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Bioaccumulation of Heavy Metals in Various Tissues of *Tilapia Mossambicus* Fish found in Gadhi River, Panvel, India

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ABSTRACT

This study investigates the bioaccumulation of heavy metals in the various tissues of *Tilapia Mosmbicus* fish found in Gadhi River, India. The bioaccumulation often results due to the constant vicinity of fish with the pollutants. Such contaminated fish acts as a pollution indicator water body and also poses life threat to the consumers. In the present study, fish samples are found to contain high concentration level of Pb, Cr, Fe and Zn. Especially muscles which are edible part of fish found to contain heavy load of Pb and Cr (10.5 ppm and 7.75 ppm respectively). Order of bioaccumulation in different organs found was liver > gill > skin > muscle. The results reveal that the water bodies are polluting rapidly and require regular biomonitoring.

Keywords: Bioaccumulation, Heavy Metals, Fish, Toxicity

1. INTRODUCTION

Pollution of aquatic ecosystem has become the matter of serious concern worldwide. Massive population, modernisation, industrialization, mining activities and domestic sewage all together are the possible sources of environmental toxicity. Pollutants in water bodies are absorbed by the marine organisms in various ways and get concentrated in their organs which account for their toxicity and also pose a direct threat to both aquatic biota and man [1].

Fishes are most often at the top of aquatic food chain and considered as rich source of nutrition, they are high in protein and a great source of omega-3 fatty acids, vitamins and can reduce the risk of various diseases. However, they have a tendency to accumulate large amount of heavy metals from the water and diet which eventually results into rise in concentration level in their body organ several times more than that of the water, sediment and food [2-4]. In fact, metal bioaccumulation is largely attributed to differences in uptake and depuration period for various metals in different fish species [5]. Also, biomagnification is very common as they grow in contaminated water [6]. The whole body including skin, gills, stomach, muscles, intestine, liver, brain, kidney and gonads of fish is prone to uptake and bioaccumulate but mainly liver, kidney and muscles shows high accumulation depending upon the exposure concentration and time [7-12]. Thus the fishes are not only indicator of the health of aquatic ecosystem but also causes potential health risk to human.

Metals such as zinc, iron, chromium and nickel are essential metals in traces amount since they play an important role in biological systems, Mercury cadmium and lead being highly toxic, even in trace amounts are non-essential metals [13]. However, the essential metals can also produce toxic effects, if metal intake is in excess [14]. In fact, any of these heavy metals pose danger to life if concentrate above the acceptable levels. Heavy metals have tendency to accumulate various tissues of fish. Consumption of contaminated fish further can pose threat to the life of predator fishes, birds as well as human.

Panvel, which was previously considered as a green belt of Navi Mumbai is one of the rapidly urbanizing coastal areas of Maharashtra, India. Gadhi is the main river flowing across it. It's vicinity to Mumbai, economical capital of India and proposed airport, industrial zone has attracted the people towards Panvel. Due to the development, the construction activities are extremely increased in this area. In addition to this,

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industrial activities, domestic sewage, waste water works are causing fatal damage to aquatic environment and ultimately to human.

The objective of this study is to evaluate *Tilapia Mossambica* fish which is commonly found and preferred as a food by the riparian villagers of Gadhi River flowing across the various villages nearby Panvel.

2. MATERIALS AND METHODS

2.1 Sampling Site

For present investigation Fish samples (*Tilapia Mossambica*) were collected from Gadhi River passing through Panvel. It lies between Latitude 19°0'.0"N Longitude 73°04'55"E.

2.2 Sample Collection

During sampling, fish samples and water samples were collected randomly from Gadhi River in the month of November of year 2016 and April, August of year 2017. The samples were carried into polythene bags to the laboratory where they stored into refrigerator at 4^0 C until prepared for analysis.

2.3 Sample Analysis

As intrinsic factors affects on the uptake of heavy metals, the physical characteristics of all samples were examined. The total length (cm) of each individual samples were measured. An electronic weight scale is used to weigh the individual mass of the fish. The weight is measured in gram (g). A condition factor index (K) was calculated to study the effect of physical characteristics on accumulation using the equation:

$K = 100W/L^3$

where, W = body weight in grams; L = body length in cm.

The frozen samples were thawed at room temperature and then dissected for analysis using stainless steel scalpels. The liver, gills, skins and muscles of the fish were dried in an oven at 40°C for two days until they reached a constant weight. The samples were then removed from the oven and allowed to cool. Each dried sample was ground using a porcelain mortar and pestle. A one gram dry weight of the powdered form of muscle and gill and skin were used for analysis. The samples were digested by adding mixture of conc. nitric acid and perchloric acid in 1:1 ratio. The solutions are heated to obtain a clear solution. The solution was then filtered and diluted to 25 mL with double distilled water. Concentrations of Zn, Fe, Co, Cr, Pb, Cd, Cr, Ni, Hg, Cd and As were then determined using an inductively coupled atomic emission spectroscopy (ARCOS from M/s. Spectro, Germany). All the glassware were washed in nitric acid for 15 min and rinsed with double distilled water before being used.

2.4 Statistical Analysis

Data obtained from the experiments were analyzed by using SPSS 11.5 software. The results were expressed as mean ± S.D. The results were evaluated using Student's t test. Values of $p < 0.05$ were considered statistically significant.

3. RESULTS AND DISCUSSION

Bioaccumulation of heavy metals in fish is considered as an indicator of aquatic pollution of water bodies. If the metals are present in fish body in high concentration may lead to deformities in the metabolism or sometimes mortality. Consumption of such fish may pose health risk to the humans. In the present study the concentration of heavy metals such as Iron (Fe), Zinc (Zn), Chromium (Cr), Cobalt (Co), Nickel (Ni), Cadmium (Cd), Lead (Pb) and Arsenic (As) in different organs like gills, skin, muscles of the samples of Tilapia fish were investigated.

3.1 Physical Characteristics of the Samples

Fish accumulates high level of pollutants if it constantly lives in polluted ecosystem. It means age factor or maturity of fish may influence the accumulation of heavy metals [15,16]. The average condition factor

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indicates the tilapia fish used for study are young. The physical characteristics of fish samples observed are given in table 1.

Species	N	Total length (cm)	Body weight (gm)	Average Fulton's Condition factor (K)	Feeding behaviour	Maturity level
Tilapia Mossambica	9	18 ± 1.201	89.44 ± 8.32	1.54 (1.42-1.66)	Omnivores	Young

3.2 Bio-accumulation Study of Fish Samples

Concentration level of various heavy metals found in the fish samples are as shown in Table 2. Data clearly shows that the considerable amount heavy metals are present in tilapia fish samples. This indicates that the aquatic environment as well as human activities contributing towards heavy metal contamination of marine organism thus causing harm to biota of aquatic bodies.

S.N.	Heavy Metal	Concentration in mg/Kg (Dry weight)				Maximum Prescribed Limit (mg/Kg) (FAO/WHO 1984, 1989)
		Liver	Gill	Skin	Muscle	
1.	Fe	3421.72±58.33	435.50±58.33	122.50±72.1	52.00±31.12	100
2.	Zn	139.22±58.33	87.75±20.94	91.35±28.01	31.25±34.5	50
3.	Cr	4.53±58.33	11.50±3.41	11.25±9.19	10.50±1.43	1
4.	Pb	11.23±58.33	9.25±1.38	7.75±3.45	7.75±1.66	1.5
5.	Ni	< 0.01	< 0.01	< 0.01	< 0.01	80
6.	Co	1.87±58.33	5.25±1.78	5.25±11.63	4.75±4.82	-
7.	As	< 0.01	< 0.01	< 0.01	< 0.01	1.4
8.	Hg	< 0.01	< 0.01	< 0.01	< 0.01	0.5
9.	Cd	< 0.01	< 0.01	< 0.01	< 0.01	0.3

Table 2: Bioaccumulation of heavy metals in various organs of *Tilapia Mossambicus* fish samples

The order of accumulation observed in different organ is Fe > Zn > Cr > Pb > Co which is in agreement with previous studies [17, 18].

The concentration of metals in fish body varies from organ to organ and is the product of equilibrium between the concentration of the metal in an environment and its rate of ingestion and excretion [19, 20]. In present study, order of accumulation observed in tissues of different organs is liver > Gill > Skin > Muscle. This difference in accumulation may be attributed to their proximity to the heavy metals in water. High concentration of metals in the liver are related to the detoxification processes take place in this organ [21]. Also metals bound with metallothioneins in liver [22]. Gills and skins are most exposed organs to heavy metals in water, thus the trend observed is obvious.

The samples were found to contain heavy concentration of Cr and Pb which is above the recommended level. Both Cr and Pb are listed as toxic heavy metals and have lethal and sub lethal damage to human health such as carcinogenic effects, respiratory disorders, brain damage, paralysis (lead palsy), anaemia and gastrointestinal symptoms. This result points out the pollution

Accumulation of Fe and Zn was found less even below prescribed limit in muscles which is edible part of fish (52.00±31.12 mg/Kg and 31.25±34.5 mg/Kg respectively). Whereas liver, gill and skin were found to have heavy uptake and accumulation of both the metals. Regular ingestion of such fish can cause accumulation and impairing of body metabolism in human.

The other metals such as Ni, As, Hg and Cd are found below detectable limit.

4. CONCLUSION

The contamination levels of heavy metals Pb, Cr, Fe and Zn were above the tolerance limit. These results are not only pollution indicator of river but also make the fishes unsafe for consumption. Consumption of such fish muscle may cause life threat to secondary and tertiary consumers. Thes study reveals that human activities such as industrial discharge domestic sewage, construction activities etc also responsible for contamination of water bodies and dependant flora and fauna. It is recommended that measures be put in place to continually biomonitor the river and create awareness.

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