http://www.pjbs.org

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 6 (12): 1027-1029, 2003
ISSN 1028-8880

Lead and Nickel Concentrations in Fish and Water of River Ravi

Ghazanfar Mahmood
[1]Department of Biology, Government Post Graduate College, Chishtian, Punjab, Pakistan

Abstract: Lead and nickel toxicity in the body organs of fish viz. *Catla catla, Labeo rohita* and *Cirrhina mrigala* and water was studied in the stretch of river Ravi from Baloki headworks to Sidhnai barrage. Significant variations were recorded in water samples and four fish organs for the concentration of metals. Lead accumulation was higher in fish gills and liver than in kidney and muscle. Nickel concentration was the maximum in liver followed by that in kidney, gills and muscle. Metal concentrations in water were significantly correlated with the temperature. However, lead in water showed positively non-significant regression on water pH. The accumulation of nickel in three fish species did not vary significantly. However, *Catla catla*, showed non-significantly higher tendency to concentrate lead in its body than *Labeo rohita*.

Key words: Fish, 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, 1996). Ever increasing industrialization and urbanization has also intensified the environmental pollution. To meet the need of increasing population, heavy industries have been developed which require large quantities of water and return it as effluent loaded with chemical residues and discharged into the rivers.

In recent years, due to awareness about pollution, the programmes for the monitoring and abatement of river pollution, including heavy metals toxicity, have been initiated in Pakistan (Javed and Hayat, 1995, 1996, 1998, 1999 and Mahmood *et al*., 2000). Due to rapid industrialization and urbanization, large amounts of heavy metals and their compounds are continuously releasing into the riverine system of Pakistan in general and of the Punjab province in particular (Javed and Hayat, 1995). This points towards desperate need for assessing the problem and to develop methods for alleviating the ill-effects of pollutants like lead and nickel because polluted water can cause paralysis, meningitis, cancer, sterility, schistosomiasis, poliomyelitis and filariasis in animals. Therefore, the present study was planned to assess the metals, viz. lead and nickel toxicities in fish and water of river Ravi stretch from Baloki headworks to Sidhnai barrage.

Materials and Methods

Eight sampling stations, along both right and left banks of the river Ravi stretch from Baloki headworks to Sidhnai barrage, were fixed for the collection of water samples, viz. Baloki headworks, Syedwala, Mari Pattan bridge, Kamalia-Chichawatni bridge, Sidhnai barrage, Degh nulla, Samundri main drain and Sukhrawa main drain. Fish samples were collected from Baloki headworks and Sidhnai barrage. The extent of river water pollution in the scenario of physico-chemical variables, viz. water temperature, dissolved oxygen, pH, electrical conductivity and total hardness and metal ions, viz. lead and nickel toxicity were determined. Fish, viz. *Labeo rohita, Catla catla* and *Cirrhina mrigala*, samples were collected on monthly basis. Water samples were collected on fortnightly basis and analyzed for temperature, dissolved oxygen, pH and electrical conductivity through meters, viz. HANNA HI-8053, HI-9143, HI-8520 and HI-8733, respectively while total hardness was determined through the method described in (APHA. and AWWA., 1989). The concentrations of lead and nickel in water and fish was determined through Atomic Absorption Spectro-photometer by following method Nos. 3500-Pb B, 3500-Ni B, respectively.

Statistics: The data on heavy metal and physico-chemical variables were subjected to statistical analysis through two-way classification (Factorial experiment) by following Steel and Torrie (1986). Analysis of variance, Duncan's Multiple Range test and correlation were performed to find-out statistically significant differences/relationships among various parameters under study.

Results and Discussion

Among the river site sampling stations, the water at Kamalia-Chichawatni bridge showed the mean highest lead concentration of 1.66±0.77 mg l^{-1} while it was lowest (0.62±0.27 mg l^{-1}) at Sidhnai barrage. The mean lead

concentration at Degh nulla was 0.95±0.41 mg l^{-1} which was higher than that of Samundri main drain and Sukhrawa main drain. The differences between Degh nulla and Sukhrawa main drain and for Samundri main drain and Sukhrawa main drain were statistically significant (Table 1).

The mean nickel concentration in water showed non-significant differences at all the sampling stations except Baloki headworks and Samundri main drain. The maximum nickel concentration of 1.30±0.32 mg l^{-1} was recorded at Baloki headworks while it was minimum at Syedwala bridge (0.96±0.21 mg l^{-1}). Among the effluent discharging tributaries, Samundri main drain showed the maximum concentration of 1.25±0.34 mg l^{-1} (Table 1).

The mean water temperature at all the river site sampling stations and effluent discharging tributaries fluctuated significantly (Table 1). Among the river site sampling stations, the mean annual water temperature of 23.94±5.47°C was the maximum at Kamalia-Chichawatni bridge while the same was minimum at Baloki headworks (22.41±5.37°C). The difference between these two sampling stations was statistically significant at $P<0.05$. Samundri main drain had the maximum mean annual water temperature of 28.12±5.77°C while Sukhrawa main drain showed the lowest value of 25.90±6.98°C.

Mean dissolved oxygen at river site sampling stations fluctuated between a maximum of 6.99±0.95 mg l^{-1} (at Mari Pattan bridge) and a minimum mean concentration of 5.70±0.95 mg l^{-1} (at Baloki headworks). Among the three effluent discharging tributaries, water at Sukhrawa main drain showed significantly higher dissolved oxygen content of 2.01±0.87 mg l^{-1} than rest of the tributaries. Samundri main drain had the mean lowest dissolved oxygen content of 0.34±0.26 mg l^{-1} (Table 1).

Among the river site sampling stations, mean highest pH was recorded at Mari Pattan bridge (7.65±0.31) while the lowest pH was recorded as 7.55±0.32 at Syedwala. Sukhrawa main drain had the mean highest pH of 7.80±0.34 and the same was lowest as 7.47±0.29 at Degh nulla (Table 1).

Electrical conductivity of water fluctuated non-significantly among all the five river site sampling stations. However, 891.20±240.91 µS was the highest mean electrical conductivity recorded at Kamalia-Chichawatni bridge. Water at Degh nulla showed the mean highest electrical conductivity of 16520.00 ± 4677.08 µS while 3311.00±1521.51 µS was the lowest mean recorded at Sukhrawa main drain (Table 1).

Three effluent discharging tributaries showed statistically significant differences for the total hardness of water. The

Table 1: Mean concentrations of physico-chemical characteristics and heavy metals at all the sampling stations

Sampling Stations	Lead (mg l^{-1})	Nickel (mg l^{-1})	Water temperature (°C)	Dissolved oxygen (mg l^{-1})	pH	Electrical conductivity (µS)	Total hardness (mg l^{-1})
Baloki headworks	0.66±0.35c	1.30±0.32a	22.41±5.37e	5.70±0.95c	7.59±0.33cd	451.10±141.29d	159.30±49.71d
Syedwala	1.00±0.79b	0.96±0.21b	22.73±5.30de	5.86±0.95c	7.55±0.32de	491.00±111.80d	144.50±38.60d
Mari Pattan bridge	0.75±0.21bc	1.05±0.23b	23.57±5.73c	6.99±0.95a	7.65±0.31bc	747.20±192.91d	200.00±52.95d
Kamalia-Chichawatni bridge	1.66±0.77a	1.03±0.27b	23.94±5.47c	6.75±1.29ab	7.61±0.26bcd	891.20±240.91d	176.50±35.14d
Sidhnai barrage	0.62±0.27c	0.98±0.34b	23.00±5.77d	6.48±0.66b	7.59±0.20cd	615.00±117.15d	158.30±21.62d
Degh nulla	0.95±0.41b	1.06±0.25b	26.23±6.62b	1.47±0.61e	7.47±0.29e	16520.00±4677.08a	691.30±298.64a
Samundri main drain	0.92±0.38b	1.25±0.34a	28.12±5.77a	0.34±0.26f	7.70±0.35b	6888.00±2980.91b	455.50±80.35b
Sukhrawa main drain	0.51±0.19c	1.06±0.17b	25.90±6.98b	2.01±0.87d	7.80±0.34a	3311.00±1521.51c	295.30±46.09c
SE	0.0917	0.0439	0.1990	0.1570	0.0356	390.1734	24.9127

Table 2: Metals contamination of water dependent upon physico-chemical variables

Dependent variable	Regression equation					R^2
Lead						
Lead in water = 3.12 + 0.0233 (Temp.)						0.0615
	**					
SE =	0.0005					
Lead in water = -0.16 + 0.0320 (Temp.) + 0.0576 (DO)						0.1225
	**	**				
SE =	0.0000	0.0004				
Lead in water = -0.54 + 0.0310 (Temp.) + 0.0983 (DO) + 0.0008 (TH)						0.1722
	**	**	**			
SE =	0.0001	0.0000	0.0009			
Lead in water = - 2.57 + 0.0371(Temp.) + 0.1048 (DO) + 0.0008 (TH) + 0.2426 (pH)						0.1856
	**	**	**	NS		
SE =	0.0000	0.0000	0.0007	0.1380		
Nickel						
Nickel in water = 0.52 + 0.0231 (Temp.)						0.2341
	**					
SE =	0.0030					

Metals in water are in mg l^{-1} DO = Dissolved oxygen (mg l^{-1}) ; Temp. = Water temperature (°C); TH = Total hardness (mg l^{-1}); SE = Standard error; ** = Significant at $P<0.01$; NS = Not significant

Table 3: Comparison of means (μg g^{-1}) of fish organs, fish species and site of fish collection for metals

Fish organs:	Lead concentration	Nickel concentration
Muscle	7.58b	1.73c
Gills	12.55a	3.45b
Liver	12.54a	9.45a
Kidney	9.13b	3.97b
Fish species:		
Catla catla	12.29a	4.67a
Labeo rohita	10.72a	4.65a
Cirrhina mrigala	8.34b	4.62a
Site of fish collection:		
Baloki headworks	11.13a	4.91a
Sidhnai barrage	9.77a	4.39b

Means with similar letters in a column are statistically similar at $P<0.05$

water at Degh nulla showed the mean highest hardness of 691.30±298.64 mg l^{-1} while the same was the lowest at Sukhrawa main drain (295.30 ± 46.09 mg l^{-1}). The mean for total hardness was the minimum as 144.50±38.60 mg l^{-1} at Syedwala while the same was maximum at Mari Pattan bridge having the mean hardness of 200.00±52.95 mg l^{-1} (Table 1).

The accumulation of metals, viz. lead and nickel was dependent positively and significantly on the water temperature (Table 2). Lead concentrations fluctuated significantly with change in dissolved oxygen contents of water (Table 2). 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 perish (Ajmal and Razi-ud-Din, 1988). Lead in water shows positive and highly significant regression on the total hardness of water (Table 2). Javed and Hayat (1999) reported positively significant dependence of lead on total hardness of water while studying the heavy metal contamination of river Ravi stretch from Shahdera to Baloki headworks.

Maximum lead was found in fish gills followed by liver, kidney and muscle. There were non-significant differences for the lead accumulation in gills and liver. Maximum nickel was found in fish liver followed by kidney, gills and muscle (Table 3). Robinsen and Oldewage (1997) studied the bio-accumulation of metals in fish organs and reported descending order of metals as: liver > skin > muscle. There were non-significant differences among three fish species for the nickel accumulation (Table 3). However, *Catla catla* showed non-significantly higher tendency for the accumulation of metals than *Labeo rohita*. *Cirrhina mrigala* had lower tendency than *Labeo rohita* and *Catla catla* for the accumulation of metals in its body. Fish procured from Baloki headworks have more metals in their body as compared to those from Sidhnai barrage (Table 3).

References

APHA. and AWWA., 1989. Standard Methods for the Examination of Water and Wastewater. 17th Edn., American Public Health Association, Washington DC., USA.

Ajmal, M. and Razi-ud-Din, 1988. Studies on the pollution of Hindon river and Kali Nadi (India). Ecology and Pollution of Indian Rivers. Ashish Publishing House, New Delhi, pp: 447.

Davies, G., 1988. Environmental impact assessment : A partial solution to water resource development issue in Pakistan. J. Can. Pak. Coop., 2: 55-62.

Javed, M. and S. Hayat, 1995. Effect of waste disposal on the water quality of river Ravi from Lahore to head Baloki, Pakistan. Proc. Pak. Congr. Zool., 15: 41-51.

Javed, M. and S. Hayat, 1996. Planktonic productivity of river water as a bio-indicator of freshwater contamination by metals. Proc. Pak. Congr. Zool., 16: 283-298.

Javed, M. and S. Hayat, 1998. Fish as a bio-indicator of freshwater contamination by metals. Pak. J. Agri. Sci., 35: 11-15.

Javed, M. and S. Hayat, 1999. Heavy metals toxicity of river Ravi aquatic ecosystem. Pak. J. Agri. Sci., 36: 1-9.

Mahmood, G., M. Javed and M. Hassan, 2000. Assessment of river Ravi for the physico-chemistry and heavy metals toxicity of water. Pak. J. Biol. Sci., 3: 1962-4.

Robinsen, J. and A.A. Oldewage, 1997. Chromium, copper, iron and manganese bio-accumulation in some organs and tissues of *Oreochromis mossambicus* from the lower Olifants river, inside the Kruger National Park. Water S.A., 23: 387-403.

Steel, R.G.D. and J.H. Torrie, 1986. Principles and Procedures of Statistics : A Biometrical Approach 2nd Ed., McGraw Hill Book Co. Inc., New York. pp: 633.