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Editorial

Advancement in Science and technology has improved the physical quality of human life and has come to dominate every sphere of human activity. At the same time development without virtues has been posing threat to humanity and challenges to its ethical foundations."Journal of Current Studies" provides a solid forum to discuss developments in science and humanities and literature, and its impact on modern society. The journal analyses the implications of science policies, evaluates the environmental issues involved in the application of technology without human face and suggest alternatives. It also provides opportunity for academics to interact and evolve sustainable developmental strategies for a better society.

It is thus with great pleasure and gratitude, S.N.M. College Maliankara is presenting the 4th issue of our Inter disciplinary / multi disciplinary research journal. The objective of the journal is to provide a venue for academic research scholars, post graduate students in universities / colleges and other centres of research to publish current and significant research as well as other publication activities. Research papers, short communications, review articles, books reviews and professional news items will be published. From this issue onwards the journal insist strict guidelines for papers submitted for publication. Therefore, it is highly necessary that in future, research papers are to be submitted sufficiently earlier for the timely publication of the journal. From the next issue onwards, manuscripts submitted strictly in accordance with the style prescribed shall only be accepted for publication.

Looking forward to the future we can assure that the journal will continue to deliver the best of recent developments in different disciplines and publish good quality findings of high significance and relevance. On this happy occasion I wish to express my sincere appreciation to research & Journal committee for their enthusiastic support and co-operation to this academic venture. I also extend sincere appreciation of the college management and the principal, to the valued readers and *authors for their continued interest in JCS, and to every member of the editorial board to this scientific endeavour . We further gratefully acknowledge the enthusiasm and support of the college PTA who provided the financial support to this endeavour.*

We also welcome valuable suggestions and criticisms of the readers for improvement and augmentation in this regard.

With warm regards

Dr. M.G. Ramesh Babu
Chief Editor

Contents

CO-CONTINUOUS STRUCTURES IN MELT-MIXED NYLON COPOLYMER/ EPDM BLENDS

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Abstract

Co-continuous structures can be found independent of composition as intermediate stages during the initial stage of morphology development and during phase inversion process in blends in which the components finally forming the dispersed phase forms the matrix in the early mixing stages. Stable co-continuous morphologies can be created using suitable processing conditions, even at low volume fractions of one component. The interfacial tension and melt yield stress of one or both components of the blends plays an important role for the stability of the co-continuous structures. A lower interfacial tension leads to broader composition ranges of co-continuous structures. This article also reviews the influence of compatibilisation on the structure formation and stability.

Keywords: *Polymer blends, Co-continuous structure, Morphology*

Introduction

The blending of two immiscible polymers is an important technique for the achievement of advantageous material performance. A variety of properties can be significantly improved by blending. Blending may also be used to lower the cost of an expensive material by mixing it with a less expensive one while maintaining the properties critical to the application. Thermoplastic elasomers (TPEs) obtained from plastic-rubber blends combine the excellent processability characteristic of thermoplastics and the physical properties of elastomers. Most of the commercial polymer blends are immiscible .The physical, mechanical and rheological properties of immiscible blends depend not only on the constituent polymers but also on the morphologies of the blends[1]. The morphology development depends on the rheological properties of the blend components, interfacial tension, blend compositions and processing conditions[2]. The structure obtained after mixing of immiscible polymer pairs can be categorized into four basic morphology types.

- Matrix-dispersed particle structures
- Matrix –fiber structures
- Lamellar structures
- Co-continuous structures

Most commercial polymer blends have matrix-dispersed particle structure [(1,2]. There is an increasing interest in Co-continuous blends because this morphology type can offer some better combination of the component properties than are possible from dispersed type structures[3,4]. For example a Co-continuous structure gives the maximum contribution to the mechanical modulus from each component simultaneously[4,5]. Synergistic effects on impact properties have also been shown in the literature[6,7,8]. Examples of commercial Co-continuous blends are PP/PE/EPR blends[9,10] PA6/PPE blends[11,12] and PA6/ABS[13,14,15] blends .

Regarding the formation of the Co-continuous structures it is still not clear under what conditions and by which mechanism a Co-continuous structure may be formed and whether a Co-continuous structure can be stable or if it is simply an unstable intermediate that eventually transforms into a dispersed morphology.

It is the final state of dispersion that is important to the end use properties of a polymer blend. The component that forms the matrix generally dominated the properties of the blend. Thus, in Co-continuous blends, both components contributes more equally to the properties.

Experimental

Materials

Nylon copolymer (PA6-6,6)of melting point 148^{0}C and density of 1.12 g/cc ,was kindly supplied by SRF Ltd (Madras ,India).EPDM (KELTAN 720) with E/P ratio 58% to 37.5% and DCPD content 4.5 % was obtained from DSM (Netherlands).

Preparation of the blends and Test Samples

Nylon was preheated in vacuum oven at 80^{0}C for 24 hrs in order to remove the sorbed water. It was then kept in vacuum dedicator for 2 hrs. The blending was performed in a Haake Rheocord 90 mixer. Nylon was first charged into the melting chamber and melted for 2 minutes at 180^{0}C for a rotor speed of 80 rpm. Then EPDM was added .The blending was continued for 6 more minutes. Total mixing time was fixed at 8 minutes to ensure homoginity. Time and torque are also noted while mixing.

The blend was taken out and compression molded in a hydraulic press at 180^{0}C, and cold pressed to give samples for testing. The blend ratios are denoted by N_{90}, N_{80}, N_{70}, N_{60}, N_{50}, N_{40},N_{30}, N_{20}. The subscripts denote the weight percentage of nylon in the blend.

Preparation of samples for morphology studies

For determination of sample morphology, small bars (approx.25.4mm by 9.5mm by 3.2 mm) of the samples were placed in liquid nitrogen for 5 minutes. This was done to avoid any possible deformation of the phases. The bars were then fractured by bending. In order to determine the state of dispersion and phase continuity, a selective dissolution of the dispersed phase is attempted .For this, from the cryogenically fractured blends, EPDM was preferentially extracted from nylon rich blends using Xylene vapours (Soxhlet extraction) at 150^{0}C for 13 hrs and nylon from EPDM rich blends using Formic acid by immersing the fractured edge in formic acid for 9 hrs at room temperature. The samples were dried in an air oven at 80^{0}C for 24 hrs. Each etched surface was sputter coated with Au/Pd alloy in a sputter coating machine for 150s.At least five photographs were taken for each sample with Scanning electron microscope (SEM, 5400, JEOL, Tokyo, Japan).

Calculation of Co-continuity by Extration method

Because of the limitations of the microscopic methods, indirect methods seem to be more suitable for the unequivocal identification of the Co-continuous structures. Extraction method is an easy and viable way to check for Co-continuity when the components are soluble in specific solvents. Solvents were carefully chosen for completely dissolving one of the components without affecting the other component.

Uniform length of the samples were dried in vacuum oven at 80^0C for 24 hrs and then keep in vacuum dedicator for 2 hrs before weighing. The weighted out (2 to 5 g) samples were fully immersed in etchant at room temperature for 5 days. This is sufficient for the complete removal of the soluble fraction. Each polymer sample must immersed in different bottles. Nylon phase has been extracted from the blends with formic acid and EPDM phase with boiling Xylene. Then the remains were taken out of the solvents after 5 days, dried at 80^0C in vacuum oven and weighed carefully. A blend is only considered fully Co-continuous if 100% of one component can be extracted and the remaining piece is still self-supporting and its mass is approximately that in the original blend. Willemse et al [16,17,18]. Examples for quantification of the co-continuity degree by extraction experiments are given by Lyngaae-Jorgensen et al. [19,20,21]and Favis et al.[22,-26]

$$\text{Continuity index} = \frac{\text{weight of initial component} - \text{weight after extraction}}{\text{initial weight of the component}}$$

It is also possible to estimate the continuity of the phases from these tests. The continuity of one phase can be defined as the fraction of the polymer that belongs to a continuous phase. For a polymer A, this parameter is evaluated from the following expression:

$$\%\ \text{Continuity of A} = \frac{m_{\text{initil}} - m_{\text{finial}}}{W(A)\ \text{x}\ m_{\text{initial}}}$$

Where W(A) is the weight fraction of A in the initial blend. When the percentage continuity of both components equals to 100%, the morphology of the blend is considered to be continuous.

Mechanical property testing

The tensile properties of the blends were determined at room temperature Zwick universal testing Mechine.

Dynamic Mechanical Thermal Analysis

The dynamic mechanical properties of the samples were analysed with a Perkin Elmer Dynamic mechanical ananlyser.

Results and Discussion

Co-continuous structures are complicated three-dimensional interpenetrating and intertwining structures. It is much more difficult to identify a Co-continuous structure unequivocally in a melt mixed blend.

Solvent extraction results showed that the results are in good agreement with the morphology obtained from SEM observation (Figure: 1).

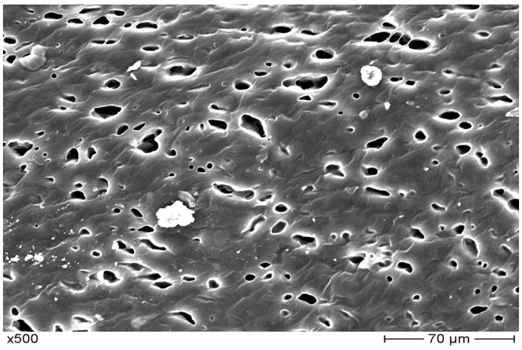

Figure 1(a) SEM photograph of solvent (Formic acid) extracted N20 blend (20/80 PA/EPDM blends)

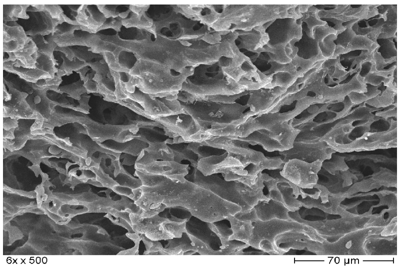

Figure 1(b) SEM photograph of solvent (Formic acid) extracted N30 blend (30/70 PA/EPDM blends)

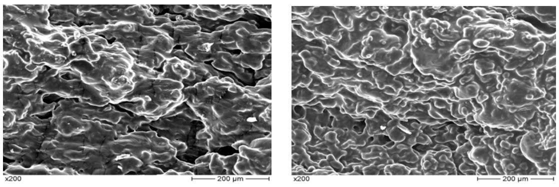

Figure 1(c,cc) SEM photograph of solvent (Boiling Xylene & Boiling Benzene) extracted N50 blend (50/50 PA/EPDM blends)

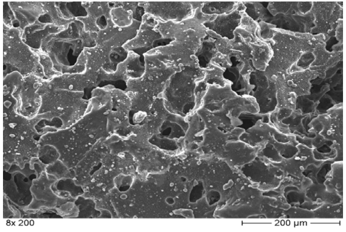

Figure 1(d) SEM photograph of solvent (Boiling Xylene) extracted N70 blend (70/30 PA/EPDM blends)

Fig: 1 Scanning Electron Micrograph of Nylon copolymer /EPDM blends at a magnification of 500 times (a) N_{20},(b) N_{30}, (C) N_{50}, (d) N_{70}

The test gives results in the shorter time for macroscopic characterization so that it can be carried out in all blend samples. For the blends consisting of matrix with dispersed particles, etching of the matrix causes a complete dissolution (disintegration) of the blend material and a milky suspension is obtained. In the case of co-continuous structures neither of the solvents could cause complete dissolution of the blend. So a colloidal solution is obtained. From the nylon rich blends ie N_{50}, N_{60}, N_{70}, N_{80}, N_{90} EPDM was extracted with boiling Xylene and from EPDM rich blends ie N_{20}, N_{30}, N_{40}, N_{50} nylon phase is extracted using formic acid. In both cases a precipitate is obtained indicating the dissolution of the minor phase .N_{40}, N_{50}, N_{60} do not disintegrate completely showing onset percolation and Co-continuity. Results of the dissolution test for the different blend series show the effectiveness of dissolution.

It is also possible to estimate the continuity of the phases from these tests. Results of disintegration tests of the different blend series shows the effectiveness of dissolution (Table1).

Table : 4 Volume fraction of the different blend series after disintegration tests

Sample code	Co-continuity index of Nylon	Co-continuity index of EPDM	% Continuity
N_{20}	0.08	0.97	35.9
N_{30}	0.17	0.92	57.0
N_{40}	0.45	0.81	95.2
N_{50}	0.72	0.80	97.3
N_{60}	0.92	0.70	97.8
N_{70}	0.95	0.27	98.2
N_{80}	0.97	0.10	98.3
N_{90}	0.98	0.06	98.6

At 20% of nylon, the level of continuity is nearly zero, which is confirmed from the scanning electron microscope. In N_{30} continuity increase considerably to a volume fraction of 0.17.Between N_{40} & N_{50} and N_{50} & N_{60} a semi-continuous morphology is observed (Figure:1).At N_{60} phase inversion take place and beyond which EPDM is seen to be dispersed in Nylon phase .From N_{60} the continuity of the phase increases gradually and reaches a volume fraction of 0.98 at N_{90}.Similar trend is observed when xylene is used as a solvent for EPDM phase. The samples containing nylon & EPDM content greater than 60%, when etched with formic acid, a jelly like mass was obtained. The percentage continuity of the blends at different blend ratios are given in Figure: 2.

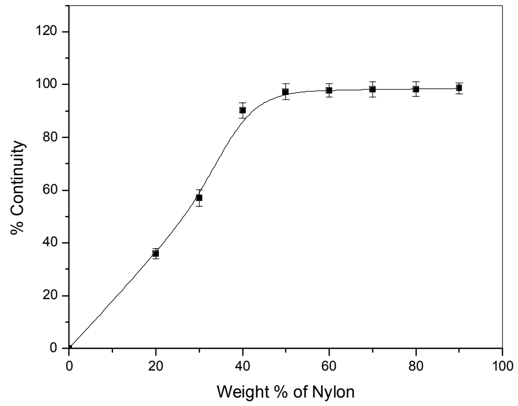

Figure: 2 Effect of blend ratio on the continuity of blends

From the figure it is clear that above 40 weight % of nylon, the nylon phase is continuous. So during extraction with formic acid dissolution of the nylon will take place only up to 40 wt % and for rest of the compositions (50-90 wt%) colloidal and milky suspensions were obtained indicating the continuous nature of the nylon matrix.

Mechanical Properties

Dynamical mechanical analysis

Dynamical mechanical analysis (DMA) can be a useful method to distinguish between dispersed and co-continues structures. Figure: 3 represents the storage moduli (E') of PA/EPDM blends as a function of the temperature.

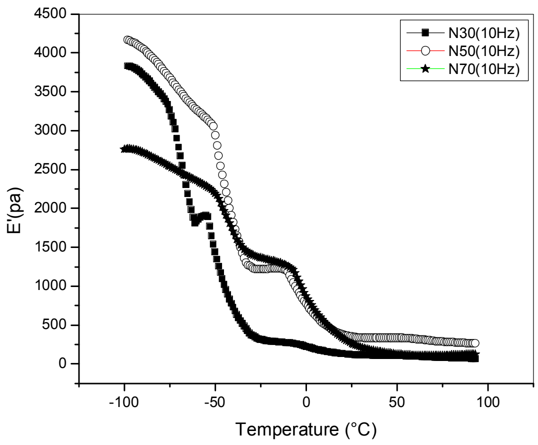

Figure: 3 Storage modulus of blends at different blend ratio

In co-continuous structures the storage modulus–temperature dependence reflects a greater contribution of both components, whereas in dispersed structures, the blend modulus is reflected by the matrix component. This is well revealed in the case of N_{50} blend ratio. The work of Groeninckx et al.[27], Gergen et al.[28] also explained this type of behaviour. Significant changes in storage modulus and tanδ peak height (Figure: 4) were observed in the Co-Continuous region .

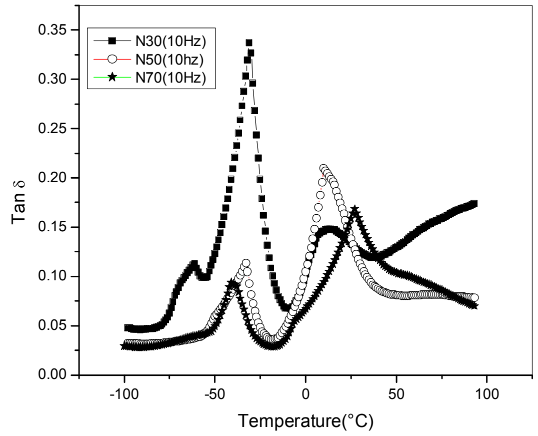

Figure : 4 Tan δ Peak of the nylon/EPDM blends at different blend ratio

DMA is also sensitive to differences in the length scale of the Co-continuous structure, which is a measure of the level of coarseness. This effect was shown by N50 blends annealed under different annealing conditions.

Conclusion

Co-continuous polymer blends is an interesting and challenging research topic. The structure offer promising opportunities for improving properties and creating tailor-made materials.

Blends with Co-continuous structures may combine the properties of both components in a favorable way. A Co-continuous structure leads to the maximum contribution of the mechanical modulus from each component simultaneously. By using the extraction method one can find out the blend ratio where the co-continuity is formed .The concept of co-continuous structure generation via sheet formation shows growing evidence. However Co-continuous structures seem to be inherently unstable during further processing, which is a limiting factor for their use.

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IN VITRO ORGANOGENESIS OF *BACOPA MONNIERI* – THE THINKING PERSON’A HERB

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Abstract

Bacopa monnieri (L) belongs to the family Scrophulariaceae is an amphibious plant of tropics and normally found growing on the banks of the rivers and lakes. It is commonly called as brahmi or jal brahmi in India. Brahmi is considered as the main rejuvenating herb played a very important role in Ayurvedic therapies. It also has anti-inflammatory, analgesic, antipyretic, epilepsy, anticancer and antioxidant activities. In the present study, in vitro propagation protocol of the medicinally important plant Bacopa monnieri was standardized using nodal and leaf segments as explants. They were surface sterilized with $HgCl_2$ *(0.01%) for 3 minutes prior to inoculation on MS media supplemented with BAP (0.5- 2.0 mg* L^{-1}*) and NAA (0.5-2.0 mg* L^{-1}*). The best performance for shoot multiplication for nodal explants was showed in MS medium supplemented with 2 mg* L^{-1} *BAP while for leaf explants is medium supplemented with 2 mg* L^{-1} *BAP + 1 mg* L^{-1} *NAA. For root induction, best rooting was observed with MS medium supplemented with NAA (2.0 mg* L^{-1}*). The present study is a stepping stone for in vitro production of Bacopa monnieri.*

Keywords: *Thinking person’s herb, nodal explants, leaf explants, Direct organogenesis*

Introduction

Today’s life is totally dependent on plants that serve as food for our daily vitamin requirement or as sole raw material for drug preparations, and hence revival of herbal treatment to alleviate health problems has emerged as a novel cure to revolutionize the reported side effects caused by allopathic drugs. In majority of cases nature cure is *sans* side effects helping to combat illness and support the body’s efforts to regain good health and intellect that is needed in much larger amounts to accomplish the demand. *Bacopa monnieri* is a vegetatively propagated medicinal plant from Scrophulariaceae enlisted among the most endangered plants due to its overexploitation. *Bacopa* is also known by name *Nir-Brahmi* in Sanskrit and *Brahmi* in Hindi and Malayalam is a creeping, glabrous and succulent herb with numerous branches, small oblong leaves, and light purple flowers. In India and the tropics, it grows naturally in wet soil, shallow water, and marshy areas showing rooting at nodes. It has no distinct odour and slightly bitter to taste. Earlier *brahmi* is used for brain power enhancement, concentration, and learning and to relieve anxiety, epilepsy, mental retardation and schizophrenia like disorders. This supernatural plant also possesses antioxidant property that provides protection from free-radical damage in cardiovascular diseases so used as a cardio tonic in India and Pakistan. *Brahmi* is also used as a diuretic, aperient, digestive aid and in respiratory function in cases of bronchoconstriction [1].

Tissue culture in wide sense is an asexual propagation where in a small piece of tissue is cut out and inoculated into a culture bottle containing media. Nature has empowered every living cell of plant to undergo cell division and attempts have been made to obtain continuous culture of cells and organs. This *in vitro* micropropagation is rapid clonal multiplication method for mass propagation of valuable herbs and also helps in dissemination and *ex situ* conservation of this endangered medicinal plant. These micropropagated plants furnish a ready source of uniform, sterile and compatible plant material for biochemical characterization and identification of active constituents [2]. With release of new drugs like memory plus in the market; there is going to be over exploitation of the natural populations of *Bacopa monnieri* that must meet the present requirement of 0.1 million quinta/year of the herb [3]. In this context, The demand of *Bacopa* is met from natural population generally, which can lead to put heavy strain on existing natural population and hence resulting in slow depletion of this already threatened herb. Tissue culture techniques can be used to attain rapid multiplication of elite clones and germplasm conservation of *Bacopa monnieri.*

Materials and Methods

Source of explants

Twigs of Brahmi were collected from healthy plants growing in the S.N.M. College Campus, Maliankara, Ernakulam District, Kerala.

Surface sterilization

The nodal parts and leaves were carefully removed from the twigs and washed under running tap water for to remove superficial dust particle adhering to the surface. Explants were then washed with liquid detergent for 10 minutes followed by thorough rinsing with distilled water 4-5 times. For surface sterilization, 1% fungicide (Bavistin) treatment was given for 15 minutes, followed by 0.01% $HgCl_2$ treatment for 1- 3 minutes under Laminar Air Flow. The explants so washed were carefully washed 4 -5 times with autoclaved distilled water.

In- vitro establishment of cultures

Surface disinfected nodal explants were inoculated onto full strength MS medium [4] having 3% sucrose and supplemented with different concentrations and combinations of PGRs viz. 6-Benzylaminopurine (BAP - 0.5-2.0 mg L^{-1}) and ∞-Naphthalene acetic acid (NAA - 0.5-2.0 mg L^{-1}).

In- vitro shoot multiplication and maintenance

Shoots induced from nodal and leaf were excised and placed on fresh medium of same composition for establishment of initial stock of shoots. Single shoots were separated and further used to perform experiments to standardize best medium composition for optimal shoot multiplication. For the purpose, MS medium supplemented with cytokinin BAP (0.5- 2.0 mg L^{-1}) alone and in combination with NAA (0.5-2.0 mg L^{-1}) was tried. *In vitro* generated healthy shoots were maintained by regular subculturing of propagules o shoots every 24 days of culture.

Result and Discussion

The regeneration potential and metabolite analysis in intact and *in vitro Bacopa* has been dealt in this manuscript. In the present study, 0.01% mercuric chloride solution proved to be efficient in controlling contamination on nodal explants. Effectiveness of mercuric chloride in mitigating infection on brahmi explants has also been reported earlier [5]. The present study was investigated the effect of various plant growth regulators (PGR) on shoot and root induction in 42 different combinations. Here, explants directly produces root and shoot without any supplementation of growth hormones. It is interesting to note that potential of direct organogenesis of Bacopa. Both nodal and leaf explants has the potential of direct organogenesis. In the case of leaf explants, it produces direct root proliferation at first while nodal explants produces shoot proliferation. However, the explant does not form any callus in any of the hormonal treatment.

From the study we have observed that *Bacopa monnieri* leaf / nodal explants grown on MS medium supplemented with cytokinins are required for multiple shoot induction. Moreover, all the explants were incubated on MS medium fortified with different concentrations of BAP (0.5, 1.0, 1.5, 2.0 mg L^{-1}) and IAA (0.5, 1.0, 1.5, 2.0 mg L^{-1}) and their combination (Table 1-4). In both the case of nodal and leaf explants, maximum response was recorded in medium supplemented with BAP 2 mg L^{-1} and NAA 2 mg L^{-1}; while low response in medium supplemented with NAA 0.5 mg L^{-1} and NAA 1 mg L^{-1} respectively (Plate 1).

The moderate level of shoot and formation was observed with the other growth regulators. Similar type of work has been reported by Kameri and co-workers for *Wedelia chinensis* [6]. MS media containing different concentrations and combinations of growth regulators were found to promote multiple shoots from both nodal and shoot tip explants. Multiple shoots start arising from nodes after 18-22 d of inoculation. Similarly, maximum number of shoots and roots for both nodal and leaf explants were recorded in MS medium supplemented with BAP 2 mg L^{-1} (Table 1 and 2). The shoot and root initiation was observed within one week of inoculation in all sets. Among the set 90% of shoot regeneration was observed in mg L^{-1} of BAP concentration. It was also observed that root formation was best in medium supplemented with NAA 2 mg L^{-1} for both nodal and leaf explant.

One of main function of exogenous cytokinin in tissue culture is induction of adventitious shoots. Results of this study indicate that large scale propagation of *B. monnieri* by tissue culture is feasible and several plantlets can be regenerated from one nodal explant. Present study indicate that an effective cytokinin for shoot induction as well as shoot propagation in *B. monneri*. Generally BAP is employed for regeneration of shoot. Several studies also showed that media supplemented with NAA and BAP have also useful for production of shoots [7, 8]. Present study also indicates combination of BAP and NAA is best combination for micropropagation of Bacopa. In general, BAP was more effective than other cytokinins. The stimulating effect of BAP on multiple shoot formation has been reported for several medicinal plant species [9].

Shoot number and shoot length observed after 4 weeks varied in all the treatment tried. On BAP supplemented medium, results were superior to those recorded on media supplemented with other PGR. Response of rooting was different in different concentrations of auxins. Basal MS medium proved to be completely incompetent to induce *in-vitro* rooting while root induction was observed within 15-20 days in all the other combinations tried (Table 4). Maximum rooting was recorded in medium containing 1.0 mg/l NAA (Plate 1).. On medium supplemented with NAA, *in-vitro* rooting was hampered and the roots developed were small and less healthy.

Hardening and Acclimatization

In-vitro rooted shoots were maintained in the rooting medium for over 5 weeks. Thereafter they were shifted directly to pots containing soil: sand: manure (1:1:1) and maintained in polyhouse for next one month (Plate 1). In polyhouse, tissue culture raised plantlets were monitored for optimal growth and development and watering was done as required. The plantlets eventually grew into long and healthy plants and subsequently transferred to the field conditions in open ground where 100% survival rate was observed.

Conclusion

Bacopa monnieri has always been a topic of interest to a myriad of researchers. From tissue culture point of view, several studies have been performed to propagate the plant *in vitro.* The objective of the present study was to develop a micropropagation protocol resulting not only in production of large number of healthy plantlets but is also suitable for long term maintenance of short cultures of Brahmi. Use of low concentration of plant growth regulators and minimization of time required for field transfer of tissue culture raised plantlets are the highlights of the study. Besides, the multitude of disease - free plants produced open the scope for utilization of plant material for antimicrobial testing and suitable pharmaceutical preparations. If we conserve these medicinal plants of great medicinal importance which have reported to occur abundantly a century ago and very rare at present due to over exploitation have fallen in the category of endangered species; it’s sure that our future generation will be thankful for our present effort.

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Table 1: Effect of Cytokinin (BAP) and auxin (NAA) supplemented in MS medium on the initiation of multiple shoots on nodal explant of *Bacopa monnieri* L.

Treatments	Growth Hormones (mg/L)		Response of nodal explants		
	BAP	NAA	% Response	Mean number of shoots	Mean length in cm
T_1	-	-	68	4.0 ± 0.08	1.20 ± 0.06
T_2	0.5	-	62	6.6 ± 0.20	1.22 ± 0.15
T_3	1.0	-	66	8.4 ± 0.18	3.65 ± 0.21
T_4	1.5	-	65	9.8 ± 0.21	6.45 ± 0.30
T_5	2.0	-	84	14.4 ± 0.19	8.12 ± 0.64
T_6	-	0.5	58	4.2 ± 0.18	0.60 ± 0.15
T_7	-	1.0	61	4.8 ± 0.12	1.72 ± 0.20
T_8	-	1.5	62	6.5 ± 0.28	2.10 ± 0.24
T_9	-	2.0	70	8.8 ± 0.11	2.24 ± 0.31
T_{10}	1.0	1.0	88	7.2 ± 0.22	3.34 ± 0.11
T_{11}	2.0	1.0	90	12.1 ± 0.36	6.61 ± 0.29
T_{12}	1.0	2.0	84	10.1 ± 0.27	3.72 ± 0.41
T_{13}	2.0	2.0	94	13.0 ± 0.38	7.43 ± 0.60

Table 2: Effect of Cytokinin (BAP) and auxin (NAA) supplemented in MS medium on the initiation of multiple shoots on leaf explant of Bacopa monnieri L.

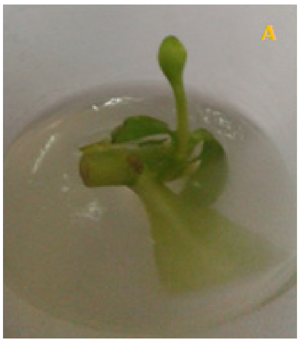
Treatments	Growth Hormones (mg/L)		Response of leaf explants		
	BAP	NAA	% Response	Mean number of shoots	Mean length in cm
T_1	-	-	68	2.2 ± 0.08	1.01 ± 0.09
T_2	0.5	-	61	2.6 ± 0.21	1.20 ± 0.10
T_3	1.0	-	58	3.4 ± 0.16	1.69 ± 0.20
T_4	1.5	-	65	3.8 ± 0.11	2.25 ± 0.11
T_5	2.0	-	82	**6.4 ± 0.31**	**2.82 ± 0.22**
T_6	-	0.5	48	2.2 ± 0.10	0.40 ± 0.06
T_7	-	1.0	44	2.4 ± 0.16	0.72 ± 0.20
T_8	-	1.5	66	3.5 ± 0.24	1.10 ± 0.24
T_9	-	2.0	70	4.8 ± 0.16	1.24 ± 0.31
T_{10}	1.0	1.0	85	4.4 ± 0.27	1.13 ± 0.08
T_{11}	2.0	1.0	93	5.3 ± 0.33	1.89 ± 0.11
T_{12}	1.0	2.0	74	3.3 ± 0.29	1.63 ± 0.13
T_{13}	2.0	2.0	90	5.5 ± 0.14	1.77 ± 0.09

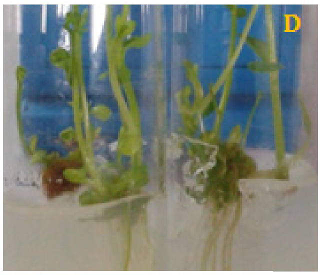
Table 3: Effect of Cytokinin (BAP) and auxin (NAA) supplemented in MS medium on the initiation of roots on nodal explant of *Bacopa monnieri* L.

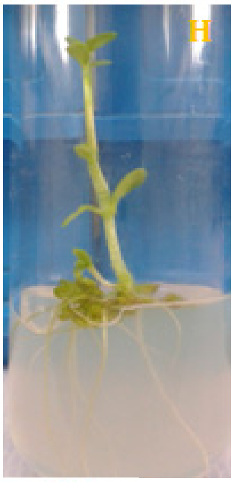
Treatments	Growth Hormones (mg/L)		Response of nodal explants		
	BAP	NAA	% Response	Mean number of roots	Mean length in cm
T_1	-	-	68	1.5 ± 0.06	2.05 ± 0.12
T_2	0.5	-	62	2.6 ± 0.21	4.20 ± 0.13
T_3	1.0	-	66	3.4 ± 0.16	3.29 ± 0.24
T_4	1.5	-	65	3.8 ± 0.14	4.33 ± 0.19
T_5	2.0	-	84	3.4 ± 0.18	3.32 ± 0.20
T_6	-	0.5	58	4.8 ± 0.16	4.40 ± 0.06
T_7	-	1.0	61	5.8 ± 0.19	6.34 ± 0.22
T_8	-	1.5	62	7.5 ± 0.14	6.48 ± 0.41
T_9	-	2.0	70	**8.8 ± 0.22**	**7.24 ± 0.16**
T_{10}	1.0	1.0	88	4.8 ± 0.33	2.25 ± 0.22
T_{11}	2.0	1.0	90	5.9 ± 0.30	4.21 ± 0.17
T_{12}	1.0	2.0	84	3.3 ± 0.29	5.50 ± 0.19
T_{13}	2.0	2.0	94	5.5 ± 0.14	5.77 ± 0.04

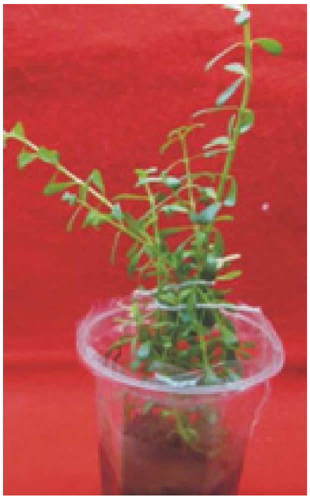
Table 4: Effect of Cytokinin (BAP) and auxin (NAA) supplemented in MS medium on the initiation of roots on leaf explant of *Bacopa monnieri* L.

Treatments	Growth Hormones (mg/L)		Response of leaf explants		
	BAP	NAA	% Response	Mean number of roots	Mean length in cm
T_1	-	-	68	2.2 ± 0.12	2.05 ± 0.12
T_2	0.5	-	61	2.8 ± 0.20	4.20 ± 0.13
T_3	1.0	-	58	3.9 ± 0.14	3.29 ± 0.24
T_4	1.5	-	65	3.8 ± 0.16	4.33 ± 0.19
T_5	2.0	-	82	4.2 ± 0.22	3.32 ± 0.20
T_6	-	0.5	48	6.6 ± 0.19	4.40 ± 0.06
T_7	-	1.0	44	6.8 ± 0.33	6.34 ± 0.22
T_8	-	1.5	66	8.4 ± 0.18	6.48 ± 0.41
T_9	-	2.0	70	**9.2 ± 0.24**	**7.24 ± 0.16**
T_{10}	1.0	1.0	85	5.8 ± 0.13	2.25 ± 0.22
T_{11}	2.0	1.0	93	5.5 ± 0.20	4.21 ± 0.17
T_{12}	1.0	2.0	74	7.3 ± 0.24	5.50 ± 0.19
T_{13}	2.0	2.0	90	7.5 ± 0.17	5.77 ± 0.04









THEORETICAL AND EXPERIMENTAL INVESTIGATIONS ON THE ELECTRONIC PROPERTIES OF EDOT-CHALCOGENADIAZOLE DONOR-ACCEPTOR COPOLYMERS

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Abstract

Conjugated polymers with donor-acceptor architecture have been widely investigated in photovoltaic devices, electrochromic devices, and in LEDs, due to their better electron-hole affinities and intramolecular charge transfer properties. Here, two low band gap EDOT-chalcogenadiazole donor-acceptor (D-A) conjugated copolymers were designed and synthesized via direct arylation. Structural characterization was performed by FT-IR, ^{1}H NMR and XPS. To investigate the electronic properties of the copolymers, quantum-chemical calculation using Density Fuctional Theory (DFT) was carried out. The alternating insertion of chalcogenadiazole unit in the PEDOT lowers the HOMO and LUMO energy levels. Present experimental results correlate with HSE06 level theoretical calculations than those with B3LYP level.

1. Introduction

Owing to their remarkable electronic, optical and mechanical properties conductive polymers (CPs) are used in a wide range of applications such as photovoltaics,[1] light-emitting diodes,[2] and field-effect transistors.[3] Even though several methods are available, copolymerization is a facile method to obtain desired properties for these types of functional materials. Resulting copolymer mostly exhibits unique optical and electronic properties with enhanced mechanical properties compared to those of the homo-polymers. Fine tuning in the band gap can be achieved by proper selection of monomer units as well as tailoring the co-monomer feed ratio in copolymerization.

Herein, we report alternate copolymerization approach to explain the effect of different acceptor groups such as benzothiadiazole and benzoselenadiazole on the electronic properties of D-A type polymers using both theoretical and experimental tools. Asymmetric polymers having 3,4-ethylenedioxytiophene (EDOT) as the donor group was designed and polymerized with chalcogenadiazole units (BTZ and BTSe) by a simple and facile method such as direct arylation reaction. Besides, the electronic properties of copolymers achieved with the co-monomers having EDOT as the donor group were also reported.

2. Experimental

2.1. Materials

3,4-Ethylenedioxythiophene (EDOT, Aldrich, 98%), o-phenylene diamine (Merck, 98%), tetrabutylammonium bromide (TBAB, Avra Synthesis Pvt. Ltd, 98%), sodium acetate (anhydrous) (Spectrochem Pvt. Ltd), triethyl amine (Spectrochem Pvt. Ltd), palladium(II) acetate ($Pd(OAc)_2$, Aldrich, 99.98%), tetrabutylammonium hexafluorophosphate (Bu_4NPF_6, Aldrich, 499%), thionyl chloride ($SOCl_2$, Merck, 97%), hydrobromic acid (HBr, Spectrochem Pvt. Ltd, 47%), bromine (Merck), sodium borohydride ($NaBH_4$, Merck, 98%), ethanol absolute (Merck), diethyl ether (Spectrochem Pvt. Ltd), magnesium sulphate (anhydrous) ($MgSO_4$, Spectrochem Pvt. Ltd) and selenium dioxide (SeO_2, Aldrich, 98%) were used as received. Acetonitrile HPLC grade (CH_3CN, Aldrich), dimethyl acetamide (anhydrous) (DMAc, Spectrochem Pvt. Ltd), chloroform ($CHCl_3$, Spectrochem Pvt. Ltd), dicholoromethane (CH_2Cl_2, Spectrochem Pvt. Ltd), tetrahydrofuran HPLC grade (THF, Spectrochem Pvt. Ltd), n-hexane (Spectrochem Pvt. Ltd) and methanol (anhydrous) (MeOH, Spectrochem Pvt. Ltd) were dried and distilled when necessary according to the standard procedures.

2.2. Computation methods

To determine the electronic properties of the EDOT–chalcogenadiazole copolymers, (P(EDOT–BTZ) and P(EDOT–BTSe)), stepwise procedures involving quantum chemical calculations, based on density functional theory (DFT) methods, were followed.[4] Initially, the ground state geometries of oligomers were optimized by means of DFT at the B3LYP (Becke, three parameter, Lee–Yang–Parr) level of theory.[5] The DFT calculations at two different energy levels were carried out with B3LYP and HSEh1PBE referred to as HSE06 (full Heyd–Scuseria–Ernzerh functional)[6] (Both the calculations used the 6-31G basis set as implemented in Gaussian 09 package).[7] The periodic boundary condition (PBC) calculation was used to study the electronic properties of EDOT–chalcogenadiazole based copolymers. The starting unit cell geometries for the PBC calculation were taken from the central portion of the optimized oligomer and optimized inside a given lattice length on the constraints of PBC by assuming that the unit cell is repeated identically an infinite number of times along the translation vector. Band structure in the positive region of the first Brillouin zone (between $k = 0$ and $k = \pi/a$) were plotted. i.e., the lowest 4 unoccupied and highest 4 occupied bands in the positive region of the first Brillouin zone were plotted.

3. Results and Discussion

3.1. Theoretical calculations of the electronic structure of copolymers

To analyse the electronic structure and properties of copolymers, P(EDOT–BTZ) and P(EDOT–BTSe) theoretical calculations were performed by hybrid density functional theory (DFT) using the B3LYP/6-31G level and the HSE06/6-31G level. These are computationally cost effective procedures to calculate the electronic structure with a good approximation and enable elimination of unsuitable materials before synthesis. The periodic boundary condition (PBC) calculation, which is computationally economical compared to the oligomer approach, was used to solve the electronic structure and properties of the copolymers at two levels of theory (B3LYP/6-31G and HSE06/6-31G) and the obtained band structures with HSE06/6-31G levels are depicted in Fig. 1.

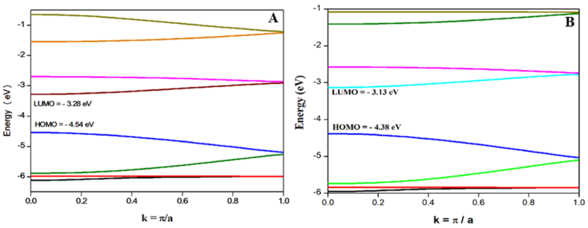
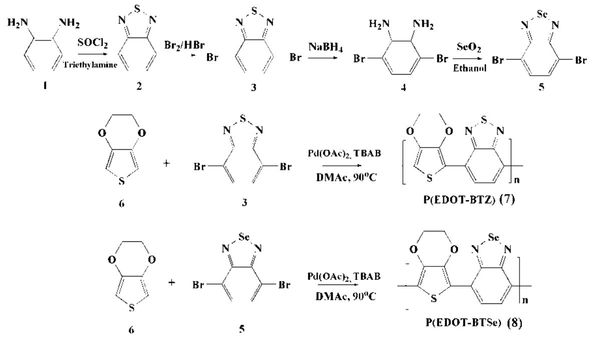


Fig. 1: Band structure of (A) P(EDOT–BTZ) and (B) P(EDOT–BTSe) by the HSE06/6-31G method.

As seen in figure, it is observed that, by the introduction of the chalcogenadiazole unit, energy of the HOMO level of PEDOT is lowered by a factor of 0.92 eV and 0.76 eV, while the LUMO level is lowered by a factor of 1.29 eV and 1.14 eV and we get P(EDOT–BTZ) and P(EDOT–BTSe) with a reduced band gap of 1.26 eV and 1.25 eV, respectively. The intramolecular charge transfer between the EDOT unit and chalocogenadiazole units induced a quinoid character in the polymer backbone resulting reduction in the band gap.

3.2 Polymer synthesis

EDOT–chalcogenadiazole (D-A) copolymers were synthesized via a simple, and facile route, i.e., the direct arylation method.[8] This method confirms the regular alternation of the donor and acceptor in the polymer backbone. The synthesis of key monomers and copolymers are summarized in Scheme 1. The molecular weights of the polymers were obtained from gel permeation chromatography in THF referring to polystyrene standards. The copolymers are readily soluble in common organic solvents such as THF and chlorobenzene (50 mg mL^{-1}), hence can be easily processed in to thin films. Structural characterization was performed by FT-IR, ^{1}H NMR and XPS.



Scheme 1: Synthesis of monomers and copolymers

3.3. Electrochemical properties

Electrochemical measurements (CV, DPV and SWV) were performed to determine the HOMO and LUMO energy levels of P(EDOT–BTZ) and P(EDOT–BTSe). From the onset of oxidation, the HOMO levels of P(EDOT–BTZ) and P(EDOT–BTSe) were calculated to be -4.66 eV and -4.63 eV (DPV), respectively, based on the equation, HOMO =-(4.4 + $E_{onset}{}^{ox}$). Whereas, the LUMO energy levels (from the onset of reduction potential) of P(EDOT–BTZ) and P(EDOT–BTSe) are calculated to be -3.6 eV and -3.6 eV, respectively. In both the polymers, the HOMO and LUMO energies were lowered upon copolymerization, indicating enhanced electron accepting/transporting properties in the conjugated backbone. These results are in good agreement with DFT/PBC calculation, though some deviations still exist.

4. Conclusion

Two low band gap copolymers composed of electron-rich 3,4-ethylenedioxythiophene unit and the electron-deficient cores 2,1,3-benzothiadiazole (BTD) and 2,1,3-benzoselenadiazole were designed and synthesized by following donor-acceptor approaches to obtain relevant electronic properties. Theoretical calculation revealed the HOMO and LUMO levels of the P(EDOT–BTZ) at -4.54 and -3.28 eV, respectively. The HOMO and LUMO levels of the P(EDOT–BTSe) were revealed at -4.38 eV and -3.13 eV, respectively, and hence copolymers had a band gap of 1.26 and 1.25 eV for P(EDOT-BTZ) and P(EDOT-BTSe), respectively. The band gap and energy levels of the polymers were also determined using electrochemical methods. The results showed good agreement with the theoretical prediction obtained by the HSE06/6-31G method.

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NANOPARTICLES USING MARINE MACROALGAE SARGASSUM WIGHTII

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Abstract

Biosynthesis of nanoparticles is an important area in the field of nanotechnology which has economic and eco-friendly benefits over chemical and physical methods of synthesis. . The present study deals with the eco-friendly biosynthesis of Silver nanoparticles (AgNPs) using the aqueous extract of brown seaweed Sargassum Wightii as reducing agent. The AgNPs obtained were characterized by UV-Visible Spectroscopy, FTIR and XRD. The characteristic absorption peak at 420 nm in the UV-Visible spectrum confirmed the formation of AgNPs. The colour intensity at 420 nm increased with duration of incubation. The FTIR analysis showed that the synthesize AgNPs were capped with bimolecular compounds which are responsible for the reduction and stabilization of nanoparticles. The XRD analysis gives the structural information of nanoparticles. Since no synthetic reagents were used in this study, it is an environmentally safe method with potential for biomedical applications.

***Keywords**: Biosynthesis, Seaweed, AgNPs, Characterization*

Introduction:

Nanotechnology deals with the synthesis of nanoparticles of different shapes and sizes and their potential applications. Biological synthesis of metal nanoparticles have drawn considerable attention due to growing need to develop environmentally benign technologies in material synthesis. The chemical synthesis methods lead to presence of some toxic species, adsorbed on the surface that may have adverse effects in its applications.Biological synthesis of nanoparticles using microorganisms and plants can potentially eliminate this problem by making the nanoparticles more biocompatible.

Compared to microbe assisted synthesis, plant-mediated synthesis of nanoparticles is an under exploited field. AgNPs have been successfully synthesized using several plants

(Amkamwar et al., 2005; Chandran et al., 2006; Li et al., 2007; Shankar et al., 2003; Venkatpurwar and Pokharkar, 2011). All these investigations were restricted to terrestrial plants and there are only limited reports on the synthesis of nanoparticles from marine plants (Govindaraju et al., 2009; Kannan et al., 2012; Nabikhan et al., 2010; Prasad et al., 2012; Venkatpurwar and Pokharkar, 2011; Vivek et al., 2011).

Algae are also used as “bio-factories” for synthesis of metallic nanoparticles.They can produce a great variety of secondary metabolites that showed therapeutic potential (Tierney et al. 2010; Mayer et al. 2011). Seaweed-mediated green biosynthesis of nanoparticles is cost effective, environment friendly, easily scaled up for large scale synthesis and further there is no need to use high pressure, energy, temperature and toxic chemicals. Among the nanoparticles, silver nanoparticles (AgNPs) have received considerable attention due to their attractive physicochemical properties and immense applications.

Hence in the present study, the eco-friendly biosynthesis of silver nanoparticles by using aqueous extract of the brown seaweed Sargassum Wightii and its characterization using UV- Visible spectroscopy, FTIR and XRD are reported.

Materials and Methods

Sample collection and extract preparation:

The brown seaweed Sargassum Wightii was collected from the coast of Thirumullavaram ($8^0$53’38’’N; $76^0$33’14’’E), Kollam district of Kerala. Washed thoroughly, shade dried and powdered.1 % of extract was prepared using sterile distilled water by heating at 60°C for 20 min. The extracts was filtered through Whatman No. 1 filter paper and the filtrate then used for further analysis.

Sargassum Wightii

Synthesis of AgNPs:

For the biosynthesis of silver nanoparticles, 10 ml of seaweed extract was mixed with 90 ml of 1 mM $AgNO_3$ solution and incubated in dark at room temperature under static condition. The bio-reduction of $AgNO_3$ into AgNPs can be confirmed visually by the change in colour from yellow to brown.

Characterization techniques:

The formation of AgNPs was confirmed by sampling the reaction mixture at regular intervals and the absorption maximum was scanned by UV–visible spectra, in a range of wavelength between300 and 600 nm using Thermo scientific Evolution 201 Spectrophotometer. The purified AgNPs were examined for the presence of biomolecules responsible for bioreduction using

FTIR Spectrometer (Perkin Elmer Spectrum 100) at the wave length range of 4000-550cm^{-1}.Crystalline nature of the purified silver nanoparticles was analysed by XRD (Bruker AXS D8 advance) operated at a voltage of 40 kV and a current of 30 mA with Cu Kα radiation.

Results and Discussion

Reduction of $AgNO_3$was visually evident from the colour change (yellow-brownish) of reaction mixture after 30 min of reaction. Intensity of brown colour increased in direct proportion to the incubation period. It may be due to the excitation of surface Plasmon resonance (SPR) effect and reduction of $AgNO_3$ (Mulvaney 1996). The control $AgNO_3$ solution (without seaweed extract) showed no colour change. Absorption spectrum of the reaction mixture at different wavelengths ranging from 400 to 700 nm revealed a peak at 420 nm (Fig.1)

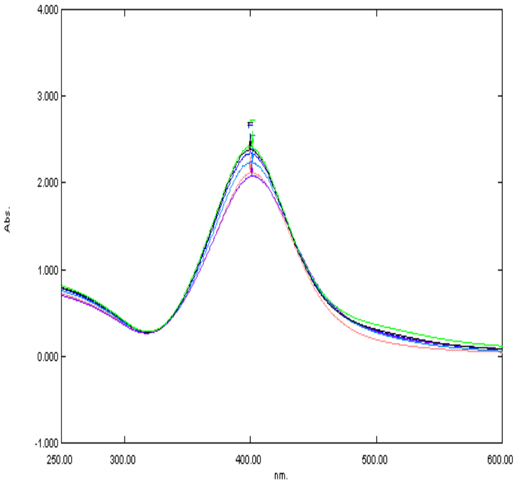

Fig.1 UV-Visible Spectrum of AgNPs at different time Intervals

The characteristic absorption peak at 420 nm in UV–Vis spectrum confirmed the formation of AgNPs.

To understand the existence of different functional groups responsible for the bio-reduction of $AgNO_3$ into Ag Nanoparticles, FTIR studies were carried out for S. Wightii extract and synthesized silver nanoparticles.

Fig.2 represents the FTIR spectrum of freeze dried seaweed extract and AgNPs. The FTIR spectrum of seaweed extract shows the presence of major peaks at 3275, 2,931, 1,681, 1,085cm-1, which are associated with the O-H bond stretching of alcohols and phenols, C–H of alkanes, the stretching vibration of the (NH)C=O group, C–N stretching vibration of amines respectively. After bio-reduction, there is a shift in the absorption band of 1,681cm–1 to1649 cm-1&1,085cm–1 to1,087 cm-1 .The shifting of the band from 1,681to 1,649 cm-1 may be due to the binding of (NH)C=O group with the nanoparticles. Thus, the peptides may play an important role in the reduction of AgNO3 into Ag nanoparticles. The FTIR analysis also showed that the synthesized Ag NP were capped with bimolecular compounds which are responsible for the reduction and stabilization of nanoparticles.

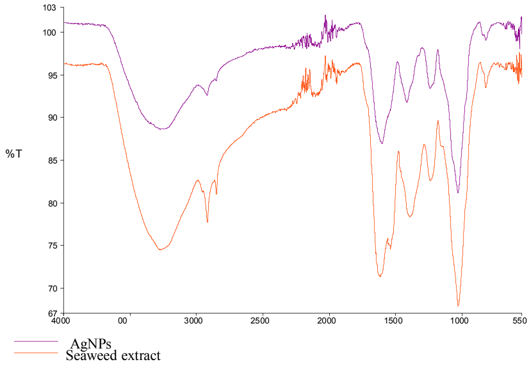

Fig.2 FTIR spectrum of freeze dried seaweed extract and biosynthesised AgNPs

The XRD pattern(Fig.3) of biologically synthesised AgNPs gave a number of Bragg reflections with 2θ values of 26.8, 36.09,44.1, 54.98, and 77.19 which correspond to the planes (110), (111),(200), (220), and (311) respectively. This shows that the Ag^+ reduced to Ag^0 by Sargassum Wightii are crystalline nature.

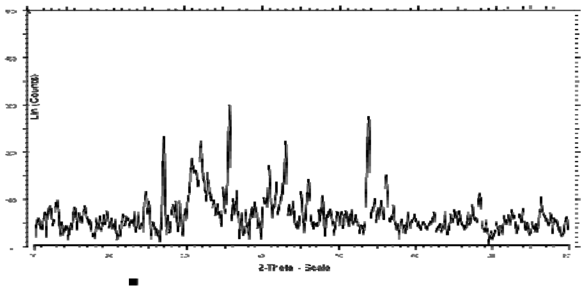

Fig.3 XRD pattern of synthesised AgNPs

Conclusions

The aqueous extract of seaweed Sargassum Wightii is capable of producing AgNPs by reducing AgNO3 solution and is an efficient, eco-friendly and simple method. The characteristic absorption peak at 420 nm in UV-Visible spectrum confirmed the formation of AgNPs. The presence of functional bio active compounds in seaweed extract is responsible for the formation of AgNPs as revealed by FTIR.The XRD pattern shows that the synthesized AgNPs are crystalline in nature. Owing to their abundance and ready availability, seaweeds are good and cost –effective sources for the synthesis of metallic nanoparticles.

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AQUEOUS SYNTHESIS AND OPTICAL PROPERTIES OF ZnS QD-SULFONATED POLYSTYRENE COMPOSITE

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Abstract

A simple and environment friendly method was used for the direct aqueous synthesis of water soluble ZnS quantum dot (QD)–sulfonated polystyrene (SPS) composite. Water soluble sulfonated polystyrene of sulfonation level, f > 75% (SPS) called polyelectrolyte was prepared and it has been used for the synthesis of ZnS QDs in aqueous medium. The two differently sulfonated polystyrene, SPS1 and SPS2 of sulfonation level 76% and 100% respectively; capped ZnS QD is stable in water and can be cast to transparent composite film. The optical properties in terms of ultraviolet (UV)-visible (Vis) absorption and photoluminescence (PL) of the composites were studied. The two composites give blue shift in UV-Vis absorption relative to bulk ZnS, which shows the presence of ZnS QDs. High resolution transmission electron microscopic (HRTEM) images confirm the existence of ZnS QDs. The aqueous solution of ZnS QD-SPS exhibits shallow defect state emission at 375 nm rather than band edge emission. The water solubility and luminescence make it suitable candidate for chemical sensing application like biomolecule labeling. Novelty of the present synthesis procedure lies in using water as the sole solvent for the sulfonation of polystyrene and ZnS QD-SPS composite synthesis.

Keywords: Sulfonation, Quantum dot, Photoluminescence, Composite.

1. Introduction

Controlled growth of semiconductor nanocrystals attached to polymers has emerged as important in designing materials with optical and electronic properties[1]. Quantum confinement of electron-hole within the semiconductor nanoparticle occurs as the size of the particle approaches its exciton Bohr radius. Because of energy level quantization, these particles called quantum dots (QDs) have size dependent physical and chemical properties.[2] Quantum size effects exhibited by the QDs were evaluated by observing the blue shift in the optical absorption spectrum.[3] Nature of surface passivation also affects the optical properties of the QDs[4]. The potential applications such as optical switching, nonlinear optics and biomedical labeling of the composite depend upon the interfacial interaction between QDs and polymer. It is well known that photocurrent generation, photocatalytic and photosynthetic reactions at semiconductor particles provide the possibility of utilization of solar energy[5]. Researchers have had a keen interest in synthesizing nanocomposites of CdS nanoparticles and a wide range of chemical methods have been developed, that includes i) *Ex situ* method[6] ii) *In situ* method[7] and iii) post-polymerization method.[8] A direct attachment between the polymer and the QDs makes the last two methods more attractive.

The challenge is to design the polymers or the monomers to control the particle aggregation during the composite formation.

The sulfonation of expanded polystyrene waste (EPS) to sulfonated polystyrene (SPS) for the synthesis of SPS-ZnS QD hybrid is the topic of this paper. Homogeneous and heterogeneous sulfonation of EPS are proposed to be carried out to obtain the SPS with a sulfonation level of around 70% and above. Sulfuric acid and silver sulfate are used for the sulfonation of EPS. The sulfonated polystyrene is likely to behave as a polyelectrolyte and is proposed to be used for nanocomposite preparation. The resultant nanocomposite is expected to display optical properties corresponding to ZnS QDs. The nanocomposite is to be characterized by Fourier transform infrared spectroscopy (FTIR), Field emission scanning electron microscopy (FE-SEM), XRD and HR-TEM. Optical properties in terms of UV-vis absorption and luminescence spectra of the synthesized composites are proposed to be used to ascertain its application as photocatalyst and biomolecule labeling. The influence of SPS sulfonation level in nanocomposite formation and optical properties are also proposed to be investigated.

2. Experimental

2.1 Materials

Expanded polystyrene(EPS), a waste collected from packing carton, was used for the synthesis of sulfonated polystyrene(SPS). Analytical reagent grade Sulfuric acid (98%), Silver sulfate, $ZnCl_2$, $Na_2S.9H_2O$, and 1,2-dichloroethane were purchased from Merck. Dialysis tubing (Sigma Aldrich) cut off M.W 12,000-14,000 was used for the purification of SPS solution.

2.2 Synthesis of sulfonated polystyrene (SPS)

The sulfonated polystyrene (SPS1 and SPS2) was synthesized from waste expanded polystyrene (EPS). Homogeneous and heterogeneous sulfonation of EPS was carried out with a slight variation in the reported procedure[9]. Homogeneous sulfonation of EPS in 1,2-dichloroethane (DCE) solvent was conducted using minimum amount of H_2SO_4 (98%) in presence of Ag_2SO_4 catalyst while excess sulfuric acid was used for the heterogeneous sulfonation of EPS in presence of Ag_2SO_4 catalyst for the formation of polyelectrolytes, SPS1 and SPS2 respectively. The detailed procedure is explained below. Sulfuric acid containing 1% Ag_2SO_4 was added to the homogeneous solution (20% w/w) of PS in DCE under ice cold condition. Temperature was gradually increased to 60°C and the reaction was carried out under stirring for 3 h. When the mixture became milky, the solvent was evaporated off to form sulfonated polystyrene and was then dissolved in water. The aqueous solution of the sulfonated polystyrene was purified by dialyzing against distilled water. The pure solution of the sulfonated polystyrene in the dialysis tubing was dried to sulfonated polystyrene film designated as SPS1. Heterogeneous sulfonation of PS was carried out by heating with excess H_2SO_4 (98%) containing 1% Ag_2SO_4 at 70°C. The viscous solution was mixed with water followed by filtration to remove the unreacted polymer. Excess sulfuric acid was removed by liming using $CaCO_3$ till no precipitate of $CaSO_4$ was obtained. The clear solution was dialyzed against distilled water and dried to sulfonated polystyrene film designated as SPS2.

2.3 Nanohybrid Preparation

The SPS films with two different sulfonation levels were dissoved in water in separate beakers. The solutions were stirred with $ZnCl_2$ slowly for 1h at 70^0C. The unreacted Zn was removed by dialyzing against water. The aqueous solution of SPS attached with Zn^{2+} ions were mixed with freshly prepared N_2 purged Na_2S aqueous solution. The composite solution of SPS-ZnS was formed which was dried to composite film.

2.4 Characterization

^{1}H NMR measurements were performed with a Bruker 400 spectrometer (400 MHz). SPS synthesized under different conditions were dissolved in deuterated water (D_2O), while EPS was dissolved in deuterated chloroform ($CDCl_3$). Relative areas of peaks corresponding to aliphatic protons and three types of aromatic protons were obtained from the Bruker spectrometer. The sufonate content in the two SPSs was determined using its NMR spectra as previously reported.

Sulfonic acid vibration bands in PSS and its change during the attachment of Zn^{2+} ions and ZnS formation was studied using Thermo Nicolet Avatar 370 FT-IR spectrometer. KBr pellet was prepared using the cracked pieces of the sample film and scanned in the range $400cm^{-1}$ to 4000 cm^{-1}. Thirty two scans were taken with a resolution of $4cm^{-1}$. HR-TEM FEI model TECNAI G2 F30 instrument operated at an accelerating voltage of 300 kV (Cs=0.6mm, resolution 1.7 A^0) was used to analyze the size of nanocrystals in the hybrid. Powdered composite was dissolved in water and a drop of the solution was placed on a 200 mesh copper grid coated with carbon film (ICON Analytical). This was subsequently dried under vacuum overnight and then loaded in the electron microscope chamber.

2.5 Optical properties

Optical properties of the composite were studied using UV-vis absorption and PL measurements. The absorption spectrum of the aqueous solution of the composite was measured using Shimadzu UV-visible spectrophotometer. Absorption onset and absorption maximum were obtained by drawing tangents on exciton peak. The steady state photoluminescence spectrum of the composite in water was acquired in the wavelength range of 300-800nm at room temperature with different excitation light from He-Cd laser. Influence of excitation wavelength in the PL of the composites was studied.

3. Results and Discussion

3.1 Synthesis of sulfonated polystyrenes (SPS1 and SPS2) and their ZnS QD composites.

The reagent H_2SO_4 in presence of Ag_2SO_4 catalyst has been used for both homogeneous and heterogeneous sulfonation. Although the sulfonated polystyrenes (SPS1 and SPS2) obtained by the two methods are soluble in water, they show difference in the easiness of solubility. The SPS2 dissolves very easily in water but SPS1 dissolves only after prolonged stirring. This clearly indicates the difference in their sulfonation level. The SPS2 contains more –SO_3H ionic functionals than the SPS1. The purified aqueous solution of SPS1 and SPS2 forms water soluble transparent films once the water is evaporated off under ambient conditions. The transparent films of SPSs redissolved in water and were used for the composite preparation. The SPS1 and SPS2 are effective stabilizers for the water soluble ZnS. The aqueous solution of SPSs stabilized CdS QDs forms composite films, SPS1-ZnS and SPS2-ZnS.

3.2 ^{1}H NMR Spectrum

NMR spectra of SPS1 and SPS2 are shown in Figure 1. The ^{1}H NMR spectra confirm the sulfonation of PS and reveal the level of sulfonation in the two SPSs. The sulfonation to a level of 76% was achieved in SPS1 as per our previous work[10]. The PS was sulfonated almost completely as evidenced from ^{1}H NMR spectrum of SPS2. The peaks at δ=6.5 and δ=7.5 ppm are due to ortho and meta protons of para sulfonated aromatic rings. In SPS2, the peak of indistinguishable meta, para protons of unsulfonated aromatic ring is absent at δ=7.1 ppm, which is present in PS. Thus PS is sulfonated to an extent of 100%.

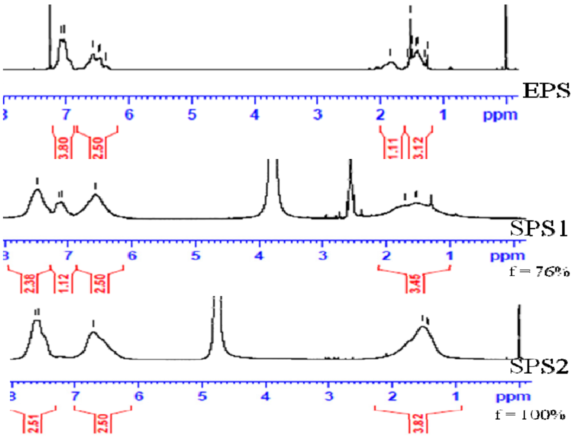


Figure 1. ^{1}H NMR spectra of EPS, SPS1, and SPS2

3.2 FT-IR

Figure 2 displays the FTIR spectra of SPS2, Zn^{2+} attached SPS2 and SPS2-ZnS composite that give evidence for the presence of –SO$_3$H functional groups and incorporation of ZnS QDs in the SPS1. Vibrational peaks at 1030 cm^{-1}, 1122 cm^{-1} and 1170 cm^{-1} are assigned to stretching vibration of the sulfonic acid functional groups[11]. Substitution at para position is confirmed from the peak at 835 cm^{-1}. The considerable decrease in these vibrational peaks after Zn^{2+} attachment suggests the coordination of Zn^{2+} ions to the sulfonic acid functionals. The regeneration of sulfonic acid peaks after the ZnS formation, clearly shows the detachment of ZnS QDs from the –SO$_3$H ionic functionals. FTIR spectra of the SPS2 and its composite film show the existence of ionic functional groups even after the formation of ZnS QDs and render the film easily soluble in water.

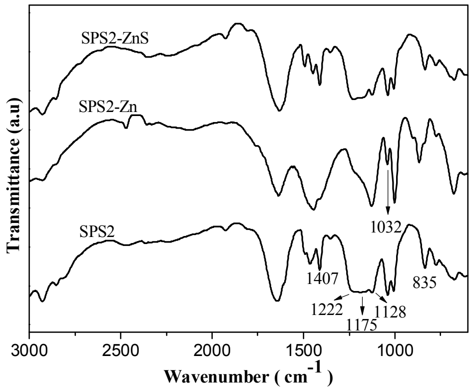


Figure 2. FTIR spectra of SPS2, SPS2-Zn^{2+} and SPS2-ZnS

3.3 HR-TEM

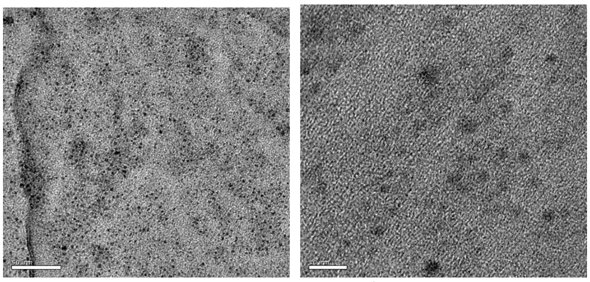
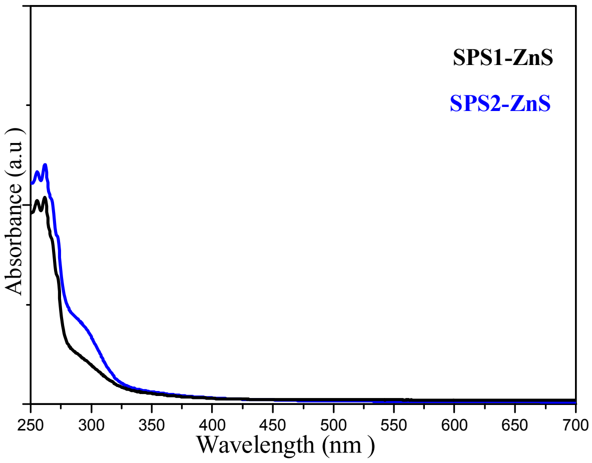


Figure 3 HR-TEM images of SPS2-ZnS

The CdS particle size and distribution of ZnS nanoparticles in the composite films are investigated using HR-TEM images (Figure 3). The SPS2-CdS films confirm the presence of ZnS

QDs of size less than 6 nm, exciton Bohr diameter of bulk ZnS.



3.3.1.1 UV-Vis absorption

The aqueous solution of SPS1-ZnS and SPS2-ZnS shows blue shift in UV-vis absorption on comparing with bulk ZnS, which is depicted in Figure 4. The band gap was calculated using the absorption edge according to a well known equation published elsewhere and substituted in the empirical model for the radius of QDs. The size of the ZnS QDs of the two composites is 3.6 and 4.1 nm corresponding to the absorption edge 315 and 322 nm respectively

3.4 Photoluminescence

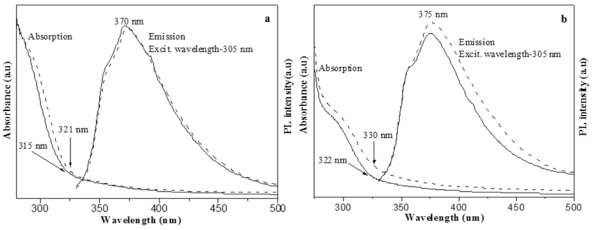


Fig. 8 UV-vis absorption and PL of the composite film a) SPS1-ZnS and b) SPS2-ZnS in water. Spectra given in dashed lines represent absorption and luminescence of their aqueous solution on standing for 5 hrs.

The absorption and PL spectra of the two composites, after standing in water for 5 hrs are also given as dashed lines in Figure 8a and b. Keeping in aqueous solution causes a minor red shift in absorption onset evidences an increase in the size of ZnS clusters. Despite the red shift observed on keeping in aqueous solution, the position of the absorption peak is still blue shifted compared to bulk ZnS. Thus the SPS1 and SPS2 are capable enough to stabilize the ZnS QDs in water. The PL of the two composite solutions is almost same with defect state emission. The emission is due to the shallow trap state levels with a peak maximum at 370 - 375 nm with a weak shoulder at 354 nm. The band gap emission is completely absent for the defect state emission. The sulfonic acid ionic groups in the polyelectrolytes (SPS1 and SPS2) make enhanced electrostatic interaction with ZnS QDs that creates dense defect state levels for the exclusive trap state emission in SPS-ZnS composites. The QD surface interaction has a strong influence on their optical properties because a large portion of atoms are located at the surface of QDs. Also, the wide band gap of the ZnS facilitates the creation of defect state levels for an alternate electronic de-excitation path to subside the near band edge emission. The photophysical studies of ZnS QDs were well established and in most cases trap state emission is dominant over band edge emission. The emission behavior of the composites is consistent with previous report on luminescent ZnS nanocrystals which show shallow donor and acceptor emission peaks (379 and 355 nm) and deep donor and acceptor emission (> 400 nm).

4. Conclusion

The sulfonated polystyrene waste is successfully used for the synthesis of luminescent water soluble ZnS QD composite. An aqueous route is used for the synthesis of SPS-ZnS composite. The SPS1 and SPS2 are effective in stabilizing ZnS QDs in aqueous solution for the ultimate formation of water soluble composites, which give only defect state emission at 375 nm. The combination of simple synthesis methodology, water solubility, luminescence, and free functional groups make the water soluble composites a great candidate to develop materials which has sought extensive application in metal ion sensing.

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REINFORCEMENT EFFECT OF RICE HUSK ASH ON MECHANICAL PROPERTIES OF ACRYLONITRILE BUTADIENE RUBBER COMPOSITES

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Abstract

This paper reveals the result of a study for the property improvement for nitrile rubber (NBR) using rice husk ash (RHA) as filler and MA-g-NBR as a compatibilizer (C). Rice husk is an agro waste product of the rice processing industry. It is used widely as a fuel which results in large quantities of RHA. In this work, NBR is compounded with RHA in the presence of compatibilizer. The compounding was done in a two roll mill. Different concentrations of RHA (0, 0.5, 1, 1.5, 2 and 2.5phr) and compatibilizer (5, 10, 15 and 20phr) were used. Characterization of composite was done by Fourier Transform infrared spectroscopy (FTIR). Cure time and scorch time were increased in both uncompatibilized and compatibilized composites. The compatibilized NBR-RHA composites have a tensile strength about 76% higher than that of virgin NBR. The elongation-at-break is also higher for the compatibilized composite. Tear strength and hardnes were also increased in compatibilized composites compared to uncompatibilized composites. All these results prove that RHA is a valuable reinforcing material for NBR and the environmental pollution arising from RHA can be eliminated in a profitable way by this technique.

Introduction

Composite materials are well known to mankind since pre-historic times and currently used for many applications ranging from house hold appliances to aeronautics [1]. Polymer composites offer unique flexibility in designing and other characteristics such as ease of manufacturing, high specific strength, stiffness, corrosion resistance, durability, adaptability and cost effectiveness have for a long time attracted the attention of engineers, material scientists and technologists [2]. The composites performance mainly depends on the reinforcing effect of the filler present in it. In the case of rubbers, reinforcement is more pronounced with noncrystallising synthetic rubbers like NBR and SBR compared to NR which undergoes crystallization on stretching [3]. Fillers should have minimum effect upon the rate of rubber vulcanization and should not adversely affect the aging characteristics of the rubber compound [4].

In practical applications, elastomers have been reinforced with mineral fillers such as silica or carbon black to improve their physical and mechanical properties. The extent of property improvement depends on several factors like size of the filler particles, their aspect ratio and the strength of the interactions between the filler and the matrix polymer. The filler–matrix interactions are especially crucial to improve the filler dispersion as well as the adhesion of the matrix polymer to the filler surface. These, in turn, increase the effective filler volume and also promote the stress transfer from the matrix to the filler when the material is subjected to mechanical deformation [5, 6].

The performance of natural byproducts and industrial wastes (natural fibres, saw dust, rice husk ash, bagasse ash, fly ash etc.) are often comparable to commercial fillers such as carbon black, precipitated silica or talc [7] in the role of reinforcing or functional ingredients. RHA is an industrial waste obtained on burning rice husk. Rice husk is an agro-waste material. RHA contains 55-97% silica with trace amounts of various elements such as potassium, sodium, magnesium and calcium. The major impurity is a form of trapped carbon. RHA takes up a combination of crystalline and amorphous forms depending upon the original combustion conditions. RHA is more reactive in the amorphous state. It is thermally stable and a tough material possessing high specific properties. It is also a low cost, readily available material. RHA has a hydrophilic nature [8].

One way to improve the final performance of the blend is by using interfacial modifiers or compatibilizing agents acting from the matrix side [9]. In general, these interfacial modifiers have created great interest in materials based on polymers such as polymer blends or polyblends, because these agents are able to enhance the interaction level, dispersion, adhesion and compatibility between the material components. Such interactions take place through the interphase [10].

In our study, NBR is used as matrix and RHA, as filler. To improve interfacial adhesion between NBR and RHA, maleic anhydride grafted NBR (MA-g-NBR) has been used as compatibilizer.

Experimental

Materials and Method

Acrylo nitrile butadiene rubber, Grade-KNB 35L. Zinc oxide (activator) and stearic acid (co- activator) were supplied by M/s Meta Zinc Ltd., Mumbai, and by Godrej Soaps Pvt. Ltd., Mumbai, respectively.Cyclohexyl benzothiazole sulphenamide (CBS) and tetramethylthiuram disulphide (TMTD) (accelerator) used in the present study were obtained from Polyolefin Industries, Mumbai. Sulphur (Crosslinking agent) was supplied by Standard Chemicals Co. Pvt. Ltd., Chennai. Maleic anhydride (MA) was obtained from Sdfine-chem Ltd., Mumbai, and dicumyl peroxide (DCP) was supplied by Merck, India. Derivative of trimethyl quinoline (antioxidant) (TQ) and methyl ethyl ketones (MEK) were of reagent grade and used as such.

Preparation of RHA

Rice husk was collected from rice mills. It was washed clean with distilled water to remove grit and dried in an oven at a temperature of 100ºC for 2h. It was burnt at 550ºC in a muffle furnace for 6h. This minimum incineration time was found to give concordant values of ash content at each temperature.

Preparation of compatibilizer (MA-g- NBR)

Maleated NBR was prepared by grafting reaction of NBR with maleic anhydride (MA) in the presence of dicumyl peroxide (DCP) by melt mixing. NBR was first cut into small pieces. It was then dried in a vacuum oven at 40°C for 24 h. The internal mixer (Brabender Plasticorder) was then used to masticate it at 100°C with a rotor speed of 60 rpm for 2 min. 1g of maleic anhydride and 0.125g of DCP were then added into the internal mixer. The mixing was continued for 10 min at 100°C. The blend was then dumped onto the two-roll mill, sheeted out and cut into small pieces.

Preparation of NBR- RHA composites

Compounding of NBR was done on a two roll mill as per the formulation given in Table 5A.4.1. NBR was masticated for 2 minutes on a two roll mill ((16×33cm^2) and the ingredients were added in the order shown in Table 5A.4.1. Varying concentrations of filler and compatibilizer were added (in parts per hundred rubbers, phr) to it. The samples were then cured at 160^{0}C in an electrically heated hydraulic press to their respective optimum cure time at a pressure of 200 Kg/cm^2 in a specially designed mould to get sample sheets having thickness of 1.5 mm approximately.

Cure characteristics

Cure characteristics of the mixes were determined at 160°C, as per ASTM standard D 2084-07 [16]. The cure times (T_{90}), scorch time (t_2), minimum torque (ML) and maximum torque (MH) were obtained from the rheograph Cure rate index (CRI), a measure of the speed with which the cure reaction is taking place is calculated using the equation:

$CRI= 100/ (t_{90}-t_2)$ …………….. (1)

Fourier transforms infrared spectroscopy (FTIR)

FTIR spectra of representative samples were recorded on a Thermo Nicolet FTIR Spectrometer Model Avatar 370. Samples in the form of thin films, <1 mm thickness, were employed.

Mechanical properties

The tensile tests were done on dumb-bell shaped specimens punched out from vulcanized sheets of 2 mm thickness. The measurements were carried out on a Universal Testing Machine (10 KN), Shimadzu Autograph AG-I series with a grip separation of 40 mm as per ASTM D 412-06 [11]. The experiments were conducted at room temperature. These tests provided the tensile strength, elongation-at-break and modulus values of the NBR RHA composites. Tear strength was determined by ASTM D 624-00(2007) [12]. The testing speed for tensile and tear properties was 500 mm/min.

Hardness

The hardness (Shore A) of the moulded samples was determined using Bareiss Digital hardness tester in accordance with ASTM D 2240-03 [13]. The tests were performed on unstressed samples of 30 mm diameter and 6 mm thickness.

Results and discussion

Table .1 Formulations used in the preparation of NBR-RHA composites

Ingredients	Weight (phr)
NBR	100
S	1.5
ZnO	4.5
Stearic acid	2.0
RHA	Varing concentration (0.5, 1, 1.5, 2, 2.5)
Compatibilizer (MA-g-NBR)	5, 10, 15, 20
HS	1
CBS	1
TMTD	0.25

FTIR of RHA and compatibilzed NBR-RHA composites

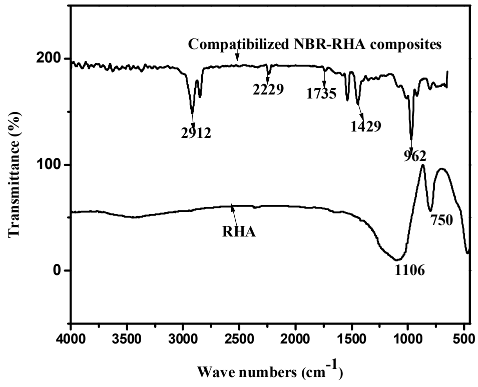

Fig .1 FTIR of RHA and compatibilized NBR- RHA composites

Fig .1 shows the FTIR of RHA and compatibilized NBR-RHA composites. The FTIR spectrum of RHA shows a peak at 1106cm^{-1} corresponding to Si-O-Si the stretching vibration. Another peak at 750cm^{-1} represents the vibration frequency of Al_2O_3 [14]. The spectrum of the compatibilized NBR-RHA composite shows peaks at 2912cm^{-1}, 1429cm^{-1} and 962cm^{-1} corresponding to the olefinic C-H stretching frequency, the CH_2 blending vibration frequency and C-H out-of-plane blending frequency of NBR structure respectively. The peak at 2229cm^{-1} shows the vibration frequency of CN group of the NBR structure. In this spectrum, the absence of peak at 1680-1620 cm^{-1}for C=C of maleic anhydride structure can be attributed to the formation of C-C radical by the grafting of maleic anhydride to NBR [15]. The peak at 1735 is assignable to symmetric stretching of C=O group in ester moieties. The C=O group present in the anhydride ring will show absorbance at a different wave number 1830 cm^{-1} [16] which is not noticeable in the spectrum. This indicates that the functional groups of MA-g-NBR react with the hydroxyl groups of RHA leading to covalent bonding and esterification reactions [16].

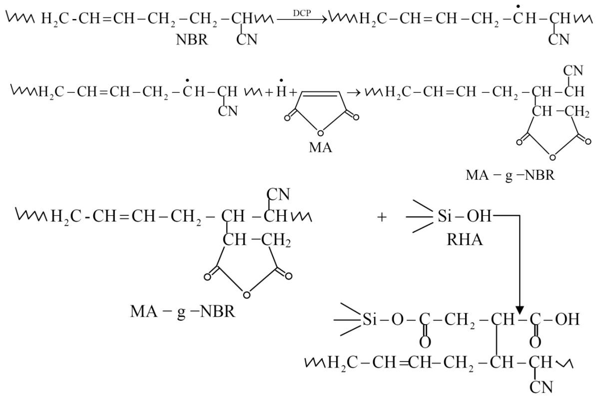

Fig.2 Reaction between MA-g-NBR and silanol group of RHA

Determination of cure characteristics

Cure characteristics of NBR/ RHA and compatibilized NBR/ RHA composites expressed in terms of optimum cure time (T_{90}), scorch time (t_2), maximum and minimum torque values and cure rate index values are given in Table.3 and 4 respectively.

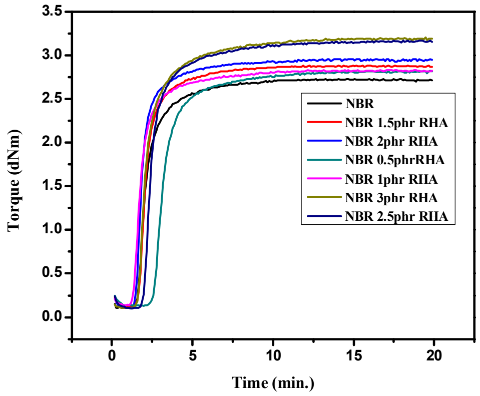

Fig.2 Cure curves of NBR -RHA uncompatibilized composites

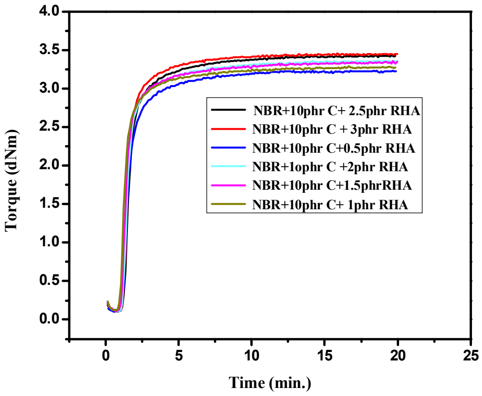

Fig.3 Cure curves of NBR/ RHA compatibilized composites

Table .3 Cure characteristics of NBR-RHA composites

Filler content(phr)	T_{90}	t_2	Minimum Torque (dNm)	Maximum Torque (dNm)	Cure rate index (CRI)
0	3.51	1.30	0.108	2.40	45.2488
0.5	3.55	1.29	0.150	2.484	44.2477
1	3.58	1.30	0.155	2.59	43.8596
1.5	3.68	1.31	0.158	2.72	42.1941
2	3.76	1.32	0.160	2.75	40.9836
2.5	3.80	1.34	0.163	2.8	40.65040
3	3.90	1.35	0.168	2.9	39.2156

Table .4 Cure characteristics of NBR-RHA compatibilized composites

Filler content (phr) at constant 10% C (MA-g-NBR) loading	T_{90}	t_2	Minimum Torque (dNm)	Maximum Torque (dNm)	Cure rate index (CRI)
0.5	3.59	1.31	1.01	2.84	43.859
1	3.67	1.37	1.04	2.90	43.478
1.5	3.76	1.40	1.15	2.95	42.3728
2	3.98	1.60	1.25	2.98	42.0168
2.5	4.20	1.65	1.28	3.08	39.2156
3	4.30	1.69	1.32	3.11	38.3141

Table .3 and 4 show the values of optimum cure time (T_{90}), scorch time (t_2) and minimum and maximum torque values of uncompatibilized NBR - RHA and compatibilized NBR- RHA composites. Cure time (T_{90}) increases with increasing filler loading in both uncompatibilized and compatibilized NBR-RHA composites. This is probably due to the fine particle sized rice husk ash, with polar groups (e-g., -OH) attached to its surface, adsorbing the accelerators, thereby slowing down the vulcanization process [17]. In compatibilized composites, the increase in the cure time of the compatibilized composites may be attributed to the cure retardancy effect of maleic anhydride .The reactions between some maleic anhydride groups of the MA-g-NBR with the accelerator may cause a lengthening of the optimum cure time. On the other hand, these reactions increase interfacial bonding between NBR and RHA in the presence of MA-g-NBR. Scorch time (t_2) also increases with increasing filler loading in both composites. The increase in minimum and maximum torque values with an increase in RHA loading is due to the increased stiffness and hardness of the nitrile rubber composites. The presence of the filler in the rubber matrix reduces the mobility of the rubber's macromolecular chains and hence the maximum and minimum torque values will be higher. The decreased CRI values for the composites compared to pure NBR also suggest a deceleration of the crosslinking reaction [18].

Mechanical properties of NBR- RHA composites

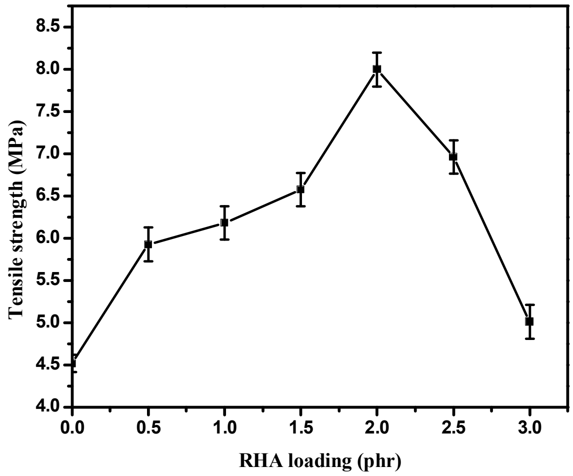

Fig.4 Tensile strength verses RHA loading in NBR uncompatibilized composites.

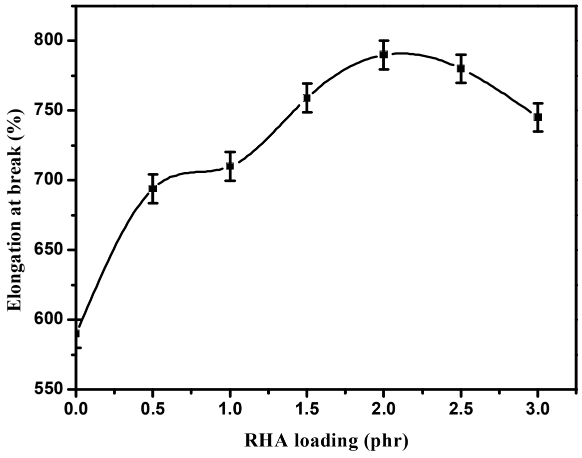

Fig.5 Elongation at break verses RHA loading in NBR uncompatibilized composites

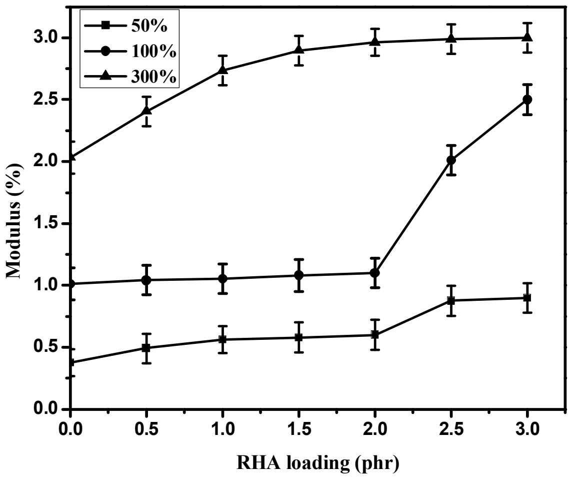

Fig.6 Modulus at elongation 300% verses RHA loading in NBR uncompatibilized composites

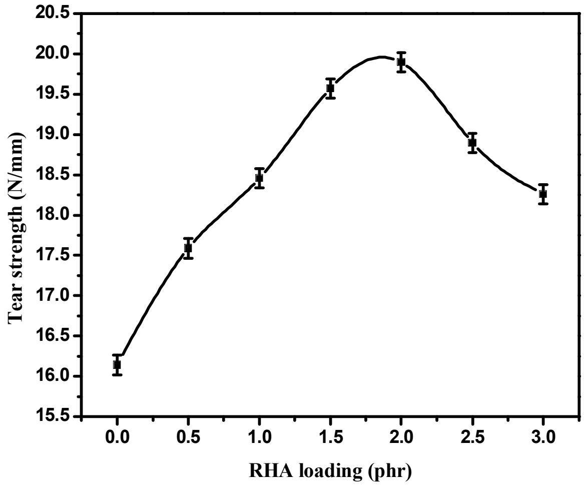

Fig. 7 Tear strength verses RHA loading in uncompatibilized composites

Fig. 4-7 shows the tensile strength, elongation at break, modulus and tear strength of uncompatibilized NBR composites in the presence of RHA loading. Tensile strength shows increase up to 2 phr filler loading and then decreases. Filler agglomeration at higher filler loading leads to lowering of tensile strength of the composites. Addition of RHA into NBR improves stiffness of the composites and hence modulus increases for all three different percentages of elongation studied. As filler particles are introduced into the rubber, the elasticity of the rubber chains is reduced resulting in more rigid vulcanizates. This is also reflected in the decrease in elongation at break. Addition of RHA fillers to rubber increases tear strength up to 2 phr after which it decreases. Tear strength is affected by the particle size and surface area of the filler particles. For this reason, tear strength decreases at higher filler loadings when the dispersion is poor[19].

Optimisation of compatibilizer content

In the preparation of compatibilized NBR/RHA vulcanisates, varying concentrations of (5, 10, 15, 20phr) compatibilizer were added to a constant concentration (2phr) of RHA during compounding. After that, these blends were subjected to mechanical testing. **Fig.8** shows the tensile strength NBR matrix in the presence of compatibilizer. Tensile strength showed a tendency to increase up to 10phr of compatibilizer and then decrease.

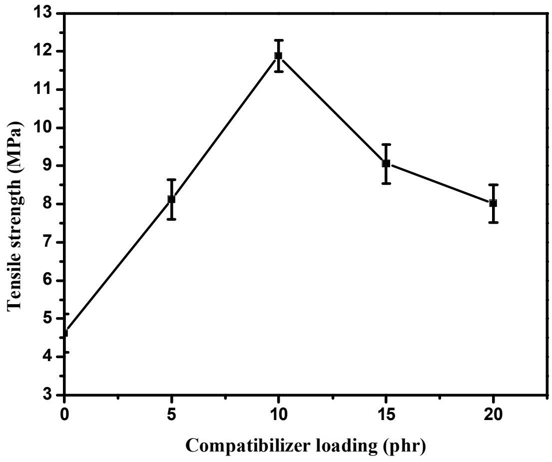

Fig.8 Tensile strength verses compatibilizer loading

Mechanical properties of compatibilized composites

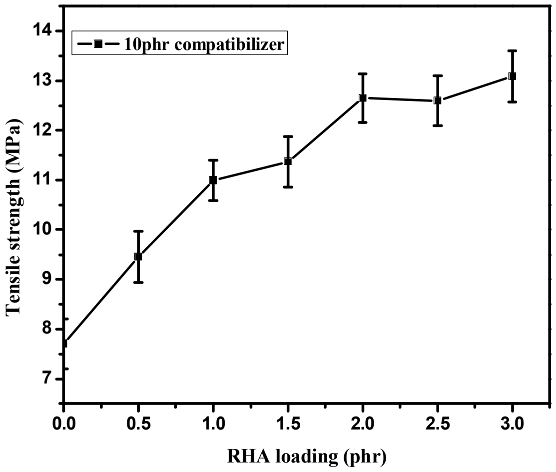

Fig.9 Tensile strength of NBR –RHA compatibilized composites

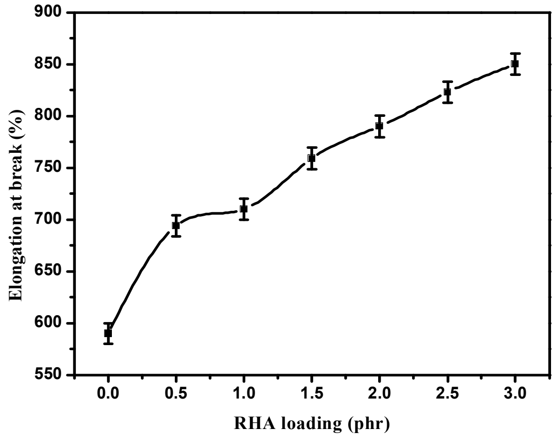

Fig.10 Elongation at break of NBR-RHA compatibilized composites

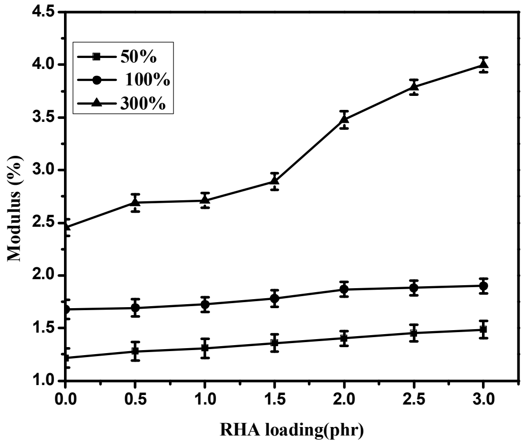

Fig.11 Modulus of NBR -RHA compatibilized composites

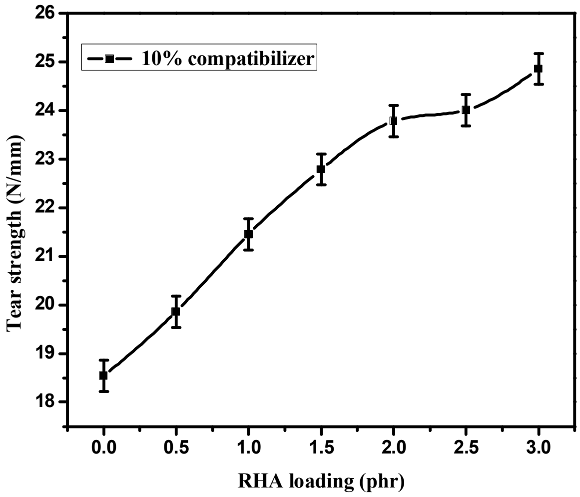

Fig. 12 Tear strength of compatibilized NBR-RHA composites

Fig. 9-12 shows the effect of RHA content on the tensile strength, elongation at break and modulus respectively of compatibilized NBR/RHA composites. The mechanical properties of the composites in the presence of the compatibilizer are superior. The use of the compatibilizer has proven to be effective in enhancing the dispersion, adhesion and compatibility of the filler with NBR matrix. The tensile strength of the compatibilized NBR-RHA composite also shows an increasing tendency with increasing filler loading. The breaking elongation of the composite also shows the same trend. When the composites are under external stress, the filler helps to distribute the stress evenly and delay the rupture of the material. The modulus of the composites increases with increasing filler loading. The interfacial adhesion is increased by the presence of the compatibilizer and the high surface area of the filler gives rise to increased modulus and strength.

Hardness

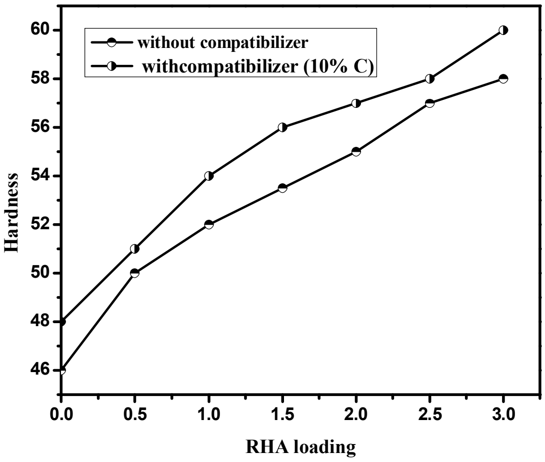

Fig .13 Hardness of the compatibilized and uncompatibilized NBR-RHA composites.

Fig.13 shows that hardness increases with increasing filler loading in both compatibilized and uncompatibilized NBR-RHA composites. Due to the presence of filler particles in the rubber matrix, the elasticity of the rubber chain is reduced, resulting in more rigid vulcanizates. RHA is a hard and stiff inorganic material in particulate form[20].

Conclusion

Addition of RHA into NBR matrix increases cure time and scorch time of the both combatibilized and uncombatibilized composites. Addition of 2phr RHA increases tensile strength and tear strength by 73% and 23% respectively over that of gum NBR. In the presence of 10phr of MA-g-NBR, compatibilized composites show 76% and 32% improvement in tensile strength and tear strength. Elongation at break, modulus and hardness show an increasing trend in compatibilized NBR-RHA composites. The results prove that a pollutant material like RHA can be used advantageously to reinforce NBR.

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DSC STUDY OF LOW DENSITY POLYETHYLENE MODIFIED BY CONDUCTING NATURAL RUBBER NANOPARTICLES

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Abstract

Low-density poly ethylene with varying amount of conducting natural rubber composites are prepared by melt mixing technique. The outstanding performance of the composites confirmed using DSC analysis. It is revealed that the reinforcer CNR nanoparticles can improve the thermal properties of the composites. It has been bring into being that the transition temperature of the composite is varied with the increase of the filler. Thermal degradation behaviour of the composite is also strongly influenced by the presence of CNR nanoparticles.

Keywords: *Elastomer, Nano composite.*

1. Introduction

Polyethylene, with one third of the world plastic production, is one of the most versatile polymers. However, its use is restricted because of several drawbacks, including lower strength poor heat resistance etc. [1-2]. Nano composites have played a major role in material science over last decade. The application of nanometer fillers to polymer materials is a promising channel for property modification. It is reported that nano-fillers have improved polymer performance remarkably because of their high specific surface area compared to conventional fibers or particles [3]. The DSC data allows to obtain quantitative information about the phase transitions. It can also be used as an efficient tool for appraise the compatibility in polymer blends. Outstanding reports on the thermal stability studies on polymers and their composites exist in literature [4-11].

The aim of this study is to investigate the thermal properties of conducting natural rubber nanoparticles filled low density polyethylene composites. The influence of the filler in the transition temperatures and thermal stability of the polymer composite is studied in detail.

2 Experimental

2.1. Composite and specimen preparation

The LDPE granules obtained from Reliance industries Ltd, Harzaria, Gujrat, India are made into ultrafine powder by chemical route method. The filler used in this study is Semi conducting Natural Rubber nanoparticles (CNR nanoparticles). The CNR nanoparticles are prepared by doping the natural rubber solution with antimony pentachloride, a lewis acid using reflux boiling technique. The precipitate obtained is filtered out and dried under vacuum. In the opening part of the study LDPE-based composites are prepared by methodical mixing of the CNR nano particles with the ultra fine LDPE powder. The samples are molded into thin films using a micro injection molding machine (venture technology) by melt mixing. The analysis of all characterization studies of virgin LDPE and its composites are carried out according to the ASTM standards. Five specimens are measured for each case and the average values are taken. Samples are prepared by varying the amount of CNR nanoparticles in LDPE matrix i.e. from 10 phr to 50 phr filler loading.

2.2. Differential scanning Calorimetry (DSC)

The thermal measurements of each sample are performed with a Mettler-Toledo 822e instrument. Samples of about 7 mg are heated under a nitrogen atmosphere from -140^{0}C (133 K) to 175^{0}C (448 K) at a scanning rate of 10^{0}C /min. The sample mass is determined by means of a Sartorius balance with an accuracy of 0.01 mg.

3. Result and Discussion

Differential Scanning Calorimetry

From these DSC curves the thermal properties of specimens are analyzed. The DSC results in terms of glass transition temperature (Tg), is illustrated below. At first the samples are heated from room temperature to 220 ^{0}C and kept for 1 minute to eliminate their thermal history, and then cooled to -140^{0}C and immediately reheated to 175^{0}C.

Glass Transition Behaviour

The different modes of molecular motions within polymer composites will get frozen by the process of gradual cooling at ambient conditions. These frozen modes of molecular motion are affiliated to specific relaxation process, i.e. transition from melt to leathery and leathery to glass stage [12]. Fig. 1 shows the DSC curves obtained during the heating of virgin LDPE and it's composite with CNR nanoparticles. For the glass transition studied the first set of peaks in the DSC thermogram is considered. The virgin LDPE shows a transition at 52^{0}C which is due to the partially ordered interface between the lamellae and the amorphous region and can be defined as the glass transition of the sterically hindered interfacial region. This transition is known as α transition which is associated with molecular relaxation [13]. Usually LDPE shows γ transition in the range -150^{0}C to -100^{0}C and is associated with the crankshaft motion of the poly methylene groups of the main-chain backbone. However, the increased presence of filler in LDPE matrix shows considerable variations in Tg towards the higher temperature region i.e. 54^{0}C. This indicates the effect of CNR nanoparticles in the mobility of molecules in the matrix.

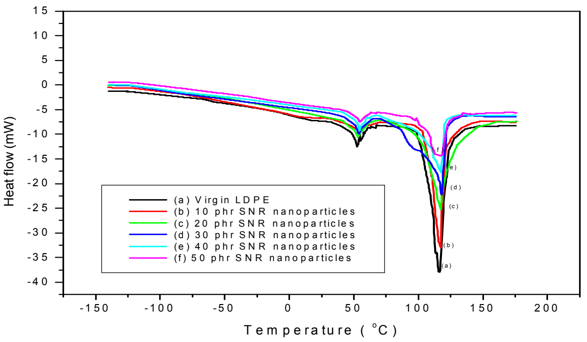

Fig. DSC thermogram of LDPE / CNR nanoparticles composite systems

Table. The glass transition temperatures of virgin LDPE and its composites

Sample Composition	Peak temperature (Tg ,^{0}C)	Heat of fusion(ΔH,J/g)
Virgin LDPE	51.7	98.26
10 phr CNR nanoparticles	52.48	96.33
20 phr CNR nanoparticles	53.10	99.36
30 phr CNR nanoparticles	53.59	103.12
40 phr CNR nanoparticles	53.59	98.24
50 phr CNR nanoparticles	54.2	94.15

4. Conclusion

This work clearly shows that conducting rubber nanoparticles can be used as an efficient reinforcer in thermoplastic LDPE matrix. The excellent properties of the composites confirmed using DSC shown that the reinforcer CNR nanoparticles can improve the thermal properties of the composites. It has been found that the transition temperature of the composite is found to be varied with the increase of the filler. Thermal degradation behaviour of the composite is also strongly affected by the presence of CNR nanoparticles.

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OPTICAL PROPERTIES OF ZnS: Mn2$^+$ NANOCRYSTALS SYNTHESIZED BY CHEMICAL PRECIPITATION METHOD

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Abstract

In this work the preparation, the crystal structure and the photoluminescence studies of pure and manganese doped ZnS nanophosphors are reported. Undoped and Mn doped ZnS are synthesised by chemical precipitation method at a temperature of 70°C. The obtained samples are characterised by X ray diffraction (XRD) spectrum , diffused reflectance spectrum and photoluminescence spectrum. The XRD analysis confirms the formation of cubic phase of undoped as well as Mn^{2+} doped ZnS nanoparticles with crystallite sizes 2.7nm and 2.8nm respectively. The room temperature PL spectrum of the undoped ZnS show a broad band with peak at 425 nm(λex=320nm) which could be ascribed to interstitial zinc. The PL spectrum of the doped sample shows two broad emission bands including a blue emission centred at 435 nm and an orange emission at 590 nm which are the characteristic emission peaks of sulphur vacancy and Mn^{2+} ions.

Keywords: *Nanophosphor, Semiconductors, ZnS, Photoluminescence.*

Introduction

Semiconductor nanomaterials have attracted widespread attention because of their special electronic and optical properties for many versatile applications ranging from DNA markers to light emitting displays [1-4].Among the semiconductors nanoparticles, Zinc Sulphide is an important II –VI semiconductors having a wide optical band gap rendering it a very attractive material especially in nanocrystaline form. Zinc sulphide with addition of suitable activators is used as phosphor in many applications. The electronic and optical properties of nano sized ZnS are strongly influenced by the doping of transition and rare earth metals. Besides this, the host material can be doped without changing this crystallography of the host lattice. White-light emission (WLE) from semiconductor nanostructures is presently a research area of intense interest, especially where the primary objective is to replace conventional light sources in order to minimize energy costs and therefore global energy consumption for lighting [5-12]. However, when ZnS phosphor simply doped with Mn^{2+} lead to undesirable changes in the chromaticity coordinates and photometric performance to generate white light. This paper deals with the synthesis, structural characterisation and PL studies of pure and white light emitting Mn^{2+} doped ZnS nanoparticles.

Experimental

Undoped and doped samples of nano crystalline ZnS has been prepared by using zinc acetate $Zn(CH_3COO)_2$, $MnCl_2$ and Na_2S in a aqueous solution. The synthesis is carried out at constant temperature of 70^0C by chemical precipitation method. To determine crystallite size and phase of the samples x-ray diffraction spectra were obtained with Bruker AXS D8 Advance x-ray diffractometer with Cu ($1.5405A^0$) as x-ray source. The diffused reflectance spectra were recorded with Varian Cary 5000 UV-VIS-NIR spectrophotometer. The photoluminescence emission spectra were recorded at room temperature using Horiba Fluromax 4C spectro fluorometer.

Results & Discussions

The XRD pattern of pure and Mn^{2+} doped ZnS taken at room temperature is shown in Fig (1).

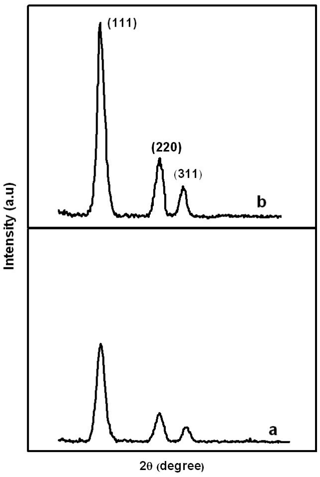

Fig.1:- XRD pattern of (a) Undoped (b) Doped ZnS

XRD pattern of the samples exhibit three consecutive peaks in the range of $15^0 - 80^0$, which are the characteristic peaks of the mineral sphalerite having cubic crystal structure of ZnS as per JCPDS file no: 80-0020. The XRD peaks are fairly broad suggesting the nanostructure of undoped and Mn^{2+} doped ZnS samples and the three peaks corresponds to (111), (220) and (311) planes. Hence XRD results revealed that the presence of dopant has not transferred the basic structure of the host ZnS. However, the increased intensity in the XRD peaks for doped sample indicates better crystalline quality [13-14]. The crystallite sizes are determined using the Scherrr's equation,

$$D = 0.9\lambda/\beta \, Cos\, \theta \qquad (1)$$

where D is the crystalline size, λ is the wavelength of the x-ray radiation, β is the full width at half maximum of the peaks and θ is the angle of diffraction. The estimated size for the pure and doped samples is 2.7 and 2.8 nm respectively. Using the relation $d_{hkl} = a/(h^2+k^2+l^2)^{1/2}$ the lattice parameters were obtained as a=b=c=5.337 A^0 & 5.327 A^0 for ZnS and ZnS : Mn^{2+}. . The strain and grain size of the samples were calculated by Williamson–Hall (W–H) method. According to this method, the FWHM (β) may be expressed as linear combination of lattice strain (ε) and particle size (D) by the equation

$$\beta \cos \theta = k\lambda/D + \varepsilon \sin\theta \qquad (3)$$

Fig (2) shows the plot of sin θ versus β cos θ which is a straight line with slope ε and intercept kλ/D. Putting the values of k and λ the crystalline size of ZnS and Zns:Mn^{2+} nanoparticles are calculated as 2.62 nm and 3.04nm(at zero strain)which are comparable to the calculated values by Scherer's equation. The strain of as prepared ZnS and ZnS:Mn^{2+} nanoparticles is obtained from the slope and found to be 0.0086, & 0.086

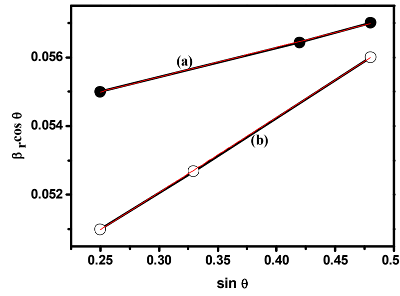

Fig.3:- W-H plot of ZnS and ZnS: Mn^{2+} nanoparticles

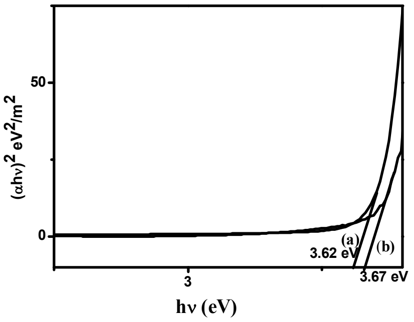

Fig.3:- hν versus $(\alpha h\nu)^2$ graph of (a) doped (b) undoped ZnS

The band gaps of the samples are determined from the diffused reflectance spectrum. The absorbance was calculated from the reflectance using Kubelka-Munk equation [15,16]. The band gaps are 3.67 eV and 3.62 eV for the ZnS and ZnS:Mn samples which are estimated from the plot of $\{(k/s)\ h\nu\}^2$ vs. hν where k and s denote absorption and scattering coefficients. There is a red shift in the band gap with doping which is due to the increase in particle size.

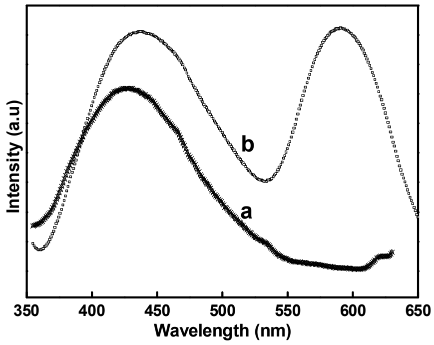

Fig.4:- PL spectra of (a) undoped and (b) doped ZnS

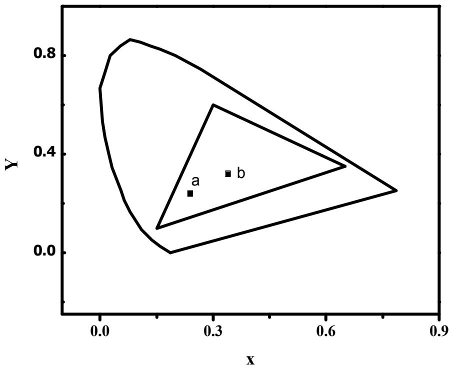

Fig.5:- CIE Chromaticity Diagram

Room temperature PL emission of undoped and doped ZnS nanophosphors is shown in figure 4. The PL emission spectrum of undoped ZnS consist of blue emission at 425 nm(λex=340nm) which could be ascribed to interstitial zinc. For doped ZnS nanoparticles Mn ions substitute for Zn^{2+} ions and hence luminescent centres of Mn^{2+} ions are formed in ZnS host lattice. The photoluminescence emission spectrum (λex= 340 nm) of Mn^{2+} doped ZnS nano particles have two broad bands with one peak at 435 nm due to sulphur vacancy of the host and the other peak at 590 nm corresponding to $^4T_1$- $^6A_1$ transition within 3d shell of manganese.

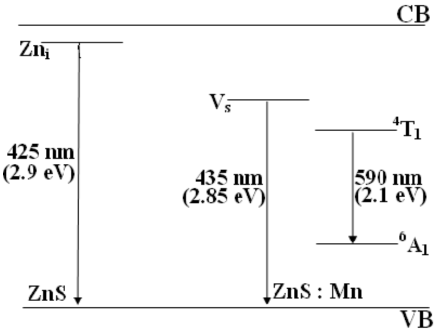

Fig.5:- Schematic energy level diagram for ZnS & ZnS : Mn

Based on the PL results observed, the schematic energy level diagram of ZnS:Mn nanoparticles can be depicted as shown in Fig.5.

This figure explains the emission mechanism of ZnS:Mn nanoparticles and illustrates the above assignment.To evaluate the effectiveness of ZnS:Mn nanoparticles to be used in light emitting devices, CIE (Commission International d'Eclairage 1931) chromaticity coordinates are calculated. For ZnS the emission color is blue with CIE coordinates are (0.24, 0.24) but for Mn^{2+} doped ZnS the emission is white with CIE co-ordinates (0.34, 0.32) in close agreement with achromatic white(x=0.33, y=0.33). They are represented by the points (a) for ZnS and (b) ZnS: Mn^{2+} in the chromaticity diagram.

Conclusion

White emitting ZnS:Mn^{2+} nanoparticles were successfully prepared by the colloidal precipitation method without the aid of any capping agent. The XRD studies show the phase singularity of pure and Mn doped ZnS particles having zinc-blende structure. The estimated size of the pure and Mn doped ZnS nanophosphors were found to be 2.7 and 2.8 nm. In PhotoLuminescence (PL) spectra of ZnS: Mn^{2+} nano particles a sulfur–vacancy related emission at 435 nm and yellow emission at 590 nm associated with $^4T_1$- $^6A_1$ transition of $Mn^{2+}$are observed.

Acknowledgement

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SYNTHESIS AND CHARACTERIZATION OF NANO ZINC ALUMINATE SPINEL

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1. Introduction

One important aluminium spinel is zinc aluminate. Zinc aluminate possesses a unique combination of desirable properties such as high thermal stability,high mechanical resistance, low temperature sinterability, better diffusion and ductility and low surface acidity(1). Due to these properties it was used as high temperature materials, catalysts and optical coatings. It was widely used in many catalytic reactions, such as dehydration and hydrogenation. Zinc aluminate is one of the most important functional oxides with a direct, wide band gap (3.37eV) and large excitation binding energy (60meV), exihibiting many interesting properties including transparent conductivity and piezoelectricity(2,3).

Zinc aluminate is also a candidate material for optical coating applications and is currently employed in catalysis for applications such as cracking, saturated alcohol dehydration, methanol and other alcohol synthesis and as a catalytic support. The catalytic functionality of sub-micron particles is strongly affected by microstructure with different facets showing differences in catalytic activity (4, 5).

The specific objectives of the study are: synthesis of nano zinc aluminate spinel by sol gel method and structural characterization of zinc aluminate using XRD, FTIR and SEM.

2. Experimental techniques

2.1 Synthesis of nano zinc aluminate

Zinc nitrate hydrate and aluminium nitrate hydrate taken in 1:2 molar ratio were dissolved in propylene glycol, by adding propylene glycol in small quantities, to form a saturated solution. The solution was heated at 70°C with constant stirring on a magnetic stirrer for several hours until gel formation had taken place following a chemical reaction. The gel was heated at a temperature of 180°C placed on a heating mantle until combustion had taken place forming slightly rose coloured fine powder. This powder was analysed using X-ray diffractometry and it was found that the phase of zinc aluminate was not yet formed. This powder was calcinated at 600°C and had been analysed using XRD. Zinc aluminate nanocrystallites thus formed were characterized using X-ray diffractometry (XRD) and Fourier transform infrared spectroscopy (FTIR).

Structural characterizations

The X-ray diffractograms of the powder samples were recorded on a diffractometer, Rigaku D-Max using Cu Kα (λ=1.5418 A^o). From the recorded diffractogram, the crystallite size can be found out by using Debye- scherrer formula,

$$P = \frac{0.9\lambda}{\beta\cos\theta}$$

Where

P - crystallite size

λ - wavelength(1.5418 A^0),

β - Full width at half maximum (in radians)

θ - Diffraction angle

2.2 Fourier transform infrared spectroscopy

Fourier transform infrared spectra are generated by the absorption of electromagnetic radiation in the frequency range 400 to 4000 cm-1. Different functional groups and structural features in the molecule absorb at characteristic frequencies. The frequency and intensity of absorption are the indication of the bond strength and structural geometry of the molecule. FTIR spectra were taken using spectrometer model Bruker Tensor 27.

2.3 Scanning electron microscope (SEM).

The scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate a variety of signals at the surface of solid specimens. The signals that derive from electronsample interactions reveal information about the sample including external morphology (texture), chemical composition, and crystalline structure and orientation of materials making up the sample. In most applications, data are collected over a selected area of the surface of the sample, and a 2-dimensional image is generated that displays spatial variations in these properties.

3. Results and discussions

3.1 X-Ray Diffraction (XRD)

X-ray diffractogram of synthesized zinc aluminate calcined at 180^{o}C and 700^{o}C are shown in the figure 1 and 2 respectively.

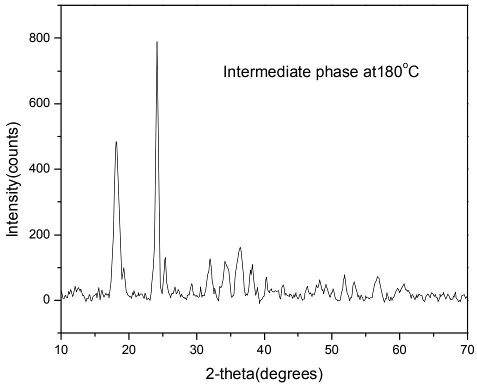

Figure 1 XRD of Zinc aluminate calcined at 180°C

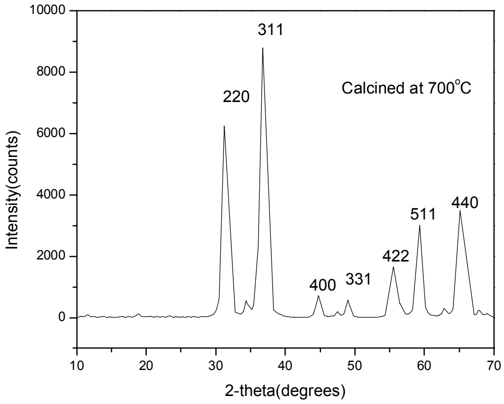

Figure 2 XRD of Zinc aluminate calcined at 700°C

Figure 1 is the XRD diagram of the intermediate phase formed at 180◦C.This compound seems to be a mixture of aluminium hydroxides and zinc hydroxide with a non cubical structure. Figure 2 shows the XRD diagrams of the compound calcined at 700◦C. It can be seen that the phase formation is complete at 700◦C. All peaks are well defined pointing to the high crystalline nature of the sample. The XRD pattern was compared with JCPDS files (file no. 74-1138) and all the diffraction peaks are in good match with the reported result and the peaks were indexed with the help of these reported patterns. The average particle size was found to be 15 nm.

3.2 FTIR spectroscopy

The FTIR spectrum of zinc aluminate calcined at 180^{o}C is presented in figure 3. An intermediate phase is formed at 180◦C. A broad absorption band centred at 3406 cm−1 is visible and this corresponds to OH group. The bands at 1626 cm−1 and 1367 cm−1 are due to the formation of metal hydroxides as an intermediate compound before the formation of the zinc aluminate spinel.

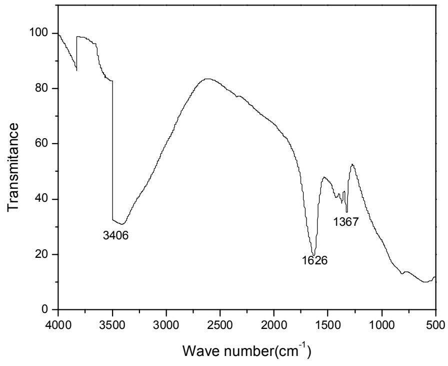

Figure 3 FTIR spectrum of zinc aluminate calcined at 180◦C

3.3 Scanning Electron Microscopy (SEM)

SEM micrograph of nano zinc aluminate is shown in the figure 4. Figure shows that the zinc aluminate particles are agglomerated to a large extent.

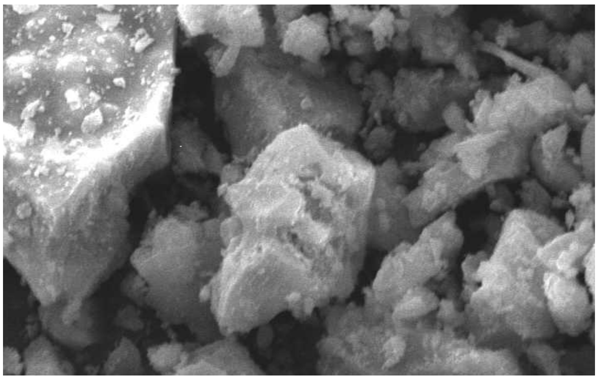

Figure 4 SEM image of Zinc aluminate

4. Conclusion

Nano zinc aluminate was prepared by sol gel method. The particle size was evaluated from the XRD results using Debye Scherrer equation and the average particle size was found to be 15 nm. SEM micrograph of nano zinc aluminate showed that particles were agglomerated to a large extent.

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MICROPHYTOBENTHOS: THE 'SECRET GARDEN' OF SHALLOW WATER HABITATS

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Tidal mudflats and other shallow water systems may be regarded as an extreme environment, in which microalgae are exposed to strong variations in temperature, irradiance and desiccation (Sundback et al., 1997). In spite of this, these areas can be highly productive, with microphytobenthos contributing up to one-third of the overall productivity of an estuary and shallow water systems.

Microphytobenthos or benthic microalgae are the microscopic, photosynthetic eukaryotic algae that live on the waterbed. They grow in habitats ranging from wave swept beaches to detritus-laden backwater lagoons such as estuaries salt marshes, submerged aquatic vegetation beds, intertidal sand and mud flats, and subtidal illuminated sediments and deep soft substrate areas (MacIntyre et al, 1997).

Microphytobenthos includes representatives of several algal classes, diatoms being the dominant group in sand and mudflats. Cyanobacteria and flagellates can be abundant in less exposed habitats and in tropical sediments, benthic dinoflagellates may be the important ones (Miller et al., 1996). In exposed habitats such as sandy beaches, the microphytobenthos are almost exclusively attached to particles and may be distributed to depths upto 20 cm and more.

Benthic microalgae are always found associated with some kind of substrata. Based on the substratum affinity, phytobenthos can be classified as epilithon, attached to stones and rocks; epipelon, attached to silt or clay; epipsammon, attached to sand; endopelon, inside the sediment; endolithon, inside rock; epiphyton, attached to macrophytes; epizoan, attached to animals and psychropelon refers to the attached microalgae on ice.

Microphytobenthos are, in fact, the dominant flora in the littoral zone and estuaries (Cahoon, 1999). They are recognized as important primary producers in shallow aquatic ecosystems and their biomass and production can equal or exceed those of phytoplankton in these waters. The contribution of the microalgae in the productivity of the benthic environment is very significant providing about one-sixth of the pelagic primary productivity. Global annual benthic microalgal productivity was estimated to be 500 million tonnes of carbon as against approximate pelagic productivity of 3000 million tonnes of carbon (Cahoon and Safi, 2002).

Microphytobenthos besides being the primary producers in the benthic ecosystem have several other ecological significance. These algae can serve as habitats for smaller invertebrates such as chironomids, amphipods and several smaller meiofauna. Benthic microalgal species serve as the food for prawns, other crustaceans and oysters and thus play a significant role in the bioproductivity of benthic environment. On tidal flats benthic macro-organisms meet their nutritional requirements by feeding on benthic microalgae and labile organic matter settling out of the overlying water. Benthic microalgae attached to macrophytes, trap nutrients before they reach water column and returns them to the sediments and serve as chemical modulators in aquatic ecosystems. The conversion of atmospheric nitrogen to ammonia and amino acids by blue green algae and diatoms with endo-symbiotic blue-green algae may increase primary productivity in nitrogen deficient habitats. Surfacial algal covers are food sources for surface deposit feeders and act as interceptors for nutrients that are regenerated in sediments (Mitbavkar and Anil, 2006). A variable proportion of fixed carbon may be secreted by these organisms in the form of high molecular weight polysaccharides. These polysaccharides play a significant role in stabilizing the sediment against erosion by movement of the overlying water.

The adaptations of these microalgae to benthic life include the raphe of the pennate diatoms, mucilage pads and stalks, or the holdfast of several filamentous algae, which facilitate them to attach the substrata. Many species of benthic microalgae can metabolize both autotrophically and heterotrophically(Mundree, et al., 2003). These two different methods of nutrition act as complementary to each other serving as an effective survival mechanism for the microalgae in the benthic environment where light becomes a limiting factor. The distribution of microalgae even beyond the compensation depth indicates their very low requirement of light intensity for growth and survival (Sanilkumar et al., 2009). The photosynthetic pigment present in these facultative heterotrophic microalgae may be considered as a “stand by” on accidental exposure to illumination during their heterotrophic growth and survival in the benthic environment (Underwood and Kromkamp, 1999).

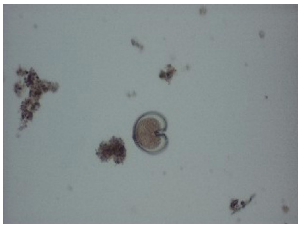
Microphytobenthos, the ‘secret garden’, was very often a neglected component of shallow water ecosystem (MacIntyre et al., 1996, Miller et al., 1996). Advanced studies have shown that it is a vital, dynamically coupled, inevitable under water resource in shallow water habitats (Sanilkumar et al, 2011).

Cocconies sp

Licmophora sp

Navicula sp

Nitzschia sp



Pyrophacus sp

Pleurosigma sp

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FINANCIAL INCLUSION – ROLE OF BANKS

(A STUDY EXECUTED AMONG BANKS IN NORTH PARAVUR TALUK, ERNAKULAM)

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Abstract

Financial Inclusion is the availability of banking services at an affordable cost to the disadvantaged and low income groups. Inorder to attain this mission the NDA Govt. had launched PMJDY (Prime Ministers Jan Dhan Yojana -2014). The scheme was formally launched on 28 August 2014 with a target to provide 'universal access to banking facilities'. The objective of financial inclusion is to extend financial services to the large population of the country and achieve broad based improvement in the living standards of all our people. The banks have encountered various problems while adopting financial inclusion Viz. Improper repayment, the need for additional workforce, more time consumption, heavy work load, high cost and so on. This study mainly targeted two objectives. First to know the measures taken by the banks for financial inclusion, the second is to examine the difficulties involved in the adoption of financial inclusion and also to enhance the extent of financial inclusion. The data required for the study was collected from both primary and secondary sources. The total numbers of samples were 20. The study was conducted among the banks in North Paravur Taluk in Ernakulam District of Kerala. Reserve Bank of India vision for 2020 is to open nearly 600 million new customers' accounts. The banks should encourage the people to access banking services by ways of no frills account, financial inclusion campaign and business correspondent. The government should encourage the banks to adopt financial inclusion by means of financial assistance, advertisement and awareness to actualize the goals of PMJDY – 2014, coined by our new NDA Government. This plan basically aims a bank account for each household and its meaningful operation for uplifting deprived groups in the society.

Keywords: *Financial services, Financial Inclusion, Inclusive Growth.*

Introduction

Quick access to finance by the poor and deprived groups is a prerequisite for poverty alleviation and social cohesion. This has become an integral part of our efforts to promote inclusive growth. In fact, providing access to finance is a form of empowerment of the vulnerable groups. Financial Inclusion denotes delivery of financial services at an affordable cost to the vast sections of the disadvantaged and low-income groups. The various financial services include credit, savings, insurance and payments and remittance facilities.

The objective of financial inclusion is to extend the scope of activities of the organized financial system to include within its ambit people with low incomes. Through graduated credit, the attempt must be to lift the poor from one level to another so that they come out of poverty. Financial inclusion is the availability of banking services at an affordable cost to disadvantaged and low-income groups. In India the basic concept of financial inclusion is having a saving or current account with any bank. In reality it includes loans, insurance services and much more.

The first-ever Index of Financial Inclusion to find out the extent of reach of banking services among 100 countries, India has been ranked 50. Only 34% of Indian individuals have access to or receive banking services. In order to increase this number the Reserve Bank of India had the Government of India take innovative steps. One of the reasons for opening new branches of Regional Rural Banks was to make sure that the banking service is accessible to the poor. With the directive from RBI, our banks are now offering .No- Frill Accounts to low income groups. These accounts either have a low minimum or nil balance with some restriction in transactions. The individual bank has the authority to decide whether the account should have zero or minimum balance. With the combined effort of financial institutions, six million new .No-Frill accounts were opened in the period between March 2006-2007. Banks are now considering Financial Inclusion as a business opportunity in an overall environment that facilitates growth

Review of Literature

An empirical study of Sendhilvelan .M and Karthikeyan .K (2006) revealed to ensure financial inclusion of all segments of the population, in both rural and urban areas banks should give wide publicity to the facility of “no frills” account. Further efforts must be made to move from the concept of anytime, anywhere banking. To anytime, anywhere and to everyone banking.

Usha Thorat (2007) reported that banks are entering into agreements with India post for using post offices as agents for branchless banking. Setting up of financial literacy center and credit counseling on a pilot basis, launching a national literacy campaign, forging linkages with informal sources with suitable safeguards through appropriate legislation, evolving industry wide standards for IT solutions, facilitating low cost remittance products are some of the initiatives currently underway for furthering financial inclusion.

The work of Ghorude .K.N (2009) indicated that attaining the objective of inclusive growth has to necessarily encompass the social, economic and political inclusion. Developing micro entrepreneurship with organizational and community based support is a way of strengthening inclusive growth.

Muthiah Manoharan .P and Krishnaveni Muthiah (2010) found limited access to affordable financial services such as savings, loans, remittance and insurance services to the vast majority of the population in the rural area and unorganized sector is believed to be a constraint to the growth impetus in these sectors. The behavioral pattern shows that many people were not comfortable with formal financial services. The reasons were difficulty in understanding language, various documents and conditions that come with financial services etc.

Financial Inclusion Plan (FIP) and Its Performance Evaluation

The RBI has encouraged banks to adopt a structured and planned approach to Financial Inclusion. The first phase of FI Plan was implemented over 2010-2013. The RBI has used FIP to gauge the performance of banks under their FI initiatives. With the completion of the first phase, a large banking network has been created and a large number of bank accounts have also been opened. It was considered as the major step of RBI for attaining financial inclusion. The below mentioned table shows the core reflections of FIP.

Financial Inclusion Plan – Summary Progress of All Banks in India

Sl No	Particulars	31-3-2010	31-3-2013	31-3-2014	Progress 1-4-2013 to 31-3-2014
1	Banking outlets in villages-Branches	33,378	40,837	46,126	**5,289**
2	Banking outlets in villages-Branchless model	34,316	2,27,617	3,37,678	**1,10,061**
3	Banking outlets in villages-**TOTAL**	67,694	2,68,454	3,83,804	**1,15,350**
4	BSBDA **TOTAL** (No. in million)	73.5	182.1	243.0	**60.9**
5	BSBDA **TOTAL** (Amt. in Rs. Billion)	55.0	182.9	312.3	**129.3**
6	OD Facility availed in BSBDA(No. in million)	0.2	4.0	5.9	**1.9**
7	OD Facility availed in BSBDA(Amt. in billion)	0.1	1.6	16.0	**14.5**
8	Kisan Credit Card (No. in million)	24.3	33.8	39.9	**6.2**
9	Kisan Credit Card (Amt. in Rs billion)	1240.1	2623.0	3684.5	**1061.5**
10	General Credit Card (No. in million)	1.4	3.6	7.4	**3.8**
11	General Credit Card (Amt. in billion)	35.1	76.3	1096.9	**1020.6**

Source – Annual Report of RBI 2014
BSBDA – Basic Savings Bank Deposit Account, OD – Over Draft

Statement of the Problem

Financial inclusion is a policy measure to address the issue of poverty which would ensure avenues for people. It is estimated that globally over two billion people are excluded from access to financial services, of which one third is in India. Access to various financial services enables the poor people to participate in the growth of the economy. Many banks are forced to adopt financial inclusion rather than their own interest. Only few banks are actively involved in financial inclusion to promote economic development. The banks have encountered various problems while adopting financial inclusion Viz. Improper repayment, the need for additional workforce, more time consumption, heavy work load, high cost etc. Hence, many banks are not fostering fully fledged financial inclusion plan to accelerate the growth of the country. This study attempts to address the issues involved in the adoption of the financial inclusion plan and to widespread the financial inclusion.

Scope of the Study

There are various types of banks which operate in our country to meet the financial requirements of different categories of people. On the basis of function, the banks can be classified into five categories Viz. central hbank, commercial bank, development bank, co-operative bank and specialized bank. This study had focused only the commercial and co-operative banks located in North Paravur Taluk in Ernakulam Dt. of Kerala State.

Objectives

The main objectives of this study were:

- ✓ To study the measures taken by the banks for financial inclusion.
- ✓ To analyze the difficulties and obstacles involved in the adoption of financial inclusion.

Methodology

The data required for the study was collected from both primary and secondary sources. The primary data was collected from the banks using a structured questionnaire. The secondary data was collected from the published journals, books and various websites. The samples were selected by administering convenience sampling technique.

The total numbers of samples were 20. The study was conducted among the banks in North Paravur Taluk in Ernakulam Dt. A pilot study was administered before going for data collection. For the pilot study, some necessary changes were made in the questionnaire. The various statistical tools used to analyze the primary data were percentage analysis, mean score analysis.

Analysis

Table. 1: Measures Taken for Financial Inclusion

Sl.No	Services	Yes	No
01	No frills Account	16 **(80%)**	04 **(20%)**
02	Core Banking	17 **(85%)**	03 **(15%)**
03	E Banking	14 **(70%)**	06 **(30%)**
04	Issue of Kissan Credit Card	10 **(50%)**	10 **(50%)**
05	Bio metric ATM	----	20 **(100%)**
06	Bancassurance	14 **(70%)**	06 **(30%)**
07	Micro Finance	17 **(85%)**	03 **(15%)**
08	Ties up with NGOs	14 **(70%)**	06 **(30%)**
09	Advertisement for Finanacial Inclusion	07 **(35%)**	13 **(65%)**
10	Business Correspondent Model	08 **(40%)**	12 **(60%)**
11	Financial Literacy and Counseling Centre (FLCC)	06 **(30%)**	14 **(70%)**

Source – Primary Data

Table 1 depicts out of 20 banks, 80% of the banks have offered no frills account, 70% of banks have offered Bancassurance, and the remaining 30% of the banks have not offered such services. 85% of the banks are offering core banking service and the remaining 15% of the banks are not offering core banking service. 70% of the banks have offered e-banking, mobile banking service and the remaining 30% of the banks have not offered such services. 50% of the banks have not issued Kisan credit card and the remaining 50% of the banks have issued the Kisan credit card to the farmers. No bank has offered Biometric ATM facility to the customers. 85% of the banks have offered microfinance and the remaining 15% of the banks have not offered microfinance to the vulnerable people. 70% of the banks have not tied up with NGOs and the remaining 30% of the banks have been tied up with NGOs to disseminate their service. 65% of the banks have not given advertisement for financial inclusion and the left over 35% of the banks have given advertisement for financial inclusion. 60% of the banks have not preferred business correspondent and the rest 40% of the banks have preferred business correspondent. 70% of the banks have not established financial literacy and counseling center and the remaining 30% of the banks have established financial literacy and counseling center to educate the customers.

Table 2: Problems Involved in Financial Inclusion

Sl. No	Problems	HA	A	NAD	D	HD	Mean Score
01	Improper Repayment	16	3	-	-	1	**4.65**
02	Need For Additional Employees	11	4	2	1	2	**4.05**
03	Consumes More Time	12	5	-	-	3	**4.15**
04	Difficult To Canvas	10	4	2	4	-	**3.80**
05	Heavy Work Load	13	5	-	2	-	**4.45**
06	Requires High Cost	12	5	-	2	1	**4.25**
07	Low Consumer Awareness	06	11	-	3	-	**4.00**

Source – Primary Data

(HA – (5) Highly Agree, **A** – (4) Agree, **NAD** – (3) Neither Agree nor Disagree, **D** (2) – Disagree, **HD** – (1) Highly Disagree)

Table 2 shows the compliance of banks on various issues faced by them. As per the above table, it is noted that few problems were highly agreed and a few were agreed by the banks. The banks highly agreed on an improper repayment (4.65), the need for additional employees (4.05), consumes more time (4.15), difficult to canvass the customers (3.80), heavy workload (4.45) and requires high cost (4.25). The banks also agreed on low consumer awareness (4.00). Hence, the main problem associated with financial inclusion is improper repayment. It shows a mean score of 4.65.

Results and Discussion

The findings which are arrived from the analysis of Role played by banks in Financial Inclusion are presented below:

- **No frills account for financial inclusion:** Majority (80%) of the banks were offering no frills account for inclusive banking.
- **Bank's support for farmers:** Only 50% of the banks were issuing KCC (Kisan Credit Card) for scaffolding poor farmers.
- **Micro Finance as a tool for meaningful financial inclusion:** Majority (85%) banks were serving Micro Finance Credit for the vulnerable group of the society.
- **Communicational aspects of Financial Inclusion:** Only 35% of the banks were conducting advertisement campaigning properly.
- **Financial Literacy endeavour:** Only 30% of the banks were following Financial Literacy and Counseling Centre (FLCC)

properly for improving financial literacy among the deprived groups.

- **Repayment problem:** Improper repayment is founded as a major barrier for the attainment financial inclusion.
- **The profile of the Respondents:** The respondents of 70% were public banks, 60% of the banks were operating more than 10 years.
- **Target for Financial inclusion:** Majority (80%) of the banks had targeted for financial inclusion.
- **Getting refinance for financial inclusion:** Majority (75%) of the banks had not received refinance for financial inclusion.
- **Inducement for financial inclusion:** All the banks had been induced by another institution to adopt financial inclusion. The majority (70%) of the banks was induced by the Reserve Bank of India to adopt financial inclusion.
- **Conducting financial inclusion campaign:** Majority (75%) of the banks had conducted financial inclusion campaigns to turn unbankable into bankable.
- **Focused people for financial inclusion:** 70% of the banks had focused rural people for financial inclusion.
- **Reason for financial exclusion:** 55% of the banks had stated that the reason for financial exclusion was illiteracy.
- **Perception towards financial inclusion:** 64% of the banks felt that adoption of financial inclusion was neither easy nor difficult.
- **Expected assistance from the government:** 60% of the banks were expecting advertisement from the government for financial inclusion.

Suggestions

The following are the suggestions recommended from this study to various beneficiaries like Banks and the Government.

Suggestions for the Banks:

The banks should offer all forms in the regional language of the customers. The banks must create awareness among the people concerning the significance of banking services by advertisement and financial inclusion campaign. ATMs are one of the most cost effective ways of reaching the rural poor. Thus, new biometric ATMs have to be established to assist the customers who are unable to memorize PIN. The banks should constitute Grievance Redressal Machinery to redress the customer's discontent promptly. And also it should offer no frills account in order to turn unbankable into bankable. The banks should appoint a business correspondent to disseminate its service to the unreached area. Technology can play a major role in reducing the cost of availing financial services. Thus, banks should adopt advanced technology to open up new avenues for service delivery by using ICT.

Suggestions to the Government:

The government should include financial literacy in the curriculum of schools and colleges. The government should also raise the Financial Inclusion Fund and a Financial Inclusion Technology Fund to reach banking services to the unbanked areas. The government should pay all the social security payments through the bank account of the beneficiary. The Government should try to frame policies for capturing meaningful financial inclusion than mere opening an account.

Conclusion

Financial inclusion becomes a major prerequisite to poverty alleviation. Reserve Bank of India's vision for 2020 is to open nearly 600 million new customers' accounts and service them through a variety of channels by leveraging on information technology. However, the improper repayment need for additional workforce, time consumption, high cost and illiteracy are continuing to be a road block to financial inclusion in many areas. Consequently, many banks are not adopting fully fledged financial inclusion plan. The banks should step up to overwhelm all these problems and to disseminate its service to remote areas. The banks should encourage the people to access banking services by ways of no frills account, financial inclusion campaign and business correspondent. The government should encourage the banks to adopt financial inclusion by means of financial assistance, advertisement and awareness program etc. to achieve the Inclusive Growth of our nation in all respects.

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THE POTENTIAL OF MGNREG SCHEME IN EMPOWERING WOMEN IN RURAL AREAS - A CASE STUDY OF CHITTATTUKARA GRAMA PANCHAYATH IN ERNAKULAM DISTRICT

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Abstract

Even if the government of India has initiated various kinds of poverty alleviation programmes under various Five Year Plans, still around 28 per cent of the people in rural areas are living below the poverty line. There may be little variations in this figures which are estimated by different offices and official agencies. A large number of people, who are belonging to the BPL category in rural areas, mainly depend on the wages that they get through unskilled, casual, manual labour. Rural women are often on the doorsill of subsistence living and are vulnerable. Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is different from the earlier employment generating schemes of the government in the sense that MGNREGS treats employment as aright and it is intended to be demand determined. This paper is an attempt to assess the performance of MGNREGS in Chittattukara Grama Panchayath, in terms of various aspects related to employment and income generation.

Keywords: *National Rural Employment Guarantee Act, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Women Empowerment. Grama Sabha, Employment Generation, Income Generation, Man Days of Work.*

Introduction

In 2006, The Government of India launched a striving scheme as an attempt to fight rural poverty. This scheme was originally named as the National Rural Employment Guarantee Scheme. The National Rural Employment Guarantee Scheme (NREGS) was implemented on February 2, 2006 after passing the NREG Act in the parliament in September 2005. It was renamed as the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) on October 2, 2009. This Act has created a justifiable "Right to work" for all households in rural India through this scheme. This Act guarantees hundred days work for the unskilled rural workers in rural area is considered as milestone legislation related to rural women empowerment in India. The Act came into force initially in two hundred backward districts of the country. In 2007, another 130 districts came under its purview and from 2008 April 1 onwards the Act is in operation in all the districts of the country. MGNREGS is a wage employment programme and it offers and provides legal guarantee of hundred days of employment to the rural, helpless unskilled workers. It is believed that the MGNREGS provides a social safety net for the vulnerable groups of people of our society and it is an attempt to attain growth with equity.

As per the legal framework of this scheme, at least one adult member of a rural family who is willing to do unskilled normal work is legally entitled for wage employment. Wages will be paid through banks, on a weekly basis. To get employment, one has to register their name in the concerned local Grama Panchayath. From there, the applicant will get a job card and can apply for employment. It is assured that employment will be given within fifteen days after the submission of the application. Employment will be provided within five kilometer radius of the locality. If employment is not provided, the state government is liable to pay an unemployment allowance. Open village meeting (Grama Sabha) is supposed to identify suitable work projects. Local government institutions (Grama Panchayath) are given a central role in planning and implementation of this scheme. However, the successful implementation of MGNREGS finally depends on the efficient and regular functioning of Panchayath institutions.

In Kerala, this Employment Guarantee Scheme came into force in February 2006, in two districts, Palakkad and Wayanad and later it was introduced in Thrissur District in April 2008 and later extended to other districts of the state. The primary target of this programme is the elimination of rural poverty and empowering the rural people by providing employment opportunities in their locality. In this context this study is an attempt to explore the role of MGNREG Scheme in women empowerment in rural area.

Statement of the Problem

The upliftment of the poor people in the economic front is the main aim of the MGNAREG Scheme. As per this scheme, those who have completed 18 years of age are eligible for employment. Those who need employment have to register their names in the Grama Panchayath. Conservation of water, construction of minor irrigation projects, cleaning of water sources, construction of rural roads, afforestation etc. are some of the activities done under this scheme. The MGNREGS is the most powerful initiatives ever undertaken for transformation of rural livelihoods in India. The unprecedented commitment of financial resources is matched only by its imaginative architecture that promises a radically fresh programme of rural development. However, for a MGNREGS to realize its potential, it must focus on raising the productivity of agriculture in India’s most backward regions. This can then lead further to the creation of allied livelihoods on the foundation of water security. It is believed that the public investment under MGNREGP can lead to higher rural incomes and help to uplift the standard of living of the rural people, especially rural unemployed women and that in turn spurs private investment and greater incomes and employment.

The MGNREGS differs from other poverty alleviation programmes in two significant facets. The first one is that, where most welfare programmes cast the state in the role of benefactor offering handouts to the poor, the MGNREGS is built around notions of citizenship and entitlement. The second aspect is that the MGNREGS also facilitates disclosure by means of regular social audits. These audits, mandated to be done by the Grama Sabhas, are intended to identify and plug pilferage and corruption, which in turn helps to build awareness and confidence among beneficiaries who learn, over time, to become vigilant and assertive.

Significance of the Study

Economic empowerment of women community is a prerequisite for sustainable development and pro-poor growth. Rural women workers are not highly skilled. The problem of unemployment is severe among them. As far as they are concerned it is very difficult to get adequate employment opportunities in their own locality. As a result of this, almost certainly many of the rural women do not have their own income and their own source of income. Women empowerment can be considered as a dynamic process which enhances women's abilities and financial conditions. Today nobody considered women as second to men. There is plenty of evidence than when women get opportunities. They successfully utilized such facilities. The MGNREGS is an important scheme meant for reducing rural poverty. Evolving the design of the wage employment programmes to more effectively fight poverty. With its legal framework and rights based approach, MGNREGS provides employment to those who demand it and is a paradigm shift from earlier programmes. The MGNREGS aims at enhancing livelihood security by providing at least one hundred days of guaranteed wage employment in a financial year to every rural household whose adult members volunteer to do unskilled manual work. This study is based on the evaluation of the performance of Chittattukara Grama Panchayath in realizing the goals of implementation of MGNREGS and enhancement of women empowerment.

Methodology of the Study

This is an empirical study based on 55 sample households selected from Chittattukara Grama Panchayath, in Ernakulum District. These 55 samples were randomly selected from the source list provided by the ADS (Area Development Society). The samples were belonging to 2 and 3 wards of the Grama Panchayath. Among them 30 samples were from ward 2 and rest 25 from ward 3. Primary data were collected from rural area by using a structured questionnaire. Relevant information was collected directly by using the questionnaire. Secondary data were collected from various publications such as Economic Review, Journals, Periodicals and Newspapers etc. Percentage method, tabular presentation and graphic presentation were the statistical techniques used for the study.

Objectives of the Study

The major objectives of the study were:

- To understand the various types of works implemented under the MGNREG Scheme in Chittattukara Grama Panchayath.
- To examine the women participation in MGNREG Scheme.
- To examine the economic status of the beneficiaries of MGNREG Scheme in the study area

Review of Literature

K.N. Nair, T.P Sreedharan and M. Anoop Kumar (2009) have made an attempt to study the impact of the National Rural Employment Guarantee programme in three Grama Panchayats of Kasaragod District, namely Madikai, Ajanoor and Trikarpur. They have also been examined the various institutional aspects in the form of Guidelines, Rules and Regulations brought out by the Government of Kerala. The role of the Grama Sabha in the formation of ward level Action Plan was found as weak.

S.M Vijayanand and V.N Jithendran have described about the implementation of the NREGA experiments of Kerala has one of the highest unemployment rates in the country. At the same time, most of the unemployed in the State are educated. Thus the MGNREG Scheme has only limited application in tackling the problem of unemployment among the poor in Kerala. They have also highlighted the innovative features of the MGNREG Scheme. The agricultural workers of Kerala are fairly well organized into trade unions. This enables proper assessment of demand and in inculcating the workers perspective in the design of the programme, in choice of the works, in preference of locations and in deciding the schedule. Kerala use strained facilitators in the workers meetings as well as in subsequent Grama Sabhas. This ensures that these forums can be used effectively to convey the principles and features of MGNREG Scheme to the lay citizen.

E.M Thomas has studied about the relevance of MGNREG Scheme in ensuring a corruption less wage employment programme and women empowerment. He also analyzed the impact of MGNREGS on the empowerment of rural women. This study was divided into two sections. Section one presents a brief discussion of the concept of women empowerment It also deals with a brief discussion of the unique features of NREGA as a wage employment programme. The second section deals with the experience of a village Panchayath in Kerala in attaining the twin objectives of implementing MGNREGS without corruption and enhancement of women empowerment. This study was conducted in Vadakkanchery Panchayath regarding the attainment of goals like erection of corruption and enhancement of women empowerment.

Works Implemented Under MGNREG Scheme in Chittattukara Grama Panchayath

Chittattukara is one of the villages in Paravur Taluk in Ernakulam District in Kerala State. Chittattukara is 21.9 Km far from Kochi city. It is 202 Km far from Thiruvananthapuram. It has an area of 9.46 Sq.Km. The total area of the Chittattukara Grama Panchayath is divided into 17 wards. Chittattukara Grama Panchayath mainly comprises of rural community and most of them are belonging to the labour class like fishermen, coir workers, handloom weavers, toddy tappers, building and construction workers and other manual workers. The total population of the e Chittattukara Grama Panchayath is 28026, of that 48.32 per cent is male and 51.68 per cent is female population. The density of population in the Panchayath is 2677/ Sq.Km. Among this total population, 2373 people are belonging to scheduled castes and 47 are belonging to scheduled tribes.

The main occupation of the people in Chittattukara Grama Panchayath is fishing. More than 60 per cent of the people are engaged in fishing sector. The remaining groups of the working class are mainly depending on coir industry, handloom industry etc. The main work of women in this locality is prawn peeling. There are seven peeling sheds are functioning in this Panchayath and these are the main occupational centers of the women community. This industry provides employment to more than 700 women workers. There are 28 Anganvadies and 4 Government LP Schools and a Higher Secondary school in the Panchayath.

Beneficiaries of MGNREG Scheme in Chittattukara Grama Panchayath

The primary goal of MGNREG Scheme is the removal of rural poverty. An evaluation of the number of the beneficiaries of MGNREG Scheme can reveal the effectiveness of the implementation of the Scheme in rural areas. The following Table shows an overview of the implementation of the MGNREG Scheme in the Chittattukara Grama Panchayath during the financial year 2011-2012. The available data reveals that the number of BPL families is 712. Likewise even though there are 1338 job card holders only 1256 people demanded job and the authority of the Chittattukara Grama Panchayath could provide jobs to all of them.

Table-1 MGNREGS Beneficiaries of Chittattukara Grama Panchayath

Sl.No	Category of Families	Frequency
1	Total BPL families	712
2	Total NREGP job card holders	1338
3	Persons demanded jobs	1256
4	Job card holders who received jobs	1256
5	SC families	134

(Source: Office of the Chittattukara Grama Panchayath)

When the scheme was launched in the Chittattukara Grama Panchayath, a lot of people expected that they would get one or another type of white collar job within the Grama Panchayath area, corresponding to their educational qualifications. Another group of youngsters thought that they would be destitute from government jobs, if they fail to register their names in the office of the Grama Panchayath for MGNREG Schemes related jobs. In the course of time they understood that all their prejudices and anxieties were baseless. Hence most of them did not appear for doing manual jobs provided by the Grama Panchayath as part of the MGNREGS. Moreover, the wage rate is low, that fails to attract male workers to MGNREGS works, for most of them could get much more than that per day by doing other jobs. Hence there is the gap between the number of job card holders and those who actually demanded jobs.

Works Implemented Under MGNREGS in Chittattukara Grama Panchayath

The primary motto of MGNREGS is to provide guarantee for employment for the rural people, with special consideration to women community, especially in village areas. The Act has specified the kinds of work that can be taken up under the scheme. The Grama Panchayath while preparing the plan of work, under the scheme should ensure that the work that has selected comes under the categories that are suggested. Identification and recommendation of the works were the responsibility of the Grama Sabha. Keeping in view the provisions of MGNREGS, priorities of the works are decided at meetings of the Grama Sabha. The representatives of the people and officials of the Grama Panchayath and the concerned staff c arrive at a consensus and sort out the works that could be carried out. 'Kudumbasree' that are functioning in the locality also plays a vital role in facilitating the people to identify the work. People who are interested in doing work under MGNREGS should come forward voluntarily and seek work job under the scheme. Job seekers should submit the application form. The members of ADS/CDS and mate facilitate the job seekers to submit the application form. On receipt of the applications, dated receipts are given. The persons responsible for issuing job cards are overseer, accountant- computer operator and secretary of the Grama Panchayath. These dated receipts are given to only those job seekers, who apply in the prescribed format. The various kinds of works that are implemented in Chittattukara Grama Panchayath under the MGNREG Schemes during the year 2011-2012 are given in Table-2. The nature of MGNREGS works undertaken by Chittattukara Grama Panchayath shows that, these are in tune with and according to the guidelines issued by MGNREGA

Table-2. Nature of Works Implemented Under MGNREGS in Chittattukara Grama Panchayath

Sl.No.	Category of Work	Frequency
1	Water conservation	10
2	Renovation	32
3	Land development	128
4	Flood control	4
5	Irrigation	53
6	Drought proofing	11
	Total	238

(Source: Office of the Chittattukara Grama Panchayath)

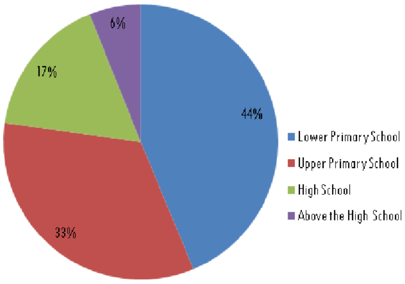
Role of Women in the MGNREG Scheme

MGNREGS can play a substantial role in empowering women economically and laying the basis for greater self-determination among the rural women community. It can also contribute to reduce the magnitude of economic inequality that exists between men and women in the society. The concept of women's empowerment go wider popularity and acceptance in Kerala with the launching of decentralized planning in the state. Kudumbasree groups are very much active in implementing MNREGS. The diverse functions taken up by the members of Kudumbasree, range from identification of projects to supervision of works and submission of records to the Grama Panchayath authorities for disbursement of the wage. Out of total employment generated in the state, the women beneficiaries were included 65.8 percent in 2010-2011 increased to 85.01 percent in 2011-2012 and this show that the empowerment of rural women has emerged as an inadvertent consequence of MGNREGS. Women have benefited more than male workers in this regard and they have gained more opportunities and it has enhanced the ability to earn independently. The success of this Scheme mainly depends on the inclusion of all, especially women in rural area. One of the important features of this Scheme is that it protects 'employment' as a fundamental right of the individuals with all its strict rules. So that this programme is called the "employer of last resort" and this programme is entirely different from those other developmental and welfare programmes. It is a fact that participation of women in this scheme is reasonably high in states like Kerala and Tamil Nadu when compared to other states.

The important area of concern of MGNREGS is the empowerment of rural women. In this regard, the Chittattukara Grama Panchayath seems to have made admirable achievements. The MGNREGS works in the panchayath is characterized by the presence of large number of women. Out of the 1343 MGNREGS workers, 1070 are women. In other words 79.67 per cent of the MGNREGS work force of Chittattukara Grama Panchayath encompasses women, belonging to the BPL households.

The Figure-1 shows the level of education of women workers in Chittattukara Gram Panchayath. There are 1070 women workers in this Panchayath. Among them 44 per cent of the women workers has lower primary education and 33 per cent have only upper primary education. The percentage of female MGNREGS workers was only 6.

Figure-1 Educational Status of the Women MGNREGS Workers in Chittattukara Grama Panchayath



(Source: Primary Data)

Majority of the sample respondents (78.56 per cent) have revealed that the launching of MGNREGS has enhanced their economic and social participation in the society. The elimination of disparity between men and women in the payment of daily wage is a notable achievement of MGNREGA. It discloses that the new wage employment programme succeeded ensuring freedom and equality for women in economic and social areas of activity.

Income Generation through MGNREGS

An important feature and advantage of MGNREGS is that it has ensured payment of minimum wages irrespective of the sex. The minimum wage of Rs 225 per day under MGNREGS had increased the wage level across the private sector benefiting both the families that could not avail MGNREGS work and families that had completed MGNREGS quota of 100 days work. It has also increased the bargaining power of the rural poor people in the labour market. Earlier, the female workers who are participating in MGNREGS were mostly voiceless and most often they failed to bargain for higher wages. Now, the condition has entirely changed and the rural women workers have economically much empowered since the inception of this Scheme. The scheme has improved the lives of the rural female community and the Scheme has brought financial stability and has assured income to the families which were desperately poor until recently. Around 72 percent of the sample respondents opined that MGNREGS is the only source of income to them. Likewise, this scheme has also generated some positive impact on the expenditure pattern of the sample households. The MGNREGS workers receiving their wages through various commercial banks is illustrated in Table-3

Table-3 Number of MGNREGS Workers Receiving Wage Income through Various Commercial Banks

Name of the Bank	Frequency
Bank of India Vadakkekkara Branch	995
Bank of India N. Paravur Branch	7
Catholic Syrian Bank	2
Co-operative Bank, Valiyapallamthuruth	40
District co-operative Bank N.Paravur	4
Federal Bank	3
Indian Bank	3
Service Co-operative Bank Vadakkekkara	1
South Indian Bank	4
State Bank of Travancore	5
State Bank of India	4
Union Bank of India	5
Total	1113

(Source:- Records of Chittattukara Grama Panchayath)

In Chittattukara Grama Panchayath, no disparities could be noticed between the estimated and actual measurements of the size of the MGNREGS projects. It seems that the monitoring committee in the panchayath is very efficient and active in ensuring the timely and proper completion of MGNREGS projects. Analysis of the muster rolls of the Grama Panchayath revealed that the Grama Panchayath could generate 90,849 man days of work during the year 2011-2012 and the workers received Rs 15626028 as wages. It is evident that all the workers received Rs 172 per day as wages. The performance of the Chittattukara Grama Panchayath in the implementation of MGNREGS wok shows that it could achieve the goal of elimination of corruption in the sanctioning of MGNREGS work, bribery, middlemen, mismatch in the measurements between the estimated and achieved targets, the implementation of the MGNREGS projects. More over all the workers received the mandatory wage rate of Rs. 167 per day through commercial banks. In short, it is found that in general the panchayath could succeed, in the implementation of MGNREGS works without any corruption.

Table-4 The Number of Households and Number of MGNREGS Work Days Received By Job Card Holders

Number of Working Days	Frequency	Percentage
Between 51-60 Days of Work	510	38.12
Between 61-70 Days of Work	280	20.93
Between 71-80 Days of Work	99	7.40
Between 81-90 Days of Work	131	9.79
Between 91-100 Days of Work	318	23.77
Total	1338	100.00

(Source: Primary data)

From the analysis of the data, it was found that 38.12 per cent of the MGNREGS workers have obtained man days ranging from 51 to 60. Around 21 per cent of the MGNREGS workers have obtained man days ranging from 61 to 70. The prominent thing is that Around 24 per cent of the MGNREGS workers have obtained man days ranging from 91 to 100.

The age wise analysis the of women workers of MGNREGS shown that 30.5 per cent of the workers are belonging to the age group of 40 to 50 age. The percentage of women workers belonging to the age group of above 50 were 28.32. It was also noticed that the percentage of women workers belonging to the age group of less than 25 was only nominal and it was only 8.57 percent.

Monthly Income of the Sample Respondents before and After Joining MGNREGS

Income is one of the important indicators of economic status and standard of the living of the people. MGNREGS has resulted in empowering the rural women due to their participation in the MGNREG Scheme. Monthly income of the sample respondents before and after joining MGNEREGS is shown in the Table-5.

Table-5 Monthly Income of the Sample Respondents before and After Joining the MGNREGS

Sl.No	Monthly Income (in Rs.)	Pre MGNREGS Period		Post MGNREGS Period	
		Frequency	Percentage	Frequency	Percentage
1	No Income Group	12	21.82	0	0.00
2	Below 1000	14	25.45	12	21.82
3	1001-2000	10	18.18	15	27.27
4	2001-3000	9	16.36	13	23.64
5	3001-4000	6	10.91	9	16.36
6	4001-5000	3	5.45	4	7.27
7	Above 5000	1	1.82	2	3.64
	TOTAL	55	100.00	55	100.00

Source: Primary data

The findings show that 21.82 per cent of the sample respondents had no income in the pre

MGNREGS period, because they had no work to do. Around one-fourth of the respondents (25.45 per cent) obtained income less than Rs.1000 per month. Likewise, in the pre MGNREGS period, only 1.82 of the sample respondents had income above Rs.5000 and it has increased to 3.64 per cent in the post MGNREGS period. In the pre MGNREGS period only 34.54 per cent of the sample respondents had average monthly income greater than Rs.2000. However, in the post MGNREGS period 50.91 per cent of the sample respondents obtained average monthly income above Rs.2000. The average monthly income of the sample respondents in the pre MGNREGS period was only Rs. 2520.65 and it has increased to Rs.3082.16 in the post MGNREGS period. The average daily wage realised by the sample respondents in the pre MGNREGS period was only Rs. 84.02 and it has increased to Rs.102.74 in the post MGNREGS period.

Income and Saving Pattern of the Female Workers Working in MGNREG Schemes Before and After Joining the MGNREGS

A comparison has been made with regard to the income, expenditure and net savings of the women workers in the pre MGNREGS period and the post MGNREGS period. This analysis reveals the income, expenditure and the net saving status of the women workers who were participated in MGNREG Schemes. The findings of the analysis of the surveyed data are furnished in Table-6

Table-6 Monthly Income and Saving of The Sample Respondents Before And After Joining The MGNREGS

Sl.No	Occupation	Pre MGNREGS Period			Post MGNREGS Period		
		Income	Expenditure	Net Savings/ Deficit	Income	Expenditure	Net Savings/ Deficit
1	Small Farmer	1525.23	1634.58	-109.35	1985.32	1728.34	256.98
2	Farm Labourer	2335.26	1856.35	478.91	2917.24	2274.52	642.72
3	Mason Works	3110.58	2546.38	564.2	3542.28	2865.75	676.53
4	Artisan	3287.36	2647.25	640.11	3980.12	3154.56	825.56
5	Other Coolie Works	2344.85	1875.45	469.48	2985.68	2315.12	670.56
	Average Value	2520.68	2112.01	408.64	3082.13	2467.70	614.47

Source-Primary Data

As per the information provided by the sample respondents, the average monthly income of the small farmers, before participating in MGNREG Schemes was only Rs.1525.23, whereas the average monthly expenditure made by them were Rs.1634.58, which resulted in a deficit of Rs.109.35. In the pre MGNREGS period they had no savings. But in the pre MGNREGS period both their income and saving potentials have increased and they have an average monthly saving of Rs.256.98.The saving potential of the women workers, in general, has increased from Rs.408.64 in pre MGNREGS period to Rs.614.47 in post MGNREGS period. All these findings reveal that the MGNREG Schemes have created a positive impact on the income, expenditure and saving ability of the women workers of rural areas.

Table-7 Growth Rate of Income, Expenditure and Saving After Joining the MGNREGS

Sl.No	Item	Pre MGNREGS Period	Post MGNREGS Period	Difference	Growth Rate
1	Income	2520.68	3082.13	561.45	22.27
2	Expenditure	2112.01	2467.70	355.69	16.84
3	Saving	408.64	614.47	205.83	50.49

Source-Primary Data

Results of the data analysis show that the growth in income of the women workers, as a result of participation in MGNREG Schemes was

22.27 per cent. The growth rate realized in the case of Expenditure and Savings were 16.84 per cent and 50.49 per cent respectively. Results are furnished in Table-7

Problems Faced by the Female Workers Working in MGNREG Schemes

An evaluation of the various kinds of problems faced by the women workers who are participating in MGNREG Schemes are also made as a part of this study. Ranking of the different problems faced by them are furnished in Table-8

Table- 8 Ranking of Problems Faced by Female Workers Working in MGNREG Schemes

Sl.No	Nature of Problem	Garrett Mean Score	Rank
1	Lack of Continuous Work	64.35	I
2	Low Wage Rate	63.28	II
3	Lack of Proper Medical and Accidental Care at Work Place	43.95	VIII
4	Absence of Awareness About the Works Initiated Under MGNREGS	52.37	V
5	Non Availability of Frequent Work	61.36	IV
6	Delayed Payment	62.15	III
7	Inconvenience Related to Family	45.85	VI
8	Other Problems	42.18	VII

Source-Primary Data

The analysis of the survey data revealed that the major problem met by women MGNREGS workers was lack of continuous work, which has a mean score of 64.35 and it was followed by low wage rate with a mean score of 63.28. The intensity of the problem related to the lack of proper medical and accidental care at work places and the other problems were least with a mean sore of 43.95 and 42.18 correspondingly.

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SOCIAL INEQUALITY AND EDUCATIONAL DISADVANTAGE IN THE SCHOOL SYSTEM IN KERALA

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Abstract

The school education system is undergoing massive structural changes in Kerala. Government has provided reservation to the backward communities in education in the government, Navodaya, and Kendriya Vidyala schools. But the participation of the backward students is extremely different in various school systems. The present study concentrated on the SC/ST student participation in terms of enrolment in the types of schools in Kerala. The study revealed that the enrolment of SC/ST students are concentrated on the government schools in the state. The intake of SC/ST students in the Navodaya, Kendriya Vidyalaya, ICSE and CBSE are extremely poor in the state. Therefore the government expenditure on education has not produced satisfactory results in the state. It is producing different types of citizens with respect to different types of school systems. Therefore government should standardize the syllabus and monitoring systems in the state. Besides this, government can provide subsidy to the SC/ST students in the private and central schools. Further, the increase in the seats and improving the quality in the state syllabus schools are also viable options.

Introduction

With Right to Education Act (RTE) being implemented from 2013-14 in Kerala; there is a great chance to improve the educational level of poor students in the state. However, focus on quality education is very important in the context of high literacy rate of the state when compared to other states in the country. As far as the school education is concerned, it is passing through a critical stage. Participation of private sector has increased in the state. Therefore, school accessibility in terms of syllabus, medium and ownership are important issues in the state. As per the government guidelines, a child belonging to weaker section means a child whose parents' or guardian's annual income is less than Rs.60000. A child belonging to the disadvantaged group includes child belonging to SC, ST community or socially and educationally backward classes, HIV infected children, orphans, children with learning disabilities and children with special needs. The government will pay for the expenditure incurred on these students by the schools, provided, they are eligible for such concession from the government. They are eligible only if there is no government or private aided schools within walking distance. The government and private aided schools are available in every nook and corner in the state and these schools are providing state syllabus. Therefore, the reservation in the private schools is inaccessible to majority of the socially and economically backward students in the state. Government schools as well as aided schools are facing problems related to academic, physical and social infrastructure. The monitoring mechanisms of the schools are comparatively poor in the state. However, the result oriented system, standard syllabus, medium of instruction and monitoring systems are better in the case of Central Board of School Education (CBSE), International Curriculum for School Education (ICSE), Kendriya Vidyalaya (K.V.) and Jawahar Navodaya Vidyalayas (JNV) schools in the state. Thus it is necessary to think about the pitfalls of government and private aided schools and the quality of school education in Kerala.

The Right to Education (RTE) and the Sarva Siksha Abhiyan (SSA) have made access to elementary education a reality for 99 percent villages in India. However, more than a quarter of enrolments in rural areas are in private schools. As per the ninth Annual Status of Education Report (ASER), 29 percent of enrolments in the six to fourteen age groups are in private schools. This is a 10 percent increase in seven years from 18.7 percent in 2006 to 29 percent in 2013. While this reflects a shifting of public faith in government schools, the growing preference for private schools is also indicative of a willingness to invest in child's education by parents who very often are themselves illiterate. The preference for private schools is not necessarily reflective of the quality of public schooling. In Kerala, where the quality of schools and teaching was found to be fairly good, 68.6 percent of all children in the elementary level were in private schools. As with private schooling, there is also a growing prevalence of private tuitions among elementary school students. The figure stands at 24.1 percent. Hence, the issue is whether all money should go into government schools or not. The preference for private education is not just because of the failure of government schools to deliver on the basic achievements in learning but also mirrors growing urbanization and increase in wealth and access to the external world and information. In this changed context the backward students especially the SC/ST students should receive due attention. The nutrient content on education in terms of type of syllabus demands urgent attention. The present study takes into account the enrolment ratio of SC/ST students in various types of syllabuses of Kerala. Besides this, the overall participation of students (all groups) in various types of syllabus is also important and is presented in table1. On the one hand some parents will prefer the state syllabus due to their preference, inaccessibility of private unaided schools, ignorance and asymmetric information. According to the table, it is seen that, there is only 1 percentage of students who had availed the Kendriya Vidyalaya and Navodaya schools in the state. The 12 percent of students are in the CBSE schools and 85 percent of the students in state syllabus in the year 2010-11. The ICSE School came third with 2 percent in the state during the same year. From the data, it is clear that accessibility of ICSE, CBSE, K.V and JNV syllabus for students in the schools is very low in the state. Of course, the rich students also may study in the State Syllabus Schools in the state. But their number is less (Thomas, 2007).

Table 1: Type of School and Students Strength in Kerala (2010-11)

Type of School Syllabus	Number of Students	Percent
State Syllabus	4351200	85
CBSE	636700	12
ICSE	92400	2
Kendriya Vidyalaya and Jawahar Navodaya	48800	1
Total	5129100	100

Source: Directorate of Public Instruction, GOK, Various issues

The present paper argues that majority of the students who are studying especially in the state syllabus should be lifted to the CBSE, ICSE or Navodaya or Kendriya Vidyalaya syllabuses. The participation of poor students in the national syllabus and private unaided schools are low. Moreover, the probability of good educational future is also comparatively low for poor students. The present paper argues that the syllabus and medium of school syllabus are crucial variables in determining the level of educational equality in the state. It is sure that the standardizing the syllabus of schools is a first step to improve the level of educational equality in the state. Further, it will enhance the level of quality of education in the state. Based on this data, SC/ST enrolment in the types of syllabus and the participation of students in Kerala during the period 2005-06 to 2011-12 are presented in tables 2 and 3. The SC students occupied 0.9 percent in the CBSE schools in the state during the period 2005-06. It gradually increased to 2.2 percent in the period 2011-12. At the same time, the representation of ST students was 0.7 percent in 2005-06 and it increased to 1.4 percent in 2011-12. Enrolment of SC/ST candidates in the ICSE syllabus is even worse in Kerala when compared to CBSE syllabus.

Table 2: Types of Syllabus and Enrolment of SC/ST Students in Kerala

Year	CBSE		ICSE		KV	
	SC	ST	SC	ST	SC	ST
2005-06	4446 (0.9)	466 (0.7)	1299 (0.2)	119 (0.2)	4751 (0.9)	586 (0.9)
2006-07	4632 (0.9)	321 (0.5)	1421 (0.3)	82 (0.1)	5093 (1.0)	532 (0.8)
2007-08	5817 (1.1)	494 (0.7)	1354 (0.3)	94 (0.1)	4751 (0.9)	586 (0.8)
2008-09	5046 (1.0)	478 (0.6)	1781 (0.4)	70 (0.1)	5594 (1.1)	598 (0.8)
2009-10	7974 (1.6)	927 (1.2)	2226 (0.4)	76 (0.1)	6201 (1.2)	625 (0.8)
2010-11	8369 (1.7)	999 (1.2)	2275 (0.5)	79 (0.1)	6367 (1.3)	554 (0.7)
2011-12	10896 (2.2)	1107 (1.4)	2292 (0.5)	47 (0.1)	7148 (1.5)	681 (0.8)

Notes:
1. *Figures in Parenthesis Indicates the Percent of Total SC/ST Students to the concerned Syllabus*
2. *School level includes 1st to 10th standard*

Source: Directorate of Public Instruction, GOK, Various Issues

It is revealed from the table 2 that the SC students have only 0.2 percent seats in 2005-06 and it slightly increased to 0.5 percent during the period 2011-12. It is noted that the enrolment of ST candidates in the ICSE syllabus is 0.2 percent and it decreased to 0.1 percent during the same period. Similarly, the enrolment of students in the Kendriya Vidyalaya (KV) was 0.9 percent in the year 2005-06. The strength increased to 1.5 percent over the period 2005-06 to 2010-11. Among the three types of syllabuses, KV has the highest enrolment of SC candidates during the year 2005-06. However, CBSE schools improved its position during the period 2010-11.The total enrolment in the ICSE and KV has nominally reduced during the period 2005-05 to 2011-12. It is noted that the percentage wise enrolment of students in the KV schools is low when compared to other syllabuses in the state. The government expenditure on school education is high when compared to higher education in India and Kerala (Nair, 2004). The social infrastructure in terms of quality of teachers is high in the state when compared to other states in India (Thomas, 2007). However, the monitoring systems of these teachers are inefficient in Kerala. Moreover, quality of physical infrastructure is poor when compared to the private un-aided schools in the state. The quality of state syllabus is low when compared to the other syllabi such as KV, JNV, ICSE and CBSE. The practical classes of KV, JNV, ICSE and CBSE are extremely useful when compared to the private aided and government schools. It is to be noted that the syllabus is one of the important factors in determining the learning outcomes.

Table 3: Types of Syllabus and Enrolment of SC/ST Students in Kerala

Year	JNV		State Syllabus		Total	
	SC	ST	SC	ST	SC	ST
2005-06	1318 (0.3)	203 (0.3)	507895 (98)	66850 (98)	519709	68224
2006-07	1288 (0.2)	255 (0.4)	506656 (98)	68781 (98)	519090	69971
2007-08	1289 (0.3)	283 (0.4)	501574 (97)	70794 (98)	514785	72251
2008-09	1305 (0.3)	272 (0.4)	492785 (97)	74112 (98)	506511	75530
2009-10	1375 (0.3)	277 (0.3)	488214 (96)	77512 (98)	505990	79417
2010-11	1353 (0.3)	269 (0.3)	479456 (96)	78790 (98)	497820	80691
2011-12	1330 (0.3)	283 (0.4)	467670 (96)	78591 (97)	489336	80709

Source: *Directorate of Public Instruction, GOK, Various Issues, Kerala*

Note: *Figures in Parenthesis Indicates the Percent of Total SC/ST Students to the concerned Syllabus*

The enrolment of SC/ST students in the state syllabus is extremely high in the state when compared to the other syllabuses. The trend of privatization in the school as well as college education is ubiquitous in Kerala (Nair, 2004). The enrolment of general candidates in the CBSE, ICSE, K.V. and JNV is increasing day by day in the state. This trend may increase in near future also. However the enrolment in the socially and economically disadvantaged groups especially SC/ST candidates may continue in the state syllabus. Therefore the government should introduce some safety nets to these groups. Of course RTE provides a protection and the accessibility to disadvantaged groups in the private schools. However, this programme is found to be ineffective. If there are schools within the five kilometers of the candidate, they cannot access the private school in the state. Enforcement of reservation of 25 percent to financially and educationally backward students in private unaided schools is a viable option to increase the SC/ST enrolment in these schools even if the government or private aided schools are available within the vicinity of a private school. Further, up-gradation of syllabus in the state schools, improvement of physical infrastructure, increasing reservation of SC/ST candidates in the private schools, providing subsidy to poor students in private schools and monitoring of teachers in government schools can improve the quality and equality of school education to a great extent.

Conclusion

The nature of syllabus, infrastructure and other school related factors have a crucial role in determining the learning outcome of students. Nowadays, the prevalence of private school and centralized syllabus has increased in India as well as Kerala. Majority of the parents are sending their children into private schools. But economically poor parents especially from socially and economically disadvantaged groups notably SC/ST candidates are not in a position to enroll in the private, J.V and K.V schools. In other words the enrolment in the government school will be fruitful only if they provide quality education. Otherwise the relative position of these students will deteriorate day by day. There are two options. First, the improvement in the system of government schools which include syllabus, medium of instruction, and modification in the teacher-student evaluation systems and improvement in the physical infrastructure. Second, increase in the reservation of SC/ST students in private as well as central government schools may improve the educational attainment of these sections. Providing subsidy in the private schools is also a viable option in the state. Government will have to increase the seats in the central syllabus for the backward students in the country. Further the reservation of seats in private schools, even if there is government school functioning in the adjacent of the residence of student, may improve the education attainment of back ward communities. These measures can improve the quality and equality of school education in the state.

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POLITICS OF REPRESENTATION OF BODY IN THE POSTMODERN CULTURAL CONTEXT

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Abstract

The article analyzes politics of representation of body in the postmodern cultural context. The body has emerged in recent years as a key problematic in the social sciences and cultural studies. In the postmodern context, the body can be theorized as a potentially powerful site of resistance to hegemonic structures and narratives. The materiality of the body is inseparable from the power relations and historical forces and it complicates the relationship between the body and its discursive formations. Thus the body can be seen as enigmatic texts to be decoded.

Keywords: *Cultural Studies, Postmodernism, Bodily Representations.*

Introduction

The body has come to be recognized as a contested terrain on which struggles over control and resistance are fought out in contemporary societies. It had become a key site of political, social, cultural and economic intervention. The body has emerged in recent years as a key problematic in the social sciences and cultural studies. The assumption of classical positivist concept, that bodies belong primarily to biology, has collapsed and the meaning of the body has become a problem for linguistic, cultural and social analysis. This inclusion of the body in sociological inquiry can be regarded as a critical and reflective response to the social changes which have brought the body to the forefront of contemporary struggle and debate in the present age. Its intellectual roots are diverse, although post structuralism and feminism can claim to be at its core.

In recent years, the body has been redefined by the claim that the physical form is not a natural reality, but a cultural concept. A culture's body ideals speak a lot about how that culture perceives itself, or wishes to be perceived. They also help in understanding how conventions can be perpetuated, or else challenged and reframed. In the postmodern context, the body can be theorized as a potentially powerful site of resistance to hegemonic structures and narratives. The body has been central to colonialist and post-colonial discourses of various kinds. Much post-colonial writing in recent times has contended that the body is a crucial site for inscription. This view of the body as a site for representation and control is central to many early analysts of post-colonial experience.

For feminists, issues around the body have inevitably focused on questions of power, gender, sexuality, and emancipatory potential. There has been an increased concern with, and understanding of, the special role played by gender in constructing images of colonial inferiority and in constructing a special 'double' colonization for women within the general field of colonial oppression.

Theoretical Perspectives

Terry Eagleton, in *The Illusions of Postmodernism*, explicates postmodernism's ambivalent conception of the body as a material body constructed culturally when he argues: "In speaking materially about culture, it began to speak culturally about the material, not least about the most obvious material bit of us, the body" (48). Eagleton also asserts on postmodernism's inclusive logic with regard to body politics: "The body has been at once a vital deepening of radical politics and a wholesale displacement of them" (70).

In *The Politics of Postmodernism*, Linda Hutcheon emphasizes the contradictory nature of postmodernism and to find the political potential of postmodernism by problematizing representation . In *The Location of Culture*, Homi Bhabha speaks of a hybrid, ambivalent space of cultural encounters in the postcolonial world and thus celebrates ambivalence from a postcolonial / poststructuralist perspective and rejects binary closures in favour of cultural differences. He locates culture at the spaces of hybridity, translation, and difference. He asserts that the postcolonial perspective resists the attempt at holistic forms of social explanation. It forces recognition of the more complex cultural and political boundaries that exist on the cusp of these often opposed political spheres.

Judith Butler in *Bodies That Matter* reconsiders bodily materiality "as the effect of power" (2), as something contingent on and governed by cultural construction, regulating norms, hegemonic heterosexual power, and discourses. She argues that culture inscribes sexual norms on sexed bodies, that sex is a matter of social construction through discourse. Bodies that matter for her are bodies which materialize norms (16).

Body and its Postmodern Representations

The postmodern body, whose materiality is mediated in culture and discourses, is a political one. Many postmodernists transform the material body into an inscribed text, or rather, view the body as a text and pit it against language. The postmodern body is also fluid and transgressive, one that exists between the textual and the material, the organic and the virtual. It loses its fixed boundaries and unified meaning and becomes a site for conflicting meanings and positions. Postmodernists celebrate the dissolution of the subject in language and the transformation of the world into a text. It is thus textualized or culturally constructed and is seen as a carrier of cultural and political inscription and attributes. Thus the material body is often entangled with discourses rooted in social, cultural, and political codes.

For an artist/writer in the, postmodern era, there is the difficulty of representing the reality of material suffering taking place in the world. He/She is aware that bodily suffering happens around us and constitutes material history. But she is also aware that such events are estranged and complicated when one represents them in fiction and translates historical materiality into the discourse of the novel. Thus a pre-discursive reality to the suffering body has to be granted. At the same time a writer/artist has to interrogate its discursive exploitation or production.

The physical body becomes richly metaphorical in a postmodern context. It becomes a discursive site for multiple significations that textualize it and constantly put its embodiment in question. The undermined body that experiences health and illness is complicated and viewed differently as different discourses mediate it. The postmodern body in a world dominated by cultural images and texts is one whose materiality is estranged in service of body theories and discursive disembodiment.

Thus the body is directly involved in a political field and power relations have an immediate hold upon it. It can be analyzed as a historically and culturally specific entity, one which is viewed, treated and experienced differently depending on the social context and historical period. The materiality of the body is inseparable from the power relations and historical forces and it complicates the relationship between the body and its discursive formations. It is inscribed by political power structures and its discursive practices. It is always subject to change and is always experienced as mediated through its different social constructions.

In the present postmodern context, the history of suffering is displaced onto the body and this corporeal suffering is mediated in language and discourse. The representation of the material body can be problematized with relation to language and the material body itself can be the body of the racial or sexual “other”. These things work at the intersecting points of postmodernism and postcolonialism.

Conclusion

Postmodern theories argue that there are no substances or ideas outside language. Substances and ideas are not realities which language reflects but rather cultural categories which language constructs. In this context the body too is a product of language, a representation. It is only through language that the body gains meaning. Language organizes the body according to the beliefs of a particular culture. Thus the human body is a flexible concept which can be interpreted in diverse ways, depending on time, place and context. They can be seen as enigmatic texts to be decoded. The body proves to be a surface for the inscription of historical events and a metaphor for power relations. It is at once singular and metaphorical, a reality and a fabrication, and a biological given and a regulatory field. It is mediated by language through metaphors and is a site for inscription by discursive power practices.

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AN ASSESSMENT OF WATER QUALITY OF DUG WELLS OF NORTH PARAVUR MUNCIPAL AREA, ERNAKULAM DISTRICT, KERALA, INDIA

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Abstract

Quality of water is an important criterion for evaluating the suitability of water for drinking and irrigation. In the present study water quality of dug wells of 15 wards of North Parvur Muncipal area was investigated for a period of 6 months from December 2013 to May 2014 with an objective to assess the water quality status in the study area and its potability. The parameters alnalysed were temperature pH, EC, TDS, acidity, alkalinity, total hardness, chloride, free CO_2, DO, BOD, COD, Iron, Sodium and Potassium. All the parameters under consideration except alkalinity and acidity were in the desirable limit and thus the water is fit for domestic and irrigation purposes.

Keywords: *North Parvur, Dug well, water quality, standards*

Introduction

Ground water is an essential and vital component of our life support system. The ground water resources are being utilized for drinking, irrigation and industrial purposes. However due to rapid growth of population, urbanization, industrialization and agricultural activities, ground water resources are under stress. There is a growing concern on the deterioration of ground water quality due to geogenic and arthropogenic activities (2010).

Ground water is a replinashable and economic resource. It has inherent advantages over surface water. The wide distribution, negligible evaporation loss, low risk of pollution, fairly closeness at hand, more uniform character, relatively free from harmful microorganisms are some of the advantages. Ground water form the major source of domestic water needs, inclusive of drinking in both urban and rural areas. Ground water accounts for nearly hundred percent of water supply sources for many of the developing countries and this is true for our country too 2010.

India, being the second highest populous in the world, the quality of ground water is deteriorated day by day due to rapid increase of urbanization and industrialization. The problem of ground water is more acute in areas that are densely populated. It has long being considered that ground water is the purest forms of water available in nature and meets the overall demands of rural and semi urban people. Large scale industrial growth has caused serious concern regarding the susceptibility of ground water contamination due to waste materials. Waste materials near the factories which are subjected to reaction with the percolating rain water and reach the aquifer system and hence degrade the ground water quality Tyagi P. and et.al (2002). The majority of people in India depends upon fresh water supplies from dug wells, ponds, bore wells, springs and the lake. The availability of ground water depends upon the rate at which it is recycled by hydrobiological cycle than on the amount that is available for use at any movement in time. In most parts of the country, finite water sources are being exploited and degraded at an accelerating rate by anthropogenic activities Ramesh Babu M.G. and Sleema. B (2009).

For the effective maintenance of the water quality, one needs continuous monitoring of water quality. No specific work has been done so far to assess the ground water quality status of the area. The presence study is designed for the physicochemical characterization of the well waters around North Paravur municipality. Monitoring of water quality is an effort to obtain information on chemical quality through representative sampling in hydro geological unit and to create a background data bank of different chemical constituents of the study area.

Study Area

North Paravur also Paravur Taluk formerly known as PARUR is a town, municipality in Ernakulam district in the Indian state of Kerala. It is an old and growing municipality considered as the gateway to Malabar. Though considered a part of Kochi for all practical purposes, the town is 17 km away from Edappally in the city of Kochi. It is the northern suburb of Kochi city. The ancient seaport of India, Muzris is located in Pattanam village 3 km away from the town. The western part of Taluk is coastal area with cultivations like prawn and Pokkali rice. The eastern parts are fertile lands. The heavy industries of Kochi is located in Udyogamandal area of the Taluk. It is once famous for its traditional industries like coir, handlooms and agriculture. Now it is changing to a major suburb of Cochin, where people looking for jobs in city. North Parur is located at 8.78º N and 76º E. It has an average elevation ie. of 10 m. It has in the flat delta region of the Periyar river and cut by several canals, which have resulted in the formation of many islands. The ‘Kodungalloor Kayal’ (backwater) and ‘Varapuzha Kayal’ (back water) are in this Taluk.

Materials and Methods

The present investigation was carried out by selecting 15 dug wells, representing each of the wards of North Paravur Muncipality. Water samples were collected from all the 15 dug wells during December 2013 to may 2014 at regular intervals of one month between 9.30 and 10.30 am. The samples were brought to the laboratory in polythene bottles and kept cool in darkness until the analysis were completed. Water quality parameters viz temperature, pH EC, TDS, acidity, alkalinity, Total hardness, Chloride, free CO_2, DO, BOD, COD, Iron, Sodium, and Potassium were analysed as per the standard method (APHA, 2005).

Result and Discussion

The average values of various physico chemical parameters of the 15 dug wells are presented in table 1. The analytical data of the water samples varied with the place of collection, which may be attributed to differences in soil composition, extend of land pollution and the surroundings of the sources. From the analytical results, it is also seen that majority of water samples collected from the observation wells of the study area, fall under desirable or permissible category and hence suitable for drinking purposes. However, a small percentage of the samples are found to have concentrations of some constituents beyond the permissible limit. Such waters are not fit for human consummation and are likely to be harmful to health on continuous use.

Water temperature of the studied samples varied from 27.4°c to 32°c and has a close relation to the variation of atmospheric temperature as observed by Sunkad and Patil (2004). According to Zaijic (1971) water with temperature above 30^0c is unfit for public use. For water from deep aquifers, the dominant factor controlling ground water temperature is the geothermal gradient, which is the measure of the distribution of terrestrial heat.

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse effect on health, however a value below four will produce sour taste and higher value above 8.5 show alkaline taste Tiwari and Ali Manzon (1998). In the present investigation the pH value varied from 7.04 to 8.64. The observed values are within the prescribed limit of WHO, BIS and ICMR (6.0 to 9.2).

Electrical conductivity in water is due to ionization of dissolved inorganic salts. EC is an excellent indicator of TDS, which is a measure of Salinity that affects the taste of potable water (WHO 1984). In the present study EC ranges from $1.05\text{x } 10^{-3}$ to $7.2\text{x}10^{-3.}$. Water with EC ranging from 750 – 3000 s/cm at 25^0c falls under the permissible limit.

Total dissolved solids of water samples were in the range of 0.012 to 1.03 mg/L. The maximum permissible limit of TDS in drinking water is 500 mg/L, according to WHO and BIS standards. The TDS values of all the studied samples are well below the permissible limit. Water containing high TDS concentration may cause laxative or constipation effects Kumara Swamy (1989) besides the taste.

Acidity in the present study was in the range of 2 to 6.5 mg/L. It showed an increasing trend. It gives a measure of effects of combination of compounds and conditions in water. Acidity lowers dissolved Co_2 content there by reducing photosynthetic activity. The permissible limit of BIS value is less than 1 mg/L. Acid waters are of great concern to industries because of their corrosive characteristic and the expense involved in removing or containing the corrosion producing substances Ramesh Babu M.G and Sleema .B (2009). In all the studied samples it is well above the permissible limit.

Alkalinity values of the present investigation varied from 62 to 425 mg/L. According to the WHO and BIS standards, permissible limit of alkalinity is 200 mg/L. In the present study alkalinity of samples 1, 2, 4, 5,8, 9 and15 showed a higher value than the permissible limit. The higher value of alkalinity indicates the presence of bicarbonate, carbonate and hydroxide in the water bodies Jain et.al (2000).

The total hardness of water samples was in the range of 2- 28 mg/L. The universal acceptable limit for total hardness is 500 mg/L. In the present study hardness is absent in sample 5,6,7,10,11,12 and 15. In the remaining samples it is well below the permissible limit. The adverse effects of total hardness are formation of kidney stones and heart diseases Freed et.al (2003), Sastry and Rathee (1998).

Chloride is present in all natural waters, mostly at low concentrations. It is highly soluble in water and moves freely with water through soil and rock. In ground water the chloride content is mostly below 250 mg/L except in cases where inland salinity is prevalent and in coastal area. In the present study concentration of chloride ion ranges from 16.28 to 122.12 mg/L. BIS have recommended a desirable limit of 250 mg/L of chloride in drinking water, this concentration limit can be extended to 1000 mg/L of chloride in case no alternative source of water with desirable concentration is available. However ground water having concentration of chloride more than 1000 mg/L are not suitable for drinking purposes.

The investigation of dissolved oxygen revealed that value was between 1.6 to 9.1 mg/L. The minimum limit of dissolved oxygen for fresh water as per ICMR (1975) and ISI (1991) standards is 5 to 6 mg/L. Its depletion is the most critical manifestation of pollution. DO determines the quality of drinking water and gives an aesthetic taste to it. Value of DO depends on physical, chemical and biological activities of the water sources B.H.Mehta and M.B. Mehta (2000).

Free CO_2 ranged from 0.88 to 10.12 mg/L. Aquatic plant life, from phytoplankton to large rooted plants, depend upon CO_2 and bicarbonates in water for growth. The significant factor is that when O_2 concentration falls through degradation of organic wastes. The limit of carbondioxide as per acceptable standards is 10 mg/L for surface water and increased carbondioxide above this level indicates increase in pollution load Koshy and Nair (1999).

The BOD values ranged from 0.2 to 4.2 mg/L. It is a measure of the organic strength of water. Typical natural waters has BOD value ranging from 0 to 8.5 mg/L. The permissible limit for BOD as per WHO (1992) is 5 mg/L. The waters from all the samples of the study area have BOD values much less than the permissible limits. Anything above 6 mg/L to be treated as it will rob the water of we needed O_2 for the fish and other organisms.

The COD values measured varied from 100 to 940 mg/L. The higher value of COD indicate the presence of oxidizable organic matters (Garg, 1998; Chandrasekhar et.al, 2003). According to BIS, the maximum permissible limit of COD for discharge of effluents into surface waters is 250 mg/L. Only two of the studied samples, exceed the maximum permissible limit.

The concentration of iron in the present study varied from .001 to .023 mg/L. Concentration above 1 mg/L will impart a foul taste to the water. In all the samples the concentration iron was well below the permissible limit. WHO (1984) recommends the maximum permissible limit of filterable iron in the drinking water as 0.3 mg/L to 1 mg/L respectively.

Sodium ion is ubiquitous in water. Drinking water usually contain about 50 mg/L. Most water supplies contain less than 200 mg/L; but in some country it may exceed 250 mg/L. Saline intrusion, mineral deposits, see water spray, sewage effluents, domestic and industrial discharges contribute significant quantities of sodium to water. The maximum permissible limit of sodium in drinking water is 50 mg/L as prescribed by WHO, (1984) whereas in the studied samples it varied from 16.6 to 56.4 mg/L.

Potassium is an essential nutrient for humans. Adverse health effects from exposure to increased potassium in drinking water are unlikely in healthy people.

In water potassium has no smell or colour, but may give water a salty taste. In the present study, potassium concentration ranged from 1.2 to 32.5 mg/L. No numerical concentration of drinking water quality guideline exist for potassium.

Conclusion

In general, the various physicochemical parameters of ground water samples indicate the type of water, its quality and the nature of aquifers, provided the water sources are free from various anthropogenic activities. The chemical composition of ground water will vary depending upon factors like frequency of rain, which will leach out the salts, time of stay of rain water in the root- Zone and intermediate zone, presence of organic matter etc. It may also be pointed out that the water front does not move in a uniform manner as the soil strata are generally quite heterogeneous. The overall effect of all these factors is that the composition of ground water varies from time to time and from place to place.

Interpretation of hydrochemical data of dug wells of North Paravur Muncipality reveals that the ground water showed an acidic trend in 50% of the samples where as in the remaining samples it is alkaline. Parameters like temperature, pH, EC,TDS, Hardness, chloride are well below the permissible limit on the other hand CO_2, BOD, COD are in the desirable limit except in one sample. Iron, Na, K are well below the permissible limit. Thus the overall results showed that water samples of the studied area remained within the safe limits throughout the study period which shows that the water samples are fit for utilization for domestic as well as for irrigation purposes.

Table 1: Results of physicochemical analysis of dug well water samples of North Paravoor Municipal area.

Sl.	Wards Parameters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Temperature	28.5	28.3	28.9	28.3	28.9	27	27.5	28	28.5	29	30	32	28	27.5	28.20
2.	pH	7.04	7.23	7.31	7.39	8.03	8.27	7.71	7.23	8.64	7.83	7.34	8.34	7.76	7.17	8.09
3.	Electrical Conductivity	1.7 x 10^{-3}	1.05 x 10^{-3}	1.3 x 10^{-3}	1.11 x 10^{-3}	2.4 x 10^{-3}	2.6 x 10^{-3}	1.2 x 10^{-3}	7.2 x 10^{-3}	4.2 x 10^{-3}	1.8 x 10^{-3}	3.3 x 10^{-3}	1.78 x 10^{-3}	2.8 x 10^{-3}	6.8 x 10^{-3}	6.9 x 10^{-3}
4.	TDS	0.52	.035	.111	.056	.093	1.03	.018	.321	.121	.012	.025	.012	.420	.052	.231
5.	Acidity	4	4	4	4	6	2	3	6	3	4	3.5	3.8	10	6.5	4.5
6.	Alkalinity	322	300	172	372	330	162	132	326	425	194	62	104	106	168	255
7.	Total Hardness	17	4	2	28	-	-	-	3	2	-	-	-	4	4	-
8.	Chloride	34.08	19.88	17.04	122.12	55.38	19.88	26.98	18.46	29.82	19.88	31.24	22.72	22.73	71	16.28
9.	DO	16	5.6	5.6	4	5.4	7.84	3.68	5.28	43.36	4.32	7.5	7.4	6.4	5.8	9.1
10	CO_2	5.67	5.9	7.97	10.12	2.64	3.52	0.88	4.4	1.76	3.52	0.88	0.88	5.28	5.23	0.88
11.	BOD	0.6	1	0.6	0.35	0.2	4.2	1.2	0.25	0.7	0.2	0.4	1.7	0.4	0.6	0.6
12.	COD	120	100	700	160	102	150	120	178	100	110	1540	940	185	200	100
13	Iron	.023	.011	.003	.003	.006	.020	.011	.001	.008	.004	.006	.004	.010	.009	.001
14.	Sodium	21.5	40	52.3	44.6	18.3	43.4	42.3	35.6	26.8	39.9	51.1	51.8	24.9	56.4	16.6
15	Potassium	13.3	8.4	7.2	20.1	4.6	5.2	6.6	1.8	1.2	34.5	6.2	2.9	12.1	6.6	32.5

All the parameters are in mg/l except temperature, pH and electrical conductivity (micro Siemens /cm)

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A POST MONSOON STUDY OF WATER QUALITY STATUS OF GROUND WATER SAMPLES OF VADAKKEKARA PANCHYATH, ERNAKULAM, KERALA, INDIA.

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Abstract

Ground water is the major source for domestic, agricultural and other related activities. Water quality status of dug well, bore well and tap water of 19 wards of Vadakkekara Panchayath in Ernakulam District of Kerala state was assessed for a period from September 2013 to December 2013, with an objective to see whether these water sources are satisfying the standards of drinking water. Parameters like temperature, pH, electrical conductivity, total dissolved solids, acidity, alkalinity, total hardness, free Carbon dioxide, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, calcium, magnesium, iron, sodium and potassium were analyzed. The investigation reveals that tap water is most suitable for drinking purposes and water sample from dug wells and bore wells have water quality problems. Therefore, it is suggested that any ground water sources in the studied area should be analyzed before use for its suitability for domestic purposes.

Key words: *Dug well, Bore well, water quality, Drinking water standards, Potability*

Introduction

Water acts as a limiting factor for survival of human being. As it is required to meet the increasing demand of power, economic growth and industrialization, many countries throughout the world are suffering from the shortage of water supply of potable water as also being affected by contamination of water resources in most developing countries (Subroto Dutta et.al 2010). The water quality of a system depends on the Terrain through which it follows and its quality depends upon physical chemical and bacterial constituents. (Krishnamoorthi 2010). The world's Groundwater reservoirs are probably the planet's must important fresh water supplies from groundwater. It is one of the major sources of drinking water in the villages and rural areas of the country. It also provides the essential source of water for irrigation and small scale industry. The availability of Ground water depends on rate at which it is recycled by Hydrological cycle. Effective management of water resources and control of pollution are becoming increasingly important for sustainable development and human welfare (Mehta 2000).

Various kinds of material and manmade activities like Industrial Domestic and Agriculture, create water pollution problems particularly in freshwater system. The chemistry of water is influenced by the inputs of materials containing minerals and the chemical equilibrium prevailing the acquatic solution. Extend of pollution also depends on rainfall pattern, depth of water, distance from the source of contamination and soil properties (Chatterji 1994). According to WHO (1984), 30-80% of human diseases occur due to impurities of water.

A survey made by Agarwal et.al shows that 70% India's fresh waters are polluted as per conventional standards. Therefore, continuous periodic monitoring of water quality is necessary. Further it has been reported the 77% of Urbum population and only 31% rural population in India has access to portable water. In the literature much of the available data on drinking water quality are from Urbun and industrialized areas. Hence, the present study on attempt has been made to study the water quality of Vadakkekara Panchayatt in Ernakulam District in Kerala (Sleema 2009).

Study Area

Vadakekkara Panchayath is a census town, panchayath in Paravoor Taluk, Ernakulam Distrtict, Kerala State in India and is located about 35 km from Ernakulam city. It is one of the early formed panchayath in the state and is situated in the north of Paravoor river. It included numerous islands and was the most important province under Paravoor Kingdom as it included Muziris, where most of the ships landed in the coasts of this Panchayath. Coconut palms are the main agriculture crop of this area. People of this area mainly depend on tap water, dug well, bore well and fresh water ponds for their water needs.

Materials and Methods

The present paper describes the result of a repeated survey of quality parameters of drinking water sources such as ground water of dug wells, bore wells, and municipal supply from 19 wards of Vadakkekara panchayath. Water samples were collected from each of the 19 wards of Vadakkekara panchayath, during September 2009 to December 2009. Samples collected in pre cleaned polyethylene bottles were brought to the laboratory for various physico chemical analyses. All the reagents used were of A.R. grade. Water quality parameters viz temperature, pH, electrical conducitivity, total dissolved solids, acidity, alkalinity, total hardness, chloride free CO_2, DO,BOD, COD, calcium, magnesium, iron, sodium, potassium, were analyzed as per the standards methods of APHA (2005) and by Vogel (2008).

Results and Discussion

The results of the physicochemical analysis of dug well, borer well and tap water of the 19 wards of Vadakkekara Panhayath in Ernakulam District of Kerala are given in tables 1, 2 and 3. The quality of water samples varied with different places of collection because of the differences in the sources or surroundings of these resources.

Temperature

Water temperature is of enormous significance as it regulate various abiotic characteristics and biotic activities of a aquatic ecosystem (Ray et.al 2008). Processes like exchange of heat with atmosphere and any localized phenomena are likely to influence the distribution of temperature (Ramesh Babu 2012). Temperature of the water samples studied ranged from 27.9 – 29.6^0 C in dug wells, 24.6 – 29. 4^0 C in tap water and 28.1 – 29. 5^{0}C in bore well samples. Present observation of surface water temperature in the study area agrees with the observation of Kaul et.al 1980 that surface water temperature remains close to the air temperature.

pH

pH is considered as an important ecological factor which provides an important piece of information on many types of geochemical equilibrium or solubility calculations. The pH values of dug well samples varied between 6.8 – 8.34, bore well samples 6.9 - 8.24 and tap water, 6.48 – 7.48, showing that in all the studied samples the value falls within the permissible limit of 6.5 and 8.5 (BIS 1991). In water, variations in pH value from 7 is mainly due to the hydrolysis of salts of strong bases and weak acids or vice versa. Dissolved gasses such as CO_2 , H_2S, NH_3 also affect pH of water (Nima 2013).

Electtrical Conductivity

EC measurements provide an indication of ionic concentration. It depends upon temperature concentration and types of ion present (Jeyavel Rajkumar et.al 2010). The EC of the studied samples varied from 1.04 x 10^{-3} – 10 x 10^{-3} in dug wells, 0.46 x 10^{-3}–13.7 x10^{-3} and 0.06 x 10^{-3} - 8.6 x 10^{-3} in tap water. The maximum limit of EC in drinking water is 15 micro ohms/cm.

TDS

As ground water moves and stays for a long time in its flow path, increase in total dissolved concentrations and major ions normally occur (Noorris et.al. 1992). The principal ions contributing to TDS are bicarbonate, carbonate, chloride, sulphate, nitrate, solidum, potassium, calcium and magnesium (EPA 1976). The TDS of water samples from dug wells ranged from .025 – 0.4201 mg/l, in bore wells it ranged from .0906 -1881 mg/l in tap water it ranged from .018 - .0461 mg/l. The ISI prescribed limit of TDS for drinking water is 500 mg/l. In all the studied samples TDS value were well below the acceptable limit and is insignificant as compared to the value suggested by WHO and Indian standards. The most important aspect of TDS with respect to drinking water quality is its effect on taste (Subin 2011).

Acidity

It is the quantitative capacity of aqueous media to react with OH ions or to accept electrons. Water attains acidity from industrial effluents, acid mine drainage, pickling, liquors and from humic acid. The acidity of dug well samples ranged from 5 – 75.5 mg/l, in bore wells it ranged from 10 - 74.5mg/l and in tap water, 2.5 to 10 mg/l. Acidity lowers dissolved CO_2 content, thereby reducing photosynthetic activity. The permissible limit of BIS value is less than 1 mg/l. Acidity is of little concern from sanitary or public health view point. But acid waters are of concern to industries because of their corrosive characteristics and the expense involved in removing or containing the corrosion producing substances (Ramesh Babu et.al 2012). In all the studied samples the acidity values are well above the permissible limit.

Alkalinity

The presence of carbonates, bicarbonates and hydroxides is the main cause of alkalinity in natural waters. Bicarbonates represent the major factor since they are formed in considerable amount from the action of carbonates upon the basic materials in the soil (Mumtazuddin 2012). In dug wells the alkalinity value ranged from 75 – 425mg/l, in bore wells, 150 – 450 mg/l and in tap water 15 – 75 mg/l. The WHO acceptable limit for alkalinity is 200 mg/l. But BIS has extended this limit to 600mg/l in the case of non availability of alternate sources. Alkalinity of water source is more significant than its pH because it takes in to account the principal constituents that influence the waters ability to regulate the pH of the medium (Sleema 2009).

Total Hardness

TH of dug well samples in the present study varied from 17 – 424 mg/l, in bore well samples, 123 – 1414 mg/l and in tap water, 22- 82 mg/l. Calcium and Magnesium along with their carbonates, sulphates and chlorides make the water hard in ground water. The water hardness is primarily due to the result of interaction between water and geological formations. The WHO/ USPH limit is 100mg/l whereas the highest desirable ISI limit is 300 mg/l. High values of total hardness in water may cause kidney stones and heart diseases in humans (Sleema 2009).

Calcium

Calcium is present in natural waters in plenty. Since it is available in large quantities in rocks, it is leached from these and contaminate the water. It is also an important source from disposal of sewage and industrial waste water. It has no hazardous effect on human health (Kavimani et.al 2011). The dug well samples have calcium concentration ranging from 33.9 – 77.9 mg/l, bore wells, ranged from 12.62 – 112.20 mg/l and in tap water it ranged from 4.81 – 11.62 mg/l. The general acceptable limit of calcium in water is usually 75 mg/l, whereas its maximum permissible limit is 200 mg/l (ICMR 1975).

Magnesium

Magnesium is a common constituent of natural water and an important contributor to the hardness of water. It forms scale in boiler when water containing magnesium is heated. Chemical softening, reverse osmosis, electro dialysis etc reduces magnesium and associated hardness to acceptable levels (Nima 2013). The magnesium varied from 11.69 – 83.03 mg/l in dug wells, 42.14 – 221.17 mg/l and 2.523 – 21.433 mg/l in tap water. In dug wells and tap water samples its concentration is below the permissible limits. But in bore wells 13 samples exceeds the permissible limits whereas in the remaining samples, it is within the desirable limits. ISI specified maximum permissible limit of Mg is 30 mg/l. According to the value prescribed by KSPCB, the relaxation allowed value for Mg is 100mg/l.

Chloride

Chloride content of water is another important parameter to be considered to know the quality of water as its higher concentrations can impart undesirable taste to water and may cause corrosion in the distribution system (Mc Connell 1972). An aesthetic objective of 250 mg/l has been established as maximum desirable limit and 100 mg/l as maximum excessive limit of chloride for drinking water (BIS 1998). The study shows that in dug wells chloride value ranged from 112.3 to 705 mg/l, in bore wells it ranged from 103.6 – 676.2 mg/l. In majority of dug wells and bore wells samples, the value exceeds the desirable limit, whereas in tap water it is well below the desirable limit.

Free CO_2

The range of free CO_2 concentration in dug well is 5.9 - 52.9 mg/l, in bore well, 13.33 - 31.42 mg/l in tap water, .099 - 3.995 mg/l. Typically surface waters contains less than 10 mg/l free CO_2, while in ground water may have much higher concentration and increase in CO_2 above this level indicates increase in pollution load (Koshy 1999). The free CO_2 concentration in water indicates the presence of decomposable organic matter, bacterial action on organic matter and physiological activities of biotic components. (Sawant et.al 2010).

Iron

The value of iron concentration in dug well ranged from .001 - .023, in bore well, .001 - .061 and in tap water, .002 - .062 mg/l. The permissible limit of iron is 0.3 – 1.0 mg/l. In all the studied samples, it is well below the permissible limits. Concentration above 1mg/l will impart a foul taste to water (Ramesh Babu 2009).

Sodium

The Sodium concentration in dug wells ranged from 19.1 – 58.2 mg/l. Sodium ion is ubiquitous in water. Drinking water usually contain about 50mg/l. Most water supplies contain less than 20mg/l, but in some countries levels can exceed 250mg/l. Saline intrusion, mineral deposits, sea water spray, sewage effluents, salt used in road for de-icing can contributes significant quantities of sodium to water. In addition, water treatment chemicals, such as NaF, $NaHCO_3$ and Sodium hypochlorite, can together result in Sodium levels as high as 30 mg/l. Domestic water softeners can give levels of over 300mg/l. Excessive salt intake seriously aggravates chronic congestive heart failure and ill effect due to high levels of sodium in drinking water have been documented.

Potassium

Potassium is an essential element for humans, plants and animals and is derived in food chain mainly from vegetation and soil. The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of sub surface water for irrigation. It is more abundant in sedimentary rocks and commonly present in felspar, mica and other clay minerals (Mumtazuddin 2012). The potassium concentration ranged from 1.2 - 34.5 mg/l in dug wells, in bore wells, it ranged from 4.3 – 25.6 mg/l and 0.4 – 4.2 mg/l in tap water. In dug wells for samples and 5 samples in bore wells have potassium concentration higher than the permissible limit of 10 mg/l as prescribed by BIS 1991.

Dissolved Oxygen

It is important to consider the DO content of drinking water because oxygen imparts a good taste to water and is an absolute requirement for the metabolism of aerobic organisms in water bodies. Decrease in DO can favor anaerobic decomposition of organic wastes and gives a bad odour to water. Its depletion is the most critical manifestation of pollution (Sallae 1974). In the present investigation DO values of dug well water ranged from 5.2 – 8.8 mg/l, in bore well waters, 3.2 - 7.6 mg/l and in tap water, it ranged from 3.8 - 8.4 mg/l. The minimum limit of DO required for fresh waters as per ICMR (1975) and the ISI (1991) standards is 5 - 6 mg/l. Generally, an increased value of BOD and COD indirectly indicate decrease in DO values.

BOD

BOD is the amount of oxygen required by the living organisms engaged in utilization and ultimate destruction or stabilization of organic matter in water (Hawkes 1963). It is an important indicator of water pollution. BOD values of water samples in the present study varied from 0.2 - 4.2mg/l in dug wells, 0.2 -8.4 mg/l in tap water and 0.4 – 5.3 mg/l in bore wells. As per BIS the maximum desirable limit of BOD for drinking water is 5mg/l. Here it is observed that all the samples from dug wells, bore wells and tap water are below the desirable limits except in one sample from tap water.

COD

COD is widely used for measuring organic strength of domestic and industrial wastes. COD test estimate the amount of waste in terms of the total quantity of oxygen required for the oxidation of organic substances. The COD values measured varied from 700 – 20,000 mg/l in dug wells 800 - 16400 in bore wells and 32500 - 46200 mg/l in tap water. According to BIS (1991), the maximum permissible limit of COD for discharge of effluents into surface waters is 750 mg/l. All the observed value were well above the permissible limits. The higher value of COD indicate the presence of oxidizable organic matter (Sleema 2009).

Conclusion

Potable water is defined as water that is free from disease producing micro organisms and chemical substances deleterious to health. Unfortunately, clean, pure and safe water exists only briefly in nature and is immediately polluted by prevailing environmental factors and human activities. On the basis of physico- chemical studies, it may be concluded that the quality of drinking water from dug wells and bore wells are not fully safe for human consumption. Study further revealed that tap water is most suitable for drinking purposes. Though temperature, pH, TDS, alkalinity, chloride, Iron, sodium and BOD were found within the desirable limits, parameters like CO2, COD and Acidity, were above the permissible limit. DO, Sodium, Iron, total hardness, calcium and magnesium in the studied samples show anomalies. The results also suggest that the even though the contamination problems is not alarming at present, ground water quality of study area may deteriorate with time. Therefore, for clean water and healthy environment, proper disposal of industrial and other effluents as well as awareness creation among the people has become urgently needed.

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TABLE 1 - DUG WELL

No	Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Temp (⁰ C)	28.5	29	29	28.8	28	28.6	29.2	28.8	29.6	29	27.9	28.4	28.6	28.2	29.9	29	28	28.7	28.9
2	pH	7.04	7.23	7.31	7.39	8.03	8.27	7.71	7.23	8.64	7.83	7.34	8.34	7.76	7.17	8.09	7.72	7.65	8.24	6.99
3	EC (Siemen)	1.7×10^{-3}	1.05×10^{-3}	1.3×10^{-3}	1.11×10^{-3}	2.4×10^{-3}	2.6×10^{-3}	1.2×10^{-3}	7.2×10^{-3}	4.2×10^{-3}	1.8×10^{-3}	3.3×10^{-3}	1.78×10^{-3}	2.8×10^{-3}	6.8×10^{-3}	6.9×10^{-3}	4.3×10^{-3}	2.8×10^{-3}	1.04×10^{-3}	2.1×10^{-3}
4	TDS	.521	.035	.111	.056	.093	.103	.068	.321	.1213	.0123	.025	.0121	.4201	.0521	.2315	.0315	.0326	.0167	.082
5	Acidity	66	13.5	15	5	18.5	19	60	75.5	30	34,5	10	12.5	51.5	17.5	18.5	54.5	30.5	10	40
6	Alkalinity	405	300	175	90	75	375	175	325	425	225	365	160	335	405	255	375	195	205	2045
7	Total Hardness	110	360	17	122	231	424	247	386	95	147	177	308	311	192	200	232	160	348	246
8	Calcium	33.9	50.05	77.9	46.3	68.9	51.3	62.7	44.4	46.9	39.2	49.7	56.2	66.6	62.3	45.6	38.1	52.0	71.2	65.4
9	Mg	18.5	75.34	19.2	18.4	39.4	90.5	44.7	83.03	11.69	26.2	30.9	61.2	59.4	31.5	37.53	47.13	26.2	67.28	43.8
10	Chloride	332.6	.705	265	438	495	213	112.3	562	700	365	635.1	621	246	321	157	474	372	321.7	426.7
11	Free CO_2	52.9	5.9	7.97	20.3	10.99	43.4	31.6	34.5	16.9	28.4	30.9	45.6	25.6	18.4	32.3	9.8	20.8	24.6	20.02
12	Iron	.023	.011	.003	.003	.006	.020	.011	.001	.008	.004	.006	.004	.010	.009	.001	.007	.010	.011	.004
13	Na	21.5	40	52.3	44.6	18.3	43.4	42.3	35.6	26.8	39.9	51.1	51.8	24.9	56.4	16.6	19.1	58.2	36.8	60
14	K	13.3	8.4	7.2	20.1	4.6	5.2	6.6	1.8	1.2	34.5	6.2	2.9	12.1	6.6	32.5	7.7	6.2	4.2	8.2
15	DO	8.2	7.4	7	6	7.2	5.4	7.4	6.8	6	8	7.7	7.8	8.8	8.2	6.2	5.2	8.1	7.6	7.2
16	BOD	0.6	1	0.6	0.35	0.2	4.2	1.2	0.25	0.7	0.2	0.4	1.7	0.4	0.6	0.6	3.8	3.4	0.2	0.2
17	COD	12000	10000	7000	16000	10200	12000	17800	10000	11000	15400	9400	18500	20000	10000	16000	15400	17800	17800	5400

All Parameters are in mg/l except temperature, pH and Electrical conductivity.

TABLE 2- BORE WELL

No	Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Temp (^{0} C)	28.9	29.3	29.1	28.8	29.3	29.3	28.9	29.5	28.8	28.2	28.5	29.2	28.4	29.6	29.2	28.1	28.9	28.8	29.1
2	pH	7.01	7.65	8.24	8.23	8.12	7.74	6.9	7.17	8.08	8.16	8.01	8.09	7.24	8.09	8.20	7.93	7.76	6.99	7.89
3	E C (Siemen)	6.9×10^{-3}	7.3×10^{-3}	14.2×10^{-3}	$.46 \times 10^{-3}$	8.5×10^{-3}	7.3×10^{-3}	8.2×10^{-3}	10.6×10^{-3}	5.5×10^{-3}	6.3×10^{-3}	8.6×10^{-3}	7.2×10^{-3}	13.7×10^{-3}	10.2×10^{-3}	9.4×10^{-3}	4.4×10^{-3}	12.2×10^{-3}	11.6×10^{-3}	10.1×10^{-3}
4	TDS	.1321	.982	.826	.1796	.1834	.927	.1637	.0906	.1727	.1681	.1264	.811	.1868	.1241	.836	.1770	.1881	.0924	.801
5	Acidity	40	36	24	60	50.5	34	10	20	35	46	40	17.5	34.6	25	10	62.5	15	30	55
6	Alkalinity	365	195	265	240	325	420	165	176	396	185	208	180	255	400	355	260	450	360	312
7	Total Hardness	340	568	835	615	470	123	596	568	916	186	499	401	516	246	625	826	370	1414	1012
8	Calcium	72.61	93.60	22.15	47.16	28.96	21.62	32.72	40.11	67.29	12.62	39.29	30.68	32.99	24.82	41.21	24.21	22.86	112.20	102.1
9	Mg	64.99	115.31	197.58	138.02	107.20	24.64	136.91	128.31	206.29	42.14	111.74	90.01	105.25	53.76	141.90	194.89	72.22	316.43	221.17
10	Chloride	161.2	324.1	301.3	468.31	142.3	676.2	362.9	624.1	103.6	414.6	246.6	423.3	186.9	526.3	394	876	443.2	496.4	276.1
11	Free CO_2	29.91	31.28	31.96	13.33	22.98	27.97	12.32	30.96	28.26	22.61	16.67	30.62	30.92	15.98	30.19	29.16	31.42	15.15	34.2
12	Iron	.006	.013	.001	.006	.001	.014	.022	.017	.027	.031	.008	.009	.027	.036	.061	.009	.018	.017	.031
13	Na	20.2	19.4	16.8	21.7	24.6	14.6	26.1	17.8	22.8	25.7	26.0	19.9	28.1	21.7	15.7	27.7	21.6	16.9	20.6
14	K	25.6	13.6	10.8	6.7	5.5	7.8	4.3	4.9	7.8	6	10.7	3.9	8.8	8.9	12.4	7.8	6.3	8.9	6.7
15	DO	7.2	4.6	3.8	4.2	5.2	7.6	6.8	4.6	4.5	5.1	3.9	4.3	7.2	3.2	6.4	4.6	6.7	5.6	4.5
16	BOD	0.8	2.2	3.6	4.6	1.2	3.7	5.0	4.7	0.4	3.4	4.4	5.1	2.4	5.2	3.8	5.3	1.4	4.8	0.7
17	COD	4600	16000	6000	5400	1100	12000	7400	6000	1050	5200	7300	800	7400	16400	5000	6000	7200	950	4500

All Parameters are in mg/l except temperature, pH and Electrical conductivity.

TABLE 3- TAP WATER

No	Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Temp (^{0} C)	29	28.3	29.4	291	28.3	29	29.1	28.2	29.1	28.4	28.8	24.6	29	28.3	29.1	28.2	28.8	29.1	29
2	pH	7.01	7.03	7.001	7.09	7.04	6.48	7.09	7.48	6.92	7.03	6.83	6.92	7.05	7.03	7.04	6.92	7.03	7.09	7.42
3	EC (Siemen)	3.4×10^{-3}	$.06 \times 10^{-3}$	$.21 \times 10^{-3}$	3.9×10^{-3}	7.6×10^{-3}	8.4×10^{-3}	$.28 \times 10^{-3}$	$.21 \times 10^{-3}$	46×10^{-3}	$.31 \times 10^{-3}$	7.5×10^{-3}	6.2×10^{-3}	$.28 \times 10^{-3}$	8.6×10^{-3}	3.1×10^{-3}	70×10^{-3}	5.5×10^{-3}	9.4×10^{-3}	93×10^{-3}
4	TDS	.0412	.0221	.0232	.0339	.0461	.0222	.0432	.0192	.0323	.0189	.018	.0310	.0232	.0432	.0314	.0278	.046	.0326	.0298
5	Acidity	7.5	2.5	10	5	2.5	7.5	10	10	2.5	7.5	2.5	7.5	5	5	10	10	7.5	2.5	10
6	Alkalinity	40	70	20	60	35	75	40	30	25	30	50	35	15	50	40	25	30	60	30
7	Total Hardness	26	68	40	22	28	62	38	26	70	64	33	94	34	28	82	30	60	32	38
8	Calcium	8.021	6.21	9.002	11.62	8.042	7.043	4.021	5.004	9.213	4.921	4.810	5.821	4.912	6.789	7.016	5.925	6.225	7.004	6.061
9	Mg	4.37	15.019	7.534	2.523	19.958	13.358	8.259	5.103	14.477	14.36	6.852	21.43	7.0704	5.155	18.26	5.851	13.065	6.0758	7.763
10	Chloride	12.32	38.42	22.72	36.6	16.28	28.89	16.26	45.62	50.06	24.70	35.5	62.25	52.06	42.36	59.63	15.62	28.82	36.62	38.46
11	Free CO_2	1.99	1.999	.099	2.995	2.991	0.998	1.998	2.998	1.998	2.996	0.999	1.995	3.992	1.998	3.995	1.998	2.995	3.991	1.998
12	Iron	0.002	0.011	0.015	0.062	0.021	0.018	0.016	0.013	0.027	0.011	0.028	0.008	0.018	0.021	0.002	0.011	0.019	0.028	0.016
13	Na	3.5	7.0	1.4	4.2	2.8	1.8	3.1	2.2	1.8	13.3	2.8	13.5	3.6	1.7	3.2	1.0	1.9	12.4	4.6
14	K	0.6	2.1	0.4	3.4	1.3	4.2	1.2	1.7	0.7	0.5	2.1	0.8	0.8	2.5	1.1	0.07	2.1	2.9	0.9
15	DO	6.8	7.2	3.8	4.6	5.6	7.2	6.8	6.6	4.2	6.2	4.8	8.4	5.6	4.6	7.4	5.2	6.6	8.6	7.4
16	BOD	2.8	8.4	4.8	0.8	0.2	0.4	1.4	1.2	0.4	1.0	1.6	4.6	2.0	0.2	1.8	1.6	1.4	0.4	1.0
17	COD	46200	41000	43800	41800	38000	42800	33000	41800	43800	40000	37200	40800	44300	39000	42000	33000	42000	32500	41800

All Parameters are in mg/l except temperature, pH and Electrical conductivity.

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