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Seasonal comparison of levels of cadmium chloride in fresh water fish *Catla catla* of Bilawali and Sirpur Lake

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Abstract

Fresh water bodies are facing serious type of pollution of heavy metal. Heavy metals are a metal of relatively high density, relative atomic weight or atomic number. Heavy metal are either essential nutrients (like cobalt, zinc) and other may be toxic (like cadmium, mercury, lead). Heavy metals cannot be easily removed by processes like oxidation, precipitation or other processes because they are stable compounds. For aquatic organisms and humans, Cadmium is a toxic non-essential heavy metal that is introduced to environment as a result of the weathering of soil/ rocks, from volcanic eruption /from various human activities involving mining and processing of ore, use of fertilizers and pesticides. Cadmium can affect biological functions in fish and cause severe histopathological, biological and physiological changes in various fish species. The three body parts of fish had been taken gills, muscle and liver because the heavy metal enter in body by three possible ways gills, skin and digestive tract in fish and then transported by blood to either a storage point such as bone, or to liver for transportation. The mean highest values of concentrations of heavy metal in dry tissues of all sampled fish species collected from Sirpur Lake and Bilawali Lake is pointed out in results. These levels might be due to anthropogenic inputs and industrial activity around the lake. The change in season may also contribute to differences in uptake of heavy metal. The purpose of this study is to check the tissue-specific heavy metal accumulation in the fresh water fish (*Catla catla*) in two different seasons.

Keywords: Fresh water bodies, heavy metals pollution, cadmium chloride, edible fish, catla catla, accumulation, instrumental analysis, AAS

1. Introduction

Aquatic community is adversely affected by heavy metal pollution particularly fresh water fishes. Different areas have different physical and chemical properties for natural waters. This is mainly due to differences in the area's climate, type of soil, geomorphology and geology^[1]. Metals are introduced in aquatic systems as a result of the weathering of soils /rocks, from volcanic eruptions, and from various human activities involving mining, processing or use of metals / substances that contain metal pollutants. Sources of pollutants may be of different types: when pollutants come from single, identifiable sources it is called point source. The second type is nonpoint sources, where source is often difficult to identify and pollutants come from dispersed sources. Most importantly the mining of metals produce contaminated drainage water, resulting in increased heavy metal concentrations in flowing and standing waters^[16].

Presence of heavy metals can affect the population depending upon different water bodies for their needs. These can also be transferred through food chain from lower trophic organism to higher trophic organisms. Consumption of aquatic food from these water bodies may cause toxic effect and can be hazardous to health^[9].

Metal solubility increases when the pH in water decreases, and the metal particles become more mobile. That is why metals are more toxic in soft waters. Metals are biodegradable in nature, they can be 'locked up' in bottom sediments, where they remain for many years.

The heavy metal which are commonly found in water bodies are cadmium, arsenic, chromium, nickel, mercury and lead. Cadmium (Atomic Number: 48 and Relative Atomic Weight: 112.41U) is a relatively rare, silvery grey metallic, soft solid (standard state). Cadmium enters water in form of, suspended sediments, smelting operations, sewage sludge, land application of sewage effluents, phosphate fertilizer, use and disposal of cadmium products and by waste dumping.

Cadmium are not required even in small amounts by any organism. Bioaccumulation of cadmium is higher as compared to other metals in animals because it is assimilated fatly and excreted slowly. Accumulation in the individual will be affected by ecological needs, age, sex, size, feeding habits, life cycle, life history and season of capture. In fish, the embryonic and larval stages are usually the most sensitive to pollutants.

The consumption of fish worldwide has increased speedily in recent years particularly with the awareness of its nutritional and therapeutic benefits. The presence of toxic heavy metals in fish can invalidate their beneficial effects.

2. Materials and Methods

2.1 Study Area

The present study was carried out in two main freshwater body sources of Indore city. The first one is Bilawali tank, situated 6 km away from Indore in the southwest direction at Khandwa road near Radha Swami satsang bhawan and the catchment area of tank is 117 hectare and water area is 69 hectare. The second one is Sirpur Talab, a small Lake located in the outskirts (Dhar Road) of about 6-8 kms away from the city of Indore.

2.2 Quality Assurance

All the reagents used were of analytical grade. Glass wares were soaked in 10% nitric acid for 24 hrs and rinsed with distilled water followed by 0.5% (w/v) KMNO₄ solution and finally with distilled water.

2.3 Fish Sampling

Ten fresh water fish *Catla catla* were caught with the help of local fishermen were sampled from two different selected water bodies of Indore in pre monsoon and post monsoon. Collected fish species brought to the laboratory. Where they were classified, weighed, with total length, and kept frozen at -20° C till further explication.

2.4 Preparation of fish tissues for heavy metal analysis

Collected fish were dissected within 12 hours of collection and their body tissues were removed, washed in distilled water and dried separately in oven at about 70⁰-80 °C. After oven drying dry weight of the tissue was measured. The tissues were powdered and stored separately by labelling with date, tissue name and sampling site name. Dry powders of fish tissues were digested in 10ml mixture of Nitric acid. After half hour stirring the samples were left whole night and digested till the clear white fumes appeared. When it cools, than in 50ml volumetric flask double glass distilled water was added after that solution was filtered by dint of what man filter paper. Likewise surface water was also processed.

2.5 Heavy metals analysis

Heavy metal concentrations in surface water and tissues of fish was carried out by using Atomic Absorption Spectrophotometer (AAS). Before each metal determination the AAS was calibrated for each metal using lower detection limit of AAS was 0.004mg/L Cd₂cl. To avoid possible contamination, all laboratory equipments were washed in 10% HNO₃ solution and rinsed by distilled water prior to use. Dry weight of each animal was used to calculate the metal concentration per unit body weight (µg/g). Results are expressed as mean ± standard deviation (SD). All results are presented on a dry weight basis as µg/gm for heavy metal concentration.

3. Results

In most cases, fish from metal-contaminated water are safe for human consumption due to low metal accumulation (except for mercury) in the muscle tissues.

Before conducting experiment Physico-chemical and heavy metal analysis of water was done by standard methods proposed by [2]. This is given below in (Table 1)

Table 1: Results of Physico-chemical parameters & heavy metal from selected sites

S. N.	Name of parameters	Bilawali Tank	Sirpur Lake
1	PH	7.92	8.95
2	Temperature	19.85 C	21.2 C
3	Total dissolve solids	308ppm	140ppm
4	BOD	less than 25 mg/lit	less than 25 mg/lit
5	Acidity	10.86mg/ lit	10.26mg/ lit
6	Alkalinity	165 mg/ lit	20.55 mg/ lit
7	suspended solid	2.5mg	2.9mg
8	Chlorides	130.68 mg/ lit	28.67mg/ lit
9	Cadmium	24.10ppm	33.18ppm

Table 2: Seasonal variations of heavy metals accumulation in *Catla catla* collected from Sirpur and Bilawali Lakes of Indore.

Parameters	Tissue type	Pre-Monson		Post-monsoon	
		Bilawali	Sirpur	Bilawali	Sirpur
Dry weight of tissues	Gills	139.08±62.19	53.76±24.04	95.20±42.5	155.22±64.69
	Muscles	95.42±42.57	145.22±64.64	230.91±95.42	196.24±87.76
	Liver	30.08±13.08	230.91±103.2	123.22±55.10	55.82±24.96
Metal concentration per unit body weight	Gills	6.43± 2.87	3.03± 1.35	2.20±0.98	1.98± 0.85
	Muscles	3.12± 1.39	2.76± 1.23	0.44± 0.19	0.10± 0.04
	Liver	0.70± 0.31	2.80± 1.25	121.21±0.5	0.30± 0.13
Chloride concentration per unit body weight(µg/g)	Gills	33.14± 14.82	41.5± 18.5	203.85±95.16	317.15± 141.8
	Muscles	12.94±5.78	42.9± 19.2	102.46±45.82	146.64± 65.58
	Liver	14.2± 6.37	51.5± 8.07	287.30±128.4	343.91±153.80

4. Discussion

The characteristics of the fish species studied revealed that *Catla catla* is herbivorous. There were variations in the concentrations of heavy metals in muscles, liver, and gills of the fish collected from both the lakes (Table 2). Result shows that fish species contained higher concentration of cadmium in gills and chloride in liver. The accumulation patterns obtained in this study were in the order of gills>liver>muscles.

4.1 Variations in Ability of Organs Accumulation of Metal

Results showed that the concentrations of the metals in the organs were in the order of gills >liver> muscles. Cd recorded higher concentration in gills.

Cadmium forms stable complexes with different compounds, due to affinity for multiple bonding. Once Cadmium is accumulated by body parts, it can not be excreted easily. Bioaccumulation of Cd in gills is because gills are pathways of metal ion exchange from water^[22, 7], and fastens diffusion of metals rapidly due to wide surface area^[15]. Hence, it is suggested that metals bio accumulated in gills are basically concentrated from water^[14]. Similar results of high Cd accumulations in gills were reported by^[12, 1, 3, 4]. Increased accumulation can increase the toxicity level and can lead to muscle degradation by protein depletion. Then, it can affect metabolic pathway including TCA cycle, glycolysis and gluconeogenesis leading to shortage of energy and slowing down conversion of intermediates to other building blocks thereby affecting glucose, cholesterol and protein metabolism. It affects the growth inhibits calcium uptake in gills and alters liver function. Exposure of cadmium decreased glycogen content and glucose uptake in white muscle of Nile tilapia which affect body weight gain^[21, 6]. Cd can enter into the body through food chain in organism but in fishes it can enters by gills and accumulates in body^[18]. Cadmium accumulates in the tissues of carp *Cyprinus carpio* highest concentration found in kidney than Liver and Gills^[26]. Bioaccumulation of Cd and Zn in freshwater fish's such as *Labeo rohita*, *Catla catla*, *Channa punctatus* and *Poecilia reticulata* after acute and sub-lethal exposure^[24, 20, 25]. Heavy metals bioaccumulation in gills and liver of *cyprinus carpio* in higher amount reported. In which order of deposition in gills and liver was Cd > Pb > Ni > Cr and Pb > Cd > Ni > Cr.^[29] Accumulation of metals in various organs of fish may cause structural lesions and functional disturbances^[13]. Lethal effects of Cd on silver carp *Hypophthalmichthys molitrix*, and sea ranching species, *Rutilus rutilus*^[5]. Harmful effect of cadmium chloride on *Ophiocephalus striatus* which targets kidney majorily and reduces protein level^[8, 9]. Physico chemical parameter have been analyzed in permissible range for fish growth and potable purpose to humans^[10]. Heavy metal concentration increases pollution load of water^[17]. Cadmium chloride alters the gonadal hormones in fish and also alters lipid content in various organs^[19, 27]. Histopathological changes in the intestine of *Channa* due to toxicity of Cd, it can alters the morphology of Gill and oxygen consumption in Indian flying barb^[23, 28].

4.2 Health Risk Assessment for Fish Consumption.

To assess public health risk fish consumption, metal concentrations in muscles of the fishes were compared with the Maximum Permissible Limits (MPL) for human consumption as set by various organizations. The mpl of heavy metal according to the WHO and FAO standards for cd is 0.05.

5. Conclusion

This study highlights the causes and consequences of heavy metals contamination in fish organs. There was a strong evidence of a correlation between heavy metals concentration in different fish tissue and those of the surface water of the water bodies in Indore. The levels of contamination by Cd in fish are of considerable interest because fish consumption is an important source of protein intake for the general population. Most of the Cd content in fish or other seafood is highly absorbable in CdCl₂ form.

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