BIOACCUMILATION OF HEAVY METALS IN FISH *LIZA PARSIA* (Hamilton, 1822), FROM KAYAMKULAM ESTUARY

ABSTRACT

Accumulation of As, Cd, Cu, Pb and Hg in water, gills, liver and muscles of fish *Liza parsia* were analyzed from the four different sites along the Kayamkulam Backwater. The results showed that the highest concentration of As was found in liver tissues followed by gills. Gill tissues of the fish had a higher accumulation of Cu followed by liver and muscles. Higher accumulation of cadmium was observed in gills followed by liver tissue. Pb accumulation was found to be higher in liver as well as in gills followed by muscles. Accumulations of heavy metals in fish organs showed a seasonal fluctuation. The concentration of the detected metals was highest during warmer months, while the lowest values were observed during colder months. The organ specific comparison of heavy metals level indicated that the highest concentration was found in liver tissues. The lowest concentration was detected in muscle because muscle is not an active tissue in the accumulation of heavy metals. Pearson correlation matrix analysis revealed that there was a significant relationship between the accumulation of heavy metals in water and tissues of the fish sample.

KEY WORDS

Bioaccumulation, *Liza parsia,* Kayamkulam estuary, Metallothionine, Pearson Correlation matrix.

INTRODUCTION

"Heavy metal are among the most usual pollutants in aquatic ecosystems and may have its sources from natural and anthropogenic origins, such as industrial, agricultural and domestic loads" (Hang et al. 2009, Ramos e Silva et al. 2006, Davutluoglu et al. 2011). "The Accumulation of metals is generally found to be species specific and may be related to their feeding habits and the bioconcentration capacity" (Friba et al.,2009;Abu Hilal et al.,2008;Huang.,2003). "The efficiency of fishes to metal uptake from contaminated water and food may differ in relation to ecological needs , metabolism and the contamination gradients of water , food and sediment ,as well as salinity and temperature" (Pagenkopf 1983). "The correlations between the different metals may result from the similar accumulation behavior of the metals in the fishes and their interactions" (Rejomon et al.,2010).

"Fish concentrate heavy metals directly because of the close relation with the aquatic environment and also because fishes have to inhale oxygen from the aquatic medium by flowing large amount of water over their gills. Fishes are dominant inhibitors of aquatic environment, are considered as indicators for heavy metal pollution" (Srivastav et al., 2013). "Studies on heavy metal accumulation in water and fish is vital to determine the current status of water contamination with heavy metal and threats to human health from heavy metal pollution in estuary. Kayamkulam estuary is an open estuary plays an important role in the life of many people in the region, most important source of commercial fishery and serves for recreation purpose. It is being degraded by human activites such as agricultural practices, deforestation, industrialization and the discharge of domestic sewage". (Abayneh Ataro et al.,2003). The study was conducted on the edible tissues of fish species , which are mostly distributed in the estuary. The analysis of heavy metals in water provides two most important sets of information. The first is the concentration of heavy metals in Fish which may be harmful to human health and another was the contamination status of water with heavy metals.

MATERIALS AND METHODS

STUDY AREA

Kayamkulam Kayal lies between latitudes 9°2'N and 9°16'N and longitudes 76°25'E and 76°32'E. Kayamkulam , it has an outlet to the Arabian sea at Kayamkulam barrage(fig 1). Four sites were selected for the study, which equally distributed between 10 km distance among site.

SAMPLE PREPARATION

Water and fish samples were collected for the study at first week of each month during the period August 2022 - July 2023 from four sites.Medium sized fishes were collected by the help of local fisherman. Heavy metals were determined after digesting the sample solution . The content of heavy metal is estimated using Atomic Absorption Spectrophotometer ((Perkin Elmer) .

STATISTICAL ANALYSIS

Parametric analysis of variance (ANOVA) was carried out to test for significant differences of the concentration of heavy metals was estimated. If significant value was obtained ($P<0.05$), Post Hoc Multiple Comparison Test was used to determine the sites of Significant differences using the computer SPSS 20 windows application. Data are presented as mean, standard deviation minimum and maximum of fish for each study sites. Sampling sites, metal type and tissue specific differences were statistically tested by analysis of variance (ANOVA).Mean values were compared by Tukey's test and $p<0.05$ was considered as statistically significant (Zar.1996). The heavy metal data were further subjected to Pearson correlation analysis using SPPS statistical software, version 20 to evaluate the significant relationship between physicochemical parameters and heavy metals in water samples.

RESULT

The results of the analysis showed that the concentration of As, Cd and Cu in water among the four sites .(table.1). In *Liza parsia* , all the heavy metals showed significant variation among the three tissues(table.2). Significant was observed at the $P>0.01$ and $P>0.05$ level. Accumilation of As in water showed strong positive correlation with all the tissues of fish(table 3), while the remaining metal showed strong relation with each of the fish tissue respectively (table 4,5 and 6).

DISCUSSION

“Adulteration of the aquatic environment by heavy metals is a worldwide problem because these metals are persistent, and majority of them have harmful effects on living organisms when they exceed a certain concentration” (Chakraborty et al.,2009). The presence of heavy metals observed in fish in this study was generally low when compared to the chronic reference values suggested by WHO (1985) and USEPA (1986). “Heavy metals naturally exist in the environment, but excessive application in different industries for several purposes has significantly altered the ecological system by the excessive discharge of these metals into the soil and aquatic systems”(Sarkar et al.,2022) . “Several authors observed that fish surviving at highly polluted areas accumulate higher levels of heavy metals than those surviving in less polluted areas of the same lake” (Bahnasawy,2011). *Liza parsia* collected from Site4(Choolatheruvu) showed the higher accumulation of metals in their tissues followed by Site1(Ayiramthengu).Comparatively lower level of accumulation of heavy metals in the tissues of *Liza parsia* collected from Site2 and Site3. Arsenic is a toxic heavy metal, even at a low concentration of arsenic can result the death of an aquatic organisms. The highest concentration of arsenic was found in liver tissues followed by gills. Muscle retains comparatively lower level of arsenic accumulation. Ashraf, et al.(2012) observed the total concentration of arsenic in fish samples taken from mining ponds are (ranged between a minimum of 0.0025 to a maximum of 0.83 mg/kg) higher than that of the accumulation of arsenic content in this study.

During the present study, gill tissues of the fish showed higher accumulation of Cu followed by liver and muscles. According to Barbara Jezierska and Malgorzata Witeska (2006) copper has a distinct affinity for the liver of fish. Razeena Karim et al.,2015 also reported that the liver tissue of *Liza parsia* from Ashtamudi lake and fishes from Kanyakumari district were found to be observed that a higher concentration of Cu, this may be due to the influence of domestic waste into the aquatic ecosystem.

Higher accumulation of cadmium was observed in the gills followed by liver tissue, similar findings were observed by Bahnasawy et al.,2011,who reported that Gill tissues had the highest concentration of Zn,followed by Cu, Pb , and Cd. Higher temperatures promote accumulation of cadmium especially in the most burdened organs: kidneys and liver (Yang and Chen,1996). The highest concentration of these metals in gill tissues may be due to the fact that fish gills play an important role in metal uptake from the environment.

"In the present study, the Pb accumulation was found to be higher in both liver and gills followed by muscles. Many researchers have been conducted study across the world is agreed with the findings of higher concentration of heavy metals in the liver tissue" (Yousuf et al., 2000; Safahieh et al.,2011).

"Accumulations of heavy metals in fish organs shows seasonal fluctuation. The concentration of the detected metals were highest during the summer, while the lowest values were observed during winter. These seasonal changes were generally consistent with fluctuation in the surrounding environment resulting from the increase or decrease of drainage water entering the lake" (Abdel-Baky et al.,1998). "*Liza parsia* is a detritus feeder and feed either by sucking up the surface layer of the mud or grazing on the rock surfaces leading to the transfer of mineral particles into the body along with food" (Zingde et al.,1976).

Pearson correlation analysis was used to examine the accumulation of heavy metals in different organs of fishes and water clearly decipher that there was a significant correlation between As ,Cu and Hg in fish tissues (gill, liver and muscle) and water sample, while Cd and Pb in gills and liver of fish sample showed strong relationship with water. These findings are in agreement with the observation of Moiseenko et al.,1994; Linde et al.,1996), evident that the higher metal concentration in the environment, the more may be taken up and accumulated by fish, it should be, however, emphasized that body metal level is related to its waterborne concentration only if metal is taken up by the fish from water.

“During the present study gills as well as liver accumulated higher concentration of heavy metals than the muscle tissues. According to (Reid and cdonald,1991) the gill surface is negatively charged and thus provides a potential site for gill-metal interaction for positively charged metal. The liver plays a significant role in the accumulation and detoxification of heavy metals” (Yousafzai,2004). “Exposure of fish to elevated levels of heavy metals induces the synthesis of metallothioneine proteins , which are metal binding proteins” (Noel-Lambot and Disteche,1978; Phillips and Rainbow,1989). “Fishes are known to posses the metallothioneine proteins” (Friberg et al.,1971). “Metallothioneine proteins have high affinities for heavy metals, since as concentrate and regulate these metals in the liver, Metallothioneine proteins bind and detoxify the metal ion” (Carpene and Vašák,1989). “The lowest concentration was detected in muscle because muscle is not an active tissue in the accumulation of heavy metals” (Alam et al., 2002; Amundsen et al.,1997). The organ specific comparison of heavy metals level indicated that the highest concentration was found in liver tissues and site specific comparison of five heavy metals in fish collected from Site 4 was comparatively higher than the other three sites. Farhan Jamil Amon et al.,2023 reported that “the bioaccumulation of toxic metals has severely affected the normal physiology of fish, reducing the growth and reproduction of fish. Bioremediation has great potentiality to reshape the existing contaminations of aquatic systems in a sustainable approach”.

CONCLUSION

The present study reveals that, Kayamkulam backwater is most suitable for fishing activity and consumption of this species of fish is safe. In conclusion the analysis of heavy metals in fish sample indicates the level of arsenic, cadmium, copper, lead and mercury were not exceeded the limits specified by the international authorities. It is therefore concluded that the fish samples from the various study sites are fit for domestic consumptions as the Samples studied did not indicate any harmful or extremely high chemical content that may affect the health of those consuming the fishes.

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Table 1: ANOVA, MEAN and SD of heavy metal content in water from the Study area

Heavy metal	Site 1	Site 2	Site 3	Site 4	F value	P value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
Arsenic	0.02 ± 0.02	0.01 ± 0.01	0.03 ± 0.01	0.07 ± 0.07	5.531**	(0.003)
Cadmium	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.01	0.02 ± 0.01	3.796*	(0.017)
Copper	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.05 ± 0.03	9.92**	(0.000)
Lead	0.05 ± 0.05	0.02 ± 0.01	0.02 ± 0.02	0.04 ± 0.02	2.618	(0.063)
Mercury	0.02 ± 0.02	0.01 ± 0.00	0.01 ± 0.00	0.22 ± 0.60	1.463	(0.238)

Table 2 ANOVA, Mean and SD of Heavy metal content in Gill, Liver and Muscle of Liza parsia from the study sites

Sites	Gill			Liver			Muscle		
	Mean ± SD	F value	Sig.	Mean ± SD	F value		Mean ± SD	F value	
Arsenic	0.047 ± 0.055	15.362	.000**	0.069 ± 0.090	12.587	.000**	0.033 ± 0.024	8.393	.000**

Cadmium	0.003 ± 0.001	3.220	.032*	0.003 ± 0.002	8.388	.000**	0.002 ± 0.002	1.217	.315
Copper	0.025 ± 0.014	4.138	.011*	0.034 ± 0.014	5.919	.002**	0.023 ± 0.016	23.912	.000**
Lead	0.004 ± 0.003	.232	.874	0.004 ± 0.002	5.928	.002**	0.003 ± 0.001	6.623	.001**
Mercury	0.019 ± 0.063	1.788	.163	0.035 ± 0.019	33.737	.000**	0. 066 ± 0.024	1.466	.237

Table 3 Pearson correlation of Arsenic in water and gills, liver and muscle of Liza parsia

Arsenic in Fish	Arsenic in Water			
	Tissues	Pearson Correlation	Sig. (2-tailed)	R square
Liza parsia	Gills	.855**	.000	0.731
	Liver	.814**	.000	0.663
	Muscle	.725**	.000	0.526

Table 4 Pearson correlation of Cadmium in water and gills, liver and muscle of Liza parsia

Cadmium in fish	Cadmium in water			
	Tissues	Pearson Correlation	Sig. (2-tailed)	R square
Liza parsia	Gills	.489**	.000	0.239
	Liver	.208	.156	0.043
	Muscle	182	.215	0.033

Table 5 Pearson correlation of Copper in water and gills, liver and muscle of Liza parsia

Copper in fish	Copper in water			
	Tissues	Pearson Correlation	Sig. (2-tailed)	R square
Liza parsia	Gills	.414**	.003	0.171
	Liver	·464**	.001	0.215
	Muscle	.821	.000	0.674

Table 6 Pearson correlation of Lead in water and gills, liver and muscle of Liza parsia

Lead in fish	Lead in water			
	Tissues	Pearson Correlation	Sig. (2-tailed)	R square
Liza parsia	Gills	-.061	.678	0.004
	Liver	.480**	.001	0.23
	Muscle	.405**	.004	0.164

Table 7 Pearson correlation of Mercury in water and gills, liver and muscle of Liza parsia

Mercury in fish	Mercury in water			
	Tissues	Pearson Correlation	Sig. (2-tailed)	R square

Liza parsia	Gills Liver Muscle	.962** .633 1.0**	.000 .000 .000	0.925 0.401 1

Fig1 MAP Showing Kayamkulam Estuary