Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

ISSN NO. 2320-5407

RESEARCH ARTICLE

3 Day National Level Seminar Cum Workshop On Recent Aspect Of Microbiological Techniques(RAMT) During 10-12 February, 2017 By Dept Of Microbiology, Techno India University, West Bengal.

BIOACCUMULATION FACTOR (BAF) OF HEAVY METALS IN *IPOMOEA PES-CAPRAE*: A CASE STUDY FROM INDIAN SUNDARBANS.

Bulti Nayak[1], *Madhumita Roy[1], Satarupa Roy[1], SandhimitaMondal Rana[2], Sufia Zaman[3] and Abhjit Mitra[3].

1. Department of Biotechnology, Techno India University, Salt Lake, West Bengal, Kolkata, India.
2. Department of Microbiology, Techno India University, Salt Lake, West Bengal, Kolkata, India.
3. Department of Marine Science, University of Calcutta, 35 B.C. Road, Kolkata, West Bengal, India.

Manuscript Info

Manuscript History

Received: 01 January 2017
Final Accepted: 02 February 2017
Published: March 2017

Key words:-
Bioaccumulation factor, heavy metals, *Ipomoea pes-caprae*, Hooghly-Matla estuarine complex.

Abstract

The Hooghly-Matla estuarine complex of West Bengal is under severe stress due to heavy metals discharged from urban sectors, industries, tourism units etc. in recent decades. The bioaccumulation of heavy metals in *Ipomoea pes-caprae* is considerable in the present study area and hence the bioaccumulation factor has been studied with respect to dissolved heavy metals and bioaccumulation of heavy metals in sediments. The study reports considerable level of bioaccumulation factor in the vegetative parts of the species.

Introduction:-

The Indian Sundarbans is one of the most biologically productive, taxonomically diverse and aesthetically celebrated ecotone of the Indian sub-continent (Mitra&Choudhury, 1992; Mitra&Zaman, 2015; Mitra&Zaman, 2016). It has been crowned with World Heritage Site and Biosphere Reserve for its unique genetic diversity (Chaudhuri&Choudhury, 1994). However, due to intense industrialization, rapid urbanization and unplanned tourism coupled with change in land use pattern, a negative impact has been posed on the positive health of the Sundarban estuaries. Considerable load of heavy metals like Zn, Cu and Pb in the ambient environment is one of the major environmental issues in and around the Indian Sundarban mangrove ecosystem (Mitra, 1998). Heavy metals in the present study area originate primarily from the highly urbanized city of Kolkata, Howrah and the newly emerging Haldia port-cum-industrial complex (Mitra&Choudhury, 1993).The heavy metals on entering in the estuarine system bioaccumulate within the organisms depending on the hydrological parameters like pH, salinity etc.

The present study has been undertaken to evaluate the seasonal variation of bioaccumulation factor in the vegetative parts of *I. pes-caprae* collected from the intertidal mudflats along two major estuaries of Indian Sundarbans mainly Hooghly and Matla during 2016.

Corresponding Author:- Madhumita Roy.
Address:- Department of Biotechnology, Techno India University, Salt Lake, West Bengal, Kolkata, India

Materials and Methods:-

Study site:-

The Sundarbans active delta in the maritime state of West Bengal is the Himalayan Ganges and Brahmaputra rivers delta at the mouth of Bay of Bengal located at latitude 21 °30′–22°15′N and longitude 88°10′–89º10′E (Banerjee, 1998) with a network of tidal rivers, channels, mudflats, creeks, distributaries, islands and coastal dunes. The intertidal mudflats are the natural abode of mangroves. The Sundarbans tidal estuary comprises an area of 4282 sqkm, of which the tidal and inter-tidal mangrove forest area is estimated of 2328 sq km. Two major estuaries in the Indian part of Sundarbans are Hooghly and Matla.*I.pes-caprae* grows abundantly along the intertidal mudflats of these estuaries from where the samples were collected during low tide during May (premonsoon), August (monsoon) and December (postmonsoon) in 2016.

The plants after collection were thoroughly washed with ambient water and then with double distilled water to remove the debris. The vegetative parts were separated into roots, stem and leaves and brought to the laboratory for further analysis as stated here in points.

Analysis of dissolved heavy Metals:-

The analysis of dissolved heavy metals was done with samples collected during high tide condition from all three stations. Before analysis, each water sample was collected and stored in clean TARSON bottles and was filtered through a 0.45 µm Millipore membrane. The filtrate was treated with diethyl dithiocarbamate and extracted in carbon tetrachloride (Chakraborti*et al*., 1987). The extracted was evaporated to dryness and the residue was mineralized with 0.1 ml of concentrated nitric acid. Analytical blank was prepared and treated with the same reagents. Analyses were done in triplicate by direct aspiration into AAS (Perkin-Elmer Model: 3030) equipped with a HGA-500 graphite furnace atomizer and a deuterium background corrector. The accuracy of the dissolved heavy metal determination is indicated by good agreement between our values and reported for certified reference seawater materials (CASS 2) (Table 1).

Table 1:- Analysis of reference material for near shore seawater (CASS 2)

Element	Certified value ($\mu g\ l^{-1}$)	Laboratory results ($\mu g\ l^{-1}$)
Zn	1.97 ± 0.12	2.01 ± 0.14
Cu	0.675 ± 0.039	0.786 ± 0.058
Pb	0.019 ± 0.006	0.029 ± 0.009

Analysis of biologically available heavy metals in sediments:-

Sediment samples from surface (1 cm depth) were collected by scrapping using a pre-cleaned and acid washed plastic scale and immediately kept in clean polythene bags, which were sealed. The samples were washed with metal free double distilled water and dried in an oven at 105^{o}C for 5 – 6 hours, freed from visible shells or shell fragments, ground to powder in a mortar and stored in acid washed polythene bags. Analyses of biologically available metals were done after re-drying the samples, from which 1 gm was taken and digested with 0.5 (N) HClas per the standard procedure outlined by Malo (1977). The resulting solutions were then stored in polythene containers for analysis. The solutions were finally aspirated in the flame Atomic Absorption Spectrophotometer (Perkin Elmer: Model 3030) for the determination of metal concentrations. No detectable trace metals were found in the reagent blank. Analysis of the NIES Sargasso sample was carried out to assure the quality of the data (Table 2).

Table 2:- Analysis of reference material (NIES Sargasso sample) for sediments obtained from the National Institute of Environmental Studies, Japan.

Element	Certified value ($\mu g\ g^{-1}$)	Laboratory results ($\mu g\ g^{-1}$)
Zn	28.6	26.2
Cu	14.9	13.7
Pb	2.4	2.9

Bioaccumulation factor:-
The bioaccumulation factor (BAF) is the ratio between the accumulated concentration of a given pollutant in any vegetative parts of a plant species to that present in ambient media (Authman and Abbas, 2007). This ratio is calculated as per the expression:

BAF= pollutant concentration in vegetative parts (mg/Kg) / pollutant in water (mg/l) or sediment (mg/Kg).

Data on the concentrations of heavy metals in the root stem and leaves of *I. pes-caprae* have been adopted from Nayak*et al.* (2016). On the basis of this data bank, BAF was calculated with respect to heavy metals in the ambient media.

Results:-
The concentration of dissolved Zn ranged from 66.52 ppm dry weight (in Bonnie camp during premonsoon) to 303.52 ppm dry weight (in Kakdwip during monsoon). Concentration of dissolved Cu ranged from 39.68 ppm dry weight (in Bonnie camp during premonsoon) to 93.42 ppm dry weight (in Kakdwip during monsoon) and concentration of Pb ranged from 5.13 ppm dry weight (in Bonnie camp during premonsoon) to 21.46 ppm dry weight (in Kakdwip during monsoon).

The concentration of biologically available Zn ranged from 21.36 ppm dry weight (in Canning during monsoon) to 94.98 ppm dry weight (in Kakdwip during premonsoon). Concentration of biologically available Cu ranged from 7.79 ppm dry weight (in Bonnie camp during monsoon) to 39.85 ppm dry weight (in Kakdwip during premonsoon) and concentration of biologically available Pb ranged from 5.85 ppm dry weight (in Bonnie camp during monsoon) to 16.64 ppm dry weight (in Kakdwip during premonsoon).

The BAF of each of the selected heavy metals are presented in Tables 3 to 8.
Table 3:- BAF of zinc in leaf, stem and roots in relation to dissolved heavy metals in selected stations during three seasons of 2016

Stations	Bioaccumulation factor or BAF								
	Premonsoon			Monsoon			Postmonsoon		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Kakdwip	0.69	1.03	0.87	0.72	1.23	1.04	0.71	1.03	0.96
Namkhana	0.80	1.30	1.17	0.78	1.51	1.39	0.78	1.43	1.36
Canning	0.73	0.99	0.92	0.67	1.04	0.88	0.79	1.16	1.00
Bonnie camp	1.49	1.69	1.59	1.29	2.05	1.83	1.43	2.24	2.02

Table 4:- BAF of copper in leaf, stem and roots in relation to dissolved heavy metals in selected stations during three seasons of 2016

Stations	Bioaccumulation factor or BAF								
	Premonsoon			Monsoon			Postmonsoon		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Kakdwip	0.50	0.80	0.74	0.47	0.75	0.74	0.44	0.85	0.68
Namkhana	0.61	0.98	0.89	0.70	1.08	0.99	0.65	1.28	0.96
Canning	0.45	0.67	0.56	0.51	0.90	0.69	0.48	0.73	0.65
Bonnie camp	0.41	0.66	0.52	0.39	0.66	0.56	0.40	0.84	0.55

Table 5:- BAF of lead in leaf, stem and roots in relation to dissolved heavy metals in four stations during three seasons of 2016

Stations	Bioaccumulation factor or BAF								
	Premonsoon			Monsoon			Postmonsoon		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Kakdwip	0.11	0.16	0.14	0.07	0.14	0.11	0.08	0.09	0.08
Namkhana	0.18	0.29	0.21	0.12	0.22	0.19	0.17	0.28	0.18
Canning	0.11	6.40	0.12	0.11	0.15	0.15	0.12	0.17	0.16
Bonnie camp	0	0.19	0	0	0.13	0.13	0	0.23	0

Table 6:- BAF of zinc in leaf, stem and roots in relation to heavy metals in selected stations during three seasons of 2016

Stations	Bioaccumulation factor or BAF								
	Premonsoon			Monsoon			Postmonsoon		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Kakdwip	2.02	3.00	2.56	2.76	4.70	3.96	2.45	3.58	3.34
Namkhana	2.56	4.14	3.73	6.00	11.67	10.72	5.40	9.78	10.16
Canning	2.11	2.86	2.65	8.00	11.90	10.09	4.20	6.26	5.41
Bonnie camp	2.01	2.30	2.16	6.00	9.63	8.63	4.58	7.19	6.50

Table 7:- BAF of copper in leaf, stem and roots in relation to biologically available heavy metals in four stations during three seasons of 2016

Stations	Bioaccumulation factor or BAF								
	Premonsoon			Monsoon			Postmonsoon		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Kakdwip	0.91	1.45	7.05	1.50	2.40	2.40	1.19	2.28	1.82
Namkhana	1.35	2.17	2.07	2.30	3.60	3.32	1.54	3.02	2.27
Canning	1.27	1.89	1.56	2.17	3.34	2.90	1.90	2.50	2.24
Bonnie camp	1.49	2.44	1.91	2.35	4.65	3.92	2.18	4.53	2.98

Table 8:- BAF of lead in leaf, stem and roots in relation to heavy metals in four stations during three seasons of 2016

Stations	Bioaccumulation factor or BAF								
	Premonsoon			Monsoon			Postmonsoon		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Kakdwip	0.08	0.11	0.08	0.13	0.25	0.14	0.10	0.13	0.10
Namkhana	0.10	0.18	0.11	0.18	0.33	0.19	0.09	0.23	0.14
Canning	0.10	0.13	0.12	0.20	0.28	0.20	0.16	0.20	0.14
Bonnie camp	0	0.13	0	0	0.30	0	0	0.23	0

Discussion:-

The estuaries in Indian Sundarbans have been polluted by heavy metals since the last few decades due to intense industrialization in the Haldia port area, unplanned tourism in Bakkhali, Sagar Island and Haldia and rapid urbanization in the city of Kolkata and Howrah (Mitra, 1998; Mitra*et al.*, 2011; Mitra, 2013; Chakraborty*et al.*, 2016). All these activities use the estuaries of Indian Sundarbans as the waste disposal bin (sink). Heavy metals, being the major components of these wastes are mainly discharged from various industries located in the upstream region of Indian Sundarbans (Figure 1).

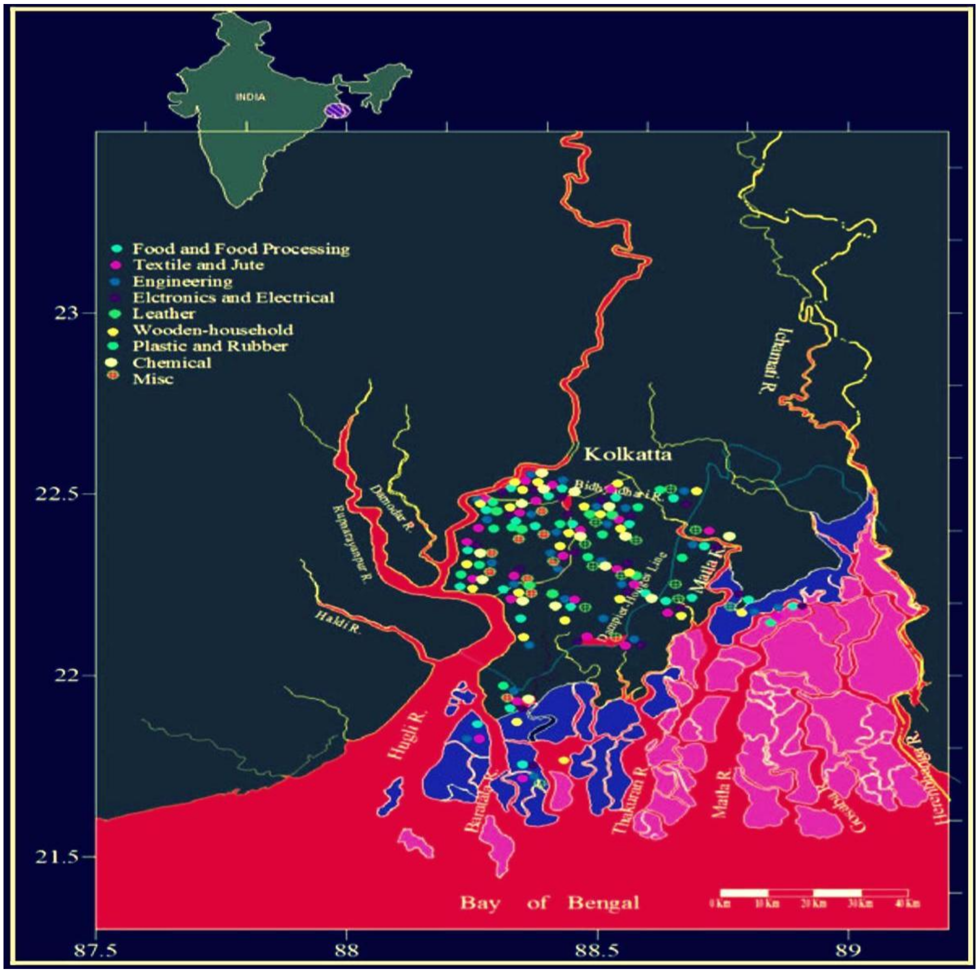

Figure 1:- Hooghly-Matla estuarine system of the Indian Sundarbans region showing all the major industrial areas along the upstream of the rivers

According to several surveys, the major industries include jute mills, brick kiln, paper and pulp industry, textiles, distilleries, tanneries, rubber industries, thermal power plants etc. Heavy metals, being the major ingredients of the wastes generated from these industries contaminate the estuarine water and sediment to a great extent. The heavy metals also find their way in the endemic plant species of the study area. In this study, it is observed that BAF is in the order of stem > root > leaf in case of dissolved zinc. However, the picture is different in other cases. It is also observed that, the BAF of zinc is highest in Bonnie camp and lowest in Kakdwip with respect to dissolved zinc, which is again different from other metals. The fluctuation of BAF is a function of bioaccumulation of heavy metals in vegetative parts and heavy metals in ambient media. The lowest BAF value in Kakdwip thus indicates the presence of considerable level of heavy metals in the ambient media of the station. Again the zero value in Bonnie camp reflects the heavy metals in BDL in the vegetative parts of the stem. The overall results indicate that the species has the ability to concentrate heavy metals both from aquatic phase and sediment in all seasons of the study period. A long term study on this program is needed to establish the species as indicator of heavy metal in the present study area.

References:-

1. **Mitra, A. andChoudhury, A. (1992)**. Trace metals in macrobenthicmolluscs of the Hooghly estuary. Indian Mar. Pollu. Bull.26(9), 521–522.
2. **Mitra, A. and Zaman, S. (2015)**.Blue planet reservoir of the blue planet.Springer publication.
3. **Mitra, A and Zaman, S. (2016)**.Basics of Marine and Estuarine Ecology.Springer ISBN 2016, 978-81-322-2705-2.
4. **Chaudhuri, A.B. and A. Choudhury. 1994**. Mangroves of the Sundarbans. Vol. I. India, The IUCN Wetlands Programme. Bangkok: IUCN. 247 pp.
5. **Mitra, A. (1998)**.Status of coastal pollution in West Bengal with special reference to heavy metals.J Indian Ocean Studies.5 (2), 135–138.
6. **Mitra, A. and Choudhury, A. (1993)**. Trace metals in macrobenthicmolluscs of the Hoogly estuary, India. Marine pollution bulletin. 26(9): 521-522.
7. **Banerjee, A. (1998)**. *Environment, population, and human settlements of Sundarban Delta*. Concept Publishing Company.
8. **Chakraborty, A.K., Banerjee, D., Ghoshal, S. & Barman, P. (1987)**.Arsenical dermatitis from tubewell water in West Bengal.Indian Journal of Medical Research. 85: 326-334.
9. **Malo, B. A., (1977)**. Partial extraction of metals from aquatic sediments.J. Env. Tech.11**:**277-282.
10. **Authman, M., and Abbas, H. H. (2007)**. Accumulation and distribution of copper and zinc in both water and some vital tissues of two fish species (Tilapia zilii and Mugilcephalus) of Lake Qarun.Fayoum province. Egypt.Pakistan Journal of Biological Science. 10(13): 2106-2122.
11. **Nayak, B., Roy, M., Chaudhuri, T. R., Zaman, S., &Mitra, A. (2016).**Bioaccumulation of Heavy Metals in Sand Binder *Ipomoea pes-caprae*: A Case Study from Lower Gangetic Delta Region.International Journal of trend in research and development. 3(2): 358-361.
12. **Mitra, A., Mondal, K., and Banerjee, K. (2011)**. Spatial and tidal variations of physico-chemical parameters in the lower Gangetic delta region, West Bengal, India. Journal of Spatial Hydrology, 11(1).
13. **Mitra, A. (2013)**. In: Sensitivity of Mangrove ecosystem to changing Climate. Springer DOI: 10.1007/978,323, 81-322-1509-7.
14. **Chakraborty, A., Bera, A., Mukherjee, A., Basak, P., Khan, I., Mondal, A., Roy, A., Bhattacharyya, A., Sengupta, S., Roy, D., Nag, S., Ghosh, A., Chattopadhyay, D. and Bhattacharyya, M. (2015).**Changing bacterial profile of Sundarbans, the world heritage mangrove: impact of anthropogenic interventions. World Journal of Microbiology and Biotechnology. 31(4): 593-610.