DETERMINATION OF HEAVY METALS IN PRISTIPOMA FURCATUS AND ACANTHURUS STRIGOSUS FISH SPECIES COLLECTED FROM PULICAT LAKE, CHENNAI

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ABSTRACT

Concentrations of heavy metals namely Pb, Zn, Fe, Cu, Cd and Cr detected in tissue of two fish species (*Pristipoma furcatus* and *Acanthurus strigosus*) collected from Pulicat Lake, Chennai mixed with effluent from industries in and around north Chennai. The report shows significant results between the organs of *P. furcatus* and *A. strigosus* but also significant changes observed in all the metals determined in this study. The concentration of heavy metals in the fish tissue was medium to low. The organs of fish species measured high level of Lead and Iron. Trace metal levels in edible component tissue of fish were within the limit and good for consumption.

Keywords: Heavy Metals, *Pristipoma furcatus*, *Acanthurus strigosus*, Aquatic Ecosystem, Sediment.

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INTRODUCTION

Trace Heavy metals usually occur in different areas of earth's crust, soil, air, water and all organic matter and are typically distributed by anthropogenic activities such as bond generation, iron steel, steam control plants, glass factories, garbage waste, mining, smelters and foundries, channeling, ignition and traffic.¹⁻⁵ Natural events such as wind, soil erosion and volcanic activity can also spread around them.⁶⁻⁹ Due to its toxicity and persistence in the aquatic environment for several decades, heavy metal contamination in marine ecosystem has become a universal phenomenon.¹⁰ Seafoods like fish, crab and prawn are delicacies and are an essential part of everyday food. The trend of heavy metals to get stored in aquatic animals is of scientific attention in heavy metal geochemistry. The bioavailability of trace heavy metals is the important factor determining tissue metal levels in the marine biota.

Aquatic animals are sensitive to heavy metals when heavy metal levels in sediment and water reach considerable levels. Fishes are more often affected than other animals because of variations in the evolutionary strategies followed by various phyla.¹¹ In the food chain, metals stored in crustaceans could be biomagnified and ultimately affect people.

Pulicatis the typical salty water ecosystem, located 60 km north of Chennai (Fig.-1). Pulicat Lagoon is considered to be the second-largest brackish water body in India measuring 759 square kilometers. Pulicat has a length of about 60km, the width of 17.5km width360 km² and its depth (water column) varies between 1 and 10m. In the previous studies, heavy-metal contamination of sediments, air, fish, algae, mullet, oyster and crop plants in Lake Pulicat was identified as part of an observation and monitoring analysis of anthropogenic activities and pollution in the PulicatLake¹⁰⁻¹⁵. The aim of the research is to estimate heavy metal pollution rates in two of the common fish species (*Pristipomafurcatus* and *Acanthurusstrigosus*), which in the Pulicat lake appear to be of great commercial and ecological significance. Partially or improperly treated effluents from the industrial and domestic area from the

Ennore Creek and Buckingham Canal finally reach Pulicat Lake through its bare mouth of Bay of Bengal coastal waters.¹⁶⁻¹⁸

Fig.-1: Map Showing the Study Area

EXPERIMENTAL

Sampling

Twenty-five samples were collected from pulicat lake with the help of fishing professionals and transport to the lab without any contamination. Each fish species (*Pristipomafurcatus* and *Acanthurusstrigosus*) in two seasons (July pre-monsoon and January post-monsoon month). The fish for the test were collected from the mouth of shallow and 10km from the upstream of the mouth. At the point of collection, the fish samples were washed with fresh water, and segregated by species and transport to the laboratory and stored in frozen condition until its autopsy.

Preparation of Sample

Samples (Fish) are brought to room temperature, and with the help of sterile blades, the organs from fish were isolated. One gram of muscle was separated for examination on the dorsal surface of the fish, the entire liver and intestine, and two gills of each specimen. They were washed with double distilled water, dried in filter paper, measured, packed in bags of polyethylene, and held at -20°C until analysis.

Analytical Procedure

During the digestion, a microwave digester was used.¹¹ The (1gram) samples were digested with 5 ml of nitric acid (65 percent) and the samples were kept in temperature after complete digestion, the samples were cooled and 25ml of double distilled water was added. All treated specimens have been analyzed

three times using Atomic Absorption Spectrophotometer (Perkin Elmer, AA 700) for metals Cadmium, d, Chromium, Zinc, Lead and iron are represented as $\mu\text{g} / \text{g}$ tissue wet weight. The device was calibrated using standard chemical solutions prepared from commercially available chemical products (Merck, Germany). Analytical blanks were performed in the same manner as specimens and concentrations were calculated using generic formulations formulated in the same acid matrix. Analyzing standard reference material (MESS-1 and DORM-2, National Research Council, Canada) has tested the reliability of data. All reagents used during the research were of analytical grade and throughout the study deionized water was used. All plastics and glassware washed in nitric acid for 15 minutes and rinsed before use with deionized water.

RESULTS AND DISCUSSION

The heavy metal(copper, cadmium, chromium, zinc, lead and iron) concentrations heavy in muscles, gills, intestines, and liver of *P.furcatus* and *A.strigosus* collected during pre-monsoon in the month of July and postmonsoon in the month of January seasons are presented in Table-1. In species *Pristipoma*, the Average amount of Cu present is 0.0087 with the deviation of 1.4%, the average amount of Cu 0.0087, Cd 0.036, Cr 0.042, Zn 0.12, Pb 0.80 and Fe 0.46 (Table-2) with the deviation of Copper 1.4%, Cadmium 2.5%, Chromium 3%, Zinc 15%, Lead 72% and Iron 30% presents in the *Pristipomafurcatus* and for *Acanthurusstrigosus* the average of Cooper 0.002, Cadmium 0.037, Chromium 0.026, Zinc 0.11, Lead 0.65 and Iron 0.93 with the deviation of Copper 0.4%, Cadmium 1.5%, Copper 3.8%, Zinc 5.9%, Lead 25%, and Iron 14.95 from the mean observation value.

Table-1: Heavy Metal Concentration in Different Organs of Fishes During Pre-monsoon and Post-monsoon

Seasons	Species	Organ	Metal ($\mu\text{g/g}$)					Iron
			Copper	Cadmium	Chromium	Zinc	Lead	
Pre Monsoon	<i>Pristipoma furcatus</i>	Liver	BDL	0.245	0.205	BDL	7.21	2.775
		Gills	BDL	0.095	0.015	0.315	2.096	0.792
		Intestine	BDL	0.073	0.064	0.036	0.12	2.834
		Muscle	BDL	0.13	0.144	0.26	2.712	0.44
	<i>Acanthurus strigosus</i>	Liver	BDL	0.127	0.338	0.091	2.8	2.187
		Gills	BDL	0.17	0.182	0.446	3.032	2.016
		Intestine	BDL	0.118	0.035	0.306	1.93	14.305
		Muscle	BDL	0.13	BDL	0.228	1.754	0.496
Post Monsoon	<i>Pristipomafurcatus</i>	Liver	0.123	0.183	0.29	1.53	3.998	0.598
		Gills	0.038	0.037	0.026	0.222	0.996	1.755
		Intestine	BDL	0.042	0.049	0.208	1.206	0.995
		Muscle	0.047	0.043	0.077	0.159	1.064	0.661
	<i>Acanthurusstri-gosus</i>	Liver	BDL	0.085	0.03	0.687	2.005	1.163
		Gills	0.039	0.042	0.036	0.354	1.017	0.471
		Intestine	BDL	0.044	BDL	0.357	1.137	1.525
		Muscle	BDL	0.154	BDL	0.154	1.56	0.264

BDL: Below Detection Level

Table-2: Descriptive Measures of Heavy Metals and Organs

	Species	Test	Organ	Cu	Cd	Cr	Zn	Pb	Fe
N	48	48	48	48	48	48	48	48	48
Mean	1.5	1.5	2.5	0.0051	0.0357	0.0338	0.111	0.727	0.693
SD	0.5052	0.505	1.13	0.0108	0.0205	0.0348	0.117	0.543	1.097
			Species	N	Mean	Std. Deviation	Std. Error Mean		
	Cu		<i>Pristipoma</i>	24	0.00867	0.01396	0.00285		
			<i>Acanthurus</i>	24	0.00163	0.00443	0.0009		
	Cd		<i>Pristipoma</i>	24	0.03533	0.02469	0.00504		

		Acanthurus	24	0.03625	0.01584	0.00323		
	Cr	<i>Pristipoma</i>	24	0.04188	0.02935	0.00599		
		Acanthurus	24	0.02588	0.0386	0.00788		
	Zn	<i>Pristipoma</i>	24	0.11375	0.15681	0.03201		
		Acanthurus	24	0.10929	0.05917	0.01208		
	Pb	<i>Pristipoma</i>	24	0.80842	0.7255	0.14809		
		Acanthurus	24	0.64679	0.2512	0.05128		
	Fe	<i>Pristipoma</i>	24	0.45167	0.31109	0.0635		
		Acanthurus	24	0.93446	1.49821	0.30582		

Table-3: Correlation of Species and Metals

	Cu	Cd	Cr	Zn	Pb	Fe	Species
Cu	1	0.034	0.312*	0.754**	0.096	-0.193	-0.328*
Cd		1	0.540**	0.179	0.837**	0.091	0.023
Cr			1	0.295*	0.629**	-0.088	-0.232
Zn				1	0.173	-0.105	-0.019
Pb					1	0.033	-0.15
Fe						1	0.222
Species							1

The relationship between the Species and Metals Presented in the species of variety are shown in Table-3. There is a less degree of a positive association between species and Cd and Fe and there is a less degree of a negative association between species and Cu, Cr, Pb & Zn. There is a significant difference between Cu, Cr, and Zn, Cd with Cr and Pb, Cr with Zn and Pb. The relationship between the organs and Metals Presented in the species of variety is shown in Table-4. There is a less degree of a positive association between organs and Fe and there is a less degree of a negative association between organs and Cu, Cd, Cr, Zn & Pb. There is a significant difference between Cr, Zn and Pb.

Table-4: Correlation of Organs and Metals

	Organ	Cu	Cd	Cr	Zn	Pb	Fe
Organ	1						
Cu	-0.265	1					
Cd	-0.283	0.034	1				
Cr	-0.586**	0.312*	0.540**	1			
Zn	-0.398**	0.754**	0.179	0.295*	1		
Pb	-0.517**	0.096	0.837**	0.629**	0.173	1	
Fe	0.001	-0.193	0.091	-0.088	-0.105	0.033	1

The present study results of heavy metals absorption examined during pre-monsoon period in many tissues of *P. furcatus* the order appears to be as follows: intestine Fe > Pb > Zn > Cd > Cr > Cu; liver Pb > Fe > Cd > Cr > Zn > Cu; muscle Pb > Fe > Zn > Cr > Cd > Cu and gill Pb > Fe > Zn > Cd > Cr > Cu respectively as shown in the Fig.-2. The post monsoon the concentrations of metals in the intestine, liver, muscle and gill of *P. furcatus* the following order intestine Fe > Pb > Cr > Cd > Zn > Cu; liver Pb > Zn > Fe > Cr > Cd > Cu; muscle Pb > Fe > Zn > Cr > Cd > Cu and Fe > Pb > Zn > Cu > Cd > Cr respectively (Fig.-3). The mean concentrations of Cd, Zn, Pb Cr, Cu and Fe in *P. furcatus* the following order is sequence during pre-monsoon and post-monsoon Pb > Fe > Zn > Cd > Cr > Cu (Fig.-4). The

following two metals Fe and Pb showing the higher values of Liver, Gills, Intestine and Muscle and the order is given as Liver > Muscle > Intestine > Gills during pre-monsoon and the sequence is shown as Liver > Gills > Muscle > Intestine in the post-monsoon.

The absorption of heavy metals analysed during pre-monsoon period in various organs of *A. strigosus* the sequence seems to be as follows: intestine, Fe > Pb > Zn > Cd > Cr > Cu; liver, Pb > Fe > Cr > Cd > Zn > Cu; muscle Pb > Fe > Zn > Cd > Cr > Cu and gill Pb > Fe > Zn > Cd > Cr > Cu respectively as given in the Fig.-5. During the post monsoon the concentrations of heavy metals in the intestine, liver, muscle and gill of *A. strigosus* the following sequence Pb > Fe > Zn > Cd > Cr > Cu; Pb > Fe > Zn > Cr > Cd > Cu; Pb > Fe > Zn > Cd > Cr > Cu and Pb > Fe > Zn > Cr > Cd > Cu respectively as given in the Fig.-6.

Fig.-2: Concentrations of Heavy Metals in *P. furcatus* in Pre-monsoon

Fig.-3: Concentrations of Heavy Metals in *P. furcatus* in Post-monsoon

Fig.-4: Differences Between Pre and Post-monsoon in *P. furcatus*

Fig.-5: Concentrations of Heavy Metals in *Acanthurus strigosus* in Pre-monsoon

Fig.-6: Concentrations of Heavy Metals in *Acanthurus strigosus* in Post-monsoon

Fig.-7: Differences Between Pre and Post-monsoon in *Acanthurus strigosus*

The average concentrations of Cd, Zn, Pb Cr, Cu and Fe in *A. strigosus* during pre-monsoon seasons and post monsoon seasons of the following sequence Fe> Pb> Zn> Cr> Cd > Cu as given in the Fig.-7. The metals Pb and Fe which shows the higher concentrations in the part of Liver, Intestine, Muscle, Gills and the order is given as Intestine > Gills > Liver> Muscle during the pre-monsoon and in the post monsoon the sequence is shown as Liver> Muscle> Intestine >Gills.

Overall, the highly accumulated metals were found to be Pb and Fe, and in both fish, Cu was the less accumulated (Table-1) metal. The results are similar to earlier studies, which show high concentrations of Pb and Fe in shrimp, fish, mullet, oyster and *Ulva lactuca* from Pulicat Lake.¹⁰⁻¹⁵ The disparity in heavy metal concentrations attributed to the metabolic rate, exposure movement, metal movement, bioavailability and chelator species present in the Pulicat Lake sediment and water.^{19,20} Furthermore, environmental factors such as pH, temperature, salinity, organic carbon, organic matter and ecosystem nutrients influence metal bioaccumulation and bioavailability.²¹

CONCLUSION

The present study provides evidence on the assembling of Pb, Fe, Zn, Cd, Cr and Cu from fish species (*P. Furcatus* and *A. strigosus*) in Pulicat lake. Though the concentrations of heavy metals in an eatable portion of fishes remained below the threshold limit recommended by Food and Agriculture Organization of the United Nations (1983), this study report and the earlier study clearly indicate the biomagnification of Pb, Fe and other metals in the aquatic biota of Lake Pulicat.

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[RJC-5474/2019]