banking reforms in 1991 have produced undesirable consequences in the rural economy including the farm sector. As a result, by the early 2000's, the term 'financial inclusion' was being used in the Indian context to create accessibility for the rural masses to banking institutions. In 2004 the Khan Commission, created by the Reserve Bank of India, investigated the state of financial inclusion in India and laid out a series of recommendations. In response to the expressed concern regarding the exclusion of millions of rural populations from the formal financial system, the RBI urged banks to better align their existing practices with the objective of financial inclusion in both annual and midterm policy statements. The RBI has continued its efforts in conjunction with the Government of India to develop banking products, craft new regulations, and advocate for financial inclusion. Financial inclusion was adopted to extend financial services to those who typically lack access to financial sector (Beck et al, 2007). However, the policy of

financial inclusion also met with the criticism of imposing forceful policies for cashless financial inclusion on the people or citizens that does not give the people much of a choice in deciding whether they want to embrace cashless payments or not, especially the financial illiterates that do not know what digital payment systems are, why they exist and who are unaware of how to use digital payment systems (Ozili, 2020).

Against this background, the present paper studies the trends and patterns of rural indebtedness in India with reference to financial reforms period. The nature, extent and magnitude of indebtedness have serious implications on the rural economy and agrarian distress. The analysis is carried out using the data on rural indebtedness published by NSSO in various rounds of All India Debt and Investment Survey (AIDIS). The National Sample Survey Organisation (NSSO) has been conducting All-India surveys decennially on Debt and Investment since its 26th round (1971-1972) in both rural and urban areas. The latest available data is for the year 2012 ($70^{th}$ Round). Prior to 2012, NSSO undertook AIDIS in its $26^{th}$ Round (1971-72), $37^{th}$ Round (1981-82), $48^{th}$ Round (January-December 1992) and $59^{th}$ Round (January-December 2003). AIDIS generally deals with indebtedness of rural household in total. Though we have used data on all these rounds, emphasis was given to $48^{th}$, $59^{th}$ and $70^{th}$ rounds to focus on the period of banking reforms since 1991. The study is divided in to 3 sections. Following the introduction, in section 2, we extensively carry out the trends and patterns of rural indebtedness in India. Section 3 concludes the paper.

## 2. Rural Indebtedness in India

### 2.1 Nature and Magnitude of Rural Indebtedness

The All-India Debt and Investment Surveys by NSSO from 1961 to 2012 in respect of the number of indebted households, incidence of indebtedness and outstanding debt per indebted household in rural areas are shown in table 1. The number of indebted households, in absolute terms, declined sharply from 43.1 million in 1961 to 31.8 million in 1971 and further to 18.2 million in 1981. The steep decline during the period 1961-1981 was due to the inflow of rural credit under social banking and nationalization that reduced the dependence of rural households on informal credit. Between 1981 and 1991, however, the trend got reversed. The number of indebted households increased significantly to 27.2 million in 1991 and further to 39.2 million in 2003. The incidence of indebtedness also increased during this period to 23.4 per cent in 1991 and 26.5 per cent in 2003. As per 2012 estimates, the number of rural indebted households stands at a very high level of 43.8 million. The share of indebted household to total household has also witnessed a rise from 1991 to 2012. From 23.4 per cent in 1991, it has reached 26.5 per cent in 2003. But it has reached 31.44 per cent in 2012. The average debt per indebted household also progressively increased from ₹ 647 in 1961 to ₹ 103457 in 2012 in nominal terms (Table 1). The analysis shows that rural indebtedness has significantly increased in the post reform period.

**Table 1:** Number of Indebted Households and Outstanding Debt per Indebted Rural Households

| Year of Survey | Number of indebted households (in Million) | Incidence of Indebtedness (IOI) (Indebted HHs to Total) | Average Debt per indebted household (in Rupees) |
|---|---|---|---|
| 1961 | 43.1 | 62.8 | 647 |
| 1971 | 31.8 | 41.3 | 1180 |
| 1981 | 18.2 | 19.4 | 3411 |
| 1991 | 27.2 | 23.4 | 8166 |
| 2003 | 39.2 | 26.5 | 28443 |
| 2012 | 43.8 | 31.4 | 103457 |

*Source: All India Debt and Investment Survey (AIDIS), NSSO (Various Rounds)*

The increase in debt burden of the rural households in the post reform period is clearer from the analysis of the number of households and the outstanding debt between institutional and non-institutional sources as given in table 2. It is seen that with the declining total number of indebted households from 1971 to 1981 and its reversal from 1991 to 2002, the number of indebted households from non-institutional sources also declined from 1971 to 1981 but increased between 1991 and 2012. It shows that the number of borrowing households from institutional sources, though increased only from 7.6 million to 8.9 million in 1981, significantly rose sharply to 18.2 million in 1991 and further to 19.8 million in 2003. Though decreased minimally compared to the year 2003, it is to be noted that in the decade ending 2012, it stood at the level of 18.7 per cent. As against this, the number of borrowing households from non-institutional sources steeply declined from 24.2 million in 1971 to 9.3 million in 1981, which, then increased to 11.4 million in 1991 and rose sharply to 22.9 million in 2003. And in 2012, it further increased to

25.1 per cent (Table 2). What stems from the analysis is that in the context of the declining number of institutional indebted households, the indebted households from non-institutional sources significantly increased in the post 1991 period.

**Table 2:** Number of Indebted Households & Outstanding Household debt from institutional and non-institutional sources

| Credit Agency | Number of Indebted Households (in Million) | | | | | Outstanding Debt (Rs. in Crores) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1971 | 1981 | 1991 | 2003 | 2012 | 1971 | 1981 | 1991 | 2003 | 2012 |
| Institutional | 7.6 (24.0) | 8.9 (48.8) | 18.2 (61.5) | 19.8 (46.4) | 18.7 (42.69) | 1094 (31.7) | 3794 (63.2) | 14215 (65.2) | 63648 (57.1) | 563912 (56.0) |
| Non-Institutional | 24.2 (76.0) | 9.3 (51.2) | 11.4 (38.5) | 22.9 (53.6) | 25.1 (57.31) | 2658 (68.3) | 2399 (36.8) | 7996 (30.6) | 47820 (42.9) | 443073 (44.0) |
| All Agencies | 31.8 (100) | 18.2 (100) | 29.6 (100) | 39.2 (100) | 43.8 (100) | 3752 (100) | 6193 (100) | 22211 (100) | 111468 (100) | 1006985 (100) |

*Figures in the brackets indicates percentage to the total*

*Source: Calculated from NSSO (various rounds)*

The dependence on non-institutional debt is reflected in the increased outstanding debt of households from non-institutional sources. The percentage share of outstanding debt of households borrowing from non-institutional sources in the total outstanding debt, though continued to decline up to 1991, however, met with sharp increase in the decades ending with 2003 and 2012. The outstanding debt of households borrowing from non-institutional sources in terms of percentage to the total outstanding debt was considerably higher than that of borrowing from institutional sources in 1971, which then declined significantly between 1971 and 1991. But after 1991, the trend reversed and the share of non-institutional sources has increased to 44 per cent in 2012 from 36

per cent in 1991 (table 2). This shows that in the post reform period households are forced to depend more on informal sources in the context of withdrawal of formal institutions from rural lending.

## 2.2 Composition of Sources of Debt

In table 3, we discuss the composition of different sources of debt from institutional and non-institutional sources. It shows that among the non-institutional sources, professional moneylenders are in the top position. Though the relative share of this category varies over the years, their grip over the rural credit market has not declined. According to the All-India Rural Credit Survey Committee (1954), the share of non-institutional sources in the total rural credit was 92.7 per cent in 1951-52. The percentage has come down to 68.3 in 1971 (Table 3). This reduction in non-institutional sources occurred mainly due to the progress of commercial banks and cooperative banks during this period. Further, the nationalization of commercial banks and emergence of RRBs widened the branch network in rural areas thereby reducing the market share of non-institutional sources to 36.8 per cent in the decade ending 1991. However, it has increased to a high level of 44 per cent in the decade ended-2012. The dominance of non-institutional agencies in rural credit market has thus remained as a factor to reckon with in the post 1991 period. This is also evident from the fact that though the share of formal credit increased from 31.7 per cent in 1971 to 66.3 per cent in 1991, the trend reversed to decline significantly to reach 56.0 per cent in 2012 (Table 3). In the post reform scenario, still around 44 per cent of the rural credit has to be sourced from non-institutional sources and as a result the performance of

institutional agencies in rural credit market has attracted a lot of criticism from the planners, academicians and researchers.

**Table 3:** Share of Institutional and Non-Institutional Agencies in Rural Credit

| | 1971 | 1981 | 1991 | 2003 | 2012 |
|---|---|---|---|---|---|
| Government | 7.1 | 3.9 | 5.7 | 5.3 | 1.2 |
| Cooperatives | 22.0 | 29.9 | 23.6 | 27.3 | 24.8 |
| Commercial Banks | 2.4 | 28.9 | 35.2 | 24.5 | 25.1 |
| Others | 0.2 | 0.5 | 0.7 | 0.00 | 4.9 |
| **Institutional Agencies** | **31.7** | **63.2** | **66.3** | **57.1** | **56.0** |
| Landlords | 8.1 | 3.6 | 3.7 | 2.2 | 0.7 |
| Agricultural moneylenders | 23.0 | 8.3 | 6.8 | 8.1 | 5.0 |
| Professional moneylenders | 13.1 | 7.8 | 10.7 | 21.5 | 28.2 |
| Traders and Commission Agents | 8.4 | 3.2 | 2.2 | 3.2 | 0.1 |
| Relatives and Friends | 13.1 | 8.7 | 4.6 | 6.7 | 8.0 |
| Others | 2.6 | 5.2 | 2.6 | 1.2 | 1.9 |
| **Non-Institutional Agencies** | **68.3** | **36.8** | **33.7** | **42.9** | **44.0** |
| **All Agencies** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

*Source: Compiled from NSSO, AIDIS, Various Rounds.*

Table 3 gives the distribution of outstanding debt of all rural households by source of credit. It is seen that the most remarkable performance was that of the commercial banks. It appears that the large number of branches opened by commercial banks in 1970s and the subsequent introduction of social banking policies and priority sector lending have helped the commercial banks to assume the role of principal credit supplier in rural areas. The share of commercial banks rose to 35.2 per cent in 1991, after rising sharply to 28.9 per cent in 1981 from a meager 2.4 per cent in 1971. However, the post 1991 period witnessed declining importance of commercial banks with its share reaching to the low level of 25.1 per cent in 2012 from 35.2 per cent in 1991. Regarding cooperative banks, the share has gone up to 29.9 per cent in 1981 from 22

per cent in 1971. But later it declined to 23.6 per cent in 1991. Though it rose to 27.3 per cent in 2003, it got reversed to 24.8 per cent in 2012. On the face of the general decline in the institutional sources of banks and cooperatives, the non-institutional sources gained momentum with an increase from 33.7 in 1991 to 44.0 per cent in 2012. Among the non-institutional agencies, the most significant increase was for the debt from professional money lenders from 10.7 per cent in 1991 to 21.5 per cent in 2003 and further to 28.2 per cent in 2012 (Table 3). An interesting point is that the share of the Government in the outstanding debt of rural households in recent years declined. In 1971, the share of debt from Government was 7.1 per cent. It then declined to 3.9 per cent in 1981 though it rose to 5.7 per cent in 1991. Though it remained somewhat stagnant during 1991-2003 period, in 2012, it reached a very low level of 1.2 per cent (Table 3).

What emerges is that, as a whole, among the institutional sources, the co-operative banks and the commercial banks were the two most important categories in the rural sector. These two sources together, shared more than 90 per cent of the debt advanced by the institutional credit, accounted for 49.9 per cent of the outstanding cash debt, with co-operative societies and banks accounting for a share of 24.8 per cent and 25.1 per cent respectively in 2012. However, our analysis shows that, in spite of a significant share by cooperatives and commercial banks in institutional credit, the gradual increase in the share of formal institutional credit in agriculture witnessed some reversal during 1991-2012, mainly because of a pull back by commercial banks. This disquieting trend is, in part, due to a contraction in rural branch network in the 1990s, and in part

due to the general rigidities in procedures and systems of institutional sources of credit (Subbarao, 2012).

Against the decline in institutional sources, the non-institutional sources emerged to substitute the credit supply. Though the combined share of all the non-institutional credit agencies in the outstanding cash debt of rural households recorded a sharp decline of 32 percentage points during 1971-81 period, it got arrested in the 1980s with its level increased to 43 per cent in 2003 and further to 44 per cent in 2012. One important feature is the steep decline of agricultural money lenders whose overall share became 5 per cent in 2012 from about 23 per cent in 1971. Against this, the share of professional money lenders has jumped to about 21.5 per cent in 2003 and further to 25 per cent in 2012, after registering a fall to 8 per cent in 1981 from a high level of 14 per cent in 1971. The share of 'Relatives and friends' appears to be gradually losing their importance as a source of credit. From 14 per cent in 1971, their share fell to 9 per cent in 1981, and dipped further down to about 4.6 per cent in 1991. Though this category increased subsequently to 8 per cent in 2012, it remained well below the level in 1971. In general, among the non-institutional sources, professional money lenders were the main source of rural debt. A major reason for the increase in the overall household debt and the increase in the share of households is indebted to non-institutional sources between 1991 and 2012, especially professional money lenders. Having established the fact that post reform period witnessed increase in the dependence of households on non-institutional sources, we now turn to analyse the rural indebtedness between the urban and rural households.

## 2.3 Rural Indebtedness: Back to Money Lenders–Financial Reform Questioned

The analysis of institutional lending to agriculture proved that reforms have failed to accelerate credit flow to the rural households. This is reflected in the changes in the composition of borrowing in rural areas since 1991. The data on the sources of credit reveals that the debt of households is on the rise with a significant amount emerging from the non-institution (informal) sources. The relative share of institutional sources of credit declined from 66.3 per cent in 1991 to 56 per cent in 2012. The amount of rural credit from institutional sources is not impressive. However, when we compare the composition of the sources of credit for rural areas and urban areas, the contrast is striking since there is a sharp increase in the share of institutional agencies for the urban sector as compared to rural India. It is seen from table 4 that the share of institutional credit in the urban areas has witnessed a substantial increase from 62. 6 per cent in 1991 to 84.5 per cent in 2012. The conclusion is that though institutional sources of credit increased, its role is prominent in urban areas when compared to rural sector.

**Table 4:** Share of institutional and non-institutional sources in cash borrowings (in per cent)

| Agency | Rural | | | Urban | | |
|---|---|---|---|---|---|---|
| | **1991** | **2003** | **2012** | **1991** | **2003** | **2012** |
| **Institutional Agencies** | **66.3** | **57.1** | **56.0** | **62.6** | **75.7** | **84.5** |
| Co-operative societies/bank | 25.7 | 28 | 24.8 | 21.9 | 22 | 18.0 |
| Commercial banks | 20.7 | 22.7 | 25.1 | 16.3 | 30.6 | 57.1 |
| **Non-institutional agencies** | **33.7** | **42.9** | **44.0** | **37.4** | **24.3** | **15.5** |
| Land lord | 3.9 | 0.6 | 0.7 | 0.3 | 0.2 | 0.1 |
| Agricultural Money lender | 8.1 | 9.6 | 5.0 | 0.6 | 0.6 | 0.1 |
| Professional money lender | 13.3 | 20.6 | 28.2 | 14 | 13.3 | 10.6 |

Note: Subcategories will not be added to total since only main items are reported
Source: NSSO, All India Debt and Investment Survey (AIDIS), NSS 59th Round, 70th round

The prominent bias of institutional credit to urban area is reflected in the heavy dependence of non-institutional sources by the rural sector. While the share of non-institutional credit has increased from 42.3 percent in 1991 to 44 percent in 2012, in the urban areas, non-institutional credit witnessed tremendous decline from 37.4 percent to 15.5 percent in 2012. The dependence on non-institutional sources by the rural sector becomes more disappointing when we examine the composition of non-institutional sources of debt in rural sector. Regarding non-institutional credit (informal credit) it is seen that the share of professional money lenders in the rural sector has increased from 13.3 per cent in 1991 to 20.6 in 2003 and 28.6 per cent in 2012. On the other hand, in the urban sector, it has declined from 14 per cent in 1991 to 10.6 percent in 2012. On the aggregate, while the share of informal credit has increased only marginally from 42.9 per cent in 1991 to 44 per cent in 2012, its share has gone down sharply in the urban sector (Table 4). The increase in non-institutional credit in rural areas is thus contributed solely by the increase in professional money lenders. This suggests that in the rural credit scenario, the domination of non-institutional credit dominates with professional money lenders as an important source of rural households. The excessive dependence on professional money lenders, who generally lend at exorbitant interest rates, is a serious concern in the post reform period. The analysis lends credence to the fact that post financial reform period paves way to the re-emergence of the professional money lenders, which goes against the theoretical argument of financial liberalization that informal credit will wither away by eliminating the credit constraints and imperfections in the credit market. Now to shed light on whether the

increase in non-institutional sources is applicable generally in all areas of the country, we now attempt to study the inter-state variation in indebtedness from both formal and informal sources among rural households.

## 2.4 Incidence of Indebtedness across States

**Table 5:** Incidence of indebtedness (IOI) of rural households as to institutional and non-institutional credit agencies for selected states in 2012

| States | Institutional Sources | Non-institutional Sources |
|---|---|---|
| Andhra Pradesh | 35.2 | 32.2 |
| Assam | 4.4 | 5.9 |
| Bihar | 5.6 | 25.3 |
| Chhattisgarh | 6.7 | 8.9 |
| Gujarat | 14.6 | 13.0 |
| Harayana | 13.2 | 14.8 |
| Jharkhand | 6.1 | 13.4 |
| Karnataka | 26.7 | 29.7 |
| Kerala | 43.0 | 15.0 |
| Madhya Pradesh | 11.0 | 15.6 |
| Maharashtra | 24.4 | 11.6 |
| Odisha | 15.4 | 14.4 |
| Punjab | 15.4 | 22.3 |
| Rajasthan | 13.2 | 29.1 |
| Tamil Nadu | 26.6 | 21.3 |
| Telengana | 38.9 | 38.6 |
| Uttar Pradesh | 12.9 | 19.5 |
| West Bengal | 13.2 | 13.0 |
| **all-India** | **17.2** | **19.0** |

*Source: NSSO, AIDIS, 70$^{th}$ Round*

The Incidence of Indebtedness (IOI) measures the share of households indebted in total households. Table 5 gives the inter-state variation in indebtedness according institutional and non-institutional sources in rural areas. It is seen that except in Assam and Chattisgarh, in all other states, the incidence of indebtedness from informal sources is above 10 percent. IOI was more widespread in states like Andhra Pradesh, Uttar Pradesh, Telengana, Rajastan, Punjab, Bihar and Karnataka than the others.

In these states, the value of IOI ranged above, between 19.5 to 38.6 percent with Uttar Pradesh showing 19.5 percent and Telengana 38.6 percent. In all these southern states, except Kerala, IOI for non-institutional agencies varied in the range of 21 per cent to 39 per cent, while the all-India figure was 19 per cent. For non-institutional sources, 8 states reported higher IOI than the national average (for rural areas), whereas for states like Assam and Chhattisgarh it was much less than the said national average. Another interesting observation is that except Kerala, Maharashtra and Tamil Nadu, for all other states the incidence of indebtedness from non-institutional agencies is either close to or much higher than the incidence of indebtedness from institutional agencies.

**Table 6:** Percentage share of institutional and non-institutional agencies in outstanding cash debt for selected states

| States | Rural | | | | Urban | | | |
|---|---|---|---|---|---|---|---|---|
| | **1981** | **1991** | **2003** | **2012** | **1981** | **1991** | **2003** | **2012** |
| Andhra Pradesh | 41 | 34 | 27 | 42 | 26 | 53 | 60 | 69 |
| Assam | 31 | 66 | 58 | 72 | 77 | 97 | 83 | 89 |
| Bihar | 47 | 73 | 37 | 22 | 61 | 67 | 65 | 71 |
| Chhattisgarh | - | - | 85 | 66 | - | - | 86 | 93 |
| Gujarat | 70 | 75 | 67 | 64 | 86 | 59 | 74 | 92 |
| Haryana | 76 | 73 | 50 | 52 | 66 | 81 | 56 | 94 |
| Jharkhand | - | - | 71 | 51 | - | - | 91 | 83 |
| Karnataka | 78 | 78 | 67 | 50 | 54 | 85 | 83 | 73 |
| Kerala | 79 | 92 | 81 | 78 | 77 | 75 | 83 | 89 |
| Madhya Pradesh | 66 | 73 | 59 | 52 | 72 | 70 | 84 | 86 |
| Maharashtra | 86 | 82 | 85 | 73 | 65 | 78 | 91 | 96 |
| Odisha | 81 | 80 | 74 | 57 | 83 | 83 | 93 | 96 |
| Punjab | 74 | 79 | 56 | 64 | 61 | 59 | 76 | 81 |
| Rajasthan | 41 | 40 | 34 | 31 | 47 | 78 | 52 | 59 |
| Tamil Nadu | 44 | 58 | 47 | 62 | 56 | 71 | 59 | 78 |
| Uttar Pradesh | 55 | 69 | 56 | 57 | 59 | 65 | 58 | 90 |
| West Bengal | 66 | 82 | 68 | 51 | 55 | 74 | 75 | 87 |
| **all-India** | 61 | 64 | 57 | 56 | 60 | **72** | **75** | **85** |

*Source: NSSO, AIDIS, 37th, 48th, 59th and 70th rounds*

The role of the institutional agencies, as judged from their share in the outstanding cash dues, varied from state to state as given in table 6. A snapshot of this variation in 2012 shows that in the rural areas, institutional credit agencies accounted for 70 per cent or more of the "total cash due" (TCD) in Assam (72 per cent), Maharashtra (73 per cent), Kerala (78 per cent). In the urban areas, the share of institutional agencies had been 70 per cent or more of the "total cash due" for all states except Andhra Pradesh and Rajasthan. Among them, the share was 90 per cent or more in six states (Chhattisgarh, Gujarat, Haryana, Maharashtra, Odisha and Uttar Pradesh). In contrast, not even 50 per cent of the debt was contracted through the institutional credit agencies in the rural areas of Andhra Pradesh (42 per cent), Telangana (32 per cent), Rajasthan (31per cent) and Bihar (22 per cent). In the urban areas, however, the least share of institutional agencies was recorded (59 per cent) in Rajasthan.

During the period 1971 to 2012, the states do not reveal any uniform pattern in the share of institutional agencies in total debt. Compared to 2003, the picture had changed in some of the selected states. Of the 18 states in the rural, as many as 11 have shown a fall in the share of institutional agencies; notable among them are Bihar, Chhattisgarh, Jharkhand, Karnataka, Odisha, and West Bengal where the fall in percentage share from 2003 to 2012 values had been more than 15 percentage points. On the other hand, in urban areas, all states (other than Jharkhand and Karnataka) had registered a rise in the share in institutional sources. The urban bias in the lending of banks is clear from this analysis. The rural indebtedness and its concentration among non-institutional sources are thus not surprising. The rural indebtedness in India also

reflects in the incidence of indebtedness of farmers from non-institutional sources as discussed in the next section.

## 2.5 Incidence of Indebtedness of Farmers

**Table 7:** Incidence of Indebtedness (IOI) of rural cultivators from non-institutional sources

| Year | Incidence of debt (IOD) |
|---|---|
| 1971 | 46.1 |
| 1981 | 22.3 |
| 1991 | 25.9 |
| 2003 | 57.2 |
| 2012 | 45.9 |

*Source: All India Debt and Investment Survey, AIDIS, Various Rounds*

The agricultural indebtedness has historically been pointed out and debated by many scholars in India. The Deccan Riots Commission (1878) and the Famine Commission (1880) reported that one-third of the land holders were in deep debt. It was specifically noted by the Famine Commission that more than 80 per cent of the farmers were under debt trap. The Deccan Riots was the revolt of the Maharashtra peasants conducted in areas of Pune, Satara, and Ahmednagar districts against the acute agrarian distress of farmers in 1875. The revolt was particularly against the debt trap created by money lenders. Even in the post-independence period, the problem of the debt of farmers was existing. The measures like nationalization, norms of priority sector lending etc. introduced during 1970s and early 1980s to increase the accessibility of rural credit, resulted in the reduction in the incidence of indebtedness of farmers in the country as evident from table 7. The proportion of indebted cultivators has come down from 46.1 per cent in 1971 to 22.3 per cent in 1981. However, the

1980s witnessed a reversal in the indebtedness with its level reaching 25.9 per cent on 1991. Though banking reforms were introduced in 1991 to ensure credit flow to agriculture from the formal credit institutions, the proportion of indebted farmers alarmingly increased to reach 57.2 per cent in 2003. Even in 2012, its share is as high as 45.94 per cent (Table 7).

## 3. Conclusion

Financial Liberalisation creates new institutional structure which is market oriented and driven on profitability. Despite over three decades of systematic expansion of the banking infrastructure in the country, the study indicates that the informal sources of credit—including usurious money lenders—remain important, and often dominant and growing sources of credit for rural and agricultural households in the post reform period**.** The increasing indebtedness is one of the challenges rural population, especially farmers, face in their livelihood security and it is a clear indication of the distress of farmers. From the discussion we have carried out, we arrive at a conclusion that the proportion of indebted households is very large with a large share depending on even informal sources. It is seen that the debt outstanding has been accumulated over the years.

It is true that the formal credit market in India has grown up rapidly since the reforms of 1991 with a variety of financial products. However, the informal market continues to be pervasive, catering to diverse credit requirements of rural India. The formal credit institutions in the rural areas, after 1991, showed a lethargic attitude towards the provision of credit. There has been a contraction in rural banking in general and priority lending to the poor in particular. The explicit reversal of the

development policy of social banking with the implementation of financial liberalisation has a drastic and potential disastrous effect on the debt portfolios of the income-poor. As the formal sector withdraws, the informal sector ushers in to occupy the space it had vacated. The formal sector dominated by banks, does not provide sufficient finance as the rural masses are generally the landless, devoid of any collateral to offer. As a consequence, the informal credit filled the gap in this demand-supply mismatch. The comparative advantages the informal sector enjoys in terms of information gathering, transaction costs, risk management etc., might have given them a distinct edge over the formal sector in rural areas. The shrink in formal credit forced the farmers to borrow from private money lenders at usurious interest rates and become heavily indebted. This argument suggests a scope to study the interaction between financial liberalisation with declining agricultural credit, rising rural indebtedness and suicides of farmers to shed light on the economic context within which the rural credit market in the country operate.

## References:

[1] All India Rural Credit Survey Committee (1954). Report of the Committee of Direction. Reserve Bank of India. RBI.

[2] Assadi, M. (2000). Karnataka Seed Tribunal: Interrogating Farmers' Suicides. *Economic and Political Weekly.* 35(43-44), 3808-3810.

[3] Banerjee, Arindam. (2009). Peasant Classes under Neoliberalism: A Class Analysis of Two States, Economic and Political Weekly. 24 (15). XLIV (15): 49-57.

[4] Chandrasekhar, C.P. and Jayati Ghosh. (2004). *The Market that Failed: Neoliberal Economic Reforms in India*. Second Edition, New Delhi: Leftword Books.

[5] Chavan, Pallavi. (2005a). Banking Sector Liberalisation and Growth and Regional Distribution of Rural Banking in India, In: V. K. Ramachandran & M. Swaminathan (Eds.), *Financial Liberalisation and Rural Credit in India* (110-136) New Delhi: Tulika Books.

[6] Famine Commission Report (1880). Agricole Publishing Company. D·76 Panchsheel Enclave. New Delhi.

[7] Dandekar, A., Narawade, S., Rathod, R., Ingle, R., Kulkarni, V., & Y.D. Sateppa (2005). *Causes of Farmer Suicides in Maharashtra: An Enquiry, Final Report Submitted to the Mumbai High Court*. Tuljapur, Osmanabad: Tata Institute of Social Sciences

[8] Deshpande, R.S., Khalil, Shah., and Prasanna, Pandhari. (2008). *Market Imperfections and Farmers' Distress: A Consolidated Report' (A report prepared for Ministry of Agriculture, Government of India),* Research Report XI/ADRT/122, Institute for Social and Economic Change, Bangalore.

[9] Jeromi, P. D. (2007). Farmers' Indebtedness and Suicides: Impact of Agricultural Trade Liberalisation in Kerala, *Economic and Political Weekly*, 42(31):3241-3247.

[10] Mishra, S. (2006a). Farmer Suicides in Maharashtra. *Economic and Political Weekly*. 41(16), 2006:1538-1545.

[11] Mohan, Rakesh. (2006). Agricultural Credit in India: Status, Issues and Future Agenda. *Economic and Political Weekly.* 41(11):1013-1021.

[12] Mohanty, B. B. (2005). We are Like the Living Dead: Farmer Suicides in Maharashtra, Western India. *Journal of Peasant Studies.* 32(2):243-276.

[13] Nagaraj, K. (2008). *Farmers' Suicides in India: Magnitudes, Trends and Spatial Patterns*, Madras: Madras Institute of Development Studies.

[14] Narayana, D. (2000). *Banking Sector Reforms and the Emerging Inequalities in Commercial Credit Deployment in India*. Centre for Development Studies, Working Paper, 300, Thiruvananthapuram.

[15] NSSO (1972), All India Debt and Investment Survey, 1971-72, 26th Round, Government of India.

[16] NSSO (1982), All India Debt and Investment Survey, 1981-82, 37th Round, Government of India.

[17] NSSO (1998). Indebtedness of Rural Households as on 30-06-1991, Debt and investment Survey, NSS 48th Round, January-December 1991, Ministry of Statistics and Programme Implementation Government of India, New Delhi.

[18] NSSO (2005). Indebtedness of Farmer Households in India. Situation Assessment Survey of Farmers, Report No. 498, 59th round. 2003.National Sample Survey Organisation, Ministry of Statistics and Programme Implementation Government of India, New Delhi.

[19] NSSO (2013). Indebtedness of Farmer Households in India. Situation Assessment Survey of Farmers, 70th round. 2013.National Sample Survey Organisation, Ministry of Statistics and Programme Implementation Government of India, New Delhi.

[20] Ozili, Peterson K. (2020). *Financial inclusion: a strong critique*, MPRA Paper No. 101813, Online at https://mpra.ub.uni-muenchen.de/101813.

[21] Report of the Deccan Riots Commission, *Parliamentary Papers,* 1878, LVIII, paragraph 12.

[22] Reserve Bank of India. (2014). *Priority Sector Lending: Targets and Classification*. Mumbai, India: Financial Inclusion and Development Department.

[23] Shetty, S. L. (1997). Financial Sector Reforms in India: An Evaluation. *Prajnan*, 25 (3-4): 253-87.

[24] Subbarao, D. (2012). *Agricultural Credit-Accomplishments and Challenges*, Speech delivered at the thirty years anniversary celebrations of NABARD, Mumbai, July 12.

[25] Subbarao, D. (2012). *Agricultural Credit-Accomplishments and Challenges*, Speech delivered at the thirty years anniversary celebrations of NABARD, Mumbai, July 12.

# A GLIMPSE TO APPLICATIONS OF ALGEBRA IN OTHER SCIENCES

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## Abstract

*Mathematics is called the queen of sciences, because no science can exist on its own without the support of mathematics. The scientific explanation of any theory may trace its roots to some branch of mathematics. A complete survey of applications of mathematics in other branches of science may require more than a human lifespan. Here, my attempt is to discuss some applications of algebraic methods and algebraic structures in some branches of science. Any field of mathematics involve its own special algebraic structures. Therefore, the study of algebraic structures is important in the study of any special branch of mathematics.*

## Introduction

The name "algebra" comes from the title of the book Hisab al-jabr w'al-muqabala by Abu Ja'far Muhammad ibn Musa Al-Khwarizmi, a Persian mathematician who lived in Baghdad early in the Islamic era. He was interested in solving various algebraic equations and his method involves applying a transformation to the equation to put it into a standard form for which the solution method is known. Algebra may be broadly classified into two: Linear Algebra and Abstract Algebra. Both the

branches are equally important and has a lot of applications in many other areas.

The study of Algebra involves the study of structures on sets. A set is a well-defined collection of objects. A structure consists of one or more binary operations on the set, which obey certain rules, also called axioms. Addition is an example of a binary operation. There are a lot of basic algebraic structures such as monoid, semi group, group, ring, field, modules and vector spaces. Apart from this, a lot of algebraic structures are being defined based on these structures to fulfil particular needs from time to time. A clear understanding of algebraic structures requires understanding the basic facts and peculiarities of the domain in which we are working. For example, we cannot factor $x^2 + 1$ in the field of reals but can be factorised in the field of complex numbers as $x^2 + 1 = (x - i)(x + i)$ where $i^2 = -1$.

## Algebra as a solution provider

Almost all sciences use algebraic methods to obtain solutions to various types of problems, which occur in their way. For this reason, a strong base of mathematics is essential for the study of any branch of science. The problems related to distance and time in physics are solved using algebraic methods. The velocity and acceleration of a particle are represented by vectors in 3-dimensional Euclidean space $R^3$. The eigenvalues of a matrix are determined by solving the characteristic equation of the matrix, which has a lot of applications in spectral analysis. Similarly, chemistry and computer science use algebraic methods excessively for solving various types of problems.

As an example, we may consider the determination of the number of atoms in a chemical equation.

$$\_KMnO_4 + \_HCl \rightarrow \_MnCl_2 + \_KCl + \_Cl_2 + \_H_2O$$

Initially, we supply alphabets as the number of variables.

$$aKMnO_4 + bHCl \rightarrow cMnCl_2 + dKCl + eCl_2 + fH_2O$$

The law of Conservation of Mass tells us that the total number of atoms of each element must be the same on both sides. Thus, we can write algebraic rules for each element as follows:

$$K: a = d,\ Mn: a = c,\ O: 4a = f,\ H: b = 2f,\ Cl: b = 2c + d + 2e$$

Solving the equations algebraically and substituting the values in the equation we get

$$2KMnO_4 + 16HCl \rightarrow 2MnCl_2 + 2KCl + 5Cl_2 + 8H_2O$$

Sometimes, we may also require the rules of relevant branches of science in solving an algebraic equation. Consider the example of an equation which uses the principle of conservation of charges: $\_IO_3 + \_I^- + \_H^+ \rightarrow \_I_2 + \_H_2O$

Since oxygen appears once on each side of the equation we write 'a' in front of $IO_3$ and 3a in front of $H_2O$: $aIO_3 + \_I^- + \_H^+ \rightarrow \_I_2 + 3aH_2O$

Hydrogen also appears once on each side of the equation, and if there is 3a in $H_2O$, there must be $6a\ H^+$ ions on the LHS: $aIO_3 + \_I^- + 6aH^+ \rightarrow \_I_2 + 3aH_2O$

Now we consider iodine. If we put b in front of $I_2$ on the RHS, then the total number of atoms of iodine on the RHS is 2b and the total number of iodine atoms on the LHS (applying the Conservation of Mass) must be 2b -a (a being the number of atoms present in $IO_3$):

$$aIO_3 + 2b\text{-}aI^- + 6aH^+ \rightarrow bI_2 + 3aH_2O$$

By the principle of the Conservation of Charge, since the RHS has no net charge, the LHS also must have no net charge. That means that the coefficient in front of $I^-$ and $H^+$ must be equal. Thus we get 2b-a = 6a, 2b = 7a, hence a = 2 and b = 7. Substituting these values gives the balanced equation: $\mathbf{2}IO_3 + \mathbf{12}I^- + \mathbf{12}H^+ \rightarrow \mathbf{7}I_2 + \mathbf{6}H_2O$

## Application of algebraic structures

Algebraic structures have a lot of applications in other sciences. Among these, Groups are of prime importance. A Group [1] is a set together with an associative binary operation containing the identity element and inverses of each element. If the elements commute with respect to the operation, then it is called an abelian group and if all elements can be obtained by repeated application of a single element to itself, it is called a cyclic group. Almost all structures in abstract algebra may be considered as special cases of groups. For example, Rings [1] can be viewed as abelian groups with respect to addition, together with a second operation multiplication. A Field [1] is an additive abelian group, while the non-zero elements of a field form a multiplicative group. Even a Vector space [1] is an abelian group, with the operation being addition. A Point Group describes all the symmetry operations that can be performed on a molecule that results in a conformation indistinguishable

from the original. Point groups are used to determine properties such as a molecule's molecular orbitals. There are only two one-dimensional point groups, the identity group and the reflection group.

The concept of symmetry is very important in researches related to chemistry, physics and biology. Symmetry and asymmetry directly affect how molecules respond to light waves, form bonds and operate biologically. Group theory can provide methods to determine how symmetry of a molecule is related to physical properties of molecules, such as energy levels of the orbitals, transitions between energy levels and even details of bonds. The Cayley's Theorem [1] states that every group is the subgroup of some Symmetry group. That is, every group is a permutation group. This motivated the study of algebraic combinatorics. Group actions [2] are used to study symmetries or automorphisms of mathematical objects. Informally, a group action is a dynamical process on an object, which partitions its members into sets which we call orbits. The study of the structure and quantity of these orbits yields important combinatorial results. The Dihedral group is the automorphism group of the Cycle graph. A permutation is a one-to-one, onto function defined from a set A to itself. A permutation is actually a rearrangement of the elements. It is proved that the set of all permutations defined on a set forms a group, called the permutation group. There are n! permutations defined on a set of n elements forming the symmetric group $S_n$.

For example, if a set A has three elements, say A = {1, 2, 3} then there are 3! =6 permutations. They are $\begin{pmatrix}1 & 2 & 3\\1 & 2 & 3\end{pmatrix}$, $\begin{pmatrix}1 & 2 & 3\\1 & 3 & 2\end{pmatrix}$, $\begin{pmatrix}1 & 2 & 3\\2 & 1 & 3\end{pmatrix}$,

$\begin{pmatrix}1 & 2 & 3\\ 2 & 3 & 1\end{pmatrix}, \begin{pmatrix}1 & 2 & 3\\ 3 & 1 & 2\end{pmatrix}$ and $\begin{pmatrix}1 & 2 & 3\\ 3 & 2 & 1\end{pmatrix}$ among which $\begin{pmatrix}1 & 2 & 3\\ 1 & 2 & 3\end{pmatrix}$ is the identity element. The Collection of these six elements is known as the group of symmetries of a triangle.

Symmetry has a very big role in the study of molecular chemistry. The identity operation (E) is leaving the molecule as it is. This is equivalent to any number of full rotations around any axis. Rotation around an axis ($C_n$) consists of rotating the molecule around a specific axis by a specific angle. For example, if a water molecule is rotated 180° around the axis, it is in the same configuration as it started. Other symmetry operations are: reflection, inversion and improper rotation (rotation followed by reflection). A symmetrical molecule is one whose appearance does not change if you turn it about an axis of symmetry. i.e., original and rotated states are indistinguishable from one another.

Symmetry was studied mathematically with reference to crystal symmetry. If you rotate a crystal by certain angles about certain axes, or reflect it in certain planes, you find equivalent faces in equivalent places. The branch Spatial symmetry, [7] deals with operations that keep one point fixed, which constitute point groups. The collection of symmetry operations, form a group. For example, the Ammonia molecule (NH3) is composed of one nitrogen atom and three hydrogen atoms, has C3v symmetry (which is isomorphic to the symmetric group $S_3$ of 6 elements) and all of the properties contained in the C3v character table are relevant to an ammonia molecule. It is also estimated that the ammonia molecule has 6 vibrational transitions. Let us suppose that symmetry elements of ammonia molecule are E, $C_3$, $C_3^2$, σ, σ', σ''. If we denote the

original symmetry plane by σ, then rotations carry this plane into equivalent symmetry planes σ' and σ''. A general point P is carried into the other two solid points by rotations, and into the open points by reflections in the three symmetry planes. Now, we may consider interactions between the rotations and reflections in this group. Suppose we reflect P in σ, then rotate clockwise by $C_3$, and finally reflect again in σ. The result is the same as rotating anticlockwise by $C_3^2$. Algebraically, we can write $\sigma^{-1} C_3 \sigma = C_3^2$. The associated members of a group form a class. The members of same class are similar in nature. The algebraic approaches of quantum chemistry mainly use two alternative algebraic structures: the fundamental group of reaction mechanisms, based on the energy-dependent topology of potential energy surfaces, and the interrelations among point symmetry groups for various distorted nuclear arrangements of molecules. These two, distinct algebraic structures provide interesting interrelations, which can be exploited in actual studies of molecular conformational and reaction processes.

In theoretical organic chemistry, the algebraic structure count is introduced as the difference between the number of even and odd Kekule structures (named after the famous German organic chemist August Kekule) [7] of a conjugated molecule. Precisely, algebraic structure count (ASC-value) of the bipartite graph G corresponding to the skeleton of a conjugated hydrocarbon is defined using the adjacency matrix of G. In the case of bipartite planar graphs containing only circuits of the length of the form 4s+2 (s=1,2,...) (the case of benzenoid hydrocarbons), this number is equal to the number of the perfect matchings (K-value) of G. There are algebraic formulae due to a Serbian chemist and mathematician, Ivan Gutman, for finding the algebraic structure count.

The recurrence formula for the number of perfect matchings is given by K{G}=K{G−e}+K{G−(e)} where (G−e is the subgraph obtained from the graph G by deleting the edge e and G−(e) is the subgraph obtained from G by deleting both the edge e and its terminal vertices).

## The Role of Algebra in Physics

Researchers in Physics use group representations [4] to obtain information from symmetries. Representations of a group are in some sense a concrete realization of the group in the form of matrices acting on a vector space. It allows certain members of the space to be created that are symmetrical, and which can be classified by their symmetry. It is found that all the observed spectroscopic states of atoms and molecules correspond to such symmetrical functions, and can be classified accordingly. Vector spaces, as an abstract algebraic structure, was first defined by the Italian mathematician Giuseppe Peano in 1888. The importance of vector spaces is that nearly everything in mathematical modeling is a vector in one way or another, and frequently the vector space operations are to be applied. A Vector space (also called a linear space) is a collection of objects called vectors, which may be added together and multiplied by scalars. The operations of vector addition and scalar multiplication must satisfy the specified axioms. A subspace is a vector space inside a vector space. A plane through the origin of $R^3$ forms a subspace of $R^3$. This is evident geometrically as follows: Let W be any plane through the origin and let u and v be any vectors in W other than the zero vector. Then u + v must lie in W because it is the diagonal of the parallelogram determined by u and v, and ku must lie in W for any

scalar k because ku lies on a line through u. Thus, W is closed under addition and scalar multiplication, so it is a subspace of $R^3$.

Let us now generate some representations of the group. We can set up rectangular coordinates x,y,z, perhaps with z along the symmetry axis and x along one of the symmetry planes, with y making a right-handed system. Then point P can be expressed as (x,y,z). Any symmetry operation will take these coordinates into (x',y',z') which are linear functions of the original coordinates. Explicitly, the transformation can be expressed as 3 x 3 matrices acting on 3-dimensional column vectors. There will be six matrices, and E will correspond to the identity matrix. The matrices are easily found from the formulas for rotation of coordinates. We notice that z is not affected. It is multiplied by 1 in each transformation and the values of x,y are never mixed in. Therefore, z is the basis of a representation all by itself, the unit representation where each member corresponds to 1. The values of x and y do get mixed under the transformations, and it is easy to see that no choice of coordinates could ever change this. They form the basis of a two-dimensional matrix representation. The representation in terms of (x,y,z) is said to be reducible to the two smaller representations, and each of these is irreducible to smaller representations. It is the irreducible representations that give the essential information and a 1-dimensional representation is naturally irreducible.

Any representation changes its explicit form if we make a different choice of basis. Choosing a different basis is a linear transformation y = Ax, under which the matrices R of a representation change into $R' = A^{-1}RA$. This is called a similarity transformation [6]. The diagonal

sum or trace of the matrix R is invariant under such a transformation and this trace is called the character of the member in the representation. If the characters of two representations are the same, then the representations are equivalent and two equivalent representations differ only in the choice of basis functions used to express them explicitly.

The characters of matrices representing the members of a class will be the same, as we know that the members of a class are related by similarity transformations. The number of irreducible representations of a group is equal to the number of classes. We can construct tables showing the characters of its irreducible representations. As an example, the states of an isolated atom are classified by the total angular momentum J, and belong to irreducible representations of the rotation group in three dimensions with dimension 2J + 1. As long as there is spherical symmetry, all these states have exactly the same energy. When a magnetic field is applied, then the 2J + 1 levels now acquire different energies, and Group theory can determine these states in advance.

The electric dipole moment is a vector, and corresponds to the irreducible representation J = 1 of the rotation group. Operating on a state of angular momentum J, it gives representations corresponding to J + 1, J, and J - 1. The other state involved must have one of these values of J, or the result will not contain the unit representation J = 0. Therefore, we have the selection rule that J changes only by ±1 or 0 in an electric dipole transition.

Lie groups [3] were introduced to model the continuous symmetries of differential equations, in the same way that finite groups are used in Galois theory [1] to model the discrete symmetries of algebraic

equations. A Continuous group is a group having continuous group operations. The rotation group $O_3$ is an example of a continuous group. For $O_3$, we could use the two angles specifying the orientation of the axis of rotation, and the angle of rotation about this axis.

Angular momentum operators $J_x$, $J_y$ and $J_z$ satisfy the relation $[J_x, J_y] = iJ_z$, where the [] is the commutator of the two operators: [a,b] = ab - ba. The J operators form a Lie Algebra closed under the [] operation. The members of $O_3$, are the generators of the group in the sense that $D(\alpha) = (1 + i\alpha J_z)$ is the operator for a rotation through an infinitesimal angle $\alpha$ about the z-axis. A finite rotation can be expressed as $D(\alpha) = \exp(i\alpha J_z)$. The Lie algebra expresses the structure of the group in a concise and usable form. The conservation of angular momentum is a consequence of the $O_3$ symmetry. In general, any continuous symmetry may be considered to be associated with a conservation law. Linear momentum is similarly related to symmetry under displacement of the system in space, and energy to displacement in time. Finite symmetries are not associated with conserved quantities. Two important symmetries in quantum mechanics are inversion symmetry or parity, and time reversal symmetry.

## Applications of Algebra in Computer science

Discrete mathematics [9] and Boolean Algebra [8] form the foundation for Computer science and coding theory. Finite groups are used based on multiplication of integers in asymmetric encryption schemes [3] such as RSA (Rivest-Shamir-Adleman - algorithm used by modern computers to encrypt and decrypt messages) in cryptography. The error correction codes [3] like Reed-Solomon codes and Chinese

remainder codes use the ideas of Rings and Ideals. Algebraic concepts and structures are used in algorithms and functions [5] in computer programming. For example, when the "%" remainder function is used, we are considering a cyclic group with respect to modulo operation.

Finite fields, especially Galois fields play a very important role in Computer science. A field F is an algebraic system with two operations, namely addition and multiplication. A field K is said to be an Extension Field of a field F, if F is a sub-field of K. For example, the field of Complex Numbers is an extension of the field of Real Numbers. A theorem due to Kronecker [1] states that if F is a field and let f(x) is a non-constant polynomial in F[x], then there is an extension field E of F and an element $\alpha$ in E such that $f(\alpha) = 0$. If we have a finite field and an irreducible polynomial over the field, then we can construct a finite field using the root of the irreducible polynomial lying in an extension field. For example, $p(x) = x^2+x+1$ is irreducible over $Z_2$. Then there is an extension field E of $Z_2$ containing a zero $\alpha$ of p(x). Then $Z_2(\alpha)=\{b_0+b_1\alpha / bi \in Z_2\}$. That is, $Z_2(\alpha)=\{0, 1, \alpha, 1+\alpha\}$. Thus, we have a new finite field of four elements. The field of Complex numbers is algebraically closed. That is every non-constant polynomial f(x) in C[x] has a zero in C. We can construct a polynomial with real coefficients (for example $p(x) = x^2+1$) having no zero in R. But this is impossible in C. In other words, C may be considered as complete or perfect.

Algebraic structures like semigroups and monoids are used excessively in automata theory and coding theory. Cayley Graphs [2] are used in designing communication architectures for parallel and distributed computation, in which each vertex represents a separate processor and each edge represents a communication link between two processors.

Maximization of the number of processors, given a fixed number of links per processor, finding effective transmission schemes that minimize traffic congestion are typical research topics. Polya enumeration theory [3] studies the number of distinct colourings or automorphisms of groups such as rotations of 3D objects. Constraint satisfaction problems involving homomorphisms of relational structures arise frequently in artificial intelligence which are solved using algebraic techniques.

Algebra and algebraic geometry are the basis of nearly all modern cryptographic works. Data mining theory uses mappings between monoids and semiring structures. Grobner Basis to solve simultaneous multivariable polynomial equations use the theory of Rings and Ideals. Another important abstract structure used in computer science is lattice[8], consisting of a partially ordered set in which every two elements have a unique supremum (also called a least upper bound or join) and a unique infimum (also called a greatest lower bound or meet). The set of natural numbers is an example of lattice, partially ordered by divisibility, for which the unique supremum is the least common multiple and the unique infimum is the greatest common divisor. Lattices can also be characterized as algebraic structures satisfying certain axiomatic identities. Because meet and join both commute and associate, a lattice can be viewed as consisting of two commutative semigroups. Lattice theory was mixed with Topology to develop continuous lattices, which are continuous as posits and formed the foundations for Denotational Semantics, which is an approach of formalizing the meanings of programming languages by constructing mathematical objects (called denotations) that describe the meanings of expressions from the languages.

## Conclusion

Algebra, in all its forms, is used excessively in numerous branches of science. Apart from the areas discussed here, Algebra has applications in Economics, Commerce, Molecular biology, Botany, Zoology, Geology, Information Technology and a lot of other sciences. It may not be an exaggeration to say that Algebra provides a strong foundation to almost all the sciences. This relevance may be the reason for considering mathematics as the crest of peacock among sciences in ancient India.

## References

[1] John B. Fraleigh, A First course in Abstract Algebra, Seventh Edition (2003), Pearson Education.

[2] Joseph A Gallian, Contemporary Abstract Algebra, Eighth Edition (2013), Cengage Learning.

[3] Wade Trappe, Lawrence C. Washington, Introduction to Cryptography with Coding Theory, Second Edition (2005), Pearson Edn.

[4] Ajay Ghatak, S. Lokanathan, Quantum Mechanics—Theory and applications (2004), Macmillan Pub.Ind.Ltd

[5] Stuart Russel, Peter Norvig, Artificial Intelligence—A Modern approach, Third Edition (2010), Pearson Education.

[6] David C. Lay, Linear Algebra and its Applications, Third Edition (2002), Pearson Edn.

[7] Philip Matthews, Advanced Chemistry (December 12, 1991 Edition), Cambridge University Press.

[8] Jean Paul Tremblay, R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, First Edition (2017), McGraw Hill Education.

[9] C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics- A Computer Oriented Approach, Second Edition (2000), McGraw Hill Education.

# BIOCHEMICAL ANALYSIS OF PSEUDOSTEM OF TWO BANANA CULTIVARS FROM KERALA

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## Abstract

*The pseudostem of banana is usually treated as crop waste after harvesting the fruit. The present study is aimed to explore the nutritional information of pseudostem of two popular banana cultivars from Kerala viz. Red banana (AAA) and Rasakadali (AB). The biochemical estimation of the total carbohydrates, protein, dietary fibre, the total phenolics and the mineral analysis of the two cultivars were carried out. The results showed that Red banana contained the maximum amount of dietary fiber (96.06 ± 4.5) and phenolic compounds (46.23 ±2.5), while Rasakadali showed the maximum amount of carbohydrate (70 ± 3.5) when compared to that of Red banana (29 ± 2.8). The protein content was similar in both varieties. Mineral analysis showed that, the Sodium concentration in the sample was higher than the concentration of other elements. The maximum concentration of sodium was there in Rasakadali (600±25.6 mg/100g) and the minimum in Red banana (400±18.9 mg/100g). Potassium, Calcium and Magnesium contents were significantly higher in Rasakadali than those of Red banana. Iron and Zinc contents were significantly higher in Red banana. The study also indicates the significance of genetic diversity for the identification of the best cultivar and its potential application.*

**Keywords:** Banana Pseudostem, Red banana, Rasakadali, Biochemical analysis, Mineral analysis.

## 1. Introduction

Bananas are the fourth most important food crop in developing countries after rice, wheat and maize (INIBAP 2000). Over thousands of banana cultivars or land races have been recognized and cultivated in tropical and subtropical regions of the world. The banana plants almost resemble trees but they are actually perennial herbs, the region that appears to be the trunk is actually a false stem or a pseudostem. A pseudostem is a compact mass of overlapping and spirally arranged leaf sheaths, most of the 'true' stem lies inside it. The fruit, leaves, pseudostem and inflorescence have many useful applications such as serving as food and feed, useful for packaging, for pharmaceutical, industrial uses etc. Banana pseudostem is a waste product from banana plants after harvesting, it contains high quality starch and reduces the risk of heart attack and maintain blood pressure (Shantha and Siddappa,1970), is also used for making handicrafts, fabrics, ropes, baskets papers etc. In many parts of India pseudo stem is an edible part which is used as a food after boiling. Towards the potential application of pseudostem as a healthy food, a detailed study of its nutritional value needs to be carried out and this also helps to find out the significance of cultivar differences. The present study was designed to assess the biochemical composition of Pseudostem of two popular cultivars of Kerala such as Red Banana (AAA) and Rasakadali (AB).

## 2. Materials and Methods

### Samples

The pseudostem of two banana varieties (Red banana and Rasakadali) were collected after harvesting of the banana from the well-

maintained fields of Thiruvananthapuram district of Kerala. The specimens were identified by the Department of Horticulture, Kerala Agricultural College, Thiruvananthapuram. Pseudostems were manually peeled off their outer layers and the central core region was used for the biochemical analysis. The central core region is cut into smaller pieces and dried in an oven at $40^0$C, this was pulverized, using a homogenizer and further stored at 4°C until use.

## 3. Methodology

The total carbohydrates in each sample were estimated by Anthrone method (Hedge and Hofreiter, 1962). The amount of carbohydrate was expressed in percentage. The total proteins in each sample were estimated by Kjeldahl method (Kjeldahl,1883). Maynard method was used for estimating the total dietary fibers in each sample (Maynard,1970). The total Phenolic compounds in each sample of pseudostem was estimated by Folin-ciocalteu method.

### Mineral Analysis

The mineral contents like Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn) and Zinc (Zn) in the pseudostem samples were determined by Atomic Absorption Spectrophotometer (Perkin Elmer, USA). The digestion method involves the use of reverse aqua regia, HNO3-HCl (3:1) for 2g sample with 45 minutes ultrasonification at 60°C followed by hotplate treatment for 45 minutes. All the standards were further measured by atomic absorption spectrophotometer using sodium, potassium, calcium, magnesium, iron, manganese, and zinc hollow cathode lamp at a wavelength 589nm,

766.5nm, 422.7nm, 285.2nm, 248.3nm, 279.5nm, 213.9nm respectively using air acetylene flame. The treatment for each sample was repeated three times and the readings were taken in mg/100g.

**Statistical Analysis**

All the data were expressed as mean ± standard deviation (n = 3). The results were determined using one-way analysis of variance (ANOVA), followed by Duncan's multiple range test using SPSS Software (version 21.0, Chicago, USA). The results were considered as statistically significant if the $P< 0.05$.

## 4. Results

The biochemical composition of the Pseudostem of the two cultivars were measured and presented in Table.1. In the current analysis, there is a significant cultivar difference observed in the biochemical contents of both cultivars.

The maximum carbohydrate content was found in Redbanana pseudostem (70±3.5%) and the minimum carbohydrate content in Rasakadali pseudostem (29±2.8%). There is a significant difference between these two varieties in the amount of carbohydrate. Therefore, we can say that Red banana is more useful as a carbohydrate rich source of food. Haslinda *et al*., 2009 reported that banana pulp consists of 81.83% of total carbohydrate content.

The protein content in both the varieties of banana was very low (0.9±0.03% in Red banana and 0.9±0.026 in Rasakadali) when compared to carbohydrate content. This study is supported by another researcher,

Onyema *et al*., (2016) who reported the presence of moderate amount of protein in banana pseudostem.

Red banana pseudostem possesses (46.23±2.5 mg/g) and Rasakadali pseudostem contains (30.02±3.2mg/g) total Dietary fiber. According to Bhaskar *et al*.,2012, the amount of total dietary fiber in Musa variety Elakki bale (AB) is 28.8 mg/g, which is similar to the present study report. So Red banana pseudostem is useful as dietary fiber rich source than Rasakadali. A diet comprising of high dietary fiber reduces risk towards the development of gastric ulcers, facilitates digestion as well as elimination of wastes and also prevents constipation. The maximum phenol content was found in Red banana pseudostem (96.06±4.5 mg/g) and the minimum in Rasakadali pseudostem (78.03±3.73mg/g). The difference in phenol content may be attributed to the phenol metabolism influenced by the varietal differences (Sulaiman *et al*., 2011).

**Table 1.** Biochemical composition of Red banana and Rasakadali Pseudostem

| **Parameters** | **Rasakadali (AB)** | **Red Banana (AAA)** |
|---|---|---|
| Carbohydrate (%) | $70 \pm 3.5^{b}$ | $29 \pm 2.8^{a}$ |
| Total Protein | $0.9 \pm 0.03^{a}$ | $0.9 \pm 0.026^{a}$ |
| Total phenol | $78.03 \pm 3.73^{a}$ | $96.06 \pm 4.5^{b}$ |
| Total Dietary Fiber (mg/g) | $30.02 \pm 3.2^{a}$ | $46.23 \pm 2.5^{b}$ |

**Mineral analysis**

Mineral analysis in Redbanana and Rasakadali pseudostem are represented in Table 2. In the mineral analysis, there is high difference in mineral content seen in between these two cultivars. The results showed

that the Sodium concentration in the sample was higher than the concentration of other elements. The maximum concentration of sodium is seen in Rasakadali (600±25.6 mg/100g) and the minimum is in Redbanana (400±18.9 mg/100g). So, Rasakadali is more useful to a person who has a deficiency in sodium. The potassium content is higher in Rasakadali (400±14.36 mg/100g) and lower in Redbanana (200±10.43mg/100g). The calcium concentration is maximum in Rasakadali (21.78±3.90mg/100g) and minimum in Redbanana (10±1.32mg/100g). So, Rasakadali is more preferable as a good source of calcium than Red banana. The concentration of magnesium is higher in Rasakadali (26.4±5.63mg/100g) and lower in Redbanana (11.3±4.05mg/100g).

According to Hendricks, (1998) the macro-elements, such as Na, K, Ca, and Mg are essential for our daily diet due to their involvement in neural conduction and muscle contraction.

**Table 2.** Mineral analysis in Pseudostem of Red banana and Rasakadali.

| **Parameters** | **Rasakadali Pseudostem (AB)** | **Red Banana Pseudostem (AAA)** |
|---|---|---|
| Sodium as Na | 600±25.6mg/100g[b] | 400 ±18.9mg/100g[a] |
| Potassium as K | 400±14.36mg/100g[b] | 200± 10.43mg/100g[a] |
| Calcium as Ca | 21.78±3.90 mg/100g[b] | 10 ±1.32mg/100g[a] |
| Magnesium as Mg | 26.4±5.63 mg/100g[b] | 11.3±4.05 mg/100g[a] |
| Iron as Fe | 1.29±0.02 mg/100g[b] | 1.68± 0.06mg/100g[a] |
| Manganese as Mn | 0.43±0.0019 mg/100g | BDL (Below Detecting Limit) |
| Zinc as Zn | 0.18 ±0.0012mg/100g [a] | 0.33± 0.0016mg/100g[b] |

## 5. Conclusion

In the present study, it suggests that introducing banana pseudostem into the human diet could have a significant nutritive impact, especially Rasakadali, which is an excellent source of minerals such as Na, K, Ca, Mg compared to red banana, while Red banana is a rich source of total carbohydrate, dietary fiber and phenolics, so these two varieties can be incorporated into food. The study also indicates the significance of genetic diversity for the identification of best cultivar and its potential application.

## Bibliography

[1] Bhaskar, H. B., Sharief, A. 2012. Effect of solutionizing on dry sliding wear of Al2024-Beryl metal matrix composite. Journal of Mechanical Engineering and Sciences. 3: 281- 290.

[2] Haslinda, W. H., Cheng, L. H., Chong, L. C., Noor Aziah, A. A. 2009. Chemical composition of green banana. International Journal of Food Sciences and Nutrition 60 (S4): 232 - 239.

[3] Hedge, J. E. and Hofreiter B. T. 1962. Carbohydrate chemistry 17 Whistler R. Land Be Miller, J.N, Eds., Academic press, New York.

[4] INIBAP. 2000. Networking Banana and plantain: INIBAP Annual Report 1999. International Network for improvement of Bananas and plantain Montpellier, France.

[5] Kjeldahl, J. 1883. a new method for the determination of nitrogen in organic matter. Zeitsccrif Fur Analistiche cheme. 2: 366 - 382.

[6] Maynard, A. J. 1970. Methods in food analysis: physical chemical and instrumental methods of analysis, Academic press, London. 2:85 - 86.

[7] Onyema, C. T., Ofor, C. E., Okudo, V.C., Ogbuagu, A. S. 2016. Phytochemical and antimicrobial analysis of banana pseudostem. British Journal of Pharmaceutical Research,10 (1):1-9.

[8] Shantha, H. S., Siddappa, G. S. 1970. Accumulation of starch in banana pseudostem and fruit. Journal of Food Science.35: 74 -77.

# STUDIES ON PHYSICO-CHEMICAL CHARACTERISTICS OF VEMBANAD LAKE

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## Abstract

*Vembanad Lake, one of the three Ramsar sites in Kerala, is the largest estuarine system in the south west coast of India. The present investigation is aimed to study the physico-chemical characteristics of the selected stations in Kuttanad area of Vembanad Lake. The water samples were collected from 10 stations in the Kuttanad area every month from May 2012 to August 2013. The temperatures observed in different stations in different months did not exhibit much wider variations. Most of the time in all stations, pH remained slightly acidic. The other parameters such as salinity, dissolved oxygen, transparency and total dissolved solids exhibited seasonal variation. The physico-chemical properties of an aquatic ecosystem are directly related and controlled by many natural regulatory mechanisms.*

**Key Words:** Vembanad Lake, physico-chemical, salinity, pH, Kuttanad.

## 1. Introduction

Vembanad Lake provides hydrological and ecological services, fosters high biological diversity, and also supports livelihoods of a huge rural population. This area is more affected by monsoons which results in pronounced seasonal variations in the environmental parameters. Changes in the environmental parameters and primary production are also caused by the fresh water influx, nutrients distribution, agricultural practices, and

species composition. The fishery resource of this area also depends on the magnitude of primary and secondary production and is influenced by various physical, chemical and biological factors.

Variation in water temperature, dissolved oxygen, pH, salinity, etc. affects distribution, metabolic activities, growth, feeding, reproduction, and migratory behaviours of aquatic organisms (Lagler *et al*., 1977; Alabaster and Lloyd, 1980; Suski *et al*., 2006; Gupta *et al.,* 2008; Abowei, 2010; Palpandi, 2011). Chandramohan (1990) assessed the pre pollution status of the Vasishta Godavari estuary, east coast of India by analyzing the physico-chemical characteristics. Devi (1993) made a study on the ecological condition of coconut husk retting in Cochin backwater and its effects on fish seed availability. Radhika *et al*. (2004) delineated the abiotic parameters of a tropical fresh water lake, Vellayani Lake, in Kerala. Nirmalkumar *et al.* (2009) assessed the spatial and temporal fluctuations in water quality of a tropical permanent estuarine system, Tapi.

In an aquatic ecosystem the studies on water quality parameters play an important role in understanding the productivity of the ecosystem, and other biological processes such as growth, physiology, reproduction, etc. of the organisms inhabiting in it. This determines the health of the ecosystem and its pollution status. The physico-chemical parameters such as water temperature, pH, salinity, dissolved oxygen, transparency, nutrients, etc. and biological parameters such as microbial population, fish diversity, etc. are of profound biological significance and are often used as health indicators of an aquatic ecosystem. The objective of the present investigation is to study physico-chemical characteristics of the selected stations in Vembanad Lake.

## 2. Materials and methods

The water samples were collected from Kuttanad area of the Vembanad Lake every month from May 2012 to August 2013. The following sampling stations—Pallathuruthy, C Block, Marthandam, Chithira, R Block, Rajapuram, Kavalam, Pulimkunnu, Moncombu and Kainakari, which are interconnected by the paddy fields and inland water channels of Kuttanad, were fixed for the study.

The water samples were collected for the estimation of various physicochemical parameters like temperature, salinity, pH, dissolved oxygen, and total dissolved solids. Temperature and pH were recorded at the time of sample collection using Eutech portable water analyser. While other parameters such as salinity, dissolved oxygen, and total dissolved solids were estimated in the laboratory by using standard methods (APHA, 1998). Transparency was measured by using Secchi disc.

## 3. Results and discussion

The physico-chemical properties of any aquatic ecosystem and the nature and distribution of its biota are directly related to and influenced by each other and controlled by a multiplicity of natural regulatory mechanisms. In an aquatic system, various parameters such as temperature, alkalinity, salinity, dissolved oxygen, electrical conductivity etc. affect the chemical and biological reactions such as solubility of oxygen, increase in metabolic rate and physiological reactions of organisms, etc (Suski *et al*., 2006; Gupta *et al.,* 2008).

The physico-chemical analysis of Vembanad Lake exhibited variation. Temperature exhibited variation between 26°C and 33.9°C.

The temperature values for the entire period of observation reflect a certain extent of climatic variations. But the temperatures observed in different stations in different months did not exhibit much wider variations. There was a gradual increase in temperature from March to May, followed by a fall during June to August. Temperature is a major factor controlling oxygen saturation in water. Solubility of oxygen in water is inversely proportional to temperature (Carpenter, 1966).

Salinity is considered as an important factor among the environmental variables in the aquatic ecosystem which influences the dynamic situation by the fresh water inflow and the prevailing temperature. Salinity appeared to be a more or less constant water parameter in the study area. The operation of the salinity barrier at Thanneermukkom plays a major role in the distribution of salinity in Kuttanad waters. The effect of monsoon could be easily seen from the decreased salinity gradient in the entire backwater area during June to August. An increase in salinity was observed from March to May (11.34 ppt) and in the remaining months it was closer to zero or zero. The higher values in summer could be attributed to a high degree of evaporation with decreased fresh water inflow, mixing of saline water and land drainage. The decrease in salinity during monsoon may perhaps be due to heavy showers and consecutive flood water inflow from the rivers. Salinity acts as a limiting factor in the distribution of living organisms, and is most likely to influence the fauna in the intertidal zone (Gibson, 1982). Salinity regimes are often recorded as one of the major habitat parameters that affect the distribution and physiological performances of aquatic organisms (Chapman and Wang, 2001; Palpandi, 2011).

The pH is an important hydrological feature indicating the level of dissolved carbon dioxide in the water which may in turn reflect the activity of phytoplankton and the level of dissolved oxygen. During the study, the lowest pH value (3.75) was observed in May. But in January the pH was very high (9.13). Most of the time, in all stations, the pH remained slightly acidic. Alabaster and Lloyd (1980) stated that higher pH levels are not as great a threat to aquatic organisms as low pH levels. Increased pH is however important as it creates more favorable conditions for algal blooms, increased aquatic weed growth and is thus a concern in areas with nutrient enrichment. Lusher (1984) states that for maintenance of aquatic life, pH should lie within the range of 7.3-8.6. According to Abowei (2010) a pH higher than 7 but lower than 8.5 is ideal for biological productivity, but pH less than 4 is detrimental to aquatic life.

Dissolved oxygen is the most valuable water quality parameter in assessing water pollution as it serves as an indicator of the physical, chemical and biological activities prevailing in the water body. The dissolved oxygen is very essential for the respiratory metabolism of all aquatic animals and it favours the solubility and availability of many nutrients to the animals, therefore, increasing the productivity of aquatic ecosystem (Wetzel, 1983). Dissolved oxygen showed a distinct pattern of seasonal fluctuations in the entire area. Comparatively high values were found during monsoon season (June-August). The higher oxygen concentration during this period can be due to the higher primary production occurring in the surface layers. The lowest value of dissolved oxygen was recorded at Pallathuruthy during November (2.09 mg $l^{-1}$) and the highest value at Kainakary in July (14.4 mg $l^{-1}$). The highest oxygen

value may be because of the high turbulence in the sampling site. In general, the higher values were recorded during monsoon period, the lower during pre-monsoon season. The low dissolved oxygen concentration observed during summer may be attributed to the higher salinity of water, high temperature and less inflow of freshwater coupled with biological processes during summer (Gupta *et al.,* 2008). The dissolved oxygen content depends upon the photosynthetic activities, monsoonal floods, the turbulence caused by the wind, and also on the amount of waste added (USDA, 1992; Soundarapandyan, *et al*., 2009).

Solar radiation is the major source of light energy in an aquatic system, governing the primary productivity. Transparency is a characteristic of water that varies with the combined effect of colour and turbidity. Turbidity or total suspended solids is the material in water that affects the transparency or light scattering of the water. Some of the study area was transparent owing to its shallowness. The highest secchi disc transparency value (160.5 cm) was observed in October. The Total Dissolved Solids (TDS) values during the study ranged from 57.17 ppm in November to 18.04 ppt in May. TDS can be influenced by changes in pH. Changes in the pH cause some of the solutes to precipitate or affect the solubility of the suspended matter (Saravanakumar, 2008). Effluent that is high in degradable organic matter will rapidly use up the dissolved oxygen resources, which is essential for aquatic life (Palange and Zavala, 1987). Suspended and dissolved solids impart a turbid appearance and resist light penetration that leads to oxygen deficiency with deleterious effect on aquatic life. Thus, it can be concluded that the water quality parameters of an aquatic ecosystem are very important for the distribution and survival of its biota.

## References

[1] Abowei, J. F. N. 2010. Salinity, dissolved oxygen, pH and surface water temperature conditions in Nkoro River, Niger delta, Nigeria. *Advance Journal Food Science and Technology,* 2(1): pp. 16-21.

[2] Alabaster, J. S. and Lloyd, R. 1980. Water quality criteria for fresh water fish. European Inland Fisheries Advisory Commission Report (FAO). Butters worth, London-Boston, PP. 297.

[3] APHA (American Public Health Association). 1998. Standard methods for the examination of water and wastewater. In: Greenberg, A.E., Clesceri, L. S. and Eaton, A. D. (Eds.), WEF and AWWA, 20th ed., Washington DC, USA, PP.1193.

[4] Carpenter, J. H. 1966. New measurements of oxygen solubility in pure and natural water. *Limnology and Oceanography*, 11: pp. 264–277.

[5] Chandramohan, R. 1990. Physico chemical characteristics of Vasishta Godavari estuary, east coast of India, Pre pollution status. *Indian Journal Marine Science*, 19: pp. 42-46.

[6] Chapman, P. M. and Wang, F. 2001. Assessing sediment contamination in estuaries. *Environmental Toxicology and Chemistry,* 20: pp. 3-22.

[7] Devi, A. M. 1993. Ecological studies on coconut husk retting area in the Cochin back water and its relation to fish seed availability. *CMFRI Special Publication,* 54: pp. 14-20.

[8] Gibson, R. N. 1982. Recent studies on the biology of intertidal fishes. *Oceanography and Marine Biology Annual Review*, 20: pp. 363–414.

[9] Gupta, N., Ramesh, C., Sharma, D. and Tripathi, A. K. 2008. Study of biophysico-chemical parameters of Mothronwala swamp, Dehradun (Uttarakhand). *Journal of Environmental Biology*, 29(3): pp. 381-386.

[10] Lagler, K. F., Bardach, J. E., Miller, R. R. and Passino, D. R. M. 1977. *Ichthyology*. John Wiley and Sons Inc., New York, pp. 506.

[11] Lusher, J. A. 1984. Water quality criteria for the South African coastal zone. CSIR, Report 94, pp. 56.

[12] Nirmalkumar, J. I., George, B., Kumar, R. N., Sajish, P. R. and Viyol, S. 2009. Assessment of spatial and temporal fluctuations in water quality of a tropical permanent estuarine system - Tapi, west coast India. *Applied Ecology Environmental Research*, 7(3): pp. 267-276.

[13] Palange, R. C. and Zavala, V. 1987. Water Pollution Control, Guidelines for project planning and financing. World Bank Technical Paper No. 73, The World Bank, Washington, D C.

[14] Palpandi, C. 2011. Hydro biological parameters, population density and distribution pattern in the gastropod *Nerita* (D*ostia*) *crepidularia* Lamarck, 1822, from mangroves of Vellar estuary, Southeast India. *International Journal of Biodiversity and Conservation*, 3(4): pp. 121-130.

[15] Radhika, C. G., Mini, I. and Gangadevi, T. 2004. Studies on abiotic parameters of a tropical fresh water lake – Vellayani Lake, Trivandrum, Kerala. *Pollution Research*, 23(1): pp. 49-63.

[16] Saravanakumar, A., Rajkumar, M., Serebiah, S. J. and Thivakaran, G. A. 2008. Seasonal variations in physico-chemical characteristics of water, sediment and soil texture in arid zone mangroves of Kachchh-Gujrat. *Journal of Environmental Biology*, 29(5): pp. 725-732.

[17] Soundarapandian, P., Premkumar, T. and Dinakaran, G. K. 2009. Studies on the physico-chemical characteristic and nutrients in the Uppanar Estuary of Cuddalore, South East Coast of India. *Current Research Journal of Biological Sciences*, 1(3): pp. 102-105.

[18] Suski, C. D., Killen, S. S., Keiffer, J. D. and Tufts, B. L. 2006. The influence of environmental temperature and oxygen concentration on the recovery of largemouth bass from exercise, implications for live-release angling tournaments. *Journal of Fish Biology*, 68: pp. 120-136.

[19] United States Department of Agriculture (USDA). (1992). Agriculture Waste Management Building Design, Hand book of Soil Conservation Service, Washington, D.C.

[20] Wetzel, R.G. 1983. *Limnology.* 2nd Saunders Col., Philadelphia, USA, pp. 254.

# पर्यावरण विमर्श :- 'अनबीता व्यतीत' के संदर्भ में

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पर्यावरण दो शब्दों → परि + आवरण से मिलकर बना है, जिसका अर्थ है, परि → चारों तरफ, आवरण → घेरा, यानि प्रकृति में जो भी हमारे चारों ओर परिलक्षित होता है - वायु, जल, पेड-पौधे, प्राणी आदि सभी पर्यावरण के अंग है और इन्हीं से पर्यावरण की रचना होती है।

मानव का अस्तित्व प्रकृति पर निर्भर है। प्राकृतिक संसाधनों से लाभान्वित होते हुए प्रकृति की ही गोद में मानव अपने को सुरक्षित महसूस करता है। प्रारंभ काल से लेकर मानव में प्रकृति के प्रति संवेदन शीलता और जिज्ञासा वृत्ति परिलक्षित है। अपने भावों की प्रतिच्छाया का आभास मानव, प्रकृति में ढूँढने लगा। प्रकृति से तादात्म्य की यह अनुभूति उसके मन में सूक्ष्म संवेदनाओं को जन्म दिया। प्रकृति सौन्दर्य तथा आकर्षण से अभिभूत मानव अपनी इन संवेदनाओं को वाणी बद्ध करके उसे एक नया आकार प्रदान किया जो साहित्य नाम से अभिहित किया गया।

भारत में प्रचलित लोक कथाएँ, वैदिक साहित्य, रामायण, महाभारत एवं 400 ई.पू के पहले रचे गए तमिल व्याकरण 'तोल्काप्पियम' में भी मानव एवं प्रकृति के बीच का पवित्र व दृढ़ संबंध द्रष्टव्य है। यह केवल ग्रन्थ के रूप में नहीं बल्कि इसमें नित्य जीवन शैली की झाँकी मिलती है। हमारे पूर्वाचार्य भारतीय संस्कृति के अनन्य उपासक रहे हैं। वे पृथ्वी पर पाद स्पर्श करने के पूर्व ''पादस्पर्शम् क्षमस्वमे'' की प्रार्थना करते थे और पौधों की शाखाएँ काटने से पहले ''इषेत्वोर्जेत्वा'' कहकर उससे माफी माँगते थे। अथर्ववेद में यों लिखा है-

'यत्तो भूमे विखनामि
क्षिप्रं तदपि रोहतु।
मा ते मर्म विमृग्वरि
मा ते हृदय मर्प्पितम्।।'

अर्थात मैं तुम से जो खनिज लेता हूँ, वह पुनः तुम में भर जाए। मैं जो क्षति तुम्हें देता हूँ, वह तुम्हारी यादों और हृदय तक न पहूँचे। अतः भारतीय संस्कृति हमेशा पर्यावरण संरक्षण का संदेश देती रही है।

पाश्चात्य उपनिवेशवाद एवं ईसाई धर्म प्रचार के फलस्वरूप मनुष्य केन्द्रित समाज का आविर्भाव हुआ। इसके अनुसार मनुष्य ही सर्वप्रथम है, पृथ्वी और पृथ्वी की सारी चीज़ें मनुष्य के उपभोग केलिए हैं। प्रकृति को भय-भक्ति के साथ आराधना करनेवाला मानव अपनी आवश्यकताओं की पूर्ति की भोग वस्तु के रूप में प्रकृति को देख रहा है। अरण्य संस्कृति उपभोग संस्कृति में बदल गयी है। हम जिस पर्यावरण में जीवन-यापन कर रहें उसे हम अपार क्षति पहूँचा रहे हैं। पर्यावरण की बिगडती हुई समस्या हमारे लिए घातक सिद्ध हो सकता है। हमारा दिमाग केवल वैज्ञानिक प्रगति की ओर आकृष्ट है। फलतः हम प्रकृति का दोहन करते जा रहे हैं। किन्तु हमें प्रकृति का संतुलन पर भी विचार करना चाहिए। प्रकृति का संतुलन हमारे जीवन का संतुलन है। यदि प्रकृति असन्तुलित हो जायेगी तो धरती पर जीवन भी दुर्लभ हो जायेगा। श्री ओमप्रकाश मिश्र के अनुसार ''भौतिक सुखों की प्राप्ति में हम इस प्रकार संलग्न है कि हमें केवल अपनी सुविधाएँ नज़र आ रही हैं क्योंकि अपनी सुविधाओं की तलाश में हम प्रकृति को क्षति पहूँचाए जा रहे हैं।''[(1)]

[1] ओमप्रकाश मिश्र - आधुनिक हिन्दी निबन्ध पृष्ट : 284

पर्यावरण संतुलन को ध्यान में रखते यदि हम सोचे तो मानव जीवन में पक्षियों का बहुत बडा महत्व है। आकाश में उडते हुए ये पक्षी पर्यावरण की सफाई के बहुत बडे प्राकृतिक साधन है। गिद्ध, चीलें, कौए और इनके अतिरिक्त कई पशु-पक्षी भी हमारे लिए प्रकृति की ऐसी देन हैं, जो समस्त कीटों, जीवों तथा प्रदूषण फैलानेवाली वस्तुओं का सफाई करते रहते है, जो धरती पर मानव जीवन के लिए खतरा उत्पन्न कर सकते हैं। कितने ही पशु-पक्षी भी हमारे लिए प्रकृति की ऐसी देन है, जो समस्त कीटों, जीवों तथा प्रदूषण फैलानेवाली वस्तुओं को खाकर मानव जीवन केलिए उपयोगी वनस्पतियों की रक्षा करते हैं। ऐसे पशु-पक्षियों का न रहना अथवा लुप्त हो जाना मनुष्य केलिए बहुत अधिक हानिकार है। लेकिन इन मासूम जीवों के पीछे भी मृत्यु पडी रहती है। जगह-जगह इन्हें पकडा या मारा जाता है और इनका व्यापार किया जाता है। 'अनबीता व्यतीत' उपन्यास में अत्यन्त मासूम वन्य जीव एवं पक्षियों की पीडा तथा उनके जीवन को संकटमय करनेवाले एवं उनके संहार को ही अपनी जीविका का साधन बनानेवाले व्यक्तियों और परिस्थितियों के कटु यथार्थ को उद्घाटित करने का प्रयत्न किया गया है।

प्रकति में तरह तरह के जीव है-इनमें से सबसे मासूम और सुन्दर है वे पंछी जो हमारी वन्य-संस्कृति की संपदा भी है। अपनी मखमली पंखों को लहराते, अपनी मधुर आवाज़ों से संगीत पैदा करते, ये पंछी बरसों-बरस मन की शांती को जीवन देते हैं। और इन्हीं पंछियों में आ मिलते हैं, वे परदेसी पंछी, जो सर्दियों में सायबेरिया और उत्तरी गोलार्द्ध से उडकर हर वर्ष भारत आते हैं। यहाँ बसेरा करते हैं। ये सुन्दर और मासूम पंछी हजारों मील का सफर तय करते हैं। हिमालय को पार करते हैं और सर्दियों में भारत को अपना घर बना लेते हैं। लेकिन इन मासूम पंछियों के पीछे भी मृत्यु पडी रहती है जगह जगह इन्हें पकडा या मारा जाता है, और उनका व्यापार किया जाता है।

'अनबीता व्यतीत' हिन्दी का ऐसा एक श्रेष्ठ उपन्यास है जिसमें पक्षी प्रेम और पर्यावरण की समस्या को केन्द्र में रखकर मानवीय करुणा, दया और प्रेम की भावना को उभारा गया है। समीरा, दिव्या, महारानी राजलक्ष्मी, गौतम आदि पात्रों के माध्यम से प्रकृति और जीव-जन्तुओं के प्रति गहन प्रेम को उभारा गया है।

'अनबीता व्यतीत' उपन्यास के पात्र महारानी राजलक्ष्मी के मन में पशु-पक्षियों के प्रति गहन प्रेम था। महाराज सुरेन्द्र सिंह के पशु-पक्षियों का शिकार करने से रानी माँ हमेशा विरोध करती थी। अपने काकातुओं की हत्या करने पर रानी माँ महाराज से कहती है ''महाराज, किसी की भी जान लेना तो बहुत आसान है, लेकिन मुश्किल है किसी को जिन्दगी देना''[(2)] प्रकृति और पशु-पक्षियों के साथ सह अस्तित्व की भावना के समर्थक है, महारानी राजलक्ष्मी।

महारानी राजलक्ष्मी के समान ही उनकी नातिन समीरा है जो इस उपन्यास की नायिका है, उसके मन में भी पक्षियों के प्रति बेहद प्यार है। नीली झील में जाकर पक्षियों का निरीक्षण करना उसका शौक है। बीमार पशु-पक्षी को देखती तो उसे उठा कर अपने महल में ले आती थी। और उनका उपचार करती थी। समीरा के पक्षी प्रेम के सबसे बडी धमकी उसी के राज परिवार से आती है। राजपरिवार के लोग ऊबकर ही समीरा का विवाह रतनपुर के युवराज जयसिंह से कर देते है। लेकिन शादी के साल भर के बाद ही उसे ज्ञात हुआ कि उसका पति पक्षियों को मारकर उनके चमडे के अन्दर भूसा आदि भरकर निर्यात करता है, तो समीरा लाचार हो जाती है। अन्त में उसके पति ने ही उसे गोली मारकर हत्या कर दी। समीरा जीवन पर्यन्त पशु-पक्षियों के प्राकृतिक अधिकार की लडाई लडती रही। वह चाहती थी कि

[2] कमलेश्वर - अनबीता व्यतीत (पृष्ट : 27)

राजा-महाराजा, राजकुमारी, राजकुमार सब अहिंसा को अपना परम धर्म मानें और प्रजा की रक्षा के समान ही दूसरे जीव-जन्तुओं की रक्षा भी करें।

समीरा की तरह, नायक गौतम भी प्रकृति एवं जीव-जन्तुओं का प्रेमी है। पर्यटन के नाम पर प्रकृति के संतुलन को बिगाडने या अन्धाधुन्ध पशु-पक्षियों की हत्या करके उनका मांस परोसकर टूरिज्म बढाने का वह पक्षपाति नहीं है। यह उनके अनुसार नीच और अमानवीय है। गौतम पक्षियों को इतना प्यार करता है कि उसने नीली झील खरीदकर पक्षियों को शिकारों के हाथों से बचा लिया।

पक्षियों के सामूहिक कलरव में आर्केस्ट्रा का संगीत पुटता है, जो लोग इसे सुनकर आनंदित होते हैं, वे सौभाग्यशाली हैं। जो पशु-पक्षियों को मारकर धन कमाने में संलग्न है, उनके विरुद्ध जनमानस को उत्तेजित करने का काम इस उपन्यास के द्वारा संपन्न होता है। इस उपन्यास के पात्र अपने सुख - दुख केलिए संघर्ष नहीं करते, बल्कि पक्षियों की मुक्ति तथा उनके प्राकृतिक अधिकार केलिए संघर्ष करते हैं। बाज़ारवाद तथा व्यावसायिकता से आक्रान्त मनुष्य को इसमें आगाह किया गया है कि समय रहते यदि वह पर्यावरण के प्रति सचेष्ट नहीं होगा तो उसका जीना दूभर हो जायेगा। विदेशियों की नकल पर भारत में पर्यटन उद्योग को विकसित करना उचित नहीं है। भारतीय उद्योग में प्रकृति एवं पशु-पक्षियों के प्रति अहिंसा का भाव होना आवश्यक है।

कमलेश्वर का अपन्यास 'अनबीता व्यतीत' पर्यावरण पर पडे घातक एवं असंतुलित आवस्था को हटाने का संदेश देते हैं। भारतीय संसकृति का मूल-मंत्र ही उपन्यासकार का मार्ग दीप है। इस प्रपंच में मनुष्य के समान पशु-पक्षियों को भी जीने की पूरा का पूरा अधिकार है। अतः उन्हें मार डालना अधर्म और पाप है। मनुष्य और प्रकृति के सह अस्तित्व से ही हमारा भविष्य मंगलमय हो सकेगा।

इस प्रकार देखा जा सकता है कि यह उपन्यास आम लोगों के मन में पारिस्थितिक बोध पैदा करने में सक्षम हैं, साथ ही प्रकृति की ओर पुनः लौट आने की प्रेरणा भी देते हैं।

## मूल ग्रन्थ

1. अनबीता व्यतीत - कमलेश्वर
लोकभारती प्रकाशन, इलाहबाद - 1, 2009

## सहायक ग्रन्थ

1. आधुनिक हिन्दी निबन्ध - ओम प्रकाश मिश्र
वोहरा पब्लिशर्स, अलोपी बाग, इलाहाबाद - 2011

2. आधुनिक हिन्दी साहित्य का इतिहास - बच्चन सिंह
लोकभारती प्रकाशन, महात्मागांधी मार्ग, इलाहबाद - 1, 2009

3. पर्यावरण और जीव प्रमानन्द चन्दोला, हिमाचल पुस्तक भण्डार, महावीर चौक गान्धीनगर दिल्ली - 31, 1984

# DIVERSITY OF DRAGONFLIES IN CHERTHALA AND MUHAMMA REGIONS OF ALAPPUZHA DISTRICT

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## Abstract

***Odonata*** *constitutes a small well-known order of insects that are widely distributed all over the world. A preliminary survey on the dragonfly diversity was carried out at Cherthala and Muhamma regions of Alappuzha Dist. during August 2018 to October 2018. Observation of dragonflies was done during early morning and midday near water bodies. The study reported a total of 14 species belonging to the family* ***Libellulidae****. The most abundant species reported was* ***Libellula luctuosa*** *and the other common ones include* ***Libellula vibrance*** *and* ***Neurothermis tullia.*** *The study reported rich dragonfly diversity in Cherthala and Muhamma regions where there are plenty of water bodies.*

**Keywords:** Diversity, Odonates, dragonflies, Alappuzha

## 1. Introduction

The order Odonata comprises of dragonflies and damselflies are believed to have evolved some 250 million years ago (Subramanian 2005). They are prominent and colourful insects in tropical landscapes and are considered an integral component of freshwater ecosystem. Globally around 5,952 species of Odonates have been described so far; of

which 503 species have been reported within the geographic limits of India (Joshi *et al*., 2017). Among the Odonates, dragonflies are one of the most common insects seen in forests, fields, meadows, ponds and rivers. Habitat specificity and prey abundance plays a major role in their distribution and ecology. They lay their eggs in a wide range of aquatic habitats ranging from small tanks to rivers. They are mostly active during the midday while some are nocturnal. Dragonflies as predators play a significant role in biological control of insect pests. In addition to providing aesthetic pleasure, studying them gives a valuable insight about ecosystem health, especially of wetlands (Subramanian, 2005).

The distribution of various groups and species of dragonflies is highly variable. Some genera and species are widespread while others are highly local in their distribution. Some families are restricted to cool streams or rivers, others to ponds or still clear waters, and some to marshy places. The presence of dragonflies and damselflies may be taken as an indication of good ecosystem quality. The greatest numbers of species are found at sites that offer a wide variety of microhabitats, though dragonflies tend to be much more sensitive to pollution than are damselflies. Many ecological factors affect the distribution of these species like the acidity of the water, the amount and type of aquatic vegetation, temperature and whether the water is stationary or flowing. The major objective of the study was to prepare a preliminary checklist of dragonfly species in Cherthala and Muhamma regions and to evaluate their species diversity and abundance in the study area.

## 2. Materials and methods

### Study area

The study was mainly carried out along Cherthala and Muhamma, Alapppuzha district, Kerala. It is located at 9.6741$^{o}$ N latitude and 76.3401$^{o}$ E longitude, 9.6006$^{o}$ N latitude and 76.3579$^{o}$ E longitude respectively.

### Observation and survey

The survey was carried out by frequent field visits during the months of August 2018 to October 2018. Capturing pictures and documentation methods were used for studying dragonflies. Observation of dragonflies were done during early morning and midday near water bodies as they are most active during these times. Individual species were photo documented and the images were cross checked with standard references and field guides on Odonates such as Subramanian (2009) and Kiran and Raju (2013).

## 3. Results and Discussion

During the present study a total of 14 species of dragonflies were found in the area under study (Table 1). The species reported were identified as *Libellula vibrance, Aethriamanta brevipennis Brachydiplax chalybea, Libellula needhami, Crocothemis servilla, Pachydiplax longipennis, Brachythemis leucosticte, Trithemis aurora, Tholymis tillarga, Pantala flavescens, Libellula luctuosa, Brachythemis contaminate, Neurothemis tullia* and *Crocothemis erythraea* (Fig. 1 & 2). All the species of dragonflies reported in this study belonged to a single family Libellulidae. The dominant species reported was *Libellula luctuosa* both from

Cherthala and Muhamma. Other common ones include *Libellula vibrance* and *Neurothermis tullia.*

As cited in the present survey, family Libellulidae was also widely represented in surveys elsewhere locally and globally (Sreejamole *et al*., 2014; Kalita *et al*., 2014). The abundance of Libellulidae (Anisoptera) in the present study could be due to their shorter life cycle and widespread distribution (Norma-Rashid *et al*., 2001) and their tolerance to wide range of habitats (Samways, 1989). Species richness and diversity of Odonata are also influenced by the size of the temporary water bodies. Commendable species richness and abundance at both regions (Cherthala & Muhamma) could be attributed to the size of the water body and less pollution.

**Table 1:** List of dragonflies reported from Cherthala and Muhamma regions of Alappuzha

| Sl No. | Scientific name | Common name | Family | No. of species |
|---|---|---|---|---|
| 1. | *Libellula vibrance* | Great blue skimmer | Libellulidae | 5 |
| 2. | *Aethriamanta brevipennis* | Scarlet marsh hawk | " | 2 |
| 3. | *Brachydiplax chalybea* | Blue dasher | " | 2 |
| 4. | *Libellula needhami* | Needham's skimmer | " | 3 |
| 5. | *Crocothemis servilla* | Scarlet skimmer | " | 1 |
| 6. | *Pachydiplax longipennis* | Rare blue dragonfly | " | 1 |
| 7. | *Brachythemis leucosticta* | Banded groundling | " | 4 |
| 8. | *Trithemis aurora* | Crimson marsh glider | " | 2 |
| 9. | *Tholymis tillarga* | Evening skimmer | " | 1 |
| 10. | *Pantala flavescens* | Globe skimmer | " | 4 |
| 11. | *Libellula luctuosa* | Widow skimmer | " | 6 |
| 12. | *Brachythemis contaminate* | Ditch jewel | " | 3 |
| 13. | *Neurothemis tullia* | Pied paddy skimmer | " | 4 |
| 14. | *Crocothemis erythraea* | Scarlet darter | " | 2 |

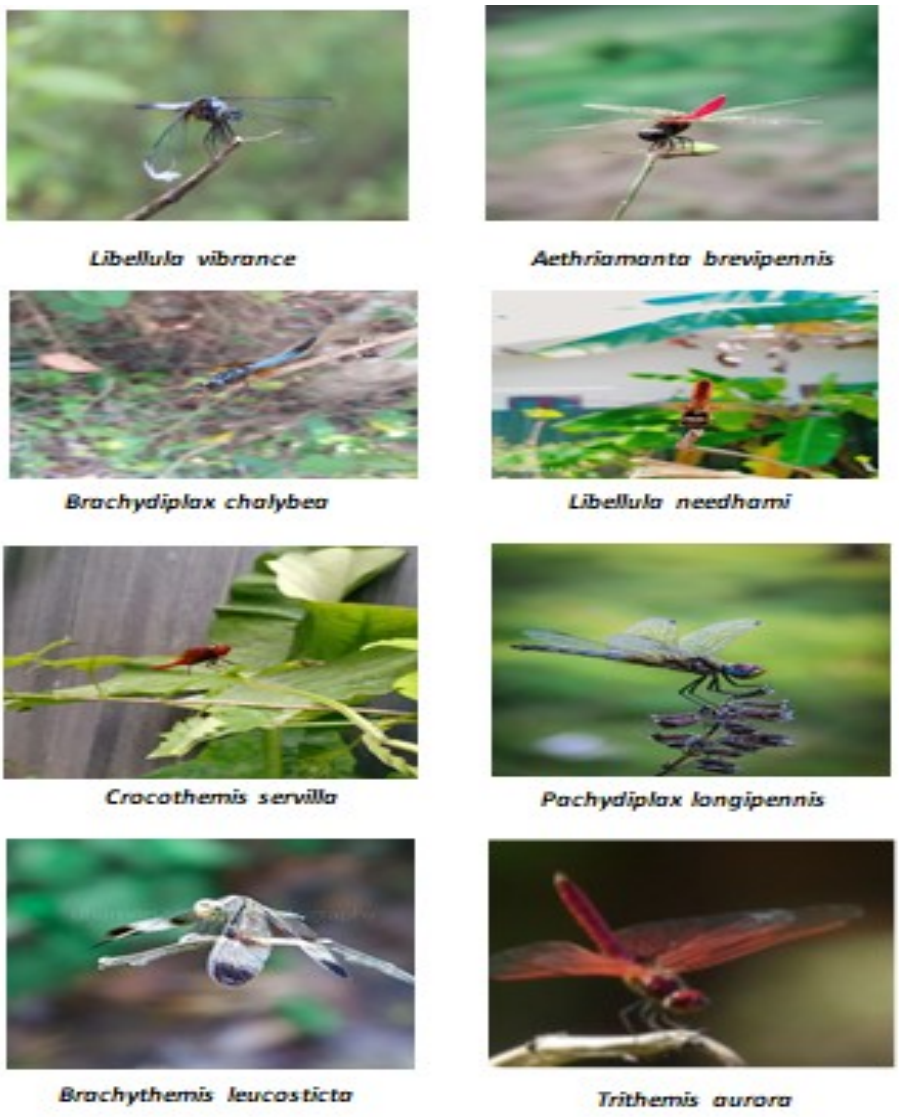


**Figure 1:** Images of dragonflies recorded during the study

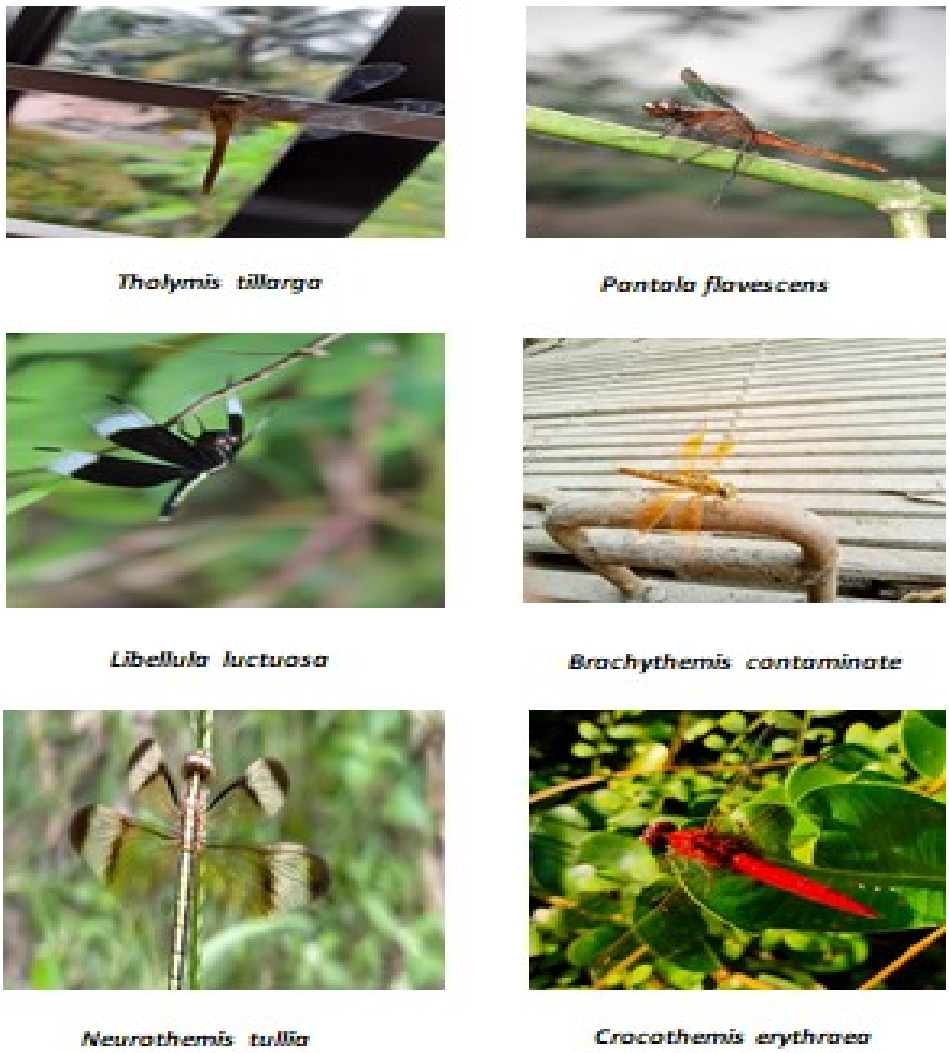


**Figure 2:** Images of dragonflies recorded during the study

Odonates are dominant aquatic insects and often referred to as the bio indicators of the aquatic ecosystem. They are also authentic indicators of human impact on freshwater ecosystem. Biological monitoring methods using aquatic insects have been developed and

reliably tested in both temperate and tropical aquatic systems. Dragonflies play a major ecological role as key predators in water, the adults scourge on gnats and midges in the aquatic realm. Hence, they serve as a natural means of controlling mosquito-borne diseases, and their population reduction could have an adverse effect on both terrestrial and aquatic food webs.

## References

[1] Joshi, S, Veino J, Veino, D, Veino L, Veino, R, Kunte, K. (2017). Additions to the Indian dragonfly fauna, and new records of two enigmatic damselflies (Insecta: Odonata) from northeastern India. *Journal of Threatened Taxa*. 9 (7): 10433–10444 pp.

[2] Kalita, G. J., Boruah, B. and Das, G. N. (2014). An observation on odonata (damselflies and dragonflies) fauna of Manchabandha reserve forest, Baripada, Orissa. *Advances in Applied Science Research*. 5 (1): 77-83 pp.

[3] Kiran, C. G. and Raju D. (2013). Dragonflies and Damselflies of Kerala, Tropical Institute of Ecological sciences, Greenleaf Publications, Kottayam, Kerala, India.

[4] Samways, M. J. (1989). Taxon turnover in odonata across a 3000 m altitudinal gradient in Southern Africa. *Odonatologica*. 18: 263-274 pp.

[5] Sreejamole K. L., Aniyan E.V., Indulekha L et al. (2014). Diversity of dragonflies in the Kanjikkuzhy region of Alappuzha Dist. Proceedings of National seminar—Trends in biodiversity studies. ISBN 978-81-924940-1-2. 117-122 pp.

[6] Subramanian, K. A. (2005). Damselflies and dragonflies of peninsular India—A field Guide. Ebook of the Project Lifescape. Indian Academy of Sciences and Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India. 118 pp.

[7] Subramanian, K. A. (2009). India—A Lifescape, Dragonflies of India—A Field Guide. Vigyan Prasar, India Offset Press, New Delhi. 180 pp.

# ENDOCRINOLOGICAL AND GENETIC STUDIES ON FAMILIAL HYPOTHYROIDISM

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## Abstract

*Hypothyroidism is believed to be sporadic, but less than 10% of hypothyroid conditions are hereditary. The actual reasons behind familial and sporadic hypothyroidism are to be identified. Hence the present study was under taken to evaluate genetic instabilities in familial hypothyroidism and compared with sporadic hypothyroid and healthy control subjects. Thirty-eight subjects with varying degrees of familial hypothyroidism, twenty subjects with sporadic hypothyroidism and twenty healthy control subjects were selected to evaluate the familial hypothyroidism, mutagen induced chromosome sensitivity analysis. Laboratory investigations like T3, T4 and TSH were also evaluated and correlated with mean b/c value. Subjects with familial hypothyroidism showed statistically significant elevation in mean b/c value compared to sporadic hypothyroid subjects and control subjects. The present study revealed that subjects with elevated TSH levels showed high mean b/c value whereas subjects with reduced T3 and T4 showed increased mean b/c values.*

## 1. Introduction

Thyroid diseases are one of the most prevalent endocrinopathies across the world. Hypothyroidism may be defined as the clinical state which results from decreased production of thyroid hormones, or, very

rarely, from their decreased action at a tissue level. Virtually every tissue in the body is affected to a greater or lesser extent by thyroid hormone deficiency. Hypothyroidism occurs most frequently in women, the sex ratio of symptomatic hypothyroidism being about 10:1. Although the disease can occur at any age, most patients present between 30 and 60 years. (Bagcchi, 2014)

Most of the cases of hypothyroidism are thought to be sporadic, but some are hereditary. The earlier study revealed that <10% of hypothyroid conditions are arising from familial cases (Mimuoni et al, 1996). Familial hypothyroidism is the condition in which any of the first- or second-degree relatives have hypothyroidism. The actual reason behind the familial hypothyroidism is yet to be identified.

The pathophysiology of thyroid dysgenesis remains unclear and until recently, this disorder was generally regarded as sporadic. However, a small (2%), but significant proportion of familial cases have been identified through the study of subjects with congenital hypothyroidism, and a more recent work revealed that higher proportions of familial thyroid dysgenesis are reported in both symptomatic and asymptomatic individuals.

Even though there are familial cases, the root cause of this hereditary pattern is unclear. Thus, the current study is on the basis of endocrinological and genetic aspects to unveil the familial mode of transmission of hypothyroid disorder using DNA repair mechanism.

## 2. Methodology

Thirty-eight subjects (Group A) suffering from various degrees of hypothyroid with family history (familial subjects) and twenty subjects (Group B) suffering from hypothyroid without family history (sporadic subjects) and twenty control subjects (Group C) were selected for the study. In the present study most of the study subjects were of the age group 41-60 in both familial as well as sporadic groups. Among the study subjects majority were females. They were referred from various hospitals to a research lab at Thiruvananthapuram. 2-3 ml of peripheral blood was aseptically collected in sodium heparinised vaccutainers by vein puncture for evaluating DNA repair mechanism.

. Mutagen Induced Chromosome Sensitivity Analysis was done for evaluating DNA repair mechanism (Hsu et al, 1987). For this analysis the mean number of breaks/cell (b/c) were calculated.

Serum tri-iodo thyronine & tetra-iodo thyronine was determined by competitive immuno assay using chemiluminescence technique. Serum thyroid stimulating hormone was determined by two-site sandwich immunoassay using direct chemiluminescence technique. For carrying out these tests, 2ml of blood was collected and allowed to clot. The serum formed was used for the analysis. For both the assays, blood samples were collected after getting informed consent. The data collected were subjected to "Students t-test" (Zar, 1974).

## 3. Results

The present study was conducted in 38 subjects with family history of hypothyroidism (Group A) and 20 subjects having hypothyroidism but with no family history (sporadic) (Group B) and 20 subjects as control (Group C). The thyroid stimulating hormone (TSH) levels were very high in study subjects (Group A & B). The T3 and T4 were observed below normal ranges.

The study subjects were grouped according to their T3 values, two ranges were taken for the study, such as ≤80 and >80 ng/dl. The data obtained showed that 31 (81%) familial and 16 (80%) sporadic belongs to ≤80 ng/dl which was under the normal range (Table 1). The mean b/c value of familial was 0.8500 and it was 0.8060 in sporadic subjects. Among the two study groups, (Group A & B) familial group showed much higher mean b/c values than the sporadic subjects. The study was statistically significant with t value -8.98766; p value <0.00001 in familial and control subjects. The result is significant at $p < .05$.

**Table 1.** Distribution of mean b/c value according to T3

| Variable | Category | Number of familial subjects | Mean b/c value of familial subjects | Number of sporadic subjects | Mean b/c value of sporadic subjects |
|---|---|---|---|---|---|
| T3 (ng/dl) | ≤80 | 31 (81%) | 0.85 | 16 (80%) | 0.806 |
| | >80 | 7 (19%) | 0.81 | 4 (20%) | 0.741 |

The study subjects were grouped according to their T4 values, two ranges were taken for the study, such as ≤4 and >4 µg/dl. The data

obtained showed that 29 (76%) familial and 17 (85%) sporadic belongs to ≤4 µg/dl which was under the normal range. The mean b/c value of familial was 0.8300 and it was 0.7900 in sporadic subjects. Among the two study groups, familial group recorded much higher mean b/c values than the sporadic subjects (Table 2). The study was statistically significant with t value -7.76504; p value <0.00001 in familial and control subjects. The result is significant at $p < .05$.

**Table 2** Distribution of mean b/c value according to T4

| Variable | Category | Number of familial subjects | Mean b/c value of familial subjects | Number of sporadic subjects | Mean b/c value of sporadic subjects |
|---|---|---|---|---|---|
| T4 (µg/dl) | ≤4 | 29 (76%) | 0.83 | 17 (85%) | 0.79 |
| | >4 | 9 (24%) | 0.81 | 3 (15%) | 0.71 |

The level of Thyroid Stimulating Hormone (TSH) was estimated and grouped into three as <8, 8-12 and >12 mlu/L. The three ranges were taken higher than the normal range. In all the three categories familial subjects showed increased mean b/c value than sporadic subjects. In familial, the highest mean b/c value was 0.895 (Table 3) and in sporadic it was 0.8560, both were in the category >12mlu/L. The study was statistically significant with t value 6.79945; p value <0.00001 in familial and control subjects. The result is significant at $p < .05$.

**Table 3** Distribution of mean b/c value according to TSH

| Variable | Category | Number of familial subjects | Mean b/c value of familial subjects | Number of sporadic subjects | Mean b/c value of sporadic subjects |
|---|---|---|---|---|---|
| TSH (mlu/L) | <8 | 22 (57%) | 0.805 | 10 (50%) | 0.7327 |
| | 8-12 | 11 (29%) | 0.8251 | 9 (45%) | 0.802 |
| | >12 | 5 (14%) | 0.895 | 1 (5%) | 0.856 |

## 4. Discussion

The present study identifies hypothyroidism as familial as much as sporadic. The hereditary pattern of hypothyroidism was found to be in association with DNA repairing efficiency of the subjects. Helfend and Redfern, (1998) reported that thyroid diseases are very common in middle aged and older adults. Vanderpump et al, (2005) reported that thyroid disease is much more prevalent in women than men. According to Godfrey et al, (2007) approximately 1 out of every 7 women develop thyroid disease, and its prevalence increases with age. These findings suggest that hypothyroidism is much more prevalent in the female population and it increases with increasing age. The results obtained in the present study is in accordance with the earlier reports. Most of the study subjects belonged to the age group 41-60 in both familial as well as sporadic subjects and majority were females. The present study revealed that subjects with elevated TSH levels showed high mean b/c value whereas subjects with reduced T3 and T4 showed increased mean b/c values.

## 5. Conclusion

The present study indicated that hypothyroid conditions were occurring familial as much as sporadic and the subjects with both these types of hypothyroidism showed increased mean b/c value than control subjects. Thus, DNA repairing capacity of study subjects were much less than that of control subjects. Subjects with elevated TSH levels showed high mean b/c value whereas subjects with reduced T3 and T4 showed increased mean b/c values. Familial as well as sporadic hypothyroid patients who were directed to take thyroxine for hormone balancing should keep their daily doses for a long time as there is no effective treatment.

## References

[1] Bagcchi, S., Hypothyroidism in India: more to be done. The Lancet Diabetes & Endocrinology, 2(10), 2014, pp.77-82.

[2] Godfrey, K. M., Lillycrop, K. A., Burdge, G.C., Gluckman, P. D., Hanson, M. A., 'Epigenetic mechanisms and the mismatch concept of the developmental origins of health and disease', PubMed, 61(5 Pt 2), 2007, 5R-10R.

[3] Helfand, M. and Redfern, C. C., Screening for thyroid disease: an update. Annals of internal medicine, 129(2), 1998, pp.144-158.

[4] Hsu, T. C., Margaret, R. Spitz., John, J. Fueger., Nancy, A. Beddingfield John, F. Annegers., Guy, R. Newell. and Stimson, P. Schantz., 'Chromosome Sensitivity to Bleomycin-induced Mutagenesis, an Independent Risk Factor for Upper Aerodigestive Tract Cancers', 49 (16), 1989, pp. 462-68.

[5] Mimouni, M., Mimouni, A. Bloch., Schachter, J., Shohat, M., 'Familial hypothyroidism with autosomal dominant inheritance', Archives of Disease in Childhood, 75, 1996, pp. 245-46.

[6] Vanderpump M.P., Tunbridge W. M. The epidemiology of thyroid disease. In: Braverman L. E., Utiger R. D., editors. 9th ed. Philadelphia, PA: Lippincott Raven, 1996, pp. 474-82.

[7] Zar, J. H., Biostatistical analysis. Prentice Hall Inc. Englewood cliffs NJ, 1974, pp. 620