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Original Article

Biochemical, Nutritive and Cooking Quality of Edible Green Leaf – *Alternanthera Sessilis* (L.) R.Br. Ex Dc

Anitha T.*, Mary Josephine R.*

Abstract

Green leafy vegetables are important protective foods and highly beneficial for the maintenance of health and prevention of diseases. Green leafy vegetables are valuable in maintaining alkaline reserve in the body and are valued mainly for their high vitamin, dietary fibre and mineral contents. Dry leaf extract of *Alternanthera sessilis* (L.) R.Br. ex DC. was evaluated for biochemical compositions like total carbohydrate, starch, proteins, aminoacids, Vitamin B1 and Vitamin B2. The cooking qualities were also analyzed for total carbohydrate, starch and proteins at different intervals of time. The biochemical compositions obtained suggest that the leaves, as a cheap source and can be incorporated into human diet to meet the recommended daily allowances.

Keywords: Biochemical; Mineral; Green Leaf.

Introduction

Most developing countries depend on starch-based food as the main staple food for the supply of both energy and protein. India being blessed with a variety of natural surrounding and varying climates and seasons has a number of edible green leafy vegetables. Green leafy vegetables are an important component of the human diet, providing fiber, minerals and vitamins (Acikgoz, 2011; Emebu and Anyika, 2011). Green leafy vegetables are rich sources of vitamins such as â- carotene, ascorbic acid, riboflavin and folic acid as well as minerals such as iron, calcium and phosphorous. They are also recognized for their characteristic color, flavor and therapeutic value. Green leafy vegetables are important protective foods and highly beneficial for the maintenance of health and prevention of diseases. Recognizing the need for identification of such green leafy vegetables, which are believed to be nutritious, may help in achieving nutritional security. The diet and the food based approach in combating micronutrient malnutrition are essential for its role in increasing the availability and consumption of micronutrient rich foods. Green leafy vegetables are important component of the dietary regime of humans because they provide the necessary vitamins and minerals (Fasuyi, 2006). The awareness of the popularity on the significance of nutrition in health has resulted to an increasing quest for biochemical knowledge of composition of foods.

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Alternanthera sessilis (L.) R.Br. ex DC. (Plate - 1)

Taxonomic Position

Division	:	Magnoliphyta
Class	:	Magnolipsida
Order	:	Caryophyllales
Family	:	Amaranthaceae
Genus	:	Alternanthera
Species	:	*Alternanthera sessilis* (L.) R.Br. ex DC.

Alternanthera sessilis (Plate 1) is an aquatic plant known by several common names, including **sessile joyweed** and **dwarf copperleaf**. It is used as an aquarium plant. The plant occurs around the world. This is a perennial herb with prostrate stems, rarely ascending, often rooting at the nodes. Leaves obovate to broadly elliptic, occasionally linear-lanceolate, 1-

15 cm long, 0.3-3 cm wide, glabrous to sparsely villous and petioles 1-5 mm long. Flowers in sessile spikes, bract and bracteoles shiny white, 0.7-1.5 mm long, glabrous, sepals equal, 2.5-3 mm long, outer ones 1-nerved or indistinctly 3-nerved toward base, stamens 5, 2 sterile. The leaves are used as a vegetable. Young shoots and leaves are eaten as a vegetable in Southeast Asia. Occasionally it is cultivated for food or for use in herbal medicines.

The present study was undertaken with the aim to evaluate the biochemical, nutritive and cooking quality of green leafy vegetable, *Alternanthera sessilis* (L.) R.Br. ex DC.

The result of our study can be used as a fundamental data for dietary recommendation to help the consumer to select appropriate cooking time to meet their nutrient and health needs.

Materials and Methods

Collection and Preparation of Sample

The green leaves of *Alternanthera sessilis* were harvested. The leaves were destalked, washed and shade dried to avoid destroying active compounds. The dried leaves were then ground to homogenous powder using willey mill grinder and then stored in a air tight container for further analysis. The sample was then subject to biochemical analysis.

Biochemical Analysis

Biochemical analysis were carried out to find total Carbohydrate, Starch, Protein, Aminoacid, Vitamin B1 and Vitamin B2 according to the procedure of Association of Official Analytical Chemist (Sadasivam and Manickam, 1992). The cooking quality was analyzed for total Carbohydrate, Starch and Proteins.

Results and Discussion

Total Carbohydrate and starch was found to be 3.60 g/100g and 3.24 g/100g (Table 1) in *Alternanthera sessilis* leaves. It has been recommended that carbohydrate in the diet be 55-65% of total energy with emphasis on complex carbohydrate. 40gm of dietary fibre in the daily adult diet is recommended (FAO/WHO, 1998). Carbohydrate and starch has been found to be a poor source in this leaf. Protein is the most important constituent of food since it is required for general growth, maintenance and repair of body tissues. Protein and aminoacid was found to be 0.74 g/100g and 0.225 mg/100g (Table 1) in *Alternanthera sessilis* leaves. For maintenance of nitrogen balance, the minimum protein requirement is 0.51- 0.66g per kg body weight. ICMR has recommended an allowance of 1.0 g per Kg for adults. The requirement for infants and children is 1.5-2.0 g/ Kg. During pregnancy and lactation an additional 10-20g protein is recommended. The amount of Vitamin B1 (Thiamin) was found to be 2.76 mg/100gm (Table 1) in *Alternanthera sessilis* leaf. It acts as a co-enzyme in the carboxylation and transamination reactions in carbohydrate, protein and fat metabolism. The requirement is based on the total energy requirement, composition of diet and cooking losses. The recommended dietary allowances is 0.5 mg thiamin per 1000 kcal of diet. Vitamin B2 (Riboflavin) was found to be 12.64 mg/100g (Table 1) in *Alternanthera sessilis* leaves. It is a constituent of enzymes and amino acid oxidases that is required for oxidation of purines and amino acids. Intake of 0.6 mg of riboflavin per 1000 kcal is recommended for adults. The leaves were rich in vitamins and can be

Plate 1: *Alternanthera sessilis* (L.) R.Br. ex DC.

Table 1: Biochemical composition of *Alternanthera sessilis* (L.) R.Br. ex DC.

Parameters	Composition
Total soluble carbohydrate	3.60 g/100g
Starch	3.24 g/100g
Protein	0.74 g/100g
Aminoacid	0.225 mg/100g
Vitamin B1	2.76 mg/100gm
Vitamin B2	12.64 mg/100gm

Table 2: Change in Biochemical composition of *Alternanthera sessilis* (L.) R.Br. ex DC.
leaf based on different cooking time intervals (g/100gm)

Parametres	Different cooking time intervals g/100g			
	0 min	5 min	10 min	15 min
Carbohydrate	3.60	3.60	3.10	0.60
Starch	3.24	3.24	2.79	0.54
Protein	0.740	0.375	0.210	0.260

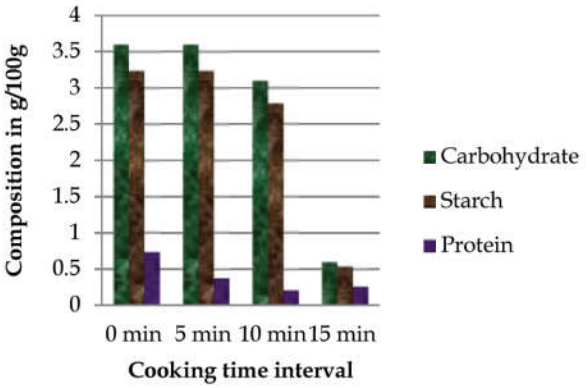

Chart 1: Chart showing Biochemical composition of *Alternanthera sessilis* (L.) R.Br. ex DC. leaf based on different cooking time intervals. (g/100gm)

added along with food.

The biochemical composition of *Alternanthera sessilis* leaves based on cooking time interval of 0 min, 5min, 10min and 15min (Table 2 and Chart 1) revealed that there was a gradual decrease in the composition of Carbohydrate and Starch. The composition of proteins remained approximately the same. Hence *Alternanthera sessilis* leaves can be recommended to be cooked in an average of 5 – 10 min.

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Original Article

Fish Diversity and Water Quality Assessment of the River Damodar in and around Burdwan, West Bengal, India

Indranil Bhattacharjee*, Biplab Mandal, Partha Sarathi Roy***

Abstract

The ichthyofauna in relation to water quality was studied on monthly basis from March 2014 to February 2015, in the Damodar River, Burdwan district, West Bengal. The result of present investigation reveals the occurrence of 35 species of fishes belonging to 6 Order, 15 families and 23 genera were recorded. Among the collected species Order Cyprinidontiforms constituting 41%, Order Perciformes constituting 37%, Order Siluriformes constituting 16%, of the total fish species. The highest richness was found in sampling site- 1– Krisak Setu. The maximum species richness (33) was recorded in site- 1 and low species richness (27) was recorded in site-2. The highest Shannon value was recorded to be (3.29) in site- 2. The low Shannon value was (2.68) in site- 3. Water parameters such as temperature, pH, alkalinity, dissolved oxygen, hardness, free CO_2, salinity, total inorganic nitrogen, and phosphate were recorded and found suitable for fish production. Conductivity, transparency, and high chloride level are minor limiting factor that may needs rectification for improved fisheries management.

Keywords: Fish Diversity; Water Parameters; Biodiversity Indices; Damodar River; Burdwan; West Bengal.

Introduction

The aquatic ecosystem is highly dependent on water quality and biological diversity. Physicochemical parameters of water play a significant role in the biology and physiology of fish (Dhawan and Kaur, 2002). Fish is very rich source of protein as well as vitamins and other minerals. In addition, to this nutrient values fishes are used in several medical treatments, provide aesthetic beauty in aquariums. Due to these multiple uses of fisheries resources, fishing has become a major industry in country like India and provided livelihood for several families. These important biological resources are under threat of extinction due to habitat and environmental degradation has critically affected the fauna of fishes. Knowledge on available information and the biological characters of fish species are provide the first hand information for further conservation aspects.

Important work has been done on fish diversity during the last few decades (Day, 1958; Jayaram, 1981; Menon, 1992; Shaji, 1995; Arunachalum, 2000; Daniel, 2001; Sarkar and Banarjee, 2000; Bhat, 2002; Mishra et al. 2003; Bossuyt et al. 2004; Rajalakshmi and Sreelatha 2006; Saha and Patra 2013; Bera et al. 2014).

The river Damodar, the prominent tributary of the holy river Ganges, is the synergistic life-line of the coal belt dwellers (1.2 million approx.) of Jharkhand and West Bengal at an elevation of about 7-10 m above mean sea level (MSL). The river is the main water source to the industries that produces 310 million tonnes of coal, 80 million tonnes of steel and 2,000 MW of thermal and hydel power, which together distribute substantially to the country's economy. Aquatic ecosystem is facing also the distorting effect as they are used as waste releasing source as well as the assimilating sink of them. The river water is the source for agriculture, community and industrial activities, power generation, fisheries, mining activity, navigation and different activities

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including sand mining and disposal of industrial and domestic wastes. At present indiscriminate anthropogenic activity has disturbed the global natural ecosystem in the name of developmental activities. Aquatic organisms are strongly influenced by physicochemical properties and a majority of them play a role of good ecological indicators of water quality. The productivity of aquatic systems including the production of fish which depends on the quality and quantity of planktonic organisms present may be influenced. Many factors such as dissolved oxygen, transparency, salinity, pH and temperature influence the occurrence, abundance and distribution of planktonic organisms. The Damodar is seasonal and flood prone mainly on account of different reasons, which are physiographic and meteorological in nature. Frequent floods ravage the lower valley area, which is not only very fertile owing to its alluvial plain suitable for irrigation and agriculture but also used for various industrial activities. Modifications of river course always bring about a variation in the hydrobiology and fishery of the river concerned, both upstream and downstream. In most of the cases, its effect on fishery of the river is adverse. Construction of barrage and dam has adversely affected the fishery of river. Damodar in its upstream is especially recognized for the migrant fish population. But the fishery of downstream has shown a continued upsurge after the commissioning of the barrage. Freshwater is the major determining factor for hydrology and fishery of any freshwater riverine system. The increased flushing of the river Damodar, and consequently the Barakar, has naturally resulted in major changes in ecology and associated chemistry of water body. The total area of Burdwan district is 7028 sq. Km and the area of Damodar basin is 2113.61 sq. Km. The 30.07% area of the district in the basin of Damodar River (About the Region – Damodar Basin, 2012).

Our main aim was to evaluate the suitability of water to nurture fishery activity. We describe the fish diversity in Damodar along Burdwan district, in connection with the physicochemical parameters of water, in order to formulate future planning for the development of the socioeconomic status of fishermen.

Materials and Methods

Study Site

Samplings are done from three sites around Burdwan. They are Site I: Krisak setu (23°12′N and 87°51′E); Site II: Barsul (23°10′N and 87°58′E) and Site III: Palla (23°09′N and 87°59′E).

Collection of Fish Samples

The study was conducted every last week of each month, between 6.00 and 8.00 a.m. The fish samples were captured with the help of local skilled fishermen in three pre selected sampling sites. Dragnet, cast net, Scoop net, Basket trap, and so forth were used for capturing fish. Fish species available at the local market and caught by local fishermen. All fish species were preserved in 10% formaldehyde solution for identification to genus and species level using taxonomic keys and standard literatures (Day, 1958; Talwar and Jhingran, 1991; Jayaram, 1981, 1999). In addition various morphological characters, shape, colors etc were recorded. The IUCN red list of threatened species was followed to assign the conservation status. The species richness was simply estimated by variety of fish species in 3 different sampling stations.

Collection of Water Samples

Samples of subsurface water were collected monthly in clean plastic air tight bottles at three above mentioned sites from March 2014 to February 2015, from 8 to 9.30 a.m. The water and air temperature were recorded by hydrothermometer and minimum-maximum thermometer, respectively; pH recorded by digital pH meter (Cystronics model 335); conductivity analyzed by conductivity meter (Labtronics model LT 16); dissolved oxygen examined by Winkler's method; photic depth measured by Secchi disc method; free CO_2, alkalinity, chlorinity, phosphorus, total inorganic nitrogen and hardness were calculated as standard laboratory protocol (APHA, 2008).

Biodiversity Indices

Margalef richness index (M), Simpson's index (D), Simpson's Index of Diversity (1-D), Simpson's Reciprocal Index (1/D), Shannon's diversity index (H) and Pielou's evenness index (J), biodiversity indices were calculated.

Statistical Analysis

Pearson Correlation matrix was calculated together with scatterplots and histograms were done using *XLSTAT* (Addinsoft 2010).

Results

The seasonal variation of physicochemical parameters of the water in the Damodar River,

Table 1: Fish species collected, their local names, Human use, feeding habit and conservation status in Damodar River around Burdwan

Order	Family	S. No	Scientific Name	Local Name	IUCN Status	Human Use	Feeding Habit	Abundance			
								Site 1	Site 2	Site 3	Total
Beloniformes	Belonidae	1	*Xenentodon cancila*	Kenkle	LC	Ornamental	Omnivore	02	00	01	03
Cyprinidontiformes	Aplocheilidae	2	*Aplocheilus panchax*	Kanpona	DD	Commercial	Herbivore	00	02	00	02
	Cyprinidae	3	*Amblypharyngodon mola*	Mourola	LC	Ornamental Commercial	Herbivore	03	01	01	05
		4	*Danio rerio*	Techokha	NT	Ornamental	Herbivore	08	09	05	22
		5	*Puntius ticto*	Punti	LC	Ornamental Commercial	Herbivore	24	35	25	84
		6	*Puntius sophore*	Punti	LC	Ornamental Commercial	Herbivore	14	19	11	44
		7	*Puntius conchonius*	Punti	VU	Ornamental Commercial	Herbivore	09	05	02	16
		8	*Labeo calbasu*	Kalbose	LC	Ornamental Commercial	Herbivore	00	05	01	06
		9	*Labeo bata*	Bata	LC	Aquaculture Commercial	Herbivore	05	09	06	20
		10	*Labeo rohita*	Rui	LC	Aquaculture Commercial	Herbivore	02	05	09	16
		11	*Cirrhinus mrigala*	Mrigel	LC	Commercial Aquaculture	Omnivore	05	00	06	11
		12	*Catla catla*	Katla	NE	Aquaculture Commercial	Herbivore	08	06	01	15
		13	*Amblypharyngodon mola*	Mourola	LC	Commercial	Herbivore	35	31	25	91
	Cobitidae	14	*Lepidocephalichthys guntea*	Guntey	LC	Ornamental Commercial	Omnivore	01	04	06	11
Clupeiformes	Clupeidae	15	*Gudusia chapra*	Khaira	LC	Commercial	Herbivore	15	09	12	36
Osteoglossiformes	Notopteridae	16	*Notopterus chitala*	Chital	EN	Ornamental Commercial	Omnivore	05	00	01	06
		17	*Notopterus notopterus*	Pholui	LC	Ornamental Aquaculture	Carnivore	01	05	02	08
Perciformes	Ambassidae	18	*Chanda ranga*	Chanda	NE	Ornamental Commercial	Omnivore	02	06	02	10
		19	*Chanda nama*	Chanda	LC	Ornamental Commercial	Omnivore	09	05	04	18
	Channidae	20	*Channa punctata*	Lata	LC	Ornamental Aquaculture	Carnivore	19	14	24	57
		21	*Channa marulias*	Sal	LC	Ornamental Aquaculture	Carnivore	05	00	03	08
		22	*Channa gachua*	Chang	LC	Ornamental Commercial	Carnivore	05	02	00	07

Table 1: Fish species collected, their local names, human use, feeding habit and conservation status in Damodar River around Burdwan

		23	*Channa striatus*	Sol	NE	Ornamental Commercial	Carnivore	01	03	01	05
	Gobiidae	24	*Glossogobius giuris*	Bele	LC	Ornamental Commercial	Omnivore	09	18	12	39
	Nandidae	25	*Nandus nandus*	Bheda	LC	Ornamental Commercial	Carnivore	04	00	01	05
	Osphronemidae	26	*Colisa fasciata*	Khalisa	LC	Ornamental	Omnivore	25	35	30	90
		27	*Colisa lalia*	Khalisa	NE	Ornamental	Omnivore	30	25	20	75
Siluriformes	Bagridae	28	*Mystus cavassius*	Tengra	LC	Commercial	Carnivore	25	10	19	54
		29	*Mystus aor*	Aard	VU	Ornamental Commercial	Carnivore	12	06	09	27
		30	*Mystus seenghala*	Tangra	NE	Commercial Aquaculture	Carnivore	02	00	01	03
	Clariidae	31	*Clarias batrachus*	Magur	LC	Ornamental Commercial	Carnivore	13	08	11	32
	Siluridae	32	*Heteropneustes fossilis*	Singi	LC	Ornamental Commercial	Carnivore	04	05	02	11
		33	*Wallago attu*	Boal	NT	Commercial	Carnivore	02	00	01	03
	Mastacembelidae	34	*Macrognathus pancalus*	Pankal	NT	Ornamental Commercial	Omnivore	02	02	00	04
		35	*Macrognathus armatus*	Ban	LC	Commercial	Carnivore	02	00	01	03
			Total					308	284	255	847

IUCN Red list: DD: Data Deficient, LC: Least Concern, VU: Vulnerable, NE: Not Evaluated, EN: Endangered, NT: Near Threatened.

Table 2: Biodiversity Indices of fish species at three different sites of the river Damodar around Burdwan

Index	Site I	Site II	Site III
Total No. of Species (S)	33	27	32
Total No. of Individuals (N)	308	284	255
Natural Log of Species (ln S)	3.49	3.29	3.46
Natural Log of Individuals (ln N)	5.73	5.64	5.54
Margalef's Index (M)	5.56	4.60	5.59
Simpson's Index (D)	0.05	0.06	0.06
Simpson's Index of Diversity (1-D)	0.95	0.94	0.93
Simpson's Reciprocal Index (1/D)	20	16.6	15.87
Shannon Index (H)	2.98	3.29	2.68
Pielou's Index (J)	0.856	0.82	0.77

Table 3: Correlation matrix (Pearson) representing the relationship of the environmental variables observed during study period (March 2014 to February 2015) study period. Note the values in bold represents significance at P < 0.001 level

Variables	at	wt	h	r	TR	con	pH	DO	ALK	CHOL	PHOS	In N	hard	SAL
at	**1**	**0.867**	-0.219	0.015	-0.345	**0.887**	0.278	-0.307	0.433	**0.704**	0.106	0.203	0.258	**0.703**
wt	**0.867**	**1**	0.097	0.362	-0.348	**0.786**	0.225	-0.357	0.270	**0.578**	0.313	0.479	0.397	**0.585**
h	-0.219	0.097	**1**	**0.722**	-0.015	-0.174	-0.265	-0.031	-0.144	0.007	0.333	**0.607**	0.331	-0.001
r	0.015	0.362	**0.722**	**1**	-0.231	-0.126	-0.294	-0.478	-0.389	0.056	-0.063	0.327	0.019	0.019
TR	-0.345	-0.348	-0.015	-0.231	**1**	-0.341	**0.728**	**0.860**	0.474	-0.060	0.143	0.235	0.544	-0.059
con	**0.887**	**0.786**	-0.174	-0.126	-0.341	**1**	0.203	-0.217	**0.599**	**0.750**	0.261	0.262	0.331	**0.752**
pH	0.278	0.225	-0.265	-0.294	**0.728**	0.203	**1**	**0.713**	**0.636**	0.186	0.315	0.403	**0.655**	0.213
DO	-0.307	-0.357	-0.031	-0.478	**0.860**	-0.217	**0.713**	**1**	0.492	-0.188	0.461	0.370	**0.608**	-0.152
ALK	0.433	0.270	-0.144	-0.389	0.474	**0.599**	**0.636**	0.492	**1**	**0.733**	0.236	0.279	**0.635**	**0.741**
CHOL	**0.704**	**0.578**	0.007	0.056	-0.060	**0.750**	0.186	-0.188	**0.733**	**1**	-0.111	0.081	0.310	**0.988**
PHOS	0.106	0.313	0.333	-0.063	0.143	0.261	0.315	0.461	0.236	-0.111	**1**	**0.850**	**0.655**	-0.081
In N	0.203	0.479	**0.607**	0.327	0.235	0.262	0.403	0.370	0.279	0.081	**0.850**	**1**	**0.770**	0.082
hard	0.258	0.397	0.331	0.019	0.544	0.331	**0.655**	**0.608**	**0.635**	0.310	**0.655**	**0.770**	**1**	0.345
SAL	**0.703**	**0.585**	-0.001	0.019	-0.059	**0.752**	0.213	-0.152	**0.741**	**0.988**	-0.081	0.082	0.345	**1**

at: Air Temperature (°C), wt: Water Temperature (°C), h: humidity (%), r: rainfall (mm), tr: Transparency (cm), con: Conductivity (µmho/cm), pH, DO: Dissolved Oxygen (mg/L), alk: Alkalinity (mg/L), chol: Chloride (mg/L), phos: Phosphate (mg/L), inN: Inorganic Nitrogen (mg/L), hard: Hardness (ppm), sal: Salinity (ppt)

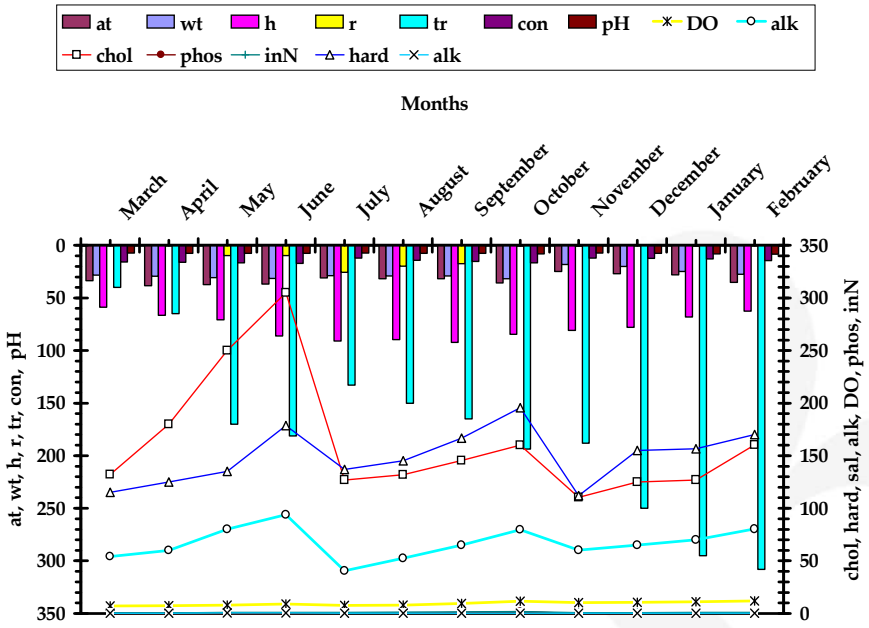


Fig. 1: Seasonal variation of physicochemical parameters of the water in the Damodar River, Burdwan district, West Bengal, March 2014 to February 2015

at: Air Temperature (°C), wt: Water Temperature (°C), h: humidity (%), r: rainfall (mm), tr: Transparency (cm), con: Conductivity (µmho/cm), pH, DO: Dissolved Oxygen (mg/L), alk: Alkalinity (mg/L), chol: Chloride (mg/L), phos: Phosphate (mg/L), inN: Inorganic Nitrogen (mg/L), hard: Hardness (ppm), sal: Salinity (ppt).

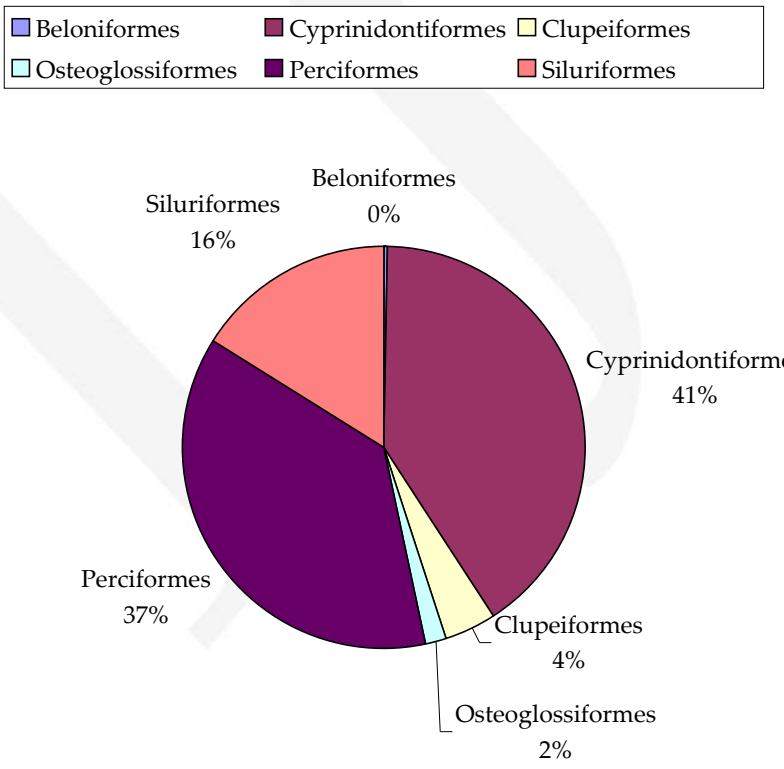


Fig. 2: Percentage representation of species at Order level in the exploited fishery in River Damodar (March 2014 to February 2015)

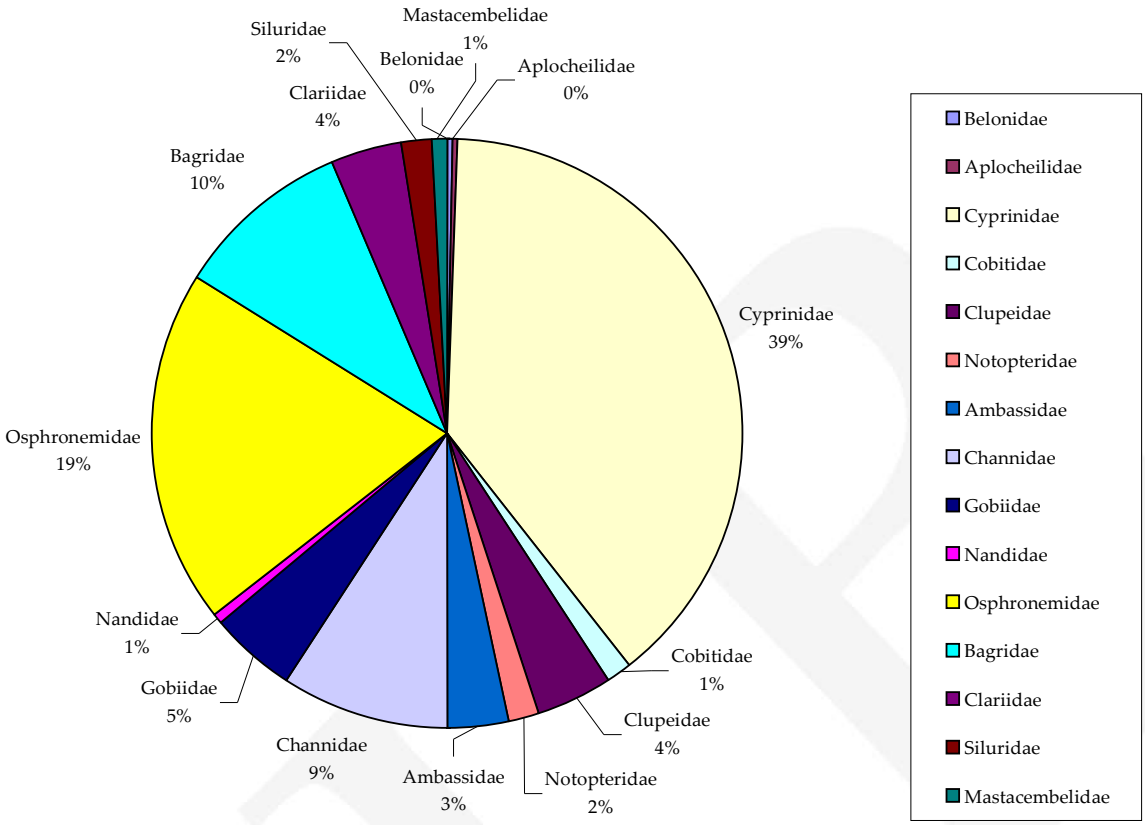


Fig. 3: Percentage representation of species at family level in the exploited fishery in River Damodar (March 2014 to February 2015)

Burdwan district, West Bengal, March 2014 to February 2015 is depicted in Figure 1, and the data on the fish community of the river Damodar is presented in Table 1. The periodical survey of the ichthyofauna revealed the occurrence of 35 species of fishes belonging to 6 Order, 15 families and 23 genera were recorded over a period of one year, from March 2014 to February 2015 (Figure 2 and Figure 3). Among the collected species Order Cyprinidontiforms constituting 41%, Order Perciformes constituting 37%, Order Siluriformes constituting 16%, of the total fish species. The data of Diversity Indices are presented in Table 2. Pearson Correlation matrix was calculated (Table 3) and scatterplots and histograms were plotted (Figure 4) which shows the correlations between environmental parameters affected in distribution of fish species. The highest richness was found in sampling site- 1– Krisak Setu. The maximum species richness (33) was recorded in site- 1 and low species richness (27) was recorded in site-2. The highest Shannon value was recorded to be (3.29) in site- 2. The low Shannon value was (2.68) in site- 3. Habitat loss and environmental degradation has seriously affected the fish fauna. Recent data regarding fish diversity of the study site, aiming to contribute a better knowledge of the fish diversity and a tool for conservation planning of aquatic environments in this region. To maintain fish biodiversity has an immense importance as it is not always possible to identify individual species critically to sustain aquatic ecosystem.

Discussions

Ichtyofaunal diversity is affected by aquatic habitat and water quality parameters. Temperature is the important factor for the aquatic biota. According to FAO report (FAO, 2010), the increase of temperature directly or indirectly impacts species distribution and the seasonality of production in fishes. According to the guidelines for water quality management for fish culture, the suitable water temperature for carp culture ranges between 24°C and 30°C. So, the water temperature of the river Damodar was suitable, except a minute fall during the winter season. Transparency helps to assess the quality of water. According to (Bhatanagar et al. 2004) a turbidity ranging from 30 to 80 cm is good for fish health. High transparency value means that enough light penetrates and encourages macrophytes growth, so that less plankton is available as food for fish. Water transparency in the study sites was not completely satisfactory.

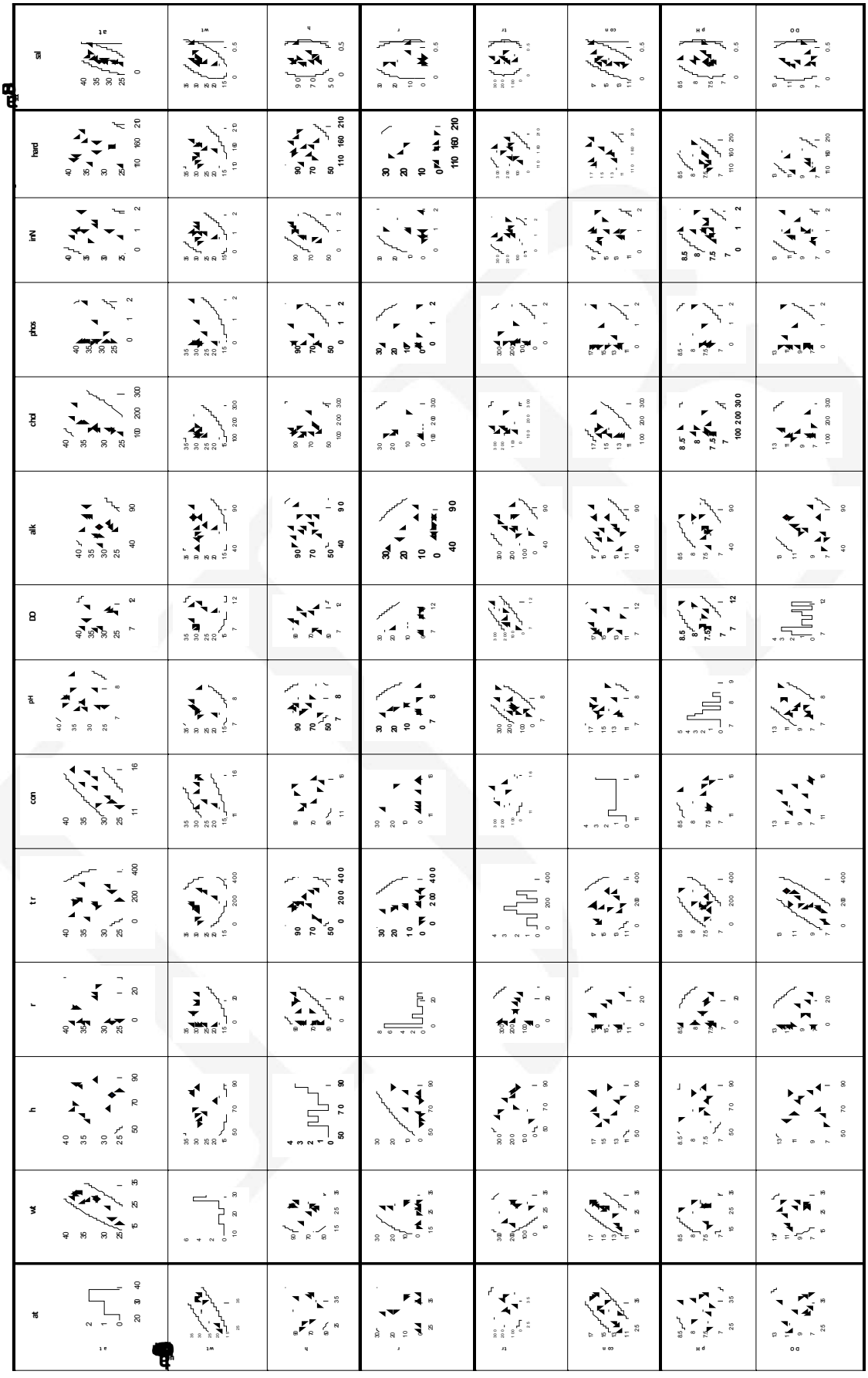
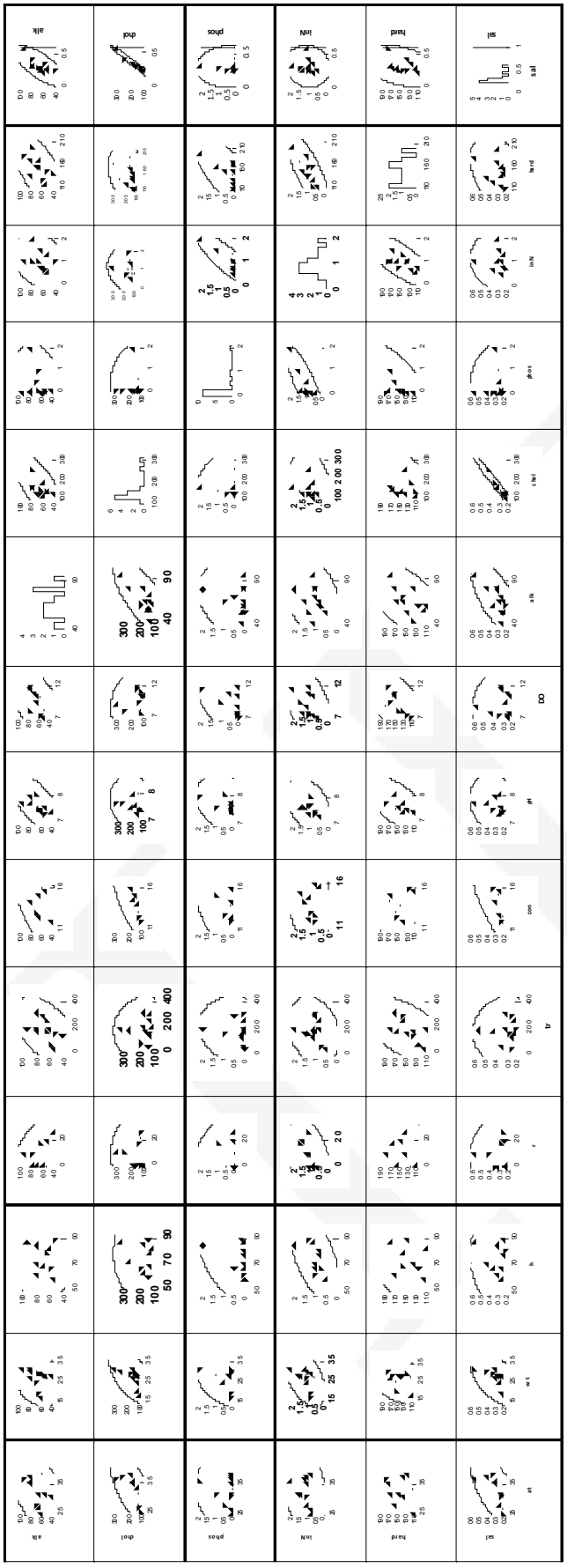


Fig. 4: The scatterplots, histogram representing the relationship of the environmental variables atmospheric as well as water parameters observed during one year study period (March 2014 to February 2015) in the Damodar River, Burdwan district, West Bengal, India



at: Air Temperature (°C), wt: Water Temperature (°C), h: humidity (%), r: rainfall (mm), tr: Transparency (cm), con: Conductivity (µmho/cm), pH, DO: Dissolved Oxygen (mg/L), alk: Alkalinity (mg/L), chol: Chloride (mg/L), phos: Phosphate (mg/L), inN: Inorganic Nitrogen (mg/L), hard: Hardness (ppm), sal: Salinity (ppt)

Electrical conductivity, comprising the total dissolved ions, is a good indicator of water chemistry. A certain level of ions in water is essential as nutrients for aquatic life (Galbrand et al. 2008). According to the report of Southern Regional Aquaculture Centre (SRAC) (Stone et al. 2013), the desirable range of conductivity for fish culture is 60–2000 µmho/cm. Our results showed values that were lower than the optimal limit. SRAC also reported that fresh water fish generally thrive over a wide range of electrical conductivity and that the upper range of tolerance varies with fish species.

pH is another important parameter for fish culture. According to the report of Northeastern Regional Aquaculture Centre (NRAC) (Buttner 1993), fish survive and grow best in waters with a pH between 6 and 9. The pH values we recorded in the river Damodar remained within such safe range.

Dissolved oxygen is one of the most important parameters and a primary limiting factor controlling fish growth and survival (Qayyum et al. 2005). According to Banerjea 1967, D.O. should be above 5.0 mg/L for average or good production. Besides, Bhatnagar and Singh, 2010 also reported that D.O. level > 5.0 mg/L is essential to support good fish production. The D.O. content in the river Damodar was very satisfactory for fish culture.

Alkalinity of water is a measure of its capacity to neutralize acids. According to the guidelines for water quality management for fish culture in Tripura, the ideal value of alkalinity for fish culture is 50–300mg/L. According to the report of SRAC, the desirable limit for fish culture is 50 to 150mg/L, and the acceptable range is from 20 to 400 mg/L. So, the alkalinity range of river Damodar permits the fisheries activity.

According to SRAC, more than 100mg/L is the desirable range for commercial catfish production. So, the chloride value of the river Damodar was very high and stressful for fish culture. Higher chloride content may be due to contamination through large quantity of sewage input (Yousuf et al. 2012). Higher concentration of chloride in water is an indicator of

eutrophy (Kausik et al. 1992). The higher concentration of chloride in the river Damodar may be due to agricultural and sewage run-off during rain from the surrounding area of the reservoir and higher evaporation rate. In most fresh waters, total hardness is mainly due to calcium and magnesium ions. According to the guidelines for water quality management for fish culture in Tripura, the ideal value of hardness for fish culture is 30–180mg/L. Bhatnagar et al. 2004 opined that 75–150mg/L is optimum for fish culture. The hardness in river Damodar was slightly outside the desirable limits but did not reach harmful values. Some euryhaline species may have high tolerance limits to hardness (Bhatnagar and Devi, 2013).

Carbon dioxide is produced in water as a result of respiration of the aquatic organisms. According to the report of NRAC, the preferred range of free $CO_2 \leq$ 10mg/L. Besides, the guidelines for water quality management for fish culture in Tripura also mentioned that water supporting abundant fish populations should contain ≤ 5mg/L free carbon dioxide.

Phosphorus is very critical in maintaining aquatic productivity. SRAC recommend desirable phosphate level for fish culture of 0.06mg/L, and the typical range for surface water is 0.005–0.5mg/L. Bhatnagar and Devi, 2013 reported an optimum range for phosphorus of 0.01–3.0mg/L. The value of phosphate in river Damodar matched the ranges given above.

Nitrogen element is a vital component of protein and is essential for fish growth. FAO recommends desirable limit of total dissolved nitrogen for fish culture of 0.2 ppm. On the other hand, Banerjea 1967 reported TDN values of 0.2–0.5 ppm as favourable for good productivity in ponds. Other than during the rainy season, the total level of inorganic or dissolved nitrogen in the river Damodar is acceptable for fish culture and does not hamper the fish production. Throughout the year, water level in the river Damodar falls from April to June but still remains in adequate amount for fish cultivation.

Therefore, each water quality parameter in the river Damodar remains within the limits suitable for fish production (Stone et al. 2013; Buttner 1993;Banerjea 1967; Bhatnagar and Devi, 2013). The end of the rainy season and the whole winter are the best and the healthier periods for fish growth.

We conclude that water quality in the river Damodar favours for fish cultivation and allows for a high ichthyofaunal diversity, with a value of highest Shannon value was recorded to be (3.29) in site- 2. The low Shannon value was (2.68) in site- 3. We recommend the adoption of scientific fishery management, in order to regulate transparency and chloride level.

Acknowledgement

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Original Article

Studies on Repellent Effect of Neem Seed Oil Cream against Anopheles Gambiae Mosquitoes

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Abstract

The paper deals an evaluation of repellent effect of neem seed oil formulated in a vanishing type cream base against Anopheles gambiae mosquito under laboratory conditions using human volunteers. The seed oil was extracted and then prepared in five different concentrations of 0, 2.5, 5.0, 7.5 and 10.0% w/w respectively in a vanishing cream base. A commercially available repellent Deet was used as control. The result shows that concentrations 2.5, 5.0, 7.5 and 10.0% w/w and Deet (control) all repelled night-biting Anopheles gambiae mosquitoes at three consecutive 10mins interval for every 5-min exposure time. The duration of protection of various concentrations of neem seed oil cream and control (Deet) was of the order 10.0%> Deet> 7.5%> 2.5%. The present study demonstrates potential of neem seed oil cream as mosquito repellent particularly at higher concentrations of 7.5 and 10.0% w/w respectively. This finding may lead to new and more effective strategies for protection from and control of mosquitoes.

Keywords: Neem; Mosquitoes; Human; Concentrations.

Introduction

Many mosquito-boune discases, such as malaria, dengue fever (DF), dengue hemorrahagic fever(DHF) and filariasis, are serious public health problems in tropical regions, especially in Africa and Asia. These diseases are transmitted to human beings through mosquito bite only since there is no effective vaccine available for the control of these diseases. Prevention of mosquito bites is one of the main strategies to control or minimize incidence of these diseases. The use of insect repellants can provide practical and economical means of preventing mosquito-borne diseases. It is important not only for local people in diseases risk areas especially in tropical countries, but also for travelers who are vulnerable to diseases spread by mosquito vectors when they visit and seek leisure away from their home countries.

Although the most common mosquito repellent currently available on the market, deet (N.N-diethyl-3-methylbenzamide) has shown excellent protection from mosquito bites (Yap, 1986; Walker et al, 1996; Thavara et al,2001) and other biting insects (coleman et al, 1993), there were reports of toxicity problems after application of deet, tange from mild effects such as contact urticaria (Malbach and Johonson, 1975) and skin eruption (Reuveni and Yagupsky,1982) to severe reactions, such as toxic encephalopathy (Zadikoff, 1979; Rolan et al, 1985; Edwards and Johnson,1987). To Overcome these adverse effect, attempts to find and develop repellents derived from plant extracts have been made by many workers. The development and use of locally available plants showing repellent activity avails an alternative strategy for the control or minimization of mosquito-borne diseases, especially in developing countries.

In the present study, neem Seed oil extracted from Azadirachta indica plant and formulated in Vanishing cream base was evaluated for repellent action against Anopheles gambiae Azadiracta indica (A Juss) belongs to family meliaceae. The plant is indigenous to the Indo-Pakistan subcontinent (Vander et al, 1987), although it is now widely distributed in many countries of the world, it is believed that Indians migrating to African countries introduced it into that continent.

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Materials and Method

Plant species: Ripe seeds of neem plant were collected from Alagappa University, campus town in Karaikudi, india. The seeds were sun dired until the moisture content was reduced to barest minimum. The seed kernels were later separated from the seeds coat and stored in air tight containers.

Extraction of the Oil

The dried seed kernels were communited using blender model MX-739 (Nakai, Japan). The blended materials were stored in air tight containers. Using the method of (Charmaine et al, 2005). Normal hexane was used as solvent for extraction at seed weight: solvent ratio 1:10. The seeds were allowed to soak in the solvent for 8 days at room temperature. The solvent was then filtered through a what man filter paper (No 1) to remove the coarse seed materials, into pre-weighed sterile containers. The containers were covered with filter paper and solvent was allowed to evaporate. The weight of the residue was calculated (Weight of the container plus extract minus the weight of the empty container) and the extracts were kept at room temperature.

Preparation of Repellant for Testing

Five different concentrations of neem oil in Vanishing Cream base were made (0%w/w, 2.5%w/w, 5.0%w/w, 7.5%w/w,and 10.0%w/w)

Test Mosquitoes

The mosquitoes used in this study were disease free laboratory-reared female mosquitoes (age 8-11 days), Anopheles gambiae that were fed with 10%w/w sugar solution. The repellency of the samples was assessed in the laboratory using human bait technique (Tawatsin et al,2006). Six volunteers (Age 23-50- years) participated in the laboratory tests as testing period lasted up to six or more hours depending on the efficacy of the repellent. Test timing was between 9pm-3am since the mosquitoes are nights biting. Evaluation was carried out in replicates using 12 (26 cubic centimeter) cages with five concentrations of the extract and Deet cream used as control.

To eliminate bias, samples were coded A-E prior to commencement of the experiment. A total of 240 female mosquitoes were used 20 adult blood seeking female mosquitoes were placed in each cage and left for 24 hours prior to the experiment to acclamitise. Mosquitoes were starved for nine hours before the experiment. Host seeking behavior of the mosquitoes wea tested prior to the experiment. This was done by placing a pre-cleaned hand (cleaned with alcohol) in each cage and counting the number of mosquitoes that alighted within 10 seconds. If at least five mosquitoes alighted on the hand, the mosquitoes inside such cage were regarded as host seeking and the repellency experiment continued. Then each volunteer will put the forearm that has been rubbed with the sample up to the wrist level and the number of mosquitoes that alighted or biting the treated area of each volunteers hand was recorded each minute (at 1, 2 and 3, 4, 5 minutes) for three consecutive 10 mins intervals to establish repellency. To determine the duration of protection of each concentration of the sample, the procedure was repeated every hour for six hours without a fresh application of the sample. Experiment was invariably terminated when it appears that none of the concentrations was capable of protection against the mosquitoes any longer particularly when there have been mosquito bite twice on two consecutive exposures.

Statistical Analysis seed Oil Cream

Correlation between different concentrations of neem and mean duration of protection against Anopheles mosquitoes was established by calculating correlation coefficient. The significance of the relationship at 5% level was determined using student t-test statistical application application.

Result

$R=\{[\Sigma(x-x)\ (y-y)]/\sqrt{[\ \Sigma(x-x)^2\ (y-y)^2]}\}$, where 'r' is correlation

Coefficient $\Sigma x=25.0$, $\Sigma y=14.42$ $\Sigma xy=104.73$, $\Sigma x\Sigma y=72.1$

Therefore, $r=32.63/34.24 = 0.95$

Value of correlation coefficient 'r' indicates that there is close association between concentrations of neem oil cream and mean duration protection time against anopheles mosquitoes. To test whether the observed correlation is due to chance or not a student t-test is used to determine the significance at 5% level

$t=\{ [(n-2)/l-r2)]$, df = n-2

$t=\{0.95\sqrt{[3/(1-0.0903)]}\} = 5.29$, df=3

This is significant at 5% level, confirming the significance of he apparent association between concentrations of neem oil cream and mean duration protection time.

Table 1: Repellency determination of various concentrations against anopheles gambiae at 10 mins intervals

Repellent Concn (w/w)	Exposure Time(min)	No of Mosquitoes that Alighted/left			No of mosquitoes that alighted/bit		
		1st	2nd	3rd	1st	2nd	3rd
0%	1		NIL		10	11	10
	2				9	8	6
	3				8	6	7
	4				8	5	5
	5				7	6	6
2.5%	1	8	4	4	1	NIL	
	2	9	6				
	3	6	6	3	3		
	4	6	4				
	5	6	6	5	1		
5.0%	1	6	5	4	1	NIL	
	2	6	6				
	3	5	4	2	1		
	4	6	1				
	5	6	3				
7.5%	1	6	5			NIL	
	2	7	4				
	3	6	6				
	4	6	4				
	5	3					
10%	1	7		4		NIL	
	2	6		2			
	3	6		4			
	4	7		4			
	5	5		3			
DEET (control)	1	5	5	6		NIL	
	2	8	8	6			
	3	8	6	5			
	4	6	5	3			
	5	9	3	2			

Table 2a: Duration of protection of repellant's concentration against anopheles gambiae at hourly intervals

Repellent Concn (w/w)	Exposure Time(min)	Mean No of Mosquitoes that Alighted/left					Mean No of mosquitoes that alighted/bit					Mean Duration In Hourse (± SE)
		1hr	2hrs	3hrs	4hrs	5hrs	1hr	2hrs	3hrs	4hrs	5hrs	
`0%	1			NIL			4	3	2	2	2	NIL
	2						4	5	1	1	1	
	3						2	5	3	1	1	
	4						1	4	3	1	2	
	5						4	3	1	2	1	
2.5%	1	3	4		4	-	Nil	Nil	2	2	-	2.45±0.2
	2	3	5		3	-	Nil	Nil	3	1	-	
	3	1	2		3	-	Nil	Nil	4	4	-	
	4	3	3		3	-	Nil	Nil	2	2	-	
	5	5	2		3	-	Nil	Nil	1	2	-	
5.0%	1	1	5	3	3	-	Nil	Nil	Nil	2	-	2.47±0.2
	2	2	5	5	2	-	Nil	Nil	Nil	2	-	
	3	2	4	4	6	-	Nil	Nil	4	3	-	
	4	2	5	6	5	-	Nil	Nil	3	4	-	
	5	4	6	3	6	-	Nil	Nil	4	2	-	
7.5%	1	2	4	2	3	2	Nil	Nil	Nil	1	1	3.5±0.1
	2	2	3	3	5	5	Nil	Nil	Nil	2	1	
	3	4	2	4	6	3	Nil	Nil	Nil	1	2	
	4	4	2	4	4	5	Nil	Nil	Nil	3	1	
	5	5	4	3	6	5	Nil	Nil	Nil	1	2	
10%	1	3	4		2	2	Nil	Nil	Nil	Nil	2	6.0±0.1
	2	2	3		1	3	Nil	Nil	Nil	Nil	2	
	3	2	2		3	1	Nil	Nil	Nil	Nil	1	
	4	2	2		1	1	Nil	Nil	Nil	Nil	1	
	5	1	1		1	1	Nil	Nil	Nil	Nil	2	
DEET	1	2	3	4	2	2	Nil	Nil	Nil	Nil	Nil	4.58±0.1
	2	3	2	3	2	2	Nil	Nil	Nil	Nil	Nil	
	3	2	3	3	4	2	Nil	Nil	Nil	Nil	Nil	
	4	4	3	2	3	3	Nil	Nil	Nil	Nil	2	
	5	3	2	1	3	1	Nil	Nil	Nil	Nil	1	

Table 2b: Analysis of association between neem oil concentrations and mean duration of protection

Neem oil Cream Conc. in percentage (x)	Mean duration of protection in hrs (y)
0w/w	0
2.5w/w	2.45
5.0w/w	2.47
7.5w/w	3.5
10.0w/w	6.0
Total = 25.0	14.42

Discussion

The neem tree has long been recognized for its unique properties both against insects and in improving health. It is grown in most tropical and sub-tropical areas of the world for shade, raw materials for natural insecticides and medicines. Azadiractin, a complex tetranorterpenoid limonoid compound from the neem seeds, is the main component responsible for the toxic effets in insects (Mordue and Nisbet, 2000)

In the previous study Hati et al, 1995 had reported that neem (Azadirechta indica) seeds oil in appropriate amount when smeared on the surface of the hand showed excellent repellent action against Aedes aegypti mosquitoes. They found out that the degree of repellency was in increasing order as the amount of oil increased.

The present work centers on focusing at the effect of neem (Azadirachta indica) seed oil in a formulated delivery design that will be cosmetically acceptable and at the same time effective as a repellent. The cream base used for the formulation is of vanishing type that has emollient property and is easily disappearing into the skin. It is non greasy and this makes it readily acceptable.

The neem seek kenel yields an acrid bitter greenish yellow to brown fixed oil. The calculated yield is between (19-25%) w/w. The experiment of the repellency was in two phases, first to determine the repellency properties of the various concentrations of neem oil cream 0.0 - 10.0%w/w and the second phase was to establish the duration of protection against the insect bite.

Table 1 shows the result of the repellency determination. As can be seen from the table, it appears that in the 5-minute exposure time i.e.(1, 2, 3, 4 and 5min) at 10 mins intervals, neem seed oil cream at concentrations (2.5%w/w-10.0%w/w) and control DEET repelled Anopheles gambiae mosquitoes. The alighting mosquitoes on the exposed part of the hand soon left without sucking blood. On the other hand the formulation without neem seed oil (0% concentration) could not protect the exposed hand from the mosquito bite.This observation could be explained thus that as soon as alighting mosquitoes sense the discomfort or lethal effect of the chemical constituent of neem seed oil cream, they left.

Also across the concentration range i.c 2.5% - 10.0% w/w, the number of alighting mosquitoes appears reducing. There is a kind of liner relationship between the concentration of the formulation and the degree of repellency. This is in agreement with earlier work done by 14 on crude neem seed oil. There was also observed a decrease in the number of alighting mosquitoes in the 5-min exposure time across the three intervals for all concentrations except the one without neem seed oil. The more effectiveness across the intervals is probably due to the disappearing and even distribution of the neem oil cream in the dermis and epidermis as time goes on.

Table 2 shows the result of the neem duration of protection time of various concentrations and control i.e DEET against Anopheles gambiae as statistically analyzed with standard error of mean calculated is (as presented in Table 2). As observed, there was no protection against mosquito bite at 0% concentration. Although it appears that at 5-,minute exposure time and hourly intervals, the no of alighting and biting mosquitoes generally was reducing. The reduction is probably due to the satisfaction of the mosquitoes being sufficiently fed as time and exposure goes on. The duration of protection for the other concentrations 2.5% -10.0% follows thus 2.45±0.2, 3.50±0.1 and 6.0±0.1 hrs respectively. While that of control (DEET) is 4.85±0.1hrs. The duration of protection is of increasing order with increase in the concentration of neem seed oil the formulation. As statistically analyzed the association between concentrations of the neem oil cream and mean duration protection time was established from computation of correlation coefficient r=0.95. The significance of the association was further confirmed using 't' test application ($p<0.05$). The repellency experiment was actually terminated at the time mosquitoes bite on two consecutive occasions. This is when it is concluded that the repellents potency has lapsed. It is interesting to note that 10.0%w/w neem seed oil cream was able to protect against mosquito bite longer than control

(DEET). It follows therefore that neem seed oil cream may be presenting great potentials against mosquito bite. Even at 7.5% concentration the formulation was able to protect for close to four hours which is the minimum acceptable number of hours for protection against mosquitoes bite in Thailand (Tawatsin et al 2006).

Conclusion

Neem (Azadirachta indica) seed oil cream has proven to be very valuable as insect repellent particularly at higher concentrations of 7.5% and 10.0%w/w respectively. This is veritable alternative to commonly used DEET that has been associated with certain skin reactions. It is therefore recommended that with a thorough stability and safety studies, neem seed oil cream formulations 7.5%w/w or 10.0%w/w could be submitted for regulatory scrutiny and subsequent availability commercially for human use.

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Original Article

Synthesis of Colloidal Silver Nanoparticle (SNP) Using *Vigna Radiata* Seed Exudate: A Novel Green Method

Jyoti Prasad Saikia

Abstract

Synthesis of green silver nanoparticle is carried out by many scientists. Most of them use extracts of plant or microb. In the present research unlike others no extract is used. Rather, seed exudates of *Vigna radiata* secreted during germination is used for synthesizing colloidal silver nanoparticle. The siver nanoparticled were characterized using UV-Vis, fourier transform infrared spectroscopy (FTIR) and transmission electron microscopy (TEM). All these characterization suggested formation of silver nanoparticle comparable with chemical synthesis using sodium borohydrate as reducer.

Keywords: Silver Nanoparticle; Vigna Radiata; Seed; Exudate; Green Synthesis.

Introduction

The seed exudes of *Vigna radiata* contain reducing sugar, proteins and polyphenols like vitexin, isovitexin and a C-glucosylflavonoid, during germination [1]. These chemicals are known to have allelopathic effects [1]. Mungbean is affected by its own toxic exudates or by phytotoxins produced when crop residues decompose in the soil [2]. Exudation of amino acids and sugars from imbibing seeds of *Vigna radiata* was reported by Zheng and Kawabata [3]. These exudates were never used properly by farmers, food industry or hourse hold users.

The environmental impact of the waste generated due to synthesis of nanomaterials is well known [4]. Therefore, research is needed for colloidal silver nanoparticle (SNP) synthesis using green precursors to develop environment friendly processes [5]. Green nanoparticles have gained momentum in pharmaceutical and biomedical applications for their low toxicity [6]. Reports have been published on the use of green reducers for synthesis of colloidal silver nanoparticle [4]. Most of the research on green methods are complicated and uses extracts of plant parts [7, 8, 9]. As we all aware of that plant extract mostly contain high amount of different types of chemical compounds including protein, lipid and charbohydrate. Because of their high content of biomoleculaes they are always prone to become microbial growth media. Another drawback of using plant extracts is their variation of the chemical composition with respect to season and maturity of the source. The nanoparticle is produced at the cost of plant material and therefore the industrial level production might lead to over exploitation of the most suitable plant.

In the view of the above a novel method is designed for synthesizing colloidal silver nanoparticle using exudes of soaked *Vigna radiata* seed. The method did not damage or destroy the seeds, rather, it used up the exudates that comes out of the seed during imbibitions.

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Materials and Methods

Materials

Silver nitrate and $NaBH_4$ (A.R. grade) was obtained from MERCK, India. Seeds of moong bean (*V. radiata*) were purchased from the local market. Double distilled water was prepared in the laboratory.

Protein, Reducing Sugar and Polyphenol Estimation

For the experiment 50 g seeds were surface sterilized as mentioned above and soaked in 200 ml sterile distilled water for 24h. Exudates of 5 ml for protein, 5 ml for reducing sugar and 5 ml for polyphenol estimation were collected at 3rd, 6th, 12th and 24th h of imbibitions. The total volume of the exudates is measured during every collection using a sterile measuring cylinder under sterile condition inside laminar air flow cabinet. These actual volumes were used later for calculating the total amount of protein, reducing sugar and polyphenol exude by seed at a particular time. Protein and reducing sugar estimation was performed using Bradford's and anthrone method respectively. Total polyphenol estimation was done using Cordenunsi *et al.*'s method [28]. In short 500 mL extract was mixed with 2.5 ml 0.2 N Folin's reagent and incubated at room temperature for 5 min followed by addition of 2.0 ml saturated Na_2CO_3 (75 g/L) and incubation for 90 min at 30°C. After incubation, absorption was measured at 765 nm using gallic acid as standard.

Synthesis of Colloidal Silver Nanoparticle Using Sodium Borohydrate

Standard colloidal SNP was prepared following method as described by Phukon et al. [8] using sodium borohydrate as reducer.

Synthesis of Colloidal Silver Nanoparticle using V. Radiata Seed Exudate

Two methods were followed for synthesis of silver nanoparticle using *Vigna radiata* seeds. In the first method surface sterilized *Vigna radiata* seeds (5, 10, 20, 30 and 40 numbers with average weight 61.0 ± 1.1 mg/seed) were soaked in 20 ml $AgNO_3$ (0.001M) solution under sterile condition. Hour wise observations were made using UV-Vis spectrophotometer (Multiscan Go 151001063C of Thermo Scientific, USA). In the second method we would like to confirm further that seeds are secreting exudates to the solution and they are responsible for silver nanoparticle synthesis. To proof the same we soaked 10 seeds (weight and surface sterilization as specified above) in 20 ml sterile double distilled water. Seeds were allowed to secret exudates to the soaked distilled water for 24 h. Ten (10) ml of $AgNO_3$ (0.001M) solution was added drop wise to the decanted seed less exudates solution. Incubated in dark at 25°C and UV-V is spectrophotometric reading were recorded at 5th and 24th hour.

Characterization

FTIR analysis of the colloidal SNP formed was performed after centrifuging, drying and mixing the pellet with KBr (FTIR grade). The SNP/KBr pellet was analyzed using a Nicolet FTIR machine. Transmission electron microscopic (TEM) examination of silver nanoparticle was done using model no. JEM-100CX II (JEOL Japan).

Results and Discussions

The protein, reducing sugar and polyphenol estimation of the seed exudate is presented in the Fig. 1. As presented in the figure the seed exudate contains lowest crude protein, highest reducing sugar and intermediate amount of total polyphenols. Slope of the lines presented in the figure suggest that rate of exudation of protein and reducing sugar increases at 6 h and then remains constant from 6-12 hrs. The same for polyphenol remains constant up to 12 h and increases slightly after that.

It was observed that the colour of $AgNO_3$ solution with *V. radiata* seeds started turning to golden yellow at 10 h when compared with colourless controls. These observations when analyzed using UV-Vis spectrophotometre (200-800 nm). The $AgNO_3$ solution with *V. radiata* seeds showed the presence of a hump near 441 nm suggesting formation of colloidal SNP (Figure 2a). The same finding when further observed using TEM silver nanoparticles formation is confirmed (Figure 5c). As observed in Figure2a, the absorption (A.U.) of 5 seeds in $AgNO_3$ is half than that of SNP ($NaBH_4$) at 10th h after incubation. These suggest that *V. radiata* seeds exudates are either weak reducer or less amount of exudate secretion than required to reduce all $AgNO_3$ in the solution. The hour wise SNP formation by the exudates of 5 seeds from 0 to 10th h was presented in Figure 2b. The additional peaks observed near 250 nm and 350 nm might be due to seeds exudate of *V. radiata* and did not correspond to SNP (Figure 2a, 5 seeds in distilled water). It has been observed that deep black opaque precipation (SNP) was formed in solution inoculated with 20, 30 and 40 seeds. Black SNP is often seen in colloidal SNP synthesis due to formation of $AgNO_3$ [9]. Since most of the SNP got precipitated due to formation of $AgNO_3$ therefore no peaks corresponding to SNP can be observed in Figure 3A, neither they are following seed number corresponding optical density for SNP. Secretion of K^+ ions by *V. radiata* is reported by Promila and Kumar [10]. Therefore, it might be suggested that at high numbers of seeds (20 and above seeds in 20 ml solution) might secret enough amount

of K^+ and other ions leading to aggregation of SNP and therefore obtained as blue precipitate as referred by Caro et al. [9]. The aggregation is further confirmed by TEM analysis as shown in Figure 5b as compared to Figure 5a (SNP synthesized using $NaBH_4$). Whereas, in the present experiment it has been observed that 10 seeds in 20 ml of $AgNO_3$ (0.001M) did not provide any blue precipitate of SNP. On comparing the 10 seeds treatment with 5, at 10^{th} h it can be seed from Figure 2a and Figure 3a that SNP formation is less in 10 seeds, which might be due to secretion of K^+ and other ions and their interference with other reducing exudates of seeds. Therefore, it has beed concluded that 5 seeds in 20 ml $AgNO_3$ (0.001M) solution is optimum to provide SNP. On allowing the treatments (5 and 10 seeds) to stand upto 24^{th} hour we found that in case of the later SNP absorption becomes double against stady absorption of the former (Figure 3b). This suggest that 10 seeds treatment might be slow in SNP synthesis at 10^{th} h but at 24^{th} h they can provide SNP comparable to $NaBH_4$ based synthesis (Figure 3b and Figure 2a).

Looking into the potency of 10 seeds at 24^{th} h for the second method, exudate is collected (as specified in materials and methods section) and allowed for reaction with 10 ml (0.001M) $AgNO_3$ solution. The spectrophotometric observation of the reaction was made at 5^{th} and 24^{th} h and found to be producing SNP (at 24^{th} h) equivalent to $NaBH_4$ (Figure 4a and Figure 2a). The formation of SNP was confirmed using TEM analysis of the sample (Figure 5d). This results confirm that major SNP is synthesized by the seed exudate and not by a process of internalization of $AgNO_3$ and then secretion of SNP [7].

To confirm the utilization of $AgNO_3$ by different numbers of seeds (5, 10, 20, 30 and 40) and $NaBH_4$, Fourier transform infrared spectroscopy (FTIR) analysis was performed (Fig. 4b). The pattern of the FTIR analysis confirms the complete utilization of $AgNO_3$ by 40 seeds [11]. As seen in the figure the signature of the $AgNO_3$ decreases with increase in the number of *V. radiata* seeds in a constant volume of 20 ml. For 40 seeds the FTIR patter is almost similar like $NaBH_4$ reduced silver nanoparticle.

TEM examination of SNP prepared using $NaBH_4$, black SNP precipitate (20 seeds in 20 ml $AgNO_3$ of 0.001M), 5 seeds in 20 ml $AgNO_3$ solution and SNP synthesis using seed less exudates (second method) are presented in Fig. 5 a, b, c and d, respectively. It can be seen that all SNP are mixture of spherical, elongated, triangular, tetragonal and hexagonal in shapes. The triangular SNP is not observed in $NaBH_4$ based method (Fig. 5a). The size of the SNP varies from several 7 nm small SNP, few 14 nm medium SNP to 52 nm large SNP in $NaBH_4$ method (Fig. 5a).

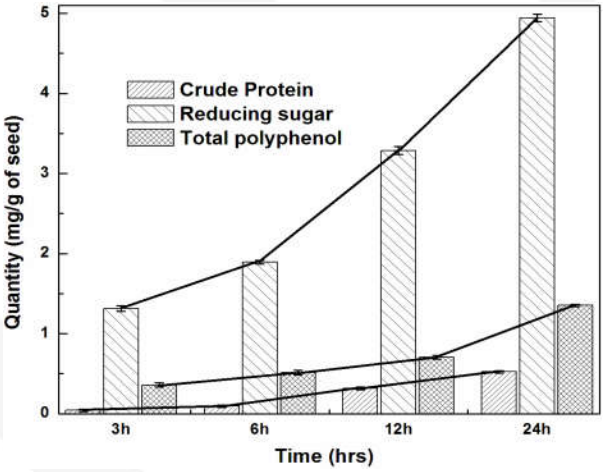

Fig. 1: Crude protein, reducing sugar and polyphenols content of the seed exudate/g of seed with respect to four different soaking time

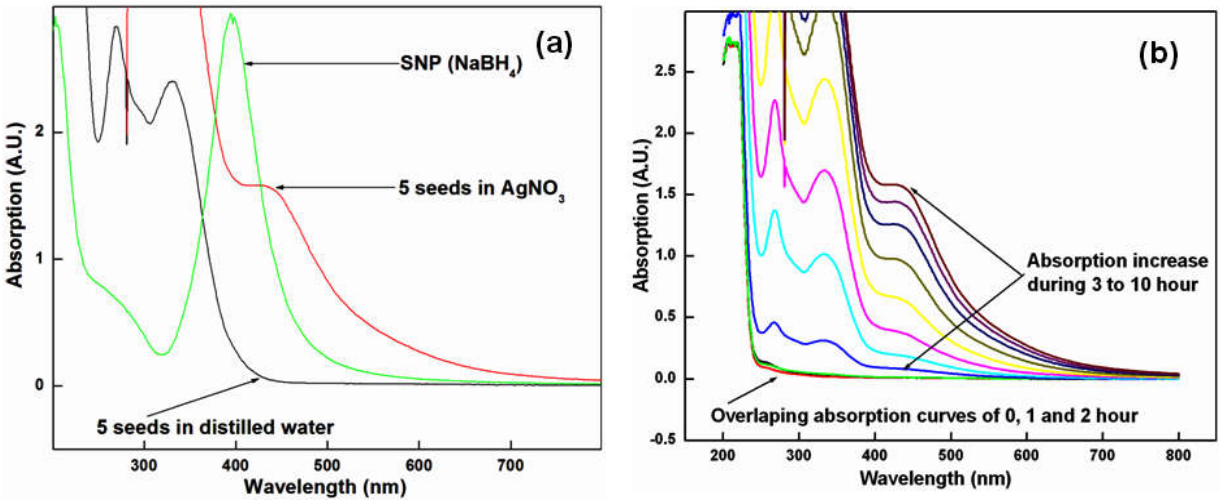

Fig. 2: UV-Vis absorption pattern of SNP synthesized by 5 seeds soaked in 20 ml 0.001M $AgNO_3$ solution **(a)** at 10^{th} h with positive and negative control; **(b)** from 0 to 10^{th} h

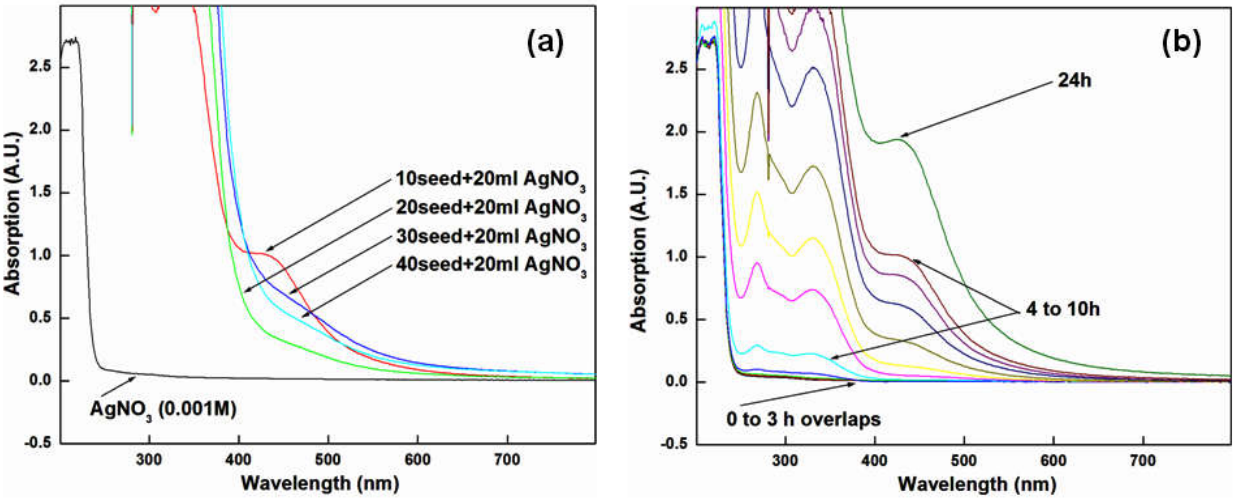

Fig. 3: UV-Vis absorption pattern of SNP synthesized by 10, 20, 30 and 40 seeds soaked in 0.001M $AgNO_3$ solution **(a)** at 10^{th} h along with a blank; **(b)** for 10 seeds only from 0 to 24^{th} h

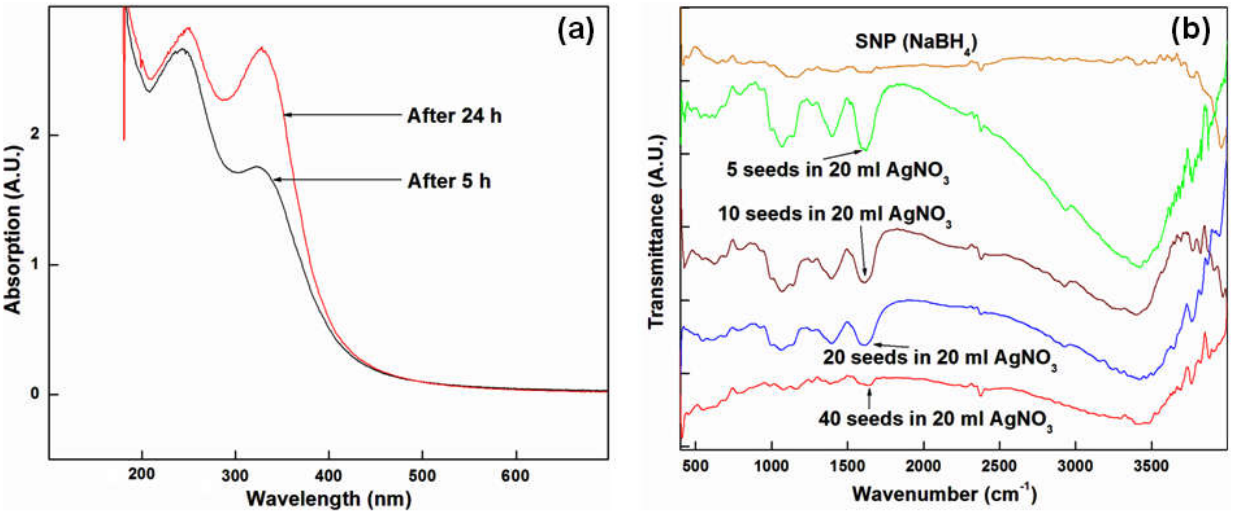

Fig. 4: (a) UV-Vis absorption pattern of SNP synthesized using seed free exudate after 5th and 24th h; **(b)** FTIR spectroscopic patterns of SNP synthesized using different number of seeds (5-40) and $NaBH_4$

The same in case of blue precipitate solution of SNP are 11 nm small, 20 nm medium and 75 nm big SNP (Figure 5b). It should be noted that small sized SNP (around 11 nm) are less in blue SNP solution, large (around 75 nm) and medium (around 20 nm) sized SNP are more in Figure 5b. Further, the aggregation of SNP as suggested from visual observation can be seen in the Figure 5b. The aggregation seen in the Figure 5b is mostly among large SNP with large and small. Most of the medium and small SNP do not aggregate. In case of the SNP produced by 5 seeds the small (around 3 nm) and medium (28 nm) SNP are of equal proportions and few large (around 42 nm) has been seen (Figure 5c). The SNP synthesized using second method (seed free exudate) some aggregation seen towards lower left side (Figure 5d). The small (around 10 nm), medium (around 20 nm) and large (around 41 nm) are seen in Figure 5d. Two hexagonal particles were seen (marked with arrow) in seed free exudate based method (Figure 5d) which were not present in other (Figure 5a, b, c).

The results established that colloidal SNP synthesis can be carried out using *Vigna radiata* seed exudes. Reports regarding synthesis of SNP using seed exudate during soaking is rare. Most of the time the justification for green synthesis is to increase biocompatibility, economic viability and use of renewable resources but rarely it is bio waste. The present research is only a preliminary investigation with one dicot species and huge amount of work like purification of the seed exudate, characterization of compounds and their individual potential for synthesis of SNP have to be studied in future. With increasing research on SNP synthesis from green precursor along with rapid industrial applications, will soon become cause of exploitation of certain

species in near future. Under, these circumstance more research on bio waste based method for SNP synthesis can prevent consumption of biomass for SNP synthesis and these will be available for other purposes like food and energy.

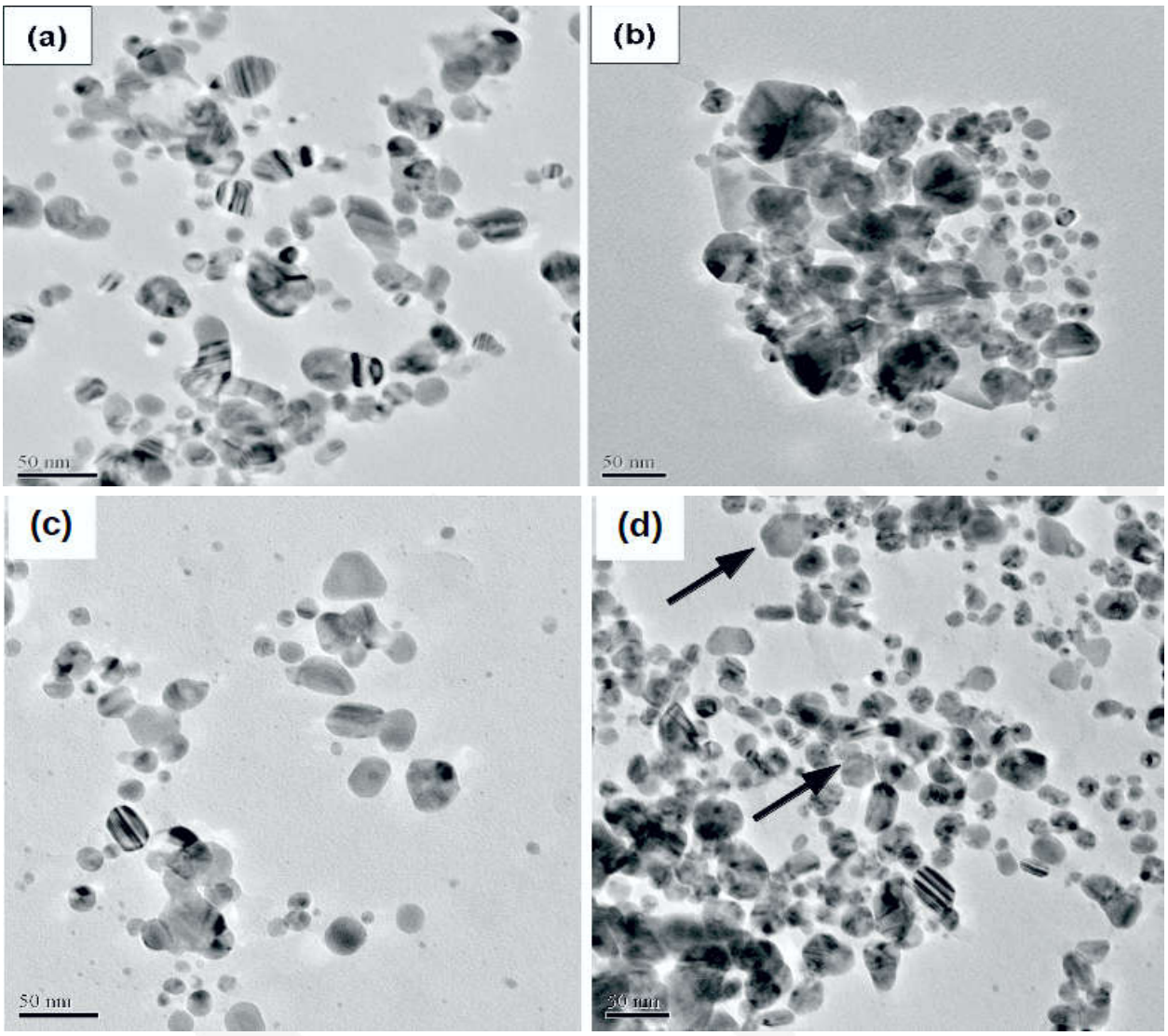

Fig. 5: TEM images of the SNP synthesized using **(a)** $NaBH_4$; **(b)** 20 seeds; **(c)** 5 seeds; **(d)** seed free exudate.

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Original Article

Bio-Bleaching of Unbleached Kraft Pulp (UKP) by Two White Rot Fungi

B. Rajitha*, M.A. Singara Charya**

Abstract

Pycnoporus cinnabarinus and *Daedaleopsis flavida,* the two white rot fungal strains were considered very useful in the bleaching of unbleached kraft pulp. The reduction of kappa number and improvement of brightness of kraft pulp was evaluated during the solid state and submerged fermentation. *P. cinnabarinus* responsible for reduction of kappa number from 10.0 (10 days) to 8.3 (15 days) and 7.4 (30 days) during solid stated fermentation (SSF) while the brightness of the pulp which was initially 34% improved up to 58% in 30 days of incubation. The viscosity values were primarily 30.5 was reduced to 28.4 in 15 days and 27.1 in 30 days of incubations. The laccase enzyme of *P. cinnabarinus* caused for improvement of brightness from 33-55% and reduction of kappa number 10.2 to 7.3 and viscosity 28.4 to 25.3. The laccase of *D. flavida* was responsible for increase in brightness from 35-59% while reduction of kappa number 10.2 to 6.8 and viscosity 28.4 to 24.5. The influence of Dupont showed the reduction in kappa number from 10.8 to 0.98 and the hemicelluloses content was reduced from 42.7 to 19.8 in the last concentration (30g/100 Kg of pulp). With novozyme the lignin content was reduced from 0.130 to 0.085% in the 25g/100 Kg concentration. The kappa number was 14.4 in control reduced to 12.2 in the last concentration. The viscosity was reduced from 15.8 to 10.2 in final concentration after 60 minutes of incubation time. The energy and wood costs were drastically reduced in biological procedures.

Keywords: Biobleaching; Unbleached Kraft Pulp; White Rot Fungi; Kappa Number; Viscosity; *Pycnoporus cinnabarinus; Daedaleopsis flavida.*

Introduction

The use of white-rot fungi for the biological delignification of wood was perhaps first seriously considered by Lawson and Still (1957) at the West Virginia Pulp and Paper Company (now Westvaco Corporation) [1]. The literature survey carried out on biopulping by pretreatment of wood chips has shown that the studies are confined only up to evaluation of properties of pulp and paper sheets produced from pretreated chips. However, there is no literature available on accessibility on different fungal strain to the fiber in order to ascertain their effectiveness. Prominent obstacles are that the fungi partially damage cellulose. They have not been successfully used because of their slow speed of degradation and cultivation.

Wood is a natural biodegradable and renewable raw material, used in construction and as a feed stock in the paper and wood product industries and in fuel production. Wood is polymeric composite whose biological and technical properties are mainly determined by the chemical composition of the cell wall. Wood cell walls are made up primarily of cellulose, hemicelluloses and lignin The tensil strength of wood fibers is primarily determined by cellulose and hemicelluloses, while lignin mediates adhesion between the fibers. Cellulose is a linear polymer of high molecular weight, exclusively built up by 1-4 glycoside linked molecular of β-D-Glucose. The chains of the more complex hemicelluloses are much shorter than those of cellulose but they usually bear side groups, such as monosaccharide and acetyl groups and in some cases they are branched [2]. Lignin is three dimensional polymer of Phenylproponoid units which are oxidatively Polymerised by a peroxidases or phenol oxidases

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during lignin biosynthesis [3].

In white rot fungi, wood polysaccharides are degraded during the primary metabolism of the fungus, while lignin degradation due to the variety of chemical bonds occurs only during secondary metabolism and yields no net energy gain [4]. During degradation process, the initial attack on lignin is considered to be performed by extracellular laccases, lignin peroxidases and manganese peroxidase [5]. Peroxidase use hydrogen peroxide as co-substrate, while laccase require molecular oxygen as electron acceptor [6] .

These enzymes catalyse the one electron oxidation of lignin related phenolic groups to relatively stable phenoxy radicals. Kirk and Yong (1979) were the first to attempt to bleach the pulp with microorganisms [7]. They observed that *Phanerochaete chryosoprium* and other white rot fungi could cover the kappa number of unbleached soft wood kraft pulp by up to 75%, leading to reduced requirement for chlorine during subsequent chemical bleaching. Screening of several white rot fungi at the pulp and paper research institute of Canada revealed that *Trametes versicolor* could markedly increase the brightness of hard wood craft pulp and noted that the Kappa number was decreased from 12 to 8, and the brightness increased from 34-48%. Due to the importance of lignin as a renewable source for the production of paper, feeds, chemicals and fuels, there has been an increasing research emphasis on the fungal degradation of lignin. Delignification of UKP by white rot fungi has been investigated by many researchers and its significance in paper industries was recorded [8,9] .

Kirk *et al.,* (1978) used *Phanerochaete chryosoprium*for bio bleaching in liquid state fermentation system and reported the kappa number was decreased by 60%, after a subsequent alkali treatment [10]. Paice *et al.,* (1990) used *Trametes versicolor* in liquid state fermentation system and achieved 15 point increase in brightness [11]. Katagiri *et al.,* (1995) noted the same level of cumulative manganese peroxidase production by *Phanerochaete chryosoprium* and *Trametes versicolor* in the solid state and liquid state fermentation systems but observed negligible increase in brightness in the liquid state fermentation system [12]. Fugita *et al.,* (1993) classified that the bio bleaching process can significantly increase the brightness of the pulp and reduce the use of chlorine based chemicals and pollution load of waste liquor [13]. Rivera *et al.,* (2000) attempted to design a solid state bioreactor for application of the process in the industrial scale [14]. The application of the white rot fungi and their enzymes in the wood based industries for the removal of lignin and increase the brightness of the pulp was thoroughly understood [15-17].

Basidiomycetes are unique in their ability to degrade most components of wood due to their ability to synthesize the relevant hydrolytic and oxidative extracellular enzymes. Laccases were used for the depolymerization of lignin; delignify wood pulps and bleaching of kraft pulps; development of new white rot fungal strains for effective treatment of bleaching actually without causing any damage to cellulose fibrils [18-20]. Gates *et al.,* (2011) used lignin peroxidase and laccase systems to detoxify the Kraft pulp mill effluents by removing the toxic chemicals and at the same time reported their role in the reduction costs in paper manufacturing [21].

In view of these interesting observations on the role of white rot fungi in treatment of kraft pulp for paper manufacture a detailed study was undertaken on the reduction of kappa number and improvement of brightness of the Kraft pulp. The study wars oriented to develop strategies for the effective beaching processes by using the fungi or their enzymes to reduce the paper manufacturing cost and also to reduce the pollution loads.

Material and Methods

The unbleached kraft pulp (UKP) of subabul (*Leucaena leucocephala*) was processed and five grams of oven dried pulp was transferred in to nine conical flasks and sterilized. Five ml of spore suspension (105 spores/ml) of two selected fungi viz., *Pyenoporous cinnanabarinus* and *Daedolepsisi flavida* (Figure 1) was poured in to the conical flask and incubated at room temperature. After incubation of 15 and 30 days one gram of the pulp was digested and used for the estimation of pH, brightness (%), kappa number and viscosity (cp). The flask with (UKP) inoculated with spore suspension sorced as control ('o' incubation). The procedure for all parameters were followed as the method suggested in TAPPI (1993).

Kappa number is used as criteria for the lignin content of pulps and is determined as the volume of 0.1 N potassium permanganate (ml) consumed by 1.0 g of moisture free pulp. A portion of the cut piece of pulp that could consume approximately 50 per cent of potassium permanganate solution (0.1%) was weighted out and disintegrated in 500 ml distilled water until free of fibre clots or bundles. The disintegrated suspension was made up to 800 ml. To 100 ml of KMnO4 solution (0.1 N), 100 ml of H_2SO_4 (4 N) was added and cooled to 25°C and immediately added to disintegrated pulp suspension. After 10 min. the reaction was stopped by adding 20 ml of

potassium iodide solution (1 N) and titrated against sodium thiosulphate solution (0.2 N). Starch solution (0.2%) was used as the indicator. A blank titration was carried out in the same manner but without pulp. The kappa number was calculated by the formula.

K= p x f / W

and

P = (b-a) N / 0.1

Where,

K = Kappa number

F = Factor for correction to the 50 per cent permanganate consumption depending on the volume of p (TAPPI, 1993)

W = Weight of moisture free pulp sample used for estimation (g)

P = Amount of 0.1 N permanganate consumed by the sample (ml)

B = Amount of thiosulphate consumed in blank determination (ml)

A = Amount of thiosulphate consumed by sample

N = Normality of thiosulphate

Correction for reaction temperature

$$K= \frac{PF}{w} [0.0+0.013(25-t)]$$

Where, t = actual reaction temperature in degree celsius.

Brightness

Brightness of the UKP was measured at 457 nm in a Perkin Elmer ë3B spectrophotometer equipped with a reflectance sphere.

Viscosity

The viscosity of the UKP was estimated by using Oswald viscometer.

Results

During the studies on the applications of white rote fungi on paper and pulp industries the pulp used was from the plant subabul *(Leucaena leucocephla)*. This Unbleached Kraft pulp (UKP) was analysed for its different parameters which will have its impact on the bleaching and pulping processes. The yield of the pulp from the plant was 32.2% (Table 1). The permanganate number was 12.6 and viscosity was recorded as 30.8 cp. The ash content was 1.66%, while aluminium, calcium oxide and magnesium oxides were 0.261%, 1.150%, 0.148% respectively. The iron content was 466 ppm and pentosans were 16.5%. The AB extractives were 2.59% while lignin was 27.2% and Holo cellulose was 74.2%.

The impact of white rot fungus, *Pycnoporus cinnabarinus* on the digestion of lignin during solid state fermentation (SSF) was analysed in 15 and 30 days of incubation and recorded (Table 2). From the table it was evident that during SSF the pH gradually decreased towards acidic side. The brightness of the pulp was improved and kappa number, the indicator of lignin content was slowly decreased. The important parameter in the pulp industries, the viscosity was not affected much with the growth of the organism. These studies were conducted with a gap of three months each in 2014 and presented. In the month of January 2014 the initial pH 9.4 was reduced to 8.2 in 15 days incubation and 7.5 in 30 days of incubation, while, the brightness of the pulp is initially 34% was improved to 45% (15 days) and 58% (30 days). The kappa number of the pulp was initially 10 was reduced to 8.3 in 15 days and 7.4 in 30 days of incubations. The viscosity values were primarily 30.5 was reduced to 28.4 (15 days) and 27.1 (30 days).

The similar data was calculated during April 2014 and the pH was initially 8.8 changed to 7.5 and 6.6 in 15 and 30 days of incubation time. The brightness was 35 % improved to 47 and 59% after 15 and 30 days of SSF. The kappa number was decreased to 8.9 to 7.5 in 15 days and 6.4 in 30 days of incubation. The viscosity was reduced from 29.6 to 27.3 and 26.3 in 15 days and 30 days respectively. After three months gap again in July 2014 the fungus was inoculated with UKP and analysed the improvement of brightness and decrease of lignin content. The pH which was initially 7.9 were 7.0 in 15 days and 6.2 in 30 days of incubation. The brightness was initially 35 improved to 45% in 15 days and 56% in 30 days of incubation period. The kappa number which was originally 9.0 was reduced to 8.1 and 7.3 in 15 days and 30 days of incubation period. The viscosity was 29.5 and reduced to 28.1 and 27.3 in 15 and 30 days of incubation period respectively. In October 2014 the pH was changed from 9.0 to 8.0 and 7.1 in 15 and 30 days of incubation period. The brightness was initially 35 was improved to 44 and 54% in 15 and 30 days of incubation. The kappa number was initially 10 reduced to 8.5 and 7.6 in 15 and 30 days incubations respectively. The viscosity was 30.6 in initial period reduced to 28.7 in 15 days and 26.1 in 30 days of incubation period.

Similarly the other potential white rot fungus,

Daedaleopsis flavida, was also studied for its effect on the pH, brightness, kappa number and viscosity during SSF and presented in (Table 3). From the table it was noticed that the pH 9.4 reduced to 8.5 and 7.2 in 15 and 30 days of incubation time. The brightness which was originally 34% was improved to 46 in 15 days and 59% in 30 days of incubation period. The kappa number which was 10 originally reduced to 8.5 and 7.3 during 15 and 30 days of incubation period. The viscosity levels were 30.5 reduced to 27.5 and 26.3 in 15 and 30 days of incubation time. Similar trends were continued in the remaining three incubation periods i.e. April, July and October 2014. The pH reduced slightly but maintained its neutrality by the end of 30 days incubation. The brightness percentage reached 60 in April 2014 after 30 days of incubation, which indicated the efficiency of the organism in replacing the oxidizing chemicals chlorine and hydrogen peroxide. The organism was good enough to digest lignin and its maximum kappa number reduction was witnessed again in April 2014, which was initially 8.9 reduced to 7.2 in 15 days and 6.8 in 30 days of incubation period during SSF. Over all, these two organisms are useful for the bio bleaching due to their activities in improvement of brightness of the pulp and decreasing the kappa number while not affecting much the viscosity of the pulp.

To understand the difference between the chemical bleaching and biological bleaching the data with chemical bleaching was also recorded in (Table 4). From the table it was evident that the original brightness of the pulp was 48% gradually improved in different chemical treatment stages with chlorination and hydrogen peroxide and at last reached to 94%. Similarly the kappa number which was originally 10 reduced to 0.5 levels in the last stage of chemical treatment. The viscosity was reduced from 30.5 to 17.5 at the final stage.

The bio bleaching of UKP with laccase enzyme of *P. cinnabarinus* was studied and reported (Table 5). From the table it was evident that the brightness of the pulp was increased from 35-55% with *P. cinnabarinus* while it was from 35-59% by *Daedaleopsis flavida.* The kappa number reduced from 10.2 to 7.3 by *P. cinnabarinus* while it reduced to 6.8 with *Daedaleopsis flavida.* There was a marginal reduction in the viscosity *P. cinnabarinus* which reduced from 28.4 to 25.3 while it was 28.4 to 24.5 with *Daedaleopsis flavida.* The enzyme laccase showed substantial improvement in the pulp treatment which helped for the improvement of brightness and reduction of lignin content (kappa number).

The influence of microbial enzymes commercially available with trade names, Dupont enzyme and Novozyme were analysed on the important pulp properties essential in paper industries were recorded in table 1. The influence of Dupont enzyme in its three concentrations i.e. 10g/100 kg pulp; 20g/100 kg pulp; 25g/100 kg pulp and after 60 minutes incubation the lignin content was reduced from 0.168% to 0.121% in its last concentration (Table 6). The kappa number was initially 10.8 was reduced to 10.2 in 10g/100kg concentration and 0.98 in last concentration (25g/100kg). The reactivity i.e. hemicellulose content was 42.7 in control and reduced gradually to 19.8 in last concentration. The viscosity was not affected with this enzyme and reduced from 14.5 to 9.8. Similarly the influence of Novozyme was also studied and the lignin content reduced from 0.130 to 0.085% in the 25g/100kg concentration (Table 7). The kappa number was 14.4 in control and reduced to 12.2 by the last incubation concentration. The reactivity percentage was 37.4 initially and reduced to 13.4 in 25g/100 kg concentration, while the viscosity was 15.8 in control and 10.2 in last concentration.

Pycnoporus cinnabarinus *Daedaleopsis flavida*

Fig. 1: Showing the fruit bodies of macro fungi

Table 1: Analysis of unbleached kraft pulp (UKP) of subabul (*Leucaena leucocephala*)

Yield (%)	32.2
Permanganate number	12.6
Viscosity(CP)	30.8
Ash (%)	1.66
Al (%)	0.261
Cao (%)	1.150
Mgo (%)	0.148
Iron(PPM)	466
Pentosens (%)	16.5
AB Extractives (%)	2.59
Lignin (%)	27.2
Holo Cellulose (%)	74.2

Table 2: Influence of *Pycnoporus cinnabarinus* on pH, brightness, kappa number and viscosity of UKP during solid state fermentation after 15 and 30 days of incubation

	pH			Brightness (%)			Kappa number			Viscosity (cp)		
	0	15d	30d	0	15d	30d	0	15d	30d	0	15d	30d
Jan. 2014	9.4	8.5	7.5	34	45	58	10.0	8.3	7.4	30.5	28.4	27.1
Apr. 2014	8.8	7.5	6.6	35	47	59	8.9	7.5	6.4	29.6	27.3	26.3
Jul. 2014	7.9	7.0	6.2	35	45	56	9.0	8.1	7.3	29.5	28.1	27.3
Oct. 2014	9.0	8.0	7.1	35	44	54	10.0	8.5	7.6	30.6	38.7	26.1

Table 3: Influence of *Daedaleopsis flavida* on pH, brightness, kappa number and viscosity of UKP during solid state fermentation

	pH			Brightness (%)			Kappa number			Viscosity (cp)		
	0	15d	30d	0	15d	30d	0	15d	30d	0	15d	30d
Jan. 2014	9.4	8.5	7.2	34	45	59	10.0	8.5	7.3	30.5	27.5	26.3
Apr. 2014	8.8	7.3	6.8	35	48	60	8.9	7.2	6.8	29.6	28.3	27.8
Jul. 2014	7.9	6.8	6.0	35	47	58	9.0	8.0	7.1	29.5	28.3	27.5
Oct. 2014	9.0	8.1	7.0	35	45	56	10.0	8.2	7.2	30.6	28.5	26.0

Table 4: Brightness, kappa number and viscosity changes during chemical bleaching of UKP of subabul pulp

Bleaching Stage	Brightness (%)	Kappa number	Viscosity (cp)
Un bleacher kraft pulp	48	10	30.5
Chlorination stage	57	8	28.7
Oxygenated H_2O_2 stage	68	6	25.3
Hypo 1 stage	73	4	22.1
ClO_2	81	3	20.5
Extracted peroxidase stage (EP)	90	2	19.2
Final brightness pulp	94	0.5	17.5

Table 5: Biobleaching of UKP with laccase enzyme of *Pycnoporus cinnabarinus* (A) and *Daedaleopsis flavida* (B) after 30 days of solid state fermentation

Treatment	Brightness (%)		Kappa number		Viscosity (cp)	
	A	B	A	B	A	B
Untreated pulp	35	35	10.2	10.2	28.4	28.4
Laccase treated pulp	55	50	7.3	6.8	25.3	24.5

Table 6: Influence of dupont enzyme on the biobleaching of kraft pulp

Enzyme concentration	Lignin (%)	Kappa Number	Reactivity hemicellulose (%)	Viscosity (cp)
Control	0.168	10.8	42.7	14.5
10g/100 kg	0.140	10.2	35.8	12.9
20g/100 kg	0.135	10.8	29.4	11.8
25g/100 kg	0.121	0.98	19.8	9.8

Table 7: Influence of novozyme on the bio bleaching of kraft pulp

Enzyme concentration	Lignin (%)	Kappa Number	Reactivity hemicellulose (%)	Viscosity (cp)
Control	0.130	14.4	37.4	15.8
10g/100 kg	0.094	13.6	27.4	12.8
20g/100 kg	0.090	12.8	25.4	12.1
25g/100 kg	0.085	12.2	13.4	10.2

Table 8: Comparison of conventional and bio pulping process in manufacturing costs (in Rs./Ton) of paper

Cost	Conventional	Biopulping
Energy	9680	6400
Wood	6720	1280
Bleaching chemicals	800	800
Other costs	4800	4800
Total:	22000	13280

The cost of paper manufacturing in conventional type and bio pulping process was compared and presented (Table 8). From the table it was clear that the energy costs were reduced drastically with bio pulping. The energy cost in conventional method was Rs. 9680 reduced to Rs. 6400 in the biological treatment process. The wood costs during paper manufacturing also showed remarkable reduction. It was Rs. 6720/- per ton in conventional while it was only 1280/- per ton in bio pulping. No change was recorded in the cost of bleaching chemicals and other costs of paper manufacturing.

Bio pulping and Bio bleaching would have a bright and promising future in pulp and paper industry because of its both economizing energy and friendly to environment. Now, it is necessary to enhance this process of lignin bio degradation and bio pulping which is very significant meaning to the sustaining development of pulp and paper industry.

Discussion

White rot fungi are most effective for delignification due to production of lignolytic extracellular oxidative enzymes. Lignin degradation was possible by several white rot fungi, such as *Phanerochaete chrysosporium*, *Pleurotus ostreatus*, *Trametes versicolor*, *Cyathus sterours, Certiporiopsis subvermispora* [22,23] . They noticed that some white rot fungi delignify wood by preferentially attacking lignin more readily than hemicelluloses and cellulose, leaving enriched cellulose. However, certain other white rot fungi such as, *Heterobasidium, Annosum, Irpex lactous* degrade the cell wall components simultaneously [24]. Lignin removal is important in the pulping and paper industry. This pulp treatment not only improves paper strength and remove low extractives but also reduce the energy consumption in the process of pulping. So, pretreatment of wood chips for mechanical and chemical pulping with white rot fungi has been developed. Bio bleaching is the bleaching of pulps using enzyme or lignolytic fungi that reduce the amount of chemical bleach required to obtain the desirable brightness of the pulps. Laccase mediated system has shown to possess the potential to substitute for chlorine containing reagents. Call and Call (2005) applied laccases as bio bleaching agents as they degrade lignin and decolourize the pulp. Bio bleaching of eucalyptus kraft pulp with certain while rot fungi in the presence of H_2O_2 resulted in significant reduction of kappa number with no change in viscosity suggesting a potential application of white rots [25]. Eugenio *et al.,* (2011) carried out the experiments on *Eucalyptus globosus k*raft pulps with laccase enzyme in the presence of aceto syringone as a netural mediator showed reduction in kappa number and increase of brightness without decreasing viscosity values, which was significantly as observed in the present investigation [26]. Selvam and Arungandhi (2013) in their studies recorded that bio bleaching and delignification of Hird Won Kraft Pulp three white rot fungi, *Trametes sp*¸ *Ganoderma sp*, and *Poria sp, r*educed the kappa number and increased the brightness of the pulp after 10 days of incubation [27].

Various studies on pretreatment of pulp by enzymes showed that they can decrease the amount of chemical required to attain same brightness in subsequent bleaching stages [28]. The utilization of lignolytic and xylanase enzymes resulted in easier bleaching in subsequent stages and better pulp brightness. The enzymatic hydrolysis of reprelipitated xylem on the surface of the fiber makes the fiber more permeable to lignin removal.

The potential applications of lignin degrading fungi and their enzymes in biotechnology has stimulated their investigation and the understanding of physiological mechanisms regulating enzyme synthesis in lignocellosic bioconversion could be useful for improving the technological process of edible and medicinal mushroom production [29,30]. Laccases are able to depolymerize lignin and delignify wood pulps, kraft pulp fibers and chlorine free in the bio pulpation process [31,32]. Strebotnik and Hammel (2000) studied the applications of white rots in the industry related to laccase mediator bleaching of kraft pulp and the efficiency of which has been proven in mill – scale trials [33]. This ability could be used in the future to attach chemically versatile compounds in the fiber surfaces and let recycled pulp for new use [34]. Lignin peroxidase and laccase are effective biocatalysts of choice for bleaching [35,36]. Lignin peroxidase and manganese peroxidase were reported

to be effective in decolourizing kraft pulp mill effluents [37]. Maijala *et al.* (2007) reported that the consumption of refining energy in mechanical pulping was reduced with manganese peroxidase pre-treatment with slight improvement in pulp properties [38,39]. They concluded that lignolytic enzymes are promising to replace the convential chemical processes of several wood based industries.

The introduction of some white rot strains (IZU - 154) to kraft bleaching made it possible to obtain bleached kraft pulp without the use of chlorine [40]. These bleached pulps had good optical and strength properties but unfortunately the use of fungal bleaching process is very slow and takes days instead of hours [41]. The direct use of an actively growing fungus for pulp bleaching is, therefore not feasible for industrial processes due to the time constraints and the degradation of the cellulose caused by cellulases secreted by the fungus [42]. The lignolytic enzymes rather than the fungus itself after a faster and more direct attack on the lignin structure, the laccase was only successful in reducing the lignin content of pulps in the presence of the living fungus, which indicated that the enzyme alone is not responsible for delignification [43]. Bourbonnais *et al.* (1995) reported that kraft pulp is delignified by laccase only in the presence of a mediator such as 2,2-azinobis (3-ethyl- benzthiazoline-6-sulphonate) (ABTS), but never by the laccase enzyme alone [44]. Thus, the ABTS has the ability to act as a mediator for laccase, thereby enabling the oxidation of non-phenolic lignin compounds that are not laccase substrates [45]. This mediator was found to prevent and ever reverse polymerization of kraft lignin and promotes the delignification of kraft pulp of laccase.

Manoharachary *et al.* (2005) reported that mushrooms alone are represented by about 41,000 species, of which approximately 850 species are recorded from India, and more than 2000 species of edible species are reported in the literature from different parts of the World [46]. Singer (1989) had reported 1320 species belonging to 129 genera under agaricales [47]. Extensive surveys an macro fungi were under taken and concluded that macro fungi are the associates of mycorhizal and determined the ecosystem dynamic of forests [48-50]. Numbers of reports are available on the diversity of white not fungi in various habitats, their lignolytic potentials and their role in the bio bleaching and bio pulping of UKP is wood based industries [51-55]. Ferraz *et al.,* (2008) visualized variety of novel technological advances and mechanistic basis for fungal bio bleaching and bio pulping. They selected very potential white rots and used strategies far the large scale production of lignolytic enzymes are used in the pretreatment of Kraft Pulp [56]. Singh and Chen (2008) screened different strains of *Phenerochaete* and identified few potential strains for the industrial purpose and also qualitatively and quantitatively different the efficiencies of those strains in the production of lignolytic enzymes [57]. Tran *et al.* (2013) identified few white rot fungi and used them as decomposers, and also in the bioremediation of industrial wastes of which they underlined the great contribution of *Trametes versicolor* in solving the problem related to degradation of toxic pollutants [58]. Andrew *et al.* (2013) surveyed the diversity and distribution of macro fungi in the Mount Cameroon and gathered the baseline information for the assessment of charges in biological diversity and used it as first step towards producing a check list of macro fungi [59]. Bindu *et al.* (2014) Krishna *et al.* (2015) collected variety of white and brown rot fungi from the forests of Andhra Pradesh and identified *Fomitopsis feei* as a potential brown rot fungus for the decolorization of effluents and their biomolecules were used as basic compounds for the manufacture of antibiotics [60,61]. Ram Prasad *et al.,* (2014) also surveyed the various habitats of Warangal town and collected good number of macro fungal strains, of which two strains of *Trametes* were proved to useful in the bleaching and pulping process [62]. The Exopolysaccharides produced from these fungi are identified as active bio compounds for the treatment of cancer. Kamali and Khodaparast (2015) reviewed the recent developments on pulp and paper mill wastewater treatment and identified the microbial enzymes as promoters of safe remediation strategy [63]. Li *et al.* (2015) and Hatice and Kasra (2016) used *Funalia trogii* and *Phanerochaete chrysosporium* respectively in the solid state fermentation to decolorize and remove heavy metals from the contaminated sites [64,65]. The role of fungal enzymes with special reference to laccases were studied for the cleavage of lignin in wood based industries for the improvement of brightness to the pulp and identified their activities in the environmental management [66,67]. Zhu *et al.* (2016) optimized the conditions of laccase production in the white rot fungus, *Pleurotus ostreatus* induced through yeast extract and copper for its use in biobleaching and biopulping of paper and pulp industries [68].

Conclusion

The conclusion of the present work indicated that the bio bleaching process is technologically feasible. The important aspect of economic analysis indicated that the biological treatment processes are

economically beneficial. Greater benefits can be realized by bio bleaching i.e. a reduction in chemicals, an increased throughput, environmental safety, health of work force etc. A large amount of effort has gone in to this research during the past 10 years to bring this technology to commercialization. However, many questions remain unanswered. The most important basic question is the molecular mechanism of bio bleaching. An understanding of the mechanism will facilitate the optimization of the process for mechanical, chemical and biological bleaching. The use of biological procedures for the kraft process is still an open research issue. Finally, the use of this technology for various other substrates with other diversified potential white rot fungal stains and their secretes of molecular mechanisms are to be investigated in future.

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Original Article

A Comparative Account of the Impact of the Urban Development on Plant and Wetland Dependent Bird Population along the Two Arms of an Ox-Bow Lake, Motijheel, in Murshidabad District

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Abstract

In this study the impact of the urban development on plant and wetland dependent bird population is compared between the two arms of the lake exposed to similar types of climatic and edaphic conditions but different anthropogenic pressure. Disturbances, specially that caused by human recreational activities, is a threat to water-birds, particularly since many recreational activities may be increasing in intensity and distribution. Wetlands plants provide important bird habitats and birds use them for breeding, nesting, and rearing young. Both wetland plants and water-birds are under intense pressure from human activities such as land claim, habitat destruction, pollution, hunting and recreation. As the wetland habitats are drained or altered, the ability of these areas to sustain bird populations decreases. The present investigation is a comparative study of the change in aquatic plant pattern and consequent displacement of the bird population vis-à-vis urban development on the two arms of an ox-bow lake Motijheel (24° 9′ 42" N, 88° 16′ 33" E) of Murshidabad district, West Bengal, India. Along one arm of the ox-bow lake there is rapid urbanization whereas along the other arm there is little human activity. Total 67 bird species were available along one arm of the ox-bow lake where there is less anthropogenic pressure. However only 31 bird species were found along the other arm of the lake where there is urban development. 32 angiosperms were found to be associated with the water birds but many of them were not found in equal proportion along the two arms of the Motijheel Lake.

Keywords: Aquatic Plants; Wetland-Dependent Bird Populations; Urban Development; Ox-Bow Lake .

Introduction

Urbanisation is a major development challenge exerting awesome pressure on social, economic and environmental sustainability (Pickett et al., 2001). Even though cities are considered as the 'engines' of economic development, failure to manage the impacts of rapid urbanization provides a threat to the health of human beings, as well as environmental quality and urban productivity (Leitmann *et al,* 1992).

Urbanisation impacts wetlands in numerous direct and indirect ways. For example, construction reportedly impacts wetlands by causing direct habitat loss, suspended solids additions, hydrologic changes, and altered water quality. Indirect impacts, including changes in hydrology, eutrophication, and sedimentation, can alter wetlands more than direct impacts, such as drainage and filling. Studies have shown that negative effect on wetland species and ecosystem functioning can be expected in such areas due to human activities (Ehrenfeld, and Schneider, 1991; Morris, 1991).

The risk of impact of recreational human activities to wild-ranging breeding birds of prey is a topic commonly addressed in environmental impact assessments (Martínez *et al.,* 2003), owing to the dramatic worldwide increase of human access to the countryside during recent decades. It is generally agreed that disturbance, especially that caused by recreational activities, is a threat to water-birds, particularly since many recreational activities may be increasing in intensity and distribution (Ward

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1990).

Impacts on wetland hydrology and water quality can, in turn, affect wetland vegetation. Horner (1989) stated that emergent zones in Pacific Northwest wetlands receiving urban runoff are dominated by an opportunistic grass species, *Phalaris arundinaceous*, while non-impacted wet lands contain more diverse groupings of species. Vegetation plays an important role in providing nest sites and nesting materials for many species of water birds.

The degradation and loss of inland wetlands and species has been driven by infrastructure development (such as dams, dikes, and levees), land conversion, water withdrawals, pollution, overharvesting, and the introduction of invasive alien species. Dams, diversions and river regulation have reduced flooding to wetlands (Kingsford 2000), altering their ecology and causing the reduction in distribution and abundance of wetland dependent species.

Wetlands are the most productive ecosystems due to habitat diversity and productivity, characterized by shallow water overlying waterlogged soil, interspersed submerged and emergent vegetation. These wetland habitats are dominated by a variety of aquatic vegetation (such as; emergent, submerged, reed beds and grasses) which are suitable habitat for fish, amphibians, reptiles and invertebrates (Rajpar *et al,* 2010). Wetlands are critical habitats for water dependent bird species. The diversity of vegetation and food resources play a significant role in the distribution and diversity of water birds and indicated where and how they used the particular habitat. These habitats are facing rapid degradation due to anthropogenic activities that affect the water birds distribution by changing their habitats. Water bird species exhibit a wide variation in habitat preference across the different wetland ecosystems depending on vegetation structures and composition, richness of food resources, occurrence of surrounded landscapes, protection from predators and harsh weather.

Water bird density and diversity is associated with vegetation structure and composition (Bersier and Meyer, 1995; Hurlbert, 2004) i.e., vegetation structure provides loafing, foraging, nesting and refuge sites from predators and harsh weather (Rajpar and Zakaria, 2011). Detailed information on the effects of vegetation composition and cover on waterbird distribution and richness is lacking. No detailed study has been carried out to examine the effects of wetland vegetation composition on water bird distribution and richness.

Diverse mosaics of wetland habitats are important determinants of waterbird distribution and abundance at all scales from the local to the continental as many waterbird species use different habitats for feeding and breeding and must move between them to survive, reproduce and recruit (Maher and Braithwaite 1992; Haig et al. 1998; Halse et al.1998; Roshier et al.2002, 2006, 2008a & b).

Diverse mosaics of wetland habitats are important determinants of waterbird distribution and abundance. Forage quality and availability, climatic factors, and a wetland's conservation status are expected to affect the densities of wetland birds. Waterbirds use an array of habitats, ranging from sewage treatment ponds, swamps, lagoons, freshwater lakes, estuaries, rivers, dams and floodplains (Belanger and Couture 1988, Kingsford and Norman 2002).

Motijheel, an ox-bow lake, (24° 9'12'' to 24° 9'42'' North and 88° 16' 33'' to 88° 15' 13'' East) of Murshidabad district, West Bengal, India is a famous wetland and historic place. It is. The influence of urban development is compared between the two arms of the lake exposed to similar types of weather conditions but different human pressure in terms of species diversity and species composition.

Wetlands of India, estimated to be 58.2 million hectares, are important repositories of aquatic biodiversity. Wetlands and water-birds are under intense pressure from anthropogenic activities such as land claim, habitat destruction, pollution, hunting and recreation (Bell &Owen 1990, Ward 1990, Yalden 1992).

Generally the ideal wetlands have all forms of vegetation depending on the depth of the water body. It is composed of marshy, swampy, floating anchored, free floating and submerged plants as the depth progresses. The food plants in Motijheel also represented all these classes of vegetation which catered for different types of birds like waders, dabblers and divers indicating the suit-ability of the habitat for avian flora. The occurrence of food plant is was very well synchronized with a large number of migratory and resident birds in the wetland. High diversity and abundance of avian flora indicated intensive use of the wetland which was due to structural diversity of vegetation provided by broadleaved species (Mitsch and Gosselin,1986). India is one of the global hotspots for birds with over 1340 bird species (13% of world species) recorded from the country (Manakadan & Pittie 2001), of which 310 species are dependent on different fresh and salt water wetlands (Kumar et al. 2005). The conversion of wetland habitat to agricultural India is one of the

global hotspots for birds with over 1340 bird species (13% of world species) recorded from the country (Manakadan & Pittie 2001), of which 310 species are dependent on different fresh and salt water wetlands (Kumar et al. 2005). The conversion of wetland habitat to agricultural land or other commertial purpose is threatening the bird populations (Chowdhury and Nandi, 2014). According to Bird Life International (2001), the wetland of this area lies in Biome - 11 (Indo-Malayan tropical dry zone). Thirteen big fresh water wetlands, out of 23 (>100 hectare) in West Bengal, are present in different blocks of this district (Anonymous, 1990). In Bengal the large or small, permanent or seasonally waterlogged marshes are popularly known as "beel". The wetlands of this region are generally palustrine (floodplains, seasonal waterlogged, marsh), lacustrine (Lakes) and riverine types. All these wetlands are directly or indirectly connected with the different rivers like Ganga, Babla, Jalangi, Bhairab etc.

Wetlands are one of the most threatened habitats of the world. Wetlands in India, as elsewhere are increasingly facing several anthropogenic pressures. Thus, the rapidly expanding human population, large scale changes in land use/landcover, burgeoning development projects and improper use of watersheds have all caused a substantial decline of wetland resources of the country. Significant losses have resulted from its conversion threats from industrial, agricultural and various urban developments. These have led to hydrological perturbations, pollution and their effects. Unsustainable levels of grazing and fishing activities have also resulted in degradation of wetlands. The current loss rates in India can lead to serious consequences, where 74% of the human population is rural and many of these people are resource dependent. Healthy wetlands are essential in India for sustainable food production and potable water availability for humans and livestock. They are also necessary for the continued existence of India's diverse populations of wildlife and plant species; a large number of endemic species are wetland dependent.

Most problems pertaining to India's wetlands are related to human population (Prasad, S. N. *et al.* 2002). many experimental studies haveshown that disturbance, which can be equated to deterioration of habitat, canhave a considerable effect on the numbersof individuals using a site (Madsen *et al*.1995 and Hill *et al*. 1997).

Urbanization of Motijheel to promote it as a tourist spot. Once a beautiful natural oxbow lake is now turned into a park for the tourists. One arm of the oxbow is cleared from weeds for boating. The habitat is partially changed. The study emphasize on the displacement of bird population from their natural habitat as a result of development.

Materials and Methods

25 consecutive surveys were executed from November 2012–March 2015. Bird species were observed visually using binoculars of different ranges and their photographs were taken using a Sony DSC HX 100 V camera for identification. Surveys started during the peak hours of their activity, in the morning, from 0500–1100hr and in the evening, from 1600–1800hr on a regular basis in different groups. To prepare the recorded bird list a total of 25 transects of 1km stretches were established in the study areas in both the arms. Observations were carried along each transect following Ridgely & Greenfield (2006). The identification and classification of birds followed Ali (2002). Plant specimen were collected and preserved as herbarium specimens for identification.

Observation

The left arm of the oxbow is still having some vegetation in comparison to right arm. Vegetation is integral part of an wetland that harbouring a large number of aquatic avifauna as well as birds present in the nearby tree. Eradication of so called 'weeds' may facilitate fisheries and tourism but the ecosystem will be highly disturbed. This is evident from the following observations as shown in Table 1 and Table 2:

Discussion

Wetland habitats are threatened by land clearing, climate change, drought and water resource development. It is key that wetlands are managed to maintain ecosystem health and provide habitat for a range of species. Along one arm of Motijheel, the ox-bow lake there is rapid urbanization whereas along the other arm there is little human activity. Total 67 bird species were available along one arm of the ox-bow lake where there is less anthropogenic pressure. However only 31 bird species were found along the other arm of the lake where there is urban development. 32 angiosperms were found to be associated with the water birds but many of them were not found in equal proportion along the two arms of the Motijheel Lake.

Out of 67 reported species 11 birds were observed to be eating aquatic food plants. They were Common Coot (*Fulica atra),* Common Pochard (*Aythya ferina*),

Table 1: Comparative distribution of avifauna in the left and right arms of the ox-bow lake, Motijheel (P= Present; A= Absent)

Common Name	Scientific Name	Left arm	Right Arm
Purple Swamp hen	*Porphyrio porphyrio*	P	A
White-breasted waterhen	*Amaurornis ph the oenicurus*	*P*	*A*
Purple heron	*Ardea purpurea*	*P*	*A*
Indian Pond heron	*Ardeola grayii*	*P*	*P*
Pheasat-tailed jacana	*Hydrophasianus chirurgus*	*P*	*A*
Bronze-winged jacana	*Metopidius indicus*	*P*	*A*
Little Grebe	*Tachybaptus ruficollis*	*P*	*A*
Common kingfisher	*Alcedo atthis*	*P*	*P*
White-throated kingfisher	*Halcyon smyrnensis*	*P*	*P*
Pied Kingfisher	*Ceryle rudis*	*P*	*P*
Little Cormorant	*Phalacrocorax niger*	*P*	*P*
Great Cormorant	*Phalacrocorax carbo*	*P*	*P*
Little egret	*Egretta garzetta*	*P*	*P*
Cattle egret	*Bubulcus ibis*	*P*	*P*
Cotton pygmy-goose	*Nettapus coromandelianus*	*P*	*A*
Wire-tailed swallow	*Hirundo smithii*	*P*	*P*
Red-wattled lapwing	*Vanellus indicus*	*P*	*A*
Sarus Crane	*Grus antigone*	*P*	*A*
Blue-winged leafbird	*Chloropsis cochinchinensis*	*P*	*P*
Intermediate egret	*Mesophoyx intermedia*	*P*	*P*
Asian Openbill	*Anastomus oscitans*	*P*	*p*
Common Coot	*Fulica atra*	*P*	*A*
Black-headed Ibis	*Threskiornis meloanocephalus*	*P*	*A*
Grey Heron	*Ardea cinerea*	*P*	*P*
Darter	*Anhinga melanogaster*	*P*	*A*
Greylag Goose	*Anser anser*	*P*	*P*
Barheaded Goose	*Anser indicus*	*P*	*A*
Gadwall	*Anas strepera*	*P*	*A*
Mallard	*Anas platyrhynchos*	*P*	*A*
Northern Pintail	*Anas acuta*	*P*	*A*
Wood Sandpiper	*Tringa glareola*	*P*	*A*
Northern Shoveler	*Anas clypeata*	*P*	*A*
Eurasian Wigeon	*Anas Penelope*	*P*	*A*
Chestnut-tailed Starling	*Sturnus malabaricus*	*P*	*A*
Garganey	*Anas querquedula*	*P*	*A*
Pied cuckoo	*Clamator jacobinus*	*P*	*P*
Rosy Starling	*Sturnus roseus*	*P*	*A*
Ashy prinia	*Prinia socialis*	*P*	*A*
Indian Silver bill	*Lonchura malabarica*	*P*	*A*
Green bee-eater	*Merops orientalis*	*P*	*P*
Black drongo	*Dicrurus macrocercus*	*P*	*P*
Laughing dove	*Streptopelia senegalensis*	*P*	*P*
Red-vented bulbul	*Pycnonotus cafer*	*P*	*P*
Brahminy Starling	*Sturnus pagodarum*	*P*	*P*
House Crow	*Corvus splendens*	*P*	*P*
Indian Robin	*Saxicoloides fulicata*	*P*	*P*
Oriental Magpie Robin	*Copsychus saularis*	*P*	*P*
Jungle Babbler	*Turdoides striatus*	*P*	*P*
Asian Pied starling	*Sturnus contra*	*P*	*A*
Common mynah	*Acridotheres tristis*	*P*	*A*
Asain Koel	*Eudynamys scolopacea*	*P*	*P*
Black-rumped flameback	*Dinopium benghalense*	*P*	*A*
White-browed Bulbul	*Pycnonotus luteolus*	*P*	*P*
Rose-ringed Parakeet	*Psittacula krameri*	*P*	*A*
Spotted Dove	*Streptopelia chinensis*	*P*	*P*
Eurasian Golden Oriole	*Oriolus oriolus*	*P*	*A*
Hoopiee	*Upupa epops*	*P*	*P*
Common pochard	*Anas ferrina*	*P*	*A*
Paddy field pipit	*Anthus novacseelanduiae*	*P*	*P*
Duscy leaf Warbler	*Phylloscopas fuscatus*	*P*	*A*
Black Stork	*Ciconus nigra*	*P*	*A*
Blacknecked stork	*Ephippiorhynchus asiaticus*	*P*	*A*
Spoonbill	*Platalea leucocordia*	*P*	*A*
Comb duck	*Sarkidiomis melanotos*	*P*	*A*
Lesser Whistling Teal	*Dendrocygna javanica*	*P*	*A*
Blackwinged stilt	*Himantopus kimomtopus*	*P*	*A*
Red Wattled Lapwing	*Vanellus indicus*	*P*	*P*
Eastern Golden Plover	*Pluvialis dominica*	*P*	*P*

Table 2: Comparative distribution of aquatic plants in the left and right arms of the ox-bow lake, Motijheel (P= Present; A= Absent)

Name of Plants	Family	Local Name	Left arm	Right arm
Submerged Plants				
Ceratophyllumdemersum L.	Ceratophyllaceae	Jhanji, Sheoyala	P	A
Hydrillaverticillata(L.f) Royle	Hydrocharitaceae	Kaschra, Jhanji	P	A
*Najasgraminea*Del.	Hydrocharitaceae	JalPalak	P	A
Floating Plants				
Azollapinnata R. Br.	Azollaceae (Pteridophyte)	Tara pana	P	A
Eichhorniacrassipes(Mart.)	Pontederiaceae	Kochuripana	P	A
*Lemnaperpusilla*Torr	Lemnaceae	Khudepana	P	A
NeptuniaoleraceaLour.	Fabaceae	Panijajak	P	A
*Pistiastratiotes*L.	Araceae	Tokapana	P	A
*Salvia molesta*D. Mitch	Salviniaceae (Pteridophyte)	Kopi pana	P	A
Wolffiaglobosa(Roxb.)	Lemnaceae	SujiPana	P	A
Plants with floating leaves				
*Euryale ferox*Salisb	Nymphaeaceae	Kantapadma	P	A
*Nelumbonucifera*Gaertn	Nelumbonaceae	Padma	P	A
*Nymphaeapubescens*Willd	Nymphaeaceae	Saluki	P	A
Nymphoideshydrophylla (Lour)	Menyanthaceae	Jalsweli	P	A
Partially submerged plants				
Aeschynomeneindica L.	Fabaceae	Kath sola	P	A
*Ipomoea carnea*Jacq. subsp. fistulosa (*Mart*. ex Choisy) D. F. Austin	Convolvulaceae	Dholkalmi	P	A
Phragmiteskarka (Retz.)	Poaceae	Nalkhagra	P	A
Sagittariamontevidensis Cham &Schltdl	Alismataceae	Biskachu	P	A
Semi aquatic plants				
Alternantheraphiloxeroidea(*Mart*.) Griseb.	Amaranthaceae	Barmishak	P	P
*Alternantheraparonychiodes*Saint-Hilarie	Amaranthaceae	Saltekeshut	P	A
Bacopamonnieri (L)	Scrophulariaceae	Brahmi	P	P
Canna indica L.	Cannaceae	Kalabati	P	P
Centellaasiatica (L)	Apiaceae	Thankuni	P	P
Colocasiaesculenta (L)	Araceae	Kachu	P	P
*Enhydrafluctuans*Lourerio	Asteraceae.	Helencha	P	P
Hygrophilaschulii (Buch-Ham)	Acanthaceae	Kulekhara	P	P
Ipomoea aquatic Forssk	Convolvulaceae	Kalmi	P	P
*Marsileaminuta*L.	Marsileaceae (Pteridophyte)	Susni	P	P
*Polygonumbarbatum*L.	Polygonaceae	Bekunjubaz	P	P
Polygonumhydropiper L.	Polygonaceae	Panimorich	P	P
Ranunculus sceleratus L.	Ranunculaceae	Jaldhane	P	P
*Sesbaniabispinosa*W. Wight	Leguminosae	Dhanche	P	A
*Sphenocleazeylanica*Gaertn	Sphenocleaceae	Jhilmarich	P	P

Eurasian Wigeon (*Anas Penelope),* Gadwall (*Anas strepera*), Gargany (*Anas querquedula*), Greylag Goose (*Anser anser),* Lesser Whistling-duck (*Dendrocygna javanica),* Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), Purple Swamphen (*Porphyrio porphyrio*), and Red-crested Pochard (*Rhodonessa rufina*). These are primarily the migratory birds except Common coot, Lesser Whistling-duck and Purple Swamphen.

It was also observed that 9 aquatic birds like Bar-headed Goose (*Anser indicus*), Common Coot (*Fulica atra*), Common Pochard (*Aythya ferina*), Graylag Goose (*Anser anser*), Northern Shoveler (*Anas clypeata*), Purple swamphen (*Porphyrio porphyrio*), Red-crested Pochard (*Rhodonessa rufina*), Spot-billed Duck (*Anas poecilorhyncha)* and Grey Heron (*Ardea cinerea*) foraged in early as well as late winter agriculture crops like paddy, wheat, mustard, pigeon pea, gram, green pea, sunflower and lentil in the neighboring agriculture fields. But their shelter is the aquatic plants. Wetlands plants provide important bird habitats and birds use them for breeding, nesting, and rearing young. Out of 31 birds found in the urbanized right wing 12 are aquatic. They mostly feed on fish, insects, worms and mollusks. These are the kingfisher, cormorant, erget and openbill group. The rest of the 19 birds are insect eater or feed upon the seeds of various crops.

Breeding water birds have high nutritional and energetic demands and can be expected to select foraging habitats that have a high abundance of accessible foods (Laubhan and Gammonley 2000). Gawlik, 2002, found that the feeding strategies employed by wading birds i.e. searching for high quality food rather than staying and exploiting food in declining patches influenced bird abundance and diversity. Bancroft *et al* 2002 found that while vegetation and water depth influence wading bird abundance, water depth has the greatest influence. These are key ecological variables that can be

managed for when manipulating flow regimes or creating wetland mosaic habitats From the above study it is evident that urbanization and organized fisheries are displacing birds from their natural habitat. Once this ox-bow lake, Motijheel was full of birds due presence of suitable habitat plants but now they are only restricted in the left arm which is still undisturbed. For sustainable development more data will be required.

At the regional and individual wetland scale there are several key areas where our knowledge is lacking. These include the interactions of water birds with hydrology, wetland habitat and wetland ecosystem components. Further studies along these lines will provide better understanding about the wetlands and their fragile biodiversity. Identification of key factors is critical, so that wetland management decisions can be more strategic and better informed with rigorous scientific data. The habitat variables such as aquatic vegetation composition, vegetation cover percentage and micro-climate and other key factors which affect on the distribution and richness of water bird in particular wetland habitat need to be studied.

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Original Article

Arsenic in Surface Water of Murshidabad, West Bengal, India: An Unprecedented Situation

Santi Ranjan Dey

Abstract

Arsenic contamination in groundwater in the Ganga- Brahmaputra basin in India and Padma-Meghna basin in Bangladesh and its consequences to the human health have been reported as one of the world's biggest natural groundwater calamities to the mankind. In India, seven states namely- West Bengal, Jharkhand, Bihar, Uttar Pradesh, Assam and Manipur and some parts in Chhattisgarh state have so far been reported affected by Arsenic contamination in groundwater above the permissible limit of 10 μg/L. People in these affected states have chronically been exposed to drinking Arsenic contaminated hand tube-wells water. With every new survey, more Arsenic affected villages and people suffering from Arsenic related diseases are being reported, and the issues are getting complicated by a number of unknown factors. Arsenic is said to be absent in the surface water like rivers, lakes, ponds etc. A recent survey in Murshidabad district, West Bengal, India reveals that arsenic contamination is also available in Ganga water and other surface water bodies. In river Ganga, at upper Murshibad region it is 0.0006 to 0.0013 mg/L, in its lower part the amount varies from 0.0008 to 0.0182 mg/L. The surface water bodies are also contaminated in varying degree (0.0014 to 0.0188 mg/L). The water supplies by the Berhampore municipality also contain 0.001 to 0.0444 mg/L. The probable source of contamination is the ground water. Huge amount of ground water is taken out by pumps for household purposes, this water is drained in the river without any treatment. In a study, it is found that the sewage falling in Ganga contain 0.0010 to 0.0444 mg/L arsenic. When arsenic is found in the surface water, it will definitely enter the food chain through plants and animals. The biological magnification poses greater threat to human being.

Keywords: Arsenic; Ganga; Murshidabad; Surface Water; Food Chain.

Introduction

Source of Arsenic in Water

Arsenic pollution is a menace to all of us. A major part of India is affected by arsenic pollution. The impact of arsenic pollution on human being, plants, other animals and environment is alarming. In West Bengal several district such as 24 Parganas (North & South), Nadia, Burdwan, Malda and Murshidabad are being affected very badly. Arsenic is found widely in nature and most abundantly in sulphide ores. The arsenic loaded iron particles are then flushed into the sand layer below (Acharyya *et al*, 1993, 1999). Arsenic is generally found in the ground water. This is known to be absent in surface water because it is thought to be oxidized and sediment. Other sources of arsenic are-

1. Some rodenticides used in the agricultural field and urban area contain arsenic.
2. Factories in India, where copper is melted, in one step of the process, arsenic is obtained as a byproduct and the factory dump this without proper safety measures.
3. In some regions, in some layer of soil, arsenic may be there. Arsenic released through some chemical process and dissolved in the water of that layer. If the tube well pumps out water from the layer, arsenic may be present above the permissible limit.
4. High arsenic concentration in ground water is generally associated with the geochemical

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environments.

5. The principle sources of arsenic are from arsenic bearing geologic material. The presence of sulphide mineral deposits in the field and the association of arsenic with such types of minerals suggest very strongly that these are the origin for the near field arsenic sources.
6. Reports indicate that high concentrations of arsenic are grounded primarily in the upper 150 meters of the alluvial sediments (Acharyya *et al,* 1993, 1999).

Arsenic Toxicity

Acute poisoning may occur due to accidental ingestion of inorganic arsenic compounds (e.g. arsenic trioxide). Cases of poisoning are characterized by profound gastrointestinal damage, resulting in severe vomiting and diarrhea which may result in shock and subsequent oliguria and albuminuia. Other acute symptoms may occur within a few minutes following exposure to the poison in solution out may be delayed for several hours if the arsenic compound is solid form or if it is taken with a meal. When ingested as a particulate, toxicity is also dependent on solubility and particle size of the ingested compound. The fatal dose of ingested arsenic trioxide has been reported to range from 70 to 180 mg./lit. Death may occur within 24 hours but the usual course runs from 3 to 7 days. Acute intoxication with arsenic compounds is usually accompanied by anemia and leucopenia especially granulocyopenia. In survivors these effects are usually reversible within 2 or 3 weeks. Reversible enlargement of the liver is also seen in acute poisoning. Exposure to irritant arsenic compounds in air, such as arsenic trioxide can causes acute damage to mucous membranes of the respiratory systems and can cause acute symptoms from exposed skin. Severe irritation of the nasal mucosa, larynx and bronchi as well as conjunctivitis and dermatitis occur in such cases (WHO, 1993).

Chronic arsenic poisoning may occurs in worker exposed for a long time to excessive concentration of airborne arsenic compounds. Local effects in the mucous membranes of the respiratory tract and skin effects are prominent features. Involvement of the nervous and circulatory systems and the liver may also occur as well as cancer of the respiratory tract. With long term exposure to arsenic via ingestion in food, drinking water or medications, symptoms are partly different from those after inhalation exposure. Vague abdominal symptoms–diarrhoea or constipation, flushing of the skin, pigmentation and hyperkeratosis–dominate the clinical picture. Anaemia and lucocytopenia often occur in chronic arsenic poisoning. Liver involvement has been more commonly seen in persons exposed for a long time via oral ingestion than in those exposed via inhalation. Arsenical skin lesions are some what different depending on the type of exposure. Eczematous symptoms of varying degrees of severity do occur. Two types of dermatological disorders may occur (WHO, 1993).

1. An eczematous type with erythema, swelling and papules or vesicles ; and

2. A follicular type with erythema and follicular swelling or follicular pustules.

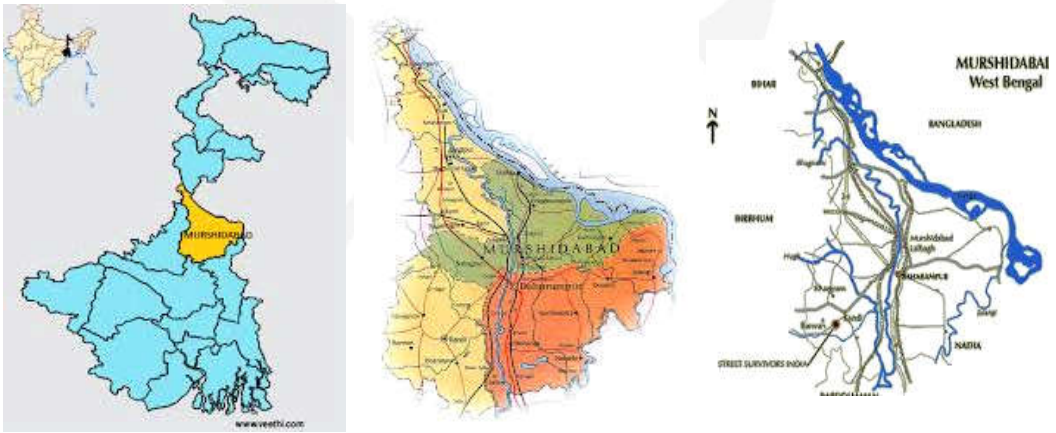
Dermatitis is primarily localized on the most heavily exposed areas such as the face, back of the neck, forearms, wrists and hands. Chromic dermal lesions may occur depending on the concentration and duration of exposure. These chronic lesions may occur after many years of environmental exposure. Hyperkeratosis, warts and nekabisus of the skin and the conspicuous signs in chronic skin lesions poisoning depigmentation , i.e. Leukoderma, especially on the pigmented areas, commonly called 'raindrop' pigmentation also occurs. These chronic skin lesions, particularly the hyperkeratosis may develop into precancerous and cancerous lesions. Mucous membrane lesions in chronic arsenic exposure are most classically reported as perforation of the nasal septum after inhalation exposure. This lesion is a result of irritation of the mucous membranes of the nose (WHO, 1993).

Arsenic in Water

In most studied areas it was seen that high-arsenic groundwater was not related to areas of high arsenic concentration in the source rock. Two key factors were identified: first, there should be very specific biogeochemical triggers to mobilize arsenic from the solid/sorbed phase to groundwater, and second, the mobilized arsenic should have sufficient time to accumulate and not be flushed away, that is, it should be retained in the aquifer (Smedley and Kinniburgh, 2002). In other words, arsenic released from the source should be quick, relative to the rate of groundwater flushing. There are number of processes for mobilization of arsenic in groundwater namely, (i) mineral dissolution, (ii) desorption of arsenic under alkaline and oxidizing conditions, (iii) desorption and dissolution of arsenic under reducing conditions, (iv) reduction of oxide mineral surface area, and (v) reduction in bond strength between arsenic and holt mineral surface (Smedley and Kinniburgh, 2002).

Oxidation of sulphide minerals (pyrite-FeS_2) was advocated strongly by many investigators in West Bengal as the cause of groundwater arsenic contamination (Das et al., 1994). According to this hypothesis, arsenic is released from the sulfide minerals (arseno-pyrite) in the shallow aquifer due to oxidation (Mandal et al., 1998). The lowering of water table owing to over exploitation of groundwater for irrigation is the cause of release of arsenic. A recent research study explained that desorption or dissolution of arsenic from iron oxides could be the process on regional distributions of arsenic in water (Smedley, 2004). Broadly, it can be stated that some critical reactions to transform to reducing conditions and subsequent arsenic release are likely to take place to reduce arsenic from its oxidized As (V) form to its reduced As(III) form. Under many conditions, As (III) is less strongly adsorbed to iron oxides than As(V). Dissolution of the iron oxides themselves under reducing conditions is another potentially important process. Some investigators explained that excessive use of water for irrigation and use of fertilizers have caused mobilization of phosphate from fertilizers down below the shallow aquifers, which have resulted in the mobilization of Arsenic due to anion exchange onto the reactive mineral surfaces. Sikdar and Chakraborty (2008) attributed that the combined processes of recharge of groundwater from rainfall, sediment water interaction, groundwater flow, infiltration of irrigation return water (which is arsenic rich due to the use of arsenic-bearing pesticides, wood preservatives, etc. and the pumping of arsenic-rich groundwater for agriculture purpose), oxidation of natural or anthropogenic organic matter and the reductive dissolution of ferric iron and manganese oxides, played a key role in the evolution of groundwater arsenic contamination in the area. Recently, a new hypothesis based on displacement of arsenic by dissolved bicarbonate as an alternative mechanism for the genesis of high-arsenic groundwater has been proposed (Smedley and Kinniburgh, 2002). The occurrence of arsnic in groundwater is well studied in West Bengal, the major problem is that it is coming in the food chain through water used for irrigation purpose (Bhattacharya *et al*, 2009, 2010; Iva *et al* , 2015). It is a convention that Arsenic is never found in surface water because surface water is rainfed mainly, thus surface water is safe for drinking and other purpose (Mukherjee-Goswami *et al*, 2008). During survey of Icthyofauna in Murshidabad district a number of water bodies were encountered. As per guidelines the water quality parameters have to be measured. It was also observed that all the major towns in Murshidabad do not have any sewage water treatment plant. They are directly disposing waste water in Ganga or the water bodies nearby. Moreover most of the households are dependent on ground water, use tube wells or pumps. The waste water produced by each and every house drains outside in municipality drains. These drains created a network, collect all the waste water and directly dispose water in Ganga or in 'Beels'. As we know, Murshidabad is highly contaminated with Arsenic, out of curiosity the surface water were tested in the laboratory. Arsenic was found and then the water samples were sent to PWD (Irrigation Laboratory), Government of West Bengal for confirmation (Sevabrata, Murshidabad, 742134).

Murshidabad is a district of West Bengal in eastern India. Situated on the left bank of the river Ganges, the district is very fertile. Covering an area of 5,341 km² (2,062 sq mi) and having a population 5.863m (according to 2001 census) it is a densely populated district and the ninth most populous in India (out of 640). It borders Malda district to the north, Jharkhand's Sahebganj district and Pakur district to the north-west, Birbhum to the west, Bardhaman to the south-west and Nadia district due south. The international border with Bangladesh's Rajshahi division is on the east. Berhampore is the headquarters of the district.



Map and location of the Major Rivers in Murshidabaad

Landscape, Rivers and Vegetation

The district comprises two distinct regions separated by the Bhagirathi River. To the west lies the Rarh, a high, undulating continuation of the Chota Nagpur plateau. The eastern portion, the Bagri, is a fertile, low-lying alluvial tract, part of the Ganges Delta. The district is drained by the Bhagirathi and Jalangi rivers and their tributaries. Bhagirathi is a branch of the Ganges, and flows southwards from Farakka barrage where it originates from the Ganges. It flows southwards through the district and divides it into more or less equal halves.

Materials and Methods

The sample water collected fixed with conc. HCl (2% of sample volume). Arsenic is measured in Spectrophotometer compared with standard curve after proper procedure. The procedure was taken from Narayan *et al*, 2006. Fe(Iron) content was also measured in the laboratory of some selected sample because arsenic is found associated with Fe frequently. The Ganga water was collected at different points at 100 Km stretch in pre-monsoon and post monsoon period. The collection point included urban and rural areas. Water sample from 'Beels' in and around Berhampore were also collected in pre-monsoon (March-April) and post-monsoon (Sepetember-October) period. The photograph of the Municipality outlet pouring directly in Ganga were also taken. The sample water was also collected from 3 major outlets of Berhampore municipality. Two of these channels are directly connected with Ganga and one is with Chaltia 'Beel'. The drinking water supplied in the houses is measured for Arsenic.

Observation

The following results were obtained in the laboratory and confirmed by PWD laboratory

Table 1: Arsenic content of surface water in berhampore municipality area

Sample Water	**Post Monsoon (As mg/L ± SD)**	**Pre Monsoon (As mg/L ± SD)**	Pre Monsoon (Fe mg/L)	Post Monsoon (Fe mg/L)
Ganga (Farasdanga Ghat)	0.0041 ± 0.0007	0.0112 ± 0.00004	Not measured	0.11
Ganga (Kandi Bus Stand)	0.0108 ± 0.0003	0.0118 ± 0.0002	1.00	0.22
Ganga (Haridas mati)	0.0005 ± 0.0001	0.0005 ± 0.0006	Not measured	0.1
Outlet 1 falling in Ganga (Kandi Bus Stand)	0.0079± 0.0002	0.0212 ± 0.0009	0.48	0.42
Outlet 2 falling in Ganga (Gorabazar)	0.0010 ± 0.0007	0.0444± 0.0005	0.49	0.40
Main Drain of Berhampore Munisapality (going to Chaltia Beel)	0.0118 ± 0.0007	0.0364 ± 0.0004	0.31	0.12
Chaltia Beel	0.0024 ± 0.0003	0.0048± 0.0008	Not measured	0.07
Bishnupur Wetland (Beel)	0.0087 ± 0.0003	0.0133 ± 0.0008	0.1	0.27
Indraprastha Beel	0.007 ± 0.0001	0.0118± 0.0008	Not measured	0.45
Dhupghati Beel	0.0122± 0.0004	0.0188 ± 0.0006	Not measured	0.38
Laldighi (Control Wetland)	0.0014±0.0001	0.0018 ± 0.0001	Not measured	0.16
Tap Water (Municipality Supplied)	0.0208± 0.0002	0.0512 ± 0.0002	0.39	0.92

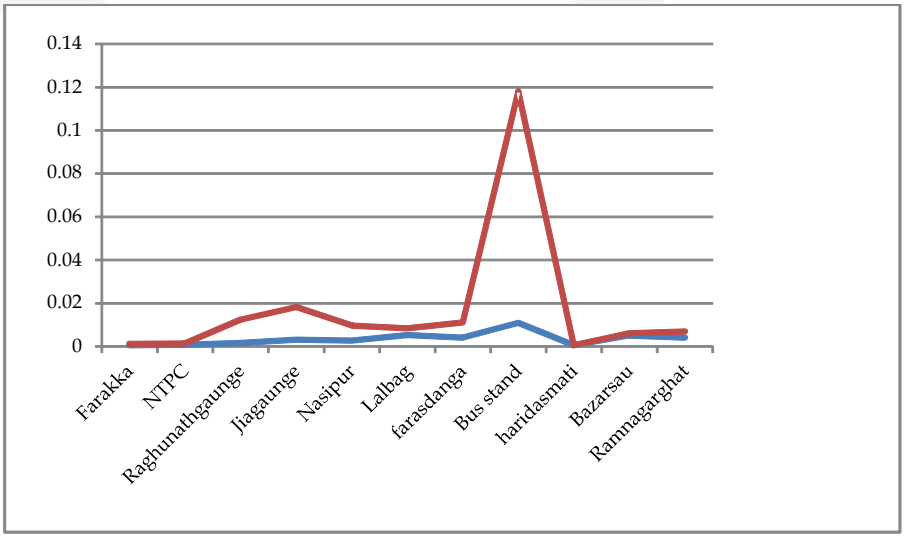


Fig. 1: Arsenic occurance in 100 km stretch in Ganga of Murshidabad. The blue is Pre-monsoon and red indicate Pre-monsoon occurrence of Arsenic in water

Table 2: Arsenic content of ganga water in murshidabad district

Sample site	Post monsoon (mg/L ± SD)	Pre monsoon (mg/L ± SD)
Farkka Feeder Canal	0.0006 ± 0.0001	0.0013± 0.0004
NTPC	0.0008 ± 0.0001	0.0014 ± 0.0005
Raghunathgaunge/Jangipur	0.0017 ± 0.0007	0.0124 ± 0.0009
Jiagaunge/Azimgaunge	0.0032 ± 0.0006	0.0182 ± 0.0008
Nasipur	0.0027 ± 0.0001	0.0096 ± 0.0003
Murshidabad/Lalbag	0.0053 ± 0.0003	0.0084 ± 0.0006
Bazarsau	0.0050 ± 0.0004	0.0061 ± 0.0004
Ranmnagar Ghat	0.0041 ± 0.0004	0.0069 ± 0.0007

Sewage water falling in Ganga

Gorabazar, Berhampore

Murshidabad

Kandi Bus Stand Bazar, Berhampore

Gopalghat, Berhampore

Raghunathgaunge

NTPC, Farakka

Jiagaunge

Discussion

It is a myth that arsenic is never obtained in surface water, so drinking surface water is safe. From the above observations, it is evident that arsenic is found in surface water in Murshidabad district of West Bengal and in some cases it is above WHO recommended level. It is much more alarming because arsenic will magnify biologically through aquatic food chain. Arsenic will be absorbed by plants, enter in the herbivore aquatic animals, herbivore consumed by carnivore and we take both the herbivore and carnivore fish. Occurrence of arsenic in food chain is already known in the terrestrial ecosystem. The source of arsenic in ground water is well studied but the source in river water is not known. It may enter from the bedrock. But the presence of arsenic in lentic system can not be explained. The probable reason of arsenic contamination is sewage water discharge from locality directly in the surface water bodies. It this study it is found that the sewage water going directly in various water bodies in and around Berhampore, Murshidabad, Jangipur, Raghunathgaunge and other places. As the people of these townships are using ground water, the contamination is going in the surface water through drainage systems. All the 'Beels" are contaminated. The sample from Ganga is collected at 100 km stretch, all these sample contain arsenic. The amount is highest near Municipality outlet. The arsenic contaminated Ganga water is taken back in Berhampore Municipality, purified in JNURM project and supplied as drinking water, that contain even more amount of arsenic. As all the sewage water sample contain high amount of arsenic, the sewage is definitely the source of arsenic in surface water. All the "Beels" are land locked, rainfed so there should not be any arsenic contamination in the 'Beels". The drains that are carrying arsenic are contaminating the 'Beels". The post-monsoon amount is low but the pre-monsoon amount of arsenic is high. The amount of arsenic in Ganga is high near the urban areas (Raghunathgaunge, Jiagaunge, Murshidabad, Berhampore) in comparison to rural areas (Hridasmati, Nasipur, Bazasau, Ramnagar Ghat). There is a need for water treatment as well as sewage treatment plant in large scale. Only then the treated sewage water can be released in Ganga or other water bodies. This type of sustainable development can only make us arsenic free.

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Original Article

Vertebrate Biodiversity in and Around Ahiran: An Important Wetland of Murshidabad, West Bengal, India

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Abstract

Wetland ecosystems are one of the most biologically productive ecosystems in the world providing the key habitat environments for mammals, birds, reptiles, amphibians and fish. In recent times the wetlands are facing tremendous anthropogenic pressure, which can greatly influence the population structure. Sustainability of wetland ecosystem is necessary for various important functions such as food storage, water quality continuation and providing habitat for different species of flora and fauna. An inventory of wetlands of any region is a pre-requisite for their conservation and management. Ahiran Lake, a wetland of Murshidabad district, West Bengal, (approximately 400 hectare, 24° 26′ N to 24° 30′ S and 87° 58′ E to 88° 02′ W) serves as a habitat of large populations of resident and migrant water birds, fish, amphibian, reptiles and mammals. But information about the vertebrate diversity, composition and structure of the community in this wetland is scarce. In the present investigation documentation and assessment of the vertebrate diversity of Ahiran lake is conducted. Our study revealed 40 species of fishes, 56 species of birds, 6 species of amphibian, 8 species of reptiles, 2 species of mammals are frequently found at Ahiran wetland. The baseline documentation will provide useful data and new insights to establish and improve management systems for sustainable development of wetlands.

Keywords: Vertebrate; Biodiversity; Ahiran Lake; Murshidabad; Wetland.

Introduction

Biodiversity has become a major concern to the biologist against the backdrop of rapid decline in the natural population of aquatic fauna. Biodiversity encompasses genetic, species and ecosystem levels of biological organization with structural, compositional and functional components. Wetlands, locally known as 'Beels' are the most common and an integral feature of the fluvial landscape of West Bengal. Wetlands are those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support and that under normal circumstances, do support a prevalence of vegetation typically adopted for life in saturated soil conditions. Wetland generally includes swamps, marshes, bogs and similar areas (Acharya and Adak, 2009). Wetland is a complex natural system that harbors a wide variety of flora and fauna, all of great economic, aesthetic and scientific importance (Das, 2015). Wetlands are not wasteland at all they are valuable natural wonderlands that keep the environment in a balance state (Mondal and Roy, 2014; Chakraborty and Nur, 2009). Wetlands of India, estimated to be 58.2 million hectares, are important repositories of aquatic biodiversity (Nath and Deka, 2012; Deka, 2015). The occurrence of food plant is was very well synchronized with a large number of migratory and resident birds, fishes, amphibians and reptiles in the wetland. High diversity and abundance of avian flora indicated intensive use of the wetland which was due to structural diversity of vegetation provided by broadleaved species (Mitsch and Gosselin, 1986). Presence of birds is a good indicator of the health of wetland. India is one of the global hotspots for birds with over 1340 bird species (13% of world species) recorded from the country

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(Manakadan & Pittie, 2001), of which 310 species are dependent on different fresh and salt water wetlands (Kumar et al. 2005). The conversion of wetland habitat to agricultural India is one of the global hotspots for birds with over 1340 bird species (13% of world species) recorded from the country (Manakadan & Pittie, 2001), of which 310 species are dependent on different fresh and salt water wetlands (Kumar et al. 2005). The conversion of wetland habitat to agricultural land or other commertial purpose is threatening the bird populations (Chowdhury and Nandi, 2014). According to Bird Life International (2001), the wetland of this area lies in Biome - 11 (Indo-Malayan tropical dry zone). Thirteen big fresh water wetlands, out of 23 (>100 hectare) in West Bengal, are present in different blocks of this district. The wetlands of this region are generally palustrine (floodplains, seasonal waterlogged, marsh), lacustrine (Lakes) and riverine types. All these wetlands are directly or indirectly connected with the different rivers like Ganga, Babla, Jalangi, Bhairab etc. Wetlands are one of the most threatened habitats of the world. Wetlands in India, as elsewhere are increasingly facing several anthropogenic pressures. Thus, the rapidly expanding human population, large scale changes in land use/land cover, burgeoning development projects and improper use of watersheds have all caused a substantial decline of wetland resources of the country. Significant losses have resulted from its conversion threats from industrial, agricultural and various urban developments. These have led to hydrological perturbations, pollution and their effects. Unsustainable levels of grazing and fishing activities have also resulted in degradation of wetlands. The current loss rates in India can lead to serious consequences, where 74% of the human population is rural and many of these people are resource dependent. Healthy wetlands are essential in India for sustainable food production and potable water availability for humans and livestock. They are also necessary for the continued existence of India's diverse populations of wildlife and plant species; a large number of endemic species are wetland dependent. Most problems pertaining to India's wetlands are related to human population (Prasad *et al.* 2002). Many species of fishes, amphibians, reptiles, birds and mammals depend on the wetland habitat for breeding, foraging and for their shelter supported by the diverse plant species. One of the best known functions of wetlands is to provide habitat for birds which use wetlands for breeding, nesting and rearing of young ones, besides using them as a source of drinking water, for feeding, resting, shelter and social interaction (Pathak and Sarma, 2013, Bhyuia, 2014). The direct and indirect benefits derive from wetlands are numerous. Direct benefits are fishing, water supply, irrigation, agriculture, tourism, soil erosion control etc. Indirect hydrological and economical benefits are of great economic value such as ground water recharge, flood control through holding, water quality improvement, wildlife habituate etc. Ahiran beel is also known as Chander beel, a wetland situated on Ahiran Mouza of Suti Police Station, J.L. No. 102, dagh no. 2875, Murshidabad district, West Bengal (Mondal and Roy 2014). Ahiran is a perennial fresh water lake of Ganges river is located between 24° 26' N to 24° 30' S and 87° 58' E to 88° 02' E, about 60 k.m. north-west of Berhampore town. The lake is ox bow in shape and east side of the beel NH-34 and Eastern Railway route connecting Kolkata with North Bengal and North-East India. It is very close to Feeder canal of Farakka Barrage and Aligarh Muslim University, Murshidabad Campus. Ahiran beel provides a unique habitat to aquatic flora and fauna, as well as numerous local birds includes migratory birds from cold areas of different parts of China, Russia, Central Asia, Tibet and from the entire range of the Himalaya (Mistry, J and Mukherjee, S. 2015). In Murshidabad, this Ahiran beel is important fishing ground. Once this beel had abundant of native fish species, prawn, snail, crabs and turtles. Due to over exploitation, indiscriminate destructive fishing practices, soil erosion, pollution from domestic and agrochemical wastes, some important wild fishes have disappeared. On March 20th, 1987 United Nations stated "sustainable development is development that meets the need of the present without compromising the ability of the future generation to meet their own need" (Reddy and Char, 2004; Nagesh *et al,* 2006). In brief, securing economic development, social equity and justice, and environmental protection is the goal of sustainable development. Although these three factors can work in harmony, they can often found to conflict with one another (Gibbs, 2000; Kumar and Meenakumari, 2002).

Materials and Methods

25 consecutive surveys were executed from November 2012–March 2015. Bird species were observed visually using binoculars of different ranges and their photographs were taken using a Sony DSC HX 100 V camera for identification. Surveys started during the peak hours of their activity, in the morning, from 0500–1100hr and in the evening, from 1600–1800hr on a regular basis in different groups. Fishes were collected from the fishermen and photographed. The fish and amphibians are preserved for further

identification. Reptiles and mammals were identified from photographs. The animal local names at Ahiran region were also recorded for future reference.

Observations

In the observations the local name of Ahiran region was emphasized, so that the animals can be located in future with the help of local people for the purpose of sustainable management. Two species of mammals *Canis aureus* (Sheal) and *Herpestes javanicus* (Beji) are frequently found in Ahiran. Besides there are 40 species of fishes, 56 species of birds, 6 species of amphibian and 8 species of reptiles.

Vertebrate Fauna

FISH: The wetland contains wild fishes and also major and minor carps. Catfishes are available to this wetland. Carps are not introduced to this wetland, so there question arise how carps are available in this beel. Proper answer of this question is during monsoon period (July to September) the beel get inundated, most of the villages of Suti-1 block surrounding the beel are also flooded. Carps are cultured in the pond of villages. The flooded water from the various ponds contains both major and minor carps flows down to this beel. As a result, the beel harbors major and minor carps beside wild fishes.

Amphibia and Reptiles: The species *Batagur baska* is introduced by release from Forest Department, which are seized from trafficking in Farakka or Malda station.

Table 1: Fishes of ahiran beel with local name

Local Name of Fish at Ahiran Region	Scientific Name
Rui	*Labeo rohita*
Kalbaus	*Labeo kalibasu*
Catla	*Catla catla*
Mirka	*Cirrhinus mrigala*
Silver (Exotic and introduced fish)	*Hypophthalmichthys molitrix*
Bata	*Labeo bata*
Sor punti	*Puntius sarana*
Tit punti	*Puntius ticto*
Sophori punti	*Puntius sophore*
Kanchon punti	*Puntius conchonius*
Mourala	*Amblypharyngodon mola*
Pata khalisha	*Colisa fasciatus*
Guri khalisha	*Colisa lalius*
Gol chanda	*Chanda ranga*
Kath chanda	*Chanda nama*
Shol	*Channa striata*
Gajar (Shal)	*Channa marulius*
Lata/Sati/Chimri	*Channa punctatus*
Chang	*Channa gachua*
Bele	*Glossogobius giuris giuris*
Bhut bele	*Eliotris fusca*
Vyada	*Nandus nandus*
Koi	*Anabas testudineus*
Bot koi	*Badis badis*
Chuno Mach	*Aplocheilus panchax*
Darika	*Esomus danricus*
Chital	*Notopterus chitala*
Folui	*Notopterus notopterus*
Deshi pabda	*Ompok pabda*
Kuchia	*Monopterus cuchia*
Kalo tangra/Bojre Tangra	*Mystus vittatus*
Paloa tangra	*Mystus cavasius*
Shingi	*Heteropneustes fossili*
Magur	*Clarias magur*
Boal	*Wallago attu*
Tyapa	*Tetraodon cutcutia*
Gunte	*Lepidocephalus guntla*
Balichata	*Nemachilus botia*
Guchi	*Mastacembelus aculiatus*
Kakila	*Xenontodon cancila*

Table 2: Amphibians and reptiles of ahiran beel with local name

Local Name of Amphibia	Scientific Name	Local Name of Reptiles	Reptiles
Kuno Bang	*Bufo melanostictus*	Keute	*Naja naja*
Sona Bang	*Euphlyctis hexadactyla*	Gosap	*Varanus bengalensis*
Sona Bang	*Pedostibes tuberculosus*	Hele	*Natrix piscator*
Sona Bang	*Hoplobatrachus tigerinus*	Kochhop	*Trionyx gangeticus*
Sona Bang	*Limnonectes limnocharis*	Roktochosa	*Calotes versicolor*
Jhi Jhi Bang	*Euphlyctis cyanophylyctis*	Saper Masi	*Eutropis carinata*
		Saper masi	*Lygosoma albopunctata*
		Jol Dhora	*Enhydris enhydris*

Table 3: Avifauna in ahiran beel with local name and common name

Common Name	Local name at Ahiran Region	Scientific Name
Purple Swamp hen	Kayem	*Porphyrio porphyrio*
White-breasted water hen	*Dahuk*	*Amaurornis phoenicurus*
Purple heron	*Lalkak* *	*Ardea purpurea*
Indian Pond heron	*Kochbok*	*Ardeola grayii*
Pheasat-tailed jacana	No local name, first time from Murshidabad	*Hydrophasianus chirurgus*
Bronze-winged jacana	*Jolpipi*	*Metopidius indicus*
Little Grebe	*Pandubi*	*Tachybaptus ruficollis*
Common kingfisher	*Choto machranga*	*Alcedo atthis*
White-throated kingfisher	*Machranga*	*Halcyon smyrnensis*
Pied Kingfisher	*Fotka*	*Ceryle rudis*
Little Cormorant	*Panitor*	*Phalacrocorax niger*
Great Cormorant	*Boro Panitor*	*Phalacrocorax fuscicollis*
Little egret	*Bok*	*Egretta garzetta*
Cattle egret	*Gobok*	*Bubulcus ibis*
Cotton pygmy-goose	*Balihas* *	*Nettapus coromandelianus*
Wire-tailed swallow	*Tarlyaja*	*Hirundo smithii*
Red-wattled lapwing	*Hatiti*	*Vanellus indicus*
Blue-winged leafbird	*Horbola /Sobuj bulbul*	*Chloropsis cochinchinensis*
Intermediate egret	*Bok*	*Mesophoyx intermedia*
Asian Openbill	*Samukkhol/Samkhol*	*Anastomus oscitans*
Common Coot	*Daukhol/Balihas**	*Fulica atra*
Black-headed Ibis	*Lohajang* *	*Threskiornis meloanocephalus*
Grey Heron	*Sada kak**	*Ardea cinerea*
Darter	*Goyar* *	*Anhinga melanogaster*
Greylag Goose	*Rajhas*	*Anser anser*
Gadwall	*Saral* *	*Anas strepera*
Northern Pintail	*Boro dighor**	*Anas acuta*
Wood Sandpiper	*Gotra*	*Tringa nebularia*
Northern Shoveler	*Khuntehas* *	*Anas clypeata*
Eurasian Wigeon	*Boro rangamuri**	*Anas penelope*
Chestnut-tailed Starling	*Chorpakhi*	*Sturunia malabarica*
Garganey	*Giriahas* *	*Anas querquedula*
Pied cuckoo	*No local name first record from Murshidabad*	*Clamator jacobinus*
Rosy Starling	*No local name first record from Murshidabad*	*Sturnus roseus*
Ashy prinia	*Nilche lalgirdi*	*Prinia socialis*
Indian Silver bill	*Patafutki / Tuntuni*	*Lonchura malabarica*
Green bee-eater	*Banspati*	*Merops orientalis*
Black drongo	*Finge*	*Dicrurus macrocercus*
Laughing dove	*Kanthi ghughu*	*Streptopelia decaocta*
Red-vented bulbul	*Bulbul*	*Pycnonotus cafer*
Brahminy Starling	*No name. First time recorded from Murshidabad*	*Sturnus pagodarum*
Indian Robin	*Kalishyama*	*Saxicoloides fulicata*
Oriental Magpie Robin	*Doel*	*Copsychus saularis*
Jungle Babbler	*Chatare/ Satvai*	*Turdoides striatus*
Asian Pied starling	*Goslikh*	*Sturnus contra*
Common mynah	*Jhut shalik*	*Acridotheres fuscus*
Asain Koel	*Kokil*	*Eudynamys scolopacea*
Black-rumped flameback	*Kaththokra*	*Dinopium benghalense*
Rose-ringed Parakeet	*Chandana*	*Psittacula krameri*
Spotted Dove	*Chiteghughu*	*Streptopelia chinensis*
Hoopiee	*Mohanchura*	*Upupa epops*
Common pochard	*Rangamuri**	*Anas ferrina*
Paddy field pipit	*Dhanibhurui*	*Anthus novacseelanduiae*
Duscy leaf Warbler	*Tuntuni*	*Phylloscopas fuscatus*
Blacknecked stork	*Lohajung* *	*Ephippiorhynchus asiaticus*

Cirrhinus mrigala

Clarias batrachus

Labeo rohita

Labeo calbasu

Notopterus notopterus

Notopterus chitala

Colisa fasciata

Colisa lalius

Lepidocephalus guntia

Nimaichilus botia

Nandus nandus

Tetraodon cutcutia

Wallago attu

Xenentodon cancila

***Bufo melanostictus* Schneider**

***Euphlyctis hexadactyla* (Lesson)**

***Hoplobatrachus tigerinus* (Daudin)**

***Limnonectes limnocharis* (Gravenhorst)**

***Pedostibes tuberculosus* Gunther**

Mabuya mabouya

Calotes versicolor

Sarkidiornis melanotos

Dendrocygna javanica

Alcedo atthis

Ceryle rudis

Ciconus nigra

Ephippiorhynchus asiaticus

Ardia purpurea

Halcyn smyrensis

Egretta garzetta

Ardia cinerea

Canis aureus

Herpestes javanicus

Birds

Ahiran beel harbor large populations of local and migratory water birds. Migratory birds displayed a definite pattern for arrival and departure from the wetland that is species specific. The peak of winter population of migratory birds was observed during the month of December to February.

Current Threats to the Biodiversity of Ahiran Beel

Threats to Fish Population

One of the major threats to Ahiran beel is overexploitation of its fish resources. It is currently estimated that there are about 30 fishermen involved in fishing. The majority of fishermen use gill nets between 1 to 2 inch mesh size. Fishermen also used small boat for transport of nets and related material and used bua jal (small lift net), sieve net (used in kata fishing), dharma jal and cast net to catch fishes. Due to indiscriminate killing of fries, fingerlings and gravid fish, the population is under heavy pressure. Killing of gravid fishes causes heavy loss of eggs per day during the breeding season. Agricultural activities also become the most dangerous practice as it causes harm to the fish fauna. They used artificial fertilizers, insecticides and pesticides for agricultural purpose that causes water pollution so fish face a greater risk of extinction. Few years ago large number of prawns was available to this beel but now a days prawns are absent species to this beel. *Nandus nandus*, *Wallago attu*, *Labeo bata*, *Glossogobius giuris guiris*, *Ompok pabda* are becoming rare each and every day.

Threats to Migratory Birds

The migratory birds come to this beel seasonally. These migratory birds faced several anthropogenic threat that affected feeding and breading habitat directly. Livestock grazing and cleaning of cattles,

using fishing net and small boat for fishing by fishermen are important threats to water birds. Sounds from automobiles on busy NH-34 road and Ahiran Halt bus stand also disturbs birds. The birds are also victims of poaching and some times the outsiders from the nearby villages like Basantapur, Ramdova, Sarla come to kill birds for fooding purpose. Local people also used nets, traps and hunting guns to kill the birds. Water hyacinth (E*ichhornia crassipes*) has covered the water surface of the beel, so the migratory birds faces an problem of their feeding areas.

Habitat Loss

The local people make plot of land for the cultivation of various crops (mainly boro rice) in the lake by filling up the shallow part of the lake, as a result the habitat area for the biotic fauna and flora is being reduced.

Lake Water Pollution

Water pollution of Ahiran Lake is a vital problem. Excessive use of pesticides and chemical fertilizer in the surrounding agricultural field go to the lake water through rain, so the lake water polluted). On the other hand 'Ghosh community' people on the south-west side of the beel clean their cattles mainly in water of the lake, which also pollutes water of the lake. The water pollution has a great harmfull impact on flora and fauna of this wet-land, so the biodiversity of the lake reduced.

Conclusion

We have seen that Ahiran beel provide many benefits to society and acts as a hotspots of aquatic fauna and migratory birds. This wet-land also plays a vital role to build up a healthy ecological system. It helps in development of agriculture in the locality by helping a lot in the irrigation system. Many families are directly and indirectly dependent on the beel. Although currently it lost its diversity in both fauna and flora including migratory birds, the existing species can conserved by conservation of the beel. It is also important to restore the wet-land for ensuring livelihood of surrounding communities. If consciousness of the people and kind attention of Panchayet and management authority increased, the wet-land must turn into important tourist spot, important source of government income and forms a perfect ecological system.

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Original Article

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Fresh weight/Dry weight percentage of *Vigna radiata (L.) R.Wilczek* (Green gram) in the Selected Tree Canopy Soil Related with Urban Greening in Nirmala College Campus, Coimbatore, Tamilnadu, South India

Arul Sheeba Rani M.*, R. Mary Josephine*

Abstract

Trees contribute significantly to the aesthetic beauty of cities, thereby helping to maintain the psychological health of the inhabitants. The most explosive urban growth is expected in India. In urban environments human alter these soil-forming factors by impacts associated with urban infrastructure. Gardens also improve localized air-cooling, help mitigate hooding and provide a harem for wildlife. Less favourable aspects include contribution of gardens and gardening to green house gas emission, misuse of fertilizers and pesticides and introduction of alien plant species Effective environmental planning, including urban greening, can assist greatly in improving the quality of the urban environment and the livelihoods of the people who live in urban areas. As a result of impacts associated with urban infrastructure, arborists and urban landscape managers perform remedial management actions to make urban soils more suitable plant-growing environments, remedial soil management actions include irrigation, aeration, radial trenching, mulching, and fertilization, all of which further alter the physical, chemical and biological properties and thus the nitrogen status of urban soils. In the present study Fresh weight/Dry weight percentage of *Vigna radiata (L.) R.Wilczek* is calculated, grown in the selected tree canopy soil from college campus were analysed and the result were compared with the standard soil profile.

Keywords: Tree Canopy Soil; Green Gram; Fresh Weight; Dry Weight; Percentage.

Introduction

Plant organs die and ultimately whole plants die but dead plant material or litter, continue to have powerful effects on ecosystem, drinking nutrient turnover, soil formation and atmospheric composition. Soil properties in turn have strong impacts on plant community composition, diversity and productivity. Litter accumulation is a major structuring force in prairies. Urban forestry is the art, science and technology of managing trees and forest resources in and around urban community ecosystems for physiological, sociological, economical and aesthetic benefits, trees provide for society (Miller, 1997).Litter has occupied the attention of ecologists at length for the reasons that it is an instrumental factor in ecosystem dynamics, is indicative of ecological productivity, and may be useful in predicting regional nutrient cycling and soil fertility. The rate of soil organic matter decomposition increases when the soil is exposed to cycles of drying and wetting compared to soils that are continuously wet or dry (James, 2010). There is need to plant trees that provide multiple benefits, particularly in house compounds for providing edible pods, flowers, fruits, leaves etc. Different land use patterns not only changed land cover types, e.g. surface vegetation. Plant litter and residual quantity but also directly affected soil nutrient supply and soil properties in urban areas. When the more barren lands are covered to urban use there is a less drastic reduction in vegetation with initial clearing, and then essentially the same transition assuming water is available to support the vegetation transition (Zhao and Wang, 2010).

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Materials and Methods

Study Area

Coimbatore is a city in Tamil Nadu, South India. It is the second largest city and urban agglomeration in the Indian state of Tamil Nadu after Chennai. It is the capital city in Kongu nadu region and is often been referred to as the Manchester of south India. The city is located on the banks of the Noyyal River surrounded by the Western Ghats and is administered by the Coimbatore Municipal. Nirmala college academic campus is located in the southern parts of the Western Ghats. The total area of college campus is 20 acre. The temperature during both summer and winter varies between 28° c to 34° c. Soil in this area is red loamy soil which is more fertile than sandy soil. Its porosity allows high moisture retention and air circulation

Plate 1: Study area

Plate 2: Location map

Collection of Tree Canopy Soil Samples

For the present study five different trees of different genera were selected in the college campus to find out the parameters of tree canopy soil. The tree canopy soil samples were collected during the year, 2013. Soil with litter formation and ground vegetation from the corners and centre of the selected samples of *Butea monosperma*, (*Lamk.) Taub., Jacaranda mimosifolia, D. Don., Cassia fistula, Linn., Albizzia lebbeck (L), Benth., and Peltophorum pterocarpum (DC.)k. Heyne.*, were collected separately in sterile bags. Barren land soil is taken from the same campus was kept as control. Soil was taken from the depth of 0-50cm. Soil samples were packed in sterile bags, and as soon as possible returned to the laboratory and processed within 2 days.

Percentage of the Selected Tree Canopy Soil

The experimental trays were filled with one third of the canopy soil of selected samples in each tray. Seeds of Green gram [Vigna radiata (L.) R.Wilczek] were collected from the Agricultural University, Coimbatore, Tamil Nadu. Seeds were sterilized with 0.1 % of mercuric chloride and soaked in water for 24 hours. Four replicates of 100 seeds were sowed from each selected samples. The growths of the plants were noted from 3rd day to 15 days. The growth parameters like shoot length, shoot length, number of leaf and leaf size were determined using the formula and the results were represented in table and chart.

Sample 1: Plate 3
Butea Monosperma, (Lamk.) Taub

Sample 2: Plate 4
Jacaranda Mimosifolia, D. Don

Sample 3: Plate 5
Cassia Fistula, Linn

Sample 4: Plate 6
Albizzia Lebbeck, (L,)Benth

Sample 5: Plate 7
Peltophorum pterocarpum, (DC.) k.Heyne

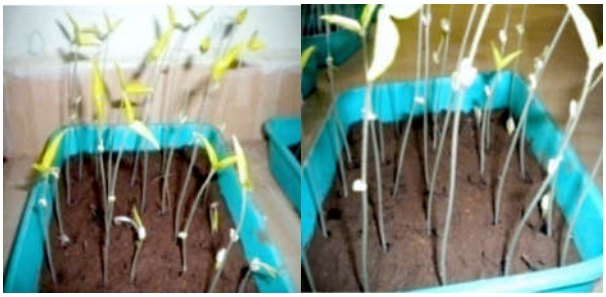
Shoot weight = total height of 100 plants / 100

Shoot/ root ratio = total shoot length / total root length

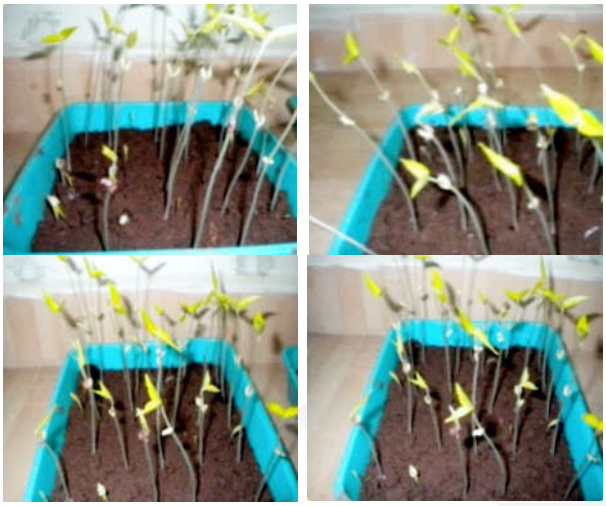
Percentage of fresh weight and dry weight = $w_1 - w_2 / w_1 * 100$

Growth of Green gram in
Barren soil (control) – 1 plate-8

Growth of Green gram in
selected tree canopy soil sample
Butea monosperma – Plate -9



Growth of Green gram in
selected tree canopy soil sample
Jacaranda mimosifolia – Plate-10

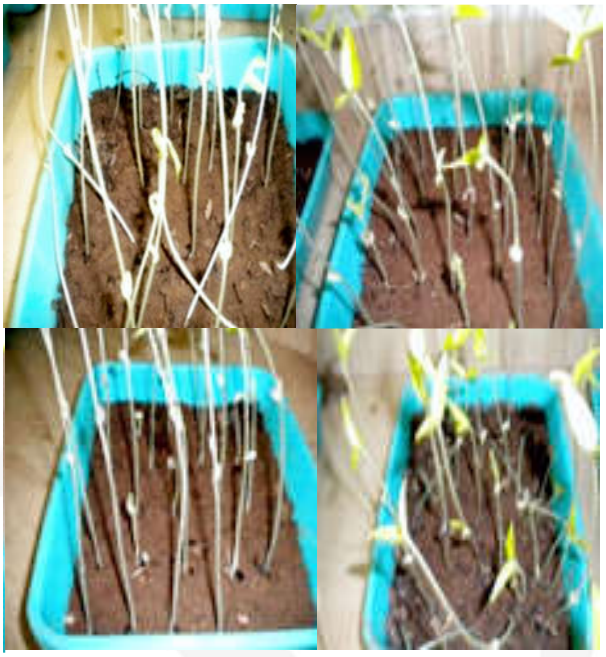


Growth of Green gram in
selected tree canopy soil sample
Cassia fistula - Plate -11

Growth of Green gram in
selected tree canopy soil samples
Albizzia lebbeck - Plate -12

Results and Discussion

The Percentage of Green gram in the selected tree canopy soil samples were represented in Table, Chart & Plates (8-13).



Growth of Green gram in
selected tree canopy soil sample
Peltophorum pterocarpum - Plate -13

Table 1: Fresh weight/Dry weight percentage of green gram in the selected tree canopy soil

S. No	Sample	Percentage
	Control	90.9
1	*Butea monosperma*	93.6
2	*Jacaranda mimosifolia*	91.3
3	*Cassia fistula*	**93.7**
4	*Albizzia lebbeck*	90.8
5	*Peltophorum pterocarpum*	92.5

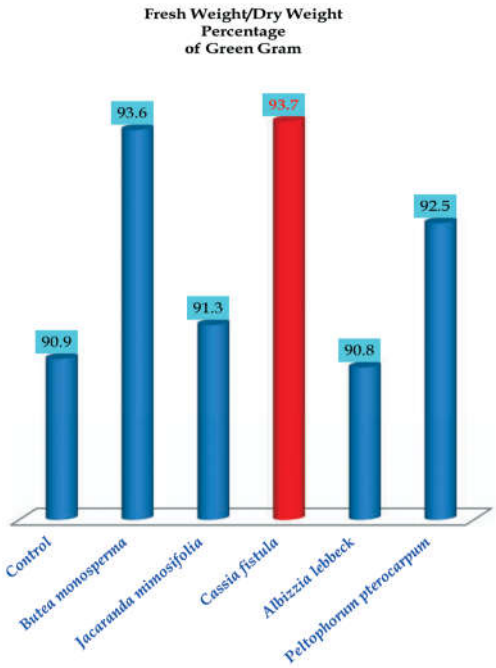


Chart: Fresh weight/Dry weight percentage of green gram in the selected tree canopy soil

The Percentage of Green Gram in the Selected Tree Canopy Soil Sample

Fresh weight/Dry weight percentage of Green gram in the selected tree canopy soil

The fresh and dry weight percentage of Green gram in *Cassia fistula, Linn.,* was 93.7 and it was the highest when compared to the other samples.

Appendix

Table: Fresh weight/Dry weight percentage of Green gram in the selected tree canopy soil

Chart: Fresh weight/Dry weight percentage of Green gram in the selected tree canopy soil

List of Plates:(1-7)

Plate: 1 Study area

Plate: 2 Location map

Plate: 3 Sample 1- *Butea monosperma (Lamk.) Taub.,*

Plate: 4 Sample 2- *Jacaranda mimosifolia, D. Don.,*

Plate: 5 Sample 3- *Cassia fistula, Linn.,*

Plate: 6 Sample 4- *Albizzia lebbeck, (L,) Benth.,*

Plate: 7 Sample 5- *Peltophorum pterocarpum, (DC.) k. Heyne.,* Growth: Plates (8-13)

Plate: 8 Growth of Green grams in barren soil (control)

Plate: 9 Growth of Green gram in selected tree canopy soil sample *Butea monosperma,(Lamk.) Taub.,*

Plate: 10 Growth of Green gram in selected tree canopy soil sample *Jacaranda mimosifolia, D. Don.,*

Plate: 11 Growth of Green gram in selected tree canopy soil sample *Cassia fistula, Linn.,*

Plate: 12 Growth of Green gram in selected tree canopy soil sample *Albizzia lebbeck (L,) Benth.,*

Plate: 13 Growth of Green gram in selected tree canopy soil sample *Peltophorum pterocarpum, (dc.) k. heyne..*

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Original Article

Studies on Mosquito Larvae (*Armigeres subalbatus*) (Coquilett 1898) in Suburban Area of West Bengal

Puspita Das Sil*, Kausik Mondal**

Abstract

Armigeres subalbatus is a day biting nuisance causing mosquito prevalent mostly in the rural area where the sanitation latrine exist. This study deals with the prevalence of larvae in different biotopes to get a comprehensive knowledge about its breeding spot with a view to control this menace. One year longitudinal survey indicate that in the study area sanitary chambers are the most favourite breeding sites of *Armigeres subalbatus* when statistical comparison is made between sanitary chamber and open drains connected with sanitary chamber. Sometimes larvae are found in domestic collection of foul water. In coconut shells and tree holes on rare occasions *Armigeres subalbatus* larvae are found. In the sanitary chambers *Psychoda* larvae are found to be associated with the larvae of *Armigeres subalbatus*. In the connecting drains its associates are the larvae of *Culex quinquefasciatus* and the larvae of *Aedes aegypti* and *Aedes albopictus* are found to be associated with the larvae of *Armigeres subalbatus* in coconut shells.

Keywords: *Armigeres Subalbatus; Larval Breeding Spot; Psychoda; Aedes Aegypti; Culex Quinquefasciatus;* Sanitary Chamber; Open Drain.

Introduction

Armigeres subalbatus (Coquilett 1898) is widely distributed in the villages and cities of India. It is big sized mosquito that bites human beings mainly in day time (VCRC, 2002 and Sil Das *et al.*,1983). Its bite is very painful and the mosquito creates nuisance. In urban situation, controlling nuisance causing mosquito like *Armigeres subalbatus* is necessary because people perceived impact of vector control operation with the relief from mosquito bite (VCRC, 2002). *Armigeres subalbatus* is reported to be a vector of *Wuchereria bancrofti* in Japan (Tanaka *et al*., 1979). It is the most efficient carrier of *Plasmodium gallinaceum* (Roy and Brown, 1970). Japanese encephalitis may also be transmitted by it, both naturally (Schichijio *et al*., 1998) and experimentally (Mitamura *et al*., 1940). Dirofilaria worm was also detected from wild caught *Armigeres subalbatus* (Vythilingam *et al*., 2005). The breeding places were sanitary chambers, open drains connected with the sanitary chambers, domesticated collection of foul water, coconut shells and tree holes where the larvae were found. The larvae of *Armigeres subalbatus* have been detected by previous researchers in the following spots such as septic tanks, earthen contaminated drains, domesticated collection of foul water, tree holes and coconut shell [Roy and Brown, 1970, Gartz, 1967 and Hati, 2001]. The objective of the study was to give recent data regarding month wise variation of abundance of larvae of *Armigeres subalbatus* in different stagnant water in Burdwan district, West Bengal.

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Materials and Methods

The data were collected from different affected villages of the Burdwan districts of West Bengal, India. The study was conducted from January to December 2010. For the collection of mosquito larvae three methods namely dipping, netting and pipetting advocated by WHO (1975) (Manual on Practical Entomology in Malaria, WHO Part II, 1975) were adopted in the present study.

Data were analyzed by single way analysis of variance (ANOVA) and the significant difference between collected data was determined by using SPSS (Statistical Package for Social Sciences, Version 10.0).

Results and Discussion

Only in the sanitary chamber larvae of *Armigeres subalbatus* were presented in all the months of the years and number of collection was much higher (9305, 81.03 %) than that of the other (Table 1) breeding places. In open drains connected with the sanitary chamber, *Armigeres subalbatus* larvae were +ve in eleven months, but –ve only in the October. Total number of collection was 1296 (11.29%). It is quite possible that with the sludge water coming from the sanitary chambers, the larvae may have traveled from the sanitary chamber to the connecting drains. Sanitary chamber are found to be the most favourite breeding site of *Armigeres subalbatus*. When statistical comparisons are made between sanitary chambers and open air drains connected to the sanitary chambers, larvae are found in greater numbers in the former than the latter (Figure 1). Larvae/dip in the sanitary chambers varies from 1.33 to 7.51. The corresponding figures in the connecting drains are 0 to 1.61 respectively.

When the date were analyzed critically, though the larvae of *Armigeres subalbatus*are are found in each month of studied year, both in sanitary chamber and drains connecting with the sanitary chamber, the larvae have been found in greater number in the summer months than in other seasons. This finding tallies with the man biting experiments (VCRC, 2002 and Sil Das *et al.*, 1983). The summer is the preferred breeding season for *Armigeres subalbatus*.

Table 1 show that in the domestic collection of foul water, larvae were +ve in the month of June, July and November and – ve in other eight months. This type of biotype also seems not to be very suitable for the breeding of this species as overall larvae/ dip is 0.1 only. From table 1 it is evident that in tree holes the larvae of *Armigeres subalbatus* were +ve during the months of June and July and - ve during other ten months. In coconut shell the collection of larvae were +ve in June, July and August. Other nine months collection of larvae was –ve (Table 1).

Table 1. Month wise collection of *Armigeres subalbatus* larvae from different breeding spots

	Sanitary chamber		Open drain connected with sanitary chamber		Domestic collection of foul water		Tree holes		Coconut shells		Total	
Months	No. of larvae collected	%	No. of larvae collected	%	No. of larvae collected	%	No. of larvae collected	%	No. of larvae collected	%	No. of larvae collected	%
January	692	7.43	122	9.41	-	-	-	-	-	-	814	7.09
Febr.	665	7.15	111	8.56	-	-	-	-	-	-	776	6.76
March	1232	13.24	219	16.44	-	-	-	-	-	-	1451	12.63
April	1502	16.14	322	25.62	-	-	-	-	-	-	1834	15.97
May	1486	15.97	215	16.59	-	-	-	-	-	-	1701	14.81
June	542	5.82	77	5.94	42	35	148	67.89	237	56.83	1046	9.11
July	395	4.25	88	6.79	58	48.33	70	32.11	128	30.7	867	7.55
August	499	5.36	15	1.16	-	-	-	-	52	12.47	566	4.93
Sept.	409	4.4	12	0.93	-	-	-	-	-	-	421	3.67
October	265	2.85	0	0	-	-	-	-	-	-	265	2.31
Novem	930	9.99	92	6.33	20	16.67	-	-	-	-	1032	8.89
Decem.	688	7.39	23	1.77	-	-	-	-	-	-	711	6.2
Total	9305	81.03	1296	11.29	120	1.04	218	1.90	417	3.63	11484	

*200 dips in sanitary chamber and open drains connected with sanitary chamber. 80 dips in domestic collection of foul water

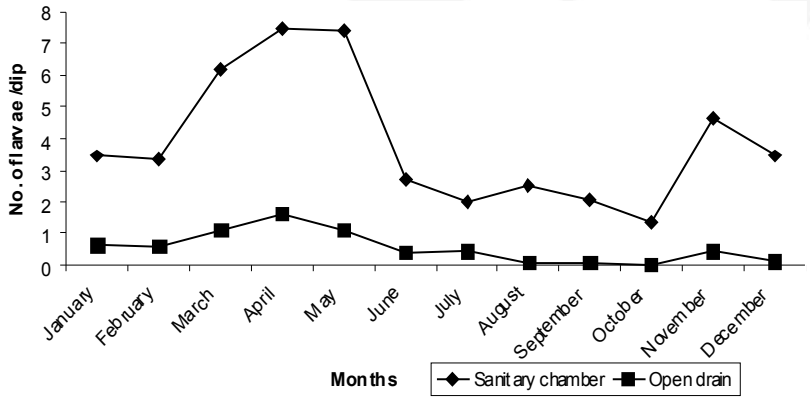

Fig. 1: *Armigeres subalbatus* larvae collection from sanitary chamber and drain in twelve month study period

In sanitary chamber *Psychoda* larvae and the larvae of *Culex quinquefasciatus* are found to be associated with the larvae of *Armigeres subalbatus*. In connecting drain its associates are the larvae of *Culex quinquefasciatus* and the larvae of *Aedes aegypti* and *Aedes albopictus* are found to be associated with the larvae of *Armigeres subalbatus* in coconut shells. In ponds, rice field and lake no larvae of *Armigeres subalbatus* were, however detected throughout the year.

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The authors are grateful to the Director, School of Tropical Medicine, Kolkata for giving permission to use the laboratory and library for this research work. Authors are also very much grateful to Dr. A.K. Hati, M.B.B.S.,Ph.D., Professor., Ex-director School of Tropical Medicine, Kolkata, for his valuable suggestion to complete the study.

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Journal of Forensic Chemistry and Toxicology	2	9000	900
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Review Article

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A Study on the Threats to the Gangetic Dolphin

Sudhan Kumar Biswas*, Susanta Nath*, A.K. Panigrahi, Bibhas Guha*****

Abstract

Platanista gangetica gangetica, the obligatory freshwater dolphin of Ganga river in the world and is distributed in the Ganges–Brahmaputra–Meghna and Sangu–Karnaphuli River systems in India, Nepal, and Bangladesh. The diets include wide range of fish, turtles and birds, those are located around the Ganges river. Dolphins are considered as potential ecological indicator of ecosystem degradation of the river. Due to various anthropogenic interferences like poaching, water pollution etc this animal is at the face of extinction. There is no credible estimate of the range-wide numbers and this subspecies was listed as endangered in the IUCN Red List on 1996.

Keywords: Gangetic Dolphin; Endangered Species; Bioindicator; Threats.

Introduction

One of the most charismatic mega fauna of the Indian subcontinent is the Gangetic Dolphin *Platanista gangetica gangetica* . It is among the four obligate freshwater dolphins found in the world. This species has been included in Schedule I of the Indian Wildlife (Protection) Act 1972 Convention on International Trade in Endangered Species (CITES), in Appendix II of the Convention on Migratory Species(CMS) and categorized as Endangered on the International Union for the Conservation of Nature's (IUCN) Red List. During the Ganga Action Plan I and II efforts have been made to gather scientific information about this species and habitat degradation, through pollution and reduced water flow and poaching were considered as threats to this animal. In fact, one species once available in the rivers of China was functionally extinct in 2006 (Turvey *et al,* 2007, Hopkin, 2007). At present the Amazon River Dolphin, the Ganges River Dolphin and the Indus River Dolphin are available as endangered condition.

As an endemic animal, the Ganges River dolphin has a fairly extensive distribution range in the Indian sub-continent. This animal is found in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of India and Bangladesh, while Karnali and the Sapta Kosi Rivers in Nepal are the sites where a few individuals may survive. Due to continuous decline in its population, the IUCN changed its status from 'Vulnerable' to 'Endangered' in 1996. Its population was recorded as 4000 to 5000 in the early 1980s to 3500 in 2014 in the distribution range (Sinha and Kannan, 2014). The average weight is 330-374 pounds, length 7 -8.9 feet and love to live in freshwater. As an oldest creatures in the world along with some species of turtles was officially discovered in 1801 (WWF, 2015).

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Habitat Preference and Fragmentation

Ganges dolphin is fluvial in habit, but also be found in brackish water, though it never finds in the sea (Sinha, 1997). Salinity defines the downstream limit, while its distribution at upstream limit is maintained by physical barriers and low prey densities at high elevations. The long stretches of deep water in association with shallow water meanderings, confluences and mid channel sand bars are the places where dolphins are abundant.

Preferable habitats of the Ganges River dolphins are specially an eddy-counter current system which is very common in the main river flow. Such current system may be due to point bar formed from sediments and deposits, a convergent stream branch, or by an upstream meander. They are also found below sand bars and bridges if eddies are formed.

The Gangs River dolphin can tolerate a wide range of temperature fluctuations like as low as 5°C and as high as 35° C in the river Karnali in the winter in Nepal and in the plains of Uttar Pradesh and Bihar during summer respectively. More over turbidity does not determine the distribution of this beautiful animal. The construction of dams and barrages on the main stream of the Ganga and its tributaries is one of the cause of population fragmentation of this animal (Smith *et al*, 1994,1998,2000). Such construction includes gates to control the stream thus restrict the movement of this aquatic mega-fauna and two subpopulations appeared in 1975 with the commencement of Farakka Barrage in West Bengal . Another two subpopulations developed when the Lower Ganga Barrage at Narora (1966) and the Middle Ganga Barrage at Bijnor (1984) were constructed (Reeves *et al*, 1991).

Dolphin also reported to disappear above the Kaptai dam in the Karnaphuli river in Bangladesh over a period of around six years after the construction of the dam and also above the Middle Ganga barrage at Bijnor, about 100 kms downstream Haridwar after 12 years of its construction .

Reproduction and Life History

It is reported that breeding season of the Gangetic dolphin extends between January and June, though newly born calves can be seen even in other months. Mating takes place between March and June, sometime in July. After a gestation period of about nine months, a single baby is born which is about 70 cm in length and 4 to 5 kg in weight and stay with mother for about one year. At an age of 10 years, male attains sexual maturity with a body length of 1.7 m, while in females, 10 or less years is required to attain maturity when they attain 2 m length (Kasuya, 1972, Harison, 1972).

Feeding Behavior

A wide range of fish, turtles and birds are diet of Ganges River Dolphins those are located around the Ganges river. The diets include catfish, carp, clams, turtles and occasionally birds. As the deeper parts of the river are the preferable dwelling area of this animal, it also try to find most of it's food in a similar area. The period of active foraging is exhibited in the morning (0700 hrs- 1000 hrs) and after noon (1500 hrs - 1700 hrs). The dolphin prefers to chase and prey upon surface dwelling fish like *Rhinomugil corsula* as well as exhibited community feeding.

Ganges Dolphin as a Bioindicator Species

The relationships between measures of ecosystem degradation and river dolphins as potential ecological indicators was investigated by Gomez-Salazar *et al*, (2012). They tested three ecological indicators of freshwater ecosystem degradation using river dolphins: (i) density of river dolphins, (ii) mean group size of dolphins, and (iii) dolphin sighting rates. Study at selected locations of the Amazon and Orinoco Rivers indicated a strong negative relationship between measures of habitat degradation and river dolphin density estimates, and perfluorinated chemicals which are below detectable levels in the river water or in other. It was revealed that river dolphins are flagship and sentinel species for monitoring the conservation status of large tropical rivers in South America. The micro-pollutants such as organochlorines, organotin compounds which were measured below detectable level in other invertebrates and fishes, but the amount in Ganges dolphin tissues suggesting their sensitivity to toxic chemical pollution in the river (Kannan *et al*, 1994, 1997; Senthilkumar *et al*, 1999, Yeung *et al*, 2009). Low population of the Ganges dolphins in the regions of India–Nepal border indicated the environmental degradation in the Ganges basin.

Threats

The threats of Ganga river Dolphin are specially anthropogenic. Environmental degradation due to chemical changes in the river, noise pollution due to river transport, fisheries by catch etc. are the main causes for the decreasing population of this animal. Considering all these here is an discussion related to the threats to the Gangetic dolphin.

Construction of Dams and Barrages

So far fifty dams and barrages are constructed in the flow of Ganga which dramatically disrupted the dolphin population. The result is the appearance of subpopulation. A subpopulation may be defined as "geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)" (IUCN 2001).

After the construction of the Farakka Barrage (24.7891°N, 87.8878°E; located on the Ganges River 400 km upstream of Kolkata near the India–Bangladesh the dolphin population have decreased rapidly as this barrage creates a number of physical barrier for movement of the dolphin (Sinha, 2000). Farakka Barrage creates peculiar physiographic and hydrologic complexity in the Bhagirathi Hooghly river which ultimately changes the population pattern of dolphin along with small tributary namely Ajay. Barrage changes the available distribution pattern of prey and also sediment transport at the same time reduce the extent of eddy-counter currents where dolphins are generally available (Reeves and Leatherwood 1994, Smith *et al*, 1998).

Chemical Pollution

Several studies revealed that the Ganga river basin is one of the most populated as well as heavily polluted area due to fertilizers, pesticides, industrial and domestic effluents. Through food chain, these pollutants enter the dolphin as biomagnified rate as this animal is the apex predator. Study revealed that rate of pollution is high but Ganges dolphins have a low capacity to metabolize such toxic pollutants. Which make the Ganges dolphins vulnerable to the effects of chemical pollution (Kannan *et al*, 1994).

Direct and Incidental Catches

One of the cause that make Dolphins vulnerable, because their preferred habitat is often in the same location as the fishing grounds. Dolphin oil is highly valued as fish attractant and fishermen intentionally prepare their net to capture the dolphin which is called "assisted incidental capture" (Sinha, 2002).

Extraction of River resource

Heavy river traffic in the Ganga and Brahmaputra increases noise pollution, deterioration of prey base alter the feeding behavior of this glorious animal. Moreover, regular removal of sand, stones and woody debris are degrading the ecological integrity of the river environment (Mohan *et al*, 1997).

Influence of Sedimentation

Continuous grazing, construction of road, landslides etc causing erosion of the soil at the high altitude from where the rivers are originated. Erosion also taking place in the catchment areas and flood plain due to lose of vegetations. Erosion produces huge amount of silt which are depositing in the river resulted in the rise of the river bed. As a result natural habitats of river dolphin are changing.

Mortality after Monsoon and Irrigation Canal

During monsoon, areas on two sides of the tributaries are flooded and dolphin enters those areas. When the water level comes down, this animal trapped in the bounded water and either capture by the local people or die due to decrease in the water level after monsoon. Small number of dolphin occasionally enter the large irrigation canals in Uttar Pradesh. Rarely they can return successfully to the main channel of the river. But in most cases either they are killed by the locals or trapped in the water-regulating gates causing death.

Conclusion

The Ganges river dolphin is an indicator as well as the flagship species for the river ecosystem. It is an endemic species of the Indian subcontinent and declared as National Aquatic Animal by the Government of India. Due to high population density in the Ganga basin especially in Bihar state (1102 person/km^2) recorded in the population census 2011, causing loss of freshwater biodiversity and inevitable uncertainty for the future of the dolphin.

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Short Communication

Changing Climatic Scenarios: Role of Crop Growth Simulation Models

Ravi Kiran

Abstract

Crop growth simulation model is an efficient tool to predict the growth and yield of a crop. The models are good to simulate the effect of various crop management factors to obtain quick results and increase the efficiency of agronomic experiments in climate change conditions. The model has also been used for climate change impact on the soil N losses, like denitrification, volatilization, N_2O emission increased. This paper discusses the importance of crop growth simulation models applications and their future projections under changing climatic scenarios.

Keywords: Volatilization; Agronomic Experiments; Phenological Development; Phenophase.

Crop yield is invariably influenced by several factors like weather, soil type and its nutrient status, management practices and other inputs available. weather is the only environmental factor which influences the growth in every phenophase of the crop cycle. Its impact on morphology, development, biomass production and days to attain the phenophase is well established. The full genetic potential of the cultivar is only obtained only when an optimum climatic condition including other environmental factors is available. The optimum sowing time and selection of improved cultivars play a remarkable role in exploiting the yield potential of the crop under a particular agro climatic condition. It also governs the crop phenological development and the efficient conversion of biomass into economic yield. weather and climate are important factors in determining our day-today and long term activities. As weather assumes significance in nearly every phase of agricultural activity from the preparatory tillage to harvest and storage interfering with routine agricultural operations and plant protection measures, hence success or failure of farming is intimately related to the prevailing weather conditions (Araya, 2010). Climate has been changing in the last three decades and will continue changing regardless of any mitigation Strategy (Ramirez-Villegas, 2013). Agriculture is a climate-dependent activity and hence is highly sensitive to climatic changes and climate variability. Climate change is influencing the growing period of the crops, crop growth, arable land acreage, soil erosion, fertility and pests, diseases and weeds incidence.

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Model is a simplified description of a system to assist calculations and predictions (Loomis *et al*., 1979). The relationship between weather and crop production has been understood through crop weather modeling and study on this aspect in a systematic manner started a century ago while in India it was initiated less than six decades ago (Aggarwal *et al*., 2006 a). The understanding of the interactions between weather, soil, and management practices etc using simulation modelling will help in impact, adaption and vulnerability studies in agriculture. Specifically, a crop model can be described as a quantitative scheme for predicting the growth, development, and yield of a crop, given a set of genetic features and relevant environmental variables (Monteith, 1996). Crop growth simulation model is a very effective tool to predict the growth and yield of a crop (Banerjee *et al*., 2014).Crop models can fulfill various requirements primarily to interpret experimental results and work as agronomic research tools for research knowledge synthesis. Lengthy, laborious and expensive field experiments, especially with a high number of treatments, can be pre-evaluated through a well-proven model to sharpen the field tests and to lower their overall costs (Whisler

et al., 1986). Another application of crop models is to use them as decision support tools for system (Pereira, 1998). Scientific modelling is also meant to be more mechanistic, based on laws and theory on how the system functions, while engineering modeling is meant to be functional, based on a mixture of well-established theory and robust empirical relationships, as termed by Addiscott and Wagenet (1985). Bhattacharya and Sastry (1999) evaluated the performance of three-crop growth models for dynamic simulation of soil water balance in the sandy loam soils cropped with oilseed *Brassica* and observed that the simulated root zone moisture from Campbell-Diaz model was more sensitive to stepwise changes in input parameters as compared to the O'Leary and SWASIM model. While calibrating these models during the post-rainy season of 1992-1993, the simulated profile moisture from the Campbell-Diaz and SWASIM models, on an average, did not deviate by more than ± 5% from the measurements except on one or two occasions whereas the O'Leary model gave slight overestimates up to seed filling stage and underestimates of the order of - 6% in the post-seed filling stage.

The crop model INFOCROP for potato, applied for increasing the efficiency of agronomic experiments in tropical environments over the period of 1976 to 1999 revealed a close agreement for simulated trends of phenological development, growth and tuber yield with the measured values within acceptable error. The model was found adequate to simulate the effect of various crop management factors to obtain quick results and increase the efficiency of agronomic experiments Singh *et al.* (2005 a). Panigrahi and Panda (2003) studied a simple soil water balance model to simulate the soil water content in the active root zone of mustard crop (*Brassica juncea*) as well as that the model was also tested with field experimental data of 2 years (1998 and 1999) under rain-fed (no irrigation) and irrigated conditions, found that the model satisfactorily simulated the soil water content in the active root zone of the crop on daily basis. Values of the mean absolute relative error (MARE) index between the observed and simulated soil water content of the rain-fed mustard in 1998 and 1999 were found to be 0.046 and 0.058, respectively, whereas for irrigated mustard, it was 0.051 in 1999. Prediction efficiency (PE) index was found to be 0.98, 0.97 and 0.97 for rain-fed mustard of 1998 and 1999 and irrigated mustard of 1999, respectively. Since the MARE index was low and PE index was high for both rain-fed and irrigated mustard, they concluded that the model could be used to simulate the soil water content in the active root zone of the crop.

On adaptation of the generic crop model INFOCROP for potato and applied it for increasing the efficiency of agronomic experiments in tropical environments over the period of 1976 to 1999. They reported a close agreement for simulated trends of phenological development, growth and tuber yield with the measured values within acceptable error. The model was found adequate to simulate the effect of various crop management factors to obtain quick results and increase the efficiency of agronomic experiments (Singh *et al.*,2005 a). Aggarwal *et al.* (2006 b) validated InfoCrop model for rice and wheat crops in contrasting agro-environments of tropics, sensitivity to the key inputs, and also illustrated two typical applications of the model, to quantify multiple pests damage through iso-loss curves and use of InfoCrop for analyzing the trade-offs between increasing crop production, agronomic management strategies, and their global warming potential.

The results of field experiments and use of simulation tools to understand the dynamics of soil N balance and relate growth and yield of rice under varying nitrogen inputs showed that the simulated results of InfoCrop model matched well with the observed values for growth and yield of rice and seasonal nitrogen uptake. The model was also used for climate change impact analysis and revealed that when temperature increased, the soil N losses, like denitrification, volatilization, N_2O emission increased, whereas grain and biomass yields was found decreased (Ebrayi *et al.*,2007). The simulated impact of elevated CO_2 and temperature on rice yield in eastern India by using the ORYZA1 and the INFOCROP rice models shows that for every 1°C increase in temperature, ORYZA1 and INFOCROP rice models predicted average yield changes of -7.20 and -6.66%, respectively, at the current level of CO_2 (380 ppm). However, increases in the CO2 concentration up to 700 ppm led to the average yield increases of about 30.73% by ORYZA1 and 56.37% by INFOCROP rice. Results suggest that the limitations on rice yield imposed by high CO_2 and temperature can be mitigated, at least in part, by altering the sowing time and the selection of genotypes that possess higher fertility of spikelets at high temperatures (Krishnan *et al.* , 2007).

Naresh *et al.* (2008) calibrated and validated InfoCrop-coconut model with data compiled from published studies comprising many physiological, agronomical and nutritional experiments conducted between 1978 and 2005 in diverse geographic locations throughout India. Simulated trends in phenological development, total dry mass and its partitioning and nut yield agreed closely with

observed values with 15% error in a few cases. InfoCrop-coconut was found suitable for the use to increase the efficiency of agronomic experiments designed to aid coconut crop management.

Haris *et al.* (2010) evaluated the effect of projected change in climate on rice growth and yield through INFOCROP model by conducting an experiment during *kharif* from 2006 to 2008 at Patna, Bihar. Using the factors from HADCM3 (Hadley Centre Coupled Model ver.3) GCM (General Circulation Model) predictions, rice yield was simulated for future scenarios. An increase in rice yields for 2020 scenario to the tune of 2.7% decrease upto 0.3% for 2050 and a decline of 31.3% in 2080 from baseline with the current agronomic practices was predicted. The simulation results also revealed that an increase in minimum temperature in future could be more detrimental for long duration rice variety (MTU-7029) in terms of yield.

The role of climate extremes in climate change impact assessment of typical winter and summer Mediterranean crops by using Regional Circulation Model (RCM) outputs as drivers of a modified version of the CropSyst model has been studied. The climate change effects were investigated on sunflower (*Helianthus annuus* L.) and winter wheat (*Triticum aestivum* L.) development and yield under the A2 and B2 scenarios of the IPCC Special Report on Emissions Scenarios (SRES) including direct impact of extreme climate events (i.e. heat stress at anthesis stage). The increase in both mean temperatures and temperature extremes under A2 and B2 scenarios (2071–2100) resulted in: a general advancement of the main phenological stages, shortening of the growing season and an increase in the frequency of heat stress during anthesis with respect to the baseline (1961–1990). It was also concluded that winter and summer crops may possess a different fitting capacity to climate change. Sunflower, cultivated in the southern regions of the Mediterranean countries, was more prone to the direct effect of heat stress at anthesis and drought during its growing cycle and resulted in severe yield reduction. In contrast, the lower frequency of heat stress and drought allowed the winter wheat crop to attain increased yields with respect to the baseline period (Moriondo *et al.* , 2011).

The simulated results of DSSAT Cropping System Model (CSM-CROPGRO) for rapeseed (*Brassic napus*) under Mediterranean conditions. Phenology, growth, and partitioning were evaluated using experimental data from two locations of Sardinia (Italy) for 2007 and 2008 for rapeseed revealed satisfactory predictions of phenology, growth, and yield of rapeseed and hence concluded that the CSM-CROPGRO model could be used for simulation of rapeseed production in Mediterranean environments (Deligios *et al.*,2013).

Soora *et al.* (2013) investigated a simulation analysis using the InfoCrop-rice model to quantify impacts and adaptation gains, as well as to identify vulnerable regions for irrigated and rainfed rice cultivation in future climates in India. Climates in A1b, A2, B1 and B2 emission scenarios as per a global climate model (MIROC3.2.HI) and a regional climate model (PRECIS) were considered for the study. As par the simulated results on an aggregated scale, the mean of all emission scenarios indicate that climate change is likely to reduce irrigated rice yields by ~4 % in 2020 (2010–2039), ~7 % in 2050 (2040–2069), and by ~10 % in 2080 (2070–2099) climate scenarios. On the other hand, rainfed rice yields in India are likely to be reduced by ~6 % in the 2020 scenario, but in the 2050 and 2080 scenarios they are projected to decrease only marginally (<2.5 %).

Validation of impact of projected climate change on yields of soybean InfoCrop model for 20 years (1989-2008) to assess impacts of the projected climate change on soybean production reveals that The Root Mean Square Error (RMSE) values were 8.8 days and 190.4 kg/ha for days to maturity and crop yield between simulated and observed yields of five years (2004-08) under two sowing environments. The elevated levels of 50 and 100 parts per million (ppm) carbon dioxide (CO_2) increased soybean yield by 5.0 to 10.2%. The projected yield losses due to elevated levels of temperature by 1 and 2°C alone ranged between 1.3 to 3.5 and 4.5 to 6.0 percent respectively, for all planting windows. The elevated temperature of 1°C coupled with 50 ppm elevated level of carbon dioxide (420 ppm) showed increase in yield up to 4.9 percent with shortened average growing period up to 2 days. The further rise of temperature to 2°C with 50 ppm elevated level of carbon dioxide caused increase in simulated yield up to 2.3 percent in simulations of 1989-2008 compared to control conditions. Similarly, 100 ppm elevated level of carbon dioxide with 1°C rise in temperature caused increase in yield between 8.8 to 10.2 percent in all planting windows whereas it was 3.1 to 3.9 percent lesser in 2°C rise in temperature with 100 ppm elevated level of carbon dioxide with compared to 1°C rise in temperature. The climatic grid of 10 percent reduction in rainfall from recent decade 1998-2008 showed small decrease in yield but yield increase of 5.2 to 8.5 percent was observed when coupled with 50 ppm elevated carbon dioxide and 1°C rise in temperature. Hence rise of temperature with elevated carbon dioxide in general increase the yield in region (Ranbir *et al.*, 2014).

It has been opined that the climate change believed to affect agriculture by inducing changes on farmer behaviour, quantity, quality, cost of production; changes in production, consumption, prices, and trade patterns; and the changes in market responses at global and local levels. These changes not only depend on the domestic and global adaptive capacity, the economic impacts also vary by region, sector, and the stakeholder groups. The adverse impacts are likely from the increased frequency of extreme weather, floods and droughts and submergence of coastal areas due to the rise in sea levels and extreme climate variability. The mountain regions are vulnerable to climate change and it would have direct impacts on livelihoods as most of the economic and livelihood sectors are vulnerable to the impacts of climate change (Sharma and Dobriyal , 2014).

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

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Article in supplement or special issue

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Corporate (collective) author

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No author given

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Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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