# Profile of Metal Contents of Sewage Contaminated Canal Fishes

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**Summary**: The metal contents of ten fish species collected from sewage contaminated Fuleli canal and fresh water (River Indus) were analysed by flame atomic absorption spectrometry after wet acid digestion. The metal contents varied differently in fish communities found in the area under investigation. Iron contents in all the fishes analysed was highest within the range 5.33-40.2 ug/g. The other metals analysed were within the limits manganese 0.11-8.11 ug/g, zinc 2.1-16.2 ug/g, copper 0.38-1.77 ug/g, lead 0.38-2.3 ug/g, nickel 0.25-0.89 ug/g, cobalt upto 0.5 ug/g and cadmium was below the detection limits. Major metals sodium, potassium, calcium and magnesium contents in the fishes were also determined. The potasisum was in high cocnentration upto 4918 ug/g.

## Introduction

Fresh water fish is an important component for human consumption. Therefore pollution aspects of fresh water environment with reference to trace metals have been paid much attention due to their toxicity and accumulation in biota [1,2].

Heavy metals may enter into fish body by gills, digestive tract and body surface [3,4]. The gills are considered to be the main site for direct uptake of metal from water [4,5], whereas a minor role is played in uptake of heavy metals in fish by body surface. Food may also be an important source of heavy metal accumulation leading to biomagnification [6,7]. Fish can be an indicator of pollution index [8-10] and the adverse effects of this sort of pollution on human health by use of fish are well known and well documented. In Pakistan by increase in urbanization and industrialization in the country and direct disposal of waste water in natural water system may elevate the contents of trace metals in fresh water fish [11-13].

Fuleli canal takes off from left bank of river Indus and is designed for 386 $m^3$/S. It passes 25 km from the Hyderabad city with a population of about 1.5 million. It receives a major portion of city sewage and industrial effluents. Exact description about Fuleli canal and city sewage added is reported else were [14]. The water quality of river Indus and Fuleli canal including the concentration of metal ion in the water bodies are reported [14-22]. It is therefore the present work examines the metal contents in fishes collected from municipal sewage contaminated Fuleli canal and fresh water form river Indus.

## Results and Discussion

The variation in the concentration of metals in different fishes may be due biochemical or physiological difference, regardless of the relative position of the organism in aquatic food-Chain [23]. The difference in the cocnentration may be due to the difference in the tendency of the metals to the various molecular groups found within the cells of fish, as well as to the degree of the fish exposure to the metal as influenced by its metabolic character and its position in the food chain [23,3].

The results of analysis for Fe, Mn, Cu, Zn, Ni, Pb, Co & Cd in different fish species (Table-1) are summarized in Table 2. Three to eight samples of each species were analysed.

Iron followed a similar pattern as for water [22] and exhibited many-fold higher level in fish species than other metal ions examined. Averagely highest concentration of iron 33.73 ug/g was found in Eutropiicheythys Vacha (F6), while the lowest contents of iron 7.10 ug/ml was noted in Wallago attu (F1), with over all range for the species analysed 5.33-40.2 ug/g. The recorded levels of iron in the fish of Fuleli canal and river Indus at Kotri barrage were higher than the fresh water fishes found in Jehlum and Satlug rivers of Pakistan reported earlier [24].

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Table-1: Fish Communities Found in Fuleli Canal and River Indus N=Number of Fishes Analysed

| S.No. | Fish Community | Common Name | Weight(g) | Length(cm) | Location | n |
|---|---|---|---|---|---|---|
| F1. | Wallago attu | Lanchi | 1165-1379 | 45-56 | River Indus | 3 |
| F2. | Tenualosa illisha | Palla | 155-875 | 25-38 | River Indus | 5 |
| F3 | Rita rita | Khago | 314-623 | 28-34 | River Indus | 6 |
| F4 | Labeo calbasu | Kalabnas | 296-495 | 26-31 | Fuleli canal | 8 |
| F5 | Cirrhinus-marigala | Morakhi | 226-498 | 24-32 | Fuleli canal | 5 |
| F6 | Eutropiichythys vacha | Jhalee | 30-73 | 12-21 | Fuleli canal | 12 |
| F7 | Macrognathus aculeate | Bam (Snake like Spiny eell fish) | 149-179.6 | 39-43.5 | Fuleli canal | 3 |
| F8 | Labeodaro | Mori | 56-68 | 17.5-22 | Fuleli canal | 7 |
| F9 | Securicula gora | Sohni | 30-49 | 18-24 | Fuleli canal | 6 |
| F10 | Mystus cavasius | Mali (Cat fish) | 22-30 | 17-23 | Fuleli canal | 8 |

Table 2: Transition Metal Ions Present in Fish Muscles of Fuleli Canal and River Indus

| Metal Ion ug/g | FISH COMMUNITIES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 |
| Fe | 15.16 (13.-17.2) | 16.99 (16.1-20.2) | 17.9 (14.58-21.7) | 28.65 (21-37.2) | 13.10 (12.23-14.25) | 33.73 (29-40.2) | 9.1 (7.8-10.5) | 7.10 (5.33-8.9) | 9.90 (7.52-13.5) | 11.13 (8.6-12.7) |
| Mn | 0.42 (0.37-0.48) | 2.42 (1.5-3.47) | 7.31 (6.0-8.11) | 1.81 (1.2-2.65) | 1.47 (1.27-1.87) | 2.21 (1.67-2.75) | 0.68 (0.52-0.85) | 0.83 (0.38-0.53) | 1.1 (0.82-1.4) | 0.91 (0.48-1.3) |
| Cu | 0.92 (0.85-0.98) | 0.69 (0.59-0.81) | 0.66 (0.55-0.76) | 0.81 (0.63-0.95) | 0.65 (0.55-0.80) | 1.58 (1.37-1.77) | 0.50 (0.46-0.55) | 0.45 (0.38-0.53) | 0.69 (0.48-0.85) | 0.80 (0.66-0.95) |
| Zn | 3.34 (2.85-4.11) | 6.97 (6.1-7.85) | 4.66 (4.1-5.2) | 6.68 (5.74-7.87) | 4.82 (3.8-5.67) | 13.95 (11.27-16.2) | 4.2 (3.53-4.8) | 2.95 (2.1-3.8) | 3.76 (3.15-4.2) | 3.92 (3.3-4.6) |
| Ni | 0.76 (0.7-0.83) | 0.39 (0.31-0.44) | 0.31 (0.25-0.37) | 0.38 (0.29-0.46) | 0.48 (0.35-0.59) | 0.75 (0.61-0.89) | 0.42 (0.38-0.47) | 0.43 (0.29-0.53) | 0.53 (0.44-0.65) | 0.65 (0.53-0.8) |
| Pb | 0.61 (0.54-0.69) | 0.56 (0.48-0.70) | 0.46 (0.38-0.57) | 0.71 (0.60-0.81) | 0.60 (0.47-0.73) | 1.49 (0.85-1.61) | 0.81 (0.67-0.95) | 0.75 (0.51-0.95) | 1.27 (0.85-1.57) | 1.38 (0.85-2.3) |
| Co | 0.16 (0.14-0.18) | 0.24 (0.15-0.33) | 0.12 (0.08-0.14) | 0.22 (0.18-0.27) | 0.13 (0.10-0.15) | 0.41 (0.31-0.53) | 0.13 (0.08-0.19) | 0.12 (N.D-0.21) | 0.23 (0.13-0.32) | 0.21 (0.18-.24) |
| Cd | 0.05 (0.04-0.06) | N.D | Traces | Traces | Traces | N.D | 0.04 (0.03-0.05) | Traces | Traces | N.D |

Mean values; ( ) = Range valuesN.D = Not detected

This may reflect the importance of environmental conditions controlling the bio-accumulation of iron in fish species, owing to the observation of higher amounts of iron in the water and the sediments at river Indus at Kotri barrage and Fuleli canal [20-25].

Manganese made up its highest concentration (7.31 ug/g) in the muscles of Rita rita (F3) while Wallago attu (F1) showed the minimum presence of manganese (0.42 ug/g). The manganese level flucutated between 0.11 to 8.1 ug/g (Table II).

Zinc is an essential trace element that is presumably homostatically controlled [26]. Toxicity of zinc on fish increases synergistic with copper and nickel [27]. The toxicity of zinc also increases with decrease in dissolved oxygen. Zinc with high mean concentration was observed with a value of 13.95 ug/g in Eutropiichythys Vahca (F-6) like iron, while other fish species also contained significant concentration > 2 ug/g of zinc with over all concentration range within 2.1-16.2 ug/g. The observed concentration of zinc was next to iron and followed a similar trend as reported in fish species examined in Satluj and Jehlum rivers [24].

The copper concentration in all the fishes analysed (F1-F10) was observed in the range of 0.38-1.77 ug/g with maximum average again in Eutropiichythys Vacha (F6) as 1.58 ug/g. The lowest copper concentration of 0.45 ug/g was estimated in Labeo daro (F8).

The fishes analysed for lead contains indicated concentrations below 1 ug/g except Eutropiichythys vacha (F6), Securicula gora (F9) and Mystus Cavasius (F10). The average lead contents in F6, F9, F10 were 1.49, 1.27 and 1.38 ug/g respectively, owing to the occurance of these community in proximity, where lead batteries are washed and burnt, with high concentration of lead in water [20].

The nickel contributed 0.76 ug/g as the maximum average concentration in Wallago attu (F1), while the lowest average concentration of 0.31 ug/g was estimated in Rita rita (F3) with overall variation in the range 0.2 to 0.89 ug/g.

The cobalt concentrations in the fishes were observed below 0.25 ug/g except F-6, which

Table 3: Major Metal Ions Present in Fish Muscles of Fuleli Canal and River Indus

| Metal Ion ug/g | FISH COMMUNITIES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 |
| Na | 395.5 (364-427) | 258.5 (196-327) | 286 (257-320) | 418 (372-490) | 296.6 (270-327) | 540 (430-695) | 325 (280-370) | 215 (169-275) | 282 (222-329) | 329 (248-397) |
| K | 3785 (3527-4044) | 2560 (2395-2836) | 143.6 (107.6-187) | 784 (707-880) | 258 (245-317) | 4918.7 (4625-5102) | 121 (94-148) | 269 (177-350) | 784 (679-890) | 695 (588-778) |
| Ca | 9.61 (7.95-11.3) | 14.70 (13.8-17.3) | 26.20 (22-31) | 1.90 (1.41-2.6) | 1.98 (1.35-2.63) | 27.10 (23.2-31.6) | 2.43 (1.8-3.1) | 5.67 (2.82-8.7) | 8.83 (5.7-11.5) | 6.23 (3.5-8.81) |
| Mg | 4.35 (3.48-5.22) | 2.80 (2.2-3.75) | 1.90 (1.61-2.3) | 5.15 (4.13-5.7) | 4.38 (3.55-5.2) | 13.20 (10.5-15.22) | 5.70 (3.8-7.7) | 9.23 (5.5-12.8) | 12.10 (8.1-14.5) | 10.63 (7.6-12.8) |

Mean values
( ) = Range values (Lowest - Highest)

contained 0.41 ug/g cobalt. The over all variation was upto 0.53 ug/g.

The cadmium is reported as toxic for aquatic life but in present work cadmium was present only as trace and below the detection limits of FAAS. The results of major metal ions Na, K, Ca and Mg are summarized in Table 3. The average sodium contents in the fishes was higher than 200 ug/g with highest content of 540 ug/g present in Eutropiichythys Vacha (F6) and lowest of 215 ug/g in Labeo daro (F8). The over all variation of sodium contents was between 169-695 ug/g.

The potassium was the most dominant with the maximum average value of 4919 ug/g in F6, while the lowest of 121 ug/g in Macrognathus aculeata (F7). The potassium values in the fishes examined varied between 94-5102 ug/g. It did not show any correlation with its concentration in the water, because the potassium was observed lowest among the major metal ions [20]. may be because of selective bioaccumulation of metal by the fish species.

The calcium and magnesium concentrations in the fishes were observed lower than sodium and potassium. The calcium exhibited its maximum level 27.1 ug/g in F6 and the lowest contents of 1.98 ug/g in Labeo calbasu (F4) and Cirrhinus marigala (F5).

Similarly F6 also indicated maximum value of 13.2 ug/g magnesium and lowest contents of 2.0 ug/g was estimated in Rita rita (F3).

The simple mathematical ratio between the concentrations of metals in muscles: liver and Gills (M:L:G) was estimated. The ratio was highly variable over the range of the metal and fish species studied. Iron and manganese were higher in quantities in gill except F7. The liver is a significant organ in toxicological processes and is also detoxification centre [28]. The copper concentration was mostly higher in liver than much muscles except F1 and F3. The nickel contents was higher in the liver of F2 and F7. The nickel contents were observed higher in liver and gills than muscles. Zinc and lead concentrations were also higher in gills except F7. The higher concentrations of metal in gills may be due to uptake mechanism of metals from water by gills.

The results indicate that iron was the dominant element in fish muscles followed by the zinc. Among the major metals potassium was the dominant. The total metal concentration exhibited the following decreasing sequence:

Fe> Zn> Mn> Cu> Pb> Ni> Co> Cd; K> Na> Ca> Mg

The trends did not obey exactly a similar pattern as for relevant water. The present work therefore do not reflect the absolute correlation in concentration of the metal and environment. Therefore the levels of the metal ions in fish may not be the total indicator of the ambient pollution [29,30]. The biological impact of heavy metals may be based on the actual concentrations in the particular species.

## Experimental

The fish samples were collected from river Indus, upstream of Kotri barrage through the Fuleli canal upto Behar colony, the limits the Fuleli canal left the Hyderabad city during the years 96-97.

Ten different fish species were collected, three (F1-F3) from river Indus and seven from different locations from Fuleli canal (F4-F10) Table-1.

The fishes were sampled thrice from Fuleli canal and river Indus. The fishes were captured with a net of mesh size 2-4 cm. The fish communities collected were brought to the laboratory and were

identified. In all 63 fish samples were obtained and analysed. The fishes were weighed and their fork lengths were measured (Table-I). Samples of fish tissue were disected from muscles, liver and gills using stainless steel implements and frozen in sample tube (-20°C) till analysis.

Triplicate sub samples (5-50 g) were taken from the mass of fish tissue (muscle, liver and gills). The samples were placed separately in digestion flasks and were treated with 50 ml of hydrochloric acid (36%) and nitric acid (65%) (1:1). The contents were digested until most of the mass dissolved. The contents were then heated gently to near dryness. The residue was dissolved in 5 ml nitric acid (0.5 M) and was diluted to 25 ml with double distilled water. The solution was run on Varian Spectr AA-20 atomic absorption spectrophotometer equipped with standard burner head at the conditions recommended by the manufacturer. Copper, nickel, iron, cobalt, lead, manganate, cadmium and zinc were analysed using analytical line at 324.7, 232.0, 248.3, 240.7, 217.0, 279.5 and 213.9 nm respectively. The analysis was carried out in triplicate with integration time 3 sec. and delay time 3 sec. The amounts were evluated form the calibration graphs obtained form respective standards.

## Conclusions

The work reports major and minor metal contents in 10 fish species found at river Indus and Fuleli canal. The variation of a metal content among the species was large may be because of different mechanisms for bio-accumulation. However the average values for the metal contents for the fishes studied indicated potassium as highest and cadmium as the lowest.

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