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Editorial

In today's academic world there is an increased focus on research. Various overlapping and interactive disciplines mobilise the research process and take the frontiers of knowledge to new horizons. This volume of *Fortis* includes articles from disciplines as varied as computer science, bioscience, social sciences and Humanities. Though all fields have their own established principles and methods of study, they all unite in illuminating the world of knowledge.

In the era of Artificial Intelligence, specialised knowledge resources should be explored, mined and disseminated. Sustained discourse resulting in new and varied perspectives and interpretations is the need of the hour. It is hoped that this issue contributes to this negotiation and interface of knowledge.

Dr. A. Biju

CONTENTS

FAECAL CONTAMINATION AND PREVALENCE OF MULTIDRUG RESISTANT *ESCHERICHIA COLI* IN SHELLFISH GROWING AREAS ALONG SOUTH WEST COAST OF INDIA

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Abstract

Season-wise prevalence of faecal coliforms in Indian black clam (Villorita cyprinoides) and harvesting waters from five shellfish harvesting areas located along the south west coast of India, was evaluated. Faecal contamination in shellfish and water collected from all stations were far above the legal standards. E. coli from shellfish showed comparatively higher MAR index values and ranged from 0.25-0.75 with an average of 0.54 ± 0.18 whereas those from water ranged from 0.13-0.63 with an average of 0.25 ± 0.14. Prevalence of high faecal contamination and MDR bacteria pose potential health hazards and act as significant reservoirs of resistance genes in the environment.

Key words: *Shellfish, Villorita cyprinoides, E. coli, antibiotic resistance, MAR index, tropical estuary*

1. Introduction

Pollution is the most important hazard affecting all environments including marine and estuarine ecosystems. Industrialization, urbanization, inadequate sewage treatment systems, poor hygienic practices and either lack of regulations or lapse in their implementation, has resulted in increased microbial contamination of aquatic bodies worldwide. Faecal contamination is the main route for entry of enteric pathogens into water bodies.

These water bodies are the biggest wild resources of seafood and faecal contamination adversely affects the sanitary quality of the commodities posing potential health hazards to the consumers.

Among the inhabitants of coastal ecosystems sedentary bivalve fauna is highly prone for contamination due to their peculiar filter feeding nature and bio-accumulation potential. The sanitary quality of shellfish growing areas have great impact on the quality of harvest due to their nonspecific, nonselective feeding habits as well as their ability to filter significant quantities of water relative to their size. Most of the shellfish growing areas are situated in shallow near-shore waters which often receive river and land run-off and domestic and other industrial sewage discharges. These filter feeders being exposed to all sorts of contaminants for extended periods tend to accumulate these contaminants in their tissues many times higher than the surrounding water at levels hazardous to the consumers. Many infectious disease outbreaks like typhoid and cholera associated with shellfish consumption have been reported worldwide (Costa, 2013; Prato et al., 2013; Rippey, 1994).

Realising the potential public health risks associated with shellfish consumption many international regulatory agencies have formulated strict guidelines regarding classification of the shellfish growing areas into approved, restricted or prohibited based on the coliform/*Escherichia coli* levels of either shellfish meat or harvesting waters. Certification and strict periodical monitoring of the growing areas have been made mandatory to ensure public food safety (EC, 1991; NSSP, 1999).

Cochin estuary, a part of Vembanad Lake, an important Ramsar site located toward the southwest coast of India, is a rich wild resource of shellfish and finfish fishery. Thousands of local people depend on this estuary for their lively hood and the seafood

harvested is exported worldwide. It is a tropical estuary which has undergone considerable pollution during recent periods, mainly due to development of satellite townships along the banks of this estuary as well as the rivers which joins this estuary. A number of markets, seafood industries and many other industrial zones located in the proximity further intensify the problem by illegal release of untreated organic as well as chemical waste into this estuary. Faecal coliforms in general and *E. coli* in particular offer an ideal indicator of faecal contamination and possible occurrence of other pathogens in the estuary. Apart from being an indicator *E. coli* can also act as causative agent of a number of food borne gastrointestinal illnesses ranging from mild diarrhoea to haemorrhagic colitis and even death due to acute renal failure. The emergence of more and more antibiotic resistant *E. coli* strains pose serious health concern as thousand of local people depend on this estuary for their livelihood (George et al., 2012; Mosquito et al., 2015).

The present study was undertaken to assess the season-wise variation of faecal contamination in selected shellfish harvesting areas of Cochin estuary to estimate the health hazard posed to the consumers as well as to those who handles raw clams. The antibiotic resistance of the isolates were also estimated in order to check its role as a permanent reservoir of antibiotic resistance and virulence genes in the environment.

2. Materials and Methods

2.1 Description of the sampling sites

Cochin estuary is a part of Vembanad lake, the largest brackish tropical wetland ecosystem and also a Ramsar site located along the south-west coast of India (9°35'N76°25'E). Five shellfish harvesting areas were selected based on their closeness to satellite

townships and increased probable levels of contamination *viz*. Aroor (station- 1), Valanthakad (station-2), Cheppanam (station-3), Valappu (station-4) and South Malipuram (station-5).

2.2 Collection of the samples

Live Indian black clams, *Villorita cyprinoides* endemic to the study area and water samples from the five selected harvesting areas were collected for a period of one year from January 2013 to December 2013. Season-wise sampling was done to study the variation during the three seasons *viz.* pre-monsoon (February to May), monsoon (June to September) and post-monsoon (October to January). Live clams were collected in sterile polythene bags and water in sterile plastic bottles, transported to the laboratory in an icebox and bacteriological analysis was done within two hours of sample collection. Environmental parameters like water temperature, pH, and salinity were determined during the various seasons.

2.3 Sample processing and isolation of *E. coli*.

Approximately 15-20 clams were surface cleaned and aseptically shucked using a flame sterilised shucking knife. About 25 g of shellfish meat and liquor was transferred to sterile stomacher bag with 225 ml of peptone water and blended with a stomacher (APHA, 1970; Hitchin et al., 1995). Total coliform and faecal coliform levels in shellfish and harvesting waters were enumerated by 5 tube most probable number (MPN) method using MacConkey broth (Himedia, India) with inverted Durham tubes. The tubes were incubated at 37 °C for total coliforms, 44.5 °C for faecal colifoms and examined for evidence of lactose fermentation after 24-48 hours. Positive tubes showing acid and gas production was used to determine the MPN from the standard MPN table and expressed as MPN counts/100 mg of shellfish and per 100 ml of harvesting water. The $\log_{10}$ MPN values

were calculated and graph was plotted. Inocula from positive tubes were streaked on to Eosin methylene blue agar (Himedia, India). Typical *E. coli* like colonies with green metallic sheen were purified and confirmed biochemically by IMViC tests which included Indole production test, Methyl red test, Voges-Prauskauer and Citrate utilization tests. Isolates showing typical reactions were further confirmed by molecular methods.

2.4 Extraction of genomic DNA from *E. coli*.

Genomic DNA was extracted by boiling method (Devi et al., 2009). Briefly overnight culture incubated at 37 °C with shaking (120 rpm) was centrifuged at 10,000 rpm, 4 °C, 1 min, to obtain a pellet. The cell pellet was washed with normal saline (0.8% NaCl w/v) and re-suspended with 0.5 ml sterile distilled water. The cell suspension was heated at 98 °C ± 2 in a boiling water bath for 15-20 min to enable cell lysis and release of DNA. The lysate was centrifuged (10,000 rpm, 4 °C, 5 min) to eliminate the cell debris and the supernatant was stored at -20 °C, until further use.

2.5 Detection of species specific *uid* A gene in *E.coli* by PCR

The presence of *uid* A gene which codes for β-D- glucuronidase enzyme was detected by PCR amplification of a 147 bp coding region using the primers UAL- 754 (5'-AAAACGGCAAGAAAAAGCAG-3') and UAR- 900 (5'ACGCGTGGTTACAGTCTTGCG-3') (Bej et al., 1991). The optimized reaction was carried out in a total reaction volume of 25 µl consisting of sterile Milli Q water (15.5 µl), 10x PCR buffer (2 µl), primer (1 µl each), dNTP mix (1 µl, 200mM), template (4 µl) and Taq DNA polymerase (0.5 µl). The PCR conditions included an initial denaturation at 94 °C for 2 min followed by 25 cycles of denaturation (94 °C for 1 min), primer annealing (58 °C for 1.5 min) and primer extension (72 °C for 2 min) followed by a final extension (72 °C for 5

min). PCR products were then electrophoresed on an agarose (1.5% w/v) gel in 1xTBE buffer (Hi-media, India), stained with ethidium bromide (Genei, India) and visualized by Gel Documentation System (Bio-Rad Gel Doc EZ Imager, USA). The amplicon sizes were compared with a 100 bp DNA ladder.

## 2.6 Antimicrobial susceptibility testing

A total of 50 *E. coli* strains from water and shellfish were tested for antibiotic resistance by standard agar disc diffusion technique (Bauer et al., 1966) strictly following Clinical and Laboratory Standard Institute guidelines (CLSI, 2011). Testing was carried out on Mueller Hinton agar using commercial antibiotic discs (HiMedia, India). The following 16 antibiotics with the disc strength in parentheses were used: ampicillin (Amp-10 mcg), chloramphenicol (C-30 mcg), streptomycin (S-10 mcg), gentamicin (Gen-10 mcg), tetracycline (Te-30 mcg), ciprofloxacin (Cip-5 mcg), nalidixic acid (Na-30 mcg), trimethoprim (Tr-5 mcg), cotrimoxazole (Cot-25 mcg), cephotaxime (Ctx-30 mcg), amoxyclav (Amc-30 mcg), cefpodoxime (Cpd-10 mcg), cefoxitin (Cx-30 mcg), amikacin (Ak-30 mcg), doxycycline (Do-30 mcg), nitrofurantoin (Nit-100 mcg). After incubation, the diameters of the inhibition zones were measured to the nearest whole millimetre, which was then translated into susceptible, intermediate and resistant categories according to the zone interpretation chart (Himedia, India). Strains resistant to three or more antibiotics were classified as multiple antibiotic resistant ones and the multiple antibiotic resistance index (MAR) was determined by calculating the ratio between the number of antibiotics to which the isolate is resistant and the total number of antibiotics used (Krumperman, 1983).

3. Results

Characterisation and molecular identification of *E. coli* isolates

A total of 80 isolates showing typical green metallic sheen on EMB agar were screened biochemically by IMViC tests. Forty nine isolates showed typical + + - - IMViC reactions of *E. coli* whereas one isolate with good metallic sheen gave - + - - reactions. All the 50 isolates were subjected to molecular confirmation by Polymerase chain reaction based amplification of *uid* A gene, which codes for β-D- glucuronidase enzyme. *E. coli* specific PCR products of 147 bp length were detected in all 50 isolates including the one which showed - + - - IMViC reactions (Figure 1). Thus, it was confirmed that out of 50 *E. coli* isolates 49 belonged to Biotype I, whereas one belonged to Biotype II (Feng et al., 2009).

Figure 1: PCR amplified *E. coli* specific *uid* A gene
Lane M: 100 bp ladder, lanes 1-2: *E. coli* isolates, lane C: negative control
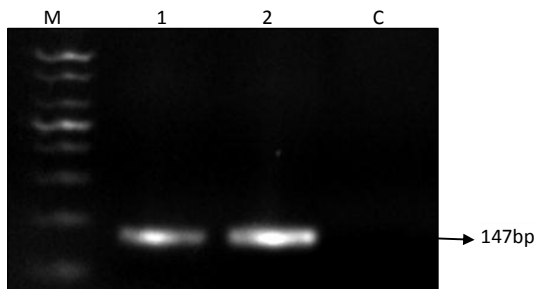
Season-wise prevalence of faecal coliforms: shellfish versus harvesting waters

Faecal coliform (FC) counts showed seasonal variation in all the 5 stations. Compared to other seasons MPN counts were considerably low in pre-monsoon season, in both shellfish and harvesting waters, but the levels were high in shellfish compared to

water (Figure 2a). FC MPN of shellfish varied from 3.32-3.96, while that of water ranged from 3.26 to 3.96.

Results revealed that faecal coliform counts followed similar patterns in monsoon and post-monsoon seasons. In monsoon season the MPN counts were higher in harvesting water than in shellfish (Figure 2b). The log_{10} FC MPN count of shellfish was 4.2 in all stations except station 2 which had a value of 3.96 while that of water was found to be 4.2 in all 5 stations.

In post-monsoon season FC MPN of fish was 4.2 in all stations except station 2 which showed slightly decreased value of 4.11 (Figure 2c). Harvesting water in all stations showed log_{10} MPN of 4.2.

Figure 2: Faecal coliform levels in *Villorita cyprinoides* (shellfish) and harvesting waters of Cochin estuary.
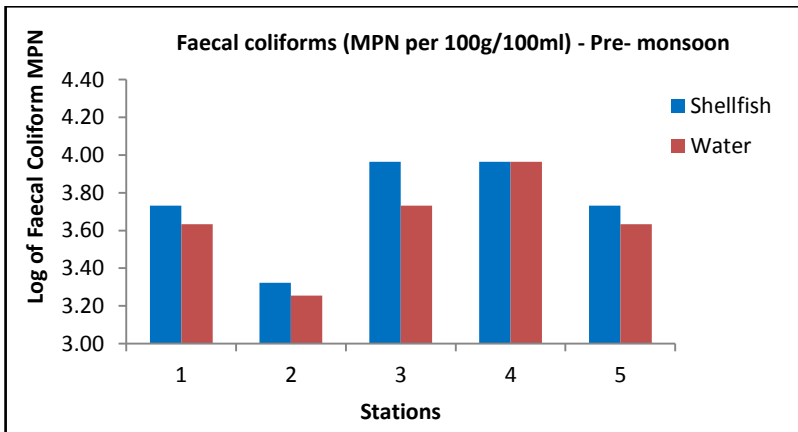
2 (a) Pre-monsoon
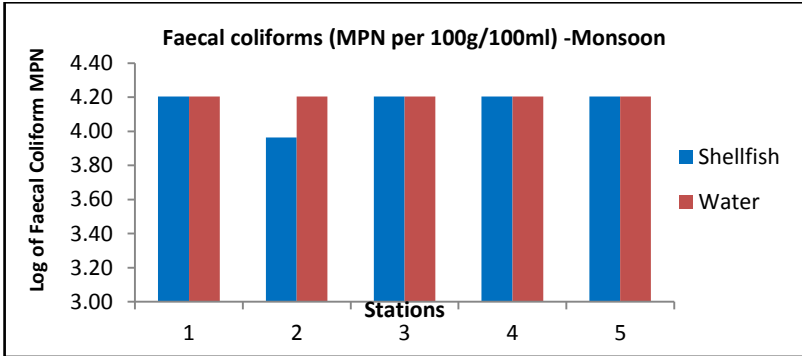
2 (b) Monsoon
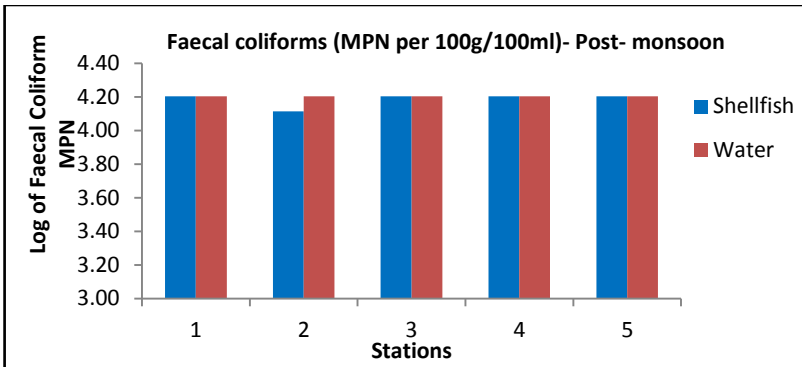
2 (c) Post-Monsoon

Antibiotic susceptibility of *E. coli* strains isolated from harvesting waters

The *E. coli* strains isolated from harvesting waters showed varying degrees of antibiotic resistance ranging from high to intermediate levels towards the 16 antibiotics used. About 61.1% of the strains were multiple antibiotic resistant with MAR indices ranging from 0.13-0.44 with an average of 0.25 ± 0.14. One strain from station 2 was resistant to 10 antibiotics and showed a high MAR value of 0.63. All the strains were resistant towards ampicillin

and cefpodoxime. Most repeated resistance patterns observed were Amp, Cpd (100 %) followed by Amp, Cpd, S (28 %). Remarkable levels of resistance were shown towards other antibiotics as shown in Figure 3a. All the strains were sensitive to ciprofloxacin. Station wise variation could be observed in the degree of resistance. All strains from station 4, 57% of strains from station 1 and 50% of strains from station 2 were multiple drug resistant.

Antibiotic sensitivity of *E. coli* strains isolated from Shellfish

All the strains isolated from shellfish were multiple drug resistant with MAR indices ranging from 0.25-0.75 with an average of 0.54 ± 0.18. Most repeated resistance pattern was Amp, Cpd (100 %) followed by Amp, Cpd, Nit (87.5 %), Amp, Cpd, Cx (87.5 %), and Amp, Cpd, Cx, Nit (81.25%). All the strains were resistant towards ampicillin and cefpodoxime. The percentage of resistance to other antibiotics is shown in Figure 3b. Shellfish associated strains exhibited resistance towards all the antibiotics. Station wise variation in antibiotic resistance could be observed. In station 1 five strains were resistant to 11 antibiotics out of which 2 were resistant to 12 antibiotics and all the strains showed very high MAR indices ranging from 0.56-0.75. In station 5 one strain was resistant to 12 antibiotics whereas in station 4 all the strains showed remarkably high MAR index values. Another important observation was the growing trend in intermediate level resistance observed in strains from clams, towards multiple classes of antibiotics (Figure 3b), which indicates that the estuary is under increased threat of contamination from antibiotic residues.

Figure 3: Antibiotic resistance of *Escherichia coli* strains from Cochin estuary
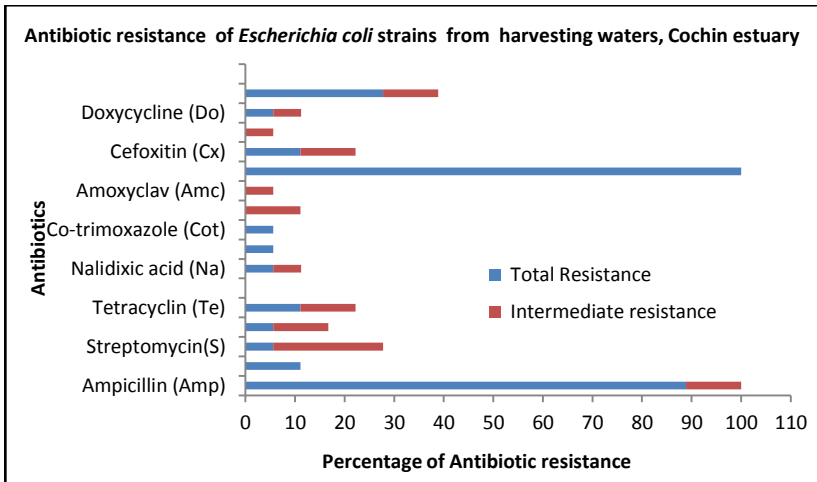
3a) Harvesting waters
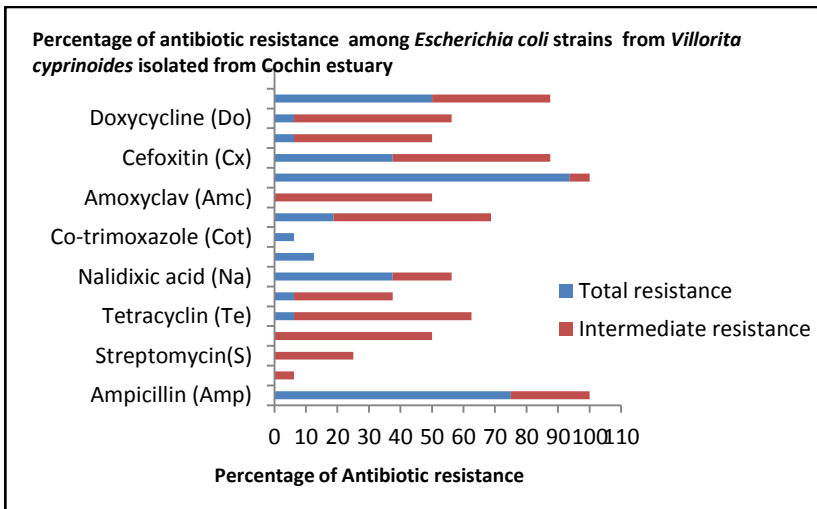
Discussion

Consumption of raw or partially cooked shellfish has long been considered as one of the main causes of many enterically

transmitted diseases. In developed countries, in spite of strict regulations and efficient monitoring systems, several such incidences have been reported, whereas in developing countries these regulations either do not exist or are not strictly implemented. There is no systematic tracking or monitoring of the diseases, which further reduces the number of reported cases than the actual figures, which is often misleading. Hence, measures should be taken to maintain the sanitary quality of shellfish growing areas as per the regulatory standards (EC, 1991; NSSP, 1999).

Rainfall events had significant negative impact on the sanitary quality of the harvesting areas and the clams harvested, which is evident from the increased coliform as well as faecal coliform levels observed during the monsoon and post-monsoon seasons. This may be due to increased sewage discharge into the estuary by surface runoff from non-point sources in addition to the point sources. Similar results were obtained during the above two seasons, as there was no clear demarcation during the study period between seasons, due to the extended rainfall even to post- monsoon season. Previous studies have showed parallel observations where high incidence of faecal coliforms was reported in seawater, clam tissue and sediments of two harvesting areas in the southern coastal district of Karnataka, India during the monsoon season. Because of their peculiar filter feeding nature and high bioaccumulation potential a direct relationship could be observed between coliform and faecal coliform counts of overlaying water and the underlying clam tissue (Sasikumar and Krishnamoorthy, 2010). Lalitha and Surendran (2005) have previously made parallel observations in a similar study from the Vembanad area. This clearly indicates that the only means to get good quality product is to maintain good sanitation levels of the

harvesting area. Additional factors that have enhanced the bacterial survival during this period included reduced salinity due to dilution by precipitation and reduced water temperatures (Anderson et al., 1979; Fujioka et al., 1981).

In pre-monsoon season the total coliform as well as faecal coliform levels were low in all the stations, which may be attributed to reduced surface run off, and other nonpoint discharges to the estuary. This is in agreement with the previous observations by Sasikumar et al (2010) who reported low coliform levels than that observed in our present study. Additional factors like increased salinity, temperature and increased protozoan predation during these warmer temperatures also might have facilitated the rapid decline in counts during warmer months as reported by researchers previously (An et al., 2002; Erkenbrecher, 1981). Comparison of both total and faecal coliforms levels in clam tissue and overlaying water showed that clams harboured the organisms many times concentrated in their tissue than the overlaying water, probably due to their characteristic non selective filter feeding. Low bottom temperatures and less penetration of sunlight could be the other factors involved in extended survival as observed in other similar studies (An et al., 2002).

In monsoon and post monsoon seasons the FC MPN counts in all five stations reached 16000/100 ml ($\log_{10}$ MPN= 4.2) of water which corresponded to that of prohibited areas classification of National Shellfish Sanitation Programme (NSSP) of US FDA (NSSP, 1999). As per the regulations, harvesting itself is prohibited from such areas until the required sanitation levels are met with. The FC MPN count in clam flesh in all stations during the above seasons were found to be 16000/100 g ($\log_{10}$ MPN = 4.2) except station 2

which had a MPN count of 9200/100 g ($\log_{10}$ MPN = 3.96) in monsoon season. All these values corresponded to category C shellfish growing area classification as per EC directive (EC, 1991) which means, the bivalves from such areas require post harvest treatments like relaying before human consumption. In pre-monsoon season the FC MPN indices of harvesting water ranged from 1800 to 9200/100 ml (($\log_{10}$ MPN = 3.26-3.96) which again corresponded to prohibited area for shellfish harvesting by US FDA. The FC MPN counts of clam flesh from stations 1,3,4 and 5 ranged from 5400-9200/100 g ($\log_{10}$ MPN = 3.73-3.96) which corresponded to Category C while that of station 2 was 2100 ($\log_{10}$ MPN= 3.32) which corresponded to Category B shellfish harvesting areas as per EC directives. This is in agreement with the previous findings where high levels of faecal contamination well above the regulatory standards were detected in shellfish and harvesting waters from Vembanad estuary (Dutta et al., 2015; Lalitha and Surendran, 2005; Sasikumar and Krishnamoorthy, 2010).

Antibiotic resistance among microorganisms is one of the most serious problems encountered during disease management. Emergence of more and more resistant bacteria to newer classes of antibiotics is a real challenge in chemotherapy, as the once commonly used life saving drugs become no longer useful and even the smallest infections prove sometimes lethal. As a result of indiscriminate use of antibiotics in aquaculture, animal husbandry, agriculture and careless disposal of hospital wastes, there is an increase in the antibiotic residues discharged into the water bodies which act as ultimate sink for all sewage. On prolonged exposure bacteria tend to develop resistance to these antibiotics. Once developed resistance there is high risk of horizontal as well as vertical transmission of resistance

rendering more and more organisms resistant. These water bodies are rich wild resources of finfish and shellfish fisheries on which thousands of local population depend for their livelihood. Contamination of these water bodies pose serious health hazard as it may contaminate the aquaculture products especially the filter feeding bivalves which tend to accumulate these multidrug resistant bacteria (Chattopadhyay et al., 2015).

Prevalence of drug resistant bacteria in Cochin estuary has been previously reported (Chandran et al., 2008; Hatha et al., 2004; Silvester et al., 2015; Sukumaran et al., 2012). The present study has revealed a slight increase in the prevalence of multidrug resistant strains from water (61.1%) than previous reports (Chandran et al., 2008; Hatha et al., 2004; Silvester et al., 2015). Sukumaran et al. (2012) reported prevalence of 53.33% of multi drug resistant *E. coli* strains in this study area. All the strains isolated from shellfish of Cochin estuary were multidrug resistant, whereas 61.1% of the strains from harvesting waters exhibited multiple drug resistance. Remarkably high differences in MAR indices and resistance patterns were observed between strains from shellfish and those from harvesting waters. The MAR indices of strains from shellfish were very high with an average of 0.54 ± 0.18 whereas that from water was comparatively low with an average of 0.25 ± 0.14. MAR indices higher than 0.2 are often indicative of contamination from high-risk sources like hospital waste, commercial poultry farm waste etc. that somehow found their way the estuarine environment (Krumperman, 1983). About 50 % of strains from harvesting water and all strains from shellfish showed MAR index higher than 0.2 which is indicative of the potential risk associated with the consumption of shellfish from the study area.

Sixteen diverse antibiotic resistance patterns were observed in strains from shellfish whereas those from water exhibited only twelve different patterns. These differences can be attributed to the prolonged exposure of the strains in these sedentary fauna, to the environmental pollutants including antibiotic residues accumulated in the less disturbed bottom waters. Most repeated resistance pattern in strains from both sources was Amp, Cpd (100%). In the present study a remarkable increase in resistance towards ampicillin and cefpodoxime was observed. All the strains from shellfish and harvesting waters exhibited resistance towards β-lactam antibiotics like ampicillin and cefpodoxime. Previous studies have showed comparatively reduced ampicillin resistances: 65.33% (Sukumaran et al., 2012) and 23.07 % (Sukumaran and Hatha, 2015) respectively. In this study the strains showed 38.9% resistance towards nitrofurantoin and 11.2% against doxycycline, commonly prescribed drugs to treat urinary tract infections caused by *E. coli*.

Interestingly tetracycline resistance followed a declining trend. Previous studies by our research group from Cochin estuary showed a gradually decreasing trend in tetracycline resistance in the estuary (Silvester et al., 2015). Chandran et al. (2008) reported a progressive decline in tetracycline resistance from 80% to 50% in two related studies conducted within an interval of three years. Similar trend was observed by Divya et al. (2012) and reported 33.3% tetracycline resistance. In the present study further reduced tetracycline resistance of 22.2% was observed which is similar to the resistance of 19.23 % reported by Sukumaran et al. (2015). This progressive decline may be due to the reduced discharge of tetracycline residues into the estuary from various sources ultimately reducing the selective pressure in the environment and

resistance towards tetracycline. As pointed out by Hsu et al (Abhirosh et al., 2011) the pattern of bacterial antibiotic resistance exhibited may reflect the history of antibiotic application and hence the drug resistance pattern observed can be used as an indicator of antibiotic application.

In present study, isolates from water showed increased resistance towards streptomycin (27.8%), gentamicin (16.7%), chloramphenicol (11.1%) and amikacin (5.6%) were observed, whereas reduced resistance was shown towards cotrimoxazole (5.6%) and trimethoprim (5.6%) compared to previous reports (Sukumaran et al., 2012). All the isolates were sensitive to ciprofloxacin and hence it remains the drug of choice to treat infections arising from these strains. On the contrary a similar previous study conducted in Cochin estuary by Sukumaran et al. (2012) showed a relatively high resistance of 12% towards ciprofloxacin.

The strains from clams exhibited increased resistance at varying levels towards all classes of antibiotics when compared with that of strains from water. Like water isolates, clam isolates also showed 100% resistance to β-lactam antibiotics like ampicillin and cefpodoxime. Greater resistance was shown by Clam isolates towards aminoglycosides like gentamicin (50%), amikacin (50%) and streptomycin (25%) than those from water. Remarkable resistance was exhibited towards nitrofurantoin (87.5%). Resistance to the potent cephalosporin group of antibiotics is quite alarming. Clam isolates showed resistance towards cefoxitin (87.5%), cephotaxime (68.8%) and cefpodoxime (100%). Remarkable resistance was observed against tetracycline (62.5%) doxycycline (56.3%), nalidixic acid (56.3%), amoxyclav (50%) and ciprofloxacin (37.5%), all well above the degree of resistances exhibited by those from water. Least

resistance was shown towards trimethoprim (12.5%), cotrimoxazole (6.25%) and chloramphenicol (6.25%). The prevalence of multidrug resistant bacteria in seafoods of Tuticorin Coast, Southeastern India has been previously reported (Hsu et al., 1992). Kumar et al. (2005) observed comparatively less resistance to penicillin (42%) and complete sensitivity to chloramphenicol, ciprofloxacin and gentamicin which was not in agreement with our present findings indicating that bacteria from environmental sources is gradually acquiring resistance to almost all discovered classes of antibiotics.

Even though *E. coli* is regarded as a harmless normal inhabitant of our gastrointestinal tract, there are many pathogenic strains capable of causing severe food borne infections. Another growing concern is about a new group of Extended-spectrum beta-lactamase (ESBL) producing *E. coli* mainly associated with urinary tract infections, showing multiple resistance to most of the life saving classes of drugs like beta-lactam antibiotics, including third-generation cephalosporins and co-resistance to fluoroquinolones, and aminoglycosides. It is one of the most common causes of morbidity and mortality associated with hospital-acquired infections (Kumar et al., 2005). In our study about 37.5 % *E. coli* strains isolated from clams of Cochin estuary showed considerable co-resistance towards all the above mentioned classes of life saving antibiotics, which is a matter of great concern. Five *E. coli* strains from clams were resistant to 11 antibiotics out of which two were resistant to 12 antibiotics tested. Another serious concern is the growing trend in intermediate level resistance of strains from clams, towards multiple classes of antibiotics to which not much prevalence were reported. This indicates that probably the estuary is under threat of increased contamination from antibiotic residues. A few studies have confirmed

the presence of ESBL-producing bacteria in the food sector, environment and among humans (Kumar et al., 2005; Rooney et al., 2009). Hence, further studies have to be undertaken to investigate the presence of ESBL producing *E. coli* in the study area.

Conclusion

Present study revealed that clams in the study area are of poor sanitary quality especially during the monsoon and post monsoon seasons, which indicates the possible incidence of food borne disease outbreaks. Depuration measures alone cannot improve the sanitary quality of clams, instead thorough cooking has to be adopted. The high prevalence of drug resistance in the study area indicates that it may serve as a permanent reservoir of antibiotic resistant genes resulting in antimicrobial resistance cycling through environment, food and human sources. This study emphasizes the necessity of regulatory interventions in improving the sanitary quality of the harvesting areas for which the present study may form a baseline reference.

Acknowledgements

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COMPARISON OF CHILDREN FROM POLLUTED AREA AND NON POLLUTED AREA ON LEARNING SPELLINGS IN ENGLISH

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India had witnessed various drastic effects of pollution such as the "endosulfan tragedy" and the "Bhopal tragedy". The lack of foresight of the authority in planning and execution of unnatural projects are one reason behind these kinds of disasters. All are concerned about the impact of such events on economy, harvest etc. But are not concerned of the most sensitive area, ie, the children who are the futures of the country and the impact of pollution.

Environmental Pollution

Pollution is one of the most crucial problems of the twenty first century. Environmental pollution is a global problem, which will be potentially dangerous to the survival of the whole living world. Any undesirable change in the physical, chemical or biological characteristics of air, water and soil which adversely affect humans or other species of animals or plants of our biosphere directly or indirectly is termed as pollution. The various activities of man such as industrialization, urbanization, intensive agriculture, waste disposal, burning of fuels and other harmful materials etc. can be considered as the major factors of pollution.

Pollutants

On the basis of their *forms they exist* in the environment pollutants are divided into

Primary pollutants

These are emitted directly from an identifiable source. Eg: sulphur dioxide

Secondary pollutants

These are substances derived from primary pollutants by chemical reactions. Eg: Formation of peroxy acetyl nitrate

On the basis of their *existence in nature* pollutants are divided into

Quantitative pollutants

A normal component of the environment which will become pollutant through its accumulation or through higher concentrations. Eg. carbon monoxide

Qualitative pollutants

A pollutant which is normally not a component of environment but passes as pollutant to the environment through human activity. Eg .pesticide

From the *ecological point* of view, the pollutants can be classified into

Biodegradable pollutants

These are completely degraded by biological process of microorganisms. Eg: vegetable waste

Non-biodegradable pollutants

These pollutants cannot be broken down by natural processes. Eg: plastics

Persistent pollutants

These are harmful even in low concentration they may be accumulated or biologically magnified as they move along the food chain and biological cycles. Eg: DDT

Types of pollution

On the basis of the component of environment which is being polluted and kind of pollutant, pollution may be classified.

Air pollution

Air pollution is defined as the occurrence of foreign particles or gases in the atmosphere which are harmful to man, vegetation, animals and buildings. It consists of the pollutants in the form of gases, liquids or solids in higher levels or concentrations high enough to harm or produce measurable effect on the biotic community.

Usually, air pollution effects on behaviour of an individual by means of smell, vision, eye irritation and respiratory problems. The substances like particulates of mercury, lead, asbestos etc: from auto emissions and industrial smokestacks can lead to headaches, fatigue, insomnia, irritability, depression, impaired judgements etc. All these conditions can be collectively called air pollution syndrome.

There are strong evidences that psychological stress increases susceptibility to adverse effects of air pollution. Numerous environmental susceptibility factors in urban populations play roles in the increased burden of diseases. Children's mental health status was significantly associated with asthma morbidity, specially wheezing.

The health effects of air pollution require additional research, particularly on the specific mechanisms for mortality and morbidity from increased Particulate Matter Exposure.

Studies conducted by Fonken,J(2011), show that long term exposure to air pollution can lead to physical changes in the brain as well as memory and learning problems and even depression. The

results suggest prolonged exposure to polluted air can have visible, negative effects on the brain, which can lead to a variety of health problems.

In other studies, several of the co-authors of this study found that chronic exposure to polluted air leads to widespread inflammation in the body, which can cause depression.

Studies conducted by Wellenius,G (2012) suggest that living in a crowded city or near a busy highway may be tied to a higher chance of losing your memory or having a stroke. It was also found that being exposed to air pollution might be associated with declining memory and thinking. And another report in the same journal documented a faster long-term decline in memory skills and thinking in women living in higher-pollution areas of the United States.

According to a new study by NIEHS children who live in neighbourhoods with heavily polluted by automobile traffic have lower scores in memory tests. They also score worse on intelligence tests than children in healthier environment. The study focuses on the effects of air pollution on the development of intelligence in children and on cognitive decline for people of all ages.   It was also found that black carbon air pollution may lower IQ.

In the other study, researchers led by Weuve, J(2011) found that more air pollution was tied to faster rates of cognitive decline including decline in memory skills and make or carry out a strategy, are normal as people get older. The study showed that women with higher levels of long-term exposure to air pollution had "significantly" faster declines in memory and executive function, including the ability to plan than those with less exposure to pollutants.

In a separate research letter published with the studies, exposure to pollutants in second-hand smoke was found to be linked to a 39 percent higher risk of dementia in Chinese women.

Three new studies in the New York Times reported that people exposed to higher levels of air pollution have a greater risk of cognitive deterioration, stroke and heart attacks(February ,15, 2012). One nationwide study found that polluted air greatly accelerates declines in measures of memory and attention span.

A new study conducted by Ailshire, J(2012) shows that air pollution may be bad for older brains. Older adults who live in areas of high pollution did not do as well on tests of memory and other thinking skills. The study also shows that air pollution has a negative impact on the memory and other thinking skills of older men and women who reflect the general population.   According to Leahy, S (2010) international environmental journalist urban air pollution from burning fossil fuels reduces children's IQ and can affect the mental development of urban children.

In a study conducted by Sears, A (2009) stated that air pollution is affecting the academic performance of the students the researchers found that the air pollution exposure before birth with lower IQ scores in childhood and smog may harm the developing brain. Low level pollution effects the fetal development. In addition, pollutions can increase risk of fetal abnormalities and cancer.

When 10 newborns were randomly selected from U.S hospitals for analysis of umbilical cord blood researchers concluded that many babies were "born polluted" by chemicals that not only impair prenatal development but also increases the chances of

health problems and life-threatening diseases later on. (Haulihon et al.,cited in Berk,2013).

Prenatal exposure to traffic related air pollution due to residence near roadways is linked to lower birth weight, with complicated pregnancies at greater risk (Rich et al, Seo et al., cited in-Berk,2013).

In a study conducted by Calderón-Garcidueñas L(2011) et al it was found that exposure to severe urban air pollution influences cognitive outcomes, brain volume and systemic inflammation in clinically healthy children. The deficits observed are consistent with impairment of parietal and temporal lobe functions.

Water pollution

Water is the most essential and prime necessity of life. It plays a vital role in the life of all living community including green plants. Water pollution is any physical or chemical change in water that can adversely affect organisms or in other words it refers to the contamination of water by toxic substances.

The nitrates used in fertilizers enter the human body through the drinking water and in the digestive tract, nitrates are reduced into toxic nitrates by intestinal bacteria. The studies conducted on rats revealed that the combined form of carbamate insecticides, triacine herbicides, nitrate nitrogen of pesticides, herbicides and fertilizers are capable of creating aggressive behaviour in many animals, because it affects the level of thyroxine produced by the thyroid gland. The aggressive behaviour increases with the level of thyroxine in the blood.

Another study conducted in Mexico among 4 year old children to identify the negative impact of insecticides and pesticides. The investigators preferred children residing in two different agricultural areas: one category followed ordinary agricultural practices while the other followed modern agricultural practices like the application of pesticides and insecticides. The study revealed that the children of second category showed much stress-related aggressive behaviour such as lack of will power, high level of aggression, lack of co-ordination of eye and limbs in physical activities, impatience etc.

Noise pollution

Any unwanted unpleasant or undesirable sound to an individual or to the recipient can be considered as noise pollution of course noise is rapidly becoming the most widespread environmental pollutant. It can cause sleep disturbances, physical and mental illness and results in aggressive behaviour.

Many studies revealed that noise can be a major factor for both psychological and physiological disorders in human beings. A study reported by Cohen et al(1986) found that children living on a floor of a particular high-rise apartment building had poorer hearing abilities and more problem with reading than did children on the upper floors. Smith and Stansfold (1986) reported that noise also affects adults in daily life. For example, people living in a noisy neighbourhood tend to make mistakes in simple tasks, forget common things and ever dropped things more often.

Mathews and Canon (1975) found that noise definitely affect our social behaviour. Other studies have shown that people living in noisy neighbourhoods have fewer social interactions, are more

aggressive and tend to dislike their neighbours more. Some research suggests that stressful noise can have an influence on our behaviour even after we stop hearing it. Many studies have been done to examine the relationship between noise and illness. These studies revealed that noise has been related to diseases like general illness or morbidity and neuropsychological disturbances like headaches, irritability, fatigue(low ability of the muscle fibers to contract), insomnia(sleeplessness)and neuroticism(symptoms of neurosis).

According to the study done by Stansfeld, A.S and Matheson, M.P (2003) was found that noise interferes in complex task performance, modifies social behaviour and causes annoyance, hypertension and also associated with psychological symptoms.

According to a case study done by Firdaus,G & Ahmad,A (2010) with the Municipal Corporation of Delhi on noise pollution and human health it was found that noise pollution can cause major health implications which include annoyance, disturbance in sleep, interference with communication and other harmful effects.

Soil pollution

Soil pollution can be defined as alteration of soil texture by addition and removal of materials leading to decrease in soil fertility. The continues application of chemical fertilizers increase the quantity and concentration of heavy metals in the soil. The pesticides of chlorinated hydro carbons like DDT, BHC,aldrin,Indane etc. are slowly degrading ones which pollute the soil for a long period of time.

Effect of pesticides on health

Pesticide residues are absorbed by lichens from the environment and through them reach higher animals and eventually human beings. Likewise pesticide residues in water, diatoms and planktons reach higher animals through the consumption of aquatic flora and fauna

A survey work on markets in India has shown the presence of DDT, BHC, endosulphan, pesticide residues in vegetables like potato, tomato, brinjal, cauliflower etc .The analysis of muscles, brain, fat and bone marrow of goat and chicken has been known to have considerable amounts of DDT and BHC in muscles and adipose tissues along with appreciable amounts of DDT and HCH in leg and breast muscles of chicken.

In a study conducted by Dallaire, R et al(2012) in 7-month-old Guadeloupean infants exposed to chlordecone to assess Cognitive, visual, and motor development it was found that chlordecone has been shown to impair neurological and behavioural functions, marginally related to reduced novelty preference, and longer processing speed. Detectable levels of chlordecone in cord blood were associated with higher risk of obtaining low scores on the fine motor development. Pre- and postnatal low chronic exposure to chlordecone is associated with negative effects on cognitive and motor development during infancy.

EFFECT OF POLLUTION ON HEALTH AND BEHAVIOR

We are exposed on a daily basis to a number of potential stressors which may ultimately affect our health. These stressors may be external, such as exposure to pollution, which may be of different types, like pollen, mold, chemicals, and infectious agents, contaminants in food or even physical phenomena such as external

cold or heat. Other stressors may be internal such as psychological, genetical or malnutritional. Abnormal reactions to food, chemicals, inhalants etc: may be related to systematic or chronic stresses.

Morbidity

Most of the stressors result in different types of general illness or morbidity in human beings. Besides the general illness, the process of aging is also closely related to many stressors, especially chemicals. Nowadays, a number of chemicals are used to boost our food productions which are hazardous to our health. Some of the general illness or morbidity due to different pollutants are as follows:

Sick- building syndrome

This condition is resulted by the pollution, but cannot be directly related to any specific environmental cause. Here, there are symptoms such as eye, nose and throat irritation, skin irritation, somatic symptoms, nonspecific allergic reactions and complaints about sensory changes there may be some psychological events such as mass hysteria and mass psychological illness.

Morbidity due to chemicals

Most of the pollutants like mercury, lead asbestos, petrochemical smog, nitrogen and sulphur dioxide, all can lead to respiratory disorders as well as headaches, fatigue, insomnia, irritability, depression, burning eyes, impaired judgments etc. Nickel, vinyl dichloride, pesticides, such as DDT, aldrin, dieidrin and endosulphan are some major causes for cancer in various parts of the body.

According to the studies conducted by Britain's Global Environmental Change Programme toxic chemicals make us less

intelligent and can affect us mentally as well as physically. According to a number of recent studies, certain pollutants are affects memory and behaviour on a global scale. The studies are as follows.

(a) A 5-year study at the University of Wisconsin in Madison found that contaminated water caused increased aggression, attention deficit and/or hyperactivity disorders in children, multiple chemical sensitivity, irritability and aggressive behaviour which are all linked to thyroid hormone levels.

(b) A study of 4 and 5 year old children in Mexico noted decreased cognitive abilities and increased aggressiveness in children exposed to particles. Pesticide-exposed children displayed poorer eye-hand coordination and could not draw a simple human stick figure. Decrease in intelligence in Indian village poisoned by fluoride-tained water was also noted. It was also found that high blood lead levels affect intelligence.

Effect of toxic chemicals on nervous system

Lead

Acute encephalopathy

Encephalopathy is one of the most severe acute clinical forms of lead poisoning. The symptoms of acute encephalopathy syndrome include vomiting, drowsiness, apathy, atxia, stupor etc in acute cases. Convulsions and coma may also appear as associated symptoms .The milder symptoms of acute encephalopathy include mental deterioration, aggressive behaviour, headache, vertigo and tremors.

Peripheral neuritis

This reflects in paralysis of muscles of hands and feet due to irreversible impairment of peripheral nerve functions due to lead poisoning. Another teratogen, lead, is present in paint flaking off the walls of old buildings and in certain materials used in industrial occupations. High levels of prenatal lead exposure are consistently related to prematurity, low birth weight, brain damage, and a wide variety of physical defects. Even at low levels, affected infants and children show slightly poorer mental and motor development (Bellinger,;Jedrychowski et al,cited in C.S Dara, 1997)The greater the prenatal lead exposure, the lower children test scores.

In a Health risk assessment of lead for children in tinfoil manufacturing and e-waste recycling areas of Zhejiang Province, China conducted by Wang X(2012) et al it was found that elevated blood lead levels (BLLs) is negatively related to IQ in children.

A 9-year prospective study in Childhood blood lead levels and intellectual development after ban of leaded gasoline in Taiwan conducted by Huang PC et al(2012) it was found that Lead (Pb) exposure is associated with children's neurodevelopment, even at low doses. BPb was significantly associated with not only decreasing intelligence quotient (IQ), but also delayed cognitive function in children at 5-8 years and other harmful effects on neurodevelopment.

Nickel

The subcutaneous or intravenous administration of nickel salts may also lead t the development of gastrointestinal and neurological disorders like tremor, chorea like movement and paralysis in experimental animals. The parental administration of

metallic nickel powder has been reported to produce sarcoma in bone, nervous tissue, connective tissue and nasal septa.

Mercury

As early as 1865 Kirchgasser observed that rabbits exposed to mercury containing ointments showed weakness and nervous disorders. Rats and mice exposed to mercuric chloride showed behavioural changes such as sluggish activity, irritability, difficulty in locomotion along with neurological disturbances like impaired reflex action, ataxa, tremor etc. Inhalation of metallic mercury vapours and organomercurials by mice, cats and dogs has resulted in weight loss, ataxia, tremor, palsy, anorexia and renal damage.

Chronic mercury poisoning

Occupational workers exposed to mercury vapours, dusts of inorganic salts and elemental mercury are the most common victims of chronic mercury poisoning.

Symptoms associated with central nervous system

The neurological changes associated with chronic mercury exposure include the development of asthenic vegetative syndrome, mercurial tremor and erethism.

Asthenic syndrome

The workers occupationally exposed to dust and vapours of mercury for a long time develop asthenic syndrome. The main symptoms include nervous irritability, decreased productivity, fatigue, loss of self-confidence and depression.

Tremor

Tremor is one of the most prominent symptoms of organic as well as inorganic mercury poisoning. The onset of tremor precedes nervous irritability and insomnia. The tremor initially begins with trembling of muscles which slowly turns into a more violent movement. The mercury induced tremor is due to dysfunction of central nervous system. Sometimes localized lesions are found in cerebellum following chronic mercury poisoning. Studies on experimental animals have shown that rabbits intermittently exposed to mercury vapours develop tremor, muscular weakness and hind limb paralysis. It has been observed that the magnitude of tremor in industrially exposed occupational workers and the level of mercury in their blood are significantly reduced when exposure was stopped.

Erethism

This is a typical neurological disturbance observed among the workers exposed to mercury vapours, elemental mercury or mercury compound dusts. The main symptoms of erethism are loss of memory, irritability, excitability, timidity, anxiety, drowsiness and depression. In advanced cases there may be hallucinations, suicidal melancholia, maniac depression and despondency.

Certain pollutants cause severe prenatal damage. In the 1950s, an industrial plant released waste containing high levels of mercury into a bay providing seafood and water for the town of Minamata, Japan .Many children born at the time displayed physical deformities, mental retardation, abnormal speech, difficulty in chewing and swallowing, and uncoordinated movements. High levels of prenatal mercury exposure disrupt production and migration of neurons, causing widespread brain damage(Clarkson,

Magos, & Myers, 2003, Hubbs-Tait et al .,2005;cited in Berk, 2013).Prenatal mercury exposure from maternal seafood diets, assessed by measuring mercury concentration in umbilical-cord blood and tissue, predicts deficits in speed of cognitive processing and motor, attention, and verbal test performance during the school years (Boucher et al.,2010,Debes et al .,2006;cited in Berk,2013).

For many years, polychlorinated biphenyls (PCBs) were used to insulate electrical equipment, until research showed that like mercury they found their way into waterways and entered the food supply. In Taiwan, prenatal exposure to very high levels of PCBs in rice oil resulted in low birth weight, discoloured skin, deformities of the gums and nails, EEG brain-wave abnormalities, and delayed cognitive development (Chen & Hsu, 1994, Chen et al.,1994;cited in Berk,2013). Steady, low-level PCB exposure is also harmful. Women who frequently ate PCB-contaminated fish, compared with those who ate little or no fish, had infant with lower birth weights, smaller heads, greater stress reactivity, persisting attention and memory difficulties and lower intelligence test score in childhood (Boucher,Muckle,&Bastien;2009,Jacobson &Jacobson,2003;Stewart et al.,2008;cited in Berk,2013).

A study published in an article in BBC News(2000) states that "pollution damages intelligence": pollution and other environmental treats are harming the intelligence of millions of people across the world The causes are poisons such as LEAD, PCBS (Polychlorinated biphenyls, synthetic compound used in electrical equipment), and RADIATION.

The Greater Boston physicians found that household chemicals like glue, solvents, pesticides and others have the

potential to harm the brain. Finally, prenatal exposure to dioxins-toxic compounds resulting from incineration-is linked to brain, immune system, and thyroid damage in babies and to an increased incidents of breast and uterine cancers in women, perhaps through altering hormone levels.

Furthermore even tiny amounts of dioxins in the paternal blood stream cause a dramatic change in the sex ratio of offspring: Affected men father nearly twice as many girls as boys(Ishihara et al.,2007;Mocarelli et al.,2000;cited in Berk,2013).Dioxin seems to impair the fertility of Y-bearing sperm prior to conception.

In a separate report published in by the scientists at the University Paris Descartes the smallest particles of pollution, can even penetrate the brain through the nasal passages.

Toxicity of pesticides

Organochlorine pesticide

Organochlorine insecticide act on the central nervous system and interface with axonic transmission of nerve impulse .They may cause sensory and equilibrium disturbances, involuntary muscle activity depression of vital centers particularly respiration and bring about behavioural changes also.

Organophosphate pesticide

It causes development of coma, pulmonary edema, ataxia, psychosis, dyspnea, paralysis and respiratory failure.

EFFECT OF POLLUTION ON NERVOUS SYSTEM

Minamata disease

Some of the pollutants affect our Central Nervous System (CNS) and cause severe health hazards. The minamata disease is one such, caused by mercuric poisoning. It is characterized by crippling and death. It was first reported in Japan in 1950. The effluent containing mercury from an industry was discharged into the sea. In the sea the mercury is converted into poisonous methyl mercury by the action of bacteria. Methyl mercury got accumulated in the body of fishes, crabs, shell fish etc: and reached the man through the consumption of these animals. As a result, several people, especially fishermen in Japan either died or permanently disabled. The symptoms of these diseases include numbness of limbs, lips and tongue, drowsiness, headache and retarded mental health. The occurrence of these diseases was also reported in some parts of India.

Lead lapsy and CNS Syndrome

The action of lead results in this condition. Lead acts on nervous system and results in neuromuscular effects and central nervous system effects or CNS syndrome. The neuromuscular effects lead to weakness, fatigue, muscular atrophy etc. The CNS syndrome causes coma and death. Lead poisoning also results in aggression, hostility, constipation, abdominal pain etc: Besides lead lapsy, lead poisoning in children has been shown to be related to poorer school performance and lower IQ scores.

Paralysis

Many polluting substances are responsible for paralysis. Of them fluoride is the most important. Fluoride-rich water consumption

may lead to endemic fluorosis. In India it is prevalent in the states of Haryana, Punjab, Andhra Pradesh, Rajasthan etc: Fluoride levels more than 0.5 ppm (parts per million) over a period of 5-10 years terminating in crippling or paralysis. The prolonged use of fluoride containing water stiffens the bone joints, particularly of spinal cord. Fluoride is not absorbed into blood streams. It accumulates in bones leading to knock knee syndrome.

A study by the Columbia Center for Children's Environmental Health (CCCEH) (2010) found that prenatal exposure to pollutants can adversely affect children's cognitive development.

Learning

Learning is acquiring new, or modifying and reinforcing, existing knowledge, behaviors, skills, values, or preferences and may involve synthesizing different types of information. The ability to learn is possessed by humans, animals and some machines. Progress over time tends to follow learning curves. Learning is not compulsory; it is contextual. It does not happen all at once, but builds upon and is shaped by what we already know. To that end, learning may be viewed as a process, rather than a collection of factual and procedural knowledge. Learning produces changes in the organism and the changes produced are relatively permanent.

Human learning may occur as part of education, personal development, schooling, or training. It may be goal-oriented and may be aided by motivation. The study of how learning occurs is part of neuropsychology, educational psychology, learning theory, and pedagogy. Learning may occur as a result of habituation or classical conditioning, seen in many animal species, or as a result of more complex activities such as play, seen only in relatively intelligent

animals. Learning may occur consciously or without conscious awareness. Learning that an aversive event can't be avoided nor escaped is called learned helplessness. There is evidence for human behavioral learning prenatally, in which habituation has been observed as early as 32 weeks into gestation, indicating that the central nervous system is sufficiently developed and primed for learning and memory to occur very early on in development.

Language acquisition is one of the quintessential human traits, because nonhumans do not communicate by using language. Language acquisition usually refers to **first-language acquisition**, which studies infants' acquisition of their native language including phonology, morphology, syntax, semantics, and an extensive vocabulary. Language can be vocalized as in speech, or manual as in sign. The human language capacity is represented in the brain. Even though the human language capacity is finite, one can say and understand an infinite number of sentences, which is based on a syntactic principle called recursion.

Vocabulary acquisition

The capacity to acquire the ability to incorporate the pronunciation of new words depends upon many factors. Before anything the learner needs to be able to hear what they are attempting to pronounce. Another is the capacity to engage in speech repetition. Children with reduced abilities to repeat nonwords (a marker of speech repetition abilities) show a slower rate of vocabulary expansion than children for whom this is easy.It has been proposed that the elementary units of speech have been selected to enhance the ease with which sound and visual input can be mapped into motor vocalization

Two more crucial elements of vocabulary acquisition are word segmentation and statistical learning (described above). Word segmentation, or the segmentation of words and syllables from fluent speech can be accomplished by eight-month-old infants. By the time infants are 17-months-old, they are able to link meaning to segmented words.

Stages of Spelling Development

As young children begin to write, they create unique spellings, called invented spelling, based on their knowledge of phonology (Read, 1975). The children in Read's studies used letter names to spell words, such as *U (you)* and *R (are)*, and they used consonant sounds rather consistently: *GRL (girl)*, *TIGR (tiger)*, and *NIT (night)*. They used several unusual but phonetically based spelling patterns to represent affricates

Stage 1: Emergent Spelling

Spelling at this stage represents a natural, early expression of the alphabet and other written-language concepts. Children may write from left to right, right to left, top to bottom, or randomly across the page, but by the end of the stage, they have an understanding of directionality. Some emergent spellers have a large repertoire of letterforms to use in writing, whereas others repeat a small number of letters over and over. They use both upper- and lowercase letters but show a distinct preference for uppercase letters. Toward the end of the stage, children are beginning to discover how spelling works and that letters represent sounds in words. This stage is typical of 3- to 5-year-olds. During the emergent stage, children learn these concepts:

- The distinction between drawing and writing

- How to make letters

- The direction of writing on a page

- Some letter-sound matches

Stage 2: Letter Name-Alphabetic Spelling

Children learn to represent phonemes in words with letters. They develop an understanding of the alphabetic principle, that a link exists between letters and sounds. At first, the spellings are quite abbreviated and represent only the most prominent features in words. Children use only several letters of the alphabet to represent an entire word. Examples of early Stage 2 spelling are *D*(*dog*) and *KE* (*cookie*), and children may still be writing mainly with capital letters. Children slowly pronounce the word they want to spell, listening for familiar letter names and sounds.

Spellers at this stage are usually 5-to 7-year-olds. During the letter-name stage, children learn these concepts:

- The alphabetic principle

- Consonant sounds

- Short vowel sounds

- Consonant blends and digraphs

Stage 3: Within-Word Pattern Spelling

Students begin the within-word pattern stage when they can spell most one-syllable short-vowel words, and during this stage, they learn to spell long-vowel patterns and r-controlled vowels. They experiment with long-vowel patterns and learn that words

such as come and bread are exceptions that don't fit the vowel patterns. Students may confuse spelling patterns and spell *meet* as *mete*, and they reverse the order of letters, such as *form* for *from* and *gril* for *girl*.

Students at this stage are 7-to 9-year-olds, and they learn these spelling concepts:

- Long-vowel spelling patterns

- r-controlled vowels

- More-complex consonant patterns

- Diphthongs and other less common vowel patterns

Stage 4: Syllables and Affixes Spelling

Students focus on syllables in this stage and apply what they've learned about one-syllable words to longer, multisyllabic words. They learn about inflectional endings (*-s, -es, -ed, and -ing*) and rules about consonant doubling, changing the final y to i, or dropping the final e before adding an inflectional suffix. They also learn about homophones and compound words and are introduced to some of the more-common prefixes and suffixes. Spellers in this stage are generally 9-to 11-year-olds. Students learn these concepts during the syllables and affixes stage of spelling development:

- Inflectional endings (*-s, -es, -ed, -ing*)

- Rules for adding inflectional endings

- Syllabication

- Homophones

Stage 5: Derivational Relations Spelling

Students explore the relationship between spelling and meaning during the derivational relations stage, and they learn that words with related meanings are often related in spelling despite changes in vowel and consonant sounds (e.g., *wise–wisdom, sign–signal, nation–national*). The focus in this stage is on morphemes, and students learn about Greek and Latin root words and affixes. They also begin to examine etymologies and the role of history in shaping how words are spelled. Spellers at this stage are 11- to 14-year-olds. Students learn these concepts at this stage of spelling development:

- Consonant alternations (e.g., *soft–soften, magic–magician*)

- Vowel alternations (e.g., *please–pleasant, define–definition, explain–explanation*)

- Greek and Latin affixes and root words

- Etymologies

Children's spelling provides evidence of their growing understanding of English orthography. The words they spell correctly show which phonics concepts, spelling patterns, and other language features they've learned to apply, and the words they invent and misspell show what they're still learning to use and those features of spelling that they haven't noticed or learned about. Invented spelling is sometimes criticized because it appears that students are learning bad habits by misspelling words, but researchers have confirmed that students grow more quickly in phonemic awareness, phonics, and spelling when they use invented spelling as long as they are also receiving spelling instruction (Snow,

Burns, & Griffin, 1998). As students learn more about spelling, their invented spellings become more sophisticated to reflect their new knowledge, even if the words are still spelled incorrectly, and increasingly students spell more and more words correctly as they move through the stages of spelling development

Learning disability

Learning disability is a general term that describes specific kinds of learning problems. A learning disability can cause a person to have trouble learning and using certain skills. The skills most often affected are:

- reading
- writing
- listening
- speaking
- reasoning
- doing math

Learning disabilities (LD) vary from person to person. One person with learning disabilities may not have the same kind of learning problems as another person with learning disabilities. One person may have trouble with reading and writing. Another person with learning disabilities may have problems with understanding math. Still another person may have trouble in each of these areas, as well as with understanding what people are saying.

Researchers think that learning disabilities are caused by differences in how a person's brain works and how it processes information. Children with learning disabilities are not "dumb" or

"lazy." In fact, they usually have average or above average intelligence. Their brains just process information differently rning disability.

Learning disability refers to significant learning problems in an academic area. These problems, however, are not enough to warrant an official diagnosis. Learning disorder, on the other hand, is an official clinical diagnosis, whereby the individual meets certain criteria, as determined by a professional (psychologist, pediatrician, etc.) The difference is in degree, frequency, and intensity of reported symptoms and problems, and thus the two should not be confused. When the term "learning disabilities" is used, it describes a group of disorders characterized by inadequate development of specific academic, language, and speech skills. Types of learning disabilities include reading disability (dyslexia), mathematics disability (dyscalculia) and writing disability (dysgraphia).

The unknown factor is the disorder that affects the brain's ability to receive and process information. This disorder can make it problematic for a person to learn as quickly or in the same way as someone who is not affected by a learning disability. People with a learning disability have trouble performing specific types of skills or completing tasks if left to figure things out by themselves or if taught in conventional ways.

Individuals with learning disabilities can face unique challenges that are often pervasive throughout the lifespan. Depending on the type and severity of the disability, interventions and current technologies may be used to help the individual learn strategies that will foster future success. Some interventions can be quite simplistic, while others are intricate and complex. Current technologies may require student training to be effective classroom

supports. Teachers, parents and schools can create plans together that tailor intervention and accommodations to aid the individual in successfully becoming independent learners. School psychologists and other qualified professionals quite often help design the intervention and coordinate the execution of the intervention with teachers and parents. Social support may improve the learning for students with learning disabilities.

In a study by Ohio State's Institute for Behavioral Medicine Research conducted by Columbus it was found that long-term exposure to air pollution can lead to physical changes in the brain, as well as learning and memory problems and can also cause depression. New research in mice suggests. In a learning and memory test, mice were placed in the middle of a brightly lit arena and given two minutes to find an escape hole leading to a dark box where they feel more comfortable. They were given five days of training to locate the escape hole, but the mice who breathed the polluted air took longer to learn where the escape hole was located.

The mice exposed to polluted air also were less likely to remember where the escape hole was when tested later .A study by the Columbia Center for Children's Environmental Health (CCCEH) (2010) found that prenatal exposure to pollutants can adversely affect children's cognitive development.

According to the study by Fronken et al(2011) reports that are-borne particles we breath will result in slow learning and depression.

NEED AND SIGNIFICANCE

India had witnessed various drastic effects of pollution such as the "endosulfan tragedy" and the "Bhopal tragedy". The lack of

foresight of the authority in planning and execution of unnatural projects are one reason behind these kinds of disasters.

In an article it was reported that the people in Kasaragod (Kerala, India) are nowadays suffering from the after effects of endosulfan chemical. The tragedy of people exposed to pesticide Endosulfan in Kasaragod district of Kerala is continuing. Incidences of children born with neurobehavioral disorders, congenital malformations, mental retardation and other abnormalities are increasing. The incidence of congenital abnormalities, neurological disorders, abortions, epilepsy and other diseases are also reported (The Hindu, October 25, 2009).(Refer appendix:1).

In another article toxicity of endosulfan and health issues due to its bioaccumulation that occurred in the Kasargod District (of Kerala) was reported. Symptoms of acute poisoning which include hyperactivity, tremors, convulsions, lack of coordination, staggering, difficulty breathing, nausea and vomiting, diarrhoea, and in severe cases, unconsciousness were also reported. In this area women are more likely to give birth to children with autism. (Refer appendix:2).

These reports show that drastic changes have occurred in the physiology of people in these areas.

The industrial area selected for the current study is an area of a large numbers of big and small industries and an area of immense pollution. Eloor is a suburb of Kochi and a municipality in Paravur Taluk, Ernakulam District in Kerala, India and is the largest industrial belt in Kerala. There are more than 247 industries of different kinds *e.g.*, Fertilisers and Chemicals Travancore (FACT), Travancore Cochin Chemicals, Indian Rare Earths Limited, Hindustan Insecticides Limited (the world's largest manufacturer of DDT) and many others

manufacturing a range of products like chemical-petrochemical products, pesticides and insecticides, rare earth elements, rubber processing chemicals, fertilizers, zinc/chromium compounds and leather products. As a result of its heavy industry, the town also suffers from heavy pollution, and is rated as one of the toxic hotspots of the world by Green Peace International.(24 November, 2013) (Refer appendix:3).

In an article it was stated that, the Kerala State Pollution Control Board (PCB) plans to introduce a check-post in the Eloor-Edayar industrial area to curb illegal dumping of chemical and other hazardous effluents into water resources (The Hindu,14 Sep 2011). (Refer appendix:4).

In another article a study was stated, that showed vegetables and other food items contains high levels of pesticide and heavy metal residues that are harmful to human beings.(The Hindu,29 Aug 2007) (Refer appendix:5).

In another article it was found that Greenpeace, an international organisation fighting against environmental pollution, said that unchecked industrial pollution of Eloor, industrial belt in Kochi, had resulted in increased rates of disease and death amongst the human population. (Times of India, 10 Sep 2003.) (Refer appendix:6).

All these reports focus on the intensity of pollution in these areas. These reports also clearly show that pollution has caused serious impairment such as mental retardation. Thus the need of the study is to discuss the impact of pollution on learning of students from industrial area and non-industrial area.

It is our duty to mould a better nation. We should make our nation well developed and prosperous. Our nation's future lies in the hands of our children or students. In order to make them perform better they should have better cognitive skills such as learning, memory and intelligence .The present study clearly try to explore and show the fact that pollution impairs the cognitive skills of the students. Children with cognitive impairment when becomes adults will not be good in decision making and building a healthy environment. Thus this study focuses on the impact of pollution on cognitive skills mainly memory, by doing so control of pollution in our nation can be promoted. When children are affected parents and other elders will take things seriously, thus we can improve the quality of life of people in this world. This study also helps us to become aware about the negative impacts of pollution .In this way everyone as a good citizen would be able to play a better role to control and to prevent pollution. Thus this study focuses on pollution control in Nation therefore some of the organic disorders can be prevented. This study also aimed to help the authority in their further policy making as well as for the better rehabilitation of people who suffered from industrial pollutions. A fine thinking is the primary process of any change. Thus this study enhances everyone to think about cognitive problems created by pollution.

Problem

To find out the influence of pollution on learning of students from polluted area.

Objective

1. To find out whether there is any significant difference between students from polluted and non polluted area with regard to their learning.

2. To find out whether there is any significant difference between males and females from polluted area with regard to their learning.

3. To find out whether there is any significant difference between males and females from non polluted area with regard to their learning.

4. To find out whether there is any significant difference between males in polluted and non polluted area with regard to their learning.

5. To find out whether there is any significant difference between females in polluted and non polluted area with regard to their learning.

Hypothesis

1. There will be no significant difference between students from polluted and non polluted area with regard to their learning.

2. There will be no significant difference between males and females from polluted area with regard to their learning.

3. There will be no significant difference between males and females from non polluted area with regard to their learning.

4. There will be no significant difference between males in polluted and non polluted area with regard to their learning.

5. There will be no significant difference between females in polluted and non polluted area with regard to their learning.

The aim of the current study is to find out the influence of pollution on learning of students from polluted area. The study makes us aware about the cognitive problems created by pollution in our country and focuses on the control of pollution.

Sample

The samples for polluted area were collected from an industrial area Mupathadam-Elloor in Eranakulam (district), Kerala, India. This place is under Panchayath system. It is a place known for a large number of industries. There were many large scales as well as small scale industries in this area. Some of the notable industries are CMRL, SSPML (Sree Sakthi Paper Mills Ltd), Binami-Zinc Ltd, Periyar chemicals, National battery, Fertilisers and Chemicals Travancore (FACT), Travancore Cochin Chemicals, Indian Rare Earths Limited, Hindustan Insecticides Limited (the world's largest manufacturer of DDT) and many others manufacturing a range of products like chemical-petrochemical products, pesticides and insecticides, rare earth elements, rubber processing chemicals, fertilizers, zinc/chromium compounds and leather product. As a result the level of pollution is very high in this area.(refer appendix 7). These industries emit a lot of pollutants day by day. This area is affected by air pollution and water pollution. The social workers and inhabitants of this area reported a lot about the pollution in this area. They are very much eager to control pollution in this area and give us a lot of support to conduct our studies.

The samples for non-polluted area was selected from a non-industrial area namely Thateakkad-Kothamangalm in Eranakulam (district), Kerala, India. This place was also under a Panchayath system. This place is known for its beautiful valleys, rivers, hills and trees. We could see a bird sanctuary here. The place is famous for its natural beauty and is a place tourist interest. There is not even an industry here and so we can conclude that the place is untouched by pollution.

Gender Distribution

Area	Males	Females
Polluted Area	31	31
Non polluted Area	28	28

Inclusion Criteria

- Students who were born and brought up in an industrial area were included.

- Students with the same economic status and family status were selected for the study.

- Students from the age group 6-11 were selected for the study.

- Parent's jobs were also considered. Special care was taken to select students whose fathers were having same job.

- The students selected were from the same family background. All of them belonged to nuclear family.

- Samples selected were from two Panchayaths (Eloor, Thateakkad) of the same district.

Exclusion Criteria

- Students who were migrated to the industrial area were excluded.

- Students with higher economic status and family status were avoided.

- Students who suffered from any kind of mental retardation were also excluded.

- Students who were not in the age group 6-12 were also avoided.

- The students who had lost any one of the parent were also avoided.

- Students whose parents engaged in professional jobs were also excluded.

Tool

Spelling Test (schonell's list):Assessment of specific learning disabilities. Which was   restandardised in NIMHANS.

Scoring

One score was given for a correct spelling**.**

Procedure

The experiment was done individually. The participant is made to seat comfortably and was given a paper and pen. They were given the following instruction. "I will be saying some words and you write that word as soon as possible. The experiment is stopped when the participant is unable to write the word correctly which corresponds to their age and grade.

Spelling Test (schonell's list) was used to find the ability of the participant to learning.

ANALYSIS

SPSS-16 was used for the analysis of the data. t-test was used for comparison. The problem of the study is to find out the influence of pollution on learning of students. This study focuses on the effect of pollution on cognitive functions and specifically on learning spellings of simple English words. The samples were collected from 31 students in an industrial area and 28 students from a non- industrial area. Their learning was assessed by spelling test. For analysis t-test was done.

Table 3.1: Means, SDs and t value after comparing the students of polluted and non polluted area with regard to learning.

Place	N	Mean	Std. Deviation	T value
Polluted area	62	24.97	15.792	-5.875**
Non Polluted area	56	42.77	16.988	

** Significance at 0.01 level.

The above table clearly shows the difference between means for students from polluted area and non polluted area with regard to their learning is significant at 0.01 level. From the table 3.1 it is clear that there is a significant mean difference between the students from polluted area (M=24.97, SD=15.792) and students from non polluted area (M=42.77,SD=16.988).

From the above table we can see that the mean and standard deviation of students from non polluted area is higher than that of the students from polluted area. So we can say the students from non polluted area are superior to the students from polluted area with regard to their learning.

That is the null hypothesis which states that **"There will be no significant difference between students from polluted and non polluted area with regard to their learning**" is rejected. Thus the alternative hypothesis is accepted which states that **"The students from non polluted area are superior to students from polluted area with regard to learning".**

The current study was conducted in a polluted area Muphathadam-Eloor in Eranakulam district, Kerala and a non polluted area Thateakkad-Kothamangalam in Eranakulam district, Kerala. The result also indicated the same. The students from non polluted area are superior to the students from polluted area with regard to their learning. The samples were collected from two different areas of the same district. The polluted area selected for this study had a lot of big and small industries. The non polluted area selected for this study had a lot of valleys, rivers, hills and trees and was untouched by pollution. The selection of the areas had contributed a lot in yielding a good result.

In a study by Ohio State's Institute for Behavioral Medicine Research conducted by Columbus it was found that long-term exposure to air pollution can lead to physical changes in the brain, as well as learning and memory problems and can also cause depression. In a learning and memory test under the above study, mice were placed in the middle of a brightly lit arena and given two minutes to find an escape hole leading to a dark box where they feel more comfortable. They were given five days of training to locate the escape hole, but the mice who breathed the polluted air took longer to learn where the escape hole was located. The mice exposed to polluted air also were less likely to remember where the escape hole was when tested later.

In another experiment, mice exposed to the polluted air showed more depressive-like behaviors than did the mice that breathed the filtered air. The polluted-air mice showed signs of higher levels of anxiety-like behaviors in one test, but not in another.

The researchers did tests on the hippocampal area of the mice brains. Results showed clear physical differences in the hippocampi of the mice who were exposed to polluted air compared to those who weren't. The hippocampus is associated with learning, memory and depression. Epidemiologic, neuropath logical, and brain imaging studies provide evidence of a negative relationship between ambient air pollution and with lower brain development conditional on observable demographic factors.

In a cross-sectional study in Quanzhou, China, the performance in multiple neurobehavioral function tests was lower in children of 8-10 years old who came from a school located in a high traffic exhausts pollution area, as compared to those studying in the other school located in a high traffic exhausts pollution area, as compared to those studying in the other school located in a clear air area (Wang et al. 2009).

In a study by the Institute for Social Research, University of Michigan conducted by Ann Arbor it was found that air pollution around schools is linked to poorer student health and academic performance. Exposing children to environmental pollutants during important times of physiological development can lead to long-lasting health problems, dysfunction, and disease. It was also examined the extent of air pollution from industrial sources around public schools in Michigan to find out whether air pollution jeopardizes children's health and academic success. We found that

schools located in areas with the highest air pollution levels had the lowest attendance rates-a potential indicator of poor health-and the highest proportions of students who failed to meet state educational testing standards. Michigan and many other states currently do not require officials considering a site for a new school to analyze its environmental quality.

According to the study by Fronken et al(2011) reports that are-borne particles we breath will result in slow learning and depression.

Gender Difference

Table 3.2: Means, SDs and t value after comparing the students of polluted and non polluted area, gender difference with in the group.

Place	Gender	N	Mean	Std. Deviation	T value
Polluted area	Male	31	22.26	16.186	
	Female	31	27.69	15.163	1.363**
Non Polluted area	Male	28	42.06	16.565	
	Female	28	43.48	17.675	0.310**

** Significance at 0.01 level.

From the table 3.2 it is clear that there is no significant mean difference between males   (M=22.26, SD=16.186) and females (M=27.69, SD=15.163) in polluted area and non polluted area-males (M=42.06, SD=16.565) and females (M= 43.48, SD=17.675).

The results from the table show that the null hypothesis which states **"There will be no significant difference between males and females in polluted area with regard to their learning"** is accepted. Also the null hypothesis which states **"There will be no**

significant difference between males and females in non polluted area with regard to their learning" is accepted.

As there is no significant difference between males and females in regard to their learning in both polluted and non polluted areas we can conclude that gender difference is not an intervening factor in case of the above study. Neither males nor females are superior with regard to their learning in both the polluted and non polluted areas.

Table 3.3: Means, SDs and t value after comparing the students of polluted and non-polluted area with in gender comparison.

Gender	Place	N	Mean	Std. Deviation	t value
Male	Polluted area	31	22.26	16.186	
	Non Polluted area	28	42.06	16.565	4.635**
Female	Polluted area	31	27.69	15.163	
	Non Polluted area	28	43.48	17.675	3.664**

** Significance at 0.01 level

From table 3.3 clearly shows the difference between means for males from polluted and non polluted area and females from polluted and non polluted area with regard to their learning is significant at 0.01 level.

The table 3.3 it is clear that there is significant mean difference between males in polluted area (M=22.26, SD=16.186) and males (M=42.06, SD=16.565) in non polluted area. It is also clear that there is significant mean difference between females in polluted area (M=27.69, SD=15.163) and females in non polluted area (M= 43.48, SD=17.675).

That is the null hypothesis which states that "**There will be no significant difference between males in polluted and non**

polluted area with regard to their learning" is rejected. Thus the alternative hypothesis is accepted which states that **"There will be significant difference between males in polluted and non polluted area with regard to their learning"**.

The null hypothesis which states that **"There will be no significant difference between females from polluted and non polluted area with regard to their learning**" is rejected. Thus the alternative hypothesis is accepted which states that **"The females from non polluted area are superior to students from polluted area with regard to spelling".**

There is significant difference between males in polluted and non polluted area with regard to their learning. And the significant difference between females in polluted and non polluted area with regard to their learning. Thus we could conclude that the male in non polluted area is superior than the male in the polluted area and the female in the non polluted area is superior than that of the polluted area with regard to their learning. So we can say that the pollution is affect the learning of the individual.

Table 3.4 Percentage and classification in Normal, Learning problem and Learning disability in students from polluted and non-polluted area with regard to learning

Place	Normal	%	Learning Problem	%	Learning disability	%	Total
Pollution	13	20.96	30	48.38	19	30.64	62
Non polluted	38	67.85	12	21.42	6	10.71	56
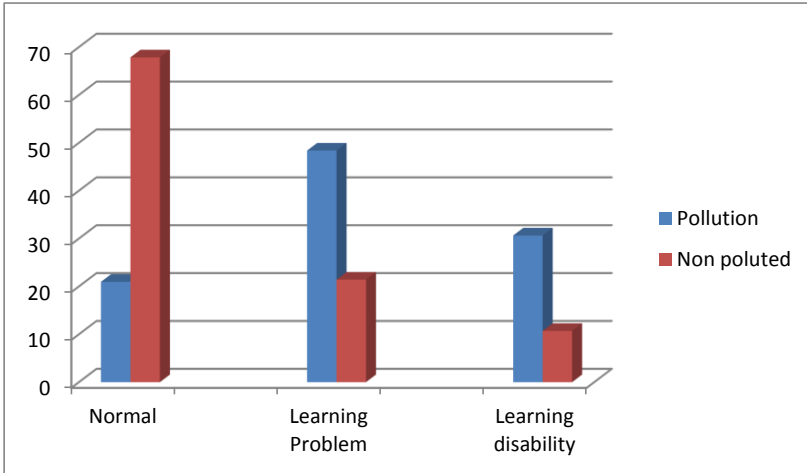
Figure 1: Percentage of children belonging to different category from polluted and non polluted area.

From the table 3.4 Percentage and classification in Normal, Learning problem and Learning disability in students from polluted and non polluted area with regard to spelling test.

Table clearly shows that the difference in Normal, Learning problem and Learning disability students, that from polluted area (N=13,LP=30,LD=19) and students from non polluted area(N=38,LP=12,LD=6).

From the graph, clearly shows that the Normal, Learning problem and Learning disability students, that from the polluted area(N=20.96%, LP=48.38%, LD=30.64%) and students from the non polluted area(N=67.85%, LP=21.42%, LD=10.71%).

When comparing the students from polluted area and non polluted area. The Percentage of normal students in polluted area is less than the non polluted area and the Percentage of learning

problem and learning disability students in polluted area is higher than that of the students from the non polluted area.

Studies show that long term exposure to air pollution can lead to physical changes in the brain as well as learning and memory problems and even depression In a learning and memory test under the above study, mice were placed in the middle of a brightly lit arena and given two minutes to find an escape hole leading to a dark box where they feel more comfortable. They were given five days of training to locate the escape hole, but the mice who breathed the polluted air took longer to learn where the escape hole was located. The mice exposed to polluted air also were less likely to remember where the escape hole was when tested later. So we can conclude that pollution is affecting the learning of the individual.

This study clearly reflect that pollution has a negative impact on the spellings of these children thus can conclude that these children have more learning related problems and cognitive impairment when compared to children from non polluted area.

Conclusion

The aim of the study was to find out the impact of pollution on learning of students from polluted area. The study was conducted among 31 students in an industrial area and 28 students from a non- industrial area. The study also aimed to find out the difference between students from polluted and non polluted area, also to explore the gender difference if any within students from polluted and non polluted area with regard to their learning. Their learning was assessed by Spelling Test (schonell's list). The data was analysed using SPSS-16 and t-test was used for comparison.

SL.NO	HYPOTHESIS	RESULT
1.	There will be no significant difference between students from polluted and non polluted area with regard to their learning.	rejected
2.	There will be no significant difference between males and females from non polluted area with regard to their learning.	accepted
3.	There will be no significant difference between males and females from polluted area with regard to their learning.	accepted
4.	There will be no significant difference between males in polluted and non polluted area with regard to their learning.	rejected
5.	There will be no significant difference between females in polluted and non polluted area with regard to their learning.	rejected

The result suggested that the students from non polluted area were superior to the students from polluted area with regard to their learning. It was also found that there is no significant difference between males and females in regard to their learning in both polluted and non polluted areas. It showed that males in non polluted area were superior to males in polluted area and females in non polluted area were superior to females in polluted area with regard to their learning.

LIMITATIONS

1. The samples for the current study were collected from panchayaths.

2. The polluted area taken for the study was a place with multiple kinds of pollution.

3. For conclusive results   the study should have been conducted using fMRI techniques.

4. The children were classified based on only spelling test. No detailed assessment were used.

Implications

The study helps us to understand the negative impact of pollution on learning. Today, parents and teachers are very much aware about the learning disabilities of the students. As we all know this disability may be due to the impairments in cognitive abilities of the students. The above study clearly shows that pollution causes impairment in learning. In this way the current study throws light on various questions regarding such disabilities. Thus the study makes us aware about the negative impacts of pollution and enables us to control pollution. For a better nation in future we should control pollution. This study can be used by the authority in their further policy making as well as for the better rehabilitation of people who suffered from industrial pollution.

Suggestions for Further Studies

Further researches can be done based on this study by using medical procedures such as fMRI, MRI etc. So that a more accurate and satisfying result can be obtained. In the current study it was not able to find out which kind of pollution caused the impairment in learning. Further studies can be done by focusing on a particular kind of pollution. So that it will be able to find the impact of a particular kind of pollution and to explore which one has the most and least impact [i]on learning.

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Appendix 1

Retrieved from The Hindu News, October 25, 2009

The tragedy of people exposed to pesticide Endosulfan in Kasaragod district of Kerala is continuing. Despite government promises, official efforts to treat and rehabilitate the victims and protect them from further exposure to contaminated soil and water are wanting.

While incidences of children born with neurobehavioral disorders, congenital malformations and other abnormalities have come down in some of the 11 worst-affected panchayats, they continue to occur in other panchayats.

While about 500 deaths from 1995 have been officially acknowledged as related to the spraying of endosulfan, unofficial estimates put the total number of deaths since the late seventies around 4000.

People are still dying from after-effects of the pesticide, while more than 1000 live in utter misery. The health of more than 9000 persons has been impaired by the pesticide used by the State-owned Plantation Corporation of Kerala at its cashew plantations.

The Corporation began aerial spraying of the pesticide in its plantations spread across 15 panchayats in the district in 1978 and its application continued till 2001.

The pesticide, which is not easily degradable, contaminated the soil and water and found its way into the food chain affecting lower and higher forms of life in the area including humans.

The half-life of endosulfan varies from 60 days to 800 days. In its Kasaragod estate alone, the Plantation Corporation sprayed 31510 litres of endosulfan between 1990 and 2000. Only a small fraction of this would be remaining in the environment now.

However, its degradative products such as endosulfan sulfate and endosulfan diol are also toxic. The combined half life of endosulfan and its toxic residues is estimated to range from nine months to six years, according to Environmental Protection Agency of the United States.

This means that toxic materials could still be present in the environment of the affected villages in measurable quantities, especially in sediments where they accumulate. (A daily intake of even 0.006 mg endosulfan per kg of body weight by humans could be harmful.)

The accumulated quantity of toxins in the environment as in 2001 would have come down to about 30 per cent or the original quantity if we assume half-life of six years and less than 0.5 per cent if we assume half-life of nine months.

The actual quantity would be something in-between spread across a large area. Besides, there is the possibility of very high levels of bioaccumulation and bio-concentration in sediments and the food chain.

With the reduction of the poison in the environment, insects, butterflies and other species, which had almost disappeared from the affected panchayats have returned.

Dr. Y.S. Mohana Kumar, who runs medical clinics at Yathrika and two nearby localities and who was the first doctor to invite public attention to the rising number of congenital abnormalities in the nineties, told The Hindu that cases of children born with abnormalities had returned to normalcy in his locality. There had been no birth of disabled children in the Perla and Padre areas for the past three months.

The incidence of congenital abnormalities, neurological disorders, abortions, epilepsy and other diseases were now comparable to the rest of the population in the State.

Abnormalities caused by hormonal imbalance would take at least ten more years to disappear.

However, Dr. M. Mohammed, who serves the public health centre at Kadarudukka, said that surveys had shown that the incidence of bone deformities, infertility, mental retardation and congenital heart diseases in the panchayat were ten times more than those among the other populations.

Babies were being born even now with cleft palates and other congenital abnormalities. New cases of mental retardation were also being reported.

The government machinery has been lax in addressing the problems ever since they were reported in the nineties.

The government failed to decontaminate the water-sources or arrange alternate water supply-either through large schemes or rain water harvesting. The sources of several of existing water supply schemes are contaminated.

Even water supplied through tankers in summer is not tested for presence of pesticides. The attempts of government to provide medical care and ensure rehabilitation of the affected people was often delayed and failed to achieve much. Though a relief and remediation cell was formed at the Kasaragod collectorate, its activities had been hampered by absence of drive, shortage of funds and other problems.

On the other hand, voluntary groups and organisations like the Solidarity Youth Movement had been able to extend better support to the victims in a better manner.

Appendix 2

Retrieved from encyclopedia,http://en.wikipedia.org/wiki/.24 November 2013

Endosulfan is an off-patent organochlorine insecticide and acaricide that is being phased out globally. The two isomers, endo and exo, are known popularly as I and II. Endosulfan sulfate is a product of oxidation containing one extra O atom attached to the S atom. Endosulfan became a highly controversial agrichemical[1] due to its acute toxicity, potential for bioaccumulation, and role as an endocrine disruptor. Because of its threats to human health and the environment, a global ban on the manufacture and use of endosulfan was negotiated under the Stockholm Convention in April 2011. The ban will take effect in mid-2012, with certain uses exempted for five additional years.[2] More than 80 countries,[3] including the European Union, Australia, New Zealand, several West African nations,[4] the United States,[5][6] Brazil,[7] and Canada[8] had already banned it or announced phase-outs by the time the Stockholm Convention ban was agreed upon. It is still used extensively in India, China, and few other countries. It is produced by Makhteshim Agan and several manufacturers in India and China.

Uses

Endosulfan has been used in agriculture around the world to control insect pests including whiteflys, aphids, leafhoppers, Colorado potato beetles and cabbage worms.[9] Due to its unique mode of action, it is useful in resistance management; however, as it is not specific, it can negatively impact populations of beneficial insects.[10] It is, however, considered to be moderately toxic to honey bees,[11] and it is less toxic to bees than organophosphate insecticides.[12]

Production

The World Health Organization estimated worldwide annual production to be about 9,000 metric tonnes (t) in the early 1980s.[13] From 1980 to 1989, worldwide consumption averaged 10,500 tonnes per year, and for the 1990s use increased to 12,800 tonnes per year.

Endosulfan is a derivative of hexachlorocyclopentadiene, and is chemically similar to aldrin, chlordane, and heptachlor. Specifically, it is produced by the Diels-Alder reaction of hexachlorocyclopentadiene with *cis*-butene-1,4-diol and subsequent reaction of the adduct with thionyl chloride. Technical endosulfan is a 7:3 mixture of stereoisomers, designated α and β. α- and β-Endosulfan are conformational isomers arising from the pyramidal stereochemistry of sulfur. α-Endosulfan is the more thermodynamically stable of the two, thus β-endosulfan irreversibly converts to the α form, although the conversion is slow.[14][15]

Health effects

Endosulfan is one of the most toxic pesticides on the market today, responsible for many fatal pesticide poisoning incidents around the world.[37] Endosulfan is also a xenoestrogen—a synthetic substance that imitates or enhances the effect of estrogens—and it can act as an endocrine disruptor, causing reproductive and developmental damage in both animals and humans. Whether endosulfan can cause cancer is debated. With regard to consumers' intake of endosulfan from residues on food, the Food and Agriculture Organization of United Nations has concluded that long-term exposure from food is unlikely to present a public health concern, but short-term exposure can exceed acute reference doses.[38]

Toxicity

Endosulfan is acutely neurotoxic to both insects and mammals, including humans. The US EPA classifies it as Category I: "Highly Acutely Toxic" based on a LD_{50} value of 30 mg/kg for female rats,[12] while the World Health Organization classifies it as Class II "Moderately Hazardous" based on a rat LD_{50} of 80 mg/kg.[39] It is a GABA-gated chloride channel antagonist, and a Ca^{2+}, Mg^{2+} ATPase inhibitor. Both of these enzymes are involved in the transfer of nerve impulses. Symptoms of acute poisoning include hyperactivity, tremors, convulsions, lack of coordination, staggering, difficulty breathing, nausea and vomiting, diarrhea, and in severe cases, unconsciousness.[16] Doses as low as 35 mg/kg have been documented to cause death in humans,[40] and many cases of sublethal poisoning have resulted in permanent brain damage.[16] Farm workers with chronic endosulfan exposure are at risk of rashes and skin irritation.[12]

EPA's acute reference dose for dietary exposure to endosulfan is 0.015 mg/kg for adults and 0.0015 mg/kg for children. For chronic dietary expsoure, the EPA references doses are 0.006 mg/(kg·day) and 0.0006 mg/(kg·day) for adults and children, respectively.[12]

Endocrine disruption

Theo Colborn, an expert on endocrine disruption, lists endosulfan as a known endocrine disruptor,[41] and both the EPA and the Agency for Toxic Substances and Disease Registry consider endosulfan to be a potential endocrine disruptor. Numerous *in vitro* studies have documented its potential to disrupt hormones and animal studies have demonstrated its reproductive and developmental toxicity, especially among males.[12][16] A number of studies have documented that it acts as an antiandrogen in animals.[42] Endosulfan has shown to affect crustacean molt cycles,

which are important biological and endocrine-controlled physiological processes essential for the crustacean growth and reproduction.[43] Environmentally relevant doses of endosulfan equal to the EPA's safe dose of 0.006 mg/kg/day have been found to affect gene expression in female rats similarly to the effects of estrogen.[44] It is not known whether endosulfan is a human teratogen (an agent that causes birth defects), though it has significant teratogenic effects in laboratory rats.[45] A 2009 assessment concluded the endocrine disruption in rats occurs only at endosulfan doses that cause neurotoxicity.[46]

Reproductive and developmental effects

Several studies have documented that endosulfan can also affect human development. Researchers studying children from many villages in Kasargod District, Kerala, India, have linked endosulfan exposure to delays in sexual maturity among boys. Endosulfan was the only pesticide applied to cashew plantations in the villages for 20 years, and had contaminated the village environment. The researchers compared the villagers to a control group of boys from a demographically similar village that lacked a history of endosulfan pollution. Relative to the control group, the exposed boys had high levels of endosulfan in their bodies, lower levels of testosterone, and delays in reaching sexual maturity. Birth defects of the male reproductive system, including cryptorchidism, were also more prevalent in the study group. The researchers concluded, "our study results suggest that endosulfan exposure in male children may delay sexual maturity and interfere with sex hormone synthesis."[47] Increased incidences of cryptorchidism have been observed in other studies of endosulfan exposed populations.[48]

A 2007 study by the California Department of Public Health found that women who lived near farm fields sprayed with endosulfan and the related organochloride pesticide dicofol during

the first eight weeks of pregnancy are several times more likely to give birth to children with autism. This is the first study to look for an association between endosulfan and autism, and additional study is needed to confirm the connection.[49] A 2009 assessment concluded that epidemiology and rodent studies that suggest male reproductive and autism effects are open to other interpretations, and that developmental or reproductive toxicity in rats occurs only at endosulfan doses that cause neurotoxicity.[46]

Appendix 3

Retrived from encyclopedia, http://en.wikipedia.org/wiki/.24 november 2013

Eloor is a suburb of Kochi and a municipality in Paravur Taluk, Ernakulam District in the Indian state of Kerala, India. It is an industrial area north of Cochin. It is an island of 14.21 km² formed between two distributaries of river Periyar and is the largest industrial belt in Kerala.

Economy

There are more than 247 industries of different kinds *e.g.*, Fertilisers and Chemicals Travancore (FACT), Travancore Cochin Chemicals, Indian Rare Earths Limited, Hindustan Insecticides Limited (the world's largest manufacturer of DDT) and many others manufacturing a range of products like chemical-petrochemical products, pesticides and insecticides, rare earth elements, rubber processing chemicals, fertilizers, zinc/chromium compounds and leather products.

As a result of its heavy industry, the town also suffers from heavy pollution, and is rated as one of the toxic hotspots of the world by Green Peace International.[1] Kuzhikkandam Thodu the most dirty toxic spot in India.

Appendix 4

Retrived from The Hindu News, 14 september 2011

In a unique proposal aimed at involving local communities in anti-pollution initiatives, the Kerala State Pollution Control Board (PCB) plans to introduce a check-post in the Eloor-Edayar industrial area to curb illegal dumping of chemical and other hazardous effluents into water resources.

Highly placed sources in the board told *The Hindu* on Monday that select members of the local population would be involved in the drive, aimed at stepping up community involvement in programmes against pollution. Activists of environmental organisations and senior officials of the board would soon meet to chalk out the details of the proposal.

The objective is to encourage fishermen, farmers, and other local people to monitor rivers to spot pollution.

They will be appointed environmental surveillance wardens, with powers to report dumping of hazardous and other wastes in rivers.

The board is also considering a recommendation by the Supreme Court that members of an alert and informed community who were fully aware of the nature of hazardous waste and its impact on their health could help in protecting and saving natural resources.

Proposals

The sources said the proposal would include recommendations made by a high-power committee of the apex court that had referred

to a law enacted in the U.S. in the wake of the Bhopal gas tragedy, the Emergency Planning and Community Right to Act, 1986, that required preparation of emergency-response plans by companies with involvement of the local communities.

Senior board officials said the funds for maintaining the check-post would be collected from the industrial units in the Eloor-Edayar industrial area. Members of the local communities would receive salary and other benefits for participating in the drive.

The decision to set up the check-post is part of the efforts being made by the board to evolve a permanent mechanism for monitoring the Periyar river round the clock. Stringent action will be taken against those who dump septic tank waste in water bodies.

Appendix 5

Retrieved from The Hindu News, 29 august 2007

KOCHI: A study has shown that vegetables, fruits and poultry grown on residents' lands in the industrially polluted Eloor-Edayar area have high levels of pesticide and heavy metal residues that are harmful to human health.

Residues were found in food articles such as milk, fish, chicken and duck meat, coconut, banana, papaya, curry leaves and a host of other items produced by Eloor residents in their homes and backyards. The study, prompted by the complaints of heavy environmental pollution caused by the chemical factories in the area, was conducted by the Cochin University of Science and Technology (Cusat) and the NGOs – Periyar Malineekarana Virudha Samiti and Thanal – under the supervision of N. Chandramohan Kumar, head of Cusat's Chemical Oceanography Department.

"We wanted to verify the locals' complaints of contamination of their land and water bodies through a scientific study," Dr. Chandramohan Kumar, said.

The study, which used only food items produced in the area, showed that there were 'unacceptably high levels' of heavy metal contamination in these food items. The levels of lead, cadmium, zinc, chromium and nickel were very high in the samples used for the analysis.

For instance, in the samples of curry leaves there was 2.364 mg/kg of cadmium; 584.2 of zinc, 8.044 lead and 5.433 of nickel. In chicken liver, the residues of these metals were 1.388, 42.88,

4.0,0.715 and 0.255 respectively. In the milk samples, there were 8.72 mg per litre of chromium and 2.688 of zinc.

"These metal residues had got into the foods from the contaminated soil of Eloor," Dr. Chandramohan Kumar said.

"The heavy metal and pesticide residues are much higher than the tolerance limits prescribed by the World Health Organisation and the Kerala State Pollution Control Board (PCB)."

C. Jayakumar of Thanal said the levels of organochlorine pesticide such as DDT, DDE, DDD and BHC were 'alarmingly high' which, had it been in Western countries, could have warranted immediate relocation of the residents.

He pointed out that BHC (benzene hexachloride) production had been banned in India way back in 1996. But in the chicken fat extracts examined for the study, the BHC level was found to be 0.372 mg/litre. "There is only one way of getting BHC into the poultry — from a possible leak in the HIL's (the public-sector Hindustan Insecticide Limited) underground storage tanks."

The study confirmed the fears of local residents, environmental activists and scientists that the industrial effluents let out by the chemical factories in the Eroor-Edayar area had got into the food chain. The study outcome was expected to trigger extensive investigations by scientific bodies as well as Government agencies such as the PCB.

Appendix 6

Retrived from The Times of India September 10 2003

Diseases like cancer, congenital birth-defects, bronchitis, asthma, allergic dermatitis and stomach ulcers were found to be extremely common in Eloor, according to a cross sectional epidemiological study conducted by Greepeace and medical teams from Occupational Health and Safety Centre, Mumbai, Manu Gopalan, Toxics Campaigner of Greepeace India, told reporters.

The teams were also supported in the study by Community Health Cell, Bangalore, NIMHANS, Bangalore, and St.John's Medical College, Bangalore, he added.

According to the first level findings of the study 'status of human health at Eloor Industrual Estate, Kerala', in comparison to the lesser polluted Pindimana in the same district, the chances that Eloor citizens would contract cancer were 2.85 times higher, he said.

Children were 2.63 times at higher risk of malformation due to congenital and chromosomal aberrations and chances of children's death due to birth defects had increased 3.8 times, he said, adding death due to bronchitis at eloor was up by 3.4 times and due to asthma was up by 2.2 times.

In the light of the findings of the study, the government should take immediate actions including zero discharge in the river, clean production at Eloor and Edayar, he said.

TWO LETTERS TO GOD: AN ECOFEMINIST READING

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Abstract

This paper attempts to bring two renowned writers, Sugathakumari and Alice Walker in to one platform to compare their ecofeminist attitudes as revealed in their selected letters. An intimate direct disclosure as it is, the reading of the letters shall be an 'open sesame' to the conscious and even unconscious revelation and concealment in the musings of the writers. The letters that unfold the milieu of the writers and characters, looked upon from an ecofeminist perspective in this paper highlight the politics of the discourse undertaken by both writers. The Black American woman writer, Alice Walker and our regional language poet, Sugathakumari are analogous in recognizing their individuality, their compassion for the poor and the oppressed, their social commitment as revealed in their activism as well their writings and their sensibility to tax the maximum of the genre they choose for the purpose. Both writers establish their strong individuality without any veil through their medium, the letters. As the writer of a letter, Walker deliberately becomes an authoritative voicing of the oppression suffered by black women in a racist and patriarchal society and designs the entire novel as a democratic historical source. The novel also optimistically turns out to portray a world free of gender distinctions governed by cultural, ethical and mutual interdependency. Sugathakumari's letter brings out the apprehensions of an empathetic social activist and it is a powerful impersonal lash at the authorities under the guise of a harmless address to God through an open medium.

Key words: Ecofeminism, the concept of 'God', 'letter' as a genre, oppression

Ecofeminism is a discourse which aims at human liberation and planetary survival by politically resisting institutions, economic structures and daily activities that assert their domination and pose threat to all life on earth. Academically, ecofeminism "seeks to identify, critique, and overthrow ideological frameworks and ways of thinking, such as value-hierarchical dualistic thinking, that sanction ecological degradation and the oppression of women" (Elizabeth Carlassare, 220). This paper attempts to bring two renowned writers, Sugathakumari and Alice Walker in to one platform to compare their ecofeminist attitudes as revealed in their selected letters.

An intimate direct disclosure as it is, the reading of the letters shall be an 'open sesame' to the conscious and even unconscious revelation and concealment in the musings of the writers. The power of the 'letter' as a genre in energizing the intended endeavour is explored by taking letters addressed to God written by an eminent environmentalist and a world famous womanist to incite the conscience of humans.

The timeless quality of letters is evoked by the renowned American poet Emily Dickinson when she writes," A letter always feels to me like immortality because it is the mind alone without the corporeal friend" (314). The letter as a personal missive addressed to a particular recipient, is an old form which dates from antiquity and has become the germinating ground for various new genres like newspapers, scientific studies and even modern novel because of its particularity and sharp attention to place and character. While writing to or about others, unknowingly the writer joins events and relationships together as a kind of dynamic logic--- a dialectic—of personal texts which over time, reveals patterns of choice and

characterization , thus forming a distinct way of representing self and others. In course of time these letters, the representations of the writers' personal presence in the wider world of the written word typical of their time and place become the most democratic of historical sources.

Using the form, sometimes the writer of a letter takes on a social identity and speaks with the particular authority or emotional intensity conferred by embracing the form as his or her own. This attitude of the writer attains its peak note when the form of a letter is used as a public medium for social criticism and rhetorical exhortation. A specimen of such a letter is Sugathakumari's *Letter to Guruvayoorappan*. Most writers have an irrepressible urge to express themselves beyond the limits of any given form, fitting the form to their own intentions, arguments or mood as they struggle to give expression to the relationships and events of their lives. The Afro-American writer   Alice Walker's characterization of Celie in her most famous novel *The Color Purple* is such an instance. The opening and closing letters addressed to God in this epistolary novel are selected for the analysis in this study.

A letter addressing God implicitly asserts how the voice fails to reach the ears of those around; and the desperate state of the speaker to pour out the pangs. Explicitly what is sought for is expression, communication and action in this world itself. Two socially committed writers address their Gods sitting at two distant places with a gap of only a few years, three decades ago. A recounting of the relevance of the content of these letters even in our times admirably highlight the visionary poet in them.

The letters that unfold the milieu of the writers and characters, looked upon from an ecofeminist perspective in this paper highlight the politics of the discourse undertaken by both writers. A social as well as political movement, Ecofeminism attempts to unite environmentalism and feminism with the argument that a relationship exists between the oppression of woman and the degradation of nature. Ecofeminists fix that the connection between women and nature is because of their shared history of oppression by a patriarchal society. The social, moral, ethical, feminist, cultural and political ideologies governed by man are identified and examined in their onward journey to tame the various issues that come under their purview. The ultimate aim of ecofeminists is to create a world without gender distinctions, where the hierarchy of domination is to be replaced by cultural, ethical and mutual interdependency.

Alice Malsenior Walker (born on February 9, 1944 in Eatonton, Georgia, to sharecropper parents, Willie Lee Walker and Minnie Tallulah Grant) who is recognized as one of the leading voices among black American woman writers, has produced an acclaimed and varied body of work, including poetry, novels, short stories, essays and criticism. Sugathakumari is an Indian poet – activist, born in 1934, who has been at the forefront of environmental and feminist movements in Kerala. She writes profusely in her mother tongue, Malayalam and is a familiar name to every Keralite. She is equally noted for her romantic poems tending to spirituality and poems penning the plights of life. Even in flights of fantasy she remains a down to earth poet. The writings of Alice Walker portray the struggle of black people throughout history, and are praised for their insightful and riveting portraits of

black life, in particular the struggle of black women against a racist, sexist and violent society. A lover and preserver of wild life and nature and an empathetic supporter of the suffering and the downtrodden, the poet Sugathakumari is there to lash at any ill-focused and unethical reform and development projects undertaken by the authorities. She looms large as a controversial critic of the contemporary culture of a Keralite as well.

Born to ambitious parents, Alice Walker could easily manage to get higher education. She was deeply committed to the civil rights movement working in voter registration and teaching black history in Mississipi in the 1970s. As the daughter of the freedom fighter and poet, Bodheswaran, Sugathakumari has witnessed the evolution of Kerala State, and the hard task of bringing a united consciousness to the different areas of Travancore and Kochi. She has been aware of the ups and downs of political stability, the creeping up of corruption and hypocrisy in the social spectrum and the gradual formation of a Keralite consciousness. Walker's revolutionary zeal has ever since the Seventies been reflected not only in her writings but also in her active involvement in environmental, feminist/womanist causes and issues of economic justice. Though Sugathakumari made a shy and hesitant entry into the realm of literature as a young girl hiding behind her pseudonym 'Sreekumar', she has gradually evolved out into the dynamic figure of a socially and morally committed speaker, writer and environmental activist.

Sugathakumari respects her God as the powerful creator of the universe, omniscient, omnipresent and omnipotent. A romantic poet as she is, she witnesses the presence of God in the mightiness of nature. She profusely and untiringly writes about Kanna who is

ever accompanying his Radha. A sensuous lover later transformed into a sincere guide in life, Krishna is portrayed in her poems as a liberator and protector of the suffering lot, women and the poor people. To Alice Walker, God is bereft of any race or gender and cannot be envisioned at all. God is absolutely interior, a matter of responsiveness, affirmation, love. Since it is inside, It includes Everything. The poet Sugathakumari considers her poems as offerings to her intimate God, lord Krishna. In his preface to Sugathakumari's *Krishna kavithakal* Vishnunarayanan Namboothiri speaks of the poet bearing 'mayilppeeli' and 'chakra', the symbols of Krishna even when she fights as a single army to reclaim the green environment which is fast vanishing from the face of this earth.   In their saga of recovering the lost self, many of Walker's characters accomplish the transformation, internalization, possession, and negation of God. In her most famous novel *The Color Purple*, when the story progresses, the concept of god is detached from one that of patriarchal oppression or one that is absent and distant to a 'close and familiar' 'It' which embraces Everything.

Sugathakumari is a poet with an unerring vision of life. Very much conscious about the social and environmental issues in the contemporary world, she is in the forefront of many activist protests waged in this regard all over Kerala. With constant exhortations to 'rise and act' to her fellow sisters she gives them every warning against all the cheating grounds of women in society. Walker calls herself a " 'womanist'- one who appreciates and prefers woman's culture , strength, emotional flexibility and at the same time remain a bold, brassy universalist committed to the survival and wholeness of entire people, male and female"(Evelyn C. White   377).   While

Walker's works speak strongly of the experiences of black women, critics have commented that the messages of her books transcend both race and gender. This writer continues not only to write but to be active in environmental, feminist/womanist causes and issues of economic justice. Sugathakumari has undertaken various projects to extend shelter and support to the little children and aged people who have no claimants around. With her humanitarian works she gains a social identity to become the voice of the downtrodden masses, an assertion of her Self. Unlike her, Alice Walker is a representative of the oppressed class, doubly oppressed as black as well as woman. But they possess many analogous attitudes. Both represent the epitome of the woman who has discovered her inner potential and has radiated it to her fellow beings, thus proving her social commitment. Both combine in themselves, activism and spirituality, remembrance of the heritage and keenness about the future.

Both the writers are very much gender conscious and individually rebel against any kind of feeling of being inferior to the 'other'. They could identify their powerful sensibilities and fuel them to their persuasive social commitment. Alice Walker grew up in a racial environment though not much typical. When in an accident in which she lost the sight of her right eye in her eighth year and until for the next six years after which the scar was removed permanently, Walker led the life of an introvert. But once she entered the college her writing, which had started when she was still a child increased in volume and quality and began to be recognized by prestigious prizes and fellowships. She recognized her innate potential and became an active worker, deeply committed to the civil rights movement. Her controversial 1982 novel *The Color Purple* deals with the black experience as Walker

has perceived and experienced it, especially the black woman's experience, wherein she finds black women to have been essentially victims, not only of racists, but of men in general and black men in particular. Their victimization was not just physical, there have been attempts to stifle all aesthetic creativity in them. For Sugathakumari the experience of gender and social inequalities is an empathetic sensitivity unfolded to a poet at heart. Her voicing the causes of the victims of political, social and physical brutalities gives her the stamp of a unique voice in the cultural spectrum of Kerala. Though the insensitive, unconcerned chauvinism tries to make her a cliché and forget the cries raised by her, the flooding of more environmental, social and woman issues into the 'God's own country's arena reinforces her towering figure as a very sensible and devoted worker with a vision for the preservation of the planet at large.

Forty years ago on 3 January, 1978 the leading weekly *Kerala Kaumudi* published **A letter to Guruvayoorappan** written by Sugathakumari. The magazine *Yukthirekha* on May 2008 published this letter once again with a note expressing their apprehensions that the poignant questions raised by Sugathakumari thirty years ago had not lost their relevance at that time. Though ten years have passed since then, those questions still exist with the same lustre, glaring and alarming. This letter which is undoubtedly a democratic historic source affirms through its distinct dialectic how the writer establishes her personal presence in the wider world. Also the writer snatches every power of the genre to project her evolving social identity as a speaker and authority of the times. Her letter is a plea to the society to protest against the hypocrisy of the authorities to gold plate the God's sreekovil, amidst the numerous

miseries of people in and around the place. Declaring her staunch devotion to the God, she urges Him to punish the corrupt bureaucracy with nightmares for having turned Him to a trade piece, his temple a flourishing business centre and her religion a blamable blemish. She closes the letter requesting the proclaimer of the Bhagavat Gita for a burning glare at the culprits and complaining whether He too is feigning sleep like the Sreepadmanabha. The rhetorical questions raised in this letter which still have contemporary significance have ingrained ecological, political, cultural, economical, religious, human and social dimensions that add more gravity to this text.   The pivotal tone of the letter is based on the assumption that religion is that which exists for alleviating the sorrows of every creature and devotion is a conglomeration of duty, responsibility and commitment to society. The plight of the starving and the homeless, the pangs of the patients due to lack of hospitals, the want of comfort stations, the pollution of the environment etc. are the burning issues of the moment. At this point, the   illogical embellishment extravaganza demands from the citizens a clamour for the re-identification of priorities.

In Alice Walker, the letter can be seen as a genre shaped so for intentional expression. An otherwise mute character, Celie pours down her plight in to the letters addressed to God and thus unknowingly establishes her personal presence in the wider world. By writing letters she regains her lost self and evolves her social identity as a speaker, in her own way shaping a distinct dialectic representing self and others. "Dear God, I am fourteen years old. –I am---I have always been a good girl. May be you can give me a sign letting me know what is happening to me" (Alice Walker 1) In her first letter to God, Celie recounts her rape at the hands of her Pa.

Celie is fourteen at the time, and she prays to God for 'a sign letting [her] know what is happening to [her]' (1). Celie's mother had grown weaker and weaker with constant child bearing. When she started refusing her husband's advances the man turned to her daughter Celie and demanded " You gonna do what your mammy wouldn't.------------ You better shut up and git used to it" (1). Throughout her life, Celie practises internalization as a compensatory technique, by writing unsent letters to God and her sister Nettie who was believed to have been dead. In her closing letter Celie addresses God, now thoroughly transformed, both internalized (as Spirit) and externalized (as Everything). "Dear God, Dear stars, dear trees, dear sky, dear peoples, Dear Everything, Dear God." (285) With this lyric, the end of *The Color Purple* proclaims the ascendancy of a new mode of national and personal identity. In a letter Celie addresses not to the god who is everything, but to the everything that incorporates godly spirit, she writes of the fulfillment of the womanist promise, as the community turns toward the future in expectation of more profit, pleasure, and satisfaction from their labour and from each other. This epistolary novel is framed at its outer edges by epigraphs that break the fiction of presence and refer us to its author. We find, on the last page of the text: "I thank everybody in this book for coming./ A.W., author and medium." Carolyn Williams makes a pertinent observation about this closing note that Walker closes the book as if it had been one long letter to the reader and that it was her signature. She adds, "When the female artist refers to her power as a 'medium', she makes a claim at once more humble and at the same time more vast than the traditional male claim. She defers to Everything, and as a consequence her voice is multitudinous, democratic, and responsive; she speaks for Everything, and as a result everyone

speaks through her" (88). The closing signature of Walker lets us reflect on the opening epigraph of the novel, "To the Spirit:/ Without whose assistance/ Neither this book/ Nor I/ Would have been/ Written." Both the scripts strikingly connects life inside and outside the text and the whole medium of epistolarity looms up as a paradigm for all creation, from the reader's perspective.

Celie, the central character in the *The Color Purple* who writes letters addressing God represents women who are isolated from one another within the patriarchal network. This isolation becomes a precondition of Celie's continued correspondence with God. She started writing to God as a substitute to confessing her sin to her mother. This choice is not made by herself but urged by the man she calls Pa who warned her, "You better not never tell nobody but God. It'd kill your mammy" (11). Also as Nettie's letter says, Celie's life made her feel so ashamed she couldn't even talk about it to God, she had to write it, bad as she thought her writing was. Sugathakumari's letter to Guruvayoorappan negates the confessional tone to a confidant we find in Celie. The former is explicitly framed as a strong purposeful address to her deity openly as a medium to bring out matters of social injustice sensitively recognized by the writer with her woman's consciousness. By writing to God, Celie is essentially writing to herself to rediscover her lost self. But as the epigraphs suggest, when we consider the whole novel as a long letter we find Alice Walker's womanly deference to everything and her transformation into a medium through which everyone speaks. By giving vent to the rage against the power structure which works with vested interest and uncaringly destroys the balance and logic of our ecosystem, Sugathakumari is adopting the 'earth healing' attitude of women.

Celie the victim of patriarchal oppression is the representative woman identified with ecosystem which also shares the history of oppression by a patriarchal society leading to the degradation of woman and nature. In the preface to the tenth anniversary edition of the novel, Walker affirms, "The real aim of the book was to explore the difficult path of someone who starts out in life already a spiritual captive, but who, through her own courage and the help of others, breaks free into the realization that she, like Nature itself, is a radiant expression of the heretofore perceived as quite distant Divine" . In *The Color Purple* , Celie's last letter closes with 'Amen', which is an enthusiastic response to 'Everything' as each incorporates godly spirit In this letter Celie writes about the fulfillment of the womanist promise and her plans to have the family reunion on July 4[th,] when the black folks celebrate each other while the white people celebrate independence from England. To Walker the treatment of ecology is internalized and spiritual, where as to Sugathakumari it is an innate realization leading to an extended response to the physical manifestations of environment. The pungent smell of the garbage loaded town, the temple getting deformed into a market place, with a flourish of business everywhere around, the inner thickets of Sabarimala being replanted with cement forests are some of the many powerful references to ecological destruction in her letter. The writer intends to caution us about this problem which shall lead to an environmental crisis in future.

The Black American woman writer, Alice Walker and our regional language poet, Sugathakumari are analogous in recognizing their individuality, their compassion for the poor and the oppressed, their social commitment as revealed in their activism as well their

writings and their sensibility to tax the maximum of the genre they choose for the purpose. But when Walker pours down her first hand experience of suffering due to racism and sexism, Sugathakumari's is an empathetic identification of a poet. In her, we see the guise of a devotee to satirise the state of affairs that prevailed in and around the temple at Guruvayoor. But when Walker's *The Color Purple* turns out to become one long letter to the Spirit, a new awareness of the numinous quality of the cosmos is invoked. The ecofeminism we visualize in Sugathakumari tends to be more of ecospirituality when it comes to Alice Walker.

Both Sugathakumari and Alice Walker establish their strong individuality without any veil through their medium, the letters. As the writer of a letter, Walker deliberately becomes an authoritative voicing of the oppression suffered by black women in a racist and patriarchal society and designs the entire novel as a democratic historical source. The novel also optimistically turns out to portray a world free of gender distinctions governed by cultural, ethical and mutual interdependency. Sugathakumari's letter brings out the apprehensions of an empathetic social activist and it is a powerful impersonal lash at the authorities under the guise of a harmless address to God through an open medium.

The fore sighted ecofeminist, the woman as healer of the Earth , women as 'survivors and champions' who refuse to become victims of oppression—all these pen pictures gain vibrant sensibility and easy acceptability in the minds of the readers, the catalyst being the form, the letter.

The contemporary popularity of these letters among readers asserts the freshness and liveliness of this intimate literary form. As

always, the letters also act as an opening to get to know more about the 'ecofeminist' self of the writers. But towering all these features, remain undeniably the power of letters to lure the reader magnetically into a compulsive reading of the work of art. This itself is the achievement of the intended endeavour—the genre, the letter.

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IMPACT OF SOCIAL ENTERPRISES (SE'S) IN THE NATIONAL ECONOMIC PROGRESS: STUDY IN THE FRAME WORK OF INDIAN ECONOMY

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Abstract

The SE's are obtainable as one of the approaches to help expansion of capacities of lively contribution and immersion. It is measured both as an managerial substitute production as a tactic of jobs, if well in emerging form, arises to enlarge as an different to the crisis of Welfare state and the market-generated disparities. This study has been done to estimate the influence of SE on the national economic growth: in the background of Indian economy. The main purpose of shepherding this investigation was to focus on SE, entrepreneurship, civic development and national economic development.

Key words: *Social Enterprises (SEs), social Entrepreneur, Entrepreneurship, Socio-Economic Growth, National Economic Growth*

1. Introduction

The social entrepreneur grants a numeral of features that distinguish SEs from other commerce proprietors and entrepreneurs by being part of businesses whose purposes are not for profit, or at least they are not a significance and exploiting. Thus, the social entrepreneurial self-employment arises whenever cooperative rather than distinct, favours the incorporation of social and economic in its corporate and delivered with a control and harmonization mechanisms based on self-governing participation (Chhabra, 2011). These features make businesses arising from SEl initiatives yield better positive effects on the economic crisis: more

and better jobs and balanced development and sustainable progress. European Union defines Social Enterprise as: an enterprise whose primary objective is to achieve social impact rather than generate profit for owners and stakeholders. It operates in the market through the production of goods and services in an entrepreneurial and innovative way, and uses surpluses mainly to achieve social goals (Anon., n.d.). India comes into view as a perfect example where SEs are flourishing and attaining considerable achievements. Studying this market can answer unanswered questions, divulge stimulating patterns and decipher obscurities of aspects that lead to the birth of this hybrid model of free enterprise. India is an astonishing country included more than 1.2 billion people and ripe with a lively and varied nous of culture. Though, more than 29.8% of India's populace – equal to the combined residents of USA and France – is living below the national poverty line (Tanvir, n.d). Whether in the metropolitan shantytowns or distant hamlet societies, large portions of Indians are not understanding their social or economic potential (Schwab Foundation for Social Entrepreneurship, n.d.).

2. Social Enterprises In India

SEs are establishments that are structured with an entrepreneurial spirit to achieve social and economic goals that take dissimilar practices according to the country laws. The peculiar feature is SEs capability to design pioneering and vibrant solutions to the hitches of unemployment and social exclusion, causative to the kind of economic development that reinforces social cohesion, which is one of the feature of sustainable development (D'Costa, 2012). SEs in Indiaare demarcated as an economic entity as a moral person established that brings composed social sector people,

united around a shared productive activity, with own business construction, aimed at enlightening the quality of life of its associates, their families and develop promise to its public, which is based on social principles of harmony, subsidiary, democracy, liberty of connotation, organization and leadership (The Guardian, 2013).

2.1 Social Scopes of Indian SEs

a) A creativity propelled by a group of citizens : SEs are the outcome of cooperative dynamics connecting people's belonging to a group that bonds a requirement or a well-defined aim, this aspect must be continued over time in one mode or another.

b) A decision-making supremacy not founded on capital ownership : This generally refers to the standard of "one member, one vote", or at least a result process in which the voting rights in the assembly holding the eventual power of decision are not circulated according to any shareholdings. (Shastri, Tripathi, & Ali, 2011).

c) A partaking nature connecting different parties tangled in the movement : Illustration and involvement of customers, the implementation of decision-making power by numerous project stakeholders and involved administration are habitually imperative features of SEs. In many cases, one of the intentions SE is to encourage consensus at the local level through economic activity (Kumar, &Sardar, 2011).

d) A restricted profit dispersal : If SEs are establishments categorized by a total responsibility of non-profit delivery, they can also be administrations such as cooperatives in

some countries have the right to dispense profits, but in a partial way - which evading behaviour to profit intensification (Rao, 2012).

e) An explicit aim to benefit the community : One of the main aims of social enterprises is to serve the community or a specific group of people. In the same vein, a feature of social enterprises is formed by their desire to promote a sense of social responsibility to the local level (Kumar, &Sardar, 2011).

3. Social Enterprises and Community Growth

The world economic directive and the instruments that have been well-known to engender and allocate well-being have produced a marked absorption of wealth in a few and therefore the inequity, dissimilarity and social exclusion. In this condition, occupational arrangements have arose that address the exact requirements of subdivisions usually excepted from expansion have not had admittance to prospects for expansion and development (Dongre, 2012). In these forms of associations are called SE. The fascinating thing is that this significant sector, which acquires dissimilar names depending on the nation and school of thought, shows an imperative role in the life and work of many people, whether decision makers, employees and unemployed. Such businesses trust on standards of unity and action based on supportive principles to complete a business on money-making terms, justifiable and competitive situation (Gill, 2012).

3.1 Positive Impact of Indian Social Entrepreneurial Activity on Country's GDP:

The prominence of the social economy in its numerous appearances and collectives in specific, goes beyond the economic quantities that are also pertinent, as well as the mass that year after year has earned impact to GDP, occupation formation, level promoting, etc.., as its utmost advantage is to become essentials of regional solidity and social driving services of economic growth and social stabilizers in rural ranges, to increase the professional with excellence service, fixed to the population on its ground, generate prosperity, advance social welfare of people and make a work of preservative landscapes and natural resources. The Social economy is for these motives, and for its part as a steadying between business fruitful and social sector, one of the key recognized segments of the Indian economy (The World Bank, 2013).

3.2 Positive Impact of Indian Social Entrepreneurial Activity on Employment Status:

In general, entrepreneurs are considered an important part of the process of job creation and growth stimulating factor as they create new businesses, generating more wealth and prosperity in the country. To enter this category, the person must possess some or all of the business or young company, including within this terminology also to the self-employed. Obviously, members of the Social Economy companies are owners, managers, shareholders, suppliers and customers of the business (Kotwal, Ramaswami, &Wadhwa, 2011). Furthermore, the effect of job-creating entrepreneurs is higher than the a priori counted in the statistics, because of the indirect effect of entrepreneurs. If a given entrepreneur is successful in its activities not only motivates others

to follow suit but also creates new opportunities for third advantage, resulting in generating higher growth and higher welfare. A greater number of Indian entrepreneurs are the creation of new companies and therefore opportunities to hire workers (Village Volunteers, 2013).

4. Indian Social Enterprises and their Good Performance

The interchange of frequent inner and outside influences that determines SEs, like any business, whether or not is effective (Village Volunteers, 2013). The subsequent are the core aspects recognized that elucidate the power and virtuous enactment of SEs that have magnificently established:

Organization: Denotes to the structural association that the business has the contribution of cohorts, levels of independent decision making, governance and consistency. Entrepreneurship, product expansion, product divergence, novelty , packaging design, collection and handling of raw materials made SEs more attractive than traditional village organisations or NGOs (Village Volunteers, 2013). Invention and usage of innovative technologies: Are SEs that have shaped and currently use a procedure or more with knowledge and technology.

- *Marketing*: These are businesses that have combined manufacture to delivery. Community Social impact, ecological incorporation with the environment, Profitability and financial consolidation, gender equity etc.. converted key attrctives of SEs (Kotwal, Ramaswami, &Wadhwa, 2011).

- *Incorporation of supply chains*: Those businesses that have combined forces to compact the offer. In spite of being countless factors that may describe successful SEs and their

influence to establishing the economy and social sector in specific, there are three factors that furthermost affect SEs improvement : product development, social impact and community organization (Kathuria, &Sen, 2013).

5. Conclusion

This study has been directed to scrutinize the circumstances and influence of Indian SEs. The focal goal of this study was to appraise the impact of SEs on the national economic progress. This study emphases SEs, entrepreneurship, civic development and nation-wide economic development. With the challenge of boosting stockholders to put money with the aim not only charitable SEs accomplished of producing funding over the opportunity of small stockholders pay a fixed rate within a sensible time.(ADB, 2012). People need to highpoint here is the paradigm shift: use the right encouragements for social market. If people suggest serious about a social market economy that overpowers the false dilemmas and extra heavy SEs will be a revolution in the discussion to where they should focus their responsiveness (Silicon India, 2012).

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CLUSTERING IN LD PREDICTION

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Abstract

The aim of this paper is to find the clusters IN ld datasets. Traditional data mining techniques such as association rule, classification and prediction, clustering, and outlier analysis identify patterns in structured data. Pediatricians are often called on to diagnose specific learning disabilities in school-age children. Mining of this database can be done for constructing certain clusters of Learning Disabilities.

Key words: Learning Disability (LD), Data Mining, clustering.

1. Introduction

In recent years the sizes of databases has increased rapidly. This has lead to a growing interest in the development of tools capable in the automatic extraction of knowledge from data. The term Data Mining, or Knowledge Discovery in databases, has been adopted for a field of research dealing with the automatic discovery of implicit information or knowledge within databases[1]. A widely accepted formal definition of data mining is given subsequently. Data mining is the non trivial extraction of implicit previously unknown and potentially useful information about data[8].

2. Learning Disability

Learning disability is a general term that describes specific kinds of learning problems. A learning disability can cause a person to have trouble learning and using certain skills. The skills most often affected are: reading, writing, listening, speaking, reasoning and doing math. Learning disabilities vary from child to child. One

child with LD may not have the same kind of learning problems as another child with LD. There is no "cure" for learning disabilities. They are life-long. However, children with LD can be high achievers and can be taught ways to get around the learning disability. With the right help, children with LD can and do learn successfully.

As many as 1 out of every 10 children in the United States has a learning disability. Almost 3 million children (ages 6 through 21) have some form of a learning disability and receive special education in school[3]. In fact, over half of all children who receive special education have a learning disability[2]. There is no *one* sign that shows a child has a learning disability. Experts look for a noticeable difference between how well a child does in school and how well he or she *could* do, given his or her intelligence or ability. There are also certain clues, most relate to elementary school tasks, since learning disabilities tend to be identified in elementary school that may mean a child has a learning disability. A child probably won't show all of these signs, or even most of them. However, if a child shows a number of these problems, then parents and the teachers should consider the possibility that the child has a learning disability. If a child has unexpected problems to read, write, listen, speak, or do math, then teachers and parents may want to investigate more. The same is true, if the child is struggling to do any one of these skills. The child may need to be evaluated to see, if he or she has a learning disability.

When a LD is suspected based on parent and/or teacher observations, a formal evaluation of the child is necessary. A parent can request this evaluation, or the school might advise it. Parental consent is needed before a child can be tested. Many types of assessment tests are available. Child's age and the type of problem determine the tests that the child needs. Just as there are many different types of LDs, there are a variety of tests that may be done to pinpoint the problem.

A complete evaluation often begins with a physical examination and testing to rule out any visual or hearing impairment[5]. Many other professionals can be involved in the testing process.

The purpose of any evaluation for LDs is to determine child's strengths and weaknesses and to understand how he or she best learns and where they have difficulty. The information gained from an evaluation is crucial for finding out how parents and the school can provide the best possible learning environment for child.

3. Data Mining Techniques

Data Mining is an analytic process designed to explore data in search of consistent patterns and/or systematic relationships between variables, and then to validate the findings by applying the detected patterns to new subsets of data[8]. The ultimate goal of data mining is prediction[5]. In this paper association rules in data mining are used to find the frequent behavior of LD.

Classification is a form of data analysis that extracts models describing important data classes. Such models called classifiers and predict categorical class labels. Classification consists of two step process. In the first step, a classification model based on previous data is build. The model describes a predetermined set of data classes or concepts [1]. This is the learning step or training phase, where a classification algorithm builds the classifier by analyzing or learning from training sets made up of database tuples and their associated class labels. In the second step, the accuracy of classifier is determined by using the model to classify new data. Using this model, first the predictive accuracy of the classifier is estimated by the help of a test set made up of test tuples and their associated class labels. The accuracy of a classifier on a given test set is the percentage of test set tuples that are correctly classified by the classifier.

4 Clustering

This study consists of using K-means algorithm in creating the clusters of LD. Clustering is a tool for data analysis, which solves classification problem [35]. Its object is to distribute cases into groups, so that the degree of association to be strong between members of same clusters and weak between members of different clusters. This way each cluster describes in terms of data collected, the class to which its members belong. Clustering is a discovery tool. It may reveal associations and structure in data which though not previously evident. The results of cluster analysis may contribute to the definition of a formal classification scheme. Clustering helps us to find natural groups of components based on some similarity. Clustering is the assignment of a set of observations into subsets so that observations in the same cluster are similar in some sense. Clustering is a method of unsupervised learning, and a common technique for statistical data analysis used in many fields, including machine learning, data mining, pattern recognition, image analysis and bioinformatics.

4.1 Classification by clustering

In clustering, using the k-means algorithm for classifying LD, the clustered instances are classified into two, viz. LD - Yes and LD - No. The K-means algorithms iterates over the whole dataset until convergence is reached.

4.2 Methodology and results

The K-means algorithm is a most well-known and commonly used partitioning method. It takes the input parameter, K, and partitions a set of N objects into K clusters so that the resulting intra-cluster similarity is high but the inter cluster similarity is low [36]. When clustering a dataset, the right number k of clusters to use is often not obvious, and choosing k automatically is a hard

algorithmic problem [37]. Cluster similarity is measured in regard to the mean value of the objects in a cluster [20]. The working of algorithm is like it randomly selects the K objects, each of which initially represents cluster mean or center. For each of the remaining objects, an object is assigned to the cluster to which it is the most similar, based on the distance between the objects and the cluster mean. It then computes the new mean for each cluster. This process iterates until the criterion function converges.

An important step in most clustering is to select a distance measure, which will determine how the similarity of the two elements is calculated. This will influenced the shape of the clusters, as some elements may be close to one another according to one distance and farther away according to one another. Another important distinction is whether the clustering uses symmetric or asymmetric distances [20]. Many of the distance function have the property that distances are symmetric. Here, we are using the binary variables. A binary variable has two states 0 or 1, where 0 means that variable is absent and 1 means that is present. In this study, we use the partitioning method K- means algorithm, where each cluster is represented by the mean value of the objects in the cluster. In this partitioning method, the database has N objects or data tuples, it constructs K partitions of the data, where each partition represents a cluster and it classifies the data into K groups. Each group contains at least one object and each object must belong to exactly one group. The clustering results obtained by us are shown in Table 4.18.

Table 4.18 Clustering results

Particulars	LD=0 (No)	LD=1 (Yes)
Clustered instances	525 Nos. 51.47%	495 Nos. 48.53%

The clustering history indicating LD = No and LD = Yes is shown in Table 4.19 and the cluster visualizer is shown in Figure 4.7 [38].
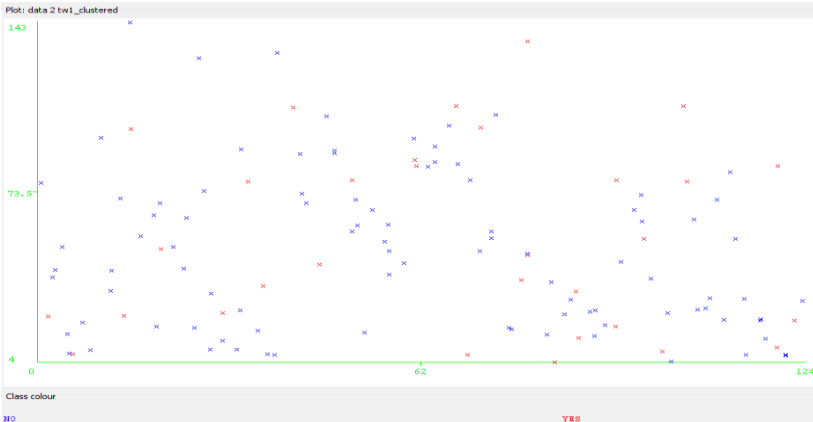
Figure 4.7 Cluster visulizer

Table 4.19 Clustering history

Sl. No	Attributes	Full Data (1020)	LD = 0 (No) (525)	LD = 1 (Yes) (495)
1	DR	0.7775	0.5676	0.9996
2	DS	0.7373	0.5105	0.9773
3	DH	0.1549	0.0210	0.2967
4	DWE	0.7176	0.5771	0.8664
5	DBA	0.2333	0.0667	0.4097
6	DHA	0.2235	0.0533	0.4037
7	DA	0.4402	0.2800	0.6098
8	ED	0.4833	0.1162	0.8719
9	DM	0.4049	0.0629	0.7669
10	LM	0.4490	0.0571	0.8638
11	DSS	0.4029	0.0229	0.8052
12	DNS	0.1206	0.0038	0.2442
13	DLL	0.5873	0.5162	0.6625
14	DLS	0.0853	0.0648	0.1070
15	STL	0.5353	0.1867	0.9043
16	RG	0.0912	0.0762	0.1070
No. of iterations				3
Within cluster sum of squared errors				2367.217653
Missing values globally replaced with mean/mode				

4.3 *Review of this work*

In this study, we are used 1020 data sets with 16 attributes. The k means algorithm in clustering classifies the data set into LD - Yes and LD - No. The main drawback of this algorithm is that the noisy or unwanted data are present in each cluster. So it is found that by removing the unwanted data at the pre processing stage, we can improve the accuracy of the unsupervised classification k-means clustering

5. Conclusion

In this paper we consider an approach to handle learning disability database to predict frequent symptoms of the learning disability in school aged children. This study mainly focus on association rule mining, because accuracy of decision making can be improved by applying these rules, however, the study can be extended by applying clustering method also. For the prediction of learning disability, we are using a checklist. This checklist contains numerous amount of signs and symptoms of LD. Since LD consists of different types, the prediction is very difficult. We are using those types of rules which are very helpful for finding the frequent symptoms and prediction of LD. This study has been carried out on data sets with most of the attributes takes binary values and more work need to be carried out on quantitative data as that is an important part of any data set. In future, more research is required to apply the same approach for large data set consisting of all relevant attributes. A true comparison of the proposed approach is possible only by applying it to large datasets and analyzing the completeness and effectiveness of the generated rules.

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COMPARATIVE STUDY OF CHITINASE PRODUCTION BY THREE BACTERIAL ISOLATES BY SOLID-STATE FERMENTATION

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Abstract

Chitinases (EC 3.2.1.14) are enzymes which can hydrolyze chitin to its oligomeric, dimeric and monomeric components. Chitinase producing bacteria were isolated based on the zone of clearance around the colonies and also on the basis of assay of chitinase. Separate screening procedure was employed for selection of high yielding strains under solid-state fermentation (SSF). The detailed SSF studies were carried out with the strains Mb126, Mb14 and Ch135 for different incubation periods and using media with different moisture content. Mb126 produced highest amount of chitinase (74.6 U/gds) after 72 h incubation with medium having 75% moisture content. The yield of Mb14 and Ch135 were comparatively low (32.6 U/gds, 29.5U/gds respectively). The isolate Mb126 was identified as Kurthia gibsonii.

Key words*: Kurthia gibsonii, solid-state fermentation, Chitinase, shellfish waste.*

Introduction

Chitin is the second most abundant biopolymer in nature next to cellulose (Gooday, 1995). Chitin is absent in prokaryotes. Chitin is present in the cell wall of fungi and its presence is used as a criterion for fungal taxonomy. Chitin is present in walls of some ciliates, amoebae, chrysophytes and algae and in the spines of diatoms. Chitin is found as a structural component of arthropods, nematodes and mollusks and in the gut lining and exoskeletons of insects (Muzzarelli, 1977).

Chitinases (EC 3.2.1.14) are enzymes which can hydrolyze chitin to its oligomeric, dimeric and monomeric components.

Chitinases have broad spectrum of distribution in nature including bacteria, fungi, plants, insects, protozoa, human and yeasts. Microbial chitinases are usually involved in mineralization of chitin, nutrition and parasitism.

Chitinolytic marine bacteria play a critical role in the process of recycling of chitinous materials such as the exoskeleton of crustaceans and insects. If the insoluble form of chitin could not be returned to the ecosystem in a biologically usable form, the marine environment would be completely depleted of carbon and nitrogen source in a relatively short time (Yu et al., 1991). The cost of chitinase production represents an important part of the total cost of bioconversion of chitin; there is necessity to develop bioprocesses with reduction in the cost of the production. Production of chitinase by solid substrate fermentation (SSF) using prawn shell waste as substrate will reduce the production cost and will be helpful in minimizing the environmental problems created by this waste. Solid substrate fermentation (SSF) holds tremendous potential for the production of enzymes. Production of this biocatalyst using agro-biotech substrate under solid substrate fermentation and conditions provide several techno economic advantages. SSF has several advantages over SmF system such as higher concentration of products, less effluent generation, requirement for simple equipments, etc [Pandey, 2000].

The purpose of this work was to study the production of chitinase by three bacterial isolates by solid-state fermentation using prawn shell as substrate.

Materials and methods

Sample collection

Soil samples were collected from the premises of prawn peeling units in the coastal areas of Kochi in Kerala. The samples

were taken from 2 to 3 cm depth using sterile spatula and put in clean plastic bags. The mouth of the bags were tied properly and brought to laboratory for further processing.

Preparation of substrate

Prawn shell waste was collected from shellfish processing units in Kochi, Kerala. The waste was then sun dried, milled into small pieces of uniform size (0.4 mm).

Screening for chitin degradation (Primary screening)

Five grams of soil was added to 250 mL flask containing 100 mL 1% suspension of dried and milled prawn shell waste in water. After incubation for five days at 37 °C the suspension was plated onto a screening medium (pH 7.5) containing (%, w/v): prawn shell powder, 1 g and agar, 2 g. The plates were incubated at 37 °C for 48 h. Chitinase producing bacteria were selected for further studies based on the zone of clearance around the colonies. The bacteria were subcultured and maintained in nutrient agar slants at 4 °C. The bacteria which showed zone of clearance of 1.5 cm or above around the colonies were selected for testing the yield of chitinase. Two chitinolytic MTCC strains, MTCC 1688 (*Pseudmonas aeruginosa*) and MTCC 2387 (*Bacillus subtilis*) were included for comparison.

Selection of high yielding strains.

Selection of high yielding strains was done by SSF in two steps.

Step 1 Preliminary studies

10 g of substrate was taken in a 250 mL Erlenmeyer flask to which 20 mL of mineral salt solution containing (g/L): KH_2PO_4, 2; NH_4NO_3, 10; NaCl, 1 and $MgSO_4.7H_2O$, 1 was added. After sterilization at 121 °C for 20 min, it was then inoculated with 1mL of overnight grown nutrient broth culture ($3x10^7$ CFU/mL) and

incubated at 37 °C for 24 h. After incubation the fermented solid substrate was mixed with 50 mL of distilled water in rotary shaker for 1 h. The suspension was then centrifuged at 8000 rpm at 4 °C for 10 minute and the supernatant was assayed for enzyme activity.

Chitinase assay

1 mL of the supernatant was mixed with 1 mL of prawn shell powder in 0.05 M phosphate buffer (pH 7) and incubated for 1 hour at 40 °C. The end products were analyzed by DNSA method [Miller, 1959]. One unit of chitinase was defined as the amount of enzyme that liberated one micromole of N-acetyl Glucosamine per mL per minute under the experimental condition. Dry mass of the substrate was determined by drying in a hot air oven at 80 °C to a constant weight. The enzyme activity was expressed in terms of units/gram dry substrate (U/gds). Dry weight of the substrate was determined by drying it in a hot air oven set at 80 °C till a constant weight was obtained.

Percent moisture content of the solid substrate was calculated as follows, Percent of moisture content

$$= \frac{\text{(wt. of the substrate - dry wt.)}}{\text{dry wt.}} \times 1OO$$

Step 2 - Detailed solid substrate fermentation studies (Selection of high yielding strain).

Mb 14, Mb126 and Ch135, the three highest yielding strains found during the preliminary studies, were tested further with different moisture levels (Substrate:moistening solution ratios - 1:1, 1:1.5, 1:2, 1:2.5) and incubated for different periods (48, 72, 96 and 120 h). Enzyme activity was assayed as in the preliminary studies.

Identification of bacterium

The cultural, morphological, physiological and biochemical properties of the highest chitinase yielding bacterium (Mb126) were studied as part of the identification. Identification was done according to the guidelines in *Bergey's Manual of Systematic Bacteriology* (Holt et al., 1986). The results were also confirmed by 16S rRNA gene sequence based molecular identification. For this isolation of genomic DNA and PCR were conducted as per methods described by Sambrook et al. (1986).

Results

Preliminary SSF studies

In preliminary studies 15 bacterial isolates which produced clear zones having the width of >1.5cm on prawn shell power plates were included. The activity shown by the three high yielding strains are shown in Table 1. Activities shown by the MTCC strains are also given for comparison.

Table 1. Chitinase production by top three high yielding strains and MTCC Strains in preliminary SSF studies.

Strains	Chitinase Production (U/Gds) ± Sd
Mb126	72.7 ± 2.570
Ch135	32.6 ± 1.020
Mb14	22.3 ± 0.000
MTCC1688	13.5 ± 0.000
MTCC 2387	24 ± 2.0400

Highest yielding strain was Mb126. The yields of other strains were comparatively lesser. Lower activities were shown by the MTCC strains. The chitinase production by these strains varied from 13 U/gds to more than 72 U/gds.

Detailed SSF studies

Three isolates were selected based on the yield of chitinase and subjected to secondary screening. Chitinase yield by the selected strains in medium with different moisture content after incubation for different time periods are shown in Table 2.

Table 2 Chitinase production by the high yielding strains in solid substrate fermentation systems with different moisture levels, incubated for different periods.

Bacterial strain	Prawn shell powder (weight in gram): mineral salt solution (volume in mL) ratio	Chitinase production when incubated for different periods (U/gds)			
		48 h	72 h	96 h	120 h
Mb126	1:1	41	46.4	31.6	8.7
	1:1.5	53	58.7	23.6	10.2
	1:2	67.67	72.7	36.8	15.6
	1:2.5	73.65	74.6	43.5	32.5
Ch135	1:1	23.4	25.3	25.67	3.4
	1:1.5	11.4	21.4	25.7	4.7
	1:2	23.7	32.6	19.5	18.9
	1:2.5	13.4	14.5	22.4	2.5
Mb14	1:1	3.9	12.5	4.5	3.9
	1:1.5	12.67	6.6	17	11.3
	1:2	15.8	22.3	12.42	12
	1:2.5	11.8	24.5	29.5	15.7

Identification of bacterium

As per the *Bergey's Manual of Systematic Bacteriology* (Holt et al., 1986**)** the bacterium was identified as *Kurthia gibsonii*. The partial 16S rRNA gene sequence of the isolate has been deposited in the GenBank data base (No. JN637370). A BLAST analysis of the 16S rRNA gene sequence against NCBI nucleotide database revealed 99% identity with *K. gibsonii*.

Discussion

Solid substrate fermentation has numerous advantages such as superior productivity, simplicity of technique, low capital investment, low energy requirement, low waste water output, improved product recovery and elimination of foam problems. Solid substrate fermentation may be used advantageously for enzyme production, especially in those cases where the crude fermented product can be used directly as enzyme source; as for agro biotechnological applications. However some limitations are there such as heat build-up, bacterial contamination, problems in scale up and difficulty in the control of the moisture level of the substrate. Separate screening procedure was employed for selection of high yielding strains under SSF. Procedures of preliminary SSF studies were simple and easy to perform. Arbitrarily selected conditions supposed to be suitable for most of the strains were provided in preliminary SSF studies. In this study the highest yielding strain was Mb126.

The detailed SSF studies were carried out with the strains Mb126, Mb14 and Ch135 for different incubation period and using media with different moisture content. Moisture level was a critical factor influencing the solid state fermentation. Mb126 produced highest amount of chitinase (74.6 U/gds) after 72 h incubation with medium having 75% moisture content. The yield of Mb14 and Ch135 were comparatively low (32.6 U/gds and 29.5U/gds respectively). Though there are several reports on SSF systems for the production of fungal chitinases (Binod et al., 2005., Nampoothiri et al., 2004; Suresh and Chandrasekaran, 1999.) reports on solid substrate fermentation for the production of chitinases from bacterial sources are limited, except from bacteria such as *Enterobacter* sp. NRG4 (Dahiya et al., 2005) and *Oerskovia xanthineolytica* NCIM 2839 (Shailesh et al., 2011). Mb126 showed stability in chitinase yield and it was used for further studies. In

addition, identification of the isolate Mb126 was also carried out, as it was essential to establish the novelty of the isolate. Various physiological and biochemical tests were carried out as outlined in the *Bergey's Manual of Systematic Bacteriology* (Holt et al., 1986). Results of the above tests have revealed that the isolate Mb126 is *K. gibsonii* and the identification was confirmed by 16S rRNA sequencing. Although chitinase production has been reported in other bacteria such as *Bacillus amyloliquefaciens* (Sabry, 1992), *Bacillus circulans* (Chen et al., 2004), *Chitinimonas taiwanensi* gen. nov. sp. (Chang et al., 2004), *B. thuringiensis* sub sp. *kurstaki* (Driss et al., 2005) and *Serratia marcescens* (Kannan and Ramachandra, 2010), the production of chitinase by *K. gibsonii* under solid state fermentation has not yet been reported. Solid substrate fermentation may be used advantageously for enzyme production, especially in those cases where the crude fermented product can be used directly as enzyme source; as for agro biotechnological applications.

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PRICE VOLATILITY OF MAJOR FOOD CROPS IN KERALA

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Abstract

Commodity prices play an important role in the determination of the well being of the society and economic development of the country. A moderate volatility in the price is acceptable and desirable for an economy. But the frequent fluctuations in the price of essential food items adversely affect the living standard of weaker and vulnerable sections of the society. From the mid 2008 onwards, India is facing the issue of rising general price level which is known as inflation. As being a state of India, Kerala is also suffering from the disturbing trend of high food price. In Kerala, Consumer Price Index increased to 291 during August 2016 from 277 in the previous year. The price of essential food crops like rice, pulses, banana, coconut, tapioca, vegetables like onion, brinjal, plantain green etc. are fluctuating over the years. The present study was conducted to analyse the price volatility of important food crops in Kerala, and its relationship with the area under cultivation, production and productivity during the period 2004-05 to 2014-15. This study also investigates the relationship between Consumer Price Index and retail price of vegetables during the period 2010-11 to 2015-16. The study shows a detailed crop wise analysis of price fluctuations during the period 2004-05 to 2014-15.

Key words: Inflation, WPI, Retail price, CPI, Productivity, price volatility.

Kerala is considered as the food deficit state or consumer state due to various reasons. In Kerala, there is a downward trend in the internal production, a persistent growth in demand for essential food items which in turn affected by the increase in population growth. Therefore, always exist an imbalance between demand for and supply of essential goods. In order to meet this gap, our state

has to depend on other states like Andhra Pradesh, Tamil Nadu, and Karnataka to feed its growing population. Around 85percent of foodgrains, more than 90 percent of pulses and 57% of vegetables are importing from neighbouring states. Therefore, we can say that Kerala is the net importer of food and food products.

The agriculture sector in Kerala is having some unique characteristics. A special feature of Kerala's agriculture sector is its cropping pattern and land utilization. There is a shift in the cropping pattern from food crops to non food crops and commercial crops which have higher demand in international commodity market. In turn, it leads to the decline in the proportion of are under food crops like food grains, cereals like rice and pulses like green gram, dhal etc. One of the prominent changes that have been taking place in agriculture sector of Kerala is the underutilization of land which is the result of fragmentation of land holdings. Higher proportion of marginal and small holdings and lower proportion of large holdings is another feature of Kerala.

Kerala is also witnessing a tremendous decline in the cultivation of commodities like rice, pulses, banana, tapioca, vegetables etc. which is partly because of the decline in the area under cultivation. It is true that the changes in the cropping pattern from essential goods to non-essential goods, changes in the land utilization pattern and changes in the area under cultivation led to the decline in the production of food crops which resulted in the fluctuations of prices. With the growing population and demand, prices of commodities are also increasing day by day. In Kerala, volatile nature of commodity prices is very common which dangerously affects purchasing power of the common man. Another trend of the price fluctuations in Kerala is that percentage of

increase in the price is higher than the percentage of decrease when compared with neighbouring states.

Frequent fluctuations in the commodity prices especially of food and food products, negatively affects the standard of living of the people in general and weaker sections in particular. A moderate volatility of price is acceptable and desirable whereas the huge fluctuating nature of the prices of essential commodities is undesirable. India is passing through a heavy pressure on food price rise over the last 10 years, specifically from the mid of 2008 onwards. Hitting on food prices since the last few years have been caused major concern all around the nation. As per the Ministry of Statistics and Programme Implementation, annual inflation rate in India was 3.78 percent in August 2015 which was less than the figure of 9.6 percent in June 2011(Economic Review 2015). Till 2013, India's major concern was to curb inflation, especially of the price rise of essential commodities and food products. From 2014-15 onwards, there has been a decline in the price of both commodity and crude oil.

As being a state of India, Kerala is also facing this disturbing trend of shy rocketing of food prices. In the context of Kerala, the prices of both vegetables and meats are increasing due to the growing demand and the inadequate supply. According to Economic Review 2016, the Wholesale Price Index (WPI) of rice was 4768.35 and it increased to 6344.85 in August 2016 which is around 33 percent growth. The overall Wholesale Price Index of food crops rose from 7396.60 in August 2015 to 8033.23 in August 2016. When compared with the other states, government intervention is very low in reducing the fluctuations of commodity prices in Kerala. In this context, PDS has significant role in reducing this fluctuations.

In the determination of the wellbeing of the society and economic development of the country, commodity prices are playing an indispensable role. In this analysis, have incorporated the concept of retail price, Consumer Price Index (CPI), area under cultivation, production and productivity of important food crops in Kerala during the period 2004-25 to 2014-15. In this context try to analyse the role of area, production and productivity in the volatile nature of essential food crops in Kerala. This study reveals a detailed crop wise analysis of price fluctuations. The major food crops included in this analysis are :1) rice, 2) pulses like green gram, blackgram, red gram and dhal, 3)banana, 4)tapioca 5)coconut and 6) Vegetables. The price fluctuations of vegetables are analysed separately in Table 3, since the data for the same is not available during the period 2004-05 to 2009-10.

Average Retail Price

Retail price of a commodity defined as the price which ultimate consumer pays for relatively small transactions of the commodity (Economic Review 2012). To assess the impact of inflation on consumers, retail price is very useful than Wholesale Price Index. Average retail price of rice, pulses, banana, tapioca and coconut are shown in Table 1 and Table 2 and retail price of vegetables are shown in Table 3.

Table 1

(a) Average retail price of important food crops in Kerala during 2004-05 to 2009-10

Item	Unit	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
1) Rice (OM) Matta	Kg.	13.50	14.03	17.67	19.76	22.89	27.15
2) Pulses							
a) Greengram	Kg.	32.60	42.16	35.55	45.80	77.45	64.01
b) Blackgram	Kg.	34.60	55.38	43.91	49.75	83.23	82.67
c) Redgram	Kg.	21.60	29.6	34.04	33.14	52.46	42.00

d) Dhal(Tur)	Kg.	33.0	34.61	46.02	51.86	89.46	70.83
3) Banana	Kg.	13.50	15.78	17.00	15.41	23.56	26.17
4) Tapioca	Kg.	6.20	6.73	7.51	8.70	8.96	14.00
5) Coconut (without Husk)	10Nos	62.58	55.71	55.06	69.93	60.75	78.90

(b) Percentage of variations of retail price of important food crops in Kerala during 2004-05 to 2009-10

Item	Unit	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
1) Rice (OM) Matta	Kg.	------	3.93	25.9	11.8	15.8	18.61
2) Pulses							
a) Greengram	Kg.	------	29.33	-15.7	28.8	69.1	-17.35
b) Blackgram	Kg.	------	60.06	-20.7	13.3	67.3	-0.67
c) Redgram	Kg.	------	37.04	15.0	-2.6	58.3	-19.93
d) Dhal(Tur)	Kg.	------	4.88	33.0	12.7	72.5	-20.83
3) Banana	Kg.	------	16.89	7.7	-9.4	51.6	11.07
4) Tapioca	Kg.	------	8.55	11.6	15.8	3.0	56.25
5) Coconut (without Husk)	10Nos	------	-10.97	-1.2	30.0	-13.13	29.87

Source: Economic Review (various issues), Kerala State Planning Board
During October (since the data on December 2010 is not available)

Table 1 contains two panels. Panel (a) shows average retail price of important food crops during 2004-05 to 2009-10. And panel (b) shows the percentage of variations of retail price of important food crops during 2004-05 to 2009-10. From table it is clear that price of all commodities are fluctuating over the years. Sharp fluctuations can be seen in the price of pulses like greengram, black gram, red gram, dhal etc. Upto 2007-08, dual trend was visible for all commodities. After 2008-09, prices of all commodities increased except coconut which registered negative trend. Highest increase was in the price of dhal (72.5%) and the lowest increase was in the price of tapioca, i.e. 3%. The percentage variation of average retail price of rice was moderate. In 2006-07, the percentage of variation of price of rice was high which showed 25.9% increase. The price of coconut shows a negative trend in all years except 2007-08 which registered 30% increase.

Table 2

(a) Average retail price of important food crops in Kerala during 2010-11 to 2014-15

Item	Unit	2010-11	2011-12	2012-13	2013-14	2014-15
1) Rice(OM) Matta	Kg.	24.44	34.64	33.21	33.89	34.26
2) Pulses						
a) Greengram	Kg.	68.04	72.27	84.16	107.13	113.50
b) Blackgram	Kg.	72.95	67.25	71.59	87.21	174.25
c) Redgram	Kg.	45.67	72.79	58.98	59.22	65.02
d) Dhal(Tur)	Kg.	69.98	79.14	78.36	85.66	171.77
3) Banana	Kg.	25.17	35.16	41.37	38.25	29.50
4) Tapioca	Kg.	14.81	14.29	26.38	19.95	18.14
5) Coconut (without Husk)	10Nos	106.10	84.33	156.79	176.06	150.23

(b) Percentage of variations of retail price of important food crops in Kerala during 2010-11 to 2014-15

Item	Unit	2010-11	2011-12	2012-13	2013-14	2014-15
1) Rice(OM) Matta	Kg.	-9.98	41.73	-4.12	2.04	1.08
2) Pulses						
a) Greengram	Kg.	6.29	6.21	16.45	27.29	5.95
b) Blackgram	Kg.	-11.75	-7.82	6.45	21.81	99.81
c) Redgram	Kg.	8.73	59.36	-18.97	0.92	9.24
d) Dhal(Tur)	Kg.	-1.2	13.09	-0.99	9.31	100.53
3) Banana	Kg.	-3.82	39.69	17.65	-7.54	-22.87
4) Tapioca	Kg.	5.78	-3.53	84.60	-24.37	-9.06
5) Coconut (without Husk)	10Nos.	34.47	-20.53	85.92	12.29	-14.67

Source: Economic Review (various issues), Kerala State Planning Board. Price Bulletin, Dept of Economics & Statistics.

Table 2 represents both (a) average retail price and (b) percentage of variations of retail price of important food crops in Kerala during the period 2010-11 to 2014-15. A mixed trend is seen in the price of all commodities except greengram. Every year, the average retail price of geengram was increasing but the rate of increase was marginal upto 2011-12 and it reached highest variation (27.29%) in the year 2013-14. The average retail price of tapioca and banana have declined by 24.37% and 7.54% respectively in 2013-14 when compared with the price of other commodities. In 2011-12, the percentage of variation of the price of rice was very high i.e. 41.73% increase was registered.

Average Retail Price of Vegetables in Kerala

The following table represents the price and percentage of variation over the years of vegetables. From the table, it is obvious that, the average retail price of vegetables shows a mixed trend over the years. The price of brinjal, cucumber, bitter gourd, snake gourd, and tomato were increasing during the period 2012-13 to 2014.15. A notable increase can be seen in the price of brinjal in 2014-15 which registered 61.57% of increase and the lowest increase was in the price of plantain green i.e. 1.18% in 2012-13.

Table 3 Average retail price of vegetables in Kerala during 2010-11 to 2015-16
(Percentage of variation of average retail price of vegetables)

Sl.No	Items	Unit	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16*
1	Onion Big	kg.	16.23	23.47 (44.60)	28.88 (23.05)	29.47 (2.04)	30.64 (3.97)	17.20 (-43.86)
2	Brinjal	kg.	19.96	21.22 (6.31)	25.36 (19.50)	32.32 (27.44)	52.22 (61.57)	27.74 (-46.87)
3	Pumpkin	kg.	14.00	14.65 (4.64)	16.66 (13.72)	17.50 (5.04)	20.36 (16.34)	18.15 (-10.85)
4	Cucumber	kg.	15.05	17.32 (15.08)	16.20 (-6.46)	19.47 (20.18)	31.15 (59.98)	17.93 (-42.43)
5	Ladies Finger	kg.	23.96	25.91 (8.13)	27.16 (4.82)	33.43 (23.08)	39.64 (18.57)	33.86 (-14.60)
6	Cabbage	kg.	18.62	17.80 (-4.40)	24.52 (37.75)	32.75 (33.56)	29.91 (-8.67)	27.41 (-8.35)
7	Bitter gourd	kg.	32.76	31.95 (-2.47)	33.98 (6.35)	39.63 (16.62)	54.61 (37.79)	42.79 (-21.6)
8	Ash gourd	kg.	14.52	16.56 (14.04)	16.54 (-0.12)	18.95 (14.75)	28.89 (52.45)	18.86 (-34.71)
9	Snake gourd	kg.	21.71	21.48 (-1.05)	23.64 (10.0)	30.32 (28.25)	44.68 (47.36)	33.33 (-25.40)
10	Tomato	kg.	16.70	21.64 (29.58)	23.43 (8.27)	28.57 (21.93)	37.29 (30.52)	22.82 (-38.80)
11	Chilly Green	kg.	3.06	3.52 (15.03)	4.02 (14.2)	4.77 (18.65)	5.65 (18.44)	4.37 (-2.26)
12	Plantain green	kg.	15.80	23.7 (50)	23.98 (1.18)	27.65 (15.30)	23.75 (-14.10)	32.58 (37.17)

Source: Economic Review (various issues), Kerala State Planning Board
*During October

The fluctuations were very high in the price of cucumber followed by tomato and plantain green over the years. The percentage of increase of cucumber was high in 2014-15 when compared to 2013-14 and it declined by 42.43% in 2015-16.The average retail price of cabbage showed a negative trend upto 8.68% within 3 years when compared with the price of all other commodities. All these food crops are the essential vegetable items of a common man's kitchen. So it is clear that the fluctuations in the price, especially the price rise affect the common man very hardly.

Another interesting point is that the highest rate of price increase and highest rate of price decrease was happened in a same commodity, i.e. brinjal. In 2014-15 the price of brinjal was high (61.57%) and the price was lowered by 46.87% in 2015-16. Majority of vegetables are importing from neighbouring states like Tamil Nadu and Karnataka since Kerala's internal production is comparatively low. Therefore, it has no meaning to compare with the area under cultivation, production and productivity vegetables in Kerala.

Consumer Price Index (CPI)

Consumer Price Index is designed to measure the changes over time in the general level of retail price of goods and services consumed by a reference population. It is an indication of inflationary trend. CPI is an approximate measuring rod to determine the impact of price rise on the cost of living of the common man. At present four CPI covering different segments of population i.e. Industrial Workers (IW), Urban Non Manual Employees (UNME), Agricultural and Rural Labourers (AL/RL) are selected at national level. In this analysis the CPI of agricultural and industrial workers are used (Economic Review 2006).

Inflationary hike is shown in the Figure 1.

Figure 1 Average Annual Consumer Price Index and Percentage of Variation of Agricultural and Industrial Workers in Kerala (Base 1998-99=100)
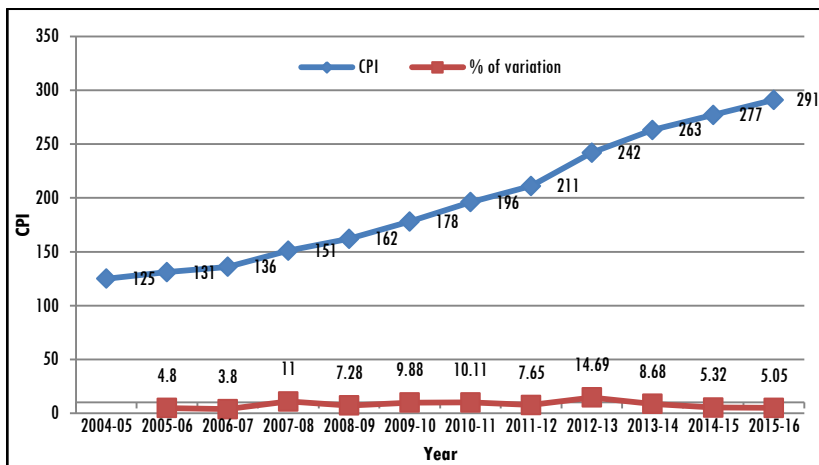
Source: Economic Review (various issues), Kerala State Planning Board
*Average monthly indices upto Aug 2016

From the figure it is clear that CPI for agricultural and industrial workers in Kerala is moving upward from 125 to 277 from the period 2004-05 to 2014-15. But the percentage of valuation was fluctuating over the years. The percentage of increase in CPI was 4.8 in 2005-06 which decreased by 3.8 in 2006-07 and again increased by 11% in 2007-08. In 2010-11, the CPI in Kerala was 196 against 178 in 2009-10. It shows that price has increased by 18 points. During the period 2013-14 to 2014-15, there is a reduction in the percentage of increase in the CPI. The percentage of increase was high during 2012-13 which registered 14.69% of increase. During this period, the price of brinjal, pumpkin, cabbage, bittergourd, snakegourd, greengram, blackgram, tapioca, coconut, has increased. With this data, conclude that increase in the price index leads to the deterioration of the purchasing power of a common

man. In other words, inflation is affecting the living standard of the people in general.

When we compared the percentage variation of Consumer Price Index of India with Kerala it seen that in 2007-08, 2010-11, 2012-13, and 2013-14 Kerala's percentage of increase of CPI is higher than that of India. Up to 2009-10, CPI of India is increasing at an increasing rate. During this period percentage of variation was fluctuating in Kerala. After 2012-13, the percentage of increase in the CPI of both India and Kerala is decreasing. Altogether we can say that fluctuations are more notable in Kerala's CPI.

Trends in Area, Production and Productivity of Important Food Crops in Kerala

Agriculture sector of Kerala is very much blessed with the climatic conditions which permit the cultivators to produce a number of varieties of crops like paddy, pulses, commercial crops, fruits and vegetables etc. A major challenge of Kerala is to produce more food and food products with limited area of land. The agrarian economy of Kerala is passing through various structural transformations after the implementation of Land Reforms. Major change has been taking place in Kerala is that higher proportion of its traditional cropped area are used for the production of commercial crops like rubber, pepper etc. Data regarding the area, production and productivity of important food crops in Kerala are shown in the Table 4, 5 and 6.

From Table 4, it is clear that area under cultivation of all food crops are fluctuating over the years. The area under cultivation was highest in the case of coconut followed by area under cultivation of rice. And the area under cultivation of pulses is very low when compared with other food crops. Therefore, with the lowest area under cultivation of and growing demand for pulses

tend to increase the prices of food crops like greengram, dhal etc. A negative trend is still continuing in the area of rice and pulses. In 2004-05, Kerala was utilizing 289974 hectares and 8428 hectares of land for producing rice and pulses for its people. In 2014-15, the area of rice and pulses were declined to 198159 hectares and 3601 hectares respectively. The percentage of variation of area under cultivation of rice was 31% and of pulses was 57%.

Table 4 Area (ha) of important food crops in Kerala during 2004-05 to 2009-10

Sl No.	Item	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
1	Rice(OM) Matta	289974	2757420	263529	228938	234265	234013
2	Pulses	8428	10562	6870	4355	3943	4449
3	Banana	58866	61400	59143	59341	53516	51275
4	Tapioca	88486	90539	87128	83990	87278	74856
5	Coconut (without Husk)	899267	897833	872943	818812	780500	778618

(a)Area (ha) of important food crops in Kerala during 2010-11 to 2014-15							
Sl No.	Item	2010-11	2011-12		2012-13	2013-14	2014-15
1	Rice(OM) Matta	213187	208160		197277	199611	198159
2	Pulses	3824	3668		2948	2989	3601
3	Banana	58671	59069		61911	62261	61936
4	Tapioca	72284	74498		69586	67589	75496
5	Coconut(without Husk)	770473	820867		798162	808647	793856

Source: Economic Review (various issues), Kerala State Planning Board

Table 5

(a)   Production (MT) of important food crops in Kerala during 2004-05 to 2009-10

Sl No.	Item	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
1	Rice(OM) Matta	667105	629987	641575	528488	590241	598337
2	Pulses	8390	7940	5211	3294	2982	3390
3	Banana	475371	491823	463766	439803	427604	406292
4	Tapioca	2400043	2568284	2518999	2556455	2710934	2525384
5	Coconut (without Husk)**	6001	6326	6054	5641	5763	5667

(b)	Production (MT) of Important food crops in Kerala during 2010-11 to 2014-15					
Sl No.	Item	2010-11	2011-12	2012-13	2013-14	2014-15
1	Rici(OM) Matta	522738	568993	508299	564325	562092
2	Pulses	2908	3128	3246	3019	3409
3	Banana	483667	514054	515607	531299	545431
4	Tapioca	2408962	2567953	2458515	2479070	2943919
5	Coconut (without Husk)**	5287	5941	5799	5921	5947

Source: Economic Review (various issues), Kerala State Planning Board

**Production in million nuts

Production of important food crops in Kerala during 2004-05 to 2009-10 is shown in the Table 5. During the period, a mixed trend can be seen in all commodities. In 2004-05, the production of rice was 667105 MT which was very high when compared with the production of coming years. In 2012-13, the production reached its lowest level i.e. 508299 MT. It shows a positive relationship between area under cultivation and production. But in 2006-07, 2009-10 and 2011-2, there is an inverse relationship between area and production of rice i.e. during this period area under cultivation was declining whereas the production was increasing. Up to 2008-09, there is a negative trend in the production of pulses and after it shows fluctuating nature. In 2005-06, 2011-12 and 2012-13 area under cultivation showed a negative trend whereas the production of pulses showed a positive trend. And this data indicates that it is exceptional case only. Altogether we can say that fluctuations in the production of food crops is the result of the fluctuation in the area under cultivation which leads to the fluctuations in the average retail price of essential food crops.

Table 6

(a) Productivity (Kg/ha) of important food crops in Kerala during 2004-05 to 2009-10

SI No.	Item	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
1	Rice(OM) Matta	2301	2285	2435	2308	2520	2557
2	Pulses	995	752	759	756	756	762
3	Banana	8075	8010	7841	7411	7990	7923
4	Tapioca	27123	28367	28911	30438	31061	33737
5	Coconut(without Husk)***	6673	7046	6935	6889	7384	7278
(b) Productivity (Kg/ha) of Important food crops in Kerala during 2010-11 to 2014-15							
SI No.	Item	2010-11	2011-12	2012-13	2013-14	2014-15	
1	Rice(OM) Matta	2452	2733	2500	2827	2837	
2	Pulses	760	853	1100	1010	947	
3	Banana	8244	8703	8451	8533	8806	
4	Tapioca	32650	34470	35330	36679	38994	
5	Coconut (without Husk)***	6862	7237	7265	7322	7491	

Source: Economic Review (various issues), Kerala State Planning Board

***Productivity in nuts/ha

Table 6 reveals the productivity (kg/ha) of important food crops in Kerala during the period 2004-05 to 2014-15. The productivity levels of different crops have indicated mixed trends during this period. The productivity of rice was highest in 2014-15. And the lowest was reported in 2005-06. Till 2007-08, the productivity of banana was decreasing and after it started to increase. Theoretically it is true that there is a positive relationship between production and productivity. When the productivity is higher, production is also higher. But here are some exceptions. From Table 5, it is seen that productivity of rice in 2006-07 is 2435kg/ha. It implies the reason for the rise in production of rice since the area of production was lowered during the same year. This is also similar in the year 2009-10 and 2011-12. This trend is also clear in the case of pulses during the year 2005-06, 2011-12 and 2012-13. But the data on area, production, and productivity shows

that there is a positive relationship between area under cultivation and production, and between productivity and production.

Crop Wise Analysis

Crop wise analysis of retail price, area under cultivation, production and productivity in detail is given below.

Rice

Rice is the staple food across our country. Therefore its demand is growing much faster than its production. Due to some reason like higher demand or growing population, decline in the production and climate changes, the price of rice are affected. In Kerala, the rate of increase was much lower when compared to the other food crops. During 2011-12, the rate of increase was high and recorded 43.73% of increase. The price of rice was declined by 4.17% only in 2012-13. During the same year, both area under cultivation and production declined when compared with the previous year. Therefore we can say that in the reduction of the price of rice, the level of production has no role during this period.

Pulses

Pulses are one of the major food crops in India. Due to its higher protein contents, demand is also increasing year by year. India is one of the largest producers of pulses in the world. Kerala is also producing the pulses like blackgram, redgram, dhal, greengram etc. When compared with other pulses the rate of increase of price of dhal was higher in 2014-15 where recorded 100.53%. And the rate of decrease was higher in the price of redgram (18.97%) in 2012-13. Upto 2007-08 the price of greengram, blackgram, redgram and dhal was fluctuating. During 2008-09, price of all pulses started to increase and registered highest variations. In 2009-10, the price of all pulses declined and the rate of decrease was higher in the

price of dhal which showed 20.83% of decrease. Till 2011-12, the price of blackgram was showing a negative trend and after it is moving upward. Higher fluctuations were notable in the price of dhal and redgram during the period 2010-11 to 2014-15.

Banana

In Kerala, banana is a part of traditional culture. Among the price of all commodities the price of banana is showing a negative trend. In 2008-09 the price of banana was higher and recorded 51.6% of increase. In 2014-15 the price of banana declined by 22.87%. The area under cultivation of banana was decreasing during the period 2006-07 to 2009-10. As a result, the level of production was declining. After 2009-10, area under cultivation was increasing continuously till 2013-14. And the production of banana was increasing over the year. The same trend is also seen in the production during the period except 2007-08, 2009-10 and 2012-13.

Tapioca

Tapioca is widely consuming tuber in Kerala. During the period 2004-05 to 2010-11 the average retail price of tapioca was increasing and the rate of increase was low 3% in 2008-09. The highest rate of increase was recorded in 2012-13 i.e. 84.60%. After 2010-11, the price was fluctuating over the years. In 2013-14 the price of tapioca declined by 24.37% which is the highest rate of decrease. A mixed trend was observable in the area under cultivation of tapioca during the period 2004-05 to 2014-15. The area under cultivation of tapioca was high in 2005-06. During the period 2013-14 the price of tapioca was showing a negative trend since the area under cultivation was low.

Coconut

Kerala is the leading state in area under cultivation of coconut and its production. The average retail price of coconut is also showing a mixed trend during the period 2004-05 to 2014-15. The highest rate of price increase was recorded at 84.60 in 2012-13. In 2011-12 the price of coconut declined by 20.53%. During the period 2004-05 to 2010-11 the area under cultivation of coconut was decreasing. After 2010-11, both area under cultivation and level of production is showing a mixed trend.

Conclusion

The above analysis tries to discuss the trends of the retail price of essential food crops of Kerala. Firstly, the analysis is provided an overview of the price volatility of food crops like rice, pulses, banana, tapioca, coconut and vegetables. Secondly, the analysis of the variation of Consumer Price Index is highlighted. Thirdly, trends in the area, production and productivity are analysed and finally, a detailed crop wise analysis are discussed. It is found that in 2015-16, the percentage of variation of the average retail price of food crops like banana, coconut and all vegetables except plantain green are showing a negative trend whereas the percentage of variation of the average retail price of blackgram, dhal and plantain green are showing upward movement. The crops like rice, greengram, redgram and tapioca are showing a moderate increase. Among all the food crops, the highest percentage of increase is recorded for dhal i.e. 100.53% in 2014-15 and highest percentage of decrease is recorded for brinjal i.e. 46.87% in 2015-16.

It is noted that the CPI is increasing during the period 2004-05 to 2015-16. After 2013-14, the percentage of variation is decreasing. The highest percentage of variation (14.69%) has

recorded in 2012-13. During this period the price of brinjal, pumpkin, cabbage, bitter gourd, snake gourd, greengram, blackgram, tapioca and coconut has increased. The discussion shows that Kerala is witnessing a tremendous decline in the cultivation of commodities like rice, pulses, banana, tapioca, vegetables etc. which is partly because of the decline in the area under cultivation and it resulted in the fluctuation of prices. In Kerala, volatile nature of commodity prices is very common which erodes the purchasing power of the common man.

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