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Bioaccumulation of some Heavy Metals in the selected five freshwater fish from Kollidam River, Tamilnadu, India

G. Ambedkar and M. Muniyan

Department of Zoology, Annnamalai University, Annamalai Nagar, Tamilnadu, India

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ABSTRACT

The Five fresh water fish species of Mystus vittatus, Tilapia mossambica Heteropneustus fossilis, Ctenopharyngodon idella and Saurida undosquamis were caught from Kollidam River, Nagai District, Tamilnadu between the periods of May 2010 to October 2010. The fish organs like liver, gill, Intestine, Kidney and Muscle from the five freshwater fish were carefully dissected for determination of heavy metals like copper, zinc, cadmium, lead and chromium. The levels of heavy metals were determined using ELICO's SL-176 double beam Atomic Absorption Spectrophotometer (AAS). The result shows the copper concentration were the maximum levels followed by Cd > Pb > Cr > Zn. The highest level of copper was observed in liver tissue of Saurida undosquamis. The lowest level of zinc was observed in muscle tissue of Saurida undosquamis. These levels of heavy metals accumulated by the five freshwater fish species might be due to the increase in agricultural influx waters and some anthropogenic activities.

Key words: Bioaccumulation, River, Freshwater Fish, Heavy metal.

INTRODUCTION

The pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms [1]. Among the environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems [2]. The accumulation of heavy metals in freshwater ecosystem has been a major concern. Heavy metals generally enter the aquatic environment through natural [atomospheric deposition, erosion of geological matrix] or anthropogenic activities [caused by industrial effluent, domestic sewage, mining and agriculture wastes [3, 4]. Fish being one of the main aquatic organisms in the food chain may often accumulate large amounts of certain metal above the levels in the aquatic environment [5]. Essentially fishes have been reported to assimilate these heavy metals through ingestion of suspended particulates, food materials and or by constants ion exchange process of dissolved metals across the lipophilic membranes such as the gills, absorption of dissolved metals on tissue and membrane surfaces [6, 7]. As a result metal bioaccumulation is a major route, thought which increased levels of the pollutants are transferred across food chain web

creating public health problems wherever man is involved in the food chain therefore, it is important to always determine the bio accumulation capacity for heavy metals by organisms especially the edible ones, in order to assess potential risk to human health [8].

The present work has been carried out to study the bioaccumulation of heavy metals [Cu, Cd, Pb, Cr and Zn] in the selected organs viz. Gills, intestine, liver, kidney and muscle of the freshwater edible fish *Mystus vittatus, Tilapia mossambica Heteropneustus fossilis, Ctenopharyngodon idella* and *Saurida undosquamis*, collected from the Kollidam River, Nagai District, Tamilnadu during May 2010 to October 2010.

MATERIALS AND METHODS

Description of the study area

The Kollidam River latitude [decimal degrees]: 11.3833 and longitude [decimal degrees]: 79.7667 are located 8 km away from the university campus, Annamalainagar, Chidambaram. A branch which flows away from the main stream, as in a delta or irrigation canal.

Collection of fish samples

Five freshwater fish, like *Mystus vittatus, Tilapia mossambica, Heteropneustus fossilis, Ctenopharyngodon idella* and *Saurida undosquamis* were caught by the local fishermen using gill net of various sizes. After identifying the fish species were ice-packed and transported to the laboratory and identified with the help of fishes of India [9].

Analysis of metal accumulation

The selected fish tissues were removed and put it in Petri dishes to dry at 120° until reaching a constant weight. The dried tissue was placed into digestion flask and ultra pure concentrated nitric acid and hydrogen peroxide [1: I V/V] [SD fine chemicals] were added. The digestion flask was heated to 130°C until all the material was dissolved [10]. Digest was diluted with double distilled water appropriately. The elements like Copper, Cadmium, Lead, Chromium and Zinc were assayed using ELICO's SL-176 Double Beam Atomic Absorption Spectrophotometer. The obtained results were analyzed for their statistical significance with ANOVA.

RESULTS AND DISCUSSION

The concentrations of heavy metals in selected organs viz Liver, Gill, Kidney, Intestine and Muscle of the five freshwater fish *Tilapia mossambica, Mystus vittatus, Heteropneustus fossilis, Ctenopharyngodon idella* and *Saurida undosquamis* were presented in Table 1 to 5. The distribution of heavy metals in selected organs analyzed were in the order of magnitude as liver > Gill > Kidney > Intestine > Muscle. The distribution of heavy metal in the all fish organs analyzed were in the order of Cu > Cd > Pb > Cr and Zn. Among the metal analyzed the highest concentration level of copper [2.46 $\pm$ 0.061 mg / kg / dry wt] was detected in the liver tissue of *Saurida undosquamis* [Table 4] while the lowest concentration of copper [0.26 $\pm$ 0.007] were found in the kidney tissue of *Heteropneusteus fossilis* [Table 5]. The highest levels of copper in the different tissues of selected fish species may be due to the presence of domestic waste and Agricultural industrial waste in the study area.

Table 1: Concentration of heavy metals in different organs of freshwater fish *Mystus vittatus* caught at Kollidam River from May 2010 to October 2010

Organs	mg/kg/dry weight				
	Cr	Cd	Cu	Pb	Zn
Gill	0.17 ± 0.007	0.16 ± 0.007	0.74 ± 0.015	0.68 ± 0.020	0.14 ± 0.006
Intestine	0.12 ± 0.003	0.6 ± 0.024	0.38 ± 0.009	0.14 ± 0.003	0.06 ± 0.002
Muscle	0.18 ± 0.005	0.66 ± 0.023	0.62 ± 0.019	0.14 ± 0.003	0.1 ± 0.004
Liver	0.04 ± 0.001	0.64 ± 0.020	0.42 ± 0.015	2.4 ± 0.084	0.2 ± 0.005
Kidney	0.08 ± 0.003	0.62 ± 0.016	0.68 ± 0.027	0.1 ± 0.002	0.3 ± 0.007

Values are expressed as mean ± S.D of six observation.

Table 2: Concentration of heavy metals in different organs of *Tilapia mossambica* caught at Kollidam River from May 2010 to October 2010

Organs	mg/kg/dry weight				
	Cr	Cd	Cu	Pb	Zn
Gill	0.47 ± 0.014	0.62 ± 0.024	2.04 ± 0.051	0.32 ± 0.008	0.5 ± 0.025
Kidney	0.40 ± 0.018	0.26 ± 0.006	0.38 ± 0.009	0.32 ± 0.008	0.4 ± 0.01
Muscle	0.64 ± 0.022	0.48 ± 0.014	1.46 ± 0.051	0.08 ± 0.002	0.3 ± 0.009
Intestine	0.14 ± 0.005	0.4 ± 0.01	1.64 ± 0.049	0.1 ± 0.003	0.6 ± 0.024
Liver	0.84 ± 0.021	0.74 ± 0.026	1.8 ± 0.054	0.2 ± 0.009	0.2 ± 0.007

Values are expressed as mean ± S.D of six observation.

Table 3: Concentration of heavy metals in different organs of *Ctenopharyngodon idella* caught at Kollidam River from May 2010 to October 2010

Organs	mg/kg/dry weight				
	Cr	Cd	Cu	Pb	Zn
Gill	0.08 ± 0.002	0.72 ± 0.025	0.74 ± 0.015	0.38 ± 0.011	0.9 ± 0.036
Intestine	0.14 ± 0.003	0.36 ± 0.018	0.38 ± 0.009	0.01 ± 0.007	0.4 ± 0.012
Muscle	0.04 ± 0.001	0.48 ± 0.021	0.62 ± 0.018	0.08 ± 0.002	0.6 ± 0.002
Liver	0.16 ± 0.005	0.62 ± 0.025	0.42 ± 0.014	2.2 ± 0.088	0.3 ± 0.007
Kidney	0.06 ± 0.001	0.56 ± 0.014	0.68 ± 0.027	0.30 ± 0.007	0.8 ± 0.028

Values are expressed as mean ± S.D of six observation.

Table 4: Concentration of heavy metals in different organs of *Saurida undosquamis* caught at Kollidam River from May 2010 to October 2010

Organs	mg/kg/dry weight				
	Cr	Cd	Cu	Pb	Zn
Gill	0.08 ± 0.002	0.58 ± 0.020	0.62 ± 0.022	0.24 ± 0.008	0.8 ± 0.008
Kidney	0.06 ± 0.001	0.64 ± 0.020	1.46 ± 0.066	0.28 ± 0.011	0.20 ± 0.036
Liver	0.12 ± 0.005	0.6 ± 0.015	2.46 ± 0.061	0.26 ± 0.006	0.60 ± 0.025
Intestine	0.018 ± 0.005	0.56 ± 0.022	0.38 ± 0.015	0.18 ± 0.005	0.77 ± 0.017
Muscle	0.1 ± 0.004	0.64 ± 0.020	1.4 ± 0.042	0.16 ± 0.003	1.2 ± 0.038

Values are expressed as mean ± S.D of six observation.

Table 5: Concentration of heavy metals in different organs of *Heteropneustus fossilis* caught at Kollidam River from May 2010 to October 2010

Organs	mg/kg/dry weight				
	Cr	Cd	Cu	Pb	Zn
Gill	0.16 ± 0.006	0.08 ± 0.002	0.30 ± 0.007	0.26 ± 0.006	0.2 ± 0.008
Muscle	0.06 ± 0.002	0.02 ± 0.005	0.6 ± 0.021	0.4 ± 0.005	0.6 ± 0.018
Liver	0.14 ± 0.012	0.16 ± 0.005	1.64 ± 0.066	0.14 ± 0.005	0.3 ± 0.006
Intestine	0.12 ± 0.003	0.2 ± 0.007	1.04 ± 0.046	0.18 ± 0.008	0.14 ± 0.006
Kidney	0.08 ± 0.002	0.1 ± 0.003	0.26 ± 0.007	0.22 ± 0.006	0.9 ± 0.031

Values are expressed as mean ± S.D of six observation.

The high concentration of cadmium [0.74 ± 0.026 mg / kg / dry wt] were detected in the liver tissues of *Tilapia mossambica* [Table 1] while the lowest concentration levels of cadmium [0.4 ± 0.01 mg / kg / dry wt] detected in the intestine tissues of *Tilapia mossambica* [Table 2]. The levels of Cd present in the selected organs of five freshwater fish may be due to industrial and agricultural operations. Cadmium is highly toxic Non – essential heavy metal and it does not have a role in biological process in living organisms. Thus even in low concentration, cadmium could be harmful to living organisms [11]. The high concentration of lead [2.4 ± 0.08 mg / kg / dry wt] found in the liver tissue of *Mystus vittatus* [Table 1] while in the lowest concentration of lead level [0.1 ± 0.003 mg/kg/dry wt) were detected in the intestine tissue of *Tilapia mossambica* [Table 2]. The high concentrations of chromium [0.64 ± 0.022 mg / kg / dry wt] were detected in the muscle tissue of *Tilapia mossambica* [Table 2]. The lowest level of chromium [0.1 ± 0.004 mg / kg / dry wt] in the kidney tissue of *Saurida undosquamis* [Table 4]. The concentration of chromium levels in the different organs of the freshwater fish and their presence could be attributed to waste water discharge from the agricultural related activities that take place high in the investigated area [12]. The high concentrations of Zinc [1.2 ± 0.038 mg / kg / dry wt] were detected in the muscle tissue of *Saurida undosquamis* [Table 4]. The lowest concentration level of Zinc [0.1 ± 0.004 mg / kg / dry wt] in the muscle tissues of *Mystus vittatus* [Table 1]. The concentration of Zinc in the selected organs of five different fish were due to the presence of the large number agricultural activities ultimately find its way into the ambient media through leaching.

CONCLUSION

The results of this study give valuable information on the heavy metals in the selected five freshwater fish from Kollidam River. *Saurida undosquamis* liver tissue exhibited maximum tendency to accumulate copper and minimum accumulation in of zinc in the muscle tissues of *Saurida undosquamis*. These concentrations were above the maximum levels recommended by regulatory agencies and, depending on daily intake by consumers, might represent a risk for human health.

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