

HEAVY METAL LEVELS IN THREE MAJOR CARPS (*CATLA CATLA*, *LABEO ROHITA* AND *CIRRHINA MRIGALA*) FROM THE RIVER RAVI, PAKISTAN

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ABSTRACT

The present study was conducted to determine heavy metal (cadmium and chromium) concentrations in gills, kidneys, liver, skin, muscles and scales of three fish species (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) from three stations viz. Lahore Siphon (Up stream), Shahdera Bridge and Baloki Headworks (Down stream) in the river Ravi, Pakistan. Heavy metal concentrations varied significantly depending upon the type of fish tissues and locations. The concentrations of cadmium and chromium differed significantly ($p < 0.001$) among five fish organs and three sites and non-significantly between the three fish species. Fish liver appeared to have significantly higher tendency for the accumulation of cadmium and chromium (4.26 ± 1.57 and $6.23 \pm 1.14 \mu\text{gg}^{-1}$), while gills had minimum concentrations (1.10 ± 0.53 and $1.46 \pm 0.52 \mu\text{gg}^{-1}$) of these metals. Generally, *Catla catla* showed higher levels of metal concentrations than *Labeo rohita* and *Cirrhina mrigala*. Metal contamination was highest at Baloki Headworks, probably due to inclusion of more effluents from industrial and sewage water.

Key words: Major carps, cadmium, chromium, river Ravi.

INTRODUCTION

Metals are non-biodegradable and are considered as major environmental pollutants causing cytotoxic, mutagenic and carcinogenic effects in animals (More *et al.*, 2003). Aquatic organisms have the ability to accumulate heavy metals from various sources including sediments, soil erosion and runoff, air depositions of dust and aerosol, and discharges of waste water (Labonne *et al.*, 2001; Goodwin *et al.*, 2003). Therefore, accumulation of heavy metals in aquatic organisms can pose a long lasting effect on biogeochemical cycling in the ecosystem. Heavy metals can also adversely affect the growth rate in major carps (Hayat *et al.*, 2007).

Fish are often at the top of aquatic food chain and may concentrate large amounts of some metals from the water (Mansour and Sidky, 2002). Metal bioaccumulation is largely attributed to differences in uptake and depuration period for various metals in different fish species (Tawari-Fufeyin and Ekaye, 2007). Multiple factors including season, physical and chemical properties of water (Kargin, 1996) can play a significant role in metal accumulation in different fish tissues. The gills are directly in contact with water. Therefore, the concentration of metals in gills reflects their concentration in water where the fish lives, whereas the concentrations in liver represent storage of metals in the water (Romeo *et al.*, 1999).

The present study was planned to investigate heavy metals viz. cadmium and chromium eco-toxicity of the river system with particular reference to fish. Bio-

accumulation patterns of these metals in fish body organs was also investigated.

MATERIALS AND METHODS

Samples of five fish from each of the three species (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) were collected from three stations viz. Lahore Siphon (Up stream), Shahdera Bridge and Baloki Headworks (Down stream) on monthly basis for one year study period, from February, 2006 to January, 2007. Sample of fish organs viz. gills, kidneys, liver, skin, muscles and scales were digested, separately with concentrated nitric acid. For this purpose, each sample was taken in a 100 ml tube and 10 ml concentrated nitric acid was added. Samples in tubes were heated at 100, 150, 200 and 250°C on a hot plate for 0.5, 0.5, 0.5 and 1.5 hours, respectively. Finally, 2 ml of 1N nitric acid was added to the residue and the solution was evaporated again on a hot plate, continuing until sample was completely digested and become colourless. The sample was cooled and 10 ml of 1N nitric acid was added again. Digested sample was transferred to 500 ml volumetric flask to make the volume by using the double distilled water. The digested sample volume was filtered through 0.45 μm Millipore membrane filter (Type HV). The filtrate was analyzed for cadmium and chromium concentrations according to APHA (1998) on an Atomic Absorption Spectrophotometer. Analysis of variance and Duncan's multiple range test were applied to find out statistical differences among various parameters (Steel *et al.*, 1996).

RESULTS

Cadmium

Among various body organs, the liver of all the three fish species sampled from three sampling stations showed significantly higher ($p < 0.05$) concentration ($4.26 \pm 1.57 \mu\text{g g}^{-1}$) of cadmium, followed by that of scales, kidneys, skin, muscles and gills (Table 1). Gills appeared as an organ that had minimum cadmium concentration ($1.10 \pm 0.53 \mu\text{g g}^{-1}$). Among the three fish species, *Catla catla* showed higher ability to accumulate cadmium than that of *Labeo rohita* and *Cirrhina mrigala*, the difference was, however, non-significant (Table 1). Among the three sampling stations, the fish at Baloki Headworks showed the higher concentrations of cadmium in their bodies ($p < 0.05$) compared to those at Shahdera Bridge and Lahore Siphon, while the difference between the latter two stations was non-significant (Table 1).

Table 1: Mean values ($\mu\text{g g}^{-1}$, \pm SD) of cadmium and chromium in various body organs of three fish species collected from three stations

Factors	Cadmium	Chromium
Gills	1.10 ± 0.53^d	1.46 ± 0.52^d
Kidney	2.88 ± 1.25^b	4.43 ± 0.92^b
Liver	4.26 ± 1.57^a	6.23 ± 1.14^a
Skin	2.35 ± 1.12^c	3.48 ± 0.60^c
Muscle	1.20 ± 0.80^d	1.48 ± 0.51^d
Scales	3.34 ± 0.74^b	4.42 ± 0.70^b
Fish species		
<i>Catla catla</i>	2.58 ± 1.69^a	3.85 ± 2.21^a
<i>Labeo rohita</i>	2.50 ± 1.32^a	3.40 ± 1.53^a
<i>Cirrhina mrigala</i>	2.48 ± 1.39^a	3.50 ± 1.87^a
Sampling stations		
Lahore Siphon	2.38 ± 1.23^b	3.60 ± 1.48^a
Shahdera Bridge	2.35 ± 1.25^b	3.49 ± 1.99^a
Baloki Headworks	2.83 ± 1.32^a	3.86 ± 2.12^a

Mean values with different letters in a column for each group are significantly different from one another ($P < 0.05$).

Chromium

The highest concentration of chromium ($6.23 \pm 1.14 \mu\text{g g}^{-1}$) was observed in the liver of all the three fish species ($p < 0.05$). However, there was a non significant difference (4.43 ± 0.92 and $4.42 \pm 0.70 \mu\text{g g}^{-1}$) between kidneys and scales. The minimum concentration of chromium ($1.46 \pm 0.52 \mu\text{g g}^{-1}$) was found in the gills (Table 1). Among the three species, the maximum concentration of chromium ($3.85 \pm 2.21 \mu\text{g g}^{-1}$) was observed in *Catla catla*, followed by *Cirrhina mrigala* and *Labeo rohita*, the difference was non-significant. Among the three sampling stations, the fish at Baloki Headworks accumulated highest chromium concentration, while the lowest value was

recorded at Shahdera Bridge. However, there was non-significant difference among the sampling stations for the accumulation of chromium (Table 1).

DISCUSSION

Knowledge of heavy metal concentrations in fish is important with respect to nature of management and human consumption of fish. In the literature, heavy metal concentrations in the tissue of freshwater fish vary considerably among different studies (Javed and Hayat, 1998; Chattopadhyay *et al.*, 2002; Papagiannis *et al.*, 2004), possibly due to differences in metal concentrations and chemical characteristics of water from which fish were sampled, ecological needs, metabolism and feeding patterns of fish and also the season in which studies were carried out. In the river, fish are often at the top of the food chain and have the tendency to concentrate heavy metals from water (Mansour and Sidky, 2002). Therefore, bioaccumulation of metals in fish can be considered as an index of metal pollution in the aquatic bodies (Javed and Hayat, 1998; Tawari-Fufeyin and Ekaye, 2007; Karadede-Akin and Unlu, 2007) that could be a useful tool to study the biological role of metals present at higher concentrations in fish (Dural *et al.*, 2007).

In the present study, the fish at Baloki Headworks showed higher accumulation of cadmium in their bodies than other two stations, while the difference for the toxicity of chromium was statistically non-significant among three sampling stations. The fish (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) at Baloki Headworks accumulated significantly higher quantities of iron and nickel in their bodies than those captured from Sidhnai Barrage (Javed, 2005); however, the response of three fish species, for the accumulation of metals in their bodies did not vary significantly.

Metal accumulations in fish bodies appear as site specific, corresponding with the metallic toxicity of three aquatic components viz. water, plankton and sediments (Javed, 2003). Fish liver exhibited highest tendency to accumulate both the metals. The accumulation of both cadmium and chromium were the minimum in fish gills. Dural *et al.* (2007) and Ploetz *et al.* (2007) reported highest levels of cadmium, lead, copper, zinc and iron in the liver and gills of fish species viz. *Sparus aurata*, *Dicentrarchus labrax*, *Mugil cephalus* and *Scomberomorus cavalla*. Yilmaz *et al.* (2007) reported that in *Leuciscus cephalus* and *Lepornis gibbosus*, cadmium, cobalt and copper accumulations in the liver and gills were maximum, while these accumulations were least in the fish muscle. The higher levels of trace elements such as lead and chromium in liver relative to other tissues may be attributed to the affinity or strong coordination of metallothionein protein with these elements (Ikem *et al.*, 2003). According to Allen-Gill and Martynov

(1995), low levels of copper and zinc in fish muscles appear to be due to low levels of binding proteins in the muscles. Canli and Kalay (1998) determined the concentrations of cadmium and chromium in the gills, liver and muscles of *Cyprinus carpio*, *Barbus capito* and *Chondrostoma regium* caught at 5 stations on the Seyhan river system. Liver and gill tissues showed higher metal concentrations than muscles tissue. Thus, heavy metals when discharged into the river, enter the food chain and accumulate in the fish body as determined during this investigation.

Conclusions

The results of this study supply valuable information on the metal contents in fish from different sampling stations of the river Ravi. Fish liver exhibited highest tendency to accumulate both cadmium and chromium, while the accumulation of both the metals was the minimum in fish gills.

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