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HEAVY METAL CONTAMINATION IN WATER AND FISHES FROM THE SHITALAKHYA RIVER AT NARAYANGANJ, BANGLADESH

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River pollution has been a major problem in Bangladesh as industrial growth has led to increase which use lot of chemicals as raw materials. Moreover, anthropogenic activities continuously increase the amount of heavy metals in the water bodies especially in the lakes, canals, rivers and in aquatic organisms which is an alarming rate and has become an worldwide problem (Malik *et al.* 2010). Aquatic organisms such as fish and shell fish accumulate metals to concentrations many times higher than present in water or sediment (Gumgum *et al.* 1994). The river port of Narayanganj is one of the oldest ports in Bangladesh. There are also a number of industrial units on its banks, including the cement factory, jute mills etc. Industrial effluent dumped into the river resulting in high levels of pollution is a cause for concern (Murshed 2012). For this reason, the investigation of physico-chemical parameters of water and heavy metal contamination in water and fishes of the Shitalakhya river is essential since even slight changes in their concentration above the acceptable levels can result in serious environmental and subsequent health problems. With this incentive, the present study was attempted to investigate the status of heavy metal pollution in water and fish of the Shitalakhya river near Narayanganj city.

The study area was selected at the Bandar ghat as St-1 and Dhakeshwari ghat as St-2 in the Shitalakhya river at Narayanganj from March to May, 2015. Samples were collected during pre-monsoon and monsoon seasons. To analyze the water quality, 500 ml of water was collected in plastic bottles with double stoppers from each sampling site. The sample bottles were pre-conditioned with 5% HNO_3 and later the bottles were rinsed thoroughly with distilled de-ionized water at least three times before sampling was done. Samples were acidified with 10% HNO_3, were placed in an ice bath and were brought to the laboratory. The samples were filtered through a 0.45 µm micro-pore membrane filter and were kept at freeze to avoid further contamination until analysis. In this study

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this study, two commonly available fish species, shing (*Heteropneustes fossilis*) and taki (*Channa punctatus*) were collected for two months (March and May). The water quality parameters such as temperature and pH were determined by the thermometer and digital pH meter (model-pH Scan WP), respectively. Electric conductivity (EC) and total dissolved solids (TDS) were determined by digital EC meter and digital TDS meter (model-HM digital, Germany), respectively. Dissolve oxygen (DO) was determined by digital DO meter (model-D 46974, Taiwan). Alkalinity was measured by titration method and the EDTA method was used to determine the hardness of water. The biological oxygen demand (BOD) was measured by two steps where initial BOD (BOD_1) was measured immediately after collection and after 5 days (BOD_5) was measured by incubation in the dark condition at 20^0C for 5 days. Then the total BOD (BOD_1 - BOD_5) was measured according to Trivedy and Goel (1984) and Haq and Alam (2005). The heavy metal as cadmium (Cd), copper (Cu) and lead (Pb) in water were determined with the help of Atomic Absorption Spectrophotometer (AAS) and chromium (Cr), copper (Cu), lead (Pb) and zinc (Zn) in fish samples were analyzed by using UNICAM-929 atomic absorption spectrophotometer.

The water color in the Shitalakhya river was almost black with bad smell during the study period. The fluctuation in river water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream (Ahipathy and Puttaiah 2006). The temperature found from two different sampling sites indicated gradual increase in water temperature which was within the standard limit for uses of all purposes (Table 1). The highest temperature (32.5ºC) was observed in St-1 in April and the lowest (29.9ºC) in St-2 in March. The EC depends on the presence of ions, their total concentrations, and their mobility along with the changing temperature (Greenberg *et al.* 1992). The lowest EC (443 µS/cm) was observed in St-1 in April and the highest (1175 µS/cm) in St-2 in March.

According to ADB (1994), the standard level of EC for fisheries and irrigation purposes are 1000 and 750 µS/cm, respectively. All the EC values are higher than the standard level, indicated the presence of ionic compounds in water. According to Islam *et al.* (2014), the EC values of some peripheral rivers of Dhaka city ranged from 53.1 - 65.1 µScm in winter and 11.7 - 71.8 µScm in summer. Adequate DO is necessary for good water quality, survival of aquatic organism and decomposition of waste by microorganism (Islam *et al.* 2010). From the present study, the highest value of DO (2.63 mg/l) was observed in St-2 in March and the lowest (1.3 mg/l) was observed in St-1 in May (Table 1). According to De (2005), the standard level of DO for fishing and drinking purposes is 4-6 mg/l. The DoE (2001) found that both the Balu and the

Shitalakhya rivers are heavily polluted with organic and human wastes, especially during the dry season, as indicated by the low values of DO and high values of coliform bacteria. Since 1989, the DO concentration in the Balu river had been much below the critical level of 4 mg/l and in Shitalakhya river, the DO values had been frequently below 4 mg/l since 1997. The DO, below 2 mg/l may lead to the death of most fish (Meghla *et al.* 2013). The greater the BOD,

Table 1. Water quality parameters in Shitalakhya river

Parameters	Sampling months	Sampling sites		Standard level
		St-1	St-2	
Temp. (ºC)	March	30.1	29.9	25 (EPA 2001)
	April	32.5	32.3	
	May	32.3	31.8	
pH	March	7.4	7.59	6.5 - 8 (EPA 2001)
	April	7.7	7.7	
	May	7.43	7.55	
EC (µS/cm)	March	1167	1175	750 - 1000 (ADB 1994)
	April	1139	1148	
	May	443	479	
DO (mg/l)	March	2.3	2.4	4 - 6 (De 2005)
	April	2.6	2.63	
	May	1.3	1.7	
BOD (mg/l)	March	1.1	1.0	5 - 7 (EPA 2001)
	April	1.2	1.3	
	May	0.55	0.63	
TDS (mg/l)	March	378	573	450-1000 (ADB 1994)
	April	557	554	
	May	269	283	
Alkalinity (mg/l)	March	293	313	200 (Bhatnagar *et al.* 2004)
	April	330	350	
	May	204	283	
Hardness (mg/l)	March	72	82	123 (Haq and Alam 2005)
	April	78	86	
	May	65.9	73	

the more rapidly oxygen is depleted in the stream (Abida and Harikrishna 2008). The highest value of BOD (1.3 mg/l) was observed in St-2 in April and the lowest (0.55 mg/l) was in St-1 during May. According to the EPA (2001) the standard level of BOD for surface water and fisheries are 5 - 7 and 3 - 6 mg/l, respectively. The standard level of TDS for drinking, irrigation and fish culture purposes are 1000, 2000 and 450 mg/l, respectively. The highest value of TDS (573 mg/l) was observed in St-2 in March and the lowest (269 mg/l) was observed in St-1 during May. All of the observed TDS values are within the standard level for drinking, irrigation water and fish culture. Hardness of water

is due to the presence of chloride, sulfate, carbonate, bicarbonate salts of Ca^{2+} and Mg^{2+} and the hardness increases in dry season and decreases in wet season (Rahman *et al.* 2012). The highest value (86 mg/l) was observed in St-2 in April and the lowest (65.9 mg/l) was observed in St-1 during May that reflects the hardness of water fluctuates with time (Table 1).

The highest alkalinity of 350 mg/l at St-2 and the lowest of 204 mg/l at St-1 were found in April and May, respectively. All the values were greater than the standard level of alkalinity for surface water that is 200 mg/l (Bhatnagar *et al.* 2004). It indicates that Shitalakhya river contains higher amounts of carbonates and bi-carbonates enriched compounds. According to Ahmed *et al.* (2010a), alkalinity ranged from 5.64 mg/l in pre-monsoon and 121.0 mg/l in post-monsoon in the Karnafuli river, which differed from the values of present study due to the chemical characteristics of pollutant in the Karnafuli which contains mostly acidic compounds. All of the observed pH values are lower than the standard level. According to Islam *et al.* (2014) the pH values of some peripheral rivers of Dhaka city ranged from 5.7- 8.2 in winter and 6.5 - 7.8 in summer.

Table 2. The concentration (ppm) of lead (Pb), cadmium (Cd) and copper (Cu) of Shitalakhya river

Heavy metals	Sampling months	Sampling sites		Standard level
		St-1	St-2	
Pb	Mar.	0.021	0.025	0.05 - 0.1 (ADB 1994)
	Apr.	0.024	0.023	
	May	0.023	0.022	
Cd	Mar.	0.005	0.008	0.005 - 0.05 (ADB 1994)
	Apr.	0.007	0.009	
	May	0.006	0.009	
Cu	Mar.	0.02	0.021	0.2 - 1.0 (De 2005, ADB 1994)
	Apr.	0.025	0.027	
	May	0.025	0.027	

The highest value of Pb (0.025 ppm) was observed in St-2 and the lowest (0.021 ppm) in St-1 in March (Table 2). The standard level of Pb for drinking, irrigation and fisheries are 0.05, 0.1 and 0.05 ppm, respectively. Here, all the observed values are lower than the standard level. Islam *et al.* (2014) found that the total concentration of Pb ranged from 0.0029 - 0.0081 ppm in the rivers adjacent to Dhaka city. Ahmed *et al.* (2010a) reported that the concentration of Pb ranged from 0.058 ppm during pre-monsoon to 0.072 ppm during monsoon in the Buriganga river.

Ahmed *et al.* (2010a) studied that the concentration of Cd ranged from 0.007 ppm during monsoon to 0.012 ppm during post-monsoon in the Buriganga river. The highest value of Cd (0.009 ppm) was observed in St-2 in April and May

and the lowest (0.005 ppm) was observed in St-1 during March (Table 2). According to ADB (1994) the standard level of Cd for drinking, irrigation and livestock water are 0.05, 0.1 and 0.05 ppm, respectively. Here, all the observed values are lower than the standard level that indicated lower level of Cd pollution. The highest Cu (0.027 ppm) was observed in St-2 in May and the lowest (0.020 ppm) was observed in St-1 during March (Table 2), which are below the standard level. Islam *et al.* (2014) found that the highest concentration of Cu was 0.042 ppm during winter and 0.020 ppm during summer season in the rivers adjacent to Dhaka city. Ahmed *et al.* (2010a) studied that the concentration of Cu ranged from 0.11 ppm during monsoon to 0.2 ppm during post-monsoon in the Buriganga river.

During the study period, Pb was not detected in sampled fish species from Shitalakhya river. Ahmed *et al.* (2009) investigated the heavy metal concentration in fish and oyster from the Shitalakhya river and found seasonal variation of Pb ranged from 9.16 - 13.09 mg/kg and the highest level of Pb in chapila (*Gudusia chapra*) (13.52 mg/kg) during monsoon and the lowest on tatkeni (*Cirrhinus reba*) (8.03 mg/kg) during pre-monsoon from the Buriganga river. Ahmed *et al.* (2010b) studied the heavy metal concentration in fish from Dhaleswari river, Bangladesh and found the seasonal variation of Pb from 7.03 - 12.18 mg/kg. The Pb was not detected in the fishes under this study, probably due to seasonal variation. Also Cr was not detected in fish species. According to Ahmed *et al.* (2010b), Cr concentration was highest in chapila (7.38 mg/kg) during monsoon and the lowest in tengra (5.27 mg/kg) during monsoon in Buriganga river. Ahmed *et al.* (2010b) studied the heavy metal concentration in fish from the Dhaleswari river found the seasonal variation of Cr 9.38 - 19.65 mg/kg. Ahmed *et al.* (2009) investigated the heavy metal concentration in fish and oyster from the Shitalakhya river, and found seasonal variation of Cr ranged from 8.12 - 9.07 mg/kg. The Cu values for two fish samples of the Shitalakhya river from the two stations in the months of March and May, 2015 are shown in Table 3. The highest Cu (0.76 ppm) was observed in *Channa punctatus* in March at St-1 and the lowest (0.22 ppm) also in *C. punctatus* in March at St-2. Ahmed *et al.* (2010b) studied the heavy metal concentration in fish from Dhaleswari river, and found the seasonal variation of Cu (7.55 - 11.50mg/kg). Ahmed *et al.* (2010b) studied that Cu level was the highest (6.34 mg/kg) in chapila during post monsoon and the lowest in tatkeni (3.36 mg/kg) during the same time in Buriganga river. Ahmed *et al.* (2009) investigated the heavy metal concentration in fish and oyster from Shitalakhya river, Bangladesh found seasonal variation of Cu ranged from 5.47 - 8.19 mg/kg. All these values differ from the findings of the present study due to different accumulation levels of Cu in different organs

of fish and also for abundance of Cu enriched pollutants in water. The Zn concentration for fish samples of the Shitalakhya river from two locations in the months from March and May, 2015 are shown in Table 3. Here, the highest value of Zn (20.13 ppm) was observed in *C. punctatus* in May at Bandar St-1 and the lowest (6.24 ppm) was observed in *H. fossilis* at St-2 of the river.

Table 3. Concentration of heavy metal (ppm) of lead (Pb), chromium (Cr), copper (Cu) and zinc (zn) in fish samples of Shitalakhya river

Fish species	Heavy metals	Bandar ghat		Dhakeshwari ghat	
		March	May	March	May
Heteropneustes fossilis	Pb				
	Cr				
	Cu	0.36	0.23	0.41	0.42
	Zn	8.68	8.24	10.2	6.4
Chana punctatus	Pb				
	Cr				
	Cu	0.76	0.45	0.22	0.45
	Zn	8.35	20.13	15.92	10.74

From the present study, it can be concluded that the water of Shitalakhya river is partly metal polluted and is unsuitable for drinking, irrigation, fishing, livestock and also recreational purposes. A very few species of fish are now available. So, for the management of water quality of Shitalakhya river near Narayanganj city, rivers water quality and monitoring and legislation on dumping of industrial waste into the river should be established as well as some mitigation measures should also be taken to recover and sustain healthy ecosystem of the river.

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