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Chemical Report of Sediments, Phytoplanktons and Fishes of Bindal River Dehradun

Ashok Kumar[1*], Balwant Singh Bisht[2] and Vishnu Dutt Joshi[3]
[1]Department of Biotechnology, HNBGU (A Central University) Srinagar Garhwal 246174 (UK) INDIA
[2]Department of Zoology/Entomology, HNBGU (A Central University), SRT Campus Badshahithaul Tehri-249199 (UK) INDIA
[3]Department of Zoology, Govt. PG College Kotdwara – 246149 (Uttarakhand) INDIA

ABSTRACT

Industrialization and urbanization is the major concern of metal pollution. The use of various types of pesticides and insecticides in agriculture cause water pollution. The pathogenic organisms of these wastes transmit to the water and pose serious problems. Analysis of water, sediments, phytoplanktons and fishes that the Bindal River is contaminated by certain heavy metals was done by ICP-MS method. Concentrations of all elements and ions increase in the downstream. Heavy metal concentration observed in water Mn > Zn > Mg >Cu > Ni > Cr > As > Pb > Co, in the sediments Mn > Cr > Ni >Cu > Co> Zn > Pb, in phytoplanktons Co > Zn > Pb > Mn > Cr and in fishes Cr > Mn > Cu > Ni > Co > Pb > Zn. Metal concentrations in the river indicate an increase in the pollution load due to movement of fertilizers, agricultural ashes, industrial effluents and anthropogenic wastes. An immediate attention from the concerned authorities is required in order to protect the river from further pollution. In general the heavy metal concentration in Bindal River was found maximum in sediments, phytoplanktons and fishes.

Key Words: Natural elements, Phytoplankton, Sediments, Fishes, Bindal River, ICP-MS

INTRODUCTION

Water is considered to be a vital and limited resource; population growth, industrial developments and other pressures faced by developing countries have lead to structured measures to ensure sustainable management of this important source (Dobson and Burgess, 2007). Many heavy metals and their compounds have been found toxic, while some are also subjected to biomagnifications (Karvelas et al., 2003). The presence of these heavy metals in wastewaters will pose an important problem for the environment as well as for the treatment process, because the disposal of both the treated water and activated sludge contaminated with heavy metals give rise to detrimental impacts on the environment (Lark et al 2002). The presence of heavy metals even in traces is toxic and detrimental to both flora and fauna.

Industrial uses of metals such as metal plating, tanneries, industrial processes utilizing metal as catalysts, have generated large amount of aqueous effluents that contain high levels of heavy metals. These heavy metals include cadmium, chromium, cobalt, copper, iron, manganese, mercury, molybdenum, nickel, silver and zinc. Metal polluted industrial effluents discharged into sewage treatment plants could lead to high metal concentrations in the activated sludge. Water pollution has become a major threat to the existence of living organisms in aquatic environment (Lokhande and Kelkar, 1999). A huge quantity of pollutants in the form of domestic and industrial effluents is discharged directly or indirectly into the water bodies, which has severe impacts on its biotic and abiotic environment. During rain, surface water with soil, mud and humus enter into the river, tanks and other water bodies. The inorganic minerals like sodium, potassium, calcium, magnesium and heavy metals like iron, manganese, lead, mercury, chromium, cadmium, nickel, cobalt, beryllium copper *etc*., when reach to the river with water cause water pollution. The use of various types of pesticides and insecticides in agriculture cause water pollution. Careless deposit of animal waste close to the wells and ponds situated in the backyards cause pollution of water through leaching. The pathogenic organisms of these wastes transmit to the water and pose serious problems. The analysis of river sediment is a useful method of studying environmental pollution with heavy metals (Batley 1989). There are basically three reservoirs of metals in the aquatic environment: water, sediment and biota. Metal levels in each of these three reservoirs are dominated by a complex dynamic equilibrium governed by various physical, chemical and biological factors (Murray and Murray 1973).

Therefore, Researchers develop a feasible method to accelerate the process of decay and removal by encouraging the microbial and associated flora and fauna within the ecosystem to accumulate, degrade and remove the pollutants from the identified sites. This process is known as bioremediation that uses naturally occurring or genetically engineered microorganisms such as bacteria and fungi to transform harmful substance into less toxic or non-toxic compounds. Bioremediation promote the growth of microorganisms to

[*] Corresponding author: asokumr@gmail.com

degrade contaminants by utilizing those contaminants as carbon and energy sources. The bioremediation systems in operation today rely on microorganisms native to contaminated sites, encouraging them to work by supplying them with the optimum levels of nutrients and other chemicals essentials for their metabolism (Shazia Iram et al. 2009).

MATERIALS AND METHODS

Selection of sample

The water, sediment, phytoplanktons and fishes of Bindal river, Chakarata Road Dehradun was selected for the study of heavy metal. The Bindal River flow in the heart of city and have many pollutants in it. The water of Bindal river is much polluted as most of the sewage material of nearby municipality area gushed into it. Therefore, the Bindal River was selected for the study purpose.

Collection of samples

The water, sediment, phytoplanktons and fishes samples were collected from six different sites of river. Water samples were collected in polyethylene bottles from 6 stations along waterway. The samples were digested according to standard methods (Abida Begum et al., 2009).

Filtration of sample

Samples were filtered through 0.45 mm filter paper. The residue discarded and the supernatant used for heavy metal detection by ICP-MS. They were concentrated 5 times by evaporation method for heavy metal analyses. All samples were preserved at 4^oC.

Analytical analysis heavy metals in water, sediments and phytoplanktons

ICP-MS (Inductive Coupled Plasma- Mass Spectroscopy) was used for the analysis of trace elements in the samples. For total concentration, 100 ml filtrate obtained by filtration method (Boevski and Daskalova 2007). The concentration of Zn, Ca, Mg, Cu, Cd, Co, Cr, As, Ni, Pb and Mn in each of the sample were determined. Blank values were negligible for all elements under consideration, which indicated the rather high purity of the reagents used.

Determination of heavy metals in the fishes

The levels of Cd, Zn, Pb, As, Ni, Co, Mn, Cr and Cu of the fleshy tissue fraction of fishes were determined with the aid of Inductive Coupled Plasma- Mass Spectroscopy.

RESULTS AND DISCUSSION

All samples including fleshy tissue fraction of fishes were analyzed by ICP-MS and compared with the other data. Heavy metal concentration in water was Mn > Zn > Mg > Cu > Ni > Cr > As > Pb > Co, (Table 1), in the sediments the heavy metal concentration was Mn > Cr > Ni > Cu > Co > Zn > Pb (Table 2), in phytoplankton Co > Zn > Pb > Mn > Cr (Table 3) and in fleshy tissue fraction of fishes was Cr > Mn > Cu > Ni > Co > Pb > Zn (Table 4).

Table 1. Analysis of Total metals in Water of Bindal River **(**μg l^{-1} except Mg; it is in mg l^{-1}**)***

Sample No./Element	W1	W2	W3	W4	W5	W6	Mean
Zn	22	5	69	55	30	142	53.83
Mg	21.8	15	31	47	25	90	38.3
Cu	20	13	19	33	23	51	26.5
Co	1	5	2	1	1.1	1	1.85
Cr	13	8	10	13	11	10	10.83
As	3.5	7.1	4.6	5.9	9.8	2.1	5.5
Ni	15	8.1	14	15	12.9	17.6	13.76
Pb	3.1	2.2	3.9	1.2	1.3	1.1	2.1
Mn	84	16	195	68	35	200	99.66

Table 2. Analysis of Total metals in Sediments of Bindal River **(**μg kg^{-1}**)**

Sample No./Element	S1	S2	S3	S4	S5	S6	Mean
Zn	21	20	31	7.5	21	43	23.92
Cu	47	44	53	13	39	80	46
Co	32	33	42	18	27	62	35.67
Cr	62	51	110	21	50	121	69.17
Ni	60	47	54	19	42	97	53.17
Pb	17	7	19	3.1	3.9	4.7	9.12
Mn	71	57	180	25	60	167	93.33

Table 3. Analysis of Total metals in Phytoplankton of Bindal River **(**μg kg^{-1}**)**

Sample No./Element	P1	P2	P3	P4	P5	P6	Mean
Zn	18	20	30	13	18	45	24
Co	30	29	33	15	20	51	29.67
Cr	11	7.1	13	5.3	9	18	10.57
Pb	14	13	22	10	13	29	16.83
Mn	14	12	20	6.2	11	28	15.2

Table 4. Analysis of Total metals in Fish Samples of Bindal River **(**μg kg^{-1}**)**

Sample No./Element	F1	F2	F3	F4	F5	F6	Mean
Zn	4	3.2	4	14	7	12	7.37
Cu	7	13	17.2	57	14.7	60	28.15
Co	5	7.5	13.1	35.1	8.4	36	17.52
Cr	10	18	22	67	17	68	33.67
Ni	6	11	15.7	41	12.2	51	22.82
Pb	4.3	5.6	4.7	17	7.2	18	9.47
Mn	8	16	18	61	16.1	64	30.52

Distribution of heavy metals in water, sediments, plants, and fish play a key role in detecting sources of heavy metal pollution in aquatic ecosystem. Almost all the important rivers of India have been studied in detail for heavy metal pollution in water and sediments. We have determined the distribution of heavy metals in water, sediments phytoplanktons and fishes collected from river Bindal Dehradun. Order of heavy metal concentration in water was Mn > Zn > Mg > Cu > Ni > Cr > As> Pb > Co, showed in Table 1, in fleshy tissue fraction of fishes Cr > Mn > Cu > Ni > Co > Pb > Zn showed in Table 4, and the order of decreasing heavy metals in the sediments was Mn > Cr > Ni > Cu > Co > Zn > Pb depicted in Table 2.

* **W:** Water Samples**; S:** Sediment Samples**; P:** Phytoplankton Samples**; F:** Fish Samples

Most heavy metals are added during industrial activities, steel processing, pharmaceutical manufacturing etc. Besides this, road traffic is also responsible for over a thousand of lead each year, a result of lead additives in petrol. The heavy metal contaminated water is vey harmful for the irrigation and other purposes. The high levels of metals due to anthropogenic sources and growing population is also the main sources. Phytoplanktons are the bioindicators of the presence of metals in an aquatic ecosystem. Because it eliminates metals from the water, accumulates and stores them over a long period, even when the concentrations of metals in the water is low. The observed concentrations of metals in the phytoplanktons are Co > Zn > Pb > Mn > Cr (Table 3 and fig. 3). The occurrence of lead concentrations in phytoplankton was attributed higher than water, sediment and fishes.

Metal mobilization in the sediment environment is dependent on physicochemical changes in the water at the sediment–water interface. The precipitation of lead, copper, manganese, chromium and zinc might be the result of alkaline pH in the form of insoluble hydroxides, oxides and carbonates. Metals such as chromium, copper and nickel have interacted with organic matter in the aqueous phase and settled, resulting in a high concentration of these metals in the sediment. Mobilization of zinc and lead is also affected by higher concentrations of manganese in the sediment concentrations of metals. Chromium, lead and zinc in the sediment are categorized as nonpolluting, nickel is categorized as moderate pollution and copper is categorized as heavy pollution as per the criteria for sediment concentration of metals established by the USEPA Mineralogical studies of polluted sediments indicate that heavy metals are found to be associated with fine particles of silt clay that have large surface areas and the tendency to adsorb and accumulate metal ions due to their intermolecular forces.

The present study is an attempt to detect changes in the water quality characteristics within the Bindal River with respect to heavy metals. The study reveals that there are additions of large quantities of effluents due to movement of fertilizers, agricultural ashes, industrial effluents and anthropogenic wastes particularly in the down streams of the river. Present study revealed heavy metal concentration in water was Mn > Zn > Mg >Cu > Ni > Cr > As > Pb > Co, (Table 1), in the sediments the heavy metal concentration was Mn > Cr > Ni > Cu > Co > Zn > Pb (Table 2), in phytoplankton Co > Zn > Pb > Mn > Cr (Table 3) and in fleshy tissue fraction of fishes was Cr > Mn > Cu > Ni > Co > Pb > Zn (Table 4).The data compared in the figures 1, 2, 3 and 4. The natural elements which cause water pollution is gases, soil, minerals, humus materials, waste created by animals and other living organisms present in water (Karnataka State Pollution Control Board 2002, Lokhande and Kelkar 1999). Heavy metals can accumulate in the tissues of aquatic animals and as such tissue concentrations of heavy metals can be of public health concern to both animals and humans. (Kalay et al., 1999, Ashraf 2005, Abida Begum et al., 2009). Abida Begum et al., (2009) suggested that the heavy metals cannot be destroyed through biological degradation and have the ability to accumulate in the environment make these toxicants deleterious to the aquatic environment and consequently to humans who depend on aquatic products as sources of food.

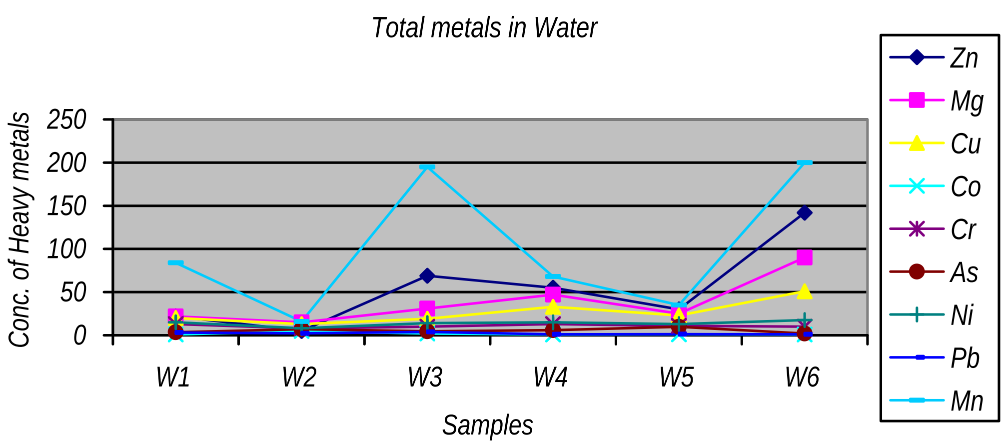

Figure 1. Total metal Analysis in River Water

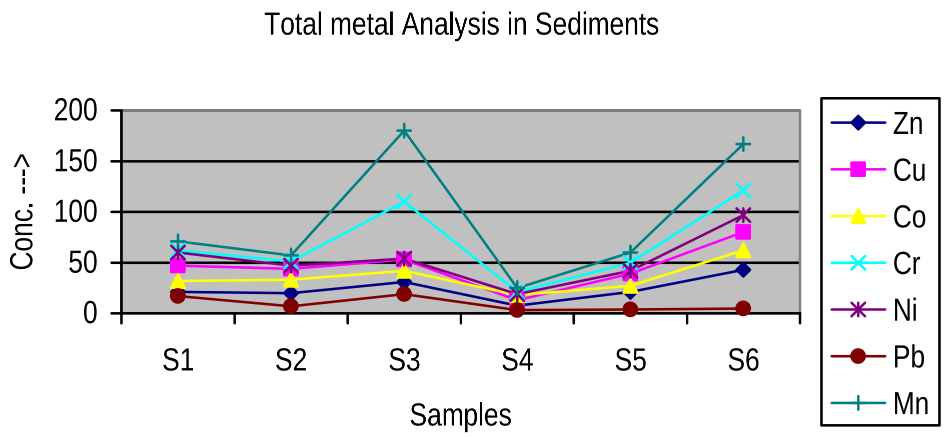

Figure 2. Total metal Analysis in Sediments

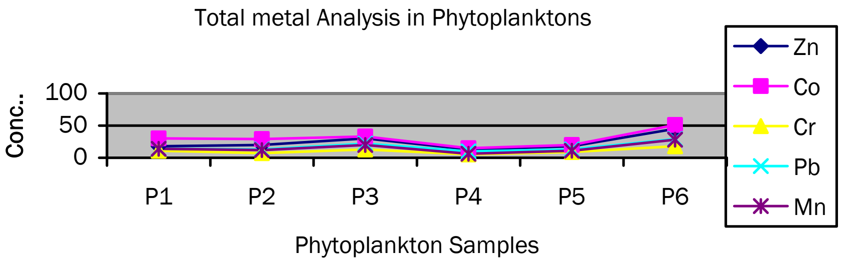

Figure 3. Total metal Analysis in Phytoplanktons

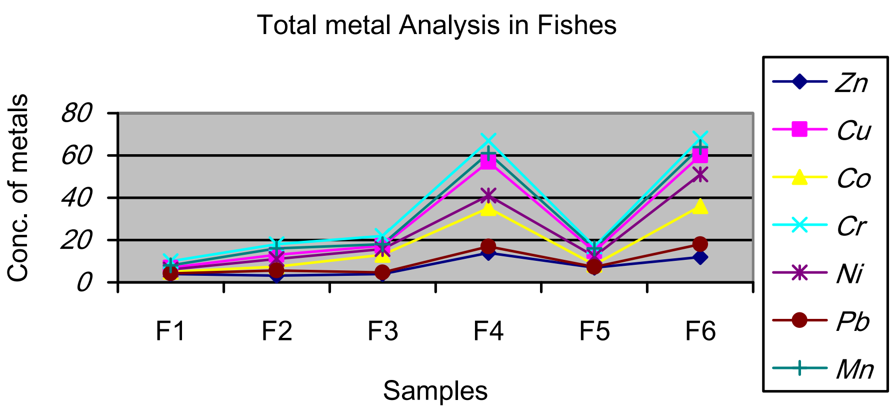

Figure 4. Total metal Analysis in Fishes

CONCLUSION

An immediate attention from the concerned authorities is required in order to protect the river from further pollution. In general the heavy metal concentration in Bindal River was found maximum in sediments, phytoplanktons and fishes.

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REFERENCES

Abida Begum, M. Ramaiah, Harikrishna, Irfanulla Khan and K. Veena, (2009), Heavy Metal Pollution and Chemical Profile of Cauvery River Water, e-Jou. Chem., 6(1): 47-52.

Ashraf, W., (2005) Accumulation of heavy metals in kidney and heart tissues of *Epinephelus microdon* fish from the Arabian Gulf, Enviro. Monit. Asst; 101: 311–316.

Batley, G. E.(1989), Physicochemical separation methods for trace element speciation in aquatic samples, In: Trace Element Speciation: Analytical methods and problems, CRC Press, Inc., Boca Raton, Florida, 43-76.

Boevski, Iv, and Daskalova N., (2007), A Method for Determination of Toxic and Heavy Metals in Suspended Matter from Natural Waters by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). Part I. Determination of Toxic and Heavy Metals in Surface River Water Samples, J. Univ. Chem. Tech. Metal., 42(4): 419-426.

Dobson, R.S. and J.E. Burgess, (2007), Biological treatment of precious metal from refinery wastewater: A review. Minerals Eng., 20(6): 519-532.

Kalay M., Ay P., Canil M. (1999), Heavy metal concentration in fish tissues from the northeast Meditereansea. Bull Environ. Contam. Toxicol., 63:673-671.

Karnataka State Pollution Control Board (2002), Water quality monitoring of lakes in and around Bangalore city, Bangalore 2, pp. 1–8.

Karvelas, M., A. Katsoyiannis and C. Samara (2003), Occurrence and Fate of Heavy Metals in the Wastewater treatment process, Chemosphere, 53: 1201-1210.

Lark, B. S., Mahajan, R. K. and Walia, T. P. S. (2002), Determination of metals of toxicological significance in sewage irrigated vegetables by using atomic absorption spectrometry and anodic stripping voltammetry, Indian J. Environ. Health, 44:164–167.

Lokhande, R. S. and Kelkar, N., (1999), Studies on heavy metals in water of Vasai Creek, Maharashtra. Indian J. Environ. Protect., 19:664–668.

Murray, C. and L. Murray (1973), Adsorption-desorption equilibria of some radionuclides in sediment-freshwater and sediment-seawater systems. In: Symposium on Interaction of Radioactive Contaminants with the Constituents of the Marine Environment. Seattle, Wash. pp. 105-124.

Shazia Iram, Iftikhar Ahmad and Doris Stubin (2009), Analysis of Mines contaminated Agricultural Soil Samples for fungal Diversity and Tolerance to Heavy Metals, Pak. J. Bot., 41 (2): 885-895.