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

SUMMARY

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 to observe 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 encounter a seasonal fluctuation. The concentration of the detected metals retained their highest values 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 to observe 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.

Commented [P1]: Remove to observe

Commented [P2]: "Encounter a seasonal fluctuation" replaced with "showed seasonal fluctuations"

Commented [P3]: Write this sentence this way better was highest during warmer months, while the lowest values were observed during colder months

Commented [P4]: The same comment remove to observe

KEY WORDS

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

INTRODUCTION

Heavy metal is one of 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). Accumulation of metals were 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).

Commented [P5]: Heavy metals are among the most common pollutants

Commented [P6]: The accumulation of metals is

Fish concentrate heavy metals directly because of the intimate relation, they have 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 the dominant inhibitors of aquatic environment, are considered as indicators for heavy metal pollution (Srivastav et al., 2013). The study on the heavy metal accumulation in water and fish is vital to determine the present status of water contamination with heavy metal and threats to human health from heavy metal pollution of the estuary. Kayamkulam estuary is an open estuary playing 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 destructed by human activites such as agricultural practices, deforestation, industrialization and discharging of domestic sewages (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 was 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.

Commented [P7]: close relationship with

Commented [P8]: Fish are dominant inhabitants

Commented [P9]: Studies on heavy metal accumulation

Commented [P10]: current status

Commented [P11]: threats to human health from heavy metal pollution in estuaries

Commented [P12]: plays an important role in the lives of many people

Commented [P13]: it is being degraded by human activities

Commented [P14]: the discharge of domestic sewage

Commented [P15]: is

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 the site.

Commented [P16]: Delete the put each

SAMPLE PREPARATION

Water and fish samples were collected for the study at first week of all months 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 digestion of the solution of the samples. The content of heavy metal is estimated using Atomic Absorption Spectrophotometer ((Perkin Elmer) .

Commented [P17]: This is more clear during the first week of each month

Commented [P18]: Simplify the expression like this Heavy metals were determined after digesting the sample solution

Commented [P19]: The concentration of heavy metals was estimated

STATISTICAL ANALYSIS

Parametric analysis of variance (ANOVA) were carried out to test for significant differences In the heavy metals concentration in terms of inter station comparison. If the significant value Were obtained ($P<0.05$), Post Hoc Multiple Comparison Test were 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.

Commented [P20]: was

Commented [P21]:

Commented [P22]: was

Commented [P23]: was

RESULT

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

DISCUSSION

Pollution of the aquatic environment by heavy metals is a worldwide problem because these metals are permanent, 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 noticed in fish in this study were generally low when compared within the limit of chronic reference values suggested by WHO (1985) and USEPA (1986). 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) noticed 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 to observe 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 had a higher accumulation of Cu followed by liver and muscles. According to Barbara Jezierska and Malgorzata Witeska (2006) copper shows distinct affinity to 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

Commented [P24]: results

Commented [P25]: the concentrations of As, Cd, and Cu in water

Commented [P26]:

Commented [P27]: remove of

Commented [P28]: remove a

Commented [P29]: Significance was observed at the $P < 0.01$ and $P < 0.05$ levels

Commented [P30]: Better to write Pollution of the aquatic environment by heavy metals is a global issue

Commented [P31]: persistent

Commented [P32]: the presence of heavy metals in fish observed in this study was generally low

Commented [P33]: when compared to the chronic reference values

Commented [P34]: showed

Commented [P35]: remove to observe

Commented [P36]: Ashraf et al. (2012) observed

Commented [P37]: gill tissues of the fish showed higher accumulation of Cu

Commented [P38]: copper has a distinct affinity for the liver of fish 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 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 liver as well as in 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 encounter a seasonal fluctuation. The concentration of the detected metals retained their highest values during summer, while the lowest values were observed during winter. These seasonal changes were more or less in accordance with the fluctuation in the surrounding environment as a consequence of the increase or decrease of drainage water enter into 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 were used for analyzing 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. This findings was in accordance 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

Commented [P39]: the

Commented [P40]: Pb accumulation was found to be higher in both the liver and gill

Commented [P41]: Accumulation of heavy metals in fish organs shows seasonal fluctuations

Commented [P42]: The concentrations of the detected metals were highest during the summer

Commented [P43]: These seasonal changes were generally consistent with fluctuations in the surrounding environment

Commented [P44]: resulting from the increase or decrease in drainage water entering the lake

Commented [P45]: Pearson correlation analysis was used to examine

Commented [P46]: These findings are in agreement with the observations of 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 to observe 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.

Commented [P47]:

Commented [P48]: Recent studies should be included. 2024- 2023

CONCLUSION

The present study reveals that, Kayamkulam backwater is by 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.

Commented [P49]: Remove by

REFERENCE

Alam, M.G.M., Tanaka, A., Allinson, G.,Laurenson, L.J.B. And Stagnitti, F., 2002. A Comparison of trace element concentrations in cultured and wild carp (Cyprinus carpio) of Lake Kasumigaura,Japan. Ecotoxicol. environ. Safety, **53:** 348-354.

Amundsen, P., Staldvik, F.J.,Ilukin, A.A.,Kashulin, N.A., Popova, O.A. And Reshetnikov, V.S., 1997. Heavy metal Contamination in freshwater fish from the border Region between norway and russia. Sci. TotalEnviron., **201:** 211-224.

E. Carpene and M. Vašák, 1989. "Hepatic Metallothioneins from Goldfish (Carassius auratus L)," Comparative Biochemistry and Physiology, Vol. 92B, No. 3, pp. 463- 468.

Environ. Pollut. **94**:83–90.

G. C. Noel-Lambot and A. Disteche, 1978, "Distribution of Cd, Zn and Cu in Liver And Gills of The Eel Anguilla anguilla with Special Reference to Metallothioneins," Comparative Biochemistry and Physiology Part C: Comparative Pharmacology, Vol. 61, No. 1, pp. 177-187.

L. Friberg, M. Piscator and G. Northberg, 1971 "Cadmuim in the Environment," Chemical Rubber, Cleveland.

Yousafzai Ali Muhammad and Shakoori, A.R.2004. Heavy metal accumulation in the Gills of an Endangered South Asian Freshwater Fish as an Indicator of Aquatic Pollution.Pakistan Journal of Zoology, 40(6):.423-430.

S. D. Reid and D. G. Mcdonald, 1991 "Metal Binding Activity of the Gills of the Rainbow Trout, Onchorhynchus mykiss," Canadian Journal of Fisheries and Aquatic Sciences, Vol. 48, No. 6, , pp. 1061-1068.

Moiseenko, T. I., Kudryavtseva, L. P., Rodyushkin, I. V., Dauvalter, V. A., Lukin, A. A., and

Nair S. M., Balchand A. N. and Nambisan P. N. K., (1990), Metal concentration in recently deposited sediments of Cochin backwaters,India, Science of the Total Environment, 97/98: 507-524.

Linde, A. R., Arribas, P., Sanchez-Galan, S., and Garcia-Vazquez, E., 1996, Eel (Anguilla

M. Berg, H. C. Tran, T. C. Nguyen, H. V. Pham, R. Schertenleib and W. Giger, Environ. Sci. Technol., 2001, 35, 2621.

Ashraf, M. A. Maah, M. J. and Yusoff, I. 2012. Bioaccumulation of Heavy Metals in Fish Species Collected From Former Tin Mining Catchment. Int. J. Environ. Res., 6(1):209-218.

D. J. H. Phillips and P. S. Rainbow, 1989 "Strategies of Trace Metal Sequestration in Aquatic Organisms," Marine Environmental Research, Vol. 28, No. 1-4, 207-210.

Mohamed Bahnasawy, Abdel-Aziz Khidr, Nadia Dheina.2011. Assessment of heavy metal concentrations in water, plankton,and fish of Lake Manzala, Egypt. Turk J Zool ; 35(2): 271-280.

Matkar, V.M., Ganapati S., Pillai, K.C.(1981).Distribution of Zn, Mn and Fe in Bombay harbour bay, Ind. J. Mar. Sci., 10: 35-40.

Zingde. M.D. S.Y.S. Singbal, C.F. Moraes and C.V.G. Reddy 1976. Arsenic, Copper. Zinc and Manganese in the Marine flora and fauna of coastal and estuarine waters Around Goa. Indian 3. Mar. Sci., 5 : 212-217.

Winkler, L.W.(1888). Ber. Dtsch. Chem. Ges. 21:2843,

Rajkhowa, I. (2005).Action in aquaculture opportunities in aquatic specialization. Business Today (May 22 Issue): 131.

Shankhadeep Chakraborty, Sujoy Biswas, Kakoli Banerjee and Abhijit Mitra.(2016). Concentrations of zn, cu and pb in the muscle of two edible finfish species in and around gangetic delta region. International Journal of Life Science & Pharma Research.Vol 6(3).14 -21.

Ashraf M A, Maah M J and Yusoff I.2012. Bioaccumulation of Heavy Metals in Fish Species Collected From Former Tin Mining Catchment. International Journal of Environmental Research, 6(1),pp:209-218.

Barbara Jezierska and Malgorzata Witeska.2006. The metal uptake and accumulation in fish living in polluted waters. Soil and Water Pollution Monitoring, Protection and Remediation,69,pp:107 – 114.

Mohamed Bahnasawy, Abdel-Aziz Khidr, Nadia Dheina.2011. Assessment of heavy metal concentrations in water, plankton, and fish of Lake Manzala, Egypt. Turkish Journal of Zoology, 35(2), pp: 271-280.

Razeena K L and Sherly W E. 2015.Accumulation of Heavy Metals in the Surface Water of Asthamudi Lake, Kollam, Kerala. Nature Environment and Pollution Technology, 14(2), pp: 431-434.

Yang H N and Chen H C. Uptake and elimination of cadmium by Japanese eel, *Anguilla japonica*, at various temperatures.1996. Bulletin of Environmental Contamination and Toxicology,56,pp:670–676.

Yousuf M H, El- shakoori M S and Al-Ghais S M. 2000.Trace metals in liver, skin and Muscle of Lethrinus kentfan f ish species in relation to body length and sex. The Science of the Total Environment, 256,pp: 87-94.

Safahieh Alireza, Ronagh M T, Monih F A and Savari A.2011. Heavy metal Concentration in Belanger's Croaker Firth, Johnius belangerii f rom petrochemical waste Receiving Estuary in the Persian Gulf, Iran. Second International Conference on Environmental Engineering and Applications,17,pp: 205-209

Abdel-Baky T E, Hagras A E, Hassan S H and Zyadah M A.1998. Environmental impact assessment of pollution in Lake Manzalah, 1-Distribution of some heavy metals in water and sediment. Journal of the Egyptian German Society of Zoology, 26,pp: 25-38.

Linde A R, Arribas P, Sanchez-Galan S and Garcia-Vazquez E.1996. Eel (Anguilla anguilla) and brown trout (Salmo trutta) target species to assess the biological impact of trace metal pollution in freshwater ecosystems,Archives of Environmental Contamination and Toxicology,31,pp:297–302.

Moiseenko T I, Kudryavtseva L P, Rodyushkin I V, Dauvalter V A, Lukin A A and Mok W M and Wai C M.1994.Arsenic in the Environment: Part I: Cycling and Characterization, ed. J. O. Nriagu, John Wiley & Sons, New York, ch. 4, pp. 99–118.

Table 1: showing 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)

Commented [P50]: Must be 3 decimal places

Table 2 Showing 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 Liver Muscle	.489** .208 182	.000 .156 .215	0.239 0.043 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 Liver Muscle	.414** .464** .821	.003 .001 .000	0.171 0.215 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 Liver Muscle	-.061 .480** .405**	.678 .001 .004	0.004 0.23 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	.962**	.000	0.925
	Liver	.633	.000	0.401
	Muscle	1.0**	.000	1

Fig1 MAP Showing Kayamkulam Estuary