ARSENIC LEVEL IN THE SURFACE WASTEWATERS OF KOLKATA AND ITS IMPLICATION ON SEWAGE- FED FISHERIES

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ABSTRACT

Arsenic pollution is a major threat in eastern India and Bangladesh. In Kolkata, sewage-fed fish is a very popular culture. Wastewater of Kolkata city is diluted with freshwater and used in sewage-fed fish ponds. In the present study the arsenic concentration in the surface wastewater from forty-four different places of southern, eastern, western and northern parts of Kolkata was estimated. In fifteen places, the arsenic level was higher than the permissible limit (0.20 mg/l). But the arsenic level in the waters, sediment of fish culture ponds and in fish flesh of sewage-fed fisheries of Kolkata was below the maximum permissible limit. So, till date there is no threat from arsenic pollution to the sewage-fed fisheries of Kolkata.

Keywords: Arsenic, surface wastewater, sewage-fed fisheries, Kolkata

INTRODUCTION

The concentration of arsenic in the environment is of great concern as this element is recognized as a cumulative poison to animals and man. There are both natural and anthropogenic sources of arsenic in the hydrosphere. Annual weathering of rocks and soil add 45 x 10^3 tons of arsenic to the oceans, accounting for less than 0.01 mg/l input to water on global basis. Smelting, refining and other processes involving combustion, release large amounts of arsenic into the aquatic environment, either indirectly (leaching of slag heaps) or directly (deposition of aerosols). The agricultural use of pesticides and fungicides can cause the soil to accumulate 700 mg/l or more arsenic, which they can leach into surface and ground waters. Domestic detergent wash water contains 2.5-1000 mg/l arsenic. Surface fresh water contains natural arsenic levels of 1-10 ppb, with occasional values reaching 300 ppb near arsenic-bearing mineral deposits (Anonymous, 1978). Arsenic is mainly transported in the environment by water.

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Generally, in most urban areas, arsenic is mainly in the form of a mixture of inorganic arsenic in the tri- or pentavalent state. In oxygenated waters arsenic usually occurs as arsenate (pentavalent form), but under reducing conditions, for instance, in deep well waters arsenite (trivalent form) predominates (EPA, 1984). Sediments around the Ganges delta of West Bengal have high proportion of clay and contain higher level of arsenic than the sediments in the Ganges alluvial tract in Bihar and Uttar Pradesh, which contain more sand. The average arsenic content in West Bengal in the layer of clay is 9.5-12 ppm (Acharya *et al.*, 1999). It is reported that large amount of arsenic is received by the Ganga basin by the way of application of fertilizers, pesticides/ herbicides and activities arising out of coal combustion. Besides, paint, detergents, metal works, smelting and refining and sewage add to the arsenic content in the Ganga basin (Sahu, 2002).

Arsenic present in water is known to be toxic to fishes (Chen *et al.*, 1980; Sloof *et al.*, 1990; Shobha Rani *et al.*, 2000). Arsenic pollution is a major threat in eastern India and Bangladesh. Metropolitan wastewater of Kolkata city is diluted with freshwater used in sewage-fed fisheries. Literature on arsenic level in different fisheries ecosystems is plenty (Tanner and Clayton, 1990; Tariq *et al.*, 1993; Azcue and Dixon, 1994; Fernandaz *et al.*, 1995; Bou *et al.*, 1995; Collings *et al.*, 1996) but reports on arsenic level in surface wastewater and sewage-fed fisheries of Kolkata is not available. In this study the arsenic concentration in the surface wastewater was estimated at forty-four different places of eastern, western southern and northern parts of Kolkata. Arsenic levels in the water, sediment and in fish flesh of common carp and catla in three sewage-fed fish culture ponds of Kolkata were also estimated to assess the role of arsenic in sewage-fed fisheries.

MATERIALS AND METHODS

Surface wastewater samples (in duplicate) were collected from 44 places in Kolkata during June, 2002 - January, 2003. Sediment, water and fish samples (catla and common carp adults) were collected from Mudialy, Nalban and Captain Bhery Fisherman Cooperative Societies of Kolkata. Water samples were immediately preserved after acidifying with concentrated nitric acid to pH<2 in refrigerator. Sediment and fish samples were preserved in deep freezer. Initial screening of arsenic level in water samples was done by "Arsenic Test strip" (mercury bromide paper) marketed by Qualigens Fine Chemicals. Sediment and fish samples were digested in concentrated nitric acid on a hot plate, then diluted with distilled water and filtered. After filtration fish samples were analyzed by cold vapour atomic absorption spectrophotometer (model: Perkin Elmer 100) method (Clesceri *et al.*, 1998) with the help of Bose Institute,Kolkata. Sediment and

water samples having higher level of arsenic (>0.05 ppm) were determined by silver diethyl dithiocarbamate spectrophotometric method at 520 nm (Aggett and Aspell, 1976) with the help of Centre for Studies of Man and Environment, Kolkata.

RESULTS AND DISCUSSION

Report of analysis of water samples is presented in Table 1. It was observed that arsenic level in the surface wastewaters and raw sewage water in main canal varied in different places. Twenty-one places had arsenic level below 0.05 ppm. Arsenic levels in surface wastewaters of eight places were below 0.2 ppm but above 0.05 ppm. Fifteen places had higher level of arsenic (>0.2 mg/l) than the permissible level recommended by Ministry of Environment and Forests for inland surface water, public sewers, land of irrigation and marine/coastal areas.

Arsenic levels in sediment, water and fish samples from the fish ponds of three

Table 1: Arsenic level in surface wastewaters of different places in and around Kolkata

Sl. No.	Date of sampling	Areas from where waste water sample collected	As level (mg/l)
1	20.11.02	Mudialy Fishermen Cooperative Society, culture pond, Kolkata-24	<0.05
2	20.11.02	Thakurpukur, M.G.Road, Kolkata-63	
3	20.11.02	Yeni Sarani, Joka, Kolkata-104	
4	20.11.02	Prince Anwar Shah Road, Jadavpur, Kolkata-32	
5	26.11.02	Nalban Fishermen Coopertive Society, culture pond, Kolkata-91	
6	07.01.03	Bantola, culture area, 24pgs, Bidhannagar	
7	07.01.03	Kulti culture area, 1km from Gusighata Lockgate	
8	07.01.03	River Bidhyadhari, Near Kulti , Gusighata, 24pgs (N) -743502	
9	19.01.03	Bag Para, Near Duccan Hospital , E.M. Bypass, Kolkata-46	
10	19.01.03	Golaghata, VIP Road, Kolkata- 48	
11	07.01.03	206 Bus stop, Krishnapur Canal, Kolkata-91	
12	19.01.03	Dum Dum Park More, Jessore Road, Kolkata - 55	
13	19.01.03	37/A, Cossipore Road, Kolkata- 2	
14	19.01.03	Patrihata, Dum Dum Cant. Kolkata-28	
15	19.01.03	VIP Bridge, Near Ultadanga, Kolkata- 28	
16	19.01.03	Bag Bazaar, Galif Street,Kolkata -3	
17	19.01.03	Subhas Sarobar, Kadapara, Kolakta-54	
18	19.01.03	Bangur Avenue, Kolkata-55	
19	19.01.03	Koikhali, VIP Road, Kolkata- 52	
20	19.01.03	Sukanta Nagar, Fisheries Project, Kolkata -91	
21	19.01.03	Sukanta Nagar, culture area of Nalban fisheries project,Kolkata- 91	
22	20.11.02	Mudialy fishermen cooperative society, entry point, Kolkata-24	≥0.05-<0.2
23	19.01.03	E.M Bypass, Near Bengal chemicals, 115 Dutta Bagh, Kol-64	
24	19.01.03	Krishnapur Canal, In between Salt lake and Bangur Avenue, Kol- 55	
25	26.11.02	Captain Bhery Fishermen cooperative society, culture pond	

26	19.01.03	Dhakinerswar, Near Alam Bazar 80/2 S.S. Road, Kolkata- 35.	
27	29.06.02	Sewage Canal in front of Nicco park. Kolkata-91	
28	20.11.02	Mandirpara, Gole park, Kolkata-107	
29	19.01.03	Sukantapalli, Belgaria, Kolkata- 57	
30	20.11.02	Tagore Park (south), Near Ruby Hospital, Kolkata-39	*0.2-0.3
31	20.11.02	Dr B.R.Ambedkar Bridge, behind Science City, Kolkata-39	
32	20.11.02	Santoshpur Avenue, Survey park, Kolkata-75	
33	20.11.02	Metropolitan, Dhapa, Tangra, Kolkata-39	
34	20.11.02	Kalikapur, Purbapalli, Kolkata-99	
35	20.11.02	Karyanomoyee Bridge, Tollyguange, Kolkata-40	
36	26.11.02	Nalban Fishermen Cooperative Society, entry point, Kolkata-91	
37	07.01.03	Kalighat, Kolkata-26	
38	07.01.03	Bantola Lockgate, enrty point, Kolkata-39	
39	29.06.02	Captain Bhery Fisheries, entry point-a	
39	26.11.02	Captain Bhery Fishermen Cooperative Society, Entry point-b	
40	07.01.03	Bantola Sewage Canal, Salt lake city, Kolkata-91	
41	07.01.03	Chingrighata, Kolkata, Eastern Metropolitan Bypass	
42	19.01.03	Shyambazar, R.G.Kar Road, Kolkata- 4	
43	19.01.03	Dunlop, 5/5, B.T. Road, Kolkata- - 56	
44	29.06.02	Main Sewage Canal of Nalban Sewage-fed Fisheries Project	

***Higher than the MOEF level [Schedule VI (1993)] i.e. 0.2 mg/l (max.) for inland surface water, public sewers, land of irrigation and marine/coastal areas.**

sewage-fed fisheries are presented in Table 2. The arsenic concentration was higher than the permissible level recommended by MOEF or National Academy of Science (NAS), Washington, DC (max. permissible concentration for open water = 0.2 mg/l) at the entry points of Captain Bhery and Nalban Sewage-fed Fish ponds. But in the culture area the level was low. EPA has set a limit of 10 ppm (10 mg/kg) as the safe limit for arsenic in soil. Arsenic concentrations in the sediments from the fish ponds of all three sewage-fed fisheries were well below the safe limit (Table 2). Arsenic concentration

Table 2: Arsenic level in water, sediment and fish flesh of three sewage-fed fisheries of Kolkata

Name of the samples	Captain Bhery		Nalban		Mudialy	
	Culture Area	Entry Point	Culture Area	Entry Point	Culture Area	Entry Point
Water samples(mg/l)	0.06	0.25	0.05	0.25	<0.05	0.1
Sediment from culture area (mg/Kg)	3.02	-	3.45	-	4.58	-
Fish samples (mg/kg)						
i) Common carp	BDL	NA	BDL	NA	0.037	NA
ii) Catla	BDL	NA	BDL	NA	BDL	Na

BDL: Below detectable limit NA: Not Applicable.

in fish flesh was also well below the maximum permissible level (0.1 mg/kg body weight by EPA). Except in common carp in Mudialy pond, in which arsenic level was 0.03 mg/kg body weight, in catla from this pond and in both fishes from the other two ponds arsenic was not detectable (below 0.01 mg/Kg body weight).

Arsenic was present above the permissible level in fifteen wastewater samples, which were collected mainly from different sewage channels of Kolkata (0.2 mg/l to 0.3 mg/l). The major sources of arsenic in these samples are most likely to be anthropogenic in nature (Sahu, 2002). Domestic sewage contains high level of soaps and detergents. Dey *et al.*, (2005) reported that 26 commonly used soaps and detergents in India contain alarmingly high level of soluble arsenic, contaminating the surface waters. Soaps and detergents also supply fatty acids as food and sulphate as electron acceptors for sulphate reducing bacteria, which in turn releases arsenic from insoluble iron-arsenic adduct. However, in the water samples from fish culture ponds of these sewage-fed fisheries, very low level of arsenic (<0.1 mg/l) was detected. This might be due to the fact that on their way of transport through channels and or after entering the oxidation ponds the concentration of arsenic was reduced significantly due to adsorption on charged pseudo-colloidal clay and humus particles (particulate organic carbon) or complexation with dissolved organic carbon and coprecipitation with sediment (Paikaray *et al.*, 2005; Raichur and Panvekar, 2002; Acharya *et al.*, 1999; Tessier, *et al.*, 1996; Bowell, 1994). In the culture pond of sewage-fed fisheries, due to dilution with freshwater, concentration of pollutants was reduced further. Sediment had much higher level of arsenic than water due to the reason described above; however, the observed level (3.02 – 4.58 mg/kg) was much lower than the permissible limit (10 mg/kg) for soil. Fish samples of sewage-fed fisheries of Kolkata were free from arsenic pollution and observed level (≤0.03 mg/Kg body wt.) was well below than the maximum permissible limit (0.1 mg/Kg body wt.). This low arsenic content was mainly due to two reasons; (a) low level of the metal in the water medium of fish culture ponds (b) for raising fingerlings in sewage-fed fish ponds, fishes are kept for a maximum period of 6-9 months, which may not be sufficient to accumulate the pollutant in the fish body beyond the permissible limit.

The result of the study indicates that at present there is no threat of arsenic pollution to the sewage-fed fisheries of Kolkata. But in nearby entry points and surface wastewaters arsenic levels were higher than the permissible limit i.e. 0.2 mg/l. If the waters from such areas are continuously used for fish culture, in the near future, arsenic pollution may pose a threat to the sewage-fed fisheries of Kolkata.

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