

RESEARCH ARTICLE

Biodiesel Production from Fungi

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ABSTRACT

The scarceness of fossil based fuels and the environmental impact produced by the conventional sources of energy over the planet, has lead new research work to seek the sustainable sources of clean energy. Biofuel is committed to becoming a worldwide leader in the development and deployment of renewable energy resources. Biodiesel is an alternative fuel, made from renewable biological sources. Biodiesel can also be produced from microbial sources like algae, bacteria and fungi. Fungi exhibit the capacity to accumulate intracellular lipids in excess of 70 percent of their biomass during metabolic stress periods. Fungal lipids as a source for biodiesel was less studied. Hence the fungal lipids source as diesel fuel was taken for this study.

Key words: Fungal lipids, Alternative fuel and Biodiesel.

INTRODUCTION

The rapid growth of world's population and increased growth of industrialization leads to the increased need for energy. A major challenge faced by the man kind is the gradual and in escapable exhaustion of the earth fossil energy sources. The combustion of these energy materials lavishly used for heating of transportation fuels is one of the key factor responsible for global warning and environmental pollution. The world is facing declining liquid fuel reserves at a time, when energy demand is exploding [1]. If consumption continues at the current rate, the fossil fuel supply could be gone before the end the century. Renewable biofuels are needed to displace petroleum derived transport fuels, which contribute to global warming and are of limited availability. Biodiesel is potential renewable fuels that

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have attracted the most attention. Biodiesel from microalgae seems to be the only renewable biofuel that has the potential to completely displace petroleum-derived transport fuels without adversely affecting supply of food and other crop products.[2] Renewable, carbon neutral transport fuels are necessary for environmental and economical sustainability. [3] The use of microbial systems for biodiesel production although not exploited industrially until now. Now this ability of microorganism to grow on an almost infinite variety of food source may play a significant role in building out society from its current energy crisis. Increasing interest is generated to explore ways to reduce the high cost of bio diesel especially the lost of the raw materials [4]. In addition, microbes can be tailored to utilize varies carbon sources as feed stock for production of oils, such as waste or agriculture by product. Many molds, yeast and algae exhibit the capacity to accumulate intracellular lipids in excess of 70 percent of their biomass during metabolic stress periods [5].However little information only available on the use of microbial sources for lipid production, Hence this present study was undertaken to exploits the microbes for biofuel production and to optimize the conditions for higher lipids production from oleaginous fungi.

MATERIALS AND METHODS**Isolation and identification of oleaginous fungi [6]**

Soil sample were collected from different part of Tamil Nadu, to isolate the oleaginous fungi for lipid production by serial dilution method. [7]. Among the several fungi isolated, five oleaginous fungi viz., PR (poombukar), VT1 (Vetharinyam), KM1 (Kollimalai), RM1 (Rameswaram), TR1 (Thanjavur) were selected based on their colony morphology in Petri plates according to [8]. Morphologically selected fungi were subjected to spore production by soaking – plain – water – agar – culture method [9]. From the PDA plate one disc of isolate (PR) was inoculated in plain water agar. After one day the plain water agar plate is soaked with 4ml of Petri's salt solution and then the plate was incubated to 4 – 6 days [10].Screening of oleaginous fungi was done by the method given by [6]. The culture were harvested and tested for lipids and biomass (gl^{-1}).

Cell biomass determination for fungi [11]

The fungal biomass of screened isolates, mycelia were harvested from the incubated flasks by suction filtration through Whatman No 1 filter paper and thoroughly washed with distilled water. Then filtered mycelia dried at 60°C in an oven for 15 hrs. The weight of the dried sample was taken and dry biomass was expressed in gl^{-1} .

Extraction of fungal lipids

Fungal lipids were extracted from the dried mycelia as described by Bligh and Tyer method [12].

The influence of different nutritional (carbon and nitrogen source) and growth conditions (pH and temperature) were studied in PR. The lipids and biomass production by fungal isolate PR with different carbon sources were also studied with following composition Glucose 30.0 (0.16 M), Yeast extract 5.0g/l, Distilled water 1000 ml, pH 5.4, Glucose in the broth was replaced individually with different carbon sources.[6]

Different carbon sources like glucose, fructose, sucrose and lactose were used in the concentration of 0.16 (M) in One gram of fungal isolate as mycelial suspension.

Nithya Devi and Velayutham**Cultural conditions**

50 ml of this broth were dispensed in 250 ml conical flasks, sterilized and incubated at 30°C, 200 rpm for 7 days in an incubator shaker. The fungal mycelium was filtered through Whatman No.1 filter paper. Liquids and biomass content of filtered fungal mycelium were analyzed. Based on their earlier study, glucose was found to be the best source for lipid production. Hence the glucose was taken at different concentration to find out the optimum level for maximum lipids production.

Lipids production and glucose utilization by fungal isolate (PR)

The rate of depletion of glucose source and the formation of lipids in fungal isolate (PR) was studied. The screening broth with 0.6 M of glucose concentration was dispensed in to the 250 ml Erlenmeyer flask and sterilized. 1g of fungal isolate (PR) was inoculated as mycelial suspension and incubated in environmental shaker at 220 rpm for 7 days. After incubation, flasks were withdrawn and filtered using Whatman No 1 filter paper. The filtrates were analyzed for glucose content and mycelia were analyzed for lipids and biomass content.

Glucose in the culture filter was determined by the method of [13]. The culture filtrate was centrifuged at 6000 rpm at 30°C and 0.2 ml of supernatant was pipetted in to a test tube. To that 1 ml of alkaline copper tartarate reagent was added and placed over boiling water bath for 10 min. After cooling, 1 ml of arsene molybdate reagent (given below) was added. The absorbance of orange red colour formed was measured in colorimeter at 620 nm after 10 min. Absorbance value of the standard was used to prepare the standard curve. The absorbance value of samples was plotted accordingly to calculate the amount of glucose present.

The ability of fungal isolate (PR) was tested with different nitrogen sources like yeast extract, ammonium chloride and ammonium sulphate. Yeast extract in the broth was replaced individually with different nitrogen source like Yeast extract, Ammonium chloride and Ammonium sulphate.

For large scale production of lipid by fungal isolate (PR) in bio reactor nutritional and growth factors were adopted for the Nutrient adopted Glucose 0.6 M, Yeast extract 10.0 g, pH 6.5 and Temperature 30 ° C. [14]. Fermentation was carried out with the optimal fermentation medium in a 5-L bioreactor (Lark innovative technologies, India), equipped with disc impeller, oxygen and pH electrodes. The equipment also monitored temperature, agitation speed, gas purging flow rate, pumping rates, antifoam addition and the vessel level. The pH value and temperature were kept constant throughout the experiment time [15]. Fermentation broth was inoculated *Rhodotorula glutinis* (24 hrs) at 10 percent level containing (28x10 cfu/ml) in the broth. After inoculation fermentation was carried out for a period of five days. After five days, the biomass was harvested by centrifugation and lipids produced by yeast strains were estimated. The lipids were further analyzed for fatty acid profiles by GC-MS. Analysis of fatty acid methyl esters by Gas Chromatography- Mass Spectrometer (GC- MS) [16]

Fungal strains were subjected to physico- chemical properties in order to test its efficiency to use as biodiesel. The following properties were analyzed according to the procedure of American standards for testing of material (ASTM) (2003).The bio-diesel esters were characterized for their physical and fuel properties including density, viscosity, iodine value, acid value, cloud point, pure point, gross heat of combustion and volatility.

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RESULTS AND DISCUSSION

Lipids production by fungal isolates

Among the five isolates studied PR sample shows high lipid production and biomass (28 % and 10g/l) (Fig.1). So the PR sample was selected for further studies.

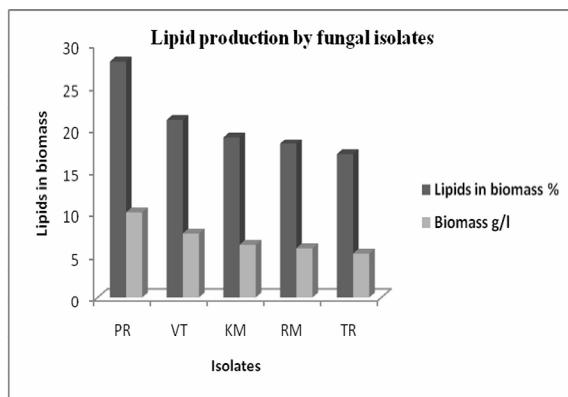


Fig.1 Lipid production by fungal isolates.

Effect of temperature on lipids production by fungal isolate

In order to optimize the temperature for maximum lipids production by fungal isolate (PR), the fungus was grown at different temperature ranges of 20, 25, 30, 35 and 40°C. The fungus accumulated significantly more lipids (43.2%) at 30°C and least amount of lipids (14.3%) was recorded at 40°C (Fig.2). The present study indicated that the optimum temperature for fungal isolate (PR) was 30°C on biomass as well as lipid production reported by [17].

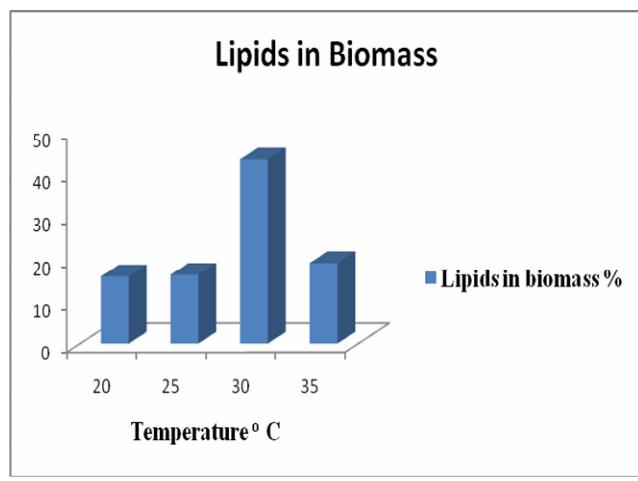


Fig.2 Temperature on lipids production by fungal isolate (PR)

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Effect of pH on lipids production by fungal isolate (PR)

The influence of pH by fungal isolate (PR) was investigated at different pH ranged from 5.5, 6.5, 7.5 and 8.5 on lipids production. Maximum lipids (43.5 %) and biomass (10.7g l^{-1}) content was obtained significantly when the fungus grown at a pH of 6.5. It is observed that the least amount of lipids (10.2%) and biomass (5.6%) content was recorded at pH 7.5 and no growth and lipids accumulation was observed at pH of 8. [18] [19] reported that best pH for biomass and lipid production together with a high proportion of PUFA's (poly unsaturated fatty acids) was around 6.0.

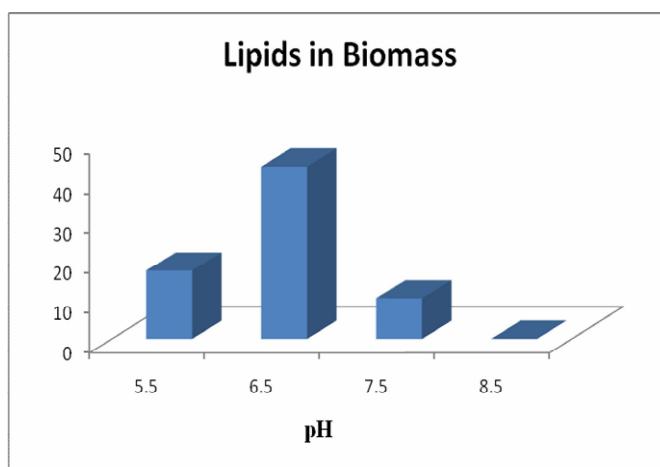


Fig.3 pH on lipids production by fungal isolate (PR)

Physico-chemical properties of fungal lipids

Lipids produced through fermenter was analysed for its physico-chemical properties in order to use as biodiesel, values were listed .The obtained values were compared with ASTM standards. The physical properties like, specific gravity of 0.92 g/cc, viscosity at 40°C of 54.81 cSt, calorific value of 32.05 Kcal/kg, Flash 218°C , Fire point 230°C cloud 4°C , pour point 7°C and the chemical properties of lipids like Free Fatty acids (FFA) of 14.55% , acid value 28.2 were obtained. Viscosity of fungal lipids (54.81 cSt) and acid value (28.2) were higher when compared to the standard (1.9- 6.0 cSt and < 0.8) respectively. Whereas other properties like flash point, carbon residue were within the limit of the standard. As the value of flash and fire point of fungal lipids satisfies the standard limits. It can be used as such, like vegetable oil. Since the viscosity, FFA and acid value of the fungal isolate is higher than the standard level, which causes engine blockage and it needs to be reduced through transesterification. Fatty acids profiles (palmitic (33.4 min), stearic (34.34) and oleic acid (34.60)) were identified based on their retention times by GC-MS.

CONCLUSION

The present study reveals that the biodiesel produced from fungi is very economical and eco-friendly because of the less amount of carbon content. The values of the fungal isolate are higher than the standard level, which causes engine blockage and it needs to be reduced through transesterification. The study summarized that the use of fungal lipids from (PR) as biodiesel should undergo some pretreatment and transesterification to meet out the standard levels of ASTM (American Society for Testing and Materials) D6751 specification.

Nithya Devi and Velayutham**ACKNOWLEDGEMENT**

I wish to express my sense of gratitude and sincere thanks to my beloved guide, my beloved friends and my beloved parents and Almighty to those who have helped immensely in the successful completion of my research work.

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RESEARCH ARTICLE

Phenology of some Butterflies in a cultivated land habitat of Peraiyur Taluk, Madurai District, TamilNadu State, India.

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ABSTRACT

Butterflies are the nature's the most beautiful insects. They are active fliers in daytime and when at rest keep their wings folded, erected upwards. They are economically important as they perform entomophilies and the pre-nature stares may cause plant infections. Butterflies contribute a great deal of interest and fascination to the natural world. They increase the earth's beauty. The most important environmental use is that butterflies serve as ecological indicators. They are capable of supplying information on changes in the ambient features of any ecosystem. Hence, the present investigation has been aimed to study the Phenology of some butterflies in a cultivated land habitat of Peraiyur Taluk, Madurai District.TamilNadu State, India. The first appearance of most of the butterflies occurred during the month of July, August and September. The last appearance occurred during the month of December, January, February and April. The pattern of phenology of some butterflies was also calculated and discussed.

Keywords: Butterflies, phenology, cultivated land habitat, ecological indicators.

INTRODUCTION

Conservation of natural habitats is very essential for the existence of many species of Lepidopterans [1]. Among the lower invertebrates, butterflies are probably the best-studied group in the Western Ghats forest [2]. Butterflies are the most attractive insect belonging to the Order Lepidoptera, which is one of the largest insect orders with more than

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105,000 known species [3]. Butterflies are holometabolous, and their reproductive output depends on the combined effect of larvae and adult derived nutrients [4]. Butterflies are among nature's beautiful insects. They are active fliers in day time and when at rest keep their wings folded, erected upwards. They are economically important as they perform entomophily and the pre-nature stings may cause plant infections [5]. Butterflies contribute a great deal of interest and fascination to the natural world. They increase the earth's beauty. The most important environment use is that butterflies serve as ecological indicators. They are capable of supplying information on changes in the ambient features of any ecosystem [6]. The present investigation has been done to register the first appearance and the last appearance of some butterflies in a year.

MATERIALS AND METHODS

Study area

The study was carried out in a cultivated land habitat of Sandaiyur village. This village is located in between Peraiyur and Mellapatti. This habitat consisted of various agricultural fields, such as, Cotton (*Gossypium hirsutum*), tomato (*Lycopersicum esculentum*), onion (*Allium cepa*), brinjal (*Solanum melongena*), paddy (*Oriza sativa*), cholam (*Sesamum vulgare*) and millet (*Eleusine coracana*), around the cultivated area the plants such as, *Tribulus terrestris*, *Calotropis gigantea*, *Tridax procumbens*, *Morinda tinctoria* and *Tagetes maritima* are also present.

Study Period

The study was extensively carried out from May 2007 to April 2008 and it was divided into pre-monsoon (June, July and August), monsoon (September, October and November), early post-monsoon (December, January and February) and late post-monsoon (March, April and May).

Methodology Adopted

The butterflies were observed on non-rainy days from 07.00 hrs to 16.00 hrs. The butterflies were observed at a distance of 2m. Some butterflies could not be identified accurately up to the species level in the field as they were difficult to locate and identify in the field because of their smaller size and cryptic coloration (Lycaenidae and Hesperiidae). The butterfly species were identified by using standard references such as, the field guide "Some south Indian Butterflies [7] and 'India – a lifescape butterflies of peninsular India [8].

RESULTS AND DISCUSSION

Generally appearance of most of the butterflies occurred during July, August, and September the last appearance occurred during the month of January, February and March in the cultivated land habitat of Peraiyur Taluk. The first appearance of most of the species of butterflies occurred during September, October and this can be related with the North – east monsoon and the availability of flowering plants. The last appearance of most of the species of butterflies occurred during the month of January and the butterflies may undergo dormant condition during this period to overcome the onset of the dry season. As the season is dry during March and April and due to the non availability of flowering plants mostly the butterfly species in these two habitats were either rarely seen or absent. The phenology of some butterflies in the cultivated land habitat presented in the Table 1. The distribution of butterflies is dependant upon the availability of their food plants. Migrants move out of their breeding areas if they do not find suitable food plants sources in the new localities as they will fail future generation [9]. The survival of butterflies depends mainly on the availability of the larval food/host plants which are generally secondary growth consisting of shrubs, creepers, saplings etc., Because of their food plant requirements, some species have colonies which are restricted to particular types of place where these plants occur[10].

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Table 1. Shows the phenology of some butterflies in the open land habitat of Peraiyur Taluk.

Period :2007-2008

S.No	Name of the butterflies	First Appearance	Last Appearance
1.	<i>Euploea core core</i>	August	April
2.	<i>Tirumala limniace exoticus</i>	August	January
3.	<i>Tirumala septentrionis dravidarum</i>	October	January
4.	<i>Ampittia dioscorides dioscorides</i>	October	December
5.	<i>Castalius rosimon rosimon</i>	August	December
6.	<i>Rapala jarbus</i>	October	January
7.	<i>Discolampa ethion</i>	August	December
8.	<i>Spindasis vulcanus</i>	October	February
9.	<i>Precis almana almana</i>	July	December
10.	<i>Byblia ilithya</i>	September	January
11.	<i>Hypolimnus bolina jacintha</i>	September	January
12.	<i>Pantoporia hordonia</i>	October	January
13.	<i>Euthalia aconthea meridionalis</i>	October	December
14.	<i>Papiliopolytes romulus</i>	August	January
15.	<i>Catopsilia florella</i>	October	February
16.	<i>Catopsilia pyranthe</i>	September	December
17.	<i>Pareonia valeria hippie</i>	September	December

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RESEARCH ARTICLE

Phytochemical Analysis of *Canna indica L.*

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ABSTRACT

The medical plant *Canna indica L.* was selected for Isolation and Characterization of its medicinal value based on phytochemical studies. This plant was collected from Sacred grove forest of Aanaivari village, Rayavaram Panchayat Arimalam block, Pudukkottai District, Tamil Nadu, India during the month of February 2010. The collected plants and their parts were cleaned with tap water and dried under shade, then ground well to find powder. About 100g of dry leaf powder of *Canna indica L.* was extracted with solvent ethanol using Soxhlet apparatus at 60-70 degree temperature. Greenish black waxy residue was obtained. The residue was used for phytochemical and Characterization studies. Phytochemical constituent like alkaloids, flavonoids, carbohydrates, glycosides, phytosterols, fixed oil and fats, proteins, phenolic compounds, tannins and saponins of ethanol solvent extract of *Canna indica L.* were analysed qualitatively. In conclusion, these results suggest that *Canna indica L.* might be a source of large amount of proto alkaloids it is an antibiotic and antioxidant. Therefore, this result may suggest that *Canna indica L.* extracts posses' compounds with antioxidant and antimicrobial properties which can be used as Phyto cancer agents in new drugs for therapy of diseases in human.

Key words : *Canna indica L.*, phytochemicals, antioxidant, antimicrobial.

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INTRODUCTION

The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed. Furthermore, an increasing reliance on the use of medicinal plants in the industrialized societies has been traced to the extraction & development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal remedies have become more popular in the treatment of minor ailments, & also on account of the increasing costs of personal health maintenance [1-20]. Indeed, the market & public demand has been so great that there is a great risk that many medicinal plants today, face either extinction or loss of genetic diversity. The World Health Organization (WHO) estimated that 80% of the population of developing countries relies on traditional medicines, mostly plant drugs, for their primary health care needs [21-30]. Also, modern pharmacopoeia still contains at least 25% drugs derived from plants and many others which are synthetic analogues built on prototypes compounds isolated from plants. Demand for medicinal plant is increasing in both developing and developed countries due to growing recognition of natural products, being non-narcotic, having no side effects, easily available at affordable prices and sometimes the only source of health care available to the poor. Medicinal plant sector has traditionally occupied an important position in the socio cultural, spiritual & medicinal arena of rural & tribal lives of India[31-40]. A number of compounds extracted from various species of higher plants have shown antiviral activity. Examples included tannins, flavones, alkaloids, that displayed in vitro against numerous viruses. It has been suggested that selection of plant on the basis of ethno medical considerations gives a higher hit rate than screening programmes of general synthetic products [41-45].

Plant description

Canna indica L.(also known as saka siri, Indian shot, canna, bandera, chancle, coyol, or platanillo, Kardal in Marathi) is a species of the Canna genus, belonging to the family Cannaceae, a native of the Caribbean and tropical Americas that is also widely cultivated as a garden plant. It is a perennial growing from 0.5m to 2.5m, depending on the variety. It is hardy to zone 10 and is frost tender. In the northern latitudes it is in flower from August to October, and the seeds ripen in October. The flowers are hermaphrodite. The seeds are small, globular, black pellets, hard and heavy enough to sink in water. They resemble shotgun pellets giving rise to the plant's common name of Indian Shot.

They are widely used for jewellery. In the last three decades of the 20th century, Canna species have been categorised by two different taxonomists, Paulus Johannes Maria Maas from the Netherlands and Nobuyuki Tanaka from Japan. Maas regards *C. coccinea*, *C. compacta*, *C. discolor*, *C. patens* and *C. speciosa* as synonyms or varieties of *C. indica*, while Tanaka recognises several additional varieties of *C. indica*. *Canna indica* var. *indica* L.A medium sized species; green foliage, oblong shaped, spreading habit; triangular stems, coloured green; spikes of flowers are erect, self-coloured red, staminodes are long and narrow, edges regular, petals red, partial self-cleaning; fertile both ways, self-pollinating and also true to type, capsules globose; rhizomes are thick, up to 3 cm in diameter, coloured purple; tillering is prolific. Introduced by Linnaeus.[46].

Aims & Objectives

- To Identify and collect the *Canna indica* L. plant material with specific review of literature.
- To extract the secondary plant metabolites of the plant stem material of the species.
- To isolate, characterize and find out the bioactive metabolites through UV-VIS and FTIR analysis method.
- To correlate the identified metabolites with pharmacological applications.

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MATERIALS AND METHODS

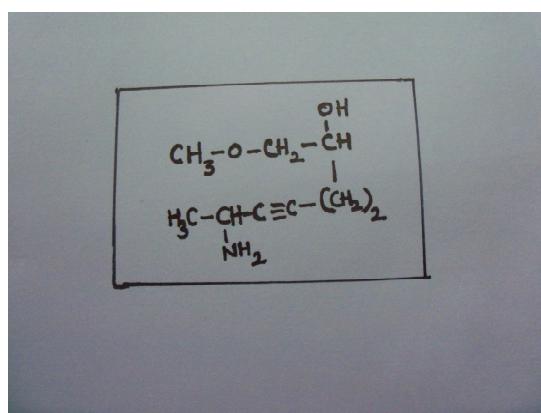
On the basis of its medicinal value which are available in the literature *Canna indica L.* was selected for phytochemical studies. The medicinal plant *Canna indica L.* was collected from Arimalam Village, Pudukkottai district during the month of January – 2010. The collected medicinal plant was brought into the TNSRO laboratory for phytochemical studies.

Phytochemical analysis

About 100 g of dry leaf powder of was *Canna indica L.* extracted with ethanol at 60°C to 70°C by continuous hot percolation using soxhlet apparatus. The extraction was filtered and kept in over at 50°C for 24 hours to evaporate the extracts from them. A greenish black waxy residue was obtained. These extracts were used for phytochemical analysis qualitatively through UV-VIS and FT-IR. Phytochemical analysis for major phyto constituents of the plant extract was undertaken using standard qualitative methods as described by various authors (Vogel 1958, Van 1997, Williams 1949). The plant extracts were screened for the presence of biologically active compounds like alkaloids, flavonoids, glycosides, carbohydrates, phytosterols and fatty acids, proteins, phenolics, tannins and saponins.[47-52]

RESULTS AND DISCUSSION

Phytochemical constituents like alkaloids, flavonoids, carbohydrates, glycosides, phytosterols, fixed oil and fats, proteins, phenolic compounds, and saponins of *Canna indica L.* were analyzed by qualitatively and reported in Table - 1. On the basis of UV-Vis and FT-IR spectral analysis on *Canna indica* we have found the following data UV-Vis shown in figure 1 yielded 4 elevations (382.89nm, 1.6344 422.36, 0.64656nm, 669.72, 0.28462 and 980.66, 0.079267) and the values were interpreted with table values and confirm the presence of **proto alkaloids** in the given sample. FT-IR result is yielded Maximum peak level 3930.13 cm⁻¹ and Minimum peak level 537.48 cm⁻¹. So that the compound may be **proto alkaloids** The compound may be **9-amino 3,4 dihydroxy 2 methoxy non-6-yne** having molecular weight : GMM, structure is given below



9-amino 3,4 dihydroxy 2 methoxy non-6-yne

Molecular weight: 171 GMM

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CONCLUSION

From the above mentioned results this study reveals the presence of various alkaloids compounds including quoins, iso quoins, etc. in *Canna indica*. In the present study, UV-Vis and FT-IR procedure was applied for the identification of secondary metabolites. In the effort to study plant of *Canna indica* from the identified localities subjected to alkaloids screening. From this total samples, 78% gave positive result for proto alkaloids, from this 33% gave a positive reaction for iso quenolins. So the final study of the result is indicating the identified plant may be used for antimicrobial, anti helminthic and anti-inflammatory agent in phyto-pharmaceutical applications.

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Table 1: Depicts various phytochemicals analyzed qualitatively

Sl.No	Metabolites	Results
1	Alkaloids	+++
2	Flavonoids	++
3	Terpenoids	++
4	Fixed oils	++
5	Phytosterols	+
6	Saponins	-
7	Phenolic compounds	++
8	Fats	++
9	Carbohydrates	++
10	Proteins	++
11	Glycosides	++
12	Tannins	+

+++ present in high concentration, ++ present in medium concentration, + present in low concentration

- not present in the sample

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RESEARCH ARTICLE

Diversity in the water bird community and physico chemical analysis of Karaivetti lake bird sanctuary in TamilNadu, India.

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ABSTRACT

We studied the waterbird community of Karaivetti Lake Bird Sanctuary (KLBS), Ariyalur District, Tamil Nadu State, India, a proposed Ramsar Site and Wetland of International Importance, to determine site-specific seasonal variation in abundance and diversity. The study was conducted at TN-05 selected site code in KLBS from October 2009 to March 2010. Data were gathered monthly to ensure quantification of seasonal changes in diversity and density. Overall, 188 Species of birds, has been identified from Karaivetti Lake, 50 Species of waterbirds belonging to 101 seasonally present or migratory species. During winter, between 20,000 and 60,000 Mostly Anatidae. 100 species of land birds and 250 nests were counted and variety like the Grey Pelican, Spoonbill, Ibis, Open bill stork, Cormorant etc., Overall waterbird density was highest where resident species such as Grey Heron (*Ardea cinerea*), Little Egret (*Egretta garzetta*), Median Egret (*Mesophoyx intermedia*), Red-wattled Lapwing (*Vanellus indicus*) and Black-winged Stilt (*Himantopus himantopus*) were present; some migratory species such as Barheaded Goose (*Anser indicus*), Painted stork, Common Coot (*Fulica atra*) and Whiskered Tern (*Chlidonias hybridus*) contributed to areas of high density. The pH and total dissolved solids (TDS) values of the lakes were found to be different from those reported almost a decade back. The concentrations of phosphate and sulphate were much lower than the earlier reported values. The present scenario states that though the

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biochemical oxygen demand and Dissolved oxygen demand values were lower for the Karaivetti Lake wetland, the values for Karaivetti Lake wetland have shown a gradual increase. Chloride concentrations were thrice higher than the previous findings. Electrical conductivity and TDS ranged from 400 to 700 micromhos/ cm, and from 294.40 to 348.40 mg/l, respectively, and were positively correlated with chloride and sulphate from 158.00 to 266.00 mg/l, from 0.271 to 0.297 mg/l. These changes are a reflection of the environmental changes happening in the Location of the Karaivetti Lake. Recommendations for management and research are made to ensure the effective conservation of water bird populations and their habitats in this region.

Key words: Karaivetti Lake Bird Sanctuary, Water quality analysis, species diversity, water bird community, water bird management.

INTRODUCTION

The Karaivetti Bird Sanctuary attracts 50 species of water birds visit this lake. Important water birds visiting the sanctuary include the high flying Bareheaded Goose, long migrants like White necked Stork, Grey Pelican, and Ibis. Sixteen species of Ducks and 23 Species of Waders have been recorded in the sanctuary. Birds start arriving in November and stay on till May. The other important characteristic of this sanctuary is the presence of water till the month of May as other water sources dry up by the month of March, this sanctuary offers habitat to the water birds till the May end. Population of migratory birds is more in the month of January. Important land birds visiting sanctuary include the Rosy Pastor, Peregrine Falcon, Osprey, Marsh Harrier, Tawny Eagle etc., and nearly 100 species of land birds have been recorded in the sanctuary 50 species of water birds visit these lake migratory birds, water birds and domestic birds of the Karaivetti Lake.

METHODOLOGY

The Karaivetti Bird Sanctuary (10° 58' 01" N, 79° 11' 07" E) is located in Ariyalur District of Tamil Nadu. The total Area of the Karaivetti Birds Sanctuary is 454 hectare and attracts large a gathering of waterbirds. This freshwater lake is fed by Pullambadi and Kattalal canals. The Birds Sanctuary gets annual rainfall of 2000 mm. Temperature varies from 14 degree centigrade to 33 degree centigrade.

The Karaivetti Bird Sanctuary is visited by various species of wandering water birds. The peak gathering takes place in the month of November to March. When over 2.5 lakhs birds visit this sanctuary. The Karaivetti Bird Sanctuary attracts 50 species of water birds visit this lake. Important water birds visiting the sanctuary include the high flying Barheaded Goose, long migrants like White Necked Stork, Grey Pelican, and Ibis. Sixteen species of Ducks and 23 Species of Waders have been recorded in the sanctuary. Birds start arriving in November and stay on till May.

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were found to be breeding. The Karaivetti Bird Sanctuary is essentially an irrigation tank that receives water from Mettur dam and North east monsoons. It remains dry from June till August.

RESULTS AND DISCUSSION

The physico-chemical parameters of each wetland (Table 1) varied, based on relative pollution and urbanization in its surroundings. It is an established fact that maintenance of healthy aquatic ecosystem is dependent on the water quality monitoring of water and biological diversity. Temperature is one of the most important ecological factors, which controls the physiological behavior and distribution of organisms. Minimum and maximum temperatures recorded in our study range from 14 to 33°C respectively (Figure 2). The temperature of lake water varied with seasons. Water temperature was found to be lower than atmospheric temperature. During the winter season water temperature was low due to frequent clouds, high humidity, high current velocity and high water level. Shakar et al., (1993) observed diurnal variation in some abiotic parameters of water at the Gupt-Ganga station of the torrential Neeru Nallah of Bhaderwah (Jammu) and Jain et al., (1996) also observed diurnal variations in temperature in the Halai Reservoir of Vidisha which influence the aquatic life and concentration of dissolved gases like CO₂, O₂ and chemical solutes.

Higher temperatures were observed during summer due to clear atmosphere, greater solar radiation, and low water level. Swaranlatha and Narsing Rai (1998) made a similar observation in their study of Banjara Lake. Yogesh Shastri and Pendse (2001) also made similar observation of the Dahikhura Reservoirs. One of the most important factors that serve as an index for pollution is pH. In our study, the pH of the Karaivetti Lake water ranged from 6.31 to 8.27 (Figure 2), which exceeded the WHO (1997) permissible limits (6.5–8.5). This is possibly related to the human activities as well as natural processes such as groundwater leaching the carbonate minerals (Skoulikidis et al. 1998). This may be due to the high buffering capacity of the system. The pH of water was relatively high in the winter months and low in the monsoon and summers. Maximum values reached 8.27 in October and the lowest value of 6.31 occurred in the month of August. The higher values of pH recorded during winter months could be attributed to increased primary productivity wherein carbonates, sulfate, nitrates and phosphates are converted to hydroxyl ions.

The lake water was always alkaline as pH constantly remained above 7. The earlier studies show that the range of pH of a majority of lakes and reservoirs lies between 6 and 9. This is in accordance with earlier reports by Wetzel (1975) who reported that the value of pH ranges from 8 to 9 units in Indian waters. The lower pH during monsoon is due to high turbidity, and in summers, the high temperature enhances microbial activity, causing excessive production of CO₂ and reduced pH. Khan & Khan (1985) and Narayani (1990) also reported similar results at Seikha Jheel in Aligarh and eutrophic wetlands (lower lake, Bhopal) respectively. Ghose and Sharma (1988) also recorded relatively high pH of water in winter months in their study of the Ganga River attributing high pH to increased primary-productivity.

The electrical conductivity values of water samples ranged between 500-700 micromhos/cm (Figure 2), with a maximum in summer and a minimum in the monsoon. Conductivity of water depends upon the concentration of ions and its nutrient status and the variation in dissolved solid content. Dilution of water during the rains causes a decrease in electrical conductance.

The total dissolved solids values of water samples ranged between 294.40 – 348.40 mg/l (Figure 2). The concentration is high during the monsoon, which may be due to addition of solids from the runoff water. Marker (1977) has made the same observation. The amounts of total solids are influenced by the activity of plankton and organic materials. Oxygen is an important parameter of the wetland /reservoir which is essential to the metabolism of all aquatic organisms that possess aerobic respiration. Concentration of dissolved oxygen indicates water quality and its relation to the distribution and abundance of various algal species. In the present study, the dissolved oxygen of water samples ranged from 1.90 to 6.13 mg/l (Figure 2). Presence of dissolved oxygen in water may be due to direct diffusion from air and photosynthetic activity of autotrophs. In the present study a strong correlation was also

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observed between pH and dissolved oxygen; with the lowering of pH, dissolved oxygen was also lowered. The addition of a variety of biodegradable pollutants from domestic and industrial sources stimulates the growth of microorganisms, which consume the dissolved oxygen. The values further deplete during summers because at high temperature, the oxygen holding capacity of water decreases. Present observations are in agreement with similar ones made by Verghese et al., (1992) at a domestically polluted tropical pond and Yogesh Shastri and Pendse (2001); Shanthi et al., (2002) who studied the Dahikhura

Reservoir and Singanallur Lake respectively. Pandey and Soni (1993) had observed high values of free carbon dioxide, and pH along with low dissolved oxygen in highly polluted lake water at Naukuchiyatal Lake situated in Kumaon, Himalayas. pH are the factors responsible for determining the amenability of water to biological treatment (Manivasakam, 1980). Bishop (1973) and Jain et al., (1996) also reported similar findings in their study on Malayan rivers and the Halali Reservoir.

The total hardness of this wetland water was observed to be high (96 mg/l) (Figure 2) during the summer season which may be due to evaporation of water and addition of calcium and magnesium salts. Bagde and Verma (1985) suggested a similar finding about J.N.U. Lake. Khan et al., (1986) studied the hardness in different reservoirs of Bhopal during the winter season and showed that the hardness varied from reservoir to reservoir due to their geological setting. Kannan (1991) has classified water on the basis of hardness values in the following manner: 0-60 mg/l, soft, 61-120 mg/l, moderately hard, 121-160 mg/l, hard and greater than as 180 mg/l very hard. Using these criteria, the water of the Karaivetti Lake wetland can be included in the moderately hard category. The hardness indicates the presence of basic salts. Sodium and potassium in addition to those of calcium and magnesium. Chloride levels of the wetland water were found to be high (266 mg/l) during the summer period.

The higher concentration of Cl⁻ is considered to be an indicator of higher pollution due to higher organic waste of animal origin. Munawar (1970) observed a direct correlation between Cl concentration and pollution level in fresh water ponds of Hyderabad. Govindan and Sundaresan (1979); Jana (1973) observed that concentration of higher Cl⁻ in the summer period could be also due to sewage mixing and increased temperature and evaporation by water. In Karaivetti Lake, reeds and other aquatic vegetation are plentiful in the shallow region and they are an ideal feeding ground for birds. Human interference, which was restricted to bathing and washing of clothes in the lake previously, now includes recreation for visitors, especially tourists. Man's activities and agricultural practices in the drier areas of the wetland have resulted in constant disturbances all around the lake.

Water Birds of Karaivetti Sanctuary

Forty-five species of water birds were recorded in the Karaivetti Lake during the study period. Among them one Species belongs to podicipediformes, three species to Pelecaniformes, twelve species to Ciconiiformes, seven species to Anseriformes, one species to Gruiformes, twelve species to charadriiformes and three species to Ciconiiforms. These birds were ecologically classified into five group namely, **Divers** (Little Grebe, *Tachybaptus ruficollis*, Little Cormorant, *Phalacrocorax niger*, Great Cormorant, *Phalacorcrax carbo*, Common coot, *fulica atra* and Darter *Anhinga rufa*), **Swimming birds** (Common Teal, *Anas crecca*, cotton teal *Nettapus coromandelianus*, Pintail *Anas acuta*, Garganey *Anas querquedula* Garganey *Anas querquedula*, Shoveller *Anas clypeata*, Lesser whistling Teal *Dendrocygna javanica*, Spotbill Duck *Anas poecilorhyncha*, and Grey Pelican *pelecanus philippensis*)

Small Waders (Pheasant-tailed, *Jacana Hydrophasianus chirurgus*, Red-wattled Lapwing *vanellus indicus*, Yellow-wattled Lapwing *vanellus malabaricus*, Golden Plover *pluvialis dominica*, Green Sandpiper *Tringa ochriopus*, Greenshank *Tringa nebularia*, Little Ringer plover *charadrius dubius*, Marsh sandpiper *Tringa stagnalitis*, Redshank *Tringa tetanus*, Common Sandpiper *Tringa hypoleucus* and Black Winged stilt *Himantopus himantopus*). Large Egret *Egretta alba*, Cattle Egret *Bubulcus ibis*, Grey Heron *Ardea cinerea*, Purple Heron *Ardea purpurea*, Night Heron *Nycticorax nycticorax*, Pond Heron *Ardeola grayii*, White ibis *Threskiornis aethiopica*, Glossy Ibis *Plegadis falcinellus*, Openbill Stork *Anastomus oscitans* and Spoonbill *Platalea Leucorodia*) and Aerial foragera (Little tern *Sterna albifrons*, whiskered Tern *Chlidonias*

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hybridus, Small blue kingfisher *Alcedo atthis*, Pied Kingfisher *Ceryle rudis* and White-breasted kingfisher *Halcyon smrensis*). Water birds recorded in the karaivetti birds sanctuary (Fig.2) During the three months study (Jan to Mar), a total of 853 birds were recorded from the study area. Among them, Jan 461.6, Feb 393.1 and 287.1 were summer migrants (Fig. 2)(Table. 3). At 2008, a total of 334 birds were observed among which 134.1, 105.5 and 94.4. At 2009, a total of 310.1 birds were observed among which 151.6, 97.2 and 61.3 were observed. At 2010, a total of 497.7 birds were observed among which 175.9, 190.4 and 131.4 were observed. The Composition of bird population at three sites is presented in Figs. 3, 4 ,5 and 6.

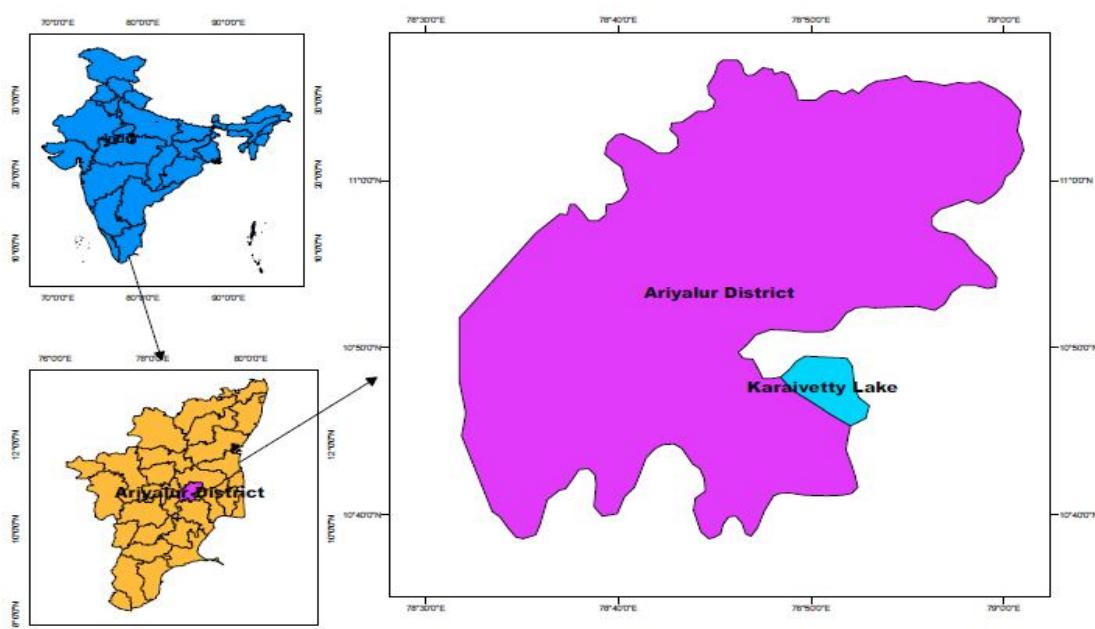
CONCLUSION

Human activities have caused shifts in wetland-dependent bird populations since Indian settlement of the Tamil Nadu States. Many acres of wetlands were drained between the 1950's and 1970. Well before any of the national bird surveys were begun. As a result, it is not possible to accurately determine the effects of habitat destruction on long-term wetland bird populations.

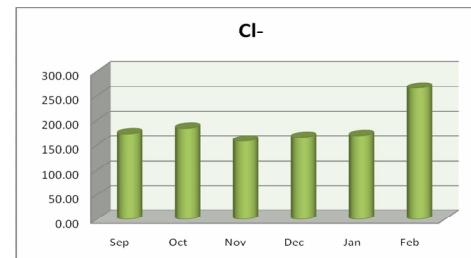
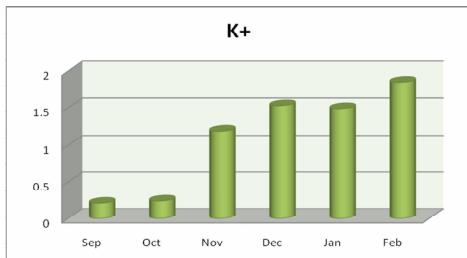
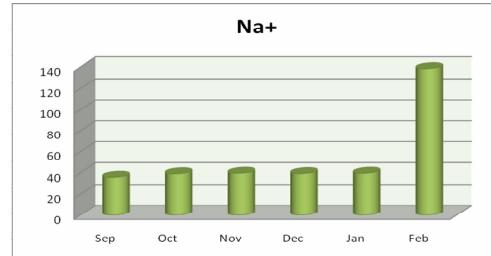
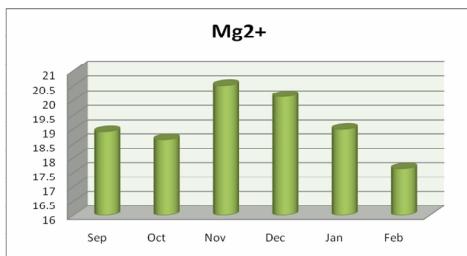
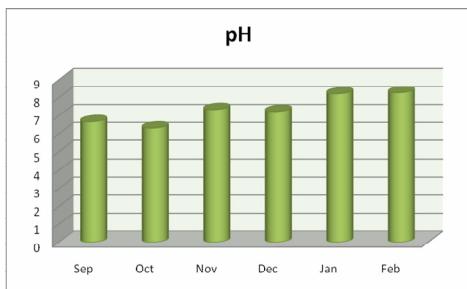
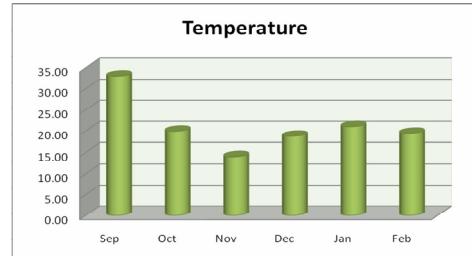
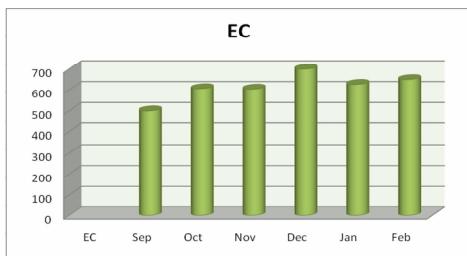
It is apparent that there have been many changes in the distribution and numbers of wetland birds. Wetlands on breeding, migratory, or wintering areas are all important to sustain bird populations. As the wetland habitats in these areas are drained or altered, the ability of these areas to sustain bird populations decreases. Each species of wetland-dependent bird has a unique and complex set of needs for wetland habitats that makes it difficult to generalize about how loss or degradation of wetlands affects bird populations. It seems reasonable to expect, however, that as the numbers of wetlands in a region decline, so too will the numbers of wetland-dependent birds.

In some parts of the Tamil Nadu States, extensive wetland losses have displaced birds from large areas. Continued wetland losses probably will cause continued losses of wetland birds. However, recent recognition of the wetland values, and the effects of their losses, has provided incentives to maintain and restore wetlands. Aquatic birds are important components of wetland ecosystem as these blinds are at relatively higher level in the food chain and represent a verity of predatory niches. According to the activities the wetland birds are grouped into Diving birds, Swimming birds, Small warders, large waders and Aerial waders. The present study was conducted in Karaivetti birds Sanctuary, Ariyalur district, Tamil Nadu one of the important sites famous for its, wintering congregation of water fowl. The censuses were conducted in the month of January 2010.

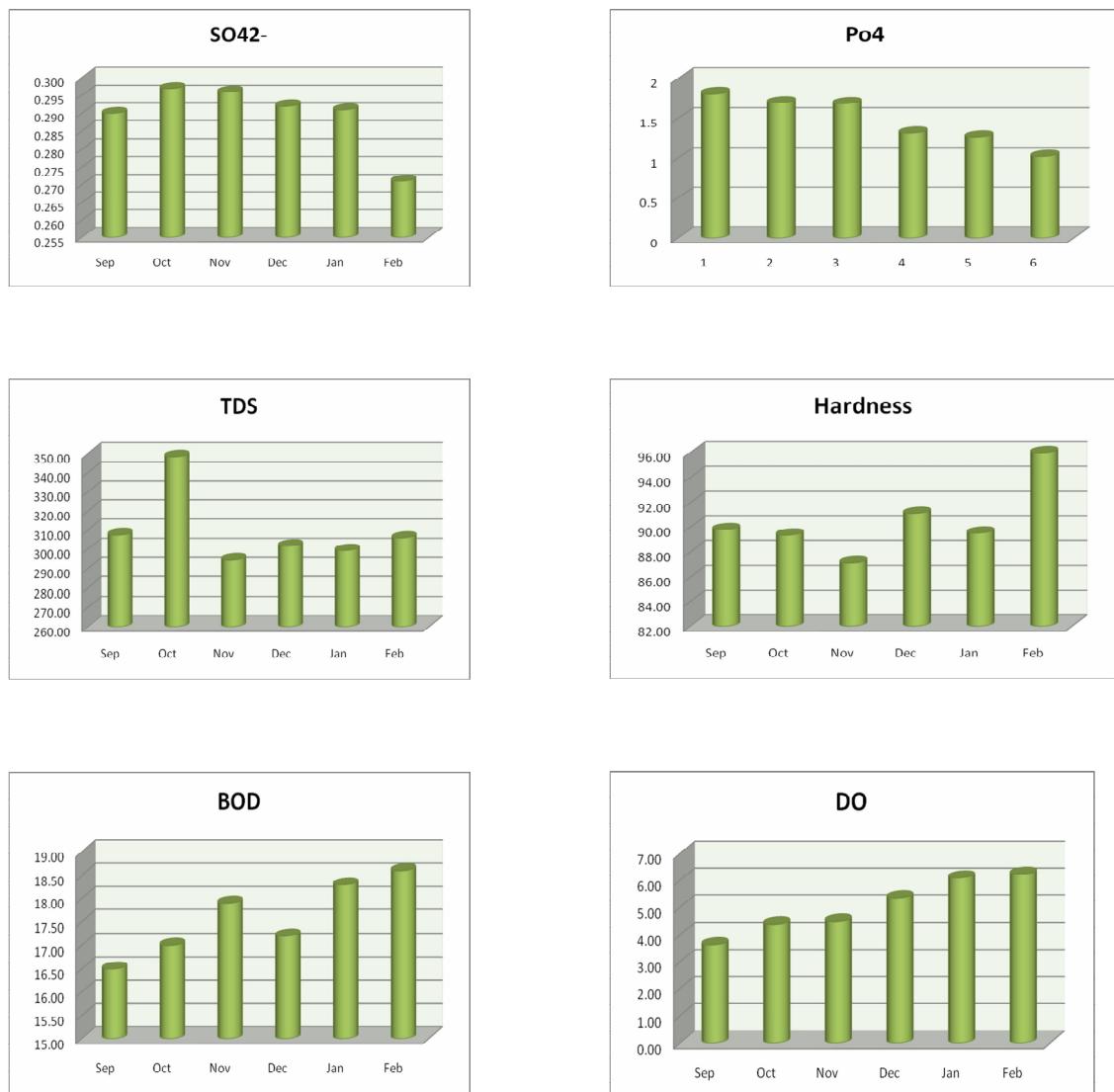
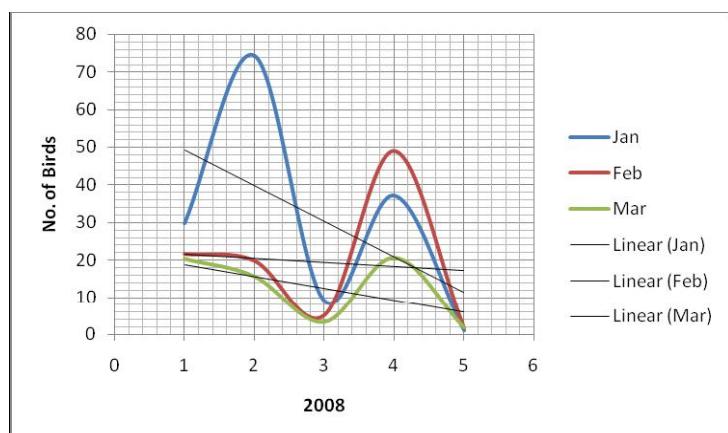
Fig.1. Location of the Karaivetty Lake, Ariyalur District.



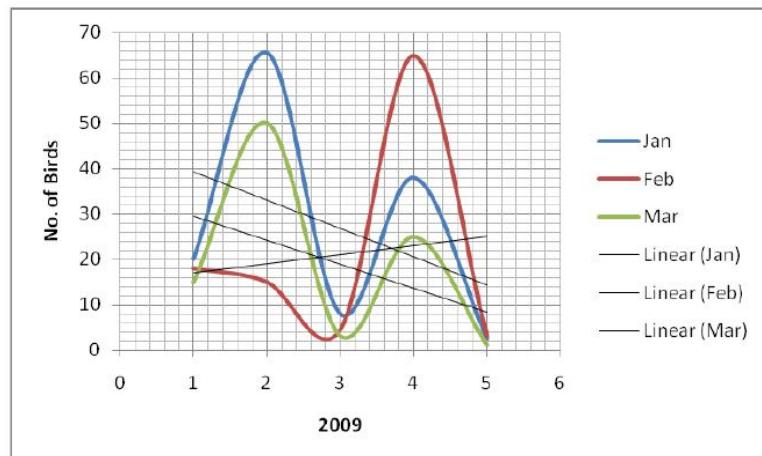
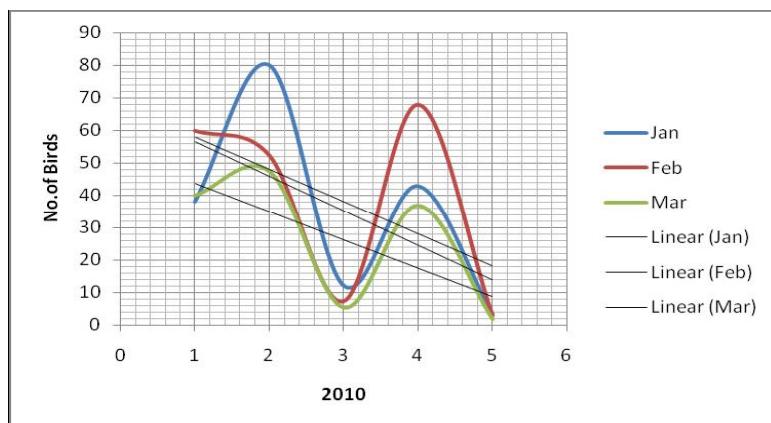
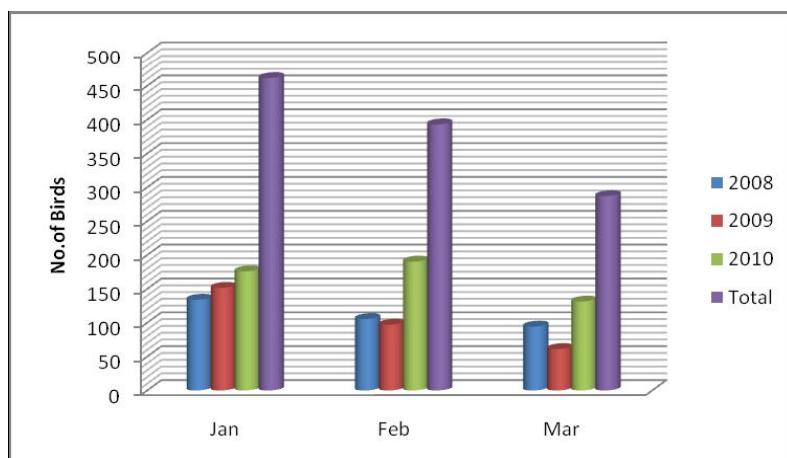
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Fig.2 Karaivetti Lake Water Quality Analysis Results (Sep 2010 – Feb 2011)

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**Fig 3. The linear trend of Birds population observed in Karaivetti Lake (2008)**

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Fig 4. The linear trend of Birds population observed in Karaivetti Lake (2009)**Fig 5. The linear trend of Birds population observed in Karaivetti Lake (2010)****Fig 6.The linear trend of Birds population observed in Karaivetti Lake (2008-2010)**

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RESEARCH ARTICLE

Removal of Cu(II), Cr(VI) and Methylene Blue from Aqueous Solution using Mixture of Flyash and Rice Husk : Adsorption on a Upflow Fixed-bed column

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ABSTRACT

In this study, the ability of low cost adsorbents such as mixture of fly ash and rice husk ash to adsorb mixture of Copper Cu(II), Chromium Cr(VI), methylene blue from aqueous solution was investigated in a upflow fixed-bed column. The effects of important parameters, such as the value of initial pH (1-7), the flow rate (10-30 ml/min), the initial concentration (50-200 mg/L) and bed depth (8-28 cm), were studied. The total adsorbed quantities and total removal percents of Cu(II), Cr(VI) and methylene blue related to the effluent volumes were determined by evaluating the graphs obtained at different flow rates, different initial concentrations, different pH value, and different bed parameter and for the mixture of fly ash and rice husk ash. The highest % adsorption of Cu(II), Cr(VI) and methylene blue were obtained at pH of 6, 3 and 5 respectively. The results show that the column performed well at lowest flow rate. Also, column bed capacity and exhaustion time increased with increasing bed height. When the initial concentration is increased from 50 to 200 mg/L, the percentage adsorption is highest at 100 mg/L was observed from the graphs.

Keywords: Mixture of fly ash and rice husk; Cu(II); Cr(VI); Methylene blue; Up flow fixed bed column; BDST model.

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INTRODUCTION

The pollution of water with heavy metals has been of great concern due to their toxic nature and their adverse effects [1]. Heavy metals can pose health hazards to man and aquatic lives if their concentrations exceed allowable limits. Concentrations of heavy metals below these limits even have potential for long-term contamination, because heavy metals are known to be accumulative within biological systems [2]. The aqueous discharges emanating from industrial processes such as mining, smelting, metal plating, ore processing activities, and energy production processes contain dissolved heavy metals that can create significant environmental problems [3]. Numerous industries use heavy metals for electroplating, leather tanning, metal finishing, paints, pigments, textile, etc. and produce aqueous effluents that contain heavy metal containments. Since the majority of heavy metals do not degrade into harmless end products, their concentrations must be reduced to acceptable levels prior to discharge of industrial effluents. Otherwise, they could pose threats to public health and affect the aesthetic quality of portable water. According to the world health organization (WHO), the metals of most immediate concern are aluminum, chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium, mercury and lead.

Removal of metal ions using adsorbents is often studied in synthetic solution prepared in dematerialized or distilled water [4]. Color is a visible pollutant and the presence of even a very minute amount of coloring substance (i) makes the water source highly unsuitable for domestic applications like drinking and recreational, (ii) affects photosynthetic activity in aquatic life because of reduced light penetration, (iii) makes water source unusable for industries, like paper mills that operating downstream along the water body and so on [16]. Methylene blue is a basic or cationic dye which ionizes in aqueous solutions forming a dye cation and chloride ion[17]. The removal of color from dye-bearing effluents is a major problem due to the difficulty in treating such wastewaters by conventional treatment methods. The sorption technique is proved to be an effective and attractive process for the treatment of these dye-bearing wastewaters [5]. The most widely used and effective physical method in industry is activated carbon, however running costs are high. If the adsorbent material used is of low cost and does not require any expensive additional pretreatment step, this method will become inexpensive.

The sorption capacity parameter obtained from a batch experiment is useful in providing information about effectiveness of dye-biosorbent system. However, the data obtained under batch conditions are generally not applicable to most treatment system, such as column operations where contact time is not sufficient long for the attainment of equilibrium[5].The fly ash contains mixture of metallic silicates and other inorganic particulate matter along with unburnt carbon and the rice husk contains abundant floristic fiber, protein and some functional groups such as carboxyl, hydroxyl and amidogen, etc., which make adsorption processes possible. Secondly, the yield of the mixture of fly ash and rice husk obtained by mixing fifty percent weight the fly ash and rice husk.

In recent years, some papers had reported several kinds of by-product such as coffee husk [6], tannin based [7], activated alumina [8], wood waste [9], chelating resin[10], bagasse[11], waste of tea factory [12] for the removal of methylene blue from its aqueous solutions. The Cu(II),Cr(VI) and methylene blue are selected as a model compounds in order to evaluate the capacity of mixture of fly ash and rice husk ash for the removal of Cu(II), Cr(VI) and methylene blue from aqueous solutions. Methylene blue has wider applications, which include coloring paper, temporary hair colorant, dyeing cottons, wools, and coating for paper stock. The mixture of heavy metals removal such as chromium, zinc, nickel, and copper etc are removed from an electroplating waste[19].

The aim of this study is to develop a cheap technology for the removal of Cu(II), Cr(VI) and methylene blue and their separate solution from aqueous solutions. The objectives of the present study is to adsorb Cu(II), Cr(VI) and methylene blue from aqueous solution by low cost adsorbents such as mixture of fly ash and rice husk ash using up flow fixed bed column. The important parameter such as pH of the solution, initial concentration of Cu(II), Cr(VI)

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and methylene blue, column bed height and flow rate of fluid of the mixture of fly ash and rice husk ash were investigated.

BDST model

The BDST (Bed Depth Service Time) analysis model is based on physically measuring the capacity of the bed at different breakthrough values. The BDST model works well and provides useful modeling equations for the changes of system parameters. A modified form of the equation that expresses the service time at breakthrough, t , as a fixed function of operation parameters is BDST model

$$t = \frac{N_0}{C_0 F} Z - \frac{1}{K_a C_0} \ln \left(\frac{C_0}{C_t} - 1 \right) \quad \text{i.e. } t = aZ - b$$

Where a is slope and b is intercept, C_t is the effluent concentration of solute in the liquid phase (mg/L), C_0 the initial concentration of solute in the liquid phase (mg/L), F the influent linear velocity (cm/min), N_0 the adsorption capacity (mg/L), K_a the rate constant in BDST model (mg⁻¹ min⁻¹), t the time (min) and Z is the bed depth of column (cm). A plot of t versus bed depth, Z , should yield a straight line where N_0 and K_a , the adsorption capacity and rate constant, respectively, can be evaluated [5].

MATERIALS AND METHODS

Preparation of biomass

Fresh biomass of rice husk ash was commercially purchased from jharsuguda orissa. The fly ash (class F) is collected from raichur thermal power station. Both fly ash and rice husk ash is mixed together 50% by weight. The biomass was sieved and a fraction of average particle size (<1 mm) was used for column studies.

Preparation of stock solution

The stock solution was prepared by dissolving accurately 3.92 g of Copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), 2.829 g of Potassium-dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and 0.1 g of Methylene blue in 1000ml of double distilled water.

Accurately 100ml of stock solution was diluted to 1000ml to get standard solution.

Estimation of copper

The copper can be estimated by copper sulphate solution of different concentration were prepared and their absorbance recorded by using UV-spectrophotometer [19]. The final concentration can be measured by obtaining calibration curve by absorbance versus concentration.

Estimation of chromium

Required quantity of the standard solutions was taken in a nessler's tube. Add 1ml of H_2SO_4 (1+1), 5 drops of phosphoric acid was added into it. Following which, 2ml of di-phenyl carbazide was added and was made up to 100ml. After 5 minute before 10 minute the reading were taken at 540nm in a UV-spectrophotometer [19]. The final concentration can be measured by obtaining calibration curve by absorbance versus concentration.

Estimation of methylene blue

The effluent (50ml) from the outlet was taken in a conical flask. The sample were filtered using whatman filter paper from this filtered sample the absorbance of methylene blue in the effluent was analyzed using UV-spectrophotometer by monitoring the absorbance changes at a wavelength of absorbance 668nm. The concentration were measured by

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the calibration curve. The final concentration can be measured by obtaining calibration curve by absorbance versus concentration.

Methods of adsorption studies

These experiments were conducted in a glass column (1.5 mm internal diameter and 80 cm height). The calibration curve was prepared by plotting a graph of concentration versus absorbance. Initially the concentration of Cu(II), Cr(VI) and methylene blue solution was 100 mg/L, flow rate 10ml/min and bed depth 28 cm. The pH of Cu(II), Cr(VI) and methylene blue solution was adjusted by adding 0.1 mol/L nitric acid or NaOH solution. The mixture of fly ash and rice husk was filled into a glass column (1.5 mm in diameter and 80 cm in height). The solution was pumped to the column in an up-flow direction by a peristaltic pump at a certain rate. Samples were collected at regular intervals in all the adsorption.

The final absorbance reading of Cu(II), Cr(VI) and methylene blue of the solution in the effluent was analyzed using a UV spectrophotometer by monitoring the absorbance changes at a wavelength of maximum absorbance of (Cu(II) 457nm, Cr(VI) 540nm and methylene blue 668 nm) and the final concentration was obtained by calibration Curves. Experiments of three different bed depth 8.0 cm, 18 cm and 28 cm were operated at the same influent concentration (100 mg/L) and flow rate (10 ml/min), respectively. Also the experiments of three different flow rates and four different initial concentrations were operated by keeping all other variables constant.

RESULTS AND DISCUSSION

Effect of pH on % removal

In order to examine the pH variation as well as its effect on Cu(II), Cr(VI) and methylene blue bioadsorption in columns, the adsorption experiments were done at different values from 1 to 7. The figure shows the effect of pH values on adsorption of Cu(II) on to a adsorbent using a plot of pH versus percentage removal. As shown in the figure 1, 2 and 3, when the value of pH was 6.0, the value of percentage removal reached 88.84. Similarly at pH 3 the percentage removal of Cr(VI) is 85.25 and at pH 5 percentage removal of methylene blue is 83.2 were obtained from the figures. Several reasons may be attributed to Cu(II), Cr(VI) and methylene blue adsorption behavior of the sorbent relative to solution pH.

The surface of adsorbent may contain a large number of active sites and Cu(II), Cr(VI) and methylene blue removal can be related to the active sites and also to the chemistry of the solute in the solution. At higher pH the surface of adsorbent particles may get negatively charged, which enhances the positively charged dye cations through electrostatic forces of attraction.

Effect of initial concentration on % removal

The effect of influent Cu(II), Cr(VI) and methylene blue concentration was shown in the figures 4,5 and 6. As shown in figures, when influent concentration was 100 mg/L, the percentage removal of Cu(II), Cr(VI) and methylene blue is high. This can be explained by the fact that more adsorption sites were being covered as the Cu(II), Cr(VI) and methylene blue concentration increased from 50-100 mg/L and lesser when increased from 100-200 mg/L .

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Effect of bed depth on % removal

The figures 7,8 and 9 shows that at different bed depth at the same influent concentration 100mg/L and flow rate 10 ml/min the percentage removal of Cu(II), Cr(VI) and methylene blue is high. As the bed height increases, Cu(II), Cr(VI) and methylene blue had more time to contact with adsorbent that resulted in higher removal efficiency of Cu(II), Cr(VI) and methylene blue ions in column. So the higher bed column results in a decrease in the solute concentration in the effluent at the same time. High percentage removal was observed at the highest bed height due to an increase in the surface area of adsorbent, which provided more binding sites for the sorption.

Effect of flow rate on % removal

To investigate the effect of flow rate on Cu(II), Cr(VI) and methylene blue bioadsorption, the influent concentration and bed depth is held constant at 100 mg/L and 28 cm, and the flow rate was 10, 20 and 30 ml/min, respectively. It was shown from figures 10,11 and 12 that decrease in flow rate increases the percentage adsorption of Cu(II), Cr(VI) and methylene blue. When at a low rate of influent, Cu(II), Cr(VI) and methylene blue had more time to contact with adsorbent that resulted in higher removal of Cu(II), Cr(VI) and methylene blue ions in column. The reason is that at higher flow rate the rate of mass transfer gets increases, i.e. the amount of metal and dye adsorbed onto unit bed height (mass transfer zone) gets increased with increasing flow rate leading to faster saturation at higher flow rate.

The lines of $t-Z$ at values of flow rate 10 ml/min, 20 ml/min and 30 ml/min were shown in Fig. respectively. The related constants of BDST according the slopes and intercepts of lines are listed in Table 1. From Table 1, as the value of flow rate increased, the rate constant of K_a increased while the adsorption capacity of the bed per unit bed volume, N_0 , decreased. From the values of R^2 it indicated the validity of BDST model for the present system. The BDST model constants can be helpful to scale up the process for other flow rates and concentration without further experimental run. These results indicate that the equation can be used to predict adsorption performance at other operating conditions for adsorption of Cu(II), Cr(VI) and methylene blue onto rice husk.

Table 1. The value of flow rate

Metal/color	Flow rate ml/min	K_a L/mg.min	N_0 mg/L	R^2
Cu(II)	10	1.05×10^{-3}	120	0.97
	20	1.621×10^{-3}	117.2	0.9825
	30	2.44×10^{-3}	116.4	0.978
Cr(VI)	10	1.1×10^{-3}	120.99	0.957
	20	1.8×10^{-3}	119	0.959
	30	2.85×10^{-3}	115.5	0.980
methylene blue	10	1.05×10^{-3}	125.5	0.95
	20	1.92×10^{-3}	119.7	0.967
	30	3.03×10^{-3}	113.4	0.989

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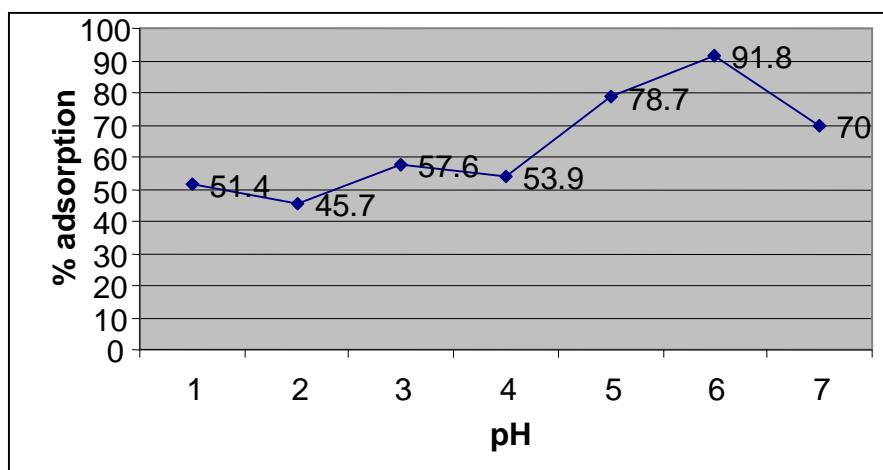
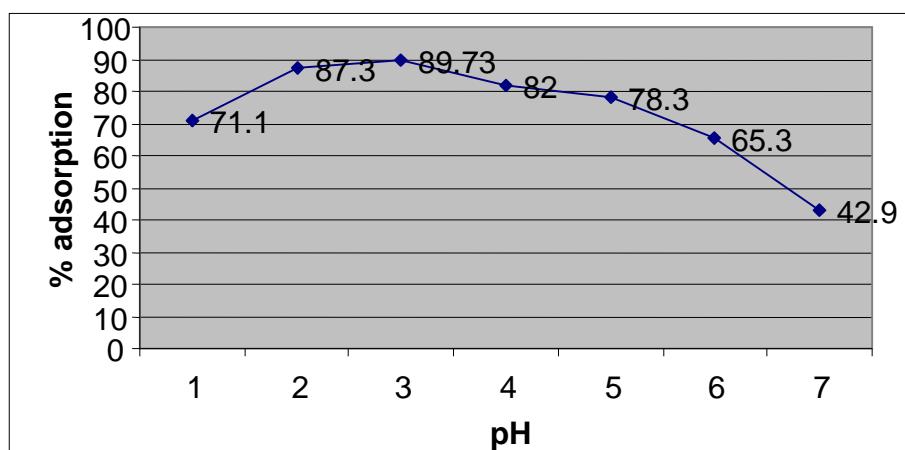
CONCLUSION

The study was mainly focused on the use of mixture of fly ash and rice husk ash as adsorbent for the removal of Cu(II), Cr(VI) and methylene blue from aqueous solution. The study was carried in an up flow fixed bed column. From the present study following conclusion were drawn:

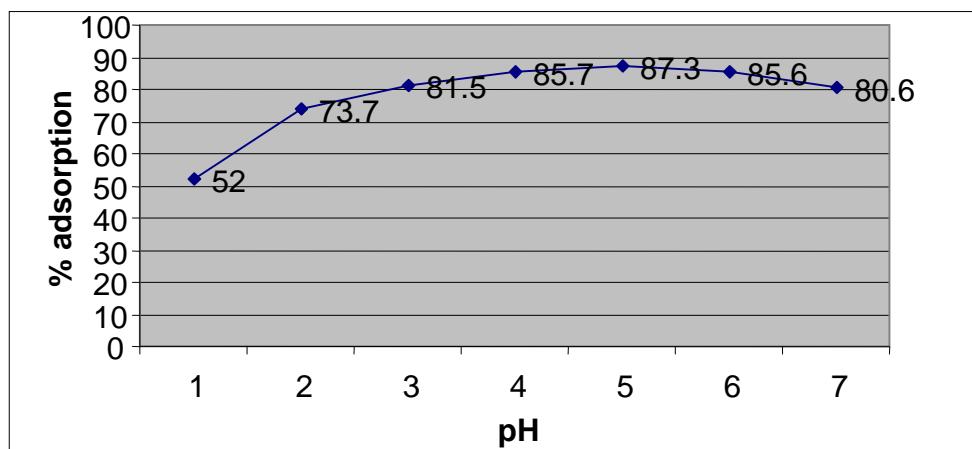
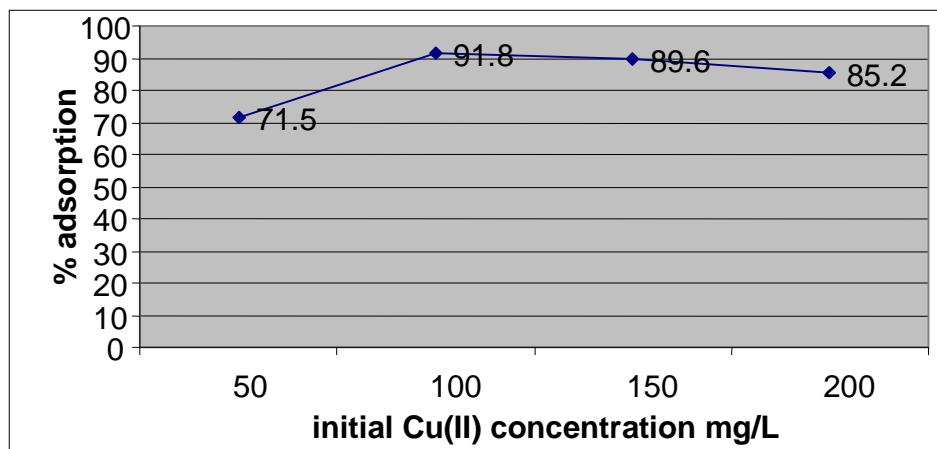
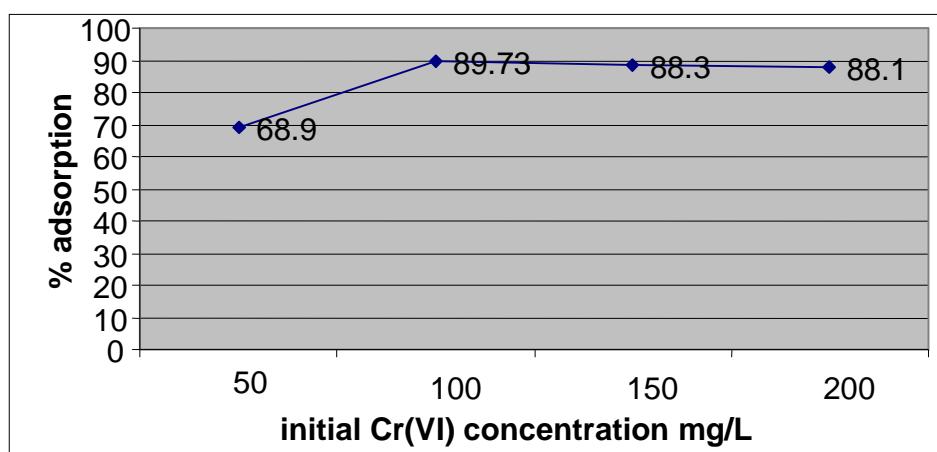
- These studies show that the mixture of fly ash and rice husk ash is an effective and inexpensive adsorbent for Cu(II), Cr(VI) and methylene blue removal from aqueous solutions.
- The adsorption capacity is strongly dependent on the pH, flow rate, inlet Cu(II), Cr(VI) and methylene blue ion, and bed height. As the flow rate increased, the percentage removal decreases and adsorbed ion concentration also decreased.
- Both percentage removal and the time increased with increasing bed height.
- BDST model adequately described the adsorption of Cu(II), Cr(VI) and methylene blue from aqueous solution on to mixture of fly ash and rice husk ash by column mode.
- The percentage adsorption of Cu(II), Cr(VI) and methylene blue are 91.8, 89.73 and 85.7.
- The highest percentage adsorption of Cu(II) is at pH of 6, Cr(VI) is at pH of 3 and methylene blue are at pH of 5.

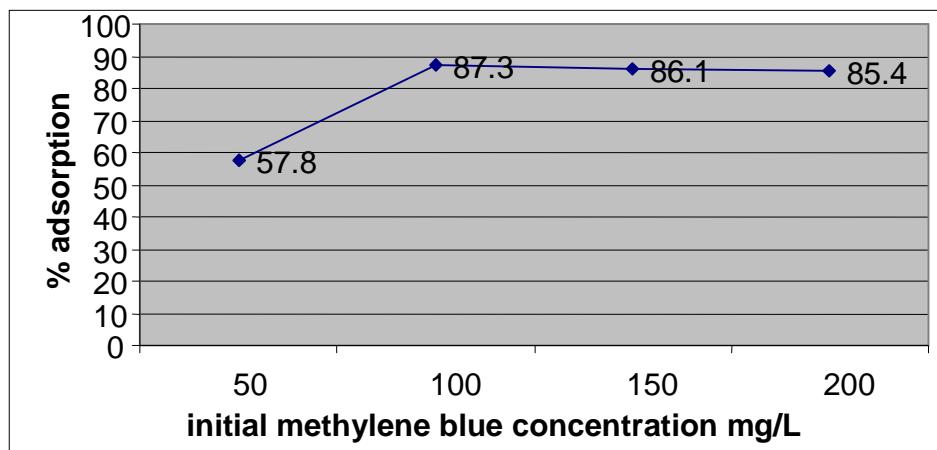
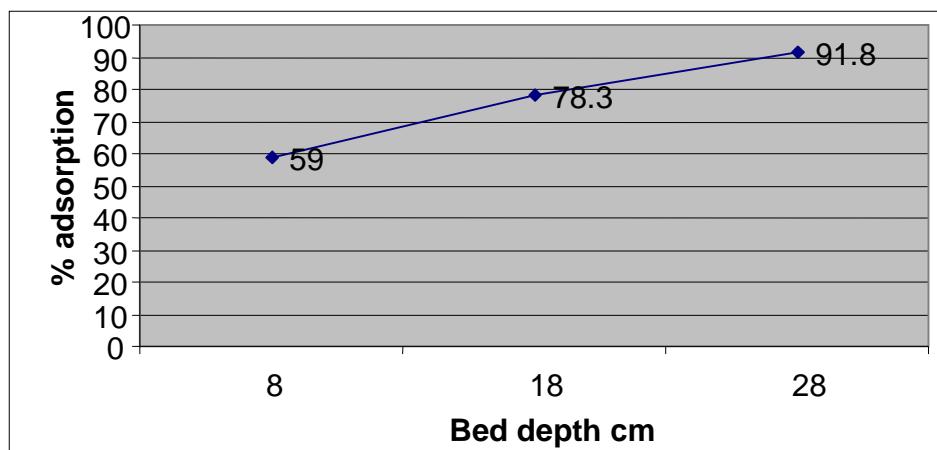
ACKNOWLEDGEMENT

Authors are very much thankful to the management and principal of college of engineering, bagalkot, India for permitting and providing the necessary facilities to conduct the experimental work.

Abdul Samad Kamdod et al**Figure1. Effect of pH on % removal of Cu(II)****Figure2. Effect of pH on % removal of Cr(VI)**

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**Figure3.** Effect of pH on % removal of methylene blue**Figure4.** Effect of initial Cu(II) concentration on % removal**Figure5.** Effect of initial Cr(VI) concentration on % removal

Abdul Samad Kamdod et al**Figure6. Effect of initial methylene blue concentration on % removal****Figure 7. Effect of bed depth for Cu(II)**

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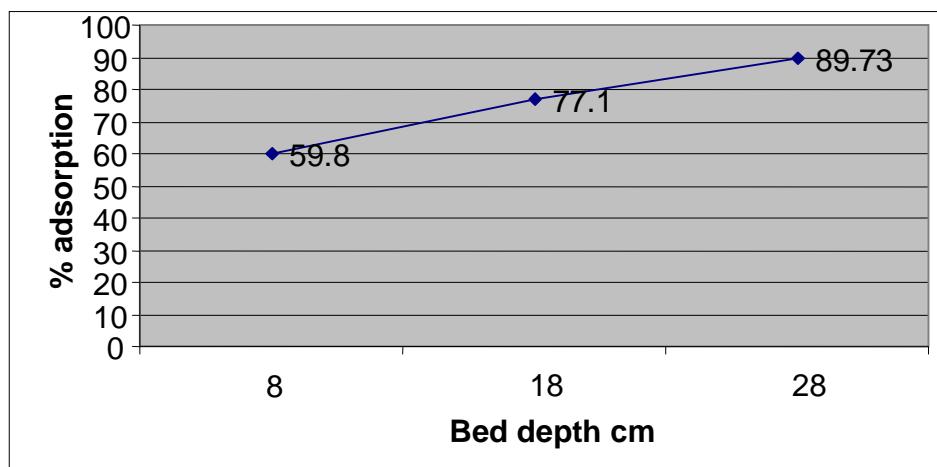


Figure8. Effect of bed depth for Cr(VI)

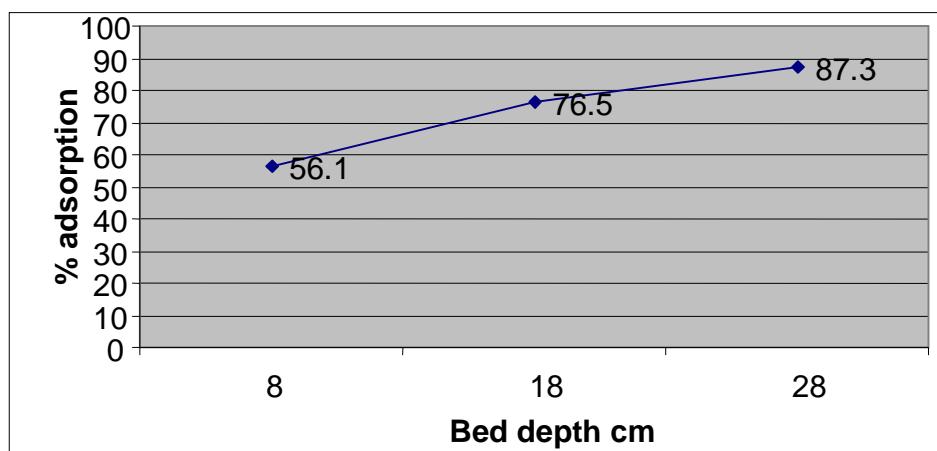


Figure9. Effect of bed depth for methylene blue

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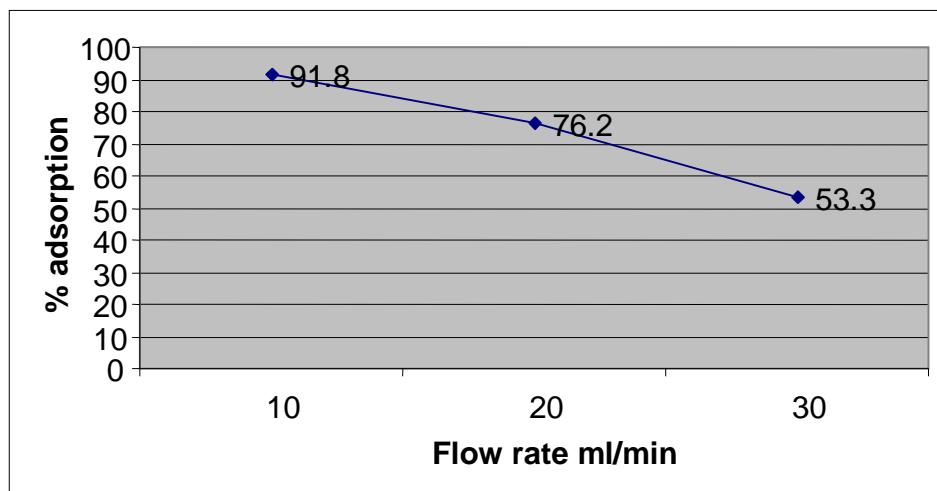


Figure10. Effect of flow rate on Cu(II)

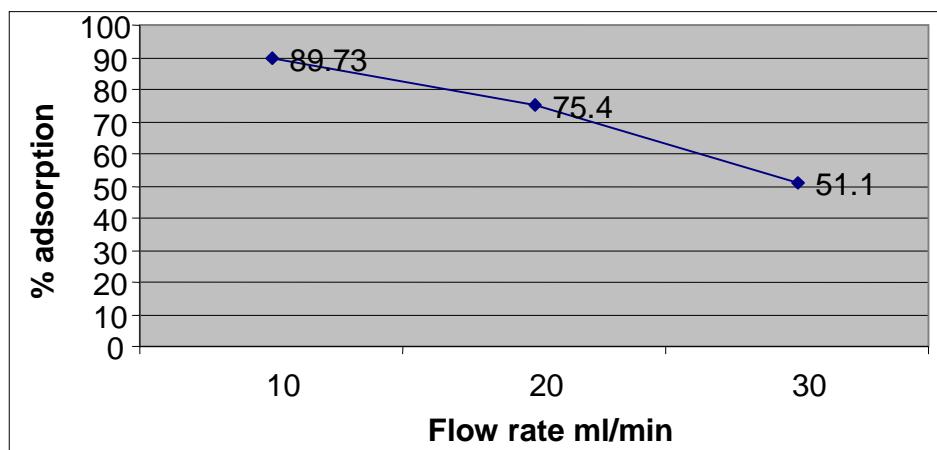
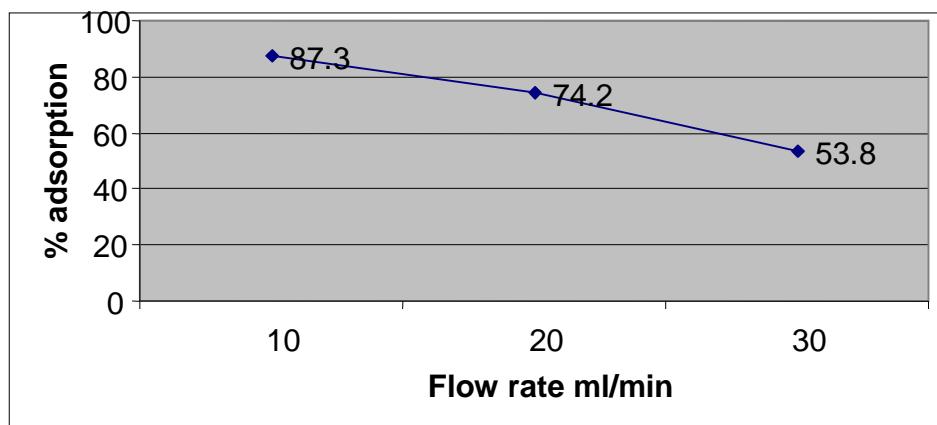
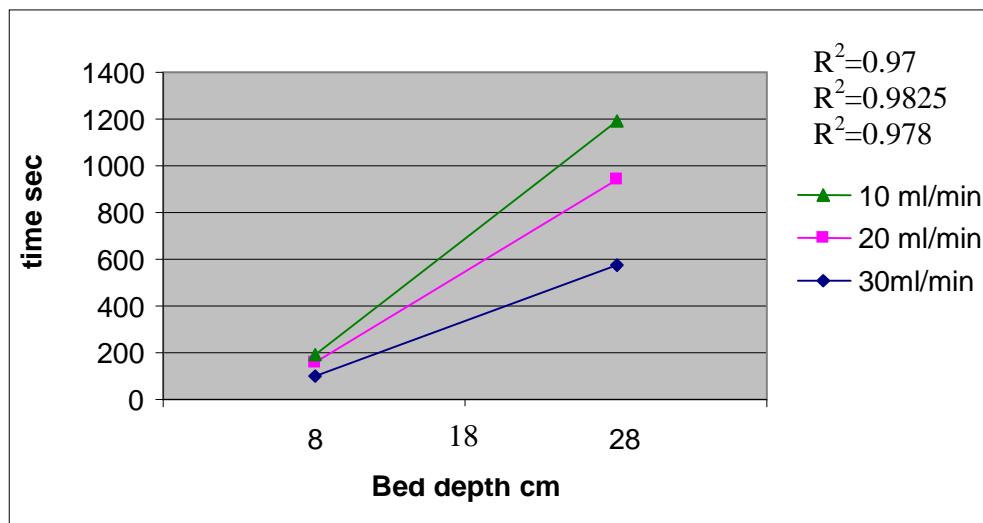


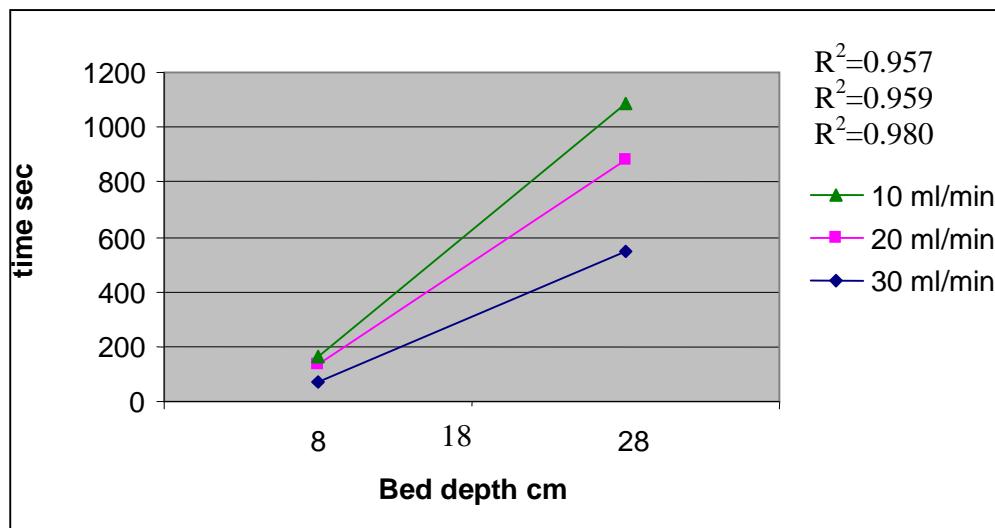
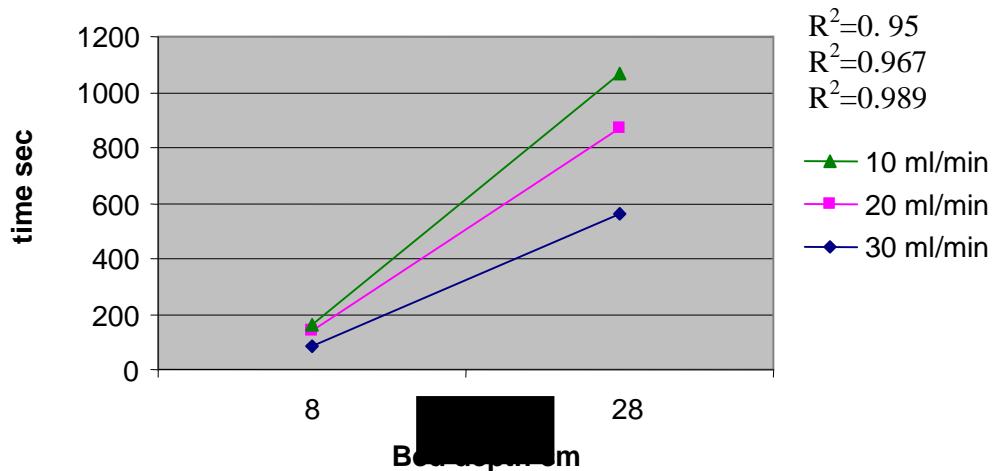
Figure11. Effect of flow rate on Cr(VI)

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**Figure12.** Effect of flow rate on methylene blue

Calculated constants of BDST model for the adsorption of Cu(II), Cr(VI) and methylene blue using linear regression analysis ($C_0=100\text{mg/L}$, Bed depth=28cm)

**Figure13.** BDST plot for Cu(II)

Abdul Samad Kamdod et al**Figure14. BDST plot for Cr(VI)****Figure15. BDST plot for methylene blue**

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Ethno medicinal use of Pteridophyte from Kolli hills Eastern Ghats, Namakkal District, TamilNadu, India.

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ABSTRACT

The present communication deals with the ethno medicinal usage of pteridophytes in the treatment of various diseases. These pteridophytes are widely used by the local tribes and the plant material is sold in the local market of kollihills and Senthamangalam. They grow naturally in rock crevices and boulders near water stream in shady and moist places. The present study documents ethno medicinal usage of Fourteen pteridophyte plants, Which are prevalent in the study area along with botanical name, family, vernacular name, distribution in kollihills, plant parts are used and mode of use.

Key words : Ethnomedicine, Pteridophytes, Kollihills, Medicinal properties.

INTRODUCTION

Pteridophytes are primitive vascular plants. These fascinating groups of plant are always attracting the botanist and naturalist all over the globe not only because of its beautiful and unique foliage but also because of their useful aspects. They grow luxuriantly in moist tropical and temperate forests and their occurrence in different eco-geographically threatened regions from sea level to the higher mountains are of much interest. In comparison to higher plants they have found very little applications in medicine. The tribal communities, ethnic groups and folklore throughout the world are utilizing their plants parts like rhizome, stem, fronds, pinnae and spores in various ways for the treatment since ancient time. According to a recent survey in member states of the European Union, the herbal medicinal preparations from the plants including Pteridophytes are widely used by local population in Europe.

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Herbal preparations have been found to be highly popular in primary healthcare in China, Malaya, Nepal, Myanmar, Belgium, France, Germany and Netherlands. Of late, developed countries too are turning towards traditional medicinal systems that involve the use of herbal drugs. The numbers of contributions about the taxonomy, ecology and distribution of pteridophytes have been published from time to time but enough attention has not been paid towards their useful aspects. An attempt has been made to explore indigenous and ethno medicinally important pteridophytes and properly document their useful aspects.

MATERIALS AND METHODS

In the present study an intensive survey was made (field survey) in various places namely, Solakkadu, Semmedu, Kuzhivalavu shoal, Nachiyarkovil, Arapallieeswararkovil and Sengari shola of Kollihills. During the course of survey ferns and ferns allies were collected and the herbarium was made. All the specimens were compared and identified with the standard herbarium available in St. Xavier's College, Palayamkottai, Tirunelveli, Tamilnadu, India. The voucher specimens were kept and preserved in Kandaswami Kandar's College, P. Velur, Namakkal District, Tamilnadu, India.

Studyarea

Kolli hills of Eastern Ghats lies in Namakkal District, Tamilnadu is well known for its rich biological diversity. It has a total area of 490 km². Kolli hills is flanked by Namakkal taluk on the south and south west, Rasipuram on the north and north east. Attur taluk is on the north east and Tiruchirappalli district in the east. The altitude ranges from 1000-1400 m rising to 1450 m at Kuzhivalavu (11°10'30" N and 75°15'75" E). Kollimalai is called as Chaturagiri or Square hill contain of high rising peaks an ravines. Slopes are quite steep forming several narrow and deep valleys and in same places rising abruptly from plains and generally steep near ridges. Kollihills is drained by two rivers, Vasisthanadhi and Swetanadhi. Swetandhi originates from kollihills and drains the northern side of Salem district. Vasisthanadhi is called as Peyer and originates from the Aranuttamalai, turns eastwards and which is an irrigation resource to Attur Taluk. Kollihills is an isolated hill range of the discontinuous Eastern Ghats mountain system situated in the Namakkal district of Tamil Nadu, Kollihills has an area of 282.92 sq.km. It stretches around 29 km north to south and 19 east to west. Kollihills on the western, eastern and southern sides rise abruptly from the plains and are thickly forested. The northern sides descend to the plains by gentle slopes, and mostly under agriculture.

RESULTS AND DISCUSSION

All known 14 species of Pteridophyte from the study area are enumerated with botanical name, family, vernacular name, mode of use and parts of used.

1. *Lygodium microphyllum* (L.) Sw. (Lygodiaceae)

Vernacular name : Kalijar

Terrestrial and climbing ferns grow on bushes and trees or trailing on the ground along the edges of forest in gravelly and sandy soil.

Collection site : Mekkenikadu

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Ethnomedicinal use : Fronds boiled with mustard oil is used as local application for carbuncles, rheumatism, sprains, scabies, ulcers and cut wounds. Extract of stems and rhizome is taken orally twice a day for a week for curing sexual diseases like gonorrhoea and spermatorrhoea. The paste of fresh leaves is applied on the piles. An infusion of plant is used in menorrhagia. Plant is considered to have antibacterial properties. Spores cure high fever.

2. *Cheilsanthes farinose* (Forsk.) Kaulf. (Cheilanthaceae)

Vernacular name : Nanha

Small plants grow on rock erevices in dry and exposed places.

Collection site : Mathikettan sholai, Arapalleeswararkovil, Kulivazhavu sholai.

Ethnomedicinal use : Extract of rhizomes and leaves is given twice a day for five days to cure urine problems and epilepsy.

3. *Cheilsathes tenuifolia* (Burm.) Sw. (Cheilanthaceae)

Vernacular name : Dodhari

Abundantly grow in dry situations and exposed places.

Collection site :Kulivazhavu sholai

Ethnomedicinal use : Preparation made from roots is given for sickness attributed to evil eye or witchcraft. It is used as tonic and the paste of roots with 'Karanj oil' is applied on wounds for a week.

4. *Dryopteriscochleata*(Ham. Ex D.Don) C.Chr (Dryopteridaceae)

Vernacular name : Jatashankari

Lithophyticfern, commonly grows along the sides of streams and nala in the forest floor in laterite soil.

Collection site :Solakkadu, Semmedu, Arapalleeswararkovil.

Ethnomedicinal use : Rhizome has antifungal property and is used as antidote. Juice extract of the dried rhizome is given in epilepsy and leprosy. The paste of fresh rhizome, stem and stipe is externally applied on cuts, wounds, ulcers, swelling and pains. Fresh paste of rhizome and fronds is externally applied on snake and dog bites. The decoction of dried rhizome, stem and stripe is used for blood purification and as tonic for strength.

5. *Tectacria coadunata* (Wakk.ex Hook.et Grev.) C.Chr. (Tectariaceae)

Vernacular name : Jatamasi

Lithophytic fern commonly grows in the rock crevices, boulders in moist place and along the stream.

Collection site :Mathikettan sholai, Arapalleeswararkovil.

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Ethnomedicinal use : Rhizomes are anthelmintic. The decoction of fresh rhizome and stipe is given in stomach pain, gastro-intestinal disorders and eradication of worm in children. Extraction of dried rhizome, stem and stipe is used in respiratory disorders like cold, cough, asthma and bronchitis. Fresh rhizome and fronds paste is used in insect bites or getting relief in centipede bite. The plant is popular amongst tribals as strength tonic. The young leaves are used as vegetable curry.

6. *Angiopteris evecta*(Frost) Hoff. (Angiopteridaceae)

Vernacular name : Ghora top

Grow on moist slopes. Near water falls, on deep forest floor.s

Collection site :Kulivazhavu sholai

Ethnomedicinal uses : Rhizome erect. Cylindrical and apex densely covered by dark brown hairs. Stipular at the base, abaxially rounded, adaxially flattened, bearing whitish lines streaks -lall over, globrous. Lamina deloid, bipinnate, pinnae upto 16 pairs, sub oppsite with about 3cm long stalk, oblong-lancolate. Margin serrate in the distal part of the pinnae, costa slightly raised and rounded above and below, veins distinct and slightly raised above and below. Pinnae dark green, glabrous expect the occurrence of few small, pale brown. Soft textures herbaceous.Sorisub marginal, ellipsoid, sporangia upto six pairs in two rows, compact. Free spores trilete, upto 20mm in diameter, pale green, exine sparsely granulose.

7. *Actiniopteris radiate* (Sw.) Link. (Actinopteridaceae)

Vernacular name : Morpankhi

Grow on Rock and expersed places near Road ways.

Collection site : Mekkenikadu

Ethnomedicinal uses : Rhizome sub erect, subglobose, densely covered by scales; scales lancolate, pale brown at the periphery, apex acuminate, pointed , margin entire Stipes numerous, tufed. Lamina flabellate.Semi-circular or wedge-shaped, upto 3.5×5.5 cm.dichotomously divided up to six times, segentsrachiform, apex acute. Margin entire; veins, obscure in mature frond, lamina pale green.Texture coriaceous soft, pale brown.Sporangia borne in intramarginal grooves throughout, protected by the segment; Spores tritete, $50\times50\mu\text{m}$, verrucate on the proximal side.

8. *Adiantum capillus-veneris* L., (Adiantaceae)

Vernacular name : Maiden hair fern

Grow luxuriently in shady, moist and along the stream line.

Collection site :Kulivazhavu sholai

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Ethnomedicinal uses : Rhizome long creeping, densely clothed by lanceolate, acuminate, entire, stipes, scaly at base, glossy above. Lamina bipinnate, lanceolate, base cuncate, pinnae ascending, basal two to three pairs bipinnate, up to 18×4cm, upper ones pinnate, pinnules stalked, parallelogram-like, flabellate, ovoid, lower edge V-shaped, entire; veins dichotomously branched, branches of the first dichotomy dark brown. The rest greenish, indusium reniform or rectangular, translucent spores trilete, 46µm in diameter, exine bearing leasurae.

9. *Dicranopteris linearis*(Burm.,f.) Underwod (Gleicheniaceae)

Vernacular name : Thicket fern

Grow on bushes in edges of the forest.

Collection site :Kulivazhavu sholai

Ethnomedicinal uses : Rhizome up to 3mm thick, densely hairy, Stipes scattered, about 60×0.25cm, grey brown, glabrous. Lamina about 40 60cm, primary branch two or three pairs, about 15cm apart, forked one or two times; secondary branches lobed or auricled; ultimate leafy branch about 20×s 4, ob lanceolate, acuminate, pinnatifid up to 1-2 mm to the costa, leaf segments 2×0.3cm, oblong, slightly narrowed towards notched apex, veins forked two or three times; pinnae pale green or glaucous green, almost glabrous. Sorisubmedian on the venilets, consisting of about 12 sporangia per sorus; spores 35µm in diameter, pale green, exine smooth.

10. *Drynaria quercifolia* (L.,) j. Smith (Polypodiaceae)

Vernacular name : Ashvakatri

Terrestrial and Lithophytic fern, occurring on Rocks hanging in walls of the buildings.

Collection site : Mekkenikadu

Ethnomedicinal uses : Rhizome short creeping, densely clothed by scales; scales; linear-lanceolate, uniformly pale brown to dark brown, apex long acuminate, margin shallowly lobed, midrib and primary veins distinctly raised above and below, secondary and tertiary veins slightly raised above and below. Veins inter connected; stipes up to 22 0.7cm grey-brown, abaxially rounded grooved, narrowly winged on either side, glabrous all over. Lamina oblong up to 77×50 cm, pinnately lobed terminated by a pinnule similar to the lateral ones, base decurrent; lobes up to 15 pairs, basal pairs much reduced; oblong-lancolate, margin entire, pinnae pale green, glabrous, texture coriaceous. Sori seated at the juncture of vein. More or less in two rows along each primary veins, orbicular, exindusiate; spores reniform, 50×30µm, pale brown. Exine finely spinulose.

11. *Marsilea minuta* L. (Marsileaceae)

Vernacular name : Water clover

Collection site : Mathikettan sholai, Arapalleeswararkovil, Kulivazhavu sholai.

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Ethnomedicinal uses : Rhizome long creeping, branched, subterranean, about 30cm long, green in aquatic plant, pale or dark brown in terrestrials, covered by about 5×0.25mm, whitish, soft, slender hairs sparsely or densely all over; roots borne usually on nodes, rarely on internodes. Stipes scattered, about 1cm apart, usually green, rarely pale or dark brown tereteglabrous or whitish few hairs as in rhizome. Leaves four, sessile, arranged at the tip of the stipe in clover leaf model, obovate or wedge shaped, base cuneate, lateral margin entire, veins distinct above and below, flabellately branched. Leaves pale of dark green, glabrous with few hairs; texture thin, soft herbaceous. Sporocarps borne at the nodes in clusters alternately, fove per cluster, peduncle 7×1mm; microsporangia and megasporangia enclosed in the same sporocarp and covered by gelatinous layers; microspores yellowish-brown, globose, 40µm in diameter with distinct exine and intine; megaspores ovate, starch granules and numerous oval-shaped oil globules.

12. *Selaginella tenera* (Hook & Grev.) (Selaginellaceae)

Vernacular name : Sajivani

Terrestrial grow in bushes under the shady and moist places.

Collection site : Kulivazhavu sholai

Ethnomedicinal uses : Stem erect, rooting at the base only, green to pink colour when fresh and stramineous to pind colour when dry. Leaves simophic throughout continuous on main stem and on axis of primary branches, lateral leaves 3×1.5mm, oblong-ovate, obtuse or sub-acute, denticulate on the acroscopic, margin lateral Sporophylls bear mega sporangia; others with micro sporangia, microspores brick red mass, 20µm in diameter with thick wavy lea sure; megaspore 150µm.

13. *Pteridiumss aquilinum* (L.) Kuhn (Dennstaedtiaceae)

Vernacular name : Bracken fern

Terrestrial grown in cultivated lands, edges of forest and exposed places.

Collection site : Mekkenikadu

Ethnomedicinal uses : Rhizome long creeping subterranean. Densely covered by about 5mm long, pale brown, multicellular. Stipes scattered, dark brown to black and hairy at the base, pale brown to stramincous and glabrous above, abaxially rounded, adaxially grooved. Lamina deltoid-ovate, acute, broadly cuncate, tripinnatifid at the base, primary pinnae about eight pairs. Opposite or sub opposite, ascending, largest primary pinna up to 60×30 cm, ovate-lanceolate, acuminate, secondary pinnae up to 12 pairs per primary pinna, alternate above shortly stalked or sub sessile, oblong-lanceolate, acuminate, pinnacles up to 20 pairs per secondary pinna. Alternate sessile. Sorifimbricate reflexed margin above and thin small fimbriate membrane below.

14. *Dryopteris cochleata*(Buch. Ham. Ex D. Don) (Dryopteridaceae)

Vernacular name : Kakolisag

Terrestrial, grow on ground along the edges of forest.

Collection site : Mathikettan sholai, Arapalleeswararkovil.

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Ethnomedicinal uses : Rhizome short creeping densely clothed by scales all over, scales lanceolate, pale brown, thin, memberanaceous, translucent. Apex long acuminate, margin with tooth like or glandular hair like out growth or with long lateral branches. Stipes up to 32×0.5cm, grey-brown whendry, scaly below, fronds dismorphic; lamina lanceolate, bipinnate; sterile lamina about 40×19 cm, fertile one much contracted. Pinnae up to 10 pairs, ascending shortly stalked, subopposite, pinnae pale green; texturesubcoriaceous, long soft pale brown. Fertile pinnule up to 1.5×0.3cm, acute, apex aacute; spores dark brown. 50×40 μm , with uniformly anastomised and heavily thickened perisporium.

DISCUSSION

Pteridophytes (Ferns and Fern allies) by virtue of their possessing great variety and fascinating foliage have drawn the attention admiration of horticulturists and plant lovers for several centuries. They are represented by about 305 genera comprising more than 10,000 species all over the world. About 191 genera and more than 1000 species are reported from India [1, 2]. The pteridophytes are known to man for more than 2000 years for their medicinal values [3, 4, 5, 6 & 7] mentioned various Pteridophyte plants to be antimicrobial in nature.

Quite a number of ferns and ferns allies are of great medicinal value, among them mention may be made of *Equisetum arvense* Linn. This is used in nasal polyps and kidney infections, ashes useful in acidity. *E. debile* Roxb, is diuretic and given in gonorrhoea. *Lycopodium clavatum* Linn., in the form of decoction used in rheumatism and diseases of lungs and kidneys. The paste of the leaves of *Ophioglossum reticulatum* Linn., is used in headache. *Botrychium virginianum* Sw. used in dysentery. *Helminthostachys zeylanica* (Linn.) Hook is used for vitality and brain tonic. *Lygodium flexuosum* (Linn.) Sw., is an expectorant and used in ulcers, cut wounds and sprains. The fronds of the gleicheniaceous fern *Dicranopteris linearis* (Burm.) under wood are used for asthuma and in sterility. The plants of the 'royal fern' *Osmunda regalis* Linn are styptic and tonic. The rhizomes of *Angiopteris evecta*(Forst.) Hoffm. are used for scabies [8].

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REVIEW ARTICLE

Heavy Metal Pollution and Plants

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ABSTRACT

Heavy metals like cadmium, selenium, arsenic, iron, molybdenum, lead, nickel, tin, zinc etc are present in nature in the trace concentration. Recent studies from all over the world reveals that the urban environment in most of the countries is contaminated by heavy metals. And one of the main sources is from vehicular activities or movement especially automotive vehicles. Some heavy metals are present in leaded diesel, automobile oils, and in lubricants. These metals are also universally present in soil, water, air, and biota. Particularly plants leaves act as good receptors of the particulate emission produced by automobile exhaust, industries and miscellaneous anthropogenic activities. This study provides baseline information on air pollution in the investigated area for the systematic future industrial development and by planting those plant species which are capable of absorbing particular air pollutants.

Key words: Iron, manganese, zinc, copper, lead, automobile exhaust, anthropogenic activities and industrialization

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INTRODUCTION

Air pollution is one of the severe problems world facing today .It deteriorates ecological condition conditions and can be defined as the fluctuations in atmospheric constituents, from the value that would have exited without human activity [1].In resent past air pollutants, responsible for vegetation injury and crop yield losses ,are causing increased concern [2].Urban air pollution is serous problem in both developing and developed countries [3].The increasing number of industries and automobiles vehicles are continuously adding toxic gasses and other substances to the environment [4].

Metals are ubiquitous in the modern industrialized environment. The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb) etc.Development of urban areas has been reflected in terms of pollution. A sudden increase in the automobile traffic and industries in the city have substantially increased the level of air contaminants in the urban areas. Major contributor to pollution is the automobile traffic. The atmosphere is a dynamic system consisting of four principal zones; troposphere, stratosphere, mesosphere and the atmosphere. The zone closet to the earth is the troposphere and is of greatest concern for the transport of pollutants. Temperature and winds are a major influence on the rate and volume of movement of pollutants in the atmosphere. It could be observed that the plants particularly leaves act as good receptors of the particulate emission produced by automobile exhaust, industries and miscellaneous anthropogenic activities. Many plants can be used as indicators of pollutants in air and the responses of these can be related to known concentrations of specific air pollutants [5]; [6] and [7]. So plants can indicate both the presence and also monitor concentrations of the air pollutant. Many studies have shown that trace elements such as Cd, Pb, Zn, Cu, Mn, Fe, Cr and Ni are found deposited on plant leaves [8], [9] and [10]. Higher vascular plants and many lower non-vascular plants are also used in the abatement of pollutants [11]

Recent studies from all over the world reveals that the urban environment in most of the countries is contaminated by heavy metals. And one of the main sources is from vehicular activities or movement especially automotive vehicles. Some heavy metals are present in leaded diesel, automobile oils and in lubricants. These metals are also universally present in soil, water, air and biota. Particularly plant leaves act as good receptors of the particulate emission produced by automobile exhaust, industries and miscellaneous anthropogenic activities.

Macro nutrients= macro elements =major elements

Those elements which are required in large quantities (More than 100 mg/liter) are called macronutrient or macro element. They usually participate in body construction and are ten in number (C, H, O, N, S, P, K, Mg, Ca and Fe)Nutrients are substances needed for growth, metabolism and for other body functions. Macronutrients are nutrients that provide calories or energy. The prefix macro is from the Greek and means big or large used because macronutrients are required in large amounts. There are three broad classes of macro-nutrients: proteins, carbohydrates and fats.

Micro nutrients=micro elements=minor elements=trace elements

Those elements which are required in smaller quantities (100mg/liter of water) are called micro elements or trace elements. They usually participate in various metabolisms and are six in number (B, Mn, Zn, Cu, Mo and Cl) .Micronutrients are nutrients required by humans and other living things throughout life in small quantities to orchestrate a whole range of physiological functions, but which the organism itself cannot produce. For people, they

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include dietary minerals in amounts generally less than 100 micrograms/day [citation needed] as opposed to macro minerals which are required in larger quantities. The micro minerals or trace elements include at least iron, cobalt, chromium, copper, iodine, manganese, selenium, zinc and molybdenum. Micronutrients also include vitamins, which are organic compounds required as nutrients in tiny amounts by an organism.

Some heavy metals and their effects in Plants

Iron

Iron is a chemical element with the symbol Fe and atomic number 26. It is a metal in the first transition series. It is the most common element in the whole planet Earth, forming much of Earth's outer and inner core, and it is the fourth most common element in the Earth's crust. Iron (Fe) deficiency is a plant disorder also known as "lime-induced chlorosis". It can be confused with manganese deficiency. A deficiency in the soil is rare but iron can be unavailable for absorption if soil pH is not between about 5 and 6.5. A common problem is when the soil is too alkaline (the pH is above 6.5). Also, iron deficiency can develop if the soil is too waterlogged or has been over fertilized. Elements like calcium, zinc, manganese, phosphorus or copper can tie up iron if they are present in high amounts.

Iron is needed to produce chlorophyll; hence its deficiency causes chlorosis. For example, iron is used in the active site of glutamyl-tRNA reductase, an enzyme needed for the formation of 5-Aminolevulinic acid which is a precursor of heme and chlorophyll. Symptoms of Iron (Fe) deficiency include leaves turning yellow or brown in the margins between the veins which may remain green, while young leaves may appear to be bleached. Fruit would be of poor quality and quantity. Any plant may be affected but raspberries and pears are particularly susceptible, as well as most acid-loving plants such as azaleas and camellias. The permissible level of iron in plants are (if it is less than 1.0 to 49.99 PPM then it is deficient, if it between 50 to 250 PPM then it is medium if it exceeds more than 251 PPM then it is more)

Manganese

Manganese is a chemical element, designated by the symbol Mn. It has the atomic number 25. Manganese is found as a free element in nature and in many minerals. As a free element, manganese is a metal with important industrial metal alloy uses, particularly in stainless steels. Manganese (Mn) deficiency is a plant disorder that is often confused with and occurs with iron deficiency. Most common in poorly drained soils, also where organic matter levels are high. Manganese may be unavailable to plants where pH is high. Affected plants include onion, apple, peas, French beans, cherry and raspberry, and symptoms include yellowing of leaves with smallest leaf veins remaining green to produce a 'chequered' effect. The plant may seem to grow away from the problem so that younger leaves may appear to be unaffected. Brown spots may appear on leaf surfaces, and severely affected leaves turn brown and wither.

Zinc

Zinc, also known as spelter, is a metallic chemical element; it has the symbol Zn and atomic number 30. Zinc is the first element in group 12 of the periodic table. Zinc is, in some respects, chemically similar to magnesium, because its ion is of similar size and its only common oxidation state is +2. Zinc is the 24th most abundant element in the Earth's crust and has five stable isotopes. Zinc is an essential component of various enzyme systems for energy production, protein synthesis, and growth regulation. Zinc deficient plants also exhibit delayed maturity. Zinc is not mobile in plants so zinc-deficiency symptoms occur mainly in new growth. Poor mobility in plants suggests the need

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for a constant supply of available zinc for optimum growth. The most visible zinc deficiency symptoms are short internodes and a decrease in leaf size. Delayed maturity also is a symptom of zinc-deficient plants.

Zinc deficiencies are mainly found on sandy soils low in organic matter and on organic soils. Zinc deficiencies occur more often during cold, wet spring weather and are related to reduced root growth and activity as well as lower microbial activity decreases zinc release from soil organic matter. Zinc uptake by plants decreases with increased soil pH. Uptake of zinc also is adversely affected by high levels of available phosphorus and iron in soils. The permissible level of Zinc in plants are (if it is less than 0.1 to 19.99 PPM then it is deficient, if it between 20.00 to 100.00 PPM then it is Medium. If it exceeds more than 101 PPM then it is more)

Copper

Copper is a chemical element with the symbol Cu and atomic number 29. It is a ductile metal with very high thermal and electrical conductivity. Pure copper is soft and malleable; an exposed surface has a reddish-orange tarnish. It is used as a conductor of heat and electricity, a building material and a constituent of various metal alloys. It is one of the most important metals used in industries. Copper mining and metallurgical operations largely contribute to contamination of aquatic environment. It is used in paints and ceramics. Most of the paints contain 100-200g copper oxide per liter. Some of the copper salts are used as algaecides and fungicides. Copper contaminates the atmosphere on account of release from industries producing nonferrous metals. In addition to wood combustion and steel/iron industries and copper is necessary for carbohydrate and nitrogen metabolism and inadequate copper results in stunting of plants. Deficiency symptoms of copper are dieback of stems and twigs, yellowing of leaves, stunted growth and pale green leaves that wither easily. Copper deficiencies are mainly reported on sandy soils which are low in organic matter. Copper uptake decreases as soil pH increases. Increased phosphorus and iron availability in soils decreases copper uptake by plants. The permissible level of Manganese in plants are (if it is less than 0.01 to 1.99 PPM then it is deficient, if it between 2.0 to 20.00 PPM and it is medium. If it exceeds more than 21.00 PPM then it is more).

Lead

Lead is a main-group element with the symbol Pb and atomic number 82. Lead is a soft, malleable poor metal. It is also counted as one of the heavy metals. Metallic lead has a bluish-white colour after being freshly cut, but it soon tarnishes to a dull greyish colour when exposed to air. Lead has a shiny chrome-silver luster when it is melted into a liquid. Lead is used in building construction, lead-acid batteries, bullets and shots, weights, as part of solders, pewters, fusible alloys and as a radiation shield. Lead has the highest atomic number of all of the stable elements, although the next higher element, bismuth, has a half-life that is so long that it can be considered stable. Its four stable isotopes have 82 protons, a magic number in the nuclear shell model of atomic nuclei.

Lead is a poisonous substance to plants and animals. In plants it damages the entire plant body and in animals it damages the nervous system and causes brain disorders. Excessive lead also causes blood disorders in mammals. Like the element mercury, another heavy metal, lead is a potent neurotoxin that accumulates both in soft tissues and the bones. Lead poisoning has been documented from ancient Rome, ancient Greece, and ancient China. It was once commonly used in pipes, solder, roofing, paint and antiknock compounds in gasoline, but its use in these products has been curtailed because of its toxicity.

CONCLUSION

Development of urban areas has been reflected in terms of pollution sudden in the automobile traffic and industries in the city have substantially increased the level of air contaminant in the urban areas major contributor to pollution is the automobile traffic. This study provides baseline information on air pollution in the investigated area for the systematic future industrial development and by planting those plant species which are capable of absorbing these air pollutants, it is also concluded that the deficiency accrued in plants due to some of the deposition of certain heavy metals.

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