

# **ACADEMIA**

**A Multi Disciplinary Journal**



**Volume 1**

**Nehru Arts & Science College Kanhangad Publication**

**Publisher:** Principal,  
Nehru Arts and Science College,  
Kanhangad, 671 314

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## **Editorial**

This is an exciting turning point in the history of Nehru college . The college with the help of Parent Teachers Association is launching a multidisciplinary research journal “Academia”. Nehru college has been imparting great service to the society by providing university level education for the past 47 years and the society around Nilaswar had changed a lot due to this. By these years our workforce which is our teachers had acquired great expertise in science, languages, mathematics, humanities etc through research and continuous learning. Through this journal we intend to share this knowledge with others.

Dr. K. M. Udayanandan

**Editor**

This volume of the journal is dedicated to the following teachers who are going to retire this year.



**Dr. A . Muralidharan**



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# Germination Performance of West Coast Tall Coconut Seeds (*Cocos nucifera* L.) Growing in Two Agro-Climatic Regions Of Kerala

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(Submitted: 16-03-2015 Revised: 23-03-2015)

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## Abstract

Coconut is known to be the most important commercial crop in the world. Coconut is propagated by seed, the selection of seed nut is very important for obtaining high percentage of germination. Present work carried out the study of germination and of ecotypes growing in hilly midland and coastal regions of Kerala and comparison of its similarity/diversity with West Coast Tall (WCT) growing in coastal regions with the help of seedling morphology. Well matured seed nuts of WCT and ecotypes were collected from two different geographical regions of Kerala. Kuttiyadi in Kozhikode district and Bedakam in Kasaragod district from the midland region, Annur in Kannur district and WCT in CPCRI field Kasaragod from the coastal region. After one month of dormancy period, during early June, the collected seed nuts were sown in the CPCRI nursery situated in coastal region. From the study it was observed that number of days taken for germination varied among ecotypes and WCT. Compared to WCT, ecotypes took less days for germination.

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**Keywords**— Coconut, germination, ecotypes, morphology.

## Introduction

Coconut is known to be the most important commercial crop in the world. Since coconuts are propagated by seed, the selection of nut is very important for obtaining high percentage of germination [1]. The growth of the coconut seedlings is dependent on the reserves for almost one year after germination. The first leaf unfolds at two months after germination. At the fourth month, the plant entirely depends up on the endosperm for its growth while at the 15<sup>th</sup> month, it becomes fully autotrophic [3]. Germination of the seed is influenced by many factors like water, aeration, temperature and light [7]. Kolhler et al., (1962)

mentioned that the germination of seeds might start during the inhibitions. Germination studies on WCT seedlings [6] indicated that whatever might be the storage period, a high percentage of germination and recovery of quality seedlings can be obtained only if the weather conditions are favorable during germination and development of seedling.

Present work carried out the study of germination characterization of ecotypes growing in hilly midland and coastal regions of Kerala and comparison of its similarity/ diversity with West Coast Tall (WCT) growing in coastal region with the help of seedling morphology the early stages of germination.

## Materials and Methods

Coconut populations of Malabar region of Kerala were selected based on farmer's participatory survey. The population was selected from coastal region and midland region. In midland region two populations of WCT ecotype were selected from Bedakam (in Kasaragod) and Kuttiyadi (in Kozhikode). Others were in coastal region WCT (CPCRI, Kasaragod), and WCT ecotype of Annur (in Kannur). Geographically, these four selected locations showed wide range of variations. The selected coastal regions were located at CPCRI, Kasaragod (12.31°N latitude and 74.51°E longitude and at an altitude ranged from 15-17 MSL) Annur (12.07°N latitude and 75.11°E longitude and at an altitude ranged from 10-15 MSL). The ecotype growing in midland regions were located at Bedakam in Kasaragod District (12.27°N latitude and 75.09°E longitude and at an altitude of 190-240MSL) and Kuttiyadi in Kozhikode District (11.41°N latitude and 75°E longitude and at an altitude of 80-350MSL). Soil and climatic conditions of these locations showed wide range of variations. (Table 1)

For this study four well matured seed nuts/palm were harvested from selected palm/ location (200 palms selected / location, 4 locations, 4 nuts/palm). The seed nuts were harvested during the summer months (February-May, 12 months old nuts) and, were stored for one month in shade till the husk dries completely. After one month of dormancy period the seed nuts were sown in early June in the coastal area nursery of CPCRI Kasaragod. The date of germination of each nut was noticed when the tip of the sprout just emerged out of the husk. Number of days taken for germination was recorded from the date of sowing. After germination the growth measurements such as height of collar, girth at collar region, collar colour and number of leaves were recorded at an interval of 3 months up to one year.

All the experimental data were analyzed statistically using SAS Software (Local, W32). In general linear model univariate ANNOVA was run for every data set to find significant difference of WCT and ecotypes. Mean value and critical differences (CD)

were calculated from WCT and ecotypes.

## Results and Discussions

### Germination Performance

The observations recorded were the number of days taken for germination, the girth of collar, the height of the collar and the average number of leaves (one year old seedlings). The results were statistically analyzed and presented in Table-2. From the result it was observed that number of days taken for germination varied among the ecotypes and WCT. Compared to WCT, ecotypes took less days for germination (Table-2). According to Jerard et al., (2010), seed nuts of tall varieties begin germination within 60-130 days after sowing and seed nuts of dwarf varieties germinate 30-90 days after sowing. Appearance of shoot above the husk varies with varieties and also in same variety (Davis and Anandan, 1956). Two growth characters leaf production and collar girth are main criteria to indicate the vigorous growth of seedlings [6]. Present study observed that girth of collar was highest in coastal seedlings (WCT and Annur) compared to midland seedlings (Table-2). The leaves production was higher in WCT compared to ecotypes. Satyabalan, (1984) reported high and positive correlation of growth characters like collar girth and leaf production of seedlings from the fifth month of growth of the seedlings with those of later months. These findings enabled them to identify palms of superior genetic value based on the growth characters of the progeny even from the fifth month onwards.

These studies indicate that compared to ecotypes WCT delayed in starting germination. But in the later stage collar height, girth of collar and number of leaves was higher in WCT. Ecotypes started germination earlier and grow slowly to acclimatized new environmental conditions. The variations in the seedlings were observed, when they were grown in the same agro-climatic conditions (coastal region). This indicates that variation in germination characters among ecotypes and WCT may be due to the adaptability of coconut seedlings to survive the adverse environmental conditions. Some adaptation traits had underly-

Parameters	Locations			
	Annur	Bedakam	Kuttiyadi	CPCRI
Altitude (meter, above sea level)	10-15	190-240	80-350	15-17
Latitude	12.07°N	12.27°N	11.37°N	12.31°N
Longitude	75.11°E	75.09°E	75.49°E	74.50°E
Temperature(°C) Maximum	32.5	31.5	32.8	31.5
Temperature(°C) Minimum	21.5	21.3	21.3	21.3
Relative Humidity	(70-90)	(70-90)	(70-91)	(70-88)
Soil pH (Average)	6.52	5.21	5.05	4.41

Table 1: Geographical position, weather and soil pH of experimental locations

Ecotype	Days taken for Germination	Height (cm)	Girth (cm)	Number of Leaves after one year
WCT	138.7	140.98	11.5	8.68
Annur	117.26	113.15	12.81	6.76
Bedakam	106.34	127.11	10.23	6.41
Kuttiyadi	129.76	108.09	9.07	6.08
CD Value	7.61	10.81	1.35	0.36

Table 2: Germination observation

ing genetic changes that were passed on to progeny; some other traits were only manifestation of physiological adaptation to the environment.

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## *Lepidagathis prostrata* Dalz. (Acanthaceae) – A new addition to the State of Kerala

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(Submitted: 13-03-2015 Revised: 21-03-2015)

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### Abstract

Extensive floristic explorations conducted in the lateritic hillocks of Kasaragod district resulted in the collection of an Acanthaceae member which is new distribution record to the state of Kerala. Brief description, comparison with allied species, nomenclature, economic importance and photographs of this taxon are provided to facilitate easy identification.

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**Keywords**— *Lepidagathis prostrata*, Acanthaceae, New report, Kerala

### Introduction

The genus *Lepidagathis* Willd. is one of the diverse genera with about 100 species distributed mainly in the tropical and warmer regions of the world (Mabberley, 2008). In Kerala the genus is represented by 10 species (Sasidharan, 2011) of which *L. keralensis* P. V. Madhusoodanan and N. P. Singh described from Kannur (Madhusoodanan and Singh, 1992) is most common on the exposed lateritic rocks of North Malabar. This plant is well known for its therapeutic potential and is known as *Paramullu* (spines of the rock) in Malayalam. During recent floristic explorations in the lateritic hillocks of North Malabar, the authors came across this dominant species. Detailed examination of the specimens revealed that the *Paramullu* found in Padaladka and many other locations of Kasaragod district are quite different from *L. keralensis* and are the allied *L. prostrata* Dalz., a species common to Concan and Southern parts of Karnataka (Dalziel and Gibson, 1861; Cooke, 1908; Bhat, 2003). An effort to identify this species led to the conclusion that the species is not included in any of the publications of Kerala (Nayar *et al.*, 2006; Sasidharan, 2011). As the species is quite abun-

dant and well established, it is quite likely that the species has been collected by others but possibly mistaken to be the closely allied *L. keralensis*. It is enumerated here with updated nomenclature, brief description, phenological data, distribution, comparison with closely allied species and ethnobotanical uses collected from the local people using questionnaire and personal interview for better understanding of this taxon.

### Enumeration

***Lepidagathis prostrata* Dalz. (Fig. 1 – 2)** in Hook. J. Bot. Kew. Gard. Misc. 2: 138. 1850; Hook. in Fl. B. I. 4: 518. 1885; Dalz. and Gibs. in Bombay Fl. 190. 1861; Nairne in Flow. Plants of West. Ind. 237. 1894; Woodr. in J. Bomb. Nat. Hist. Soc. 12: 357. 1900; Cooke in Fl. Pres. Bombay 2: 395. 1908; Anon. in J. Bomb. Nat. Hist. Soc. 19: 874. 1910 and Bhat in Fl. Udupi. 484. 2003.

A rigid prostrate under-shrub; stems creeping and rooting near the base, obtusely quadrangular, glabrous, much-branched; young branches softly tomentose. Leaves small, sessile, rigid, up to 2.5

× 0.8 cm, oblong-lanceolate, spinous-pointed, recurved, pubescent on both sides, base somewhat cuneate; main nerves 4 – 5 pairs. Flowers in simple, erect, softly pubescent spikes, 1.3 – 5 cm long, usually terminal on short lateral ascending branches; bracts ca. 1.3 cm long, oblong-obovate, glandular-pubescent, spinous pointed, nerved, often purplish, ciliate; bracteoles ca. 0.8 cm long, linear-lanceolate, spinous-pointed, glandular- pubescent. Calyx ca. 0.9 cm long, 5-partite, glandular-pubescent inside and outside; the 3 outer segments of nearly equal length, the upper 5 – 7 nerved, ovate-lanceolate, twice as broad as either of the other 2 which are lanceolate and 3-nerved, all 3 spinous-pointed and with ciliate margins; the 2 inner lateral segments much shorter and narrower, linear-lanceolate, acute, ciliate. Corolla up to 1.9 cm long, pubescent outside, rose or yellowish-white, deeply 2-lipped; upper lip ca. 0.8 cm long, broad, rounded, shortly 2-toothed, marked with dark transverse lines; lower lip nearly 1.3 cm long; deeply divided into 3 sub equal oblong spreading lobes; palate-glabrous. Capsules ca. 0.9 cm long, ovoid-lanceolate, compressed, glabrous, 2-valved, 2-seeded. Seeds ca. 0.25 cm long, broadly ovoid, shortly hygrosopically hairy.

## Distribution

Endemic to Concan and Southern Karnataka.

## Flowering and Fruiting

December to March.

## Specimen examined

K. S. Prasad, 01302, Padaladka, Kasaragod district, Kerala, on 13. 01. 2012, 150 m altitude. Well established in the study area.

## Notes

This species can be easily identified from the closely allied *L. keralensis* by the characters given in Table 1. Perennation is by means of root stock. New shoots



Fig. 1- Habit



Fig. 2 - Flowers

Characters	<i>L. keralensis</i>	<i>L. prostrata</i>
Stem	Glabrous	Young stem softly tomentose
Leaves	1×0.3 cm, glabrous, acute blunt-accuminate at apex	Up to 2.5×0.8 cm, pubescent on both sides, spinous-pointed at apex
Spikes	Up to 2 cm long	Up to 5 cm long
Corolla	Upto 1 cm long without brown spots or lines in the palate	Upto 1.9 cm long, with dark lines in the palate

Table 1: Comparison of *L. keralensis* and *L. prostrata*

arise from the rootstock on the onset of monsoon. Spiny bracts and calyx are of much help in seed dispersal.

## Etymology

It is known as *Paremullu* in Kannada, *Paramullu* in Malayalam and *Pademullu* in Tulu (all three meaning rock spines) which are clear indicators of its habitat and spiny nature.



## Medicinal uses

Spiny bracts tied in a cloth are cooked with rice and resulting gruel is recommended to children as a preventive medicine for malnutrition, malabsorption and digestive disorders. Whole plant paste is applied on the head for same purpose. Whole plant decoction is advised for kidney stone and malnutrition. Whole plant decoction with cumin seeds is given for chest pain. Whole plant decoction is used for albumin in urine and digestive disorders. It is a blood purifier and increases blood. This plant is a much valued drug for children's diseases.

## Acknowledgements

The author is thankful to the local people for sharing the medicinal uses during the field visit, to the Principal and Management, Sir Syed College, Taliparamba and Nehru Arts and Science College, Kanhangad for providing the facilities.

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# Synthesis and Characterization of pH Responsive PVP-PEO Hydrogels Grafted with Methacrylic acid

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(Submitted: 16-03-2015 Revised: 23-03-2015)

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## Abstract

Methacrylic acid (MAA) grafted hydrogels composed of two hydrophilic polymers, namely Poly(ethylene oxide) and Poly(vinyl pyrrolidone) (PEO-PVP) have been made in aqueous medium via a two-step process, employing electron beam irradiation. The optimum conditions with regard to the feed composition, the dose for crosslinking and the subsequent grafting process have been optimised. The gels have been characterized for their swelling behaviour.

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**Keywords**— Hydrogel, Grafting, Electron beam irradiation, pH sensitivity.

## Introduction

Hydrogels are three dimensional networks of hydrophilic polymers obtained by physical or chemical crosslinking of the polymer chains. They possess the ability to absorb large amount of water while retaining the three dimensional structure and find extensive use in medical, pharmaceutical, agricultural and industrial fields [1–6]. “Stimuli responsive hydrogels” refers to a special class of hydrogels which exhibit dramatic changes in their physical or chemical behaviour in response to slight variations in external conditions such as temperature, ionic strength or pH of the medium etc. Intensive studies are being carried out on the development of such hydrogel materials, especially for biomedical and pharmaceutical applications [7–12].

## Results and Discussion

### Effect of Reaction Conditions On Crosslink Density and Extent of Grafting of Hydrogels

The gels used in the present study were made by a two-step process. In the first step, crosslinking of PVP and PEO chains has been achieved using electron beam. The irradiation experiments have been performed by varying the total concentration of the polymer in the 1:1 binary feed mixture and the total dose. In order to understand the effect of these parameters on the nature of the gel, The %S values have been recorded. The values obtained have been tabulated in Table 1. The minimum dose required for appreciable degree of crosslinking was 30kGy. The extent of crosslinking in the gels increased with increase in the concentration of the polymer in the irradiation mixture as well as the total dose given. The

hydrogels that were obtained from 16-20% polymer solutions irradiated with 100kGy retained integrity of their structure even on complete swelling and were selected for further studies of grafting with MAA.

In the second step of preparation, grafting of MAA units on the PEO-PVP hydrogels was achieved with electron beam irradiation at low doses. A series of experiments were carried out with the objective of obtaining the highest grafting percentage by changing the irradiation dose and MAA concentration. The extent of grafting was found to be influenced by the concentration of the monomer in the solution as well as the total dose employed for grafting, as shown in Figures 1a & 1b. For a particular concentration of MAA, the degree of grafting did not change much with dose, but, the influence of the concentration of MAA on the degree of grafting was appreciably high. Hence, the extent of grafting appears to be highly influenced by the concentration of the network polymer as well as of the grafting monomer. The results are tabulated in Table 2.

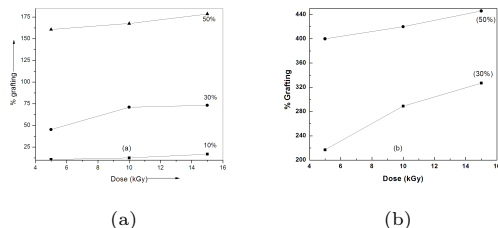


Figure 1: Effect of [MAA] and dose on %Grafting; polymer concentration (a) 20% & b) 16%

## Characterization of Gels

The scanning electron micrographs of PVP-PEO gels before and after grafting are presented in Figures 2a & 2b respectively. The surface of the PEO-PVP gels appears to be smooth, as shown by Figure 2a, and homogeneous texture is indicative of high miscibility between the two component polymers. The surface morphology appears to have changed on grafting, shown by Figure 2b, which is a clear indication of grafting on the PEO-PVP gel.

Total Polymer Concentration (%)	Dose (kGy)	Equilibrium Swelling ratio ( $S_e$ ) (%)
2.0	30	4834
2.0	50	3529
2.0	70	2831
2.0	90	2632
4.0	70	2040
4.0	90	1890
6.0	70	1632
6.0	90	1554
6.0	100	1476
8.0	90	1347
8.0	70	1581
8.0	100	1300
12.0	100	1027
16.0	100	978
20.0	100	720

Table 1: Effect of polymer concentration and dose on the equilibrium swelling of PEO-PVP (1:1) mixtures at pH 7.0

The FTIR spectra of pure and grafted hydrogels depicted in Figure 3a show the characteristic peaks of the components PVP, PEO & MAA. The peaks observed at  $3525\text{ cm}^{-1}$  for PVP-PEO gel & at  $3405\text{ cm}^{-1}$  for MAA grafted PVP-PEO are due to O-H stretching of end groups of PEO & carboxylic group of MAA respectively. The peak corresponding to C-H stretching is observed at  $2895\text{ cm}^{-1}$  for ungrafted gel loses its sharpness in the grafted gel indicating the occurrence of grafting on backbone of PEO-PVP chains reducing the intensity of C-H bond absorption. The peak observed at  $1668\text{ cm}^{-1}$  for PVP-PEO gel is due to carbonyl stretching of PVP. In the grafted gel, this peak gets shifted to  $1719\text{ cm}^{-1}$ . The peaks at  $1495\text{ cm}^{-1}$  for PVP-PEO &  $1483\text{ cm}^{-1}$  for MAA grafted PVP-PEO are due to the asymmetric bending of C-H bonds. The C-N stretching of PVP is shifted from  $1236\text{ cm}^{-1}$  to  $1256\text{ cm}^{-1}$  on grafting. The peak corresponding to C-O-C stretching of PEO is seen at  $1150$  &  $1171\text{ cm}^{-1}$  in the ungrafted and grafted gels respectively.

The DSC thermograms of PVP-PEO hydrogels before and after grafting with MAA are presented in Figure 3b. The peak around  $-50^\circ\text{C}$  is due to Tg of PEO and Tg of PVP appears around  $120^\circ\text{C}$  masked by melting peak of PEO. The presence of PMMA branches is proved by the shifts the broad endotherm from  $120^\circ\text{C}$  to lower temperature. An additional

Code	Polymer conc.	MAA (%)	Dose (kGy)	% grafting
PPM 1	20	10	5	11
PPM 2	20	30	5	45
PPM 3	20	50	5	161
PPM 4	20	10	10	11
PPM 5	20	30	10	71
PPM 6	20	50	10	168
PPM 7	20	10	15	17
PPM 8	20	30	15	73
PPM 9	20	50	15	179
PPM 10	16	30	5	217
PPM 11	16	50	5	400
PPM 12	16	30	10	289
PPM 13	16	50	10	420
PPM 14	16	30	15	327
PPM 15	16	50	15	446

Table 2: Effect of concentration of MAA & polymer and dose on % grafting

peak appears due to melting of PMMA portion of the material around 220°C. Considerable changes observed in the thermogram of the grafted gel provides a conclusive evidence for presence of grafted MMA chains on PEO-PVP network.

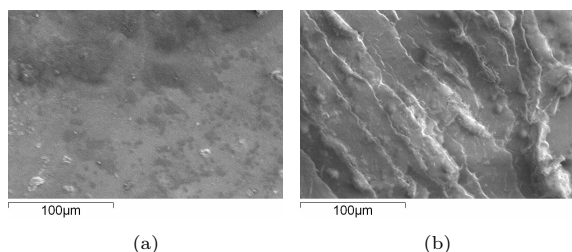


Figure 2: Scanning Electron Micrographs of (a) PVP-PEO & (b) (PVP-PEO)-g-MAA

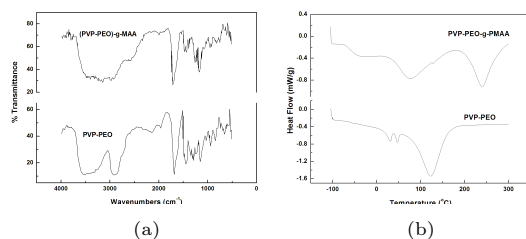


Figure 3: (a) FTIR Spectra & (b) DSC thermograms of PVP-PEO & (PVP-PEO)-g-MAA

Formulation Code	PPM2	PPM3	PPM10	PPM11
Equilibrium Swelling, S%	841	453	286	230
The initial swelling rate $R_i \times 10^{-2}$	8.4	4.6	1.3	1.9
Swelling rate constant $k_s \times 10^{-4}$	5	12	13	30
Maximum equilibrium swelling $S_{max}\%$	1298	623	319	250
Swelling exponent N	0.79	0.70	0.59	0.53
Swelling constant K	0.14	0.10	0.05	0.08

Table 3: The swelling parameters for representative gels

The effect of pH of the swelling medium on the swelling behaviour of the gels was studied by maintaining the pH of the swelling medium at 4.0, 7.0 and 9.0. The swelling behaviour exhibited by the representative hydrogels PPM 2 & PPM 11 are shown in Figures 4a & 4b. The % S value of the hydrogels at various pH follows the order  $pH\ 4 < 7 < 9$ . At pH 7 & 9, the amount of water absorbed by the hydrogel was much higher than at pH 4, at the same time point. This is due to the fact that when the pH of the external environment is above the  $pK_a$  of poly(methacrylic acid), the ionization of the carboxylic acid groups occurs and the increased electrostatic repulsion between the ionized groups leads to chain expansion. As a result the hydrogels at higher pH swelled by relaxation controlled mechanism [13–17]. Also, the gels PPM 2 made from 20% solution of PEO-PVP exhibited much higher swelling capacity compared to PPM11 made from 16% solution indicating the role of gel matrix structure on the overall swelling behaviour of the grafted gel. The swelling nature of the gels made from 50% MAA solutions PPM11 is found to be very similar to PPM 2 made from 30% MMA, indicating that MMA concentration above 30% has negligible effect on the swelling of the gels.

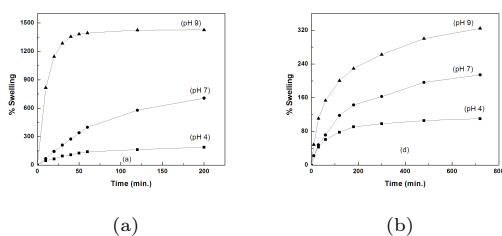


Figure 4: The swelling isotherm of the hydrogels at different pH ; (a) PPM 2 and b) PPM 11

## Conclusions

MAA grafted PEO-PVP hydrogels were made in aqueous solution by electron beam irradiation technique by a two step process. With a minimum dose of 30 kGy, crosslinked networks of PEO-PVP polymers were obtained and with 5 kGy, grafting of MMA on PEO-PVP network was achieved. The swelling nature of the network was found to depend on the concentration of component polymers and the dose given for crosslinking reaction. The gels exhibited pH responsive swelling behaviour, swelling to much higher degrees in basic medium compared to acidic and neutral media. In addition, the swelling nature is found to be influenced by both the network structure and the MAA content. The results of the study reveal that MAA grafted PEO-PVP hydrogels with different crosslink density and MAA content can be conveniently made by electron beam irradiation technique. The equilibrium swelling of these hydrogels can be controlled by the network structure as well as the content of the grafted monomer. From the present study, it can be concluded that these gels possess pH responsive swelling nature and may find potential pharmaceutical and agricultural applications.

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# Polycarbosilane Supported Titanium Catalyst For Mannich Reaction

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(Submitted: 16-03-2015 Revised: 24-03-2015)

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## Abstract

Polycarbosilane with highly crosslinked structure and high surface area was synthesized from the monomer trichloromethylsilane. The reaction was conducted in the presence of sodium metal. Then titanium ion was supported on polycarbosilane. The immobilization of transition metal ions to polymer support leads to a number of advantages over homogeneous catalyst; viz easy product recovery, increased selectivity etc. The catalytic activity of polycarbosilane supported titanium ion was studied by considering three-component Mannich reaction. Reaction with diverse sets of aldehydes, amines and ketones were examined.

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**Keywords**— polymer synthesis and characterization, functionalization of polymers, catalysts, supports, transition metal chemistry.

## Introduction

Transition metals have important role as catalysts in various organic reactions. Homogeneous catalysts are often used for these purposes because of their high activity and selectivity. However, they are more expensive and usually cannot be recovered and reused. The immobilization of transition metal ions to heterogeneous supports leads to a number of advantages like ease of separation, handling, recovery and regeneration [1].

Polycarbosilane (PCS) is a rather neglected class of organic-inorganic hybrid polymer; considerable interest has been focused on it [2–8] recently. Polycarbosilane represents structural hybrids between polysilanes and polyolefines, a combination of low T<sub>g</sub>s and high synthetic versatility similar to that of such inorganic polymer and with good chemical backbone stability as polyolefines. The introduction of metal

atoms into the polymer creates functional macromolecular and supramolecular materials, which combine processability with interesting redox, preceramic and catalytic properties [9–21, 25].

The Mannich reaction is an important carbon-carbon bond forming reaction in organic synthesis and one of the widely utilized chemical transformations for constructing  $\beta$ -amino ketones and other  $\beta$ -amino carbonyl compounds, which in turn are important synthetic intermediates for various pharmaceuticals and natural products [22–25]. There are lots of catalysts reported for the Mannich reaction. Most of these methods have draw backs like requirement of large amount of catalyst, expensive reagents or catalyst, long reaction time and low yield.

In this article we describe the titanium ion incorporated polycarbosilane catalysts, their preparation and application in Mannich reaction.



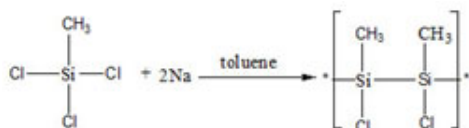
Figure 1: Monomer trichloromethylsilane

## Experimental

### Materials and Characterization

Monomer, trichloromethylsilane was purchased from Sigma-Aldrich, USA. All the other chemicals were purchased from different local suppliers and used as received. All the solvents were purified according to standard procedures. The metal content of the polymer was analyzed by ICP-AES (from STIC, CUSAT), TLC was done on silica coated alumina plates (Merk, 60, F254), FTIR spectra were recorded on JASCO model 4100 FTIR spectrometer as KBr pellets.  $^1\text{H}$  NMR spectra were recorded on Bruker 400 MHz instruments with TMS as internal standard in  $\text{CDCl}_3$  (from STIC, CUSAT), TG-DTA analysis was done on Perkin-Elmer Diamond model TG/DTA system using Platinum as standard. The products were each analyzed for purity by HPLC analysis on Shimadzu CLASS VP Ver 6.1. Column: Phenomenex Luna 5u C18 (2) 100 Å using methanol: water (75:25) solvent ratio with a run time of 30 minutes operating at flow rate 1 mL/minute and at 28°C temperature; analysis was conducted at 254 nm wavelength and retention times were recorded.

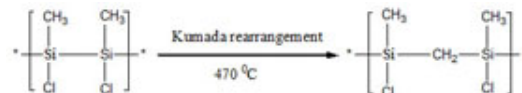
### Preparation of PCS



Scheme 1: Preparation of polymer by Wurtz type coupling

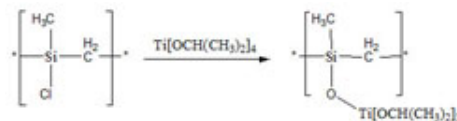
Trichloromethylsilane (figure 1) was used as monomer. This was refluxed with sodium in toluene

for three hours; polymer is formed by Wurtz-type coupling. It was filtered. The transparent viscous liquid polymer was heated to 500°C, the polycarbosilane was formed by Kumada rearrangement. The white solid was characterized by FT-IR, and TG-DTA.

Scheme 2: Thermal rearrangement of Si-Si into -Si-CH<sub>2</sub>-Si- bonds

### Metal Incorporation on Polymer

The polymer (0.2g) was stirred in toluene to swell. Titanium isopropoxide (17.5mmol) was added. It was stirred for four hours. It was filtered, washed in a soxhlet with methanol and dried. The titanium incorporated PCS was characterized by FT-IR and ICP-AES.

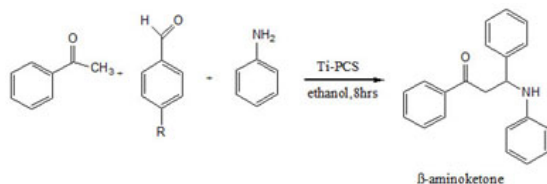


Scheme 3: Metal ion incorporation to PCS

### Catalytic activity study: Mannich reaction

To a mixture of ketone (1eq) and aldehyde (1eq), amine (1eq) was added. To this mixture Titanium incorporated polymer was added as catalyst and stirred at room temperature. The progress of the reaction was noticed using TLC (EtOAc:Hexane; 1:4). After eight hours, the reaction mixture was dissolved in ethanol and filtered. The crude product was purified by column chromatography (EtOAc:Hexane; 2:25). Purity of the product was analyzed by HPLC. All the products were characterized by melting point determination, FT-IR,  $^1\text{H}$  NMR and LCMS. The catalytic activity of Ti-PCS was generalized by carrying

out the Mannich reaction with different substrates. The results are summarized in Table 1.



Scheme 4: Mannich reaction of ketone, aromatic aldehydes and aromatic amines

## Results and Discussion

The present investigation is centered on the synthesis and characterization of the polymer, polycarbosilane and its metal incorporation. In addition, the application of this polymer in catalysis was also investigated.

### Synthesis of Polycarbosilane

Toluene was distilled from sodium wire. PCS was prepared by a Wurtz type coupling reaction of trichloromethylsilane with sodium (1eq) (scheme 1). The typical procedure is as follows. In a 3-necked round bottom flask equipped with a reflux condenser, a dropping funnel and a magnetic stirrer were placed. 10 mL of toluene and 0.5 g (21 mmol) of sodium was added. Heating and stirring made a sodium dispersion. The monomer trichloromethylsilane (2.5 mL, 21 mmol) was added dropwise, to keep a steady reflux. After completion of addition, the mixture was refluxed for three hours. The reaction mixture was cooled, and the obtained suspension was filtered, to remove solid materials (excess sodium and sodium chloride). Evaporation of the solvent gave a viscous liquid. The polymer obtained was highly transparent. The neat polymer is fairly air sensitive as reported, and thus was stored in a desiccator. All the operations were performed in nitrogen atmosphere. The polymer was found to be soluble in toluene.

Solvent toluene was removed from the polymer by evaporation. The polymer was taken in a silica crucible and heated to 500°C in a furnace. After heat-

ing, the polymer was changed from a transparent liquid to a rigid colourless solid. During heating Si-CH<sub>2</sub>-Si- group was formed by Kumada rearrangement (scheme 2) [2].

It was found that the polymer was insoluble in toluene. The white solid polymer was washed in a soxhlet using water to remove the sodium chloride by-product.

The TG curve (figure 2a) of polymer showed only 7% weight loss. It is highly stable. That means the polymer is highly cross linked. Hence it is insoluble.

The FT-IR spectrum (figure 2b) shows a peak at 800 cm<sup>-1</sup> corresponds to Si-CH<sub>3</sub> wagging, 920 cm<sup>-1</sup> due to SiH<sub>2</sub> stretching, 1038 cm<sup>-1</sup> due to CH<sub>2</sub> wagging in Si-CH<sub>2</sub>-Si, 1231 cm<sup>-1</sup> due to Si-CH<sub>3</sub> deformation, 2332 cm<sup>-1</sup> due to Si-H stretching, 2828 cm<sup>-1</sup> due to CH stretching.

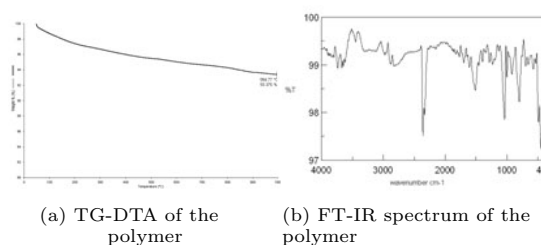


Figure 2: The TG-DTA and FT-IR spectrum of the polycarbosilane

### Metal incorporation to PCS (Ti-PCS)

About 0.2 g polymer (2.59 mmol) was stirred in previously distilled toluene for 20 hours for swelling. Then 5.2 mL of titaniumisopropoxide was added (scheme 3). It was then stirred for four hours and filtered. The polymer was then washed in a soxhlet using methanol. It was then dried. The metal content of the polymer was analyzed by ICP-AES. It was found that polymer contained 2.09 m.equiv/g titanium. The FT-IR spectrum of the Ti-PCS was taken. It shows the peak corresponding to Si-O-Ti at 922 cm<sup>-1</sup>. The spectrum shows a broad band at 1058 cm<sup>-1</sup> corresponding to Si-O vibration. Its catalytic activity in Mannich reaction was studied.



Entry	Aldehyde	Ketone	Amine	Yield (%)	Melting point ( $^{\circ}$ C)
1	4-chlorobenzaldehyde	acetophenone	aniline	70	110-112
2	1-naphthaldehyde	acetophenone	aniline	20	120-122
3	benzaldehyde	acetophenone	aniline	60	104-106
4	4-methoxybenzaldehyde	acetophenone	aniline	60	104-106
5	4-chlorobenzaldehyde	cyclohexanone	aniline	50	134-136

Table 1: Mannich reaction catalyzed by Ti-PCS in ethanol\*

\*reaction condition-equimolar mixture of aldehyde, ketone and amine in presence of 2 mol Ti-PCS at room temperature for 8 hours

## Catalytic activity study: Mannich reaction

Mannich type reactions are very important carbon-carbon bond forming reactions in organic synthesis and one of the most widely utilized chemical transformation for constructing  $\beta$ -amino ketones and other  $\beta$ -amino carbonyl compounds (scheme 4), which in turn are important synthetic intermediates for various pharmaceuticals and natural products.

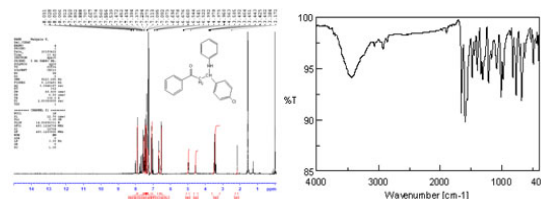
Aniline was distilled using potassium hydroxide by applying vacuum. To a mixture of acetophenone(11mmol) and benzaldehyde (11mmol), aniline(11 mmol) was added in a 10mL round bottom flask fitted with a condenser. To this mixture titanium incorporated polymer (2mol %) was added and stirred at room temperature for 8 hours. The progress of the reaction was noticed by TLC (EtOAc: Hexane; 1:4). After the reaction was completed, the reaction mixture was dissolved in ethanol and filtered. It is evaporated in a rotatory evaporator and the precipitated solid was recrystallized using acetone. The crude product was purified with silica column chromatography (EtOAc: Hexane; 2:25). The purity of the product was analyzed by reverse phase HPLC. The products were characterized by melting point determination, FT-IR,  $^1$ H NMR, and mass spectra on LCMS. The reaction was repeated using different aromatic aldehydes and ketones.

The characterization data of the products are given below;

Entry 1: 3-(4-chlorophenyl)-1-phenyl-3-(phenylamino)propan-1-one

M. p.: 110-112 $^{\circ}$ C

$^1$ H NMR (400Hz,  $\text{CDCl}_3$ ) : 3.38-3.50(m, 2H), 4.56(s, 1H), 4.96-4.99(m, 1H), 6.52-6.54(m, 2H), 6.69-6.66(t, 1H,  $J=7.2$ Hz), 7.07-7.11(m, 2H), 7.27-7.29(m, 1H), 7.37(m, 1H), 7.39(m, 2H), 7.43-7.47(m, 2H), 7.55-7.57(m, 1H), 7.88-7.91(m, 2H).



(a)  $^1$ H NMR spectrum of entry 1 (b) FT-IR spectrum of entry 1

Figure 3: The  $^1$ H NMR and FT-IR spectra

The  $^1$ H NMR spectra of the product was taken. It shows a multiplet around 3.38 ppm. This is due to  $\text{CH}_2$ - protons, a singlet at 4.56 ppm due to the NH-proton, a multiplet in the range 4.90-4.99 ppm due to tertiary CH- proton, 14 aromatic protons show peaks in the range 6.52-7.91ppm.

FT-IR (KBr,  $\text{cm}^{-1}$ ): The spectrum shows peaks at  $3434 \text{ cm}^{-1}$ ,  $2626 \text{ cm}^{-1}$ ,  $1654 \text{ cm}^{-1}$ ,  $1594 \text{ cm}^{-1}$  and  $1080 \text{ cm}^{-1}$  corresponding to NH-, aliphatic CH-, -CO-, ring C-C and C-Cl groups.

The LC-MS spectrum (figure 4) of the product is shown below,

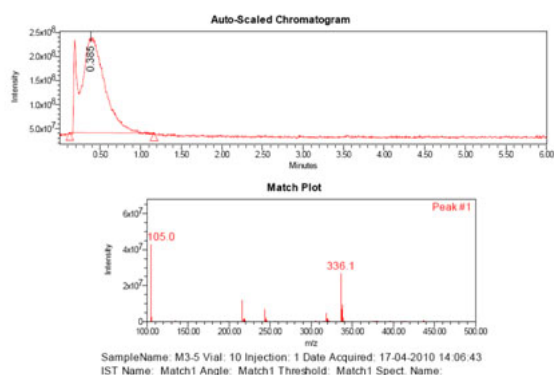


Figure 4: LC-MS of entry 1

Mass spectrum of the product showed the corresponding molecular ion peaks LCMS:  $ES^+$  ( $M^+ + 1$ )  $m/z$ : 336; HPLC: Retention time: 20.26 minutes. This reaction was found to be in good yield.

Entry 2: 3-(naphthalen-1-yl)-1-phenyl-3-(phenylamino)propan-1-one. M. p.: 120-122°C; FT-IR (KBr,  $cm^{-1}$ ): 3444, 2921, 1656, 1611; LCMS:  $ES^+$  ( $M^+ + 1$ )  $m/z$ : 352; HPLC: Retention time-20.26 minutes.

Entry 3: 1, 3-diphenyl-3-(phenylamino)propan-1-one. Melting point: 154-156°C; FT-IR (KBr,  $cm^{-1}$ ): 3442, 2923, 1665, 1597; LCMS:  $ES^+$  ( $M^+ + 1$ )  $m/z$ : 302; HPLC: Retention time: 12.51 minutes.

Entry 4: 3-(4-methoxyphenyl)-1-phenyl-3-(phenylamino)propan-1-one. M. p.: 104-106°C; FT-IR (KBr,  $cm^{-1}$ ): 3442, 2921, 1647, 1532, 1021; LCMS:  $ES^+$  ( $M^+ + 1$ ): 332; HPLC: Retention time-11.638 minutes.

Entry 5: 2-((4-chlorophenyl)(phenylamino)methyl)cyclohexanone. M. p.: 134-136°C; FT-IR (KBr,  $cm^{-1}$ ): 3423, 1658, 1590, 1081; LCMS:  $ES^+$  ( $M^+ + 1$ ): 314; HPLC: Retention time-12.67 minutes.

## Summary and Conclusion

In this report, we are presenting a detailed description of work done about the application of Ti-PCS as catalyst for Mannich reaction. The polymer, polycarbosilane was prepared from the monomer

trichloromethylsilane. Then titanium ion was incorporated into the polymer. Ti-PCS was characterized by FT-IR, TG-DTA and ICP-AES. The catalytic activity of polymer was checked for carrying out Mannich reaction. Five reactions were carried out with different substrates. All the products were obtained in good yield in short reaction time, showing the efficiency of the catalyst, hence we can conclude that the catalyst used here is very apt for the preparation of mentioned products.

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# Educational Governance in a Multi-Campus Institution

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(Submitted: 16-03-2015 Revised: 23-03-2015)

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## Abstract

Grouping of individual campuses under a unified framework of governance is the simplest attribute of a multi-campus institution. Such an institution encourages intra-institutional co-ordination through effective democratic decentralization. The paper addresses some of the governance issues of a multi-campus university.

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## Context and Concept

Effective university governance calls for proper co-ordination among academic and administrative bodies, officers and authorities of the university. Transparency in governance as an organizational goal strengthens efficiency. Autonomy with accountability makes the whole system efficient and it is the quality attribute representing standard of professionalism. Professionalism, commitment of teaching and administrative staff are important determinants of governance quality. Production, integration, dissemination of quality and secular knowledge promote educational development and socio-economic transformation. Democratization of academic and administrative bodies in educational institutions encourages social justice and equity and makes the system socially accountable. That is why governance is defined as a series of disparate and diverse social practices that are constantly being created and recreated through concrete and meaningful human activity. The term governance is broader than government because the former focuses not only on the state and its institu-

tions but also on the creation of laws, rules and norms in social practices. Broadly, we define governance as the exercise of authority or power under a system of rules or law in the management of an institution's or country's limited human or/and non-human resource endowments to achieve and sustain institutional or national development through appropriate human intervention. For good university governance, the size and composition of different academic and governing bodies must truly be representative and democratically elected bodies shall instill confidence and promote accountability.

## A Multi-Campus University

Multi-campus university system is a typical higher education management model. Conceptually, each campus ought to be independent and autonomous in the sense that it promotes and integrates overall academic and curriculum development. The radical departure from a centralized university system to a multi-campus system with an additional task of using a problem-based, student-centered and community-

based approach to teaching and learning process to fulfill expectations and demands of the beneficiaries within the local community in the vicinity of the University. Grouping of individual campuses under a unified framework of governance is the simplest attribute of a multi campus institution. The basic philosophy of a multi-campus university is that it encourages intra-institutional co-ordination, academic and administrative autonomy through effective decentralization. Each university campus has the specific advantage of extending, diversifying and exploiting spatial or regional economies of scale. This great potential for socio-economic transformation and regional sustainability elevate these individual campuses into the status of a 'mini university'. But the problem is how the individual campuses can effectively address institutional divisions of power and resources through decentralized decision making processes. The basic constraint is lack of academic autonomy, highly inflexible administrative system and weak financial autonomies across governance hierarchies. What is disturbing in the whole process of educational governance is that the self-images or internal identities of the administrators are, in general, influenced not by truth and realism but motivated by their self-interests leading to discriminatory, partial and biased decisions which distorts and pull down the efficiency, standard and professionalism of the system. Similar instances are not infrequent in the case of teaching and research. This is the background in which we examine the governance issues of a multi-campus Kannur University in Kerala.

### Governance Issues

Multi campus universities follow, in general, a two tier governance structure. Firstly, there is intra-institutional or sub-system governance (at the individual campus level) and secondly governance at the institution or system or university level. System governance depends on co-ordinated functioning at the sub-system level. However, the multi campus universities invite many challenges and inconveniences for administrators, staff and students. For instance, the frequency of academic and administrative staff expected to travel between the administrative head

quarters and other campuses is an important issue. It is not encouraging for anyone to function effectively away from their office, their files and their computer with which they are familiar. There are also other variables such as reliability of public transport, and sometimes even the predictability of weather problems that could interfere with travel and the mobility of the academia. Identification of the concerns of the stakeholders involved in multi campus operations can be addressed through institutional or managerial action to provide a better workplace environment by incorporating the factors raised by staff and students. Institutional functioning depends on formal rules, norms of behavior and their enforcement. Institutional constraints and the choices individuals make in the specific institutional setting depend largely on the effectiveness of enforcement. Enforcement, in turn, depends on commitment, accountability and management of the system.

Multi campus operations offer Universities a dual opportunity in the form of increased enrollments and encouraging territorial advantage by its presence in various regions, localities and communities. Thus, educational inclusion is an important hallmark of multi campus institutions. These individual campuses extend the regional development advantages and identify them as focal points creating a chain of positive externalities, including human capital formation and ultimately research and development. University administrators and governance hierarchies involved in establishing and maintaining multi campus operations should be cognizant of their responsibility to provide an efficient system of operation which limits the need to travel between campuses and provides a supportive working environment for staff and students. To improve efficiency, a decentralized governance structure aiming at delegation of powers, functions and resources from the top administrative officers to their immediate subordinates is an important option. In multi-campus universities, administrative and financial autonomies to Campus Directors/Heads of Departments/Deans improve efficiency of the sub-systems which shall ultimately contribute to the overall development of the system.

The crucial problem faced by state universities is that of finance. Financial problems of (state) uni-

versities have become so severe that they are constrained to postpone even curriculum reforms or specific examination reforms. Thus, good governance aims at making effective and legitimate use of economic and non-economic resources for achieving well-defined practical and policy oriented goals. UGC grants-in-aid to multi campus (state) universities should be based on regional development indicators and human development indicators. As a minimum requirement at least five faculty members, say, as a ten year package, in the ratio of one professor, one associate professor and three assistant professors in all teaching departments may be essential to sustain the system. The same criteria may also be followed in the case of both state and central universities. Apart from this, campuses or departments engaging in per-doctoral, doctoral and post doctoral research studies should be entitled to get more academic and financial autonomy to improve the quality of teaching and research. However, it is difficult to separate these autonomies because they are inextricably interwoven with their simultaneous and harmonious presence, both at the sub-systems and system level.

There are seven campuses in Kannur University. The Kannur campus is the university administrative head quarters. Of the other six different campuses, three campuses viz., the Thalassery campus at Palayad (the oldest campus), Nileswaram and Payyannur have administrative heads named campus directors apart from the academic heads of the respective teaching departments. But Mangattuparamba, Kasaragod and Mananthavadi campuses have only academic heads and no campus directors. Campus directors in individual campuses co-ordinate the sub-system governance and help improving system level governance. Further, nomination of Campus Directors (one each from Kasaragod and Kannur revenue districts and Mananthavadi taluk of Wayanad district) in the governing bodies or the Syndicate shall improve quality of sub-system and university governance. This will also restrict over politicization of the system making it more democratic and accountable.

Kannur University instituted in 1996 now boasts of 27 teaching departments and eight centers of studies, but has only 39 permanent teachers and 152 contract or guest faculty members. The permanent teaching

staff in Kannur university account for less than 20 percent or the university is functioning with more than 80 percent underpaid temporary or contract teachers! The fundamental question is how is it possible to provide and maintain the quality of higher education with this 5:1 ratio of contract regular teaching staff pattern in Kannur University or elsewhere in India? Even if we accept this ratio why are the qualified contract/guest faculty members denied the actual pay scale given to entry level assistant professors in Kannur University? One possible response to this question is the poor quality of the teaching learning process. Further, there are 13 Teaching Departments in Kannur University without a permanent teaching staff! A university which is going to celebrate its twentieth anniversary next year craves for creation of minimum teaching posts as a primary requirement for sustaining the higher education system. The fundamental question is how the quality education can be provided when we compromise with the pay scale, with the quality of the teaching faculty and sometimes discriminate according to their apparent non-academic characteristic traits, it is alleged. Under remuneration pulls down the morale of the teachers and discourages young and quality minds to join the higher education system. The sixth pay commission has revised the pay scale of university and college teachers to attract brilliant minds into the higher education stream. This unfolds another structural problem of higher education in the country.

Privatization of the education system has further accelerated the structural divide in the country. Against the backdrop of for profit educational institutions, the logic and theory of the neo-classical profit maximizing firm can be extended to higher education system. The political economy of privatizing educational development may be summarized as follows: "there are two possible ways to maximize profit: i) unfair cost cutting by paying less to the teachers, and putting up inadequate infrastructure; ii) revenue maximization by exploiting the full potential of admission fees overtly or covertly. Both are inimical to quality education and equity objectives" (Saumen, 2014). In the wake of increased privatization of higher education, the standard UGC pay scale is beyond the reach of more than 90 percent of the teachers of the

unaided self financing arts, science, and engineering colleges. Further, for want of post creation, teachers in the government and aided educational institutions are denied the UGC pay scale, instead managed by the underpaid 'contract or temporary teachers'. The recommendation of the National Knowledge Commission to start 1500 new universities in India to expand its knowledge base and increase the higher education gross enrollment ratio to 30 percent from the present 19 percent by restricting the number of affiliated colleges in a university to 100 will be an important land mark. When existing universities, both state and central, struggle for survival, the whole logistics of the National Knowledge Commission turns out to be undesirable and unsustainable. Most state universities are starved off funds for infrastructure, research and development and to meet both the short term and long term (human) development requirements. It is argued that, the norms or procedure for the allocation of funds under the Rashtriya Uchatar Shiksha Abhiyan (RUSA) further restricts or dilutes the powers and functions of the University Grants Commission. The main apprehension is that the RUSA intermediation complicates the system and invites new problems of external and internal university governance. What is wrong with the present UGC-University or the UGC-affiliated college provider -receiver system of academic or educational grants? Academia have the apprehension that the new system may create deeper inroads in educational planning, governance and development thereby inviting crucial issues of accountability, legitimacy, competence and public management. The whole system of governance would be incomplete and inefficient if responsiveness, transparency, participation, efficiency, democracy, values, and economy are outside the governance orbit. That is why educational governance becomes a composite identity in its plurality of attributes.

The concept of a multi-campus university has certain inherent problems relating to governance and development. Typically, governance is about the interaction between state, institutions and citizens. Interaction between the providers and receivers depends on the nature of laws, policies and regulations made by the legislature and the way these are executed in

higher education institutions. It includes how the state treats its citizens and the effort it makes to protect and fulfill their human rights. Accountability is at risk when the elite group exercises power and influence over government. Governance cannot be separated from accountability, efficiency, commitment, and participation. Governance is the manner in which public officials and institutions acquire and exercise the authority to shape public policy and provide public goods and services. Governance also involves the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them. To put it holistically governance is about the laws, policies and regulations that the state makes and the way these are implemented in everyday life. Governance includes how the state treats its citizens and the effort it makes to protect and fulfill their human rights.

Good governance enhances institutional quality and its performance in terms of both quality and quantity of education services. This largely depends on standards, information system, commitments, incentives and accountability. Quality data base and standard information system make the governance process smooth, transparent and reliable. In multi-campus universities, each campus director should be entitled to have more administrative and financial freedom. Even for small maintenance work involving few hundreds of rupees, the campus director has to wait for an official order from the registrar which will take sometimes a couple of weeks! This is a major governance problem in multi-campus universities. One viable and effective option is devolution of functions, powers and resources to the academic heads of the teaching departments or to the campus directors through a governing body decision, if necessary. Governance system becomes quite complex and inefficient because of the existence of gaps between ( statutory) rules and their implementation. Information asymmetry, poor quality social and political capital also restricts quality of governance. Strengthening these

governance capabilities require institutional reforms. It is argued that the autonomy of the universities is under serious scanner which raises eyebrows of the members of the academic and administrative bodies, authorities, statutory officers of the university and the academia in general. Universities, have the prime responsibility of developing and maintaining quality higher education system. Democratization of the Indian university, enabling more social classes to gain access to higher learning, has not always been a smooth process and its consequences, at least in the short run, have not always been beneficial. Much depends, however, on the process of becoming socially inclusive and the forces that drive this process. For such an undertaking to be successful, the tensions between demands of social inclusion and those of academic discrimination need to be tackled convincingly.

The quality of university governance largely depends on the quality and integrity of the governing body or the Syndicate, Academic Council, Statutory Officers and of course on the quality and vision of the Vice-Chancellor. Unfortunately, in many Indian universities the selection process to the post of Vice Chancellor is not transparent and in general, academic and administrative credentials are undermined or the process of selection was discriminatory. The former Prime Minister Manmohan Singh's address at the 150th Anniversary Function of University of Mumbai is very contextual: "Our university system is, in many parts, in a state of disrepair...In almost half the districts in the country, higher education enrollments are abysmally low, almost two-third of our universities and 90 per cent of our colleges are rated as below average on quality parameters... I am concerned that in many states university appointments, including that of vice-chancellors, have been politicized and have become subject to caste and communal considerations and there are complaints of favoritism and corruption."

## Conclusion

Multi-campus institution has the potential to transform each campus into a 'mini university' through exploitation of regional scale economies. But the ba-

sic problem is how the individual campuses can effectively address the institutional divisions of power from the top-down hierarchy under resource constraints. The fundamental question is how to maintain quality of higher education with 5:1 ratio of contract-regular teaching staff pattern in Kannur University? It is argued that a committed political decision to fill the existing vacancies in all universities and in affiliated colleges- both government and aided- should have the top most priority and the logistics of the National Knowledge Commission to start 1500 new universities may be honored at a later stage. Nevertheless, the real challenge is effective implementation of strategies, schemes and decisions. What is needed is comprehensive governance reform involving economic, administrative, political and institutional changes. Deepening democracy and strive for greater equity and empowerment can improve governance options, which will necessarily demand peace and tranquility in the system. The system also demands clean, committed, accountable and competent political management together with empowered and democratic public institutions and well informed citizenry. The use of modern ICT to enhance people's access to resource endowments and entitlements encourage good governance. Resources are vital but good governance is the appropriate path for reaching optimum output and quality decision. Nevertheless, governance deficit does not allow accountable, efficient and equitable development to materialize.

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# Trade Liberalization and Metropolitan Growth: Indian Experience in the Framework of Economic Geography

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(Submitted: 16-03-2015 Revised: 23-03-2015)

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## Abstract

The present enquiry is an attempt to test the hypothesis that large cities will decline in size with a reduced core and an increased periphery in the open trade regime in the context of India by taking the case of Greater Mumbai. The study concludes that the decline in size of the core and growth of the periphery has started even before the opening up of the economy and the theoretical argument does not find any support in the Indian context.

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## Introduction

'Geography' was in the periphery of economic science for a long time until increasing returns and monopolistic competition were conceptualized. Conventional economic theories in general and international economic theories in particular have modeled economies as dimension lacking entities with free inter-sectoral mobility of factors of production [9]. The logical reason behind marginalization of 'spatial' dimension was due to the inherent problems of conceptualizing a suitable imperfect market structure and returns to scale in production. Conventional economic models were primarily based on the assumptions of perfectly competitive market and constant returns to scale in production. Hence, conventional economics could not explain why there is spatial concentration of economic activities in general and manufacturing in particular. The firms require necessary incentives to be in close proximity which is provided by the increasing

returns to scale. Hence, economic geography models are constructed in the framework of an imperfect competitive market structure and increasing returns to scale in production.

A large number of big cities or metropolises have become a special feature of urbanization process of the developing economies. It has been argued that the large metropolitan cities in the developing world are the result of the import substitution policies followed in these countries [8]. This happens due to the presence of agglomeration forces when the manufacturing activities of the country depends upon 'home market' alone. When the economy is opened up for trade these forces are weakened and a large scale manufacturing decentralization from the core to the peripheries will reduce the size of large cities. The empirical studies regarding the pattern of metropolitan growth in the framework of economic geography are rare in the context of an emerging economy like India. The present enquiry, in this backdrop, is an at-

tempt to analyze the pattern of metropolitan growth in India in the framework of economic geography by taking the case of Greater Mumbai, one of the oldest metropolises in India. The paper is outlined in five sections including an introduction. The second section deals a clear theoretical underpinning of the argument of metropolitan decentralization. The third section spells out the methodology part. The fourth section deals with analysis part and the final section summarizes the main findings of the paper.

## Theoretical Framework

Million plus cities of the developing economies are viewed as the unintended result of import substitution policies followed in these countries and a shift from such policies will prevent their growth [8]. They related the metropolitan growth of the developing world with their trade policies. In their view large cities of the developing world are the result of a strong backward and forward linkages created in the city when the manufacturing serves only the domestic market. These linkages will be weakened and the monopoly power of the larger cities will decline when the economy is opened up. Hence, metropolises are expected to shrink in size when the economy is liberalized. Krugman and Elizondo have built up this argument in the light of the Mexican City's experience. Mexico City, which was the world's most populous city till the 1980's, started decentralizing when the economy was liberalized during the 1980's. The city, which accounted for forty percent of the country's manufacturing employment and more than fifty percent of the manufacturing value added, had declined substantially after the opening up of the economy.

Generally, Economic Geography models involve a tension between two forces- 'centripetal' and 'centrifugal' forces [8, 9]. Centripetal forces pull the population and production into the core resulting in larger agglomerations. They may include pure external economies and a variety of market size effects such as the forward and backward linkages. Centrifugal forces weaken the agglomeration effects. These forces include pure external diseconomies of large cities like congestion, pollution and high urban land

rents. When the economy is opened up for free trade the market is no more domestic alone and firms need not stay in the heart of the city. Then, the disadvantages of being in the core (centrifugal forces) become powerful and the manufacturing activities will shift away from the core to the peripheries. Hence, in closed economies backward and forward linkages are powerful enough to keep the activities concentrated in the central metropolis, which will be decentralized when the economy is opened up for free trade with the weakening of forward and backward linkages. The argument is built upon two assumptions - 1) manufacturing share of the economy is reasonably high and 2) trade openness will result in manufacturing to depend mainly on external markets.

## Methodology

### Data Sources

The study primarily depends on secondary sources. Data on Mumbai urban agglomeration with its peripheral areas are taken from the Table A4, "Towns and Urban Agglomerations classified by population size by class" of the Economic Tables of the Census of India from 1961 to 2011 census.

### Choice of Variables

The variables, which the study rely upon are Population Size, Density, Area or Landscape and the Size of Main Workers. The size of the city is often expressed in terms of the population and area. Area can be a measure of the geographical size of the city. Size of the city in terms of population can be clearly understood in a relative sense- city in relation to the peripheral areas (city population / the periphery population).

## Mumbai Metropolitan Decentralization: An Analysis at the Micro Level

The aim of the study is to verify the hypothesis that the cities will decline in their size in the open trade and investment regimes. This can be understood by way of looking at the relative size of the city in terms of actual population, population density, landscape and main work force.

### Core Vs Periphery in terms of Actual Population, Density and Landscape

Size of the city is often measured in terms of its population, density and landscape. The size of population is a proxy for economic activities. If population is regularly getting concentrated, a greater amount of economic activities are implied to be undergoing in the locality. It has already been observed that the relative size of the core in relation to the periphery has been coming down continuously since 1961 (table 1). In addition to that, relative size of core in terms of population density and landscape are also reported. The size of core in relation to periphery in terms of population density also shows the same trend of relative size in terms of population except from 1981 to 1991. The share of core in the urban agglomeration also shows a declining trend over the census years. During 1961 core was 91.95 percent of the Urban Agglomeration, indicating a small share of the periphery (8.05 percent) and it declined to 67.7 percent by 2011 census. The period 1991 can be taken as a time of departure from import substitution to open trade regime. From 1961 to 1991 city's share in the agglomeration has declined to a larger extent (13.1 percent point) compared to the decline in the period from 1991 to 2001 (11.1 percent point). Hence, the argument that the decline in city's share has something to do with the trade openness has not come true in the Indian context.

Turning to landscape structure, the general trend of Mumbai is that of a continuous increase in its peripheral areas, with core has been growing at a lower

rate compared to the peripheries. From 1961 to 2011 urban agglomeration has been growing. The growth of urban agglomeration from 1961 to 1981 was mainly due to the increase in peripheral areas, because city remained virtually the same with 437 Sq. Km. From 1981 to 1991 core also has increased in its areas, but much of the increase to the agglomeration has been contributed by the peripheries. There was a larger increase in area of core from 1991 to 2011, which has been attributed to the reorganization of the city in the 2001 and 2011 census. Periphery at the same time has not decreased much during 1991 to 2011, implying that when the core has agglomerated much of the periphery, periphery has agglomerated a lot of its hinterlands. This could be seen in the core and periphery as a proportion of urban agglomeration. There was a continuous decline in size of the city as a percentage of urban agglomeration till 2011 with some fluctuations in between.

We have seen that the growth rate of periphery is higher than that of the core in all the census periods; hence, the relative size of the core is declining continuously. The decline in size of population of the core could be largely due to the problems in cotton textile sector of Mumbai (Deshpande, 1995). Textile remained as the main industry till the mid 1970's in Mumbai. Most of the textile mills were privately owned with 13 mills being owned by the National Textile Corporation. Majority of the workers were migrants from interior parts of Maharashtra and a minority from UP and Bihar. Due to the collapse in the cotton textile there was large scale migration from the core Mumbai. It has been observed that the general pattern in the 1970's and 1980's has been a large scale but often unnoticed migration of ex-textile workers and the slum dwellers from the central areas of Mumbai to the northern parts and the outlying suburbs (Deshpande, 1995). The land rent also played a crucial role in the transformation. Land prices started rising in the center at a higher rate during the 1970's, which lead many owners of the mill and other industrialists to shift their investments to the commercial and residential estates (Judy and More, 2007). Another important trend which was happening during that time was the informalization of the textile sector with the raise in real estate value

Variables		1961	1971	1981	1991	2001	2011
Population	Core / Periphery	11.4	9.5	7.0	3.7	2.7	1.6
	City Density / Periphery Density	2.6	2.6	2.4	4.5	2.3	1.9
	Growth Rate of Core	-	43.8	38.1	20.4	20.7	19.8
	Growth Rate of Periphery	-	72.2	88.3	126.6	66.9	67.7
	City as % of U A	91.9	90.5	87.1	78.8	72.9	67.7
	Periphery as % of UA	8.1	9.4	12.5	21.2	27.1	32.3
Landscape	Core / Periphery	4.3	3.6	2.9	0.8	1.1	0.7
	City as % of UA	81.1	78.1	74.3	44.8	53.1	50.3
	Periphery as % of UA	18.9	21.8	25.6	55.2	46.8	49.6

Table 1: Population and Landscape

Note: UA stands for Urban Agglomeration, which includes both core and periphery

Source: Census of India, 1961 to 2011

in Bombay with owners opting for contracting out a major part of their works to the small scale level operators at cheaper rate to the urban hinterlands.

The decentralization of Mumbai way back since 1960's and 1970's itself could be attributed to town planning as well (Shah, 1999). The development of industry in the core was discouraged through legislations way back since 1970's. At the same time new sites within the metropolitan area was developed by the government to accommodate the shifting of population and activities and to reduce congestion in the built up area (Navi-Mumbai is an Example). Apart from these factors the shift was also market driven that high land cost pushing many firms to the peripheries since 1970's. Meanwhile, there was a structural transformation happening in Mumbai in terms of increasing importance of finance and growing specialization in certain types of manufacturing and service activities. By 1970 itself, Mumbai has become the financial capital with many foreign banks also operating. Financial deregulation again boosted the financial activities in Mumbai. The lands earlier occupied by the mills were given to the banks, publishing houses, advertising agencies and so on.

## Concluding Remarks and Inferences

The argument of Krugman that large metropolitan cities in developing countries will decline in size when

the economy is opened up for trade is applicable to countries with high proportion of manufacturing in value added. In the case of Mumbai the study found that the city is diminishing in its size even before the opening up of the economy and many factors like metropolitan planning, environmental concerns, strong political demands from the peripheries, and the congestion costs were identified in the metropolitan decentralization of Mumbai. The peripheries' growth has also been recognized as a result of increased immigration from rural to the urban areas which ultimately results in greater population in the peripheries. Periphery has been agglomerating many of the nearby rural hinterlands which also raise the population of peripheries. The conclusion which follows from the analysis is that the metropolitan decentralization in India has started quite long back and not just with the opening up of the economy. In an economy like India where manufacturing forms only a small part of the economy which depends mainly upon home market even when the economy is opened up, we cannot see a decline in City with trade openness. Hence, Krugman's view that the declining size of the city and the implied growth of periphery when the economy is opened up for trade through a huge manufacturing relocation from the center to the periphery has not come out clearly in the Indian context.

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## Shashi Deshpande's *Roots and Shadows*: No Roots, Only Shadows

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(Submitted: 22-03-2015 Revised: 24-03-2015)

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### Abstract

*Roots and Shadows* focusses on the question of woman's place in society where the traditional joint family functions as a miniscule cross-section of the same. Indu embarks on a quest for self-identity to unearth her roots, as she finds that she thrives on the shadows of others and the past. The various characters serve as archetypes of the typical roles women subscribe to in society and exemplify her position in relation with the various other characters in the novel. The novel presents this family saga in twelve chapters with the opening prologue retelling the story from Indu's point of view: the story of three generations as dominated by Akka. This motif of retelling also retells the story of Woman.

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Family is the smallest social unit. The joint family therefore functions as a microcosm of the patriarchal society that we live in. Each woman in the joint family that Indu visits presents a stereotype of how women have relegated or withheld their own concerns/aspirations to fulfill their roles with regards to the ones close to them, especially men. We live in a society that is all about power politics and particularly control over the female in a heteropatriarchal society. The assertion of this domination begins right at the family, and the woman is made to internalize this ideology as it is perpetrated through generations, so that it comes across as a written rule beyond the precepts of questioning. Evading it, one becomes a rebel against decorum itself and the very concept of femininity. There is gender stereotyping as evident in the play where women are to adorn their putative domestic roles, not succumb to individual aspiration but only social obligation.

Mini is asked not to work on the day of the mar-

riage as a bride was not supposed to and Indu tells her to do whatever she wanted to. Mini's delicate wrist seemed loaded with bangles, as they had lost the carefree touch of girlish life and looked heavy like a symbol of womanhood. The bangle if it cracked only hurt her hands. Amongst the rituals, women are described to be running around like "demented souls". This is why Indu gets termed a rebel. She always questions the ways of the family where the woman is accorded a secondary citizen status, goes away from home and later arrives with the person she loves. Later, to her utter dismay she finds these principles of patriarchy ingrained in her marriage too. While the uneducated had a direct way of establishing control, the educated had a hegemonic way of going about the same. She is caught between aspiration and tradition, aspiration and obligation. She discovers herself unconsciously imbibing this subliminal ideology as she find herself complete only with Jayan.

She finds herself always thinking about him while he comes across as not reciprocating her feelings. This subliminal ideology is too deep rooted, that even when a woman (Akka) rules over the family though the sex is female, the female gender almost transmogrifies to an androgynous dictator. There is a particular instance when the female voices in the kitchen are silenced by an authoritative male voice, that of Akka. The lady is invested with powers and exercises them and enjoys the position, and in doing the same advocated the male power paradigm. Akka had experienced severe injustice at the hands of her own husband and mother-in-law. However, this factor and the power wealth had invested in her makes her play the same role with a renewed vigour. Her caustic tongue renders Kaka into a stuttering school boy. She remains a huge question mark on Simone de Beauvoirs dictum that sex is biologically determined but gender socially constructed.

While she is the quintessence of male authority, in contrast, Kaki and Atya while away their lives slaving on the male members of the family. Indu's attitude is a reflection of the asperities of a divided family set up where women are treated as domestic animals without individuality. Mini is married to a man much below her stature. Indu ruminates over the unquestionable stance: "A woman's life, they had told me contained no choices. All my life, especially in this house I had seen the truth of this. The women had no choice but to submit, to accept. And I had often wondered have they been born without wills, or have their wills atrophied through a lifetime of disuse?" (Roots 6). At a point, the women folk are shown to blame themselves for having girls.

A woman's life seems to end and begin with marriage, and if she does not possess children, she is deemed to have no utility value. In other words, she is objectified, a machine that produces children. Her efficiency is judged on the basis of the capacity for production, and later how well the goods are processed. In the case of Indu, when she returns home, Kaku, the old maid looks upon her with a sense of sympathy. Mini also has been paraded as an object auctioned before many men who have rejected her on the basis of being fashionable, tall short or dark. Finally she had to settle for someone who accepted

her. The question is not whether she has accepted the man. Indu realizes that her love marriage with Jayant has not made her fare any better. She made all sort of adjustments in the name of love, and in the process was only deluding herself from the truth. Her adjustments were taken for granted as women were meant to compromise and man, not even keep the promise. She treats marriage as a sort of bargain when she quips: "What as marriage after all, but two people after cold-blooded bargaining to meet, mate and reproduce so that generations may continue" (Roots 3).

Indu's dream has a particular significance. She dreams that she is in an immensely large hall and they are being led by a Christ-like bearded figure who is dressed in white. He has an ascetic quality but power without gentleness. His holds significance as she realizes that the people following him are her own. The connotations of religion invoke a sense of religiosity in which women adhere to their roles with unflinching obedience. The Christ-like figure leads them on a journey of life that is this time without redemption particularly for women. Particularly, Indu says that she can feel the subterranean feeling that the whole endeavour is taking place where women move about in the maze of male monopolistic chauvinism. Even the very mode or the methodology of their domestic chores highlighted the mechanical nature of their life that the men of the household engineered for them. "Since childhood the right method of serving food had been drilled into me. Salt here, chutney and pickles below it, vegetables on the right, dal in the centre, ghee only after serving the dal." The pattern was rigid and there could be no deviation from it. These rigid boundaries had lines ingrained on Akka, the oldest woman in the house: "the semi-darkness deepened the shadows on the old woman's face making it all sharp lines and angles" (Roots 27). Indu realizes as she looks at the body of Akka that if one lived long enough one could practically lose everything even one's sex. Thus, Akka's transformation comes as an attempt to evade the submissive path outlined for her and renders herself into the prototype of male patriarchy.

And the walls seemed to smell of childbirth only, as that was the only relevant benchmark set by the women of the house. Indu tries to carve out her indi-

viduality, which is why she gets hurt when Naren tells her that her sharp edges had blurred. Indu wanted her lines distinct even if the sharpness hurt the others. At the end of the day, the lines were her own. And yet, Indu could not find solace in the women's hostel that she lived. The loneliness used to appall her and repel her at the same time. She meets Jayant and loses the ability to be alone. In her case, it is not a financial dependence but a purely emotional one. She wants to dress for him, undress for him. She describes herself as a fluid that attained shape only with the thing that contained her. Her marriage had only one gift to give her: "The gift of silence" (Roots 40). "Indu, the journalist, is torn between self-expression and social stigma", says Smita Jha, in "Indu in Dilemma: A Critical Analysis Shashi Deshpandes Roots and Shadows" There is no point of intersection in their lives where their souls meet. The novelists states: "Husbands and wives: their worlds touched briefly only in the darkness of the night"(Roots 47). Her mother who died at birth proves to be a non-existent entity that only left a sense of void or blankness in her. "Indu's problematic of becoming expresses Deshpandes feminist polemics against sexual and gender roles imposed upon woman in a patriarchal culture" (Prasad and Chandra 66).

In a metafictional stance, the writer also ponders on the themes of woman as a writer. Even with respect to writing, women are supposed to pen about domestic experiences. The novel thus becomes a mouthpiece of its theme. However, they are asked to draw the line there also. When Indu ruminates

on writing on menstrual pains, pangs of childbirth, the ecstasy of orgasm, even Naren; the not-so conservative stops her. When the woman becomes expressive or takes the upper hand in the course of sex, the man by default gets put off by the act as in the case of Indu and Jayant. It left a biased chasm where there was supposed to be a neutral union. The woman in this case is supposed to roll over and play dead. Indu terms herself an anachronism(82). She loves him passionately and is ashamed of it. Here is an act of unconsciously submitting to a custom that she consciously does not subscribe to. The protagonist admits that she is caught between two names-one given by her father when she was born, and the other by her husband when she was married. A woman does have her own roots but thrives in someone else's shadow.

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## रजनी पनिकर के उपन्यास और नारी जागरण

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(Submitted: 16-3-2015 Revised: 23-03-2015)

### सारांश

प्रारंभकालीन महिला लेखिकाओं में अग्रणी हैं रजनी पनिकर। उनके लेखनकाल में भारत में नारी जागरण का माहौल पनप रहा था। ऐसी स्थिति ने रजनी जी के लेखन को कहीं तक प्रभावित किया है और महिला लेखिका होने के नाते अपने उपन्यासों द्वारा नारी जागरण को आगे बढ़ाने में वे कहीं तक सफल हो पाई है इस बात पर गौर करना इस लेख का उद्देश्य है।

भारत की संस्कृति पूरे विश्व में अक्वल मानी जाती है। भारतीय संस्कृति एवं परंपरा के अनुसार स्त्री संपूर्ण सृष्टि में सबसे विशिष्ट एवं उन्नत स्थान रखती है। अतः भारत में एक ऐसा समय था जब नारी की 'माँ' और 'देवी' के रूप में पूजा की जाती थी और समाज एवं परिवार में भी उसे वांछित आदर और सम्मान प्राप्त होता था। परंतु आगे चलकर जैसे-जैसे सामाजिक एवं राजनीतिक गतिविधियों में बदलाव तथा उतार-चढ़ाव आने लगा, नारी की इस उन्नत दशा में भी हास आने लगा। उसका स्थान केवल भोग एवं मनोरंजन की वस्तु के रूप में परिणत होने लगा। उस पर तरह-तरह के अत्याचार होने लगे और वह सृष्टि की सबसे निकृष्टतम वस्तु बनती गई।

लगभग उन्नीसवीं सदी तक यह स्थिति बनी रही। उन्नीसवीं सदी में नवजागरण के प्रारंभ के साथ नारी की इस दीन दशा में भी जागरण की शुरुआत होने लगी। राजा राममोहन राय, स्वामी दयानंद सरस्वती, स्वामी विवेकानंद, गाँधीजी जैसे अनेक महापुरुषों एवं समाजसुधारकों के प्रयत्नों से नारी की आत्मा में जागृति की लहर दौड़ गई।

नारी जागरण और सशक्तीकरण के इस माहौल में नारी को जागृत करने और उसे समाज की मुख्यधारा में लाने हेतु महिला लेखन परंपरा का आरंभ हुआ। महिला लेखन कला के क्षेत्र में पदार्पण करनेवाली लेखिकाओं की प्रारंभिक श्रेणी में कंचनलता सब्बरवाल, उषादेवी मित्रा, शशिप्रभा शास्त्री आदि के साथ रजनी पनिकर का नाम भी गिना जाता है।

रजनी पनिकर के उपन्यासों में मोम के मोती, प्यासे बादल, काली लड़की, सोनाली दी, महानगर की मीता, तीन दिन की बात, बदलते रंग, दूरियाँ आदि प्रमुख हैं। उन्होंने अपने उपन्यासों के ज़रिए तत्कालीन नारी की सामाजिक दशा के चित्रण के साथ-साथ उस वक्त समाज में व्याप्त नारी जागरण की लहर को पाठकों तक पहुँचाने का सफल प्रयास किया है।

शिक्षा नारी के लिए कितना आवश्यक है, शिक्षित होने से वह अपना जीवन किस प्रकार अपनी इच्छा और हैसियत के अनुकूल जी सकती है इस बात को रजनी जी ने अपने उपन्यासों में दर्शाया है। 'महानगर की मीता' में उन्होंने नारी शिक्षा के फलस्वरूप नारी में आई जागृति एवं अस्मिता के बोध को उजागर करते हुए लिखा है - "बेचारी नारी का

जीवन रोते ही कटता था। कभी तो वह जीवन भर रिश्तेदारों के बर्तन ही माँजती रहती थी। उसके बच्चे होते, तो वह भी घर में नौकर-चाकर की तरह समझे जाते। आज पढ़-लिखकर नारी के लिए वह सब सहन करना कितना कठिन है। आज नारी बराबरी का दम भरती है।”<sup>1</sup>

स्त्री-शिक्षा के फलस्वरूप घर की दहलीज़ पार कर बाहर निकलना, अपनी जीविका खुद कमाने पुरुषों के साथ कंधे से कंधा मिलाकर अपना दायित्व निभाने की जो क्षमता नारी में जागृत हुई है उसका चित्रण भी रजनी जी ने किया है। स्त्री-पुरुष मित्रता को पैनी दृष्टि से देखनेवाले उस ज़माने में भी रजनी जी ने ऐसे रिश्तों का खूब समर्थन किया है। साथ ही नौकरीपेशा एवं आर्थिक रूप से स्वावलंबी नारियों का चित्रण करके उनकी समस्याओं को पाठकों के सम्मुख प्रस्तुत किया है। “आज हमारे समाज की व्यवस्था बदल गई है। पहले एक पुरुष परिवार भर की नारियों का भार अपने ऊपर ले लेता था। अब अपना पति भी भार लेने को तैयार नहीं। भाई हो तो वह भी मुँह चुराता है।”<sup>2</sup> पुरुष की इसी कर्तव्यविमुखता के कारण नारी को नौकरी करनी पड़ती है। परिवार के भरण-पोषण का भार भी कहीं-कहीं नारी के कंधों पर आ पड़ा है। नारी उसका साहस के साथ निर्वाह करना चाहती है, परंतु इसके परिणाम उसके पक्ष में अच्छे नहीं होते। ‘मोम के मोती’ की माया का कथन इसका द्रष्टव्य है - “लगातार नौकरी करने से नारी जीवन की आत्मसत्ता जाती रहती है। नारी हृदय की कोमलवृत्तियों का विनाश हो जाता है। दिनरात अफसरों की खुशामद और आफिस के सहकर्मियों की त्रुटियाँ पकड़ने की धुन में रहते-रहते मन की कोमल भावनाएँ विदग्ध हो जाती हैं। यहाँ तक कि आफिस

के क्षुद्र घेरे से दूर पहुँचनेवाली दृष्टि भी बिलकुल क्षीण पड़ जाती है।”<sup>3</sup>

रजनी जी ने अपने उपन्यासों में विवाह संबंधी बदलती मानसिकता को व्यक्त किया है। उन्होंने एक ओर विवाह को प्रमुखता देनेवाली परंपरावादी मानसिकता का चित्रण किया है तो दूसरी ओर विवाह को केवल मनबहलाव और ‘एरिस्टोक्रसी’ माननेवाली आधुनिक एवं घटती मान्यता को भी दर्शाया है। ‘महानगर की मीता’ की मीता के अनुसार, “विवाह जीवन का एक भाग है, जीवन नहीं। माता-पिता से छूटकर लड़की को एक असुरक्षा की भावना महसूस होती है। वह अपने को संसार में बिलकुल अकेली पाती है, शायद इसीलिए विवाह को इतनी महत्ता दी गई है। विवाह से एक साथी मिल जाता है, जो दुःख-सुख में साथ देता है। परंतु वैसा होना भी ज़रूरी नहीं।”<sup>4</sup> और यह नज़रिया आज के ज़माने के हिसाब से बिलकुल खरा उतरता है।

इसके साथ ही रजनी जी ने बाल विवाह, अनमेल विवाह, दहेज प्रथा आदि के दुष्परिणामों का चित्रण करके उनका विरोध प्रकट किया है तो दूसरी ओर विधवा विवाह को खूब समर्थन भी किया है। उन्होंने इस बात पर भी ज़ोर दिया है कि अगर पुरुष को दूसरी शादी करने का अधिकार है तो नारी को भी इस बात का उतना ही हक है जिसे उस ज़माने में कठोर पाप समझा जाता था।

विवाह के बाद नारी की जो दुर्गति होती है जिस प्रकार वह पति और ससुरालवालों के हाथ की कठपुतली बन जाती है इसको भी उपन्यासों में अंकित किया है। ‘महानगर की मीता’ की मीता, ‘बदलते रंग’ की रूपकुमारी चौधरी, ‘दूरियाँ’ की नमिता सबका जीवन इसका साक्ष्य है। नारी जागरण की वक्ता होने के बावजूद रजनी जी ने अपने

उपन्यासों में आदर्श भारतीय पत्नी और पतिव्रता धर्म को महत्ता दी है। उन्होंने 'मोम के मोती' और 'महानगर की मीता' में पति को सबकुछ मानकार उसका अनुगमन करनेवाली पत्नी को ही मान्यता दी है।

दूसरी ओर तत्कालीन नारी को जागृत करने और इस दयनीय दशा से उसे बचाने के लिए रजनी जी ने अपने उपन्यासों में तलाक का खूब विवेचन किया है। 'महानगर की मीता' में उन्होंने तलाक लेने की विभिन्न परिस्थितियाँ, उसके प्रमुख नियम, वकील की अहमियत सब पर विस्तार से प्रकाश डाला है ताकि आवश्यकता पड़ने पर पाठक नारी भी इससे फायदा उठा सकें।

रजनी जी ने नारी शोषण के विविध आयामों को भी अपने उपन्यासों में प्रस्तुत किया है। घर-बाहर दोनों जगहों पर रिश्तेदारों तथा अन्य लोगों द्वारा, दफ्तरों में अफसरों द्वारा सब कहीं वह शोषण का शिकार बनती रहती है। स्त्री को केवल एक भोग एवं मनोरंजन की वस्तु के रूप में देखनेवाली पुरुष मानसिकता का उद्घाटन भी लेखिका ने किया है। 'दूरियाँ' का कमल, 'मोम के मोती' के कबाड़, सेठ धनपति सब इसी खयालात के हैं। 'काली लड़की' में रानी के माध्यम से लिखिका ने इस पर अपना विचार प्रकट किया है, "पहले भी नारी की यही समस्या थी कि वह संतान को जन्म देती थी, पुरुष उसे शरीर से अधिक उसके अस्तित्व को महत्व नहीं देता था। नारी की यह समस्या अभी तक ज्यों-की-त्यों ही बनी है।"<sup>5</sup> अतः लेखिका ने नारी सशक्तीकरण का नारा लगानेवाले इस युग में भी कभी न बदलनेवाली नारी की शापग्रस्त जिंदगी का पर्दाफाश किया है।

रजनी जी ने अपने उपन्यासों में अपनी अस्मिता को पहचानकर अपना स्वतंत्र जीवन जीने

की प्रेरणा पाठकों को दी है। उन्होंने इस बात को स्पष्ट किया है कि स्त्री को जीने के लिए पुरुष के सहारे की ज़रूरत नहीं है। स्वयं को पुरुष का गुलाम मानने की नारी की संकुचित मानसिकता का विरोध भी रजनी ने किया है। साथ ही अस्मिता को बनाए रखने के लिए, अपने हक के लिए लड़ने का आह्वान भी उनके उपन्यासों में देख सकते हैं। 'मोम के मोती' का सुधाकर जब अपनी पत्नी कला को छोड़कर चंपा के साथ भाग जाता है तो माया का मन विद्रोह से भर उठता है। वह सोचती है, "नारी को वोट का अधिकार है। नारी वोट दे सकती है। वोट से क्या होगा? परंपरा से चला आता पुरुष का स्वामीत्व समाप्त हो जाएगा? कला कौन-सी कोर्ट में जाकर अपने अधिकार माँग करेगी? अपने पति को वापस माँगेगी?"<sup>6</sup> अतः रजनी जी ने इस बात पर जोर दिया है कि संवैधानिक तौर पर सारा अधिकार प्राप्त होने के बावजूद स्त्री को अपना हक पाने के लिए लड़ना पड़ता है जो पुरुष लोग उससे छीन लेते हैं। परंतु सचाई तो यह है कि मन में अस्मिता और जागृति की पहचान होने पर भी परंपरा और संस्कृति में जकड़े रहने के कारण पूर्ण रूप से उसे आत्मसात करने में नारी समर्थ नहीं हो पाती है। रजनी जी ने इस बात को भी पाठकों के सम्मुख अपने उपन्यासों द्वारा पेश किया है।

रजनी जी ने अपने उपन्यासों में इस बात को भी उजागर किया है कि समाज में स्त्री और पुरुष का समान स्थान है। लड़की को बोझ मानने और कन्या जन्म पर निराश होनेवाली समाज की मानसिकता को 'काली लड़की', 'सोनाली दी', 'महानगर की मीता' आदि उपन्यासों में दर्शाकर पाठकों को यह समझाने की कोशिश की है कि लड़का हो या लड़की, दोनों में कोई भेदभाव नहीं दिखाना चाहिए। आधुनिक ज़माने में दोनों का समान स्थान

है। पुरुष जिन राहों से गुज़रकर इस दुनिया में आते हैं, स्त्रियाँ भी वहीं से आती हैं और भगवान ने भी दोनों को एक समान बनाया है। अगर उसके सामने दोनों ही समान हैं तो हमें भी इस बात को स्वीकार कर लेना चाहिए यही रजनी जी का मत है। और उन्होंने इस बात पर भी ज़ोर दिया है कि नारी के दुःख का कारण वह स्वयं ही है। शिक्षित होने के बावजूद अत्याचारों का विरोध न करके सबकुछ सहने की उसकी बेवकूफी ही इसका कारण है। अतः रजनी जी ने परंपरा और नियमों के खिलाफ लड़कर उसे अपने अनुकूल बदलने का आह्वान पाठक नारियों को दिया है।

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7. सं. आनंदप्रकाश जैन, कथायन, पृ. 124

“श्रीमति रजनी पनिकर की कला सूक्ष्म निरीक्षण के साथ-साथ गंभीर यथार्थवादी समस्याओं को खोलती है और आधुनिक समाज की असंगतियों पर सीधी-सच्ची, किंतु भावनामय चोट करती है”<sup>7</sup>, आनंदप्रकाश जैन का यह कथन बिलकुल तर्कसंगत है क्योंकि नारी जागरण के प्रारंभिक चरण की लेखिका होने के बावजूद जितनी शिद्धत से रजनी जी ने अपने उपन्यासों द्वारा नारी को जागृत करने का उसकी दयनीय दशा को उन्नत बनाने का प्रयास किया है, वह बहुत ही सराहनीय है। साथ ही आज की आधुनिक शोषित नारी के प्रगतिपथ को आलोकित करने का श्रेष्ठतम प्रयास भी उन्होंने किया है।

# Social Stratification and Occupational Groups in Pre-modern North Malabar

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(Submitted: 16-03-2015 Revised: 21-03-2015)

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## Abstract

Social stratification with occupational specialization was an inherent element of different groups in North Malabar in the pre-modern period. This process of specialization and the resultant developments of different social groups created a co-existence and inter dependence. This paper is an attempt to understand the formation of a village community identified as a part of mobilization of several social segments.

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## Introduction

Social stratification is a unique characteristic of Indian society. Indian society is one of the most stratified among all human societies. The caste system, cultural diversity and economic inequality are all central issues of social stratification. Social stratification means differentiation of a given population into hierarchically super imposed classes [1]. It is manifested into existence of upper and lower layers. Quite obviously social inequality and hierarchy were the stuffs of social stratification where various layers of North Malabar society were arranged horizontally and vertically.

## Role of castes

Some of the caste distinguishes themselves from the other castes by claiming superior rights to the land in the village society. This type of caste is called dominant caste. The members of other castes obtain direct or indirect access to the means of subsistence, through personal relation with the members of the

dominant caste.

Each caste has its special skill required by the dominant caste, with which it can serve other non dominant caste also. In the development of the social structure, along with production relation, ideology of the period also played an important role. According to the peculiarity of the social system, ideology of the period acquire the character and nature of a material force. Political domination and ideological institution which were part of the social system are the examples of the material force. In the discussion of Social stratification these factors could be included [2].

The role of castes in the integration of the agrarian society, whose mechanism of appropriation depended on extra economic coercion, was extremely crucial. It is reasonable to assume that the crystallization of functionally specific families into jatis had its beginning in the Brahmin households. However this had not acquired institutional forms in the early period, through this disintegration of kingship ties, a natural consequence in the clan settlement linked to the Brahmin household. Thus disintegration of clan ties

became almost total among the agrarian tracts as paddy cultivation expanded with the corresponding development like social stratification and widening of the division of labor through specialization. In this process clan identity disappeared and Jati came as the substitute, mostly by retaining the name of the clan like Parayas, Vettuvas, Vedas, Kuravas etc for the retention of clan names for Jati [3].

### Jati hierarchy

The first notable development towards the transformation of clan into jati was specialization labour with land based entitlement that made specialization of labour hereditary. How the labouring clan of hereditary specialization got absorbed into jati system cannot be explained easily. We know that proliferation of hereditary occupation and absorption into jati hierarchy were advancing side by side with the spatial expansion of paddy cultivation. Also we know that at a later period new institutional agencies like the temple and the service of tenants were instrumental in crystallising the jati system [4]. It was the dominant position of the Brahmins that was crucial in the operation of jati hierarchy. Tacitly the recognized ritual supremacy, knowledge system, resource potential, social control, political influence and cultural forms provided the Brahmins with the best conditions of the domination [5].

The basic character of the caste system was the consolidation of the brahmanical supremacy and the suppression of the production forces. The notion of pure self and the impure other that originally constituted the basis of Jati, was tribal and the part of horizontal social division of the primeval kinds [6].

The Cherumas, Pulayas, Mavilas and Vettuvas, who were the actual tillers and the production forces constitutional the base of the North Malabar society. They belonged to the aboriginal groups. Their life was miserable and primitive. There are records, which show that the Pulayas, Cherumas, etc were bought and sold as slaves and often transferred with or without land from one owner to another as a part of transaction [7]. These aborigines must have been masters of soil at one time, but seemed to be already reduced to bonded labour. They refused to come un-

der brahmanical influence and became the marginalized section. They were enslaved by the upper strata of the society and lost freedom in social economic and political field.

The Brahmin or the namboothiri caste was the dominant caste in the north Malabar society as well. There were many Brahmin settlements in the region. The Brahmins controlled Devaswam and Brahmaswam lands. Almost all villages have temples administered by the Brahmins. The development of various land rights through the redistribution of resources by the temples went hand in hand with the formation of a power group in the society. They had immense control over the land as owners of their individual holdings and corporate custodians of temple holdings. As land lords and priestly class the Brahmins enjoyed a very high social ritual status [8].

With the rights of Allada swaroopam large number of nair chieftains and soldiers came and settled in different parts of Hosdurg taluk. Many of them became powerful and dominant force. The different nair groups of North Malabar can be placed in to different classes with diverse interest. Some of the nair families emerged as influential janmies exercising hegemonic domination over other social groups with political and economic control which they possessed. But many of the nairs remained cultivating groups and servants of the Janmies. The newly acquired position as protectors of temples and landlords helped some of the nair families to sustain their influence by asserting their power over other avarna communities, through the koyma rights of their worshipping centers.

The major section of the population of North Malabar belonged to the thiyya caste. It is assumed that the ezhavas of south Kerala and the billavas of south canara are the counterparts of the thiyyas. It is held that the nair, ezhava, and thiyya are belonged to the same social groups but later the nairs came under the brahmanical influence and nair Brahmin social alliance was established by accepting sanbandham system and brahmanical supremacy. Subsequently the nairs rose to a dominant social group and the thiyyas came under the Buddhist influence and they were pushed backward.

The Maniyani caste is a peculiar caste of North

Malabar. This caste is not found in other parts of Kerala. Their ancestors may be the pastoral people of Mullai thinai. A group of these people became traditional stone cutters and another group specialized in herding of cows. Later they transformed in to a separate Jati.

The vaniyas were specialized in the production of oil out of dried coconuts by using a particular device chakku. The members of the vaniya group also engaged in trading and commercial activities.

The vannan and Malayan occupational groups specialized in theyyam performance. Some of the members of the vannan community specialized in the ayurvedic medicine. The women of vannan caste were specialized in washing of clothes. For the removal of pollution caused by death and birth vannathi mattu is essential to all castes except scheduled caste and Brahmins. The women of the Malayan caste were specialized as midwives. The service of malayi was very much needed among various people to assist in the delivery of children. The men and women of the caste were noted for their artistic talents in singing.

The Mappillas are another important section of North Malabar society. They are considered as a caste group of the society. The important settlement of the Mappillas are Madayi, Kottapuram, Athinjal, and Kottikulam. The chaliyar, mogayar, kammalas, assarian are other important occupational groups of North Malabar.

## Conclusion

During the pre modern period, north Malabar society was a stratified society. The appropriation of labour for the expanding wetland agriculture by the Brahmins and temple resulted in the transformation of

tribal descent group in to jatis. The growth of Jati system corresponded to the growth of the medieval agrarian system and committant political order. In the medieval society the caste based social division of labour, temple centered redistribution and hierarchical social relation and janmi naduvazhis appropriation of resources made the life of the vast majority of people complex and tense.

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# Synthesis and Characterisation of 4-amino-5-2-[(2,3-dimethyl phenyl) amino]phenyl-3-mercapto-1,2,4-triazole

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(Submitted: 16-03-2015 Revised: 24-03-2015)

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## Abstract

4-amino-5-2-[(2,3-dimethyl phenyl)amino]phenyl-3-mercapto-1,2,4-triazole was synthesized from an aminobenzoic acid, namely Mefenamic acid by a one-pot synthesis using TCH. 4-amino-5-2-[(2,3-dimethyl phenyl)amino]phenyl-3-mercapto-1,2,4-triazole was well characterized on the basis of IR, NMR and mass spectral data.

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**Keywords**— Triazole, NSAIDs, Mefenamic acid, Characterization.

## Introduction

Nonsteroidal anti-inflammatory drugs [1] (NSAIDs) are a class of drugs that provide analgesic and antipyretic (fever-reducing) effects, and, in higher doses, anti-inflammatory effects. The term non-steroidal distinguishes these drugs from steroids, which, among a broad range of other effects, have a similar eicosanoid-depressing, anti-inflammatory action. As analgesics, NSAIDs are unusual in that they are non-narcotic and thus are used as a non-addictive alternative to narcotics.

Non-steroidal anti-inflammatory drugs are not only useful in the treatment of inflammation and pain but also reduce the risk of many cancers and even Alzheimer's disease [2–8]. Non steroidal anti-inflammatory drugs have been satisfactorily used for decades in the treatment of inflammatory or rheumatic disorders and as common pain-killers. All

NSAID inhibit cyclooxygenase, reducing the endogenous production of mucosal prostaglandins that are inflammatory mediators [9]. Many inflammatory phenomena are correlative with the surface membranes properties of cells that also act as a barrier encountered during the treatment process. Some effects of the surface active drugs on membranes, such as organization, fluidity and permeability changes, membrane disruption and even solubilisation are often involved in the toxic side effects of drugs. Unfortunately, gastrointestinal side-effects are associated with NSAID therapies. In fact, NSAID result in gastric mucosal damage, mucus secretion inhibition, structure and viscosity modification, and reduced surface hydrophobicity by altering the phospholipid composition.

Chronic use of NSAIDs, including Mefenamic acid, may elicit appreciable GI toxicity, therefore, synthetic approaches based upon NSAIDs chemical mod-



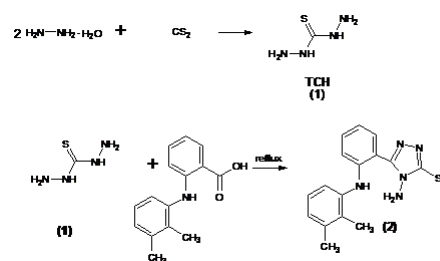
ification have been undertaken with the aim of improving the NSAID safety profile.

Prolonged use of NSAIDs has been associated with gastrointestinal complications ranging from stomach irritation to life threatening gastrointestinal ulceration bleeding and nephrotoxicity [10,11]. Therefore the development of new NSAIDs without these side effects has long been awaited. Selective COX-2 inhibitors with better safety profile have been marketed as a new generation of NSAIDs [12–15]. Thus there remains a compelling need for effective NSAIDs with an improved safety profile.

So keeping in view all these aspects 1,2,4-triazole derivatives of Mefenamic acid was synthesized using one pot synthesis and the compounds were characterized using spectral data.

## Synthesis and Characterisation

To a vigorously stirred solution of hydrazine hydrate, carbon disulphide was added drop wise. The temperature of the mixture was maintained below 60°C. The reaction mixture was then refluxed for 30 minutes, cooled in ice-salt and the precipitated Thiocarbohydrazide was filtered, washed with ethanol, ether and air dried. The separated thiocarbohydrazide(1) was collected. Recrystallization from minimum amount of water, acidified with few drops of concentrated hydrochloric acid yielded colorless needle shaped crystals. An equimolar mixture of 2-(2,3-dimethyl phenyl)amino benzoic acid and thiocarbohydrazide(1) were heated on oil bath till the contents melted. The reaction mixture was continuously stirred and maintained at a temperature of 160°C for further half an hour. The reaction mass became thick and finally solidified. It was allowed to cool and treated with dilute sodium bicarbonate solution in order to remove any unreacted acid left. The solid was filtered, washed with water, dried and recrystallized from ethanol to obtain the pure pale yellow triazole(2).



Scheme

## Results and Discussion

The melting point of the newly synthesized compound was determined in an open capillary. The newly synthesized substituted 1,2,4-triazole is obtained as pale yellow substance with melting point 198-200°C. The structure of the compound was confirmed by NMR, IR and Mass spectral data.

The  $M^+ + 1$  peak at 312 corresponds to the molecular formula  $\text{C}_{16}\text{H}_{17}\text{N}_5\text{S}$ . The peak at  $m/z = 334$  corresponds to  $M^+ + 23$  peak. (Fig. 1)

The IR peaks corresponding to C=N observed at  $1623.95 \text{ cm}^{-1}$ . The CH stretching observed at  $3062.75 \text{ cm}^{-1}$  and C=S stretching band is observed at  $1473.51 \text{ cm}^{-1}$  etc. (Fig. 2)

The  $^1\text{H-NMR}$  spectra were recorded using TMS as an internal standard. The chemical shift values are expressed in delta scale down field from TMS. In the NMR spectra of 4-amino-5-(2-(2,3-dimethyl phenyl) amino) phenyl -3-mercapto -1, 2, 4-triazole the signal due to two methyl groups present in the N-phenyl aniline appeared as singlet at  $\delta 2.177$  and  $\delta 2.319$ , integrating for 6 protons of 2 methyl group. Aromatic protons appeared as a multiplet in the region  $\delta 6.66-7.29$  corresponds to seven aromatic hydrogen. A weak peak at  $\delta 3.7$  integrates NH protons of N-phenyl aniline. The signal due to thiol/thione proton appeared as a singlet at  $\delta 9.2$  integrating for 1 proton.(Fig. 3)

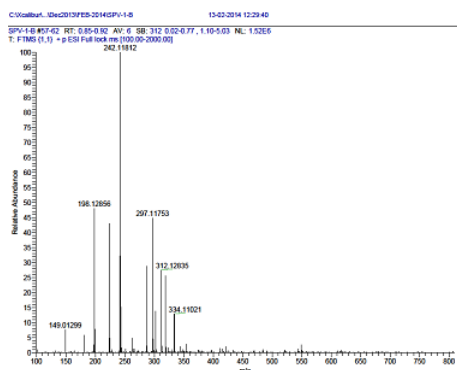


Figure 1: Mass spectrum of synthesized 1,2,4-triazole

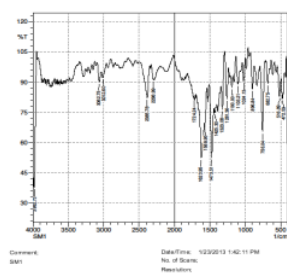
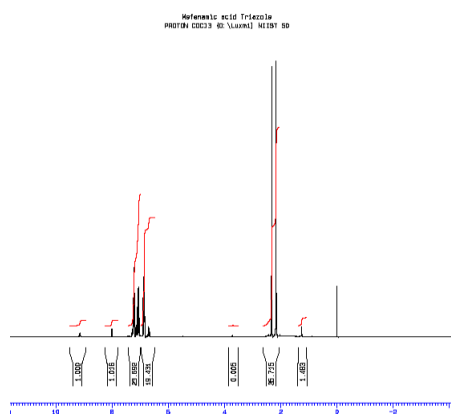


Figure 2: IR Spectrum of synthesized 1,2,4-triazole

Figure 3: <sup>1</sup>H-NMR of synthesized 1,2,4-triazole

## Conclusion

1,2,4-triazole of Mefenamic acid prepared by one-pot method employing Mefenamic acid and TCH with an yield of 63%. A simple one pot method was employed for the synthesis of the triazole. The synthesized triazole appeared to be pale yellow substance with melting point 198-200°C. The synthesized triazole was further confirmed by the spectral data.

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# Malappuram Special Force: The Pre-1921 Face of the Malabar Special Police

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(Submitted: 16-03-2015 Revised: 23-03-2015)

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## Abstract

There is a great misunderstanding regarding the formation of Malabar Special Police (MSP), which was launched as a punitive force in South Malabar during the colonial period. This paper endeavors to find out the reasons for the transformation of an 'ill-equipped force' to a 'well equipped police' in 1921 and its role in the suppression of the Mappilla Outbreaks and the Rebellion of 1921.

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## Introduction

The Malappuram District in the Kerala State came into being on June 16, 1969. The district gets its name from its headquarters, Malappuram, which was formerly one of the villages in Eranad taluk. Considering the hilly nature of the local geography, Malappuram used to be called by this name, the land of hills, from very early times. Even though the nearby town Manjeri seems to be more advanced, the headquarters of the district was fixed at Malappuram owing to its historical importance and centrally located position. Malappuram figures in the annals of the British rule as a place where the authority of the English in Malabar was questioned [1]. A cantonment and the headquarters of a Revenue Divisional Officer and of a District Superintendent of Police were begun in this place during the colonial rule.

In ancient times, the naduvazhis and desavazhis supported by their armed Nayar retainers maintained law and order in Malabar [2]. To arouse fear in the

minds of jungle Mappillas, Nayar sibbandi corps was raised to serve under their native chieftains. The commissioners felt the turbulent nature of the natives and they proposed to create a Nayar militia and Mappila militia separately for the purpose of keeping the tranquility of the country. The proposal was accepted by the Bombay Government and Governor General.

## Formation of Police Forces

By the end of eighteenth century a more regular police force had been established in each of the collectorates into which the district was then divided. In the collectorate of Angadippuram which included Vellattiri, Cheranad, Vettathunad, and Parappanad, established a police force in 1800. In 1801, the irregular and undisciplined sibbandi corps was disbanded, and their place was taken by a force of 500 armed police raised by Captain Watson, mainly for the purpose of collecting revenue. This force was disbanded in 1810, and since that date the Malabar police have

followed normal lines of development. In 1830s the district administration entered upon a period of disturbances, which unhappily continued for long years.

There were a dozen serious outbreaks between 1836 and 1850, seven in Eranad taluk and five in Walluvanad taluk. The British officers found the incidents involving such violence difficult to explain especially because those who started the riots generally suffered more in terms of lives lost than those who were attacked [3]. The District Magistrate, Connolly, in reporting the outrage and wholesale murders suggested that a commission should be appointed to report on the question of Mappilla disturbances generally. This led to the appointment of Judge T.L. Strange as Special Commissioner in February 1852 to report on the question of Mappilla disturbances generally to suggest remedies and to make a special enquiry in to the question of agrarian disputes. Strange proposed the organization of a special force to put down these risings. The Magistrate Connolly was in favor of this scheme [4].

In 1854, the Government of India sanctioned the establishment of a local police corps consisting of 31 native officers, 2 buglers, and 150 men under the command of 2 military officers. A policy of repression set in with the passing in to law the Acts of XXIII and XXIV of 1854. In December 1854, Connolly proceeded on a tour to collect the war knives through the heart of the Mappilla country and brought in 2725, and by the 31st of the following month of January 1855 war knives surrendered to the authorities numbered 7561. A few months after this Connolly was barbarously murdered by 4 Mappillas. The murder of Connolly once more exposed the 'utter inefficiency of the police'. The ease with which the collector of Malabar had been murdered was a strong argument for the reform of the police. Thus the repressive policy initiated in 1854 has had a reverse effect. It was then under discussion, and a few years later the present police force organized under Act XXIV of 1859.

## Malabar Special Police (MSP)

The colonial government put its money into creating relatively small but specialized and powerful police

units. Hence Malappuram Special Force was established as a punitive force in the Mappilla zone temporarily in 1885 and made permanent in 1897. All the finest recruits are drafted in to the Special Force, which is quartered in permanent lines at Malappuram, consists of 80 constables, 4 native head constables, 4 sergeants, a bugler, and a European Inspector [5]. The force rendered a good account of itself in the Outbreak of 1896.

The Mappilla Rebellion showed that the Malappuram Special Force was too small and ill-equipped to quell armed disorder of a serious and widespread character. The Special Force was disbanded in 1921, and the Malabar Special Police was constituted with six strong companies organized and trained on military lines. It was initially intended to assist troops in the crushing of the Mappilla rebellion and to garrison the district after martial law had been withdrawn. It was commanded by European officers and seconded from Indian army; and it was run on strict military lines. The force was created to crush the Mappillas and its primary task remained to keep them in subjection. The companies are now located at Malappuram, Angadippuram, Areakode, Nilamboor, Karuvarakundu, and Tirurangadi. Eventually the three posts at Angadippuram, Nilamboor, and Karuvarakundu will be concentrated at Pandikkad.

In 1932, one of the six companies raised during the rebellion was disbanded and the force was reorganized with four active companies. During the time of Second World War the force was rapidly expanded from four to 16 active companies in order to meet the new demands of the war and the political unrest in the country. In 1946, the strength of this force was reduced to 12 companies due to the dismissal of 950 sepoys as a result of a strike conducted by them [6]. After the formation of Kerala state in 1956, six active companies were taken by the Madras government and the remaining six companies were allotted to Kerala state. During the time of state wide agitation known as 'Vimochana Samaram' which took place in 1959, 3 new companies were added to this force. One of these was formed of ex-service men and the other two of personnel received on transfer to the Malabar Special Police from The Special Armed Police of Andhra Pradesh. Thus at present there are 9 active compa-

nies in this force.

## Conclusion

MSP was the most unpopular unit of the armed police with the public, but the Madras government found it invaluable. Recent European studies of the colonialism stressed the part played by the collaboration of the indigenous population in supporting a colonial regime. But it should also be appreciated that collaboration was often the only practical alternative to futile resistance, and they were constantly being adjusted and strengthened to meet new varieties of opposition to colonial rule. The British imported to India with the protection of property and with the racial supremacy which was essential for their maintenance of the empire. The police force in Malabar in colonial period served both these racial and propertied interests before the formation of the Malabar Special Police.

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### കോലത്തുനാടിന്റെ ബൗദ്ധപാരമ്പര്യം

ഷീജ കെ.പി

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Submitted:16-03-2015 Revised:23-03-2015

#### സാരാംശം

അറുനൂറോളം പാലി വാക്കുകൾ മലയാള ഭാഷയിൽ നിന്നും കണ്ടെടുക്കപ്പെട്ട സാഹചര്യത്തിലും അശോകന്റെ മൗര്യ സാമ്രാജ്യം കോഴിക്കോടുവരെ വ്യാപിച്ചിരുന്നു എന്ന പഠനത്തിന്റെ പശ്ചാത്തലത്തിലും കണ്ണൂരിൽ അവശേഷിക്കുന്ന ബൗദ്ധ ചരിത്ര രേഖകൾ ഭാഷയെ ആസ്പദമാക്കി പരിശോധിക്കുകയാണ് ഈ പ്രബന്ധം. കണ്ണൂർ, കോലത്തുനാട്, കണ്ണൻ, കണിയാൻ, മലപ്പട്ടം എന്നീ പദങ്ങളെ മുഖ്യമായി പരിശോധിക്കുന്നു.

കോലത്തുനാടിന്റെ ശ്രമണ പാരമ്പര്യത്തെക്കുറിച്ച് നടന്നിട്ടുള്ള പഠനങ്ങളിൽ എത്രയെങ്കിലും കുട്ടിച്ചേർപ്പുകൾ യുക്തി സഹമായി അവതരിപ്പിക്കാനാവുമോ എന്നതാണ് ഈ പ്രബന്ധം അന്വേഷിക്കുന്നത്.

കോലത്തുനാടിന്റെ പേരിൽ തന്നെ ബൗദ്ധ പാരമ്പര്യം കുടികൊള്ളുന്നുണ്ടെന്ന് നിരീക്ഷിക്കപ്പെട്ടിട്ടുണ്ട്. പ്രബലമായ ചില നിരീക്ഷണങ്ങൾ കോലത്തുനാട് ബൗദ്ധരുടേതാണ്, ധർമ്മമോ മാടായിയോ ശ്രീമൂല വാസമാണ്, പള്ളിക്കൂന്ന്, പള്ളിക്കുളം തുടങ്ങിയ സ്ഥലനാമങ്ങൾ കൃത്യമായും ബുദ്ധമതസ്ഥാന സൂചനകൾ നൽകുന്നവയാണ് എന്നിങ്ങനെയാണ്. ‘ബുദ്ധന്റെ കാല്പാടുകൾ’ എന്ന ഗ്രന്ഥം മലയാളത്തിലെ പാലി/മഹാരാഷ്ട്രീ പദങ്ങളുടെ സാന്നിധ്യത്തെക്കുറിച്ച് പഠിക്കുന്ന പുസ്തകമാണ്. പ്രസ്തുത പുസ്തകത്തിന്റെ രചനാവഴികളെ മുഖ്യമായും പിൻപറ്റിക്കൊണ്ട് ചില നിരീക്ഷണങ്ങൾ ഈ പ്രബന്ധം മുന്നോട്ടു വെക്കുന്നു.

കണ്ണന്റെ ഊരാണ് കണ്ണൂർ അഥവാ കണ്ണൂർ. കണ്ണൻ കൃഷ്ണനാണെന്നാണ് (കടലായിശ്രീകൃഷ്ണൻ) നിലനിൽക്കുന്ന പുരാവൃത്തം. പ്രഫസർ പുരുഷോത്തമൻ കണ്ണൻ എന്നും കിട്ടൻ എന്നും ഉള്ള കൃഷ്ണശബ്ദത്തിന്റെ രണ്ടു പ്രാദേശിക രൂപങ്ങൾ യഥാക്രമം പാലി,മഹാരാഷ്ട്രീ എന്നിവയിൽ നിന്നുണ്ടായതാണെന്നു ചൂണ്ടിക്കാട്ടിയിട്ടുണ്ട്. ചിത്രങ്ങളിലും ശില്പങ്ങളിലും കാണുന്ന കൃഷ്ണൻ രൂപത്തിലും വേഷത്തിലും പൂർണ്ണമായും ഒരു ബോധിസത്വനാണ്. ഭാവത്തിലും ബോധിസത്വചൈതന്യമാണ് കൃഷ്ണൻ പ്രകടിപ്പിക്കുന്നത്. മഹായാനികളാവാം കൃഷ്ണസങ്കല്പം കേരളത്തിൽ അവതരിപ്പിച്ചത്. ഇവിടെ പ്രചാരം നേടിയ സംജ്ഞകളെല്ലാം ബൗദ്ധ വ്യവഹാരത്തിലുള്ളവയാണെന്നു തിരിച്ചറിയണം.

കൃഷ്ണൻ - സംസ്കൃതം

കൻഹൻ - കണ്ണൻ - പാലി

കിട്ഠൻ - കിട്ടൻ - മഹാരാഷ്ട്രീ

കേരളത്തിലെ കൃഷ്ണൻ അഥവാ കണ്ണൻ ശ്രീകൃഷ്ണ സാമിയായും ഉണ്ണിക്കണ്ണനായുമാണ് ആരാധിക്കപ്പെടുന്നത്. പത്മനാഭസ്വാമി ബുദ്ധനാണെന്ന് ദലിതബന്ധു നിരീക്ഷിച്ചിട്ടുണ്ട്. ഉത്തരേന്ത്യയിലുള്ളതുപോലെ പ്രണയദേവതയായ രാധാകൃഷ്ണ സങ്കല്പം നമുക്കില്ലാതെ പോയതിനു പിന്നിൽ ഈ ശ്രമണ പാരമ്പര്യമാവാം കാരണം.

കണ്ണൂരിൽ മാത്രമല്ല കണ്ണൻ ശബ്ദം കാണുന്നത്. കോലത്തുനാടിന്റെ ഏറ്റവും വലിയ വയലായിരുന്നു കോലത്തുവയൽ. കോലം എന്നതിന്റെ ഒരർത്ഥം ബൗദ്ധ ആരാധനാ കേന്ദ്രമെന്നാണ്. കോലത്തുവയൽ ഉൾക്കൊള്ളുന്ന കണ്ണൂരും ദേശത്തിന് ആ പേര് ലഭിച്ചതിനു പിന്നിലും ബൗദ്ധപാരമ്പര്യം തന്നെയായിരിക്കണം കാരണം. കണ്ണമുനി തപസ്സു ചെയ്ത സ്ഥലം എന്നാണ് നേരത്തേയുണ്ടായിരുന്ന കഥ.

കുട്ടൻ എന്ന വാക്ക് സവിശേഷ ശ്രദ്ധയാകർഷിക്കുന്നു. കരുമാടിക്കുട്ടൻ ബുദ്ധവിഗ്രഹമാണല്ലോ. വാത്സല്യം കിനിയുന്ന സംജ്ഞകളാണ് കുട്ടനും കുട്ടപ്പനും. ഏതോ ബോധിസത്വനാണ് ഇവ വിവക്ഷിക്കുന്നത്. ആ ഭഗവാന്റെ പ്രതിഷ്ഠ കൊണ്ട് പരിപൂതമായ സ്ഥലങ്ങളാണ് കുട്ടനാട്, കുട്ടനല്ലൂർ എന്നിവ എന്നു പുരുഷോത്തമൻ എഴുതുന്നു. ഇന്ന് വേട്ടയ്ക്കൊരുമകൻ എന്നു വിളിക്കപ്പെടുന്ന തെയ്യം വാസ്തവത്തിൽ വേട്ടക്കരുമകൻ ആണെന്ന് തെയ്യം ഗവേഷകനായ വൈ.പി. കണ്ണൻ എഴുതിയിട്ടുണ്ട്. ഈ തെയ്യം ശാസ്താവ് അഥവാ അയ്യപ്പനാണെന്നും വിശ്വാസമുണ്ട്. കരുമാടിക്കുട്ടൻ, കരുമകൻ എന്നീ പദങ്ങൾ വിശ്വാസനീയമായ സമാനത പുലർത്തുന്നുണ്ട്.

കോലം എന്നതിന് തുള്ളൽക്കാർ കെട്ടുന്ന വേഷമെന്നും പുരുഷോത്തമൻ അർത്ഥം പറയുന്നുണ്ട്. കോലത്തുനാട്ടിലെ കീഴാള ദൈവങ്ങളായ തെയ്യക്കോലങ്ങളിലെ കോലം (കോലയാരി) ഇതു തന്നെയാവുമല്ലോ. തെയ്യങ്ങൾ അനുഭവിച്ച പീഡാനുഭവങ്ങളിൽ മദ്ധ്യകാലഘട്ടത്തിലെ ബൗദ്ധനിഷ്കാസനത്തിന്റെ സൂച

നകളില്ലേ? കളിവിരന്മാരും ജ്ഞാനികളും സിദ്ധമായ കീഴാളരാണ് തന്മൂലകന്മാരുടെ കോപത്തിന് ഇരകളായിത്തീരുന്നത്. ജാതിമതഭേദമില്ലാത്തതും സമാധാനത്തിന്റെയും പലപ്പോഴും മദ്ധ്യസ്ഥം അഥവാ മധ്യമാർഗത്തിന്റെയും വക്താക്കളായി നിലകൊള്ളാൻ തെയ്യങ്ങൾക്കു സാധിക്കുന്നത് അവയിലെ കോലം എന്ന പാലി വാക്കിന്റെ ബൗദ്ധമൂല്യത്താലാവാം.

**കണിയാൻ**

ആയുർവേദം, ജ്യോതിഷം, കൂട നിർമ്മാണം എന്നിവ കുലത്തൊഴിലായി സ്വീകരിച്ചിട്ടുള്ള ഒരു സമുദായമാണ് കണിയാൻ. കണിശൻ, ഗണകൻ, ഗണക കണിച്ചൻ തുടങ്ങി അനേകം പേരുകൾ ഈ ജാതിക്കുണ്ട്. ഗണകൻ എന്ന സംസ്കൃത പദത്തിന്റെ പാലിരൂപമാണ് ഗണയ എന്നും അതിന്റെ മലയാള രൂപമാണ് കണിയ, കണയ എന്നും ബുദ്ധന്റെ കാല്പാടുകൾ എന്ന പുസ്തകം വ്യക്തമാക്കുന്നു. എഴുത്ത്/ പയറ്റ് കളരി പാരമ്പര്യവും ഇവർക്കുണ്ട്. ഇവരെക്കുറിച്ച് ലോഗനും മറ്റും രേഖപ്പെടുത്തിയ പുരാവൃത്തം. ശ്രേഷ്ഠനായ തലക്കുളത്തൂർ ഭട്ടതിരിക്ക് (ഏ.ഡി. 1237-1295) തീയ്യ സ്ത്രീയിലോ കണിയാട്ടിയിലോ ജനിച്ച സന്താനങ്ങളാണ് കണിയാന്മാർ. തീയ്യസ്ത്രീയുടെ സ്ഥാനത്ത് വെളുത്തേടത്ത് സ്ത്രീയെന്ന് പാഠഭേദവുമുണ്ട്. സംഘകാല കൃതികളിൽ കണിയാന്മാരെക്കുറിച്ച് പരാമർശമുണ്ടെന്നും അതുകൊണ്ട് ഈ കഥകൾക്ക് അടിസ്ഥാനമില്ലെന്നും ഡോ.എം.വി. ലളിതാംബിക (കണിയാന്മാരുടെ ജീവിതവും സംസ്കാരവും) രേഖപ്പെടുത്തുന്നു. കണിയാന്മാർ വളരെ പുജിക്കുന്ന ദേവതമാരിൽ ചിലർ സുബ്രഹ്മണ്യനും ചാത്തനുമാണ്. മുരുകൻ എന്ന ബ്രാഹ്മണേതര ദൈവമാണ് സുബ്രഹ്മണ്യനെന്ന് ആര്യദൈവമായി പരിവർത്തിക്കപ്പെട്ടത്.

ഇന്നും എഴുത്തിനിരുത്തുന്ന കണ്ണുപുരം മലപ്പുട്ടം തുടങ്ങിയ സ്ഥലങ്ങളിലെ പല കുടുംബങ്ങളും നവരാത്രി

**സഹായക ഗ്രന്ഥങ്ങൾ**

1. ബുദ്ധന്റെ കാല്പാടുകൾ - പ്രഫ. പി. ഒ. പുരുഷോത്തമൻ
2. ബുദ്ധമതവും ജാതിവ്യവസ്ഥയും - കെ. സുഗതൻ

പുജയ്ക്ക് ചാത്തനെ പുജിക്കുന്നുണ്ട്. നവരാത്രിയുടെ അഹിംസയനുഷ്ഠിച്ചു കൊണ്ടുള്ള പുജയിലാണ് ചാത്തൻ ആരാധനാവുന്നത്. അയ്യപ്പന്റെ മണ്ഡലമാസവ്രതവുമായി ഇതിന് സാമ്യതയുണ്ട്.

ഈ സമൂഹത്തിന് കെന്റോൻ പാട്ട്, കളം പാട്ട് എന്നിങ്ങനെ അനേകം അനുഷ്ഠാനകലാരൂപങ്ങളുണ്ട്. അവയിലൊന്നാണ് കോലംതുള്ളൽ. കോലം പാലി വാക്കാണ് നേരത്തേ നിരീക്ഷിച്ചിട്ടുണ്ടല്ലോ. ബൗദ്ധരുടെ പവിത്ര പ്രതീകങ്ങളിലൊന്നാണ് മുത്തുകൂട. കണിയാന്മാരുടെ കുലത്തൊഴിലിൽ സുപ്രധാനമായ ഒന്നായിരുന്നു കൂട നിർമ്മാണം. കണിയാന്മാരുടെ പ്രാചീനമായ തറവാടുകൾ നിലനിൽക്കുന്ന സ്ഥാനങ്ങൾക്കടുത്ത് ശ്രമണ പാരമ്പര്യത്തിന്റെ അടയാളങ്ങൾ കാണുന്നുണ്ട്. ബുദ്ധമതം സ്വീകരിച്ചുവെന്നു കരുതപ്പെടുന്ന ശ്രീകണ്ഠ മുഷകന്റെ പേരിലുള്ള ശ്രീകണ്ഠപുരത്തിന് തൊട്ടടുത്തുള്ള മലപ്പുട്ടമാണ് ഇതിലൊന്ന്. മലയോരത്തെ പട്ടണം മല+പട്ടണം ലോപിച്ച് മലപ്പട്ടം, മല+പട്ടം - മലപ്പട്ടം എന്നിങ്ങനെ രണ്ടു വിധത്തിൽ ഈ വാക്കിനെ മനസിലാക്കാം. പട്ടണം എന്നത് പത്തനം എന്ന പാലിവാക്കിന്റെ മഹാ രാഷ്ട്രീ രൂപമാണ്. ജനവാസകേന്ദ്രമെന്നർത്ഥം. പട്ടം എന്നത് ആലിലയുടെ പാലി വാക്കാണ്. രണ്ടായാലും ശ്രീ കണ്ഠന്റെ കാലത്തുതന്നെ മലപ്പട്ടം ബൗദ്ധസങ്കേതമാണെന്ന് ഊഹിക്കാം. ജൈനസങ്കേതമായ ധർമ്മശാല നീലിയാർകോട്ടത്തിന്റെ സമീപം മാങ്ങാട്ട് ദേവർ കുന്നത്തുതറവാട്, കണ്ണുപുരത്ത് തൃക്കോത്തുതറവാട് എന്നിവയും ശ്രമണ സാമീപ്യം ഉറപ്പാക്കുന്നുണ്ട്. ഇവർക്കിടയിൽ കഴിഞ്ഞ തലമുറയിൽ വളരെയേറെ പ്രചാരമുണ്ടായിരുന്ന വാക്കാണ് അപ്പ എന്നത്. അപ്പൻ ജൈനനാമമാണെന്ന് നിരീക്ഷിക്കപ്പെട്ടിട്ടുണ്ട്. അങ്ങേയറ്റം ബ്രാഹ്മണാധീശത്വത്തിനു വഴിപ്പെട്ടു പോയിട്ടുണ്ടെങ്കിലും തീയ്യ/ഈഴവ ജാതിയെപ്പോലെ തന്നെ ശ്രമണപാരമ്പര്യത്തിന്റെ പല അടയാളങ്ങളും ഇവരിൽ കണ്ടെത്താൻ പറ്റുന്നുണ്ട്.



# Zinc Oxide Nano Structures with Cauliflower Morphology by SILAR Technique

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(Submitted 16-03-2015, Revised 24-03-2015)

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## Abstract

Zinc oxide (ZnO) nanostructures were deposited on soda-lime glass substrates using Zinc sulfate and ammonia solution by successive ionic layer adsorption and reaction (SILAR) technique. Nanostructures were characterized by X-ray diffractometer, Scanning electron microscopy (SEM) and optical studies. Highly adherent milky white ZnO nanostructures with cauliflower morphology were obtained. These zinc oxide nanostructures with the peculiar morphology will facilitate for developing dye-sensitized solar cells.

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**Keywords**— Zinc oxide, nanostructures, XRD, SEM.

## Introduction

Zinc oxide (ZnO) is a key technological compound semiconductor material with a direct wide band-gap of 3.37 eV and a high exciton binding energy of 60 meV. ZnO is a promising material and has occupied an inevitable place among other metal oxides for many applications in optoelectronics and photovoltaic applications especially in dye sensitised solar cells (DSSCs) [1-3]. Various chemical methods such as successive ionic layer adsorption and reaction (SILAR) [4], chemical bath deposition [5], spray pyrolysis [6], electrodeposition [7], etc. have been used to obtain ZnO films. Wet chemical methods like SILAR are more suitable for producing ZnO films with good surface roughness [8]. Solar energy conversion efficiency can be improved by modulating the path taken by light on the surface of solar cells. Greater surface roughness is one way to make light scattering more efficient [9]. SILAR method has

been demonstrated to be a facile technique because of the safe and environmentally benign processing conditions. It is free from bulk precipitation and wastage of material. Hence, in the present work, SILAR technique alone is employed as a single step soft chemical route to investigate the influence of complex agent ammonia on the morphology of the nanostructures fabricated on soda-lime glass substrates.

## Experimental details

The chemicals used in the work are analytic grade and used as received. Method of preparation SILAR has been described in detail elsewhere [10-12]. A complete deposition cycle of this method comprises of four processes involving subsequent immersion of substrates in cationic and anionic solution for adsorption and reaction along with rinsing the substrate in between to remove the loosely held species in distilled water kept at room temperature. Zinc oxide nanostructures were fabricated from the cationic precursor

of zinc complexes while distilled water kept at 95 ° C served as anionic precursor.

### Preparation of zinc oxide nanostructure using ammonia

Soda-lime glass substrates were cleaned thoroughly using distilled water, extran solution and chromic acid and dried in hot air before use. Cationic precursor was prepared by adding 17.3 M (25%) ammonia solution in 0.1 M zinc sulfate solution along with continuous stirring using a magnetic stirrer until a transparent solution was obtained. The pH of the final solution was kept at 11. Distilled water kept at 95 ° C served as the anionic precursor. Immersion time in cationic and anionic solution was 2 s. The immersion time for rinsing the substrates was 6 s. 350 deposition cycles were carried out to obtain highly adherent ZnO nanostructures. After deposition, substrates were removed, washed in distilled water and dried in hot air before characterization.

### Characterization

The crystalline properties of the as-prepared ZnO nanostructures were studied by X-ray diffractometer (Bruker AXS-8 advance) using CuK radiation of wavelength 1.5406 Å. Morphology was examined by Scanning electron microscopy using JEOL Model JSM6490 instrument and Energy-dispersive X-ray (EDAX) spectroscopic measurement was performed via the same instrument. Optical absorption and transmission spectra were recorded using a Hitachi-U-3410 UV-Vis-NIR spectrophotometer in the 200 to 900 nm wavelength range.

### Results and discussion

Highly adherent milky white ZnO nanostructures were prepared by the soft chemical route on glass substrates without seed layers.

### Morphological analysis

The morphology of the as-synthesized ZnO nanostructures prepared was examined through SEM.

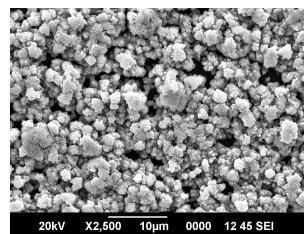


Figure 1: SEM image-Low, magnification of ZnO nanostructures

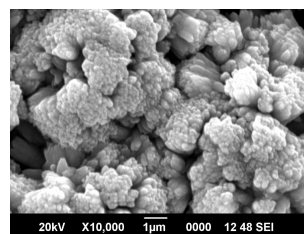


Figure 2: SEM image- medium magnification of ZnO nanostructures

Figure 1, and 2 show SEM images of the nanostructures prepared using ammonia. The images clearly expose the formation of cauliflower like dense ZnO nanostructures with higher surface to volume ratio. In addition, this type of morphology offers a greater surface roughness and gives effect to efficient light scattering.

### Structural analysis

The crystalline properties of the synthesized ZnO nanostructures were examined via powder X-ray diffraction (XRD). Figure 3 shows the XRD patterns of ZnO samples. The very high intensity of the diffraction peaks demonstrates the crystalline nature of the nanostructures.

No characteristic peaks corresponding to other phases or impurities, such as zinc hydroxide, basic reactants etc., were observed in the XRD patterns and that indicated the formation of pure ZnO nanostructures. The peaks observed for the samples match that of bulk wurtzite hexagonal ZnO (JCPDS file no. 36-1451). The mean crystallite size of the ZnO nanos-

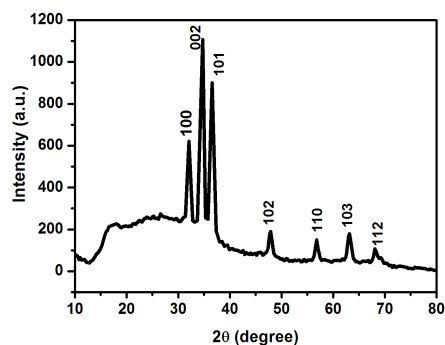


Figure 3: XRD patterns of ZnO nanostructures

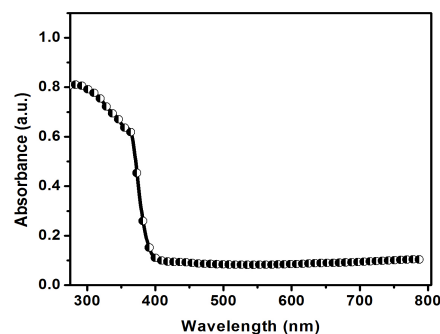


Figure 4: Room temperature optical absorption spectra

structure was 18 nm, determined using the FWHM of the (100), (002) and (101) peaks by the Debye-Scherrer's equation given by,

$$D = 0.98 \frac{\lambda}{\beta} \cos \theta \quad (1)$$

where 0.98 is the value of the shape factor,  $\lambda$  is the wavelength of X-rays which is 1.5406 nm for CuK,  $\beta$  is the half width of diffraction peak measured in radians and  $\theta$  is the Bragg's angle. The compositional purity of the ZnO nanostructures has been confirmed by energy dispersive X-ray analysis (EDAX) (not shown here) and indicates that they contain only Zn and O elements, and notably no other elements were detected.

### UV-Vis-NIR spectroscopy based optical studies

Optical absorption measurements were carried out using UV-Vis-NIR spectrophotometer at room temperature. The absorption spectrum of as-synthesized samples is shown in Figure.4.

The spectra reveal that ZnO nanostructures have low absorbance in the visible region and a steep absorption edge in 375-425 nm. Figure. 6 shows the transmission spectrum of as-synthesized samples. Samples have a higher and steady transmittance of 80% in the visible region.

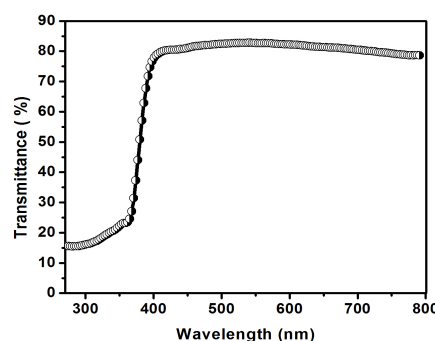


Figure 5: Room temperature optical transmission spectra

### Conclusion

Cauliflower like ZnO nanostructures with high specific surface area and greater surface roughness were synthesized by SILAR method. SEM images denude the role of ammonia as a structure directing agent in determining the surface morphology of the nanostructures. XRD studies revealed the wurtzite hexagonal structure of ZnO of average grain size 18 nm. Optical studies show low absorption and high transmission in the visible region. Studies confirmed the high surface-to-volume ratio, good optical quality, excellent crystalline nature and purity of the as-synthesized ZnO nanostructures. Experimental results confirmed that

single step chemical route utilized in the present work is highly efficient to prepare high quality nanostructures on substrates without ZnO seed layer. These zinc oxide nanostructures with the peculiar morphology and properties will facilitate for developing dye-sensitized solar cells.

### Acknowledgements

KVM acknowledges UGC, India for supporting research work through FIP. We express our sincere thanks to STIC, Cochin, Kerala, India for offering technical support.

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# $\chi^{(3)}$ Measurement And Optical Limiting Studies Of Benzhydrazides

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(Submitted 16-03-2015 Revised:23-03-2015)

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## Abstract

Four hydrazones, 4-chloro-N'-[(4-nitrophenyl)methylidene] benzhydrazide (B<sub>1</sub>), 4-Chloro- N'-[4-(dimethylamino)phenyl] methylidenebenzhydrazide (B<sub>2</sub>), 4-Nitro-N'-[(4-chlorophenyl) methylidene] benzhydrazide (B<sub>3</sub>) and 4-Nitro-N'-[(4-methoxyphenyl) methylidene] benzhydrazide (B<sub>4</sub>) were synthesized and their third order nonlinear optical properties have been investigated using a single beam Z-scan technique with nanosecond laser pulses at 532 nm. The nonlinear refractive index  $n_2$ , nonlinear absorption coefficient  $\beta$ , magnitude of effective third order susceptibility  $\chi^{(3)}$ , the second order hyperpolarizability  $\gamma h$  and the coupling factor  $\rho$  have been estimated. The value of  $\text{Re } \chi^{(3)}$  for compound-B<sub>4</sub> is  $2.04 \times 10^{-13}$  esu, which is larger than that for the other compounds of the Benzhydrazide series. Among the benzhydrazide series, the compounds-B<sub>3</sub> and B<sub>4</sub> show better optical limiting at 532 nm wavelength compared to compounds-B<sub>1</sub> and B<sub>2</sub>. It is seen that in all the compounds, the power limiting threshold decreases with increasing concentration. Our studies suggest that these compounds are potential candidates for the optical device applications.

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**Keywords**— Non-linear optical properties, Z-scan, Optical limiting, two photon absorption.

## Introduction

The interaction between materials and intense electromagnetic fields from high power laser pulses modulates the parameters of the laser pulse itself, which is referred to as nonlinear optical effect [1]. Materials possessing such nonlinear optical response can be exploited for the manipulation of optical signals in a variety of optical devices. Generally, optical limiting property exhibited by organic molecules is related to high delocalization of the pi-electrons.

In general, the method adopted to improve the

nonlinear optical properties is to synthesize organic compounds of the type, electron donor-bridge-electron acceptor/donor (D-bridge-A or D-bridge-D). A series of compounds with different donor and acceptor groups at the terminal positions of a hydrazone bridge have been synthesized. The experimental investigation of the third order nonlinear optical susceptibility in the synthesized compounds, 4-chloro-N'-[(4-nitrophenyl) methylidene] benzhydrazide (B<sub>1</sub>), 4-Chloro- N'-[4-(dimethylamino)phenyl] methylidene benzhydrazide (B<sub>2</sub>), 4-Nitro-N'-[(4-chlorophenyl)

methylidene] benzhydrazide ( $B_3$ ) and 4-Nitro-N'-[(4-methoxyphenyl) methylidene] benzhydrazide ( $B_4$ ) dissolved in dimethyl formamide (DMF) with the single beam Z-scan technique with nanosecond laser pulses at 532nm have been reported. We also discuss the influence of donor/acceptor groups on the third order nonlinear optical properties of these molecules.

## Materials and Methods

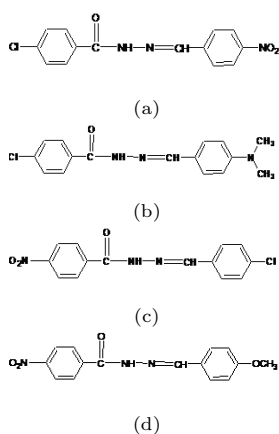


Figure 1: Structure of benzhydrazides (a)  $B_1$  (b)  $B_2$  (c)  $B_3$  (d)  $B_4$

The structure of synthesized benzhydrazides are given in Figure 1. The third order optical nonlinearity was investigated by the Z-scan technique. A Q-switched Nd:YAG nanosecond laser with a pulse width of 8ns at 532 nm and a pulse repetition rate of 10Hz was used as a source of light in our experiment. Solutions of the compounds in dimethyl formamide (DMF) were prepared and the concentration of the solution was  $1 \times 10^{-2}$  mol/L. The Gaussian laser beam was focused by using a lens of focal length 25cm, into the sample solution contained in a 1mm quartz cuvette. The resulting beam waist radius at the focus was calculated using the formula,  $\omega_0 = 1.22f \lambda/d$ , where 'f' is the focal length of the lens and 'd' the diameter of the aperture. It was found to be 18.9  $\mu\text{m}$ . The corresponding Rayleigh length, calculated using the formula  $Z_R = \pi\omega_0^2/\lambda$ , was found to be 2.11mm. The sample thickness of 1mm was less than the Rayleigh length and hence it could be treated

as a 'thin medium'. The Z-scan was performed at laser pulse energy of 200 $\mu\text{J}$ , which resulted in an on-axis peak irradiance of 4.78  $\text{GW}/\text{cm}^2$ . The optical limiting measurements were carried out keeping the sample at the focal point and varying the input energy and recording the output energy without placing an aperture in front of the detector. The model described in [2] was used to determine the magnitude of nonlinear absorption coefficient  $\beta$  and the third order susceptibility  $\chi^{(3)}$  of the samples.

## Results and Discussion

The open aperture Z-scan traces of the compounds obtained by performing the open aperture Z-scan experiment are given in Figure 2. The magnitude of nonlinear absorption coefficient  $\beta$  is calculated from the open aperture Z-scan traces. Closed aperture Z-scan was performed to determine the sign and magnitude of nonlinear refraction. The peak-valley configuration of the pure nonlinear refraction curves for the studied compounds clearly demonstrate that the index change is negative (Figure 3), exhibiting defocussing effect. Figure 4 shows the resulting curve corresponding to pure nonlinear refraction, obtained by dividing the value of closed aperture data by the open aperture data. The difference between the peak and valley in the pure nonlinear refraction curve is used to calculate the nonlinear refractive index of the compounds.

The nonlinear optical susceptibility of compound- $B_1$  is found to be greater than compound- $B_2$ . Compared to dimethyl amino group in compound- $B_2$  which is an electron donor, the nitro group attached to the compound- $B_1$  being a strong acceptor receives electrons readily to create electron delocalization. Hence the charge transfer is more effective in compound- $B_1$  and shows a higher nonlinear response compared to compound- $B_2$ . The value of  $\text{Re } \chi^{(3)}$  for compound- $B_4$  is  $2.04 \times 10^{-13}$  esu, which is larger than that for the other compounds of the Benzhydrazide series. The nonlinear response of the compound- $B_4$  is mainly due to the pi-electron density and the electron accepting ability of the nitro group in the molecule. The highly electron accepting nitro group attached to the left hand side of the carbon ring and the donor

methoxy group at the right hand side of the molecule together forms a stable pi electron distributed system. A methoxy group which is an electron donor is attached to the hydrazone Bridge of compound-B<sub>4</sub> and shows higher nonlinearity than compound-B<sub>3</sub>. This may be due to the strong donating ability of the methoxy group rather than the electron acceptor, chlorine present in the compound-B<sub>3</sub>. Compounds B<sub>1</sub> and B<sub>3</sub> are formed by interchanging the positions of the attached chlorine and nitro groups, out of which nitro group is a strong electron acceptor compared to chlorine. Though they have the same molecular formula, we can find an increase in nonlinear absorbance in compound-B<sub>3</sub>. These values are comparable with that of dibenzylideneacetone and its derivatives [3], 4-methoxy chalcone derivatives [4] and that of substituted benzohydrazides [5].

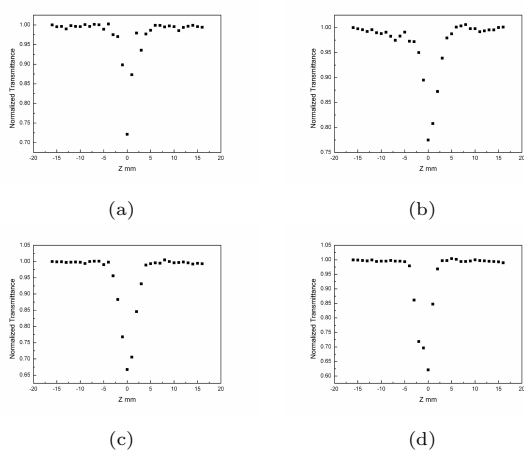


Figure 2: Open aperture Z-scan curves of benzhydrazides (a) B<sub>1</sub> (b) B<sub>2</sub> (c) B<sub>3</sub> (d) B<sub>4</sub>

The nonlinear optical susceptibility of compound-B<sub>1</sub> is found to be greater than compound-B<sub>2</sub>. Compared to dimethyl amino group in compound-B<sub>2</sub> which is an electron donor, the nitro group attached to the compound-B<sub>1</sub> being a strong acceptor receives electrons readily to create electron delocalization. Hence the charge transfer is more effective in compound-B<sub>1</sub> and shows a higher nonlinear response compared to compound-B<sub>2</sub>. The value of  $\text{Re } \chi^{(3)}$  for compound-B<sub>4</sub> is  $2.04 \times 10^{-13}$  esu, which is larger than

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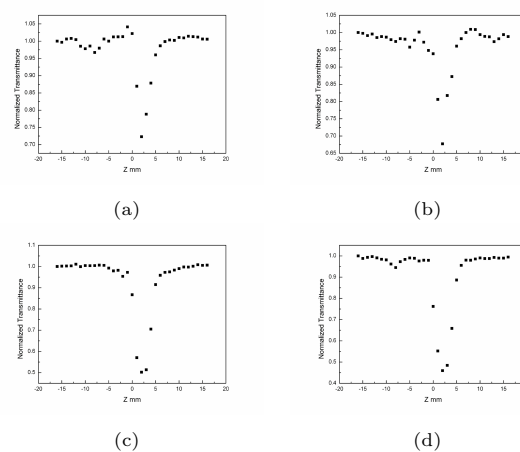


Figure 3: Closed aperture Z-scan curves of Benzhydrazide (a) B<sub>1</sub> (b) B<sub>2</sub> (c) B<sub>3</sub> (d) B<sub>4</sub>

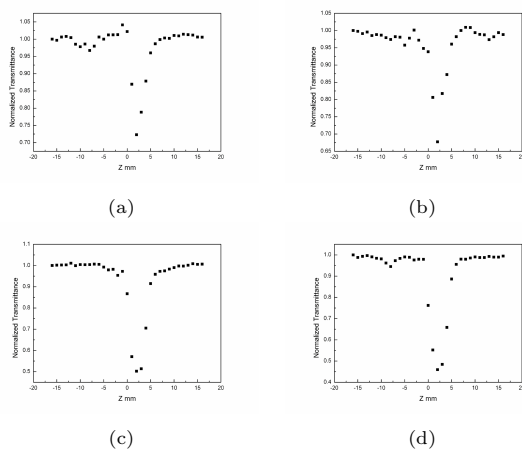


Figure 4: Nonlinear refraction curves of benzhydrazides (a) B<sub>1</sub> (b) B<sub>2</sub> (c) B<sub>3</sub> (d) B<sub>4</sub>

By the introduction of electron donors or acceptors, the electron density is enhanced. As a result, there is an increase in the magnitude of dipole moment which leads to large nonlinear susceptibilities. This shows that by increasing the donor /acceptor strength in hydrazone molecules, we can increase the third order nonlinear response. Hence through structure modification in this class of materials, one can achieve the nonlinear optical property.

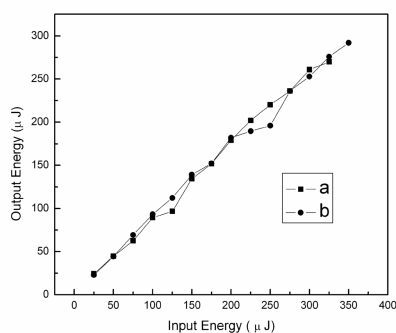


Figure 5: Optical limiting for the compounds of (a) B<sub>1</sub> and (b) B<sub>2</sub>

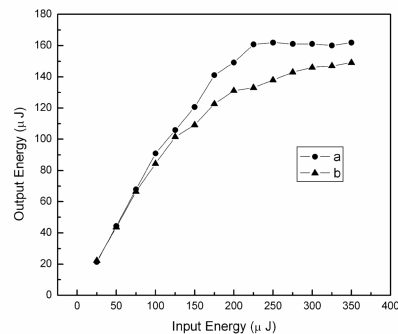


Figure 6: Optical limiting for the compounds of (a) B<sub>3</sub> and (b) B<sub>4</sub>

The optical limiting experiment was conducted at 532nm wavelength for all the compounds. Among the benzhydrazone series, the compounds-B<sub>3</sub> and B<sub>4</sub> show better optical limiting at 532nm wavelength (Figs.5 and 6), compared to compounds-B<sub>1</sub> and B<sub>2</sub>.

It is seen that in all the compounds, the power limiting threshold decreases with increasing concentration. This is because at the higher concentration, there exists more molecules per unit volume; hence it absorbs the harsh laser pulses more efficiently. Higher conjugation length and stronger end groups can decrease the limiting threshold. Since the third order nonlinear response arises due to delocalization of electrons, the optical limiting is ascribed to the two photon absorption mechanism.

The basic requirements for optical limiting applications, ie; large nonlinear refraction and positive nonlinear absorption are observed in the reported compounds. It is confirmed by the presence of optical limiting. The large nonlinearities of the reported compounds are due to the delocalized electronic states [6]. The present result shows that the samples exhibit remarkable optical responses in the nanosecond domain, which help in designing organic materials suitable for optical limiters and optical switches.

## Conclusion

Four hydrazones, B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub> and B<sub>4</sub> were synthesized and their third order nonlinear optical proper-



Compounds	$n_0$	$n_2$ (esu)	$\beta$ (cm/GW)	Re $\chi^{(3)}$ (esu)	Im $\chi^{(3)}$ (esu)
B <sub>1</sub>	1.425	$-1.29 \times 10^{-11}$	1.65	$-1.39 \times 10^{-13}$	$0.26 \times 10^{-13}$
B <sub>2</sub>	1.423	$-1.03 \times 10^{-11}$	1.33	$-1.11 \times 10^{-13}$	$0.21 \times 10^{-13}$
B <sub>3</sub>	1.407	$-1.56 \times 10^{-11}$	1.97	$-1.64 \times 10^{-13}$	$0.30 \times 10^{-13}$
B <sub>4</sub>	1.408	$-1.94 \times 10^{-11}$	2.24	$-2.04 \times 10^{-13}$	$0.33 \times 10^{-13}$

Table 1: Experimentally determined values of nonlinear optical parameters

ties have been investigated using a single beam Z-scan technique with nanosecond laser pulses at 532nm. The nonlinear refractive index  $n_2$ , nonlinear absorption coefficient  $\beta$  and magnitude of effective third order susceptibility  $\chi^{(3)}$  have been estimated. Among the benzhydrazide series, the compounds-B<sub>3</sub> and B<sub>4</sub> show better optical limiting at 532nm wavelength compared to compounds-B<sub>1</sub> and B<sub>2</sub>. It is seen that in all the compounds, the power limiting threshold decreases with increasing concentration.

The basic requirements for optical limiting applications, ie; large nonlinear refraction and positive nonlinear absorption are observed in the reported compounds. The present result shows that the samples exhibit remarkable optical responses in the nanosecond domain, which help in designing organic materials suitable for optical limiters and optical switches.

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# A pedagogical approach to explore new informations from a basic experiment

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(Submitted 19-03-2015, Revised 23-03-2015)

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## Abstract

While discussing the equations of motion of pendulum oscillations in classrooms, we usually neglect the effect of large amplitude oscillation due to its non linear nature. Solving non linear differential equation is an Herculean task during an undergraduate course. In this article, we try to solve this nonlinear equation using certain basic concepts in mechanics, within certain limitation. We believe that these types of attempts will make clarity in conceptual understanding in the cognitive domain of students.

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## 1 Introduction

In physics we have large number of fundamental demonstrative experiments which generate, not only curiosity but also new knowledge and experience. Pendulum experiment is one among them. When a pendulum oscillates with small amplitude it exhibit the property of a harmonic oscillator, and is called a simple pendulum. It is employed to determine the acceleration due to gravity of earth in laboratory. With large amplitudes, pendulum experiments are also used to demonstrate non linear motion and even properties of chaos[3]. Some of the textbooks of Mechanics for undergraduate courses [1] discuss theory of large amplitude pendulum, but we feel it is a heavy lifting problem for graduates. In this article we discuss about period of large amplitude pendulum and demonstrate it with experimental support.

## 2 Perceptual experience

Harmonic oscillator is a physical system which execute oscillations obeying Hookes law.

$$F = -kx$$

The differential equation for harmonic oscillator is

$$\frac{d^2x}{dt^2} + \frac{k}{m}x = 0$$

where k is the force constant[2]. The period of the harmonic oscillator is

$$T = 2\pi\sqrt{\frac{k}{m}}$$

For a pendulum the differential equation of motion is

$$\frac{d^2\theta}{dt^2} + \frac{l}{g}\sin\theta = 0$$

When amplitude is very small, the equation becomes,

$$\frac{d^2\theta}{dt^2} + \frac{g}{l}\theta = 0$$

Hence the period is

$$T' = 2\pi\sqrt{\frac{l}{g}}$$

. Thus the period of the simple pendulum is constant since force constant is constant.

### 3 Rationalization of equation

To accommodate large amplitude oscillation in the expression for period, we use the basic definition of force constant. Modulus value of force constant is

$$k = \frac{dF}{dx}$$

In the case of simple pendulum the expression for the restoring force for an amplitude  $\theta$  is

$$F = -mg \sin \theta$$

here  $x = l\theta$ . Hence modulus value of force constant is

$$k = \frac{mg \cos \theta}{l}$$

Substituting this value for  $k$  in the expression for period  $T$  we obtain a new expression for period which is related to the amplitude  $\theta$  and period  $T'$  of the simple pendulum.

$$T = 2\pi\sqrt{\frac{l}{g \cos \theta}}$$

This leads to

$$T = \frac{T'}{\sqrt{\cos \theta}}$$

This expression for period itself reveals the role of elliptical integral for finding the exact solution of large amplitude pendulum.

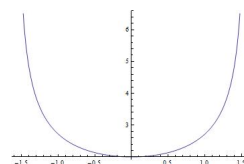


Figure 1: Theoretical variation of  $T$  with  $\theta$

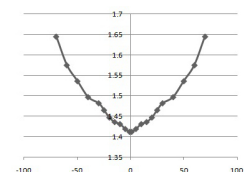


Figure 2: Experimental variation of  $T$  with  $\theta$

## 4 Experimental demonstration

For the verification of the theoretical result, we conducted the pendulum experiment in our laboratory with length 50 centimeters. Repetition of the experiments reveals that the data obtained were matched with theoretical predictions with some variation in large amplitude oscillation. We also studied the nature of the graph indicating the variation of the period with angle both for theoretical (Fig-1) and experimental data (Fig-2). Table 1 illustrate a comparison between theoretical and experimental values of the period.

## 5 Conclusion

This study is pedagogically important such that it helps to get a clear concept in the definition of force constant, and the variation of period with amplitude of oscillation. One of the limitation of the expression for the period  $T = \frac{T'}{\sqrt{\cos \theta}}$  is it that we could not apply it when  $\theta$  value is positive and negative of  $\frac{\pi}{2}$  radian.

Angle	Theoretical $T$	Experimental $T$
1	1.418	1.412
2	1.418	1.414
3	1.419	1.415
4	1.419	1.418
5	1.421	1.419
10	1.429	1.431
15	1.443	1.436
20	1.463	1.447
25	1.489	1.465
30	1.524	1.482
40	1.620	1.497
50	1.769	1.536
60	2.605	1.575
70	2.425	1.645

Table 1: Theoretical and experimental data

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# A Case Study of Endosulphan Effects

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(Submitted: 16-03-2015 Revised: 23-03-2015)

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## Abstract

There was a lot of hue and cry in the use of Endosulphan in the Cashew Plantation owned by the Plantation Corporation of Kerala (PCK) in the Kasaragod district. The spraying of Endosulphan effected the health and environment of the district. The Tea mosquito bug sucks the juice of the flowers of the cashew tree and this results in considerable loss in the yield of the crop. Hence for controlling the pest attack on a large scale, the PCK since 1980 resorted to aerial spraying of highly toxic Endosulphan. Over the years many people of the area reported very serious health problems such as cerebral palsy, birth abnormalities, mental retardation, infertility, epilepsy etc. Endosulphan is a very poisonous compound belonging to the organo chloro class of compound which has been classified as one of the persistent organic pollutant substance (POPS). Endosulphan was originally classified under cyclodienes. Its chemical name is 6, 7, 8, 9, 10, 10 – hexachloro – 1, 5, 5a, 6, 9, 9a – hexahydro 9 – methane – 2, 4, 3 benzo dioxanlyapin-3-oxide. There is sufficient statistical evidence to affirm that the flora and fauna are direct victims of spraying of pesticide. Also skin diseases, digestion problems and menstrual disorders, lung problems were found more frequent in the households near to the PCK. Statistical techniques were used.

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**Keywords**— Endosulphan effect, Health Problems, Survey, Statistical Techniques.

## Introduction

There was a lot of hue and cry in the use of Endosulphan pesticide in the Cashew Plantations owned by the Plantation Corporation of Kerala (PCK) in the Kasaragod district. While the PCK authorities and a section of political parties supported the use of the pesticide, a few strongly opposed it. The PCK employees and local people of the Kasaragod district living within and around the plantations were silent victims of the lethal pesticide for the last twenty years. Due to the protest from various quarters to the aerial spray of the pesticide, the government and several other agencies employed expert groups/study groups to assess the damage to the health of the people, impact on the flora and fauna of the region, if any. In-

terestingly, the report of each of the study group gave way to a lot of hue and cry for and against its findings, the authenticity, the reliability of the study etc. Also, while the finding of the study by one agency strongly recommends the ban of the use of Endosulphan, another agency asserts it is no way harmful to health and environment. Another very surprising aspect is that the political parties adopted a dual stand on the issue-while in power they supported the aerial spray of Endosulphan on the cashew plantations and they opposed it while not in power. Of late, rather than a very severe health and environmental problem of the district of Kasaragod, the Endosulphan menace has given way to political tug. So the authorities show little interest to look in to the problems of the poor victim's sufferings of various diseases alleged to

have caused by the use of Endosulfan.

Endosulfan is a very dangerous chemical compound belonging to the organochlor class, which has been classified as one of the persistent organic pollutant substance (POPS), Endosulfan was originally classified under cyclodienes. Its chemical name is 6, 7, 8, 9, 10-hexachloro-1, 5, 5a, 6, 9, 9a - heclahydro-6, 9-methano-2, 4, 3-benzo dioxaniyapil-3-oxide.

It is available in the market containing two isomers (alpha and beta) in the ratio of 70:30. Between the two, alpha is more poisonous than beta. Endosulfan is available in the market in the brand name such as agrosulphan, aginarosulfan, bangagesulfan, siyosulphan, endocell, E sulfan etc.

## Review of Literature

Endosulfan being a lethal poisonous compound, several studies have been made to assess its impact on environment and humanity.

Labunska. I, Stephenson A, et.aI. (1999) has published a book named 'Toxic Hotspots' based on a Greenpeace Investigation of Hindustan Insecticides Ltd. Udyogmandal, Kerala. The results of this investigation strongly support the conclusion that the manufacture of this pesticide at Hindustan Insecticide Ltd. Results in the continued release of diverse mixture of other organochlorine chemicals to the environment.

Usha. S (2000) in her book named Endosulfan: problems and facts' published by Thanal Conservation Action explains the chemical structure of the compound, some history of Endosulfan, the problems and precautionary measures that should be taken while spraying the chemical and the symptoms of occurrence of danger and other ecological problems.

Romeo f. Quijanao (2001) has studied on Endosulfan poisoning in Kasaragod, Kerala. The Government appointed a committee to undertake a detailed study and scientific analysis on the effects of Endosulfan on human population and environmental pollution on 21/02/2001. Dr. A. Achuthan, environmentalist, was the chairman of the committee.

On the basis of the investigations and the above conclusions, the committee submitted the re-

port to the Government with recommendations on 22/11/2001. The significant recommendations are :

1. The ban on the aerial spraying of pesticides in all the Cashew plantations of PCK in Kasaragod district
2. Aerial spraying should be banned
3. Water source should be protected
4. Soil nutrient status should be maintained and it should not be degraded

Sri. Sankaracharya University (2001-2002) conducted a study to analyse social aspects connected with aerial spraying of Endosulfan in Periya. The suggestions of the study are: The government should take keen interest to bear treatment expenses and also should conducted medical camps in all the plantation areas, and environmental analysis should be conducted in the area to find out environmental damages due to aerial spraying of the pesticides and to take proper steps to prevent the use of pesticides hazardous to the environment.

The main objectives of the study are:

1. To determine the veracity of reports that serious health problems and adverse environmental effects have appeared in Kasaragod since the time the cashew plantation started its operations
2. To determine whether the reported illness were largely due to Endosulfan aerial spraying

"Endosulfan is not a quick degenerating chemical. It stays in the environment as a toxic element for a good number of years". (Shell, producer of Endosulfan).

## Analysis

The enumeration of population by sampling methods proposed by Laplace in 1782 came into widespread use only by mid thirties of the last century. "Sampling is not mere substitution of a partial coverage for a total coverage. Sampling is the science and art of

controlling and measuring reliability of useful statistical information through the theory of probability". (Deming 1950). The proposed study aims at studying the effects of the chemical pesticide Endosulfan to various living organisms in Kasaragod district.) For the study purpose, two populations were taken into considerations.

1. The population which is very near to the Plantation Corporation of Kerala (PCK), designated as case population. The case population is the households in the specified area where Endosulfan was sprayed aerielly for 20 years.
2. Second population is the households in area far away from the PCK, designated as control population, geographically similar to that of the case group.

Based on the questionnaire number of deaths in the previous 20 years and diseases usually seen in the area were recorded. The questions were concerned with the problems relating to the spraying of pesticide Endosulfan.

The data collection, analysis and interpretation are based on the statistical methods. Using the data, cross tabs between the variables and the presence of diseases was also explored to find the effect on the parameters. Chi-square test was used for testing the dependence/independence between the variables, population type, distance between the PCK and house, distance between the PCK and well.

As part of the cross table procedure SPSS produces a table that includes the chi-square statistics and its significant value. The Pearson chi-square statistic tests whether the two variables are independent. If the significant value is small enough (p-value must be less than 0.05) then we reject the null hypothesis that the variables are independent and accept the alternate hypothesis that they are some way related. The p-value of a test statistic is the probability of getting a value of test statistic greater than or equal to the computed value under the null hypothesis. The null hypothesis of non-association between the characteristics is rejected if the p-value is not more than 0.05. If the p-value is larger than the conventional value of 0.05,  $H_0$  is accepted.

	Lung Diseases		Total
	No	Yes	
Population type count	292	55	312
% within population type	82.4	17.6	100
% within presence of lung diseases	64.4	75.3	66.1
Control Count	142	18	160
% within population type	88.8	11.3	100
% within presence of lung diseases	35.6	24.7	33.9
Total	399	73	472
% within population type	84.5	15.5	100
% within presence of lung diseases	100	100	100

Table 1: Test for the Independence of population type and presence of lung diseases

	Value	Approx Sig
Nominal by Phi	-0.084	0.070
Nominal by Cramer's V	0.084	0.070
No. of Valid cases	472	

Table 3: Symmetric Measures

Several measures have been proposed to measure the strength of association between the categorical variables. An ideal measure should mimic the correlation coefficient by having a maximum value of 1 for perfect association and a value of 0 for no association. One such statistics is the Phi coefficient. Phi is used with 2x2 contingency tables. Phi is calculated by dividing the value of chi-square statistic by the total frequency and then taking the square root of this value. If one of the two categorical variables contains more than two categories, then Cramer's V is preferred to Phi because Phi falls to reach its minimum value of zero indicating no association in these circumstances.

The table 1 gives there is an association between population type and presence of lung diseases and the measure of association is 0.084. The proportion of lung diseases in the endosulfan sprayed area (17.6) is significantly higher compared to the other area (11.3).

Ods ratio (OR) = 1.7 i.e. 1.7 times higher risk of getting skin diseases due to endosulfan (since  $OR > 1$ )

## Conclusion

It is believed that the aerial spraying of a pesticide may cause lung diseases. As per the data this belief

	Value	df	Asymp. Sig. (2 sided)	Exact. Sig. (2 sided)	Exact. Sig. (2 sided)
Pearson Chi-square	3.291 <sup>5</sup>	1	0.070		
Continuity Correction	2.821	1	0.093		
Likelihood ratio	1	0.064			
Fisher's Exact test linear-by- Linear association	3.284	1	0.070	0.080	0.044
No. of Valid cases	472				

Table 2: Chi-square Tests

Endosulan lung diseases	Cases	Control	Total
Yes	55	18	73
No	257	142	399
Total	312	160	472

could be true. The percentage of infection is 17.6 in the study population and 11.3 in the control population. The difference is found to be statistically different.

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# A Fuzzy Economic Order Time Inventory Model

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(Submitted: 16-03-2015 Revised:23-03-2015)

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## Abstract

Inventory model in which the time period of sales is a decision variable is considered in fuzzy environments. The components in the model are represented by trapezoidal fuzzy numbers. Optimum policy of the model is derived and numerical examples are provided in order to ascertain the sensitiveness in the decision variable with respect to fuzziness in the components.

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**Keywords**— Inventory, Fuzzy set, Economic order time, Lagrangian optimization.

## Introduction

The first scientific approach to inventory management problem was the Harris - Wilson method popularly known as the Economic Order Quantity (EOQ) formula. In the EOQ inventory system, the input is made in equal sizes against continuous withdrawal of items at a constant rate. Being very simple to implement, stock manufacturers use the EOQ formula for fixing the quantity to be produced while the stock distributors use it for fixing the quantity to be purchased.

One or more components of an inventory model often appear to be vague and imprecise and hence for getting realistic models all such components are to be represented by fuzzy sets. A number of researchers have applied the fuzzy set concepts to deal with the EOQ problems. Park [1987] developed a fuzzy EOQ model where the ordering and holding costs are represented by trapezoidal fuzzy numbers. Vujoevi *et al.* [1996] considered EOQ model under fuzzy cost components. Roy and Maiti [1997] rewrote the problem of classic EOQ into a form of nonlinear programming problem and introduced fuzziness both in the objective function and constraints of storage area. Lee and

Yao [1998] developed an EOQ model where the demand and order quantities are represented by fuzzy sets. An EOQ model without backorders with fuzzy total demand and fuzzy storage cost was discussed by Yao and Chiang [2003]. Chang [2004] studied an EOQ model with imperfect quality items where fuzziness is introduced in the defective rate and annual demand. Wang *et al.* [2007] developed an EOQ problem with imperfect quality item characterized as a fuzzy random variable while the setup and holding costs as fuzzy variables. Shiang [2008] studied an EOQ model under fuzzy demand quantity and fuzzy cost. An EOQ model for perishable items with fuzzy partial backlogging factor and fuzzy deterioration rate was developed by Halim *et al.* [2008].

In this paper, an inventory system in which the time period of sales is the decision variable proposed by Chen [2003] is reconsidered assuming the components of the model as fuzzy sets. Arrival of customers and the number of customers in the planning period are both random. The author derived the optimal length of the selling period so as to minimize the average inventory cost per unit time. It was pointed out that the number of customers arriving in the planning time period in Chen's model is equivalent

to the order quantity in the traditional EOQ model. As such, Chen's model can be considered as an EOQ model with quantity representing the time period, hence we name it as the Economic Order Time (EOT) model. Section 2 briefly presents the EOT model under random demand and random purchasing time. The fuzzy equivalent of the EOT model with all components fuzzy is described in section 3. The defuzzified value of fuzzy cost function is derived by adopting the graded mean integration representation of fuzzy numbers. The last section presents the numerical illustrations of the developed model followed by some concluding remarks.

## EOT model with random demand

The basic EOQ model determines the economic order quantity which minimize the total cost based on the assumptions that the total demand is constant and shortage is not permitted. The Wilson-Harry's optimal inventory size formula is given by

$$Q = \sqrt{\frac{2Ka}{h}}, \quad (1)$$

where  $K$ ,  $h$  and  $a$  are the setup cost, holding cost per unit and total demand per unit time respectively. Chen [2003] reconstructed the EOQ model based on the random demand.

The following notations and assumptions are used.

### Notations

$[0, t]$  = the selling period,  $t$  being the length of the given period.

$C$  = the purchasing cost per unit of goods.

$K$  = the setup cost.

$h$  = the unit holding cost per unit time.

The expected total cost per unit time is (Chen [2003])

$$\mathcal{A}(t) = \frac{K}{t} + C\theta + \frac{h\theta t}{2}. \quad (2)$$

The objective is to find the length of the selling period  $t$  which minimize the average cost per unit time. The optimum value of  $t$  is given by

$$t = \sqrt{\frac{2K}{\theta h}}, \quad (3)$$

It is noted that variations in the purchasing cost will not affect the optimum time period.

The above model can be considered as an EOQ model. Let  $N_t^*$  denote the number of customers arriving in the time interval  $(0, t)$  when  $t$  equals the optimum value given in eq. (3). Since the probability distribution of  $N_t^*$  is assumed to be Poisson, expected value of  $N_t^*$  or expected quantity of demand is given by

$$\mathcal{E}(N_t^*) = \theta t = \sqrt{\frac{2K\theta}{h}}. \quad (4)$$

It should be noted that, eq. (4) is also equivalent to the result of traditional EOQ formula, provided that the quantity of total demand  $a$  per unit time in eq. (1) is replaced by  $\theta$ , the expected demand per unit time. Thus  $\mathcal{E}(N_t^*)$  is the expected economic order quantity.

The fuzzy equivalent of the above model is described in following section.

## Fuzzy EOT model

In this section, we consider model in section 2 with all the five parameters  $C, K, t, h$  and  $\theta$  as fuzzy and they are represented by trapezoidal fuzzy numbers, as follows.

$$\begin{aligned} \tilde{C} &= (C - \kappa_1, C - \kappa_2, C + \kappa_3, C + \kappa_4), \\ \tilde{K} &= (K - \kappa_5, K - \kappa_6, K + \kappa_7, K + \kappa_8), \end{aligned}$$

$$\begin{aligned} \tilde{h} &= (h - \kappa_9, h - \kappa_{10}, h + \kappa_{11}, h + \kappa_{12}), \\ \tilde{t} &= (t - \nu_1, t - \nu_2, t + \nu_3, t + \nu_4), \text{ and} \end{aligned}$$

$$\tilde{\theta} = (\theta - \nu_5, \theta - \nu_6, \theta + \nu_7, \theta + \nu_8).$$

$\kappa_i, i = 1, 2, \dots, 12$  and  $\nu_i, i = 1, 2, \dots, 8$  are arbitrary positive numbers which satisfy  $\kappa_1 > \kappa_2, \kappa_3 < \kappa_4, \kappa_5 > \kappa_6, \kappa_7 < \kappa_8, \kappa_9 > \kappa_{10}, \kappa_{11} < \kappa_{12}, \nu_1 > \nu_2, \nu_3 < \nu_4, \nu_5 > \nu_6$  and  $\nu_7 < \nu_8$ .

Fuzzy expected cost per unit time from eq. (2) is given by

$$\tilde{\mathcal{A}}(\tilde{t}) = \frac{\tilde{K}}{\tilde{t}} + \tilde{\theta}\tilde{C} + \frac{\tilde{h}\tilde{\theta}\tilde{t}}{2}, \quad (5)$$

Using fuzzy arithmetic operations, we have the trapezoidal fuzzy number

$$\tilde{\mathcal{A}}(\tilde{t}) = (\mathcal{A}_1, \mathcal{A}_2, \mathcal{A}_3, \mathcal{A}_4), \quad (6)$$

where

$$\begin{aligned} \mathcal{A}_1 &= \frac{K - \kappa_5}{t + \nu_4} + (\theta - \nu_5)(C - \kappa_1) + \frac{(\theta - \nu_5)(h - \kappa_9)(t - \nu_1)}{2}, \\ \mathcal{A}_2 &= \frac{K - \kappa_6}{t + \nu_3} + (\theta - \nu_6)(C - \kappa_2) + \frac{(\theta - \nu_6)(h - \kappa_{10})(t - \nu_2)}{2}, \\ \mathcal{A}_3 &= \frac{K + \kappa_7}{t - \nu_2} + (\theta + \nu_7)(C + \kappa_3) + \frac{(\theta + \nu_7)(h + \kappa_{11})(t + \nu_3)}{2}, \\ \mathcal{A}_4 &= \frac{K + \kappa_8}{t - \nu_1} + (\theta + \nu_8)(C + \kappa_4) + \frac{(\theta + \nu_8)(h + \kappa_{12})(t + \nu_4)}{2}. \end{aligned}$$

The graded mean integration value of the fuzzy number in eq. (6) is obtained as

$$\begin{aligned} \varrho(\tilde{\mathcal{A}}(\tilde{t})) &= \frac{1}{6} \left( \frac{K - \kappa_5}{t_4} + (\theta - \nu_5)(C - \kappa_1) + \frac{(\theta - \nu_5)(h - \kappa_9)t_1}{2} \right) + \\ &\frac{2}{6} \left( \frac{K - \kappa_6}{t_3} + (\theta - \nu_6)(C - \kappa_2) + \frac{(\theta - \nu_6)(h - \kappa_{10})t_2}{2} \right) + \\ &\frac{2}{6} \left( \frac{K + \kappa_7}{t_2} + (\theta + \nu_7)(C + \kappa_3) + \frac{(\theta + \nu_7)(h + \kappa_{11})t_3}{2} \right) + \\ &\frac{1}{6} \left( \frac{K + \kappa_8}{t_1} + (\theta + \nu_8)(C + \kappa_4) + \frac{(\theta + \nu_8)(h + \kappa_{12})t_4}{2} \right), \end{aligned} \tag{7}$$

where  $t_i = t - \nu_i, i = 1, 2; t_i = t + \nu_i, i = 3, 4; C - \kappa_i > 0, i = 1, 2; K - \kappa_i > 0, i = 5, 6; h - \kappa_i > 0, i = 9, 10$  and  $\theta - \nu_i > 0, i = 5, 6$ .

The defuzzified value,  $\varrho(\tilde{\mathcal{A}}(\tilde{t}))$ , is taken as the crisp estimate of fuzzy model. In order to find the parameters which minimizes  $\varrho(\tilde{\mathcal{A}}(\tilde{t}))$ , we have to solve the following partial derivatives of  $\varrho(\tilde{\mathcal{A}}(\tilde{t}))$  with respect to  $\tilde{t} = (t_1, t_2, t_3, t_4)$  each equated to zero. Solving the above, we get

$$\begin{aligned} t_1 &= \sqrt{\frac{2(K + \kappa_8)}{(\theta - \nu_5)(h - \kappa_9)}}, \quad t_2 = \sqrt{\frac{2(K + \kappa_7)}{(\theta - \nu_6)(h - \kappa_{10})}}, \\ t_3 &= \sqrt{\frac{2(K - \kappa_6)}{(\theta + \nu_7)(h + \kappa_{11})}}, \quad \text{and } t_4 = \sqrt{\frac{2(K - \kappa_5)}{(\theta + \nu_8)(h + \kappa_{12})}}. \end{aligned} \tag{8}$$

Note that  $t_1 > t_2 > t_3 > t_4$  and hence the constraint

$0 < t_1 < t_2 < t_3 < t_4$  is not satisfied. Hence, we adopt the Lagrangian method. For this, we convert the inequality constraint  $t_2 - t_1 \geq 0$  into equality constraint  $t_2 - t_1 = 0$  and minimize  $\varrho(\tilde{\mathcal{A}}(\tilde{t}))$  subject to  $t_2 - t_1 = 0$ . We have the Lagrangean function as

$$\mathcal{L}(t_1, t_2, t_3, t_4) = \varrho(\tilde{\mathcal{A}}(\tilde{t})) - \lambda(t_2 - t_1), \tag{9}$$

where  $\lambda$  is the Lagrangian multiplier.

Taking the partial derivatives of  $\mathcal{L}(t_1, t_2, t_3, t_4)$  with respect to  $t_1, t_2, t_3, t_4$  and  $\lambda$  and equate to zero, we get

$$\begin{aligned} t_1 &= t_2 = \sqrt{\frac{2(K + \kappa_8 + 2(K + \kappa_7))}{(\theta - \nu_5)(h - \kappa_9) + 2(\theta - \nu_6)(h - \kappa_{10})}}, \\ t_3 &= \sqrt{\frac{2(K - \kappa_6)}{(\theta + \nu_7)(h + \kappa_{11})}}, \quad \text{and } t_4 = \sqrt{\frac{2(K - \kappa_5)}{(\theta + \nu_8)(h + \kappa_{12})}}. \end{aligned} \tag{10}$$

Since  $t_3 > t_4$ , the above solution is not a local optimum. We get the similar result if repeat the procedure by selecting any one of the other inequality constraints. Hence, we convert two of the inequality constraints  $t_2 - t_1 \geq 0$  and  $t_3 - t_2 \geq 0$  as equality and minimize  $\varrho(\tilde{\mathcal{A}}(\tilde{t}))$  subject to  $t_2 - t_1 = 0$  and  $t_3 - t_2 = 0$ . The Lagrangean function with multipliers  $\lambda_1$  and  $\lambda_2$  as

$$\mathcal{L}(t_1, t_2, t_3, t_4) = \varrho(\tilde{\mathcal{A}}(\tilde{t})) - \lambda_1(t_2 - t_1) - \lambda_2(t_3 - t_2). \tag{11}$$

The solution obtained by setting the derivatives of  $\mathcal{L}(t_1, t_2, t_3, t_4)$  in eq. (11) with respect to  $t_1, t_2, t_3, t_4, \lambda_1$  and  $\lambda_2$  are all equal to zero is given by

$$\begin{aligned} t_1 = t_2 = t_3 &= \sqrt{\frac{2(K + \kappa_8 + 2(K + \kappa_7) + 2(K - \kappa_6))}{(\theta - \nu_5)(h - \kappa_9) + 2(\theta - \nu_6)(h - \kappa_{10}) + 2(\theta + \nu_7)(h + \kappa_{11})}} \quad \text{and} \\ t_4 &= \sqrt{\frac{2(K - \kappa_5)}{(\theta + \nu_8)(h + \nu_{12})}}. \end{aligned} \tag{12}$$

It may be noted from eq. (11) that  $t_1 = t_2 = t_3 > t_4$ . That is, the solution given above is not local optimum as it does not satisfy the constraint  $0 < t_1 \leq t_2 \leq t_3 \leq t_4$ . We get the similar result if we repeat by selecting any two of the inequality constraints. Hence, the constraints  $t_2 - t_1 \geq 0, t_3 - t_2 \geq 0$  and  $t_4 - t_3 \geq 0$  are converting into equalities,  $t_2 - t_1 = 0, t_3 - t_2 = 0$  and  $t_4 - t_3 = 0$ .

The Lagrangian function with  $\lambda_i \ i = 1, 2, 3, 4$  multi-

pliers is

$$\mathcal{L}(t_1, t_2, t_3, t_4) = e(\tilde{A}(\tilde{t})) - \lambda_1(t_2 - t_1) - \lambda_2(t_3 - t_2) - \lambda_3(t_4 - t_3) \tag{13}$$

In order to minimize  $\mathcal{L}(t_1, t_2, t_3, t_4)$ , we take the partial derivatives of  $\mathcal{L}(t_1, t_2, t_3, t_4)$  with respect to  $t_1, t_2, t_3, t_4, \lambda_1, \lambda_2$  and  $\lambda_3$  and equate to zero. Thus, we have  $t_1 = t_2 = t_3 = t_4 = t^*$ , where

$$t^* = \sqrt{\frac{2(K + \kappa_8 + 2(K + \kappa_7) + 2(K - \kappa_6) + K - \kappa_5)}{(\theta - \nu_5)(h - \kappa_9) + 2(\theta - \nu_6)(h - \kappa_{10}) + 2(\theta + \nu_7)(h + \kappa_{11}) + (\theta + \nu_8)(h + \kappa_{12})}} \tag{14}$$

$P_C$	$P_h$	$P_K$	$P_\theta$	$t^*$ (months)	$\tilde{A}(\tilde{t})$
-40	-40	-40	-40	8.7	(31, 110, 3354, 3630)
-20	-20	-20	-20	7.9	(116, 520, 4390, 6255)
-10	-10	-10	-10	7.8	(388, 973, 4020, 7009)
00	00	00	00	8.5	(3141, 3141, 3141, 3141)
+10	+10	+10	+10	7.3	(765, 1498, 5822, 12403)
+20	+20	+20	+20	7.1	(972, 2103, 6714, 13406)
+40	+40	+40	+40	6.5	(1284, 2647, 9868, 17356)

Table 1: Optimum policy under fuzzy EOT model

Because the solution  $t^*$  satisfies all inequality constraints, the procedure terminates with  $t^*$  as the local optimum solution to the problem. Since the above local optimum solution is the only one feasible solution, it is the optimum solution of the model. The results of extensive numerical study performed are presented in the following section.

## Numerical Study

Consider an inventory system with crisp parameter values  $C = \$300$  per unit,  $K = \$50$  per setup/year,  $h = \$20$  per unit/ year and  $\theta = 10$  units. The optimum time period and expected (total cost obtained from eqs. (2) and (3) are  $t = 8.5$  months and  $A(t) = \$3141$ .

We conclude that the solution of the EOT model with all components fuzzy is the same as those un-

der the fuzzy model with crisp time period. Hence the fuzziness in the optimum period has no much relevance. The decision variable and the average total cost are highly sensitive due to fuzziness in the cost components and arrival rate when considered together. Under fuzzy arrival rate, the percentage change due to fuzziness cause approximately equal percentage changes in the total cost and the decision variable is nearly half of the changes in the component. The case where the upper and lower modes of the trapezoidal number coincides, the sensitivity in the optimum decision variable and average total cost reduces. The decision maker should adopt a better trade of judgement for accounting flexibility in the characteristics of the model in order to tackle the uncertainty which fits to the real situations.

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# Biochemical Analysis of Some Common Species of Fishes in North Malabar(Kerala)

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(Submitted 16-03-2015, Revised 20-03-2015)

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## Abstract

The studied samples were represented by four fishes, *Sardinella longiceps*, *Leiognathus bindus*, *Solea solea* and *Nemipterus japonicus*. These species constitute the main food fishes of the common people. The major chemical components such as total proteins, total lipids and the water content were determined. The percentage of the protein was found to be high in edible parts of raw fish weight. The mean percentage of protein was found to be 23.9, 20.52, 15.6 and 16.2 in *S. longiceps*, *L. bindus*, *S. solea* and *N. japonicus* respectively. The percentage of lipid ranges from 4.33 to 17.19. Water content in all the four species was found to range between 74 and 78 %. The present investigation has shown that the protein and lipid profiles in different small indigenous fishes are more or less equal and therefore small fishes can play a significant role to fulfill the nutrient demand of the country.

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**Keywords**— Fish, Species, Protein, Lipid, Indigenous.

## Introduction

Fishes constitute one of the most important and plentiful sources of animal protein for maintenance of healthy body (Andrew, 2001). The Fish can form a very nutritious part of mans diet; it is rich in most of the vitamins he requires, it contains a good selection of minerals, and the proteins contain all the essential amino acids in the right proportions. Although the amount of protein in fish varies a little from species to species and, on occasions, within a species, the protein content for meat and for fish is roughly comparable. The chemical composition of fish meat is very different depending on species, the breeding conditions, and the biological and physiological aspects. The main constituent of fish flesh is water, which usually accounts for about 80 per cent of the weight of a fresh fish fillet. Whereas the average water content of the flesh of fatty fish is about 70 per cent, individual specimens of certain species may

at times be found with water content anywhere between the extremes of 30 and 90 per cent (Shamsan and Ansari, 2010).

The water in fresh fish muscle is tightly bound to the proteins in the structure in such a way that it cannot readily be expelled even under high pressure. The amount of protein in fish muscle is usually somewhere between 15 and 20 per cent, but values lower than 15 per cent or as high as 28 per cent are occasionally met with in some species. All proteins, including those from fish, are chains of amino acids, certain of them are essential in the human diet for the maintenance of good health. Two essential amino acids called lysine and methionine are generally found in high concentrations in fish proteins. Fish protein provides a good combination of amino acids which is highly suited to man's nutritional requirements. The fat content of fish can vary very much more widely than the water, protein or mineral content. There is usually considerable seasonal variation in the fat con-

tent of fatty fish. Sardines, sprats and mackerel also exhibit this seasonal variation in fat content. The fat is not always uniformly distributed throughout the flesh of a fatty fish.

## Materials and Methods

The principal components of fish muscle such as total proteins, total lipids and the water were determined on four commonly used fish species *Sardinella longiceps*, *Leiognathus bindus*, *Solea solea* and *Nemipterus japonicus* collected from Nileshwar fish market. The muscles from each fish were used to determine the biochemical composition. The fishes were properly cleaned in the laboratory and the total length and total weight were determined. Body muscle samples (free from skin and scales) of each fish were collected. Protein content of the fish was determined by Biuret method (Fine, 1935). To estimate the total lipid, the dried tissue was subjected to Soxhlet extraction using chloroform as the solvent (Vogel, 1959). From the weight of the lipid fraction thus obtained, the total lipid content was estimated. The moisture content was calculated using the formula

Percentage of moisture =

$$\frac{\text{Loss in gm in the mass of sample} \times 100}{\text{Mass in gm of the sample taken for the test}}$$

## Observations

The results obtained from the study of the chemical composition of *Sardinella longiceps*, *Leiognathus bindus*, *Solea solea* and *Nemipterus japonicus* meat are presented in Table 1 and Figure 1. The percentage of total lipid in *S. longiceps*, *L. bindus*, *S. solea* and *N. japonicus* were 7.55, 4.33, 8.31 and 17.19 respectively. The mean percentage of total protein in *S. longiceps*, *L. bindus*, *S. solea* and *N. japonicus* were 23.9, 20.52, 15.6 and 16.2 respectively. The mean value of water content of *S. longiceps*, *L. bindus*, *S. solea* and *N. japonicus* was 75.38, 77.76, 74.96 and 78.26 respectively.

Name of fishes	<i>S. longiceps</i>	<i>L. bindus</i>	<i>S. solea</i>	<i>N. japonicus</i>
Total protein	23.9	20.52	15.6	16.02
Total lipid	7.55	4.33	8.31	17.19
Water	75.38	77.76	74.96	78.26

Table 1: Showing the protein, lipid and water content in *S. longiceps*, *L. bindus*, *S. solea* and *N. japonicus*

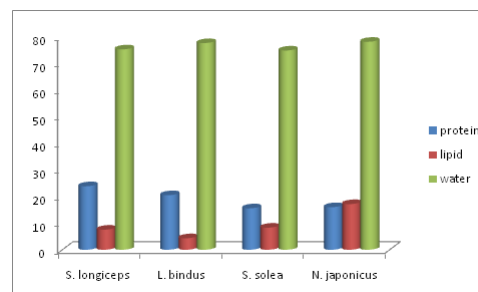


Figure 1: Graph showing the protein, lipid and water content in *S. longiceps*, *L. bindus*, *S. solea* and *N. japonicus*

## Discussion

The biochemical composition of the fish muscle generally indicates the fish quality. Therefore proximate biochemical composition of a species helps to assess its nutritional and edible value. The percentage of the protein was found to be high in edible parts raw fish weight. The percentage of protein in the four fishes showed considerable variation ranging from about 15 to 24 %. The mean percentage of protein was found to be 23.9 % in *S. longiceps*, 20.52 % in *L. bindus*, 15.6 % in *S. solea* and 16.2 % in *N. japonicus*. The highest percentage of protein was found to be in *S. longiceps* and the lowest in *S. solea*. Protein content can be correlated with the phases of maturity and spawning when the gonads were ripe and decline during post-spawning period (Parulekar and Bal, 1969; Das, 1978). The percentage of lipid ranges from 4 to 17. The percentage of lipid was found to be 7.55 in *S. longiceps*, 4.33 in *L. bindus*, 8.31 in *S. solea* and 17.19 in *N. japonicus*. Depending upon the level of lipids in the fish muscles, fishes are classified into

three categories e.g. fat fish with more than 8 % average fat content, average fat fish with fat content varying between 1 to 8 % and lean fish with fat content less than 1 % (Srivastava, 1999). Accordingly, *S. longiceps* and *L. bindus* having an average < 8 % fat content falls into the second category (average fat fish), while *S. solea* and *N. japonicus* with >8 % fat falls under the first category. The average value of the water content in all the four species was found to range between 74 and 78 %. Lowest water content was in *S. solea* (74.96 %) while highest in *N. japonicus* (78.26 %). An inverse relationship between moisture and lipid content has been reported by Shamsan and Z.A. Ansari (2010). Variations in the lipid content are much wider than that in protein. Fish with fat content as low as 0.5 % and as high as 16-18 % are of common occurrence in many species during the breeding season and decrease during spawning in fatty fishes like oil sardine, mackerel, herring etc (Torry). The biochemical components fluctuated widely irrespective of size and growth of the fish. It did not show a distinct pattern. Inverse relationship between lipid and moisture content was observed forming a negative correlation between the two constituents.

Small fishes are lower in the food chain and are safer to eat than large fishes higher in the food chain which concentrate heavy metals and pesticide. The present investigation has shown that the protein profiles in different small indigenous fishes are more or less equal and therefore small fishes can play a significant role to fulfill the nutrient demand of the poorer sections of the country.

## Acknowledgement

The author thanks the BSc Zoology 2013 batch for their project work .

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