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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (11): 1962-1964, 2000

Assessment of River Ravi for the Physico-chemistry and Heavy Metals Toxicity of Water

Ghazanfar Mahmood[1], M. Javed[1] and M. Hassan[2]
[1]Fisheries Research Farms, Department of Zoology and Fisheries, University of Agriculture, Faisalabad, Pakistan
[2]Department of Zoology, Government College, Faisalabad, Pakistan

Abstract: The water was alkaline throughout the stretch under study. The electrical conductivity of water at Hudiara nulla was the maximum due to the input of large amounts of salts and other nutrients in thiS tributary. Dissolved oxygen contents were significantly lower at Farrukhabad nulla, Munshi hospital nulla, Baker mandi nulla and Hudiara nulla than rest of the sampling stations. These significantly low values of dissolved oxygen corresponded inversely with the metal ion concentrations in water. There were significant variations among different sampling stations for heavy metals toxicity and physico-chemical variables viz. total hardness, water temperature, dissolved oxygen, pH and electrical conductivity. The variable significance of different parameters with positive and negative partial regression coefficients at different sampling stations were due to the difference of these stations for metals toxicity levels. On the whole, both zinc and iron toxicities in water were positively and significantly dependent on water temperature while negative but significant on pH of water.

Key words: Effluents, EPA, heavy metals, physico-chemical variables, river Ravi

Introduction

In developing countries demographic explosion is creating serious environmental concerns, the most significant of which is associated with sewage disposal and water quality (Davies, 1988; Javed and Hayat, 1995). Due to rapid industrialization and urbanization, large amounts of heavy metals, sewage effluents and their compounds are being released continuously into the riverine system of Pakistan in general and of the Punjab province in particular that adversely affected the aquatic ecosystem (Javed and Hayat, 1994). This points towards the desperate need for assessing the problem and to develop methods for alleviating the ill-effects of pollutants like zinc and iron because, polluted water can cause paralysis, meningitis, cancer, sterility, schistosomiasis, poliomyelitis and filariasis in animals (Kumar, 1977; Singh *et al.,* 1982). When organic metals are added to surface waters, the proliferation of oxygen consuming decomposers, mainly bacteria and fungi are encouraged. These decomposers reduce the oxygen supply and consequently, members of aquatic communities especially fish and shell fish, become deprived of aquatic oxygen and consequently perish.

In recent years, due to awareness about pollution, the programmes for the monitoring and abatement of river pollution including heavy metals pollution have been initiated. The present project was, therefore, planned to assess the physico-chemical properties and heavy metals viz. zinc and iron toxicity of the stretch of river Ravi from Shandera (Lahore) to Baloki headworks.

Materials and Methods

Data on metal toxicity of water was collected from the following seventeen sampling stations selected throughout the stretch of river Ravi, i.e., from Shandera to Baloki headworks, following proportionate sampling procedure (Steel and Torrie, 1986), at both right and left banks.

Shandera tool tax bridge, right bank (S1), Infront of Baradarri (S2), Farrukhabad nulla (S3), Shargpur (S4), Thane Polian wale (S5). In between 0.8. link canal and head Baloki (S6), Baloki headworks, right bank (S7), Shandera tool tax bridge, left bank (S8), Munshi Hospital nulla (S9), Taj company nulla (S10), Baker mandi nulla (S11), Choohang (S12), Sundder (S13), Baloki headworks, left bank (S14), Hudiara nulla (S15), 0. B. link canal (S16), Deg fall (S17).

Samples were collected on fortnightly bases from December 1, 1994 to November 30, 1995. Sampling was done in the morning hours between 9:00 am to 12:00 noon. Water samples were collected from just below the surface and column (two meters below the surface), mixed to have a composite sample, for the heavy metals and physico-chemical variables. Each sampling station was divided into three sub-stations, at equal distances from the coming source (within the diameter of 100 m), Water temperature, dissolved oxygen, pH and electrical conductivity were determined through electronic meters viz. HANNA HI 8053, HI 9143, HI 8520 and HI 8733 respectively while total hardness was determined through the method described by Clesceri *et al*. (1989). After the wet digestion of water samples (AOAC, 1984), the water samples were run through the Atomic Absorption Spectrophotometer (Perkin Elmer 5100) to determine the percentage compositions of metals viz, zinc and iron by following the method Nos. viz. 3500-Zn B and 3500-Fe B respectively as described in Clesceri *et al*. (1989). Analysis of variance and Duncan's multiple range tests were performed to find out statistically significant differences among various sampling stations for different variables under study. Regression and correlation were also computed to find out relationship/trends among various parameters under study.

Results and Discussion

During ecological studies it has been observed that the physico-chemical and the metal ion equilibrium of river Ravi water has been disturbed by the domestic sewage and the effluent discharges through various tributaries which carried effluents from numerous industries and cities situated along both right and left banks of the river.

Table 1: Annual mean values for physico-chemical characteristics and concentrations of heavy metals at different sampling stations of the river Ravi water

S.S	Water Temp. (°C)	D.O. (mg/l)	pH	E.C (S)	T.H (mg/l)	Zn (mg/l)	Fe (mg/l)
S1	24.82±5.83F	7.52±0.72BC	8.32±0.23ABCD	342.44±61.69J	177.92±31.27FCH	0.50±.22EF	4.57±1.75EF
S2	25.70±5.69E	7.10±0.72CD	8.23±0.28CD	393.72±81.55H	196.94±32.556	0.57±0.23EF	5.47±2.64CD
S3	31.15±5.2.8A	1.62±0.481	7.47±0.41F	1029.04±87.27C	319.22±24.928	3.71±0.88A	10.80±4.22A
S4	25.91±5.54E	6.45±0.59E	8.25±0.33BCD	521.88±51.59EF	227.92±35.99CD	0.67±0.27E	6.89±2.336
S5	24.74±6.09FG	5.71±1.68F	8.35±0.24ABCD	498.42±118.49F	215.92±32.45D	0.64±0.24E	5.86±2.15C
S6	23.95±6.23GH	7.55±0.47B	8.36±0.18ABCD	386.24±84.29HI	182.28±26.16EFG	0.53±0.19EF	4.54±1.49EF
S7	23.65±6.23H	7.57±0.46B	8.35±0.19ABCD	322.06±65.47JK	164.96±14.14HI	0.49±0.18EF	4.28±2.66F
S8	24.81±15.86F	7.39±0.71BC	8.37±0.23AB	346.18±66.79IJ	177.20±30.85FGH	0.50±0.22EF	4.60±1.78EF
S9	28.25±4.53C	1.82±0.361	7.55±0.31EF	1089.46±79.63E1	320.86±33.668	1.77±0.36C	6.00±2.04C
S10	28.96±4.37BC	2.37±0.60H	7.68±0.50E	1109.70±68.72B	328.56±39.108	1.83±0.39C	5.31±1.92CDE
S11	20.21±4.928	1.76±0.511	7.58±0.30EF	1124.94±72.166	328.40±44.8313	2.21±0.65B	5.33±1.85CDE
S12	24.69±6.14FG	5.97±1.63F	8.32±0.18ABCD	552.56±77.020E	213.44±39.060	0.63±0.27E	5.37±1.85CDE
S13	23.96±6.11	6.68±0.64DE	8.24±0.238CD	455.14±77.37G	187.04±22.32EF	0.61±0.22E	4.61±1.52DEF
S14	23.44±6.16H	7.49±0.518C	8.32±0.18ABCD	322.80±68.29Jk	166.58±14.06GHI	0.51±0.20EF	4.37±2.65F
S15	27.18±6.04D	1.44±0.511	8.22±0.400	1614.82±98.68A	416.60±46.52A	1.57±0.611D	2.64±1.346
S16	23.25±5.92H	8.29±0.73A	8.44±0.18A	283.36±31.61K	158.04±12.581	0.40±0.18F	2.29±1.073
S17	24.64±5.53FG	5.17±1.51G	8.36±0.23ABC	565.78±179.90D	233.50±51.31C	0.58±0.22EF	5.29±2.94CDE

Table 2: Corelation coefficients among physico-chemical and metal ion concentrations in water throughout the stretch of river Ravi

Variables	Water temperature°C	Dissolved Oxygen mg/l	pH	Electrical conductivity μS	Total hardness mg/l	Zinc mg/l
Water temperature °C						
Dissolved Oxygen mg/l	-0.25691					
pH	-0.26374	0.58555				
Electrical conductivity μS	0.22295	-0.90379				
			-0.54175			
Total hardness mg/l	0.17070	-0.85735		0.91377		
			-0.55170			
Zinc mg/l	0.24545	-0.74167		0.68789	0.67466	
			0.05891			
Iron mg/l	0.58213	-0.17124		0.05928	0.05891	0.33804
-0.65891						
			-0.32214			

Critical value (II Tail test: 0.05) = ±0.07992

The data on the mean annual heavy metals concentrations and physico-chemical variables, in the water is presented in Table 1. The presence of heavy metals in the aquatic environment is dependent on Wide range of chemical, biological and environmental factors (Ajmal and Razi-ud-Din, 1988). Among the physico-chemical factors, an important factor which influences the availability of heavy metals in the aquatic system is the hydrogen ion concentration (Polprasert, 1982). The mean annual pH of river Ravi stretch, under study, varied from 7.47±0.41 (at Farrukhabad nulla) to 8.44±0.18 (at Q.B. link canal). Zinc concentrations ranged from 0.40±0.18 mg/l (at Q.B. lind canal) to 3.71±0.88 mg/l (at Farrukhabad nulia). The highest mean concentration of zinc was recorded at Farrukhabad nulla where the pH of water was the lowest recorded (7.47±0.41), Metzner (1977) studied the solubilities of copper, lead and zinc at different pH values in waste waters and reported the optimum value of these metals at pH 7. Hayat (1995) reported significantly negative correlation between zinc concentration and pH of water. The concentration of zinc at all the sampling stations, under study, were found higher then the EPA (USA) standard (0.01 mg/l) for safe fresh water fisheries. The levels of iron ranged between 2.29±1.07 mg/l and 10.80±4.22 mg/l at 0.8. link canal (S16) and Farrukhabad nulla (S3) respectively. Ferric ions tend to form complexes with natural water organics. These organics and iron get associated and form large particles which are colloidal in character (Hall and Lee, 1974). Iron and zinc rnight have entered river water from the effluents of various metal industries situated at Lahore-Sheikhupura road. The concentrations of iron at all the sampling stations were significantly higher than the EPA (USA) standard of 0.36 mg/l for sustainable conservation of aquatic habitats for fresh water fisheries.

Table 2 shows positively significant dependence of both the heavy metals viz. zinc and iron on water temperature. Jackson (1988) reported uptake of metals by benthos with the decrease in water temperature. However, Hayat (1995) reported significant and positive correlation between the heavy metal ions and temperature of water. During the present investigation it has been observed that the zinc and iron in water corrected significantly but negatively with the dissolved oxygen in water. This may be due to the proliferation of the oxygen consuming decomposers at high metal ion concentrations to reduce the oxygen supply and consequently, members of aquatic communities, especially fish and shell fish, become deprived of aquatic oxygen (Ajmal and Razi-ud-Din, 1988).

Total hardness of water almost followed the similar trend as that of total alkalinity in water. The correlation coefficient between iron and zinc was positive and highly significant (Table 2). Hayat (1995) reported positive and highly significant correlation between iron and zinc in river Ravi water. In the present investigation total hardness appeared as a water quality variable that influenced the concentrations of both zinc and iron in river Ravi water at different sampling stations. Iron at S1, S2, S5, S8, S12 and S13 had negatively significant regression on electrical conductivity of water. Sunder (1988) reported that the specific conductivity of inland fresh water for supporting a good fish fauna lies between 150-500 mhos. In the present study, the maximum mean annual level of electrical conductivity was observed as 1614.82±98.68 μS at Hudiara nulla (S15). However, the correlation coefficient between metals ion concentrations and the electrical conductivity in water were positive and significant (Table 2).

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