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Status of Heavy Metal Contaminations of River Water of Dhaka Metropolitan City

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Abstract

A study was conducted to evaluate the level of water pollution and its influence on the chemical properties of river water of Dhaka metropolitan city. The water samples were collected from forty five locations of Dhaka metropolitan city during February to March, 2008. Analysis of the major chemical contaminations of river water samples containing Cu, Zn, Mn, As, Pb and Cd was conducted at the Central Laboratory of Bangladesh Agricultural University, Mymensingh. The heavy metal concentrations of river water were recorded as in case of Cu = 0.006 ppm, in case of Zn = 0.021 ppm, in case of Mn = 0.075 ppm, in case of As = 0.003 ppb, in case of Pb = 0.002 ppm and in case of Cd = 0.012 ppm, respectively. The pH of river ranged from 6.28 to 7.61. The EC values were 17.61 to 34.61 μScm^{-1}, revealed that all the water samples were low salinity and also excellent for irrigation. According to drinking water (Potable water) and public water standard, Mn and Cd toxicity were detected in river water. For aquaculture standard Mn and Cd were found at harmful level for all living organism. Some water were found unsuitable due to higher concentration of Mn over the recommended limit but other ions like Zn, As, and Pb were within the 'safe limit'.

Kew Words: Heavy metals, River water, Dhaka city

Introduction

Bangladesh is a developing country in South Asia located between 20°34' to 26°38'N latitude and 88°01' to 92°41' E longitude with an area of 1,47,570 sq.km. It is one of the most density populated country of the world with population growth rate of 1.48 per annum (BBS, 2005).

Water is an inevitable component of natural resources and plays an important role to serve as many purposes like drinking, irrigation, aquaculture and livestock usage. It is needless to say that without enough good water our survival will be threatened. Quality water is a great challenge for 21' century and is more essential than its quantity. Water quality is deteriorated day by day due to numerous of biological, physical and chemical variables causing water toxicity. Water is an universal solvent and various types of elements are dissolved in its, but the concentration of any element or compound beyond tolerance limit for organisms and other usage, treated as pollutants. We have plenty of both surface and ground water supply to support the entire population in Bangladesh. In fact, after human resources water is the most abundant resource in Bangladesh (Azad, 2003).

In Bangladesh, water sources are being polluted for many reasons. Human waste (excreta) is one of them. The average sanitation coverage in Bangladesh is around 43% which indicates that rest 57% of the 150 million people lack sanitation facilities (Ali, 2002a). Everyday 20,000 metric tons of faeces deposit in the open places of Dhaka city due to open defecation and hanging latrines pollute the water bodies like river, cannels, drains and ponds etc. (Ali, 2002b). Tannery and other industrial wastes, unplanned sewage system, medical wastes, nuclear and toxic materials polluting waters as well as the environment, threatening people's liver with health hazards related to toxicity (Abadeen, 2002).

The Buriganga, Turag, Balu, Meghna and Shitalakashya are an attractive rivers is now highly polluted with different chemical residues released from different industries. There are plenty of industries that the spontaneously polluting our rivers. About 3072 industrial polluting entities are polluting the Buriganga, Turag, Balu, Meghna, Shitalakashya and the tanneries of Hazaribag is the major sources (Anonymous, 1997a). From Hazaribagh to Pagla 80% water of the Buriganga river is polluted during dry season (Anonymous, 1997b).

Among soluble constituents in water, common major and secondary constituents are Ca, Mg, Na, Fe, B, MO_3, HCO,, SO, and CI but minor or trace constituent are As, Cd, Cr. Cu, Mn, P and Zn (Davis and Weist, 1966). Contaminated water directly affects the health of inhabitants, fish resources flora and fauna. Pollution and contamination of the rivers, water has impacts on the aquatic resources. When water is polluted with highly concentrated heavy metals then more people will die from the water home diseases including diarohoea, cholera, jaundice, hepatitis, dysentry, skin diseases etc. It is reckoned that some 75 million in 59 out of the countries 64 districts, are virtually exposed to the risk of becoming arsenic victims. Arsenic has contaminated groundwater of GI districts in Bangladesh (Rukshana *et al*., 2002). About 80% of the diseases in developing countries are related to contaminated water the resulting death toll in as must as 10 million per year (Anonymous, 2004).

In the study area the surface water are used for irrigation (for home, kitchen gardening and field crop irrigation), drinking and domestic uses, air-conditioning, beverage, confectionary, laundering, dyeing, ice factory, cold storage, brick field and other industries. In view of the above mentioned multidirectional usage, a study have been conducted to assess the water quality from different non-point sources of the Buriganga, Turag, Balu, Meghna and Shitalakashya rivers of Dhaka metropolitan city.

The present study was conducted with the following objectives:

i) To determine the heavy metal constituents present in the river water environment of Dhaka metropolitan city and their degree of toxicity; and

ii) To identify the suitability of freshwater for irrigation, aquaculture and livestock usage on the basis of international standard.

Materials and Methods

Dhaka Metropolitan City, the study area lies within the north central region of Bangladesh. The area is enclosed by the Tongi khal on the north, the DND embarkment on the south, the Meghna river, Shitalkshiya river, Balu river on the east and the Turag and Buriganga river on the west. Forty five water samples were collected from five rivers during February to March 2008. The water samples were collected in 100 ml plastic bottles. These bottles were cleaned with dilute HCl (1:1) and then washed with tap water and distilled water as well. Before sampling bottles were rinsed again 3 to 4 times with water to be sampled. After collection the bottles containing samples were sealed immediately to avoid exposure to air. The samples were taken from the midstream and few centimeters below th3e surface. To provide necessary information for each sample such as data collection, location, source of water, depth etc. were recorded in a note book and each sample collected in a plastic bottle, was labeled separately with unique identification number. After collecting, all samples were filtered with Whiteman No. 1 filter paper to remove unwanted solid and suspended materials before analysis. Then transferred 90 ml of water sample into another 100 ml bottle which contained 10 ml 2M HCl solution. HCl solution was protected water samples from any fungal and other pathogenic attack. After collection all the water samples were carried to the "Central Laboratory" of Bangladesh Agricultural University, Mymensingh for chemical analysis.

Heavy metals viz. Cu, Zn, Mn, Pd, Cd and As were determined with the help of atomic absorption spectrophotometer (AAS, UNICAM 969) following the method of Clesceri *et al*. (1989). The wavelengths of Cu, Mn, Zn, As, Pb and Cd were 324.8nm, 213.9 nm, 193.7nm, 217.0nm, and 228.8 nm, respectively. Statistical Analysis of the data generated out of chemical analysis of water samples were done with help of Laptop following standard procedure (analysis of variance) as described by Gomez and Gomez (1984).

Results

The collected surface water samples from the Meghna, Shitalakshiya, Buriganga, Turag and the Balu river contained significant amount of copper (Cu) and ranged from 0.0006 to 0.0147 ppm with the mean of 0.006 ppm. The standard deviation (SD) and co-efficient of variation (CV) were 0.004 and 61.42% respectively. Out of 19 samples, 8 samples (about 42%) contained higher Cu than mean value (0.006 ppm) and the rest 11 samples (58%) contained less than that of mean value (0.006 ppm). The highest Cu of 0.0147 ppm (at S_{12}) was detected in near Balu river and the lowest value of Cu was found 0.0006 ppm (at S_7) in the National Zoo at the Turag river (Table 1).

The average Cu values in the water of the Buriganga, Turag, Balu, Meghna, and Shitalakshiya rivers were 0.0063 ppm, 0.0042 ppm, 0.0101 ppm, 0.0057 ppm and 0.0051 ppm, respectively (Table 2).

Zinc (Zn) was recorded which varied from 0.0078 to 0.0487 ppm in the Meghna, Shitalakshiya, Buriganga, Turag and the Balu rivers water. The mean value, standard deviation and co-efficient of variation were 0.021 ppm, 0.010 and 45.46%, respectively. Nine samples (about 47%) showed below the mean (0.021 ppm) and other 10 samples (53%) were above the mean (Table 1).

The average Zn values in the water of the Buriganga, Turag, Balu, Meghna, and Shitalakshiya rivers were 0.0187 ppm, 0.0191 ppm, 0.0249 ppm, 0.0204 ppm and 0.0243 ppm, respectively (Table 2).

The concentration of manganese (Mn) ranged from 0.0144 ppm to 0.6141 ppm in river water samples and the mean value was 0.075 ppm. Out of 19 samples, 17 samples (about 90%) gave below the mean value and the rest 2 samples (about 10%) were above the mean value. The highest concentration 0.6141 ppm was found in near the Buriganga river (S_2) and the lowest 0.0144 ppm found in Meghna river (S_{15}). The standard deviation (SD) and co-efficient of variation (CV) were 0.133 and 175.99%, respectively (Table 1).

The average Mn values in the water of the Buriganga, Turag, Balu, Meghna, and Shitalakshiya rivers were 0.1511 ppm, 0.0555 ppm,

0.0470 ppm, 0.0345 ppm and 0.0514 ppm, respectively (Table 2).

Arsenic (As) was recorded from 0.001 to 0.003 ppb in river water samples where the mean, standard deviation (SD) and co-efficient of variation (CV) were 0.002 ppb, 0.001 and 40.29%, respectively (Table 1).

The average As values in the water of the Buriganga, Turag, Balu, Meghna, and Shitalakshiya rivers were 0.0076 ppm, 0.0020 ppm, 0.0013 ppm, 0.0020 ppm and 0.0020 ppm, respectively (Table 2).

Lead (Pb) content of rivers samples ranged from 0.0002 to 0.0043 ppm with the mean of 0.002 ppm. Amoug 19 samples, 8 samples (80%) were indicate the higher values than the mean and the rest 11 samples (20%) were less than that of the mean (0.002 ppm). The standard deviation (SD) and co-efficient of variation (CV) were 0.001 and 55.65%, respectively (Table 1).

The average Pb values in the water of the Buriganga, Turag, Balu, Meghna, and Shitalakshiya rivers were 0.0028 ppm, 0.0021 ppm, 0.0010 ppm, 0.0013 ppm and 0.0011 ppm, respectively (Table 2).

Cadmium (Cd) concentration in river water samples varied from 0.004 to 0.018 ppm in the Meghna, Shitalakshiya, Buriganga, Turag and the Balu rivers water.The mean value, standard deviation and co-efficient of variation were 0.012 ppm, 0.004 and 32.938%, respectively (Table 1). Eight samples (about 42%) showed below the mean (0.012 ppm) and other 11 samples (about 58%) were above.

The average Cd values in the water of the Buriganga, Turag, Balu, Meghna, and Shitalakshiya rivers were 0.0132 ppm, 0.0136 ppm, 0.0137 ppm, 0.0080 ppm and 0.0110 ppm, respectively (Table 2).

The pH value of river water samples ranged from 6.28 to 7.61 within the mean value of 7.039. Individually, the pH ranged of the Buriganga and the Turag river water were 6.28 to 7.34 and 6.28 to 7.01, respectively. None of the sources showed neutral pH value. All the river water samples were acidic in nature (pH value below 7.0). The lowest value (6.28) was recorded near Sadarghat (S_1) and the highest (7.61) pH value were recorded near Meghna ghat (S_{16}), respectively. Individually pH ranges of the Meghna, Shitalakshya, Buriganga, Turag and Balu rivers were 7.26, 6.93, 7.15, 6.74 and 7.24, respectively, where the highest pH value was found in Meghna river and the lowest in Turag river (Table 3).

The average EC value was recorded 27.153 μscm^{-1} for all river. EC value of different water samples ranged from 17.61 to 36.18 μscm^{-1}. Out of 19 samples only 10 samples showed higher EC values than that of mean value(27.153μscm^{-1}). The standard deviation was 5.474 and the coefficient of variation was 20.159%. Lowest EC (17.16μscm^{-1}) was found at the Buriganga river where highest EC (36.18μscm^{-1}) was found at the Balu river west side (Table 3).

Table 01. Heavy metal (Cu, Zn, Mn, Pd, Cd and As) concentrations of different rivers in Dhaka metropolitan city during March-April, 2008

Sample	Name of river	Location	Cu (ppm)	Zn (ppm)	Mn (ppm)	As (ppb)	Pb (ppm)	Cd (ppm)
S_1	Buriganga river	Near Sadarghat (IWTA) Terminal	0.0017	0.008	0.0246	0.001	0.0018	0.009
S_2		Near SSMC Hospital	0.0033	0.0487	0.6141	0.002	0.0032	0.008
S_3		Lalbag area	0.0061	0.0192	0.045	0.003	0.0022	0.018
S_4		Near Hazaribag tenary-F	0.0115	0.0098	0.0273	0.03	0.0023	0.015
S_5		Buriganga, Kamrangirchar area	0.009	0.0079	0.0445	0.002	0.0043	0.016
S_6	Turag river	Ausulia river ghat	0.004	0.0097	0.0357	0.001	0.0031	0.014
S_7		Near national zoo	0.0006	0.0136	0.1339	0.002	0.0021	0.016
S_8		Diabari river ghat	0.0061	0.0229	0.0281	0.003	0.0016	0.013
S_9		Near rupnagar	0.008	0.0235	0.0421	0.003	0.0014	0.01
S_{10}		Gabtali river ghat	0.0021	0.0259	0.0378	0.001	0.0021	0.015
S_{11}	Balu river	Near Ishapur	0.0093	0.0279	0.0486	0.002	0.0014	0.015
S_{12}		Balu river ghat East side	0.0147	0.0219	0.0487	0.001	0.0002	0.01
S_{13}		Balu river West side Uttar Khan	0.0063	0.0249	0.0436	0.001	0.0013	0.016
S_{14}	Meghna river	Meghna ghat East side	0.0086	0.0199	0.0418	0.003	0.0005	0.009
S_{15}		Meghna ghat	0.0029	0.0219	0.0144	0.001	0.0011	0.006
S_{16}		Meghna ghat West side	0.0057	0.0193	0.0474	0.002	0.0022	0.009
S_{17}	Shitalakshiya river	Matuail ghat	0.0048	0.0288	0.0566	0.003	0.0005	0.004
S_{18}		Donia ghat	0.0016	0.0172	0.0454	0.001	0.0017	0.017
S_{19}		Kachpur ghat	0.0089	0.0269	0.0522	0.002	0.0012	0.012
Mean			0.006	0.021	0.075	0.003	0.002	0.012
SD			0.004	0.010	0.133	0.006	0.001	0.004
CV			61.427	45.460	175.990	192.959	55.648	32.938

Table 02. Studies on heavy metal average concentration of Cu, Zn, Mn, Pd, Cd and As of different rivers in Dhaka metropolitan city March-April, 2008

Name of river	Cu (ppm)	Zn (ppm)	Mn (ppm)	As (ppb)	Pd (ppm)	Cd (ppm)
Buriganga river	0.0063	0.0187	0.1511	0.0076	0.0028	0.0132
Turag river	0.0042	0.0191	0.0555	0.0020	0.0021	0.0136
Balu river	0.0101	0.0249	0.0470	0.0013	0.0010	0.0137
Meghna river	0.0057	0.0204	0.0345	0.0020	0.0013	0.0080
Shitalakshiya river	0.0051	0.0243	0.0514	0.0020	0.0011	0.0110

Discussion

The Arsenic (**As)** concentration of rivers water were same and ranged from 0.001 to 0.002 ppm, which is under the recommended limit of drinking, irrigation and livestock consumption.

The average value of Copper (**Cu)** was 0.018 ppm, where rivers water Cu concentration were 0.0006 to 0.0147 and 0.0255 to 0.0115 ppm, respectively. According to WHO (1972) and U.S. Environmental Protection Agency (1975) the water of study areas were not harmful for drinking.

The concentration of Manganese (**Mn**) for rivers water ranged from 0.0144 to 0.6141 and 0.0469 to 0.1085 ppm. The average concentration of Mn in river were 0.075 and 4.084 ppm and both of the value were suitable for human and livestock drinking but unsuitable for irrigation. For both rivers water average Mn concentration in the study areas was 0.49 ppm which was unsuitable for drinking and irrigation.

Recommendation concentration of Mn for drinking is 0.05 mgL^{-1} (U.S Environmental Protection Agency, 1975). According to the recommendation to the above mentioned agency all the tested water samples were unsuitable for drinking.

Lead (**Pb**) status varied from 0.03 to 1.14 ppm for rivers water and the average concentration of Pb 0.40 ppm, which exceeded the permissible limit.

The concentration of Zinc (**Zn**) varied from 0.08 to 3.065 ppm. In case of Zn concentration the samples of surface water was unsuitable for drinking and irrigation water all the samples were lower than the maximum permissible limit.

The pH of river ranged from 6.28 to 7.61. The EC values (17.61 to 34.61 μScm^{-1}) revealed that all the water samples were low salinity and also excellent for irrigation.

Conclusion

It may be concluded from the study that the rivers of Dhaka metropolitan city contained acceptable amount of As, Zn, Pb, Cd where Mn exceeded the recommended limit for drinking water, public water irrigation water and for aquaculture. In that sense it is hazardous for health, crops and aquaculture. All the water of rivers of Dhaka city can safely be used for specific purpose after proper treatment. Routine research work with wide public awareness, government participation and government regulations can save the water of Dhaka metropolitan city and thus a safe and sound water environment can be made for future generations.

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