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# Adverse Effects of Metal Ions Pollution on Aquatic Biota and Seasonal Variations

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**Abstract:** A study was conducted to assess the level of heavy and trace metals in water and fish caught from Soan and Korang rivers located in the surrounding of Rawalpindi and Islamabad areas. Results indicates that the higher concentrations of metals like Cd, Cr, Cu Zn and Fe were present not only in river waters but also in muscles, livers and gills of various fish species surviving in these rivers. Therefore on basis of results obtained it is predicted that if present trend of metal pollution will continue then in future our drinking water will also get more than enough metals. The input concentrations of heavy and trace metals in the drinking water or in the food adversely effects on various organs of humans and animals.

**Key words:** Metal pollution, fish, drinking water

## INTRODUCTION

Environmental pollution is indeed a matter of great concern as it has now grown as global problem. Pollution of all types adversely affects on health of humans, animals and plants[1] .

The rate of water pollution was increased much more as compared to other fields of pollution due to the discharge of all sorts of obnoxious matter. The heavy and trace metals such as zinc, iron, manganese, cadmium, lead and nickel and their compounds has not pollute the riverine systems of Pakistan, but now has started affecting the fresh water fisheries[2].

The pollutants discharged in the aquatic environment, accumulated in fish and represented a potential risk, not only to the fish but also to humans population [3].

Toxic substances even present in minute quantity causes serious harmful effects on biotic and abiotic factors, so that, the organic and inorganic pollutants including metals when added to surface waters the proliferation of oxygen consumption by the (mainly bacteria and fungi) is encouraged. These decomposers reduce the oxygen supply that should be available to other members of aquatic communities. Thus fish and shellfish get deprived of aquatic oxygen. Furthermore if concentration of these pollutants i.e. metals increased beyond the permissible limits. That causes toxic effects on aquatic animals which could be transferred to human populations[4].

Among the most harmful metallic pollutants are mercury, lead, zinc, cadmium and copper. The continuous addition of heavy metals into the aquatic environment from various processes is a great threat to aquatic organisms[5].

Keeping in the view the above mentioned facts the present study was under takes with following aims and objectives is to assess the level of heavy and trace metals in river's water and visceral organ of fish and assess the variation in concentration of metals in various seasons.

## MATERIALS AND METHODS

**Collection of samples:** A total of 96 fish samples were collected from six different locations of Korang and Soan rivers. The procedure of sampling was adapted as suggested by Jaffar *et al.*[6] and further modified by Gulfraz and Ahmed[7].

**Preparation of samples:** The samples were washed with deionized water for removal of any type of extra coetaneous contaminations. The fish samples were dried in folds of filter papers, packed I polythene bags and finally stored at 4°C until dissected for metal analysis[8]. The internal organs (gills, liver and muscles), digested by adding concentrated acids ($H_2SO_4$ and $HNO_3$), which

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convert the solid material into liquid form[9]. This liquid was further diluted by adding deionized water and making the volume of the digested up to 50 mL[7]. Where as water samples were analyzed after the filtration.

**Analysis of fish and water samples:** The concentration level of metal ions (like cadmium, calcium, chromium, copper, iron, lead, magnesium, potassium, sodium and zinc ) in the water and fish samples, were analyzed with Atomic Absorption Spectrophotometer (Shimadzu AA-670). Data were analyzed statistically by Standard Deviation.

## RESULTS AND DISCUSSION

The level of Cadmium (Cd) is highest (0.927 mg $L^{-1}$) in liver of *Labeo calbaso* fish species. But maximum absorption takes place in gills of different fish species (i.e. 0.29, 0.64, 0.47 and 0.39 mg $L^{-1}$ respectively). Table 2 level of Cd of Sohan River are indicated. In the present study higher concentration of metal ions in various organs of fish were obtained, as reported by the Ogindo[10]. The concentration level of Cd (0.927 μg $g^{-1}$) found was higher than found by Zyadah and Chouikhi[11] in *Mullus barbatus*. Whereas it was observed that fish species has accumulated the metal ions in gills following similar ways as represented by Lieven and Ronny[12].

Lowest concentration of the Cd metal was found in the muscles of *Cyprinus carpio* (0.147 mg $g^{-1}$) from Korang River and is comparable with the results provided by Zyadeh and Chouikhi[11], where, as highest concentration of the Cd was found in *Labio calbaso* (0.789 mg $g^{-1}$) from Korang River and shows greater concentration than Cd value in the muscle of *Labio rohita* captured from Ravi River by Gulfraz and Tahira[8].

Liver is the accumulatory organ of higher animals including fish. All synthesis and storage of all the products takes place in the liver. Concentration level of Cd (0.927 μg $g^{-1}$) was found in *Labio calbaso* those were comparable with results reported by Zyadeh and Chouikhi[11].

Cd anions effect on respiration process, which enhances deposition of mucus and hinders in exchange of gases[13].

The level of (Copper) Cu (mg $L^{-1}$) is highest in gills (1.15 mg $L^{-1}$) in *Putinus* sp. (Table 1). While in Sohan river the concentration of Cu is higher than Korang (i.e 2.72 mg $L^{-1}$). Lieven and Ronny[12] and Dewani *et al.*[14] found the similar level of Cu in muscles of *Gobio gobio* and other samples of fish captured from Indus river. Cu present in muscles of fish showed similar results as reported by Yuka *et al.*[15] while working on the fish captured from the Yangminshan National park, Taiwan.

*Puntius sophore* from Korang Soan Junction showed the accumulations of Cu in similar tissues as accumulation level observed by Zyadah and Chouikhi[11]. Zn and Cu are known to weaken the fish through effects on ionic changes in tissues and blood.

Lowest concentration of Cr (0.085 μg $g^{-1}$) was found in muscles of *Cyprinus carpio* caught from Korang and Soan rivers.

Cr level is highest in gills (0.14-0.38 mg $L^{-1}$) (Table 1). While in Sohan river the maximum concentration is observed in muscles (i.e. 1.12 mg $L^{-1}$) (Table 2). The concentration of Cr was observed in gills of almost all the species of fish however this concentration was lower than found by the Nussey *et al.*[16] in *Labio umbratus* captured from wit bank dam.

Table 1 shows the level of Zinc, liver accumulates more Zn (3.28 mg $L^{-1}$) as compared to muscles. In Sohan river (Table 2) similar trend is observed (3.35 mg $L^{-1}$ in liver). It is an important element for human life. It is used as ingredients for manufacturing of pipes, tin cans and many other such utensils.

The fish species like the *Puntius sophore* from almost all sampling sites gave the similar accumulation of metal ions. The concentrations of Zn in various organs of fish species are given in Table 1-3. Similarly Zn level in gills was comparable with finding of Yuka *et al.*[15] in gills of *T. hankonesis. Cirrhinus mrigala* from Chattar Stream also accumulate similar concentrations of zinc as observed by the Lieven and Ronney[12] in gills of *Gobio gobio.* Yuka *et al.*[15] and Dewani *et al.*[14] reported the zinc accumulation in muscles of fish and similar was found in muscles of *Barilus vagra.*

The fish species like *Puntius sophore* captured from all sampling sites in present study showed similar Zn accumulation in their livers (Table 1-3)[10].

Zinc damages the gills tissues and muscle cause of fish coagulation in the gills and effect on the skin. This leads to respiratory stress and sluggishness of swimming movements[16].

Among species maximum absorption of metal ions takes place *Putinus sophore* sp. Three sampling sites (i.e. Korang Sohan Junction (KSJ), Sohan River (SR), Lai Sohan Junction(LSJ) are compared with reference to this particular species. Maximum concentration of these metal ions (Cd, Cu, Cr, Fe, Pb and Zn) is observed at LSJ (Table 3).

The levels of accumulation of lead in gills were more as compared to the liver and muscles (Table 1-3).

Table 1: Concentration level of metal ions (mg $L^{-1}$) in different fish species captured from Korang river before monsoon season 2004

| | | Cadmium | | | Copper | | | Chromium | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name of sp. | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills |
| *Cyprinus carpio* | 0.29±0.0120 | 0.191±0.018 | 0.275±0.016 | 0.319±0.015 | 0.107±0.011 | 0.221±0.003 | 0.503±0.005 | 0.123±0.006 | 0.41±0.009 | 1.493±0.007 |
| *Labeo calbaso* | 0.641±0.468 | 0.715±0.098 | 0.927±0.055 | 0.338±0.047 | 0.214±0.020 | 0.232±0.015 | 0.476±0.018 | 0.184±0.055 | 0.403±0.013 | 0.143±0.105 |
| *Labeo dero* | 0.472±0.013 | 0.214±0.003 | 0.445±0.030 | 0.305±0.004 | 0.123±0.001 | 0.233±0.003 | 0.409±0.008 | 0.159±0.037 | 0.387±0.014 | 0.382±0.082 |
| *Puntius sophore* | 0.397±0.003 | 0.201±0.001 | 0.375±0.001 | 0.384±0.002 | 0.116±0.002 | 0.297±0.002 | 1.156±0.003 | 0.437±0.577 | 0.126±0.003 | 0.328±0.003 |

| | | Iron | | | Lead | | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|
| Name of sp. | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills | Muscles | Livers |
| *Cyprinus carpio* | 0.29±0.0120 | 0.028±0.003 | 0.111±0.002 | 0.09±0.008 | 0.015±0.004 | 0.011±0.003 | 3.87±0.950 | 1.045±0.057 | 2.179±0.229 |
| *Labeo calbaso* | 0.641±0.468 | 0.113±0.007 | 0.215±0.018 | 0.088±0.003 | 0.009±0.002 | 0.016±0.005 | 3.39±2.836 | 2.274±2.433 | 2.656±0.981 |
| *Labeo dero* | 0.472±0.013 | 0.086±0.060 | 0.233±0.013 | 0.104±0.003 | 0.009±0.002 | 0.023±0.003 | 4.17±5.010 | 2.196±0.860 | 3.259±0.981 |
| *Puntius sophore* | 0.397±0.003 | 0.164±0.003 | 0.192±0.002 | 0.102±0.002 | 0.007±0.001 | 0.106±0.002 | 5.12±0.104 | 3.28±0.178 | 3.905±0.015 |

Table 2: Post monsoon mean and standard deviations of metal ions concentration (mg $L^{-1}$) in different fish species captured from Korang river

| | | Cadmium | | | Copper | | | Chromium | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name of sp. | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills |
| *Cyprinus carpio* | 0.258±0.014 | 0.147±0.016 | 0.240±0.017 | 0.291±0.008 | 0.074±0.012 | 0.241±0.124 | 0.471±0.005 | 0.092±0.005 | 0.401±0.016 | 1.444±0.023 |
| *Labeo calbaso* | 0.445±0.016 | 0.199±0.001 | 0.141±0.010 | 2.72±0.017 | 0.094±0.005 | 0.196±0.006 | 0.375±0.011 | 0.130±0.032 | 0.347±0.007 | 0.362±0.065 |
| *Labeo dero* | 0.929±0.048 | 0.789±0.145 | 0.881±0.035 | 0.314±0.036 | 0.175±0.012 | 0.162±0.054 | 0.437±0.03 | 0.154±0.058 | 0.365±0.0023 | 0.176±0.011 |
| *Puntius sophore* | 0.364±0.003 | 0.184±0.005 | 0.333±0.006 | 0.357±0.004 | 0.097±0.003 | 0.264±0.064 | 1.124±0.002 | 0.085±0.001 | 0.106±0.002 | 2.276±0.009 |

| | | Iron | | | Lead | | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|
| Name of sp. | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills | Muscles | Livers |
| *Cyprinus carpio* | 0.258±0.014 | 0.229±0.051 | 0.418±0.062 | 0.352±0.010 | 0.074±0.006 | 0.220±0.018 | 2.300±0.207 | 0.984±0.017 | 1.957±0.030 |
| *Labeo calbaso* | 0.445±0.016 | 0.095±0.008 | 0.199±0.003 | 0.277±0.008 | 0.095±0.002 | 0.223±0.003 | 3.989±0.491 | 2.551±0.375 | 2.935±0.236 |
| *Labeo dero* | 0.929±0.048 | 0.088±0.001 | 0.181±0.007 | 0.361±0.007 | 0.075±0.01 | 0.216±0.005 | 3.153±0.214 | 1.885±0.346 | 2.170±0.086 |
| *Puntius sophore* | 0.364±0.003 | 0.137±0.025 | 1.751±0.024 | 0.084±0.004 | 0.005±0.008 | 0.008±0.01 | 49.94±0.036 | 2.680±0.074 | 3.350±0.031 |

Table 3: Pre monsoon mean and standard deviations of metal ions concentration (mg $L^{-1}$) in Puntius sophore captured from different Sampling sites

| | | Cadmium | | | Copper | | | Chromium | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name of sp. | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills |
| KSJ | 0.411±0.010 | 0.219±0.002 | 0.393±0.007 | 0.401±0.002 | 0.127±0.001 | 0.23±0.005 | 1.417±0.407 | 0.104±0.020 | 0.226±0.061 | 3.301±0.952 |
| SR | 0.477±0.025 | 0.245±0.015 | 0.436±0.021 | 0.359±0.044 | 0.136±0.002 | 0.238±0.003 | 0.389±0.080 | 0.137±0.019 | 0.308±0.105 | 2.295±0.225 |
| LSJ | 0.512±0.016 | 0.239±0.028 | 0.437±0.039 | 0.813±0.017 | 0.252±0.058 | 0.591±0.066 | 0.434±0.050 | 0.142±0.008 | 0.27±0.017 | 3.245±1.411 |

| | | Iron | | | Lead | | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|
| Name of sp. | Gills | Muscles | Livers | Gills | Muscles | Livers | Gills | Muscles | Livers |
| KSJ | 0.411±0.010 | 0.156±0.055 | 2.423±0.279 | 0.121±0.002 | 0.013±0.001 | 0.016±0.002 | 4.77±0.144 | 3.345±0.348 | 3.63±0.479 |
| SR | 0.477±0.025 | 0.237±0.264 | 1.89±0.645 | 0.125±0.005 | 0.003±0.002 | 0.021±0.002 | 6.026±0.292 | 3.00±0.082 | 4.25±0.126 |
| LSJ | 0.512±0.016 | 2.344±0.146 | 2.429±0.331 | 0.144±0.014 | 0.009±0.004 | 0.027±0.006 | 5.94±0.017 | 3.389±0.656 | 4.85±0.133 |

KSJ: Korang Sohan Junction, SR: Sohan River, LSJ: Lai Sohan Junction

The lead is a toxic heavy metals and not required by any function of human and animal bodies. It is mostly release from vehicles and industrial smoke and through water and food accumulation into human body causing various health problems[17].

Therefore it is concluded that distribution of trace metal in fish are mostly specific to various species and variation takes place due to variation of organs of fish. Therefore fish species do not belongs to geographically different areas their trace metal contents are largely dependent on the mineral composition of habitat. Difference in the concentration of metal ions may possibly be due to difference in tendency of metals for formation of complexes with other molecules found in the cells of fish as well as the degree of the fish that is exposed to the metal.

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