

Concentration of the Heavy Metals in Muscle Tissue of the Carnivorous Fishes Obtained from Udera Sthan Dam (Bihar)

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Abstract: Concentration of different essential and non-essential heavy metals in water samples collected from Udera Sthan Dam was examined during present research work. The concentration of essential and non-essential heavy metals in muscle tissue of almost all five carnivorous fish species showed almost increasing trend from the month of July to September. Highest concentration of essential heavy metals remained in the muscle of *Wallago attu* as compared to other four carnivorous fish species examined during present study. The concentration of Arsenic was not detected during month of July and September in *Channa punctata* Mercury during month of July, August and September in *Channa punctata* and Nickel in *Clupisoma garua* muscle tissues. Highest concentration of Arsenic (2.123-3.906 µg/g) was detected in muscle of *Clupisoma garua* as compared to other carnivorous fish species. Highest concentration of Cadmium (1.032-1.087 µg/g) and Lead (9.802-11.623 µg/g) were detected in muscle of *Wallago attu* as compared to other carnivorous fish species examined during present research work. Highest concentration of Nickel was also observed in the muscle of this fish species (9.296-20.323 µg/g) as compared to other carnivorous fish species. But the concentration of Mercury was recorded highest in the muscle of *Clupisoma garua* (4.210-5.218 µg/g) as compared to other carnivorous fish species. Lowest concentration of Arsenic in muscle of *Channa punctata*, cadmium Lead and Mercury in muscle of *Mastacembelius armatus*, and Nickel in the muscle of *Channa punctata* were detected during present research work.

Keywords: Heavy Metals, Muscle Tissue, Carnivorous Fishes, Udera Sthan Dam

1. Introduction

Any metallic element can be termed as heavy metal which have density of 4 gm/cm³ or more or equal to five times the density of the water. Presence of heavy quantity of heavy metals in any water body leads to mortality of fishes. These metal come to human body also through food chain. The acute toxicity of heavy metals above permissible range attracted research scholar towards their detection in fish samples obtained from Udera Sthan Dam.

Zinc and copper are essential elements but lead is a nonessential element for fishes. The concentration of heavy metals in fish tissues differs in different species of fishes due to ecological needs and metabolism of respective fish species (Panda and Mahanta, 2023). Salinity and temperature also affect the process of bioaccumulation of heavy metals in fish tissues. Lead is the most toxic element for fishes. Lead comes to aquatic ecosystem through industrial waste and battery servicing units. Non-essential heavy metals pollution in water bodies cause distressing effects on fishes. Heavy metals remain highly persistent and bioaccumulate and biomagnify in fishes. Copper is a widely distributed natural element in rivers. Copper comes to rivers by natural weathering of soil. The dissolved form of copper remain very toxic to aquatic animals including fishes. But the organic lead compounds converts itself into inorganic lead quickly in water. There exists significant co-relation between concentration of heavy metals in water and fish tissues of any water body. (Sharma *et al.*, 2024).

Malik and Maurya (2014) conducted a study to determine heavy metal concentration in water, sediment and tissues of fish species from Kali River (India). They studied the effect

of different heavy metal pollution on Fish. They observed concentrations of all metals in the fish samples. Different heavy metals cause toxic effects on fishes in synergistic way. Essential heavy metals remain less toxic for fishes as compared to non-essential heavy metals. Rai and Tripathi (2009) stated that heavy metals remain as one of the major pollutants of aquatic ecosystem.

In above mentioned perspective, concentration of essential and non-essential heavy metals in muscle tissue of five carnivorous fish species obtained from Udera Stan Dam were analysed.

2. Materials and Method

Fish samples were collected with help of local fishermen. Fishermen captured fishes by use of gill net. The collected fish samples were kept in polythene bags and kept in Ice-box and transported to the laboratory for identification and biochemical analysis. The collected fishes were separated and identified in the basis of key identifying features with help of taxonomy key and standard literature of Talwar and Jhingran (1991) and Jayaram (1999) upto species level.

Fish samples were properly cleaned before dissection. Then dissection of fish was conducted on a clean working glass surface for taking out the muscle tissue selected species was isolated with the help of a clean knife. The obtained fish muscle was properly washed with distilled water then placed in sterilized boys and stored at- 20°C temperature in a freezer for further analysis of heavy metal concentration. Standard procedures were adopted for analysis of metal concentration in fish tissue.

Volume 15 Issue 2, February 2026

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1gm wet weight of muscle tissues of each fish species were dried and digested in a microwave digestion system in 1:1., HNO₃ and H₂O₂ at 130°C temperature. Then digested material was cooled and diluted with double distilled water and filtered with help of what man filter paper No.42. Filtered and homogenized sample was again diluted with distilled water before analysis for presence of heavy metals.

50 gram of fish muscle sample of each fish species were dried separately at 15°C temperature for 2 hours. The ash of dried muscle was obtained after ignition at 500°C temperature for 16 hours. Cooled ash was dissolved in 2 ml of Nitric acid, dried and again ignited at 500°C temperature for 1 hour. Then obtained residue material was dissolved in 1 N Hydrochloric acid. Distilled water was added in this solution to obtain desired volume. This sample was used for determination of Iron, Nickel, Copper, Zinc, Lead, Arsenic and Cadmium using atomic absorption spectrophotometer (AAS).

3. Result and Discussion

The data related to permissible limit of essential and non-essential heavy metals in fresh water fish muscle as prescribed by World Health Organisation is presented in table-1. Heavy metals concentration in muscle tissue of three carnivorous fish species such as *Channa punctata*, *Clupisoma garua* and *Mastacembelus armatus* observed during present research work are presented in table-2. Two non essential heavy metals such as Arsenic and Mercury were not detected in muscle of *Channa punctata* obtained during the months of July and August but during the month of September the concentration of Arsenic as 0.101 µg/g was detected in muscle of this fish species but mercury also remain absent. The concentration of essential heavy metals such as Copper, Iron and Zinc showed increasing trend during the months of July, August and September in muscle of *Channa punctata*. The highest concentration of Copper, Zinc and Iron remained as 46.880, 11.210 and 0.187 µg/g respectively during the month of September. The concentration of Iron was detected highest as compared to other essential and non-essential heavy metals in this species during all three months of observation such as July, August and September. Among non-essential heavy metals the concentration of lead remained highest in the muscle of *Channa punctata* during all three months of observation as compared to Cadmium and Mercury. The concentration of Cadmium, Lead and Nickel showed increasing trend during the months of July, August and September in the muscle of this fish species. The concentration of nickel remained lowest as compared to Lead and Cadmium in the muscle of this species during all three months of observation. The concentration of heavy metals in muscle of this fish species were observed in the sequence as Iron>Zinc>Lead>Cadmium> Copper> Nickel>Arsenic.

The data presented in table-2 also exhibits the concentration of different essential and non-essential heavy metals in the muscle of *Clupisoma garua* during three months of observation. The concentration of Nickel was not detected in

muscle tissue of this species during all three months of observation such as July, August and September. Among essential heavy metals the concentration of Iron, Zinc and Copper was observed as Iron>Zinc>copper. The concentration of all these three essential heavy metals in muscle of this fish species showed increasing trend from July to September. The maximum concentration of Iron, Zinc and Copper in the muscle tissue of this fish species was observed as 72.985, 18.240 and 0.610 µg/g respectively in the samples obtained in the month of September. Among non-essential heavy metals the concentration was observed as Mercury>Arsenic>Cadmium>Lead. The increasing trend of the concentration of these non-essential heavy metals was observed in the muscle of this fish species collected during July, August and September but the concentration of Lead was observed minimum in the fish samples obtained in the month of August.

Thus, it became evident that concentration of Iron, Zinc, Arsenic and Mercury remained higher in Muscle of *Clupisoma garua* as compared to *Channa punctata* but the concentrations of Copper, and Cadmium remained higher in the muscle of *Channa punctata* as compared to *Clupisoma garua*. Nickel was detected in muscle of *Channa punctata* but not detected in muscle of *Clupisoma garua* during all three months of observation.

The data related to concentration of essential and non-essential heavy metals in the muscle of *Mastacembelus armatus* observed during present research work is also presented in table- 2. The concentration of almost all essential and non-essential heavy metals in this fish species showed gradually increasing trend from the month of July to September except Lead. The concentration of Lead in muscle of this species was observed highest as 0.093 µg/g in the sample obtained in the month of July. The concentration of Lead was observed as 0.029 and 0.32 µg/g in the muscle of this fish species in the samples obtained in the month of August and September respectively. The highest concentration of essential heavy metals as 50.933, 5.129 and 1.398 µg/g respectively was observed in the samples of this fish species obtained during the month of September. The concentration of almost all observed non-essential heavy metals except Lead in muscle tissue of this fish species also showed increasing trend from the month of July to September. Among non-essential heavy metals, the Lead concentration in muscle tissue of this fish species remained as 0.093, 0.29 and 0.032 µg/g in the samples obtained in the month of July, August and September respectively.

After analysis of the data presented in table-2, it became evident that the concentration of Copper remained highest in muscle of *Mastacembelus armatus* as compared to *Channa punctata* and *Clupisoma garua* but the concentration of Iron remained lower in the muscle of *Mastacembelus armatus* as compared to *Clupisoma garua*. The concentration of Arsenic remained higher in muscle of *clupisoma garua* as compared to other two species.

Table 1: Permissible Levels of Heavy Metals in Fresh Water Fish Muscle (µg/gm)

Sl. No.	Heavy Metals	Permissible Limit according to WHO
1.	Copper (Cu)	30
2.	Iron (Fe)	100
3.	Zinc (Zn)	100
4.	Arsenic (As)	0.5
5.	Cadmium (Cd)	1.0
6.	Lead (Pb)	1.5
7.	Mercury (µg)	0.3-0.6
8.	Nickel (Ni)	5.0

Note: Mercury Concentration → In Non Predatory Fish = 0.3

→ In Predatory Fish = 0.6

Table 2: Heavy Metal Concentration in muscle of Carnivorous Fish Species (µg/g dry weight)

		Fish Species								
Sl. No.	Heavy Metals	<i>Channa punctata</i>			<i>Clupisoma garua</i>			<i>Mastacembelius armatus</i>		
		July	August	Sept.	July	August	Sept.	July	August	Sept.
1.	Copper (Cu)	0.387±0.010	0.625±0.20	0.930±0.187	0.495±0.018	0.532±0.021	0.610±0.040	1.185±0.101	1.210±0.085	1.398±0.089
2.	Iron (Fe)	32.353±5.105	38.520±5.890	46.880±6.119	40.863±7.162	59.332±10.113	72.985±9.303	40.681±6.119	49.989±8.033	50.933±8.966
3.	Zinc (Zn)	6.585±1.307	9.330±1.805	11.210±2.332	13.938±3.010	16.397±2.983	18.240±1.990	4.780±0.102	4.883±0.093	5.129±0.112
4.	Arsenic (As)	ND	ND	0.101±0.002	2.123±0.011	2.766±0.038	3.906±0.303	0.818±0.014	1.939±0.130	2.980±0.396
5.	Cadmium (Cd)	0.926±0.003	0.943±0.009	0.978±0.030	0.323±0.022	0.397±0.031	0.512±0.019	0.277±0.008	0.339±0.103	0.450±0.133
6.	Lead (Pb)	1.288±0.130	1.610±0.030	1.953±0.320	0.083±0.090	0.078±0.725	0.089±0.078	0.073±0.018	0.029±0.001	0.032±0.010
7.	Mercury (µg)	ND	ND	ND	4.210±0.823	4.739±0.633	5.218±0.326	0.088±0.012	0.094±0.014	0.176±0.020
8.	Nickel (Ni)	0.275±0.010	0.610±0.110	0.883±0.203	ND	ND	ND	0.410±0.105	0.632±0.180	0.905±0.093

n = 3, ± SD, ND= Not Detected

Table 3: Heavy Metal Concentration in muscle of Carnivorous Fish Species (µg/g dry weight)

		Fish Species					
Sl. No.	Heavy Metals	<i>Mystus tengra</i>			<i>Wallago attu</i>		
		July	August	Sept.	July	August	Sept.
1.	Copper (Cu)	3.193±0.908	3.279±0.190	4.388±0.813	5.307±0.012	8.391±0.011	10.572±0.020
2.	Iron (Fe)	72.122±10.011	75.828±9.885	76.940±11.092	79.031±14.029	80.923±11.117	81.690±13.193
3.	Zinc (Zn)	3.583±11.117	0.543±0.098	31.152±10.134	47.426±0.812	48.508±2.152	45.557±3.084
4.	Arsenic (As)	0.518±0.021	0.543±0.098	0.580±0.122	0.323±0.013	0.346±0.021	0.371±0.018
5.	Cadmium (Cd)	0.280±0.118	0.339±0.107	0.483±0.009	1.032±0.010	1.082±0.013	1.087±0.016
6.	Lead (Pb)	0.978±0.143	0.903±0.201	0.889±0.087	9.802±2.168	9.990±2.321	11.623±3.160
7.	Mercury (µg)	0.120±0.013	0.367±0.008	0.573±0.011	0.226±0.012	0.49±0.082	0.573±0.041
8.	Nickel (Ni)	1.399±0.010	1.609±0.235	1.810±0.280	09.296±11.023	12.113±7.118	20.323±6.983

n = 3, ± SD.

The data observed for heavy metal concentration in muscle tissue of two carnivorous fish species as *Mystus tengra* and *Wallago attu* is presented in table-3. The concentration of three essential heavy metals such as Copper, Iron and Zinc were observed higher in muscle of *Wallago attu* as compared to *Mystus tengra* in all the three months of observation such as July, August and September. However increasing trend of the concentration of essential heavy metals such as Copper and Iron were observed in muscle of both fish species the month of July to September. Among these three heavy metals the concentration of Iron remained highest followed by Zinc and the lowest concentration was observed for Copper. The highest concentration of Zinc as 48.508 µg/g was observed in the muscle of *Wallago attu* collected in the month of August and lowest in the month of September as 45.557 µg/g. The higher concentration of

Mercury and Arsenic were observed in the muscle of *Mystus tengra* as compared to *Wallago attu* during all the three months of observation. The concentration of Lead and Nickel were observed as much higher in the muscle of *Wallago attu* as compared to *Mystus tengra* during all the three months of observation. The concentration of cadmium was observed high in the muscle of *Wallago attu* as compared to *Mystus tengra* during all the three months of observation such as July, August and September.

It was concluded after the analysis of the data mentioned in table-3, that the concentration of Arsenic, Cadmium, mercury and Nickel shows increasing trend from July to September in the muscle of both fish species. But the concentration of Lead shows decreasing trend from July to September in the muscle of *Mystus tengra*.

Eyckmanas *et al.* (2011) pointed out that fishes exhibit poor growth, shorter life span and reduced fertility during chronic toxicity of copper. Lead toxicity remain responsible for histological alterations and reduction in body weight of fishes (Biswas and Ghosh, 2016). Behavioral changes takes place in *Cyprinus carpio* even during exposure of sub-lethal concentration of nickel (Al-Ghanim, 2011). Histological alterations was observed in *Channa punctata* due to arsenic exposure by Ahmad *et al.* (2013).

Iron, Copper and Zinc are essential metals in right concentrations. Excess concentrations of these essential metals also remain toxic and cause deleterious effects on fishes and ultimately on human health (Riaz and Naeem, 2024). Genotoxic effect was reported due to metal contamination in fishes (Mallick and Khudabuksh, 2003). Metal uptake from contaminated water and sediments may differ in relation to feeding habit of respective fish species. The bioaccumulation of heavy metals in fishes depends on age, developmental stages and other physiological factors as well as physico-chemical parameters of respective water body. Higher concentration of essential heavy metals leads to oxidative stress in fishes by formation of free radicals (Modak *et al.*, 1990). Increasing trend in concentration of heavy metals in fish muscle from July to September was observed during present study (Tables-2 and 3).

When concentration of any heavy metal remain more than concentration of respective heavy metal in water is termed as bioaccumulation. Absorbed heavy metals accumulates are excreted. Metals accumulated in different organs of fishes finally remain dangerous for fishes. Fishes remain as an important part of aquatic ecosystem for the assessment of environmentally harmful pollutant like heavy metals.

4. Conclusion

Essential heavy metal concentration in water of Udera Sthan Dam was observed in sequence as Cu>Fe>Zn. The concentration of non-essential heavy metals in water of this Dam was observed in sequence as Ni>As>Pb>Hg>Cd. Most of the essential and non-essential heavy metals was observed in decreasing order from the month of July to September. The concentration of Copper, Iron, Zinc, Mercury, Arsenic, Lead, Cadmium and Nickel in water samples remained below the permissible limits prescribed by WHO, BIS and CPCB. Thus, it became evident that the concentration of different essential and non-essential heavy metals in water of Udera Sthan Dam is not at dangerous level.

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