

# Estimating The Accumulation of Potentially Harmful Elements in *Cirrhinus mrigala* From Indus River, South Punjab, Pakistan.

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## Abstract

Pollution is a worldwide issue this time. Increased industrialization is causing the emission of many harmful elements in the ecosystem. Fish show huge biodiversity, possessing an assortment of living spaces and are significant marks of water quality. In this study, the accumulation of harmful elements was measured and studied in *Cirrhinus mrigala*. A total of 50 fish samples were collected from the Indus River at Ghazi Ghat, South Punjab, Pakistan. The accumulation of harmful elements was studied by using atomic absorption spectrophotometer (AAS). The five elements were studied which include Zinc (Zn), Copper (Cu), Lead (Pb), Arsenic (As) and Mercury (Hg). The detectable range of the elements was Zn>As>Pb>Cu>Hg. Mercury was below the detectable limit. These accumulations were calculated in *Cirrhinus mrigala* to assess the human health risk. The present study revealed that the presence of these elements is significantly fluctuated in the fish samples. This study revealed that high levels of harmful elements are creating the serious hazardous situation and it lead to food chain contamination.

**Keywords:** Fish, Metals, Zinc, Copper, Lead, Arsenic, Mercury, Atomic Absorption Spectrophotometer.

## INTRODUCTION

World utilization of fish has expanded all over the world. The most significant feature of the fish is its protein's value. Fish regularly have rich substance of fundamental minerals, nutrients and unsaturated fats. Fish is the biggest source of omega-3 unsaturated fats, which play an important role in the development of the cells. The American Heart Association prescribed eating fish at least twice per week in order to arrive at the day by day requirement of omega-3 unsaturated fat (Kris-Etherton *et al.*, 2021). Metals exist naturally in the environment are directly and somewhat indirectly affecting the life of animals. These affect the biodiversity of any species. Metals are producing in the aquatic environment due to industrialization and many other human made activities and because of increased pollution of these metals in aquatic environment, the aquatic life is poorly affected (Naeem *et al.*, 2011).

The fundamental element that undermines marine fish biodiversity around the world is fishing. For instance, worldwide more than 40 different populations of marine fishes have become terminated because of aquatic pollution. These neighbourhood misfortunes address a disintegration of worldwide biodiversity. Besides, stresses because of different factors, for example, environmental change, natural surroundings misfortune, intrusive species, eutrophication and contamination of toxic elements can complement fishing-instigated decays and hinder or forestall recuperations (Garcia *et al.*, 2006). Mrigal is an exceptionally fruitful fish. Fruitfulness increments with age, and regularly goes from 100,000 – 150,000 eggs/kg BW (Fatima *et al.*, 2019). Fisheries and hydroponics are frequently dismissed in public advancement strategy and contributor needs, as strategy creators regularly don't approach information which mirrors the significance of fisheries and hydroponics to improvement (Finegold, 2009). For instance, fish populations in many areas of the world are declined because of high fishing death rates joined with disintegrating environment and oceanographic conditions created by presence of toxic element (Köster *et al.*, 2005).

Two primary ways by which weighty metals enter the sea-going pecking order are by direct utilization of water and food through the intestinal system and non-dietary routes across permeable membranes such as the muscle and gills. Hence levels of metals in the fish ordinarily reflect levels found in different feed of the fish and water of the specific aquatic climate from which they are obtained. Fish can gather weighty metals in their tissues by retention along gill surface and

kidney, liver and stomach parcel divider to more elevated levels than ecological focus (Annabi *et al.*, 2013). Collection of weighty metals by living organisms might be uninvolved or particular; and divergences in aggregation of weighty metals by life forms could be because of differences in osmosis, egestion or both. Gushing release and metropolitan spill over raise levels of follow metals in surface water and effect different life phases of oceanic life (Adeogun *et al.*, 2015). These ecotoxic circumstances limit the turn of events and flourish capacity of beach front and freshwater fish populations and other inhabitant biotas inside affected territories (Sharma, 2021). Although groupings of insignificant metals inside satisfactory or passable cut off points have been the subject of hazard evaluation in oceanic conditions and nearby amphibian fauna fundamental components including aluminium, nickel, and selenium could establish more serious dangers because of the tight edge among harmful and non-poisonous impacts in sea-going species (Shiry, 2021). The capacity to distinguish, recognize and appropriately react to regular compound improvements is a significant part of the ecological physiology of fishes. Advancement of intense harmfulness bioassay information should be seen as a vital stage for giving relative poisonousness data on various poisons and types of living beings (Vutukuru, 2005).

Some non-essential toxic metals include the mercury and the concentration of this metal is increased to become a global concern. It combines with the elements and changed into the organic ( $Hg^{+2}$ ) and inorganic compounds ( $CH_3Hg$ ) depends upon those elements to which it attached. It is non-biodegradable compound and become the permanent part of food chain and this is the largest threat to the health of human being and causing many neurological disorders (Poopal *et al.*, 2013). Contrary to this there are some metals which are important for the growth of the aquatic animals but the increased concentration of these metals causing the elemental toxicity for the animals (Huang *et al.*, 2011).

The reduced concentration of the elements in body of living organism is not harmful but if these elements accumulated in the body for the long period of time than it may produce harmful effects. There is wide use of zinc and arsenic in the Industries specially in the medicine and agriculture industry and according to the IARC- International agency for research cancer these metalloids are declared as Class-I carcinogens (Kumar *et al.*, 2022). These increased concentration in the aquatic animals is a global threat to the human health through the food chain (AnvariFar *et al.*, 2018).

The present study determined the accumulation of different metals in marine water fish. *Cirrhinus mrigala* is the most used fish because of its good taste Comparative studies are required to identify the effects of industrial pollution on fish and on its health. This work will help sustainable conservation of fisheries in Pakistan.



**Figure 1:** Image of *Cirrhinus mrigala*

## MATERIAL AND METHODS

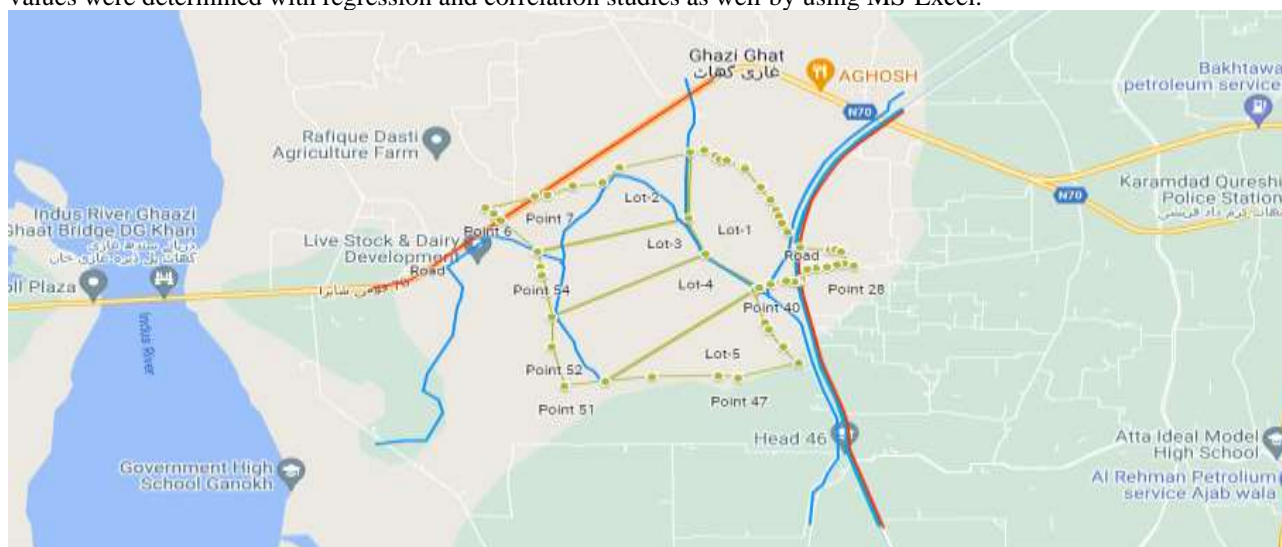
The total area of the Indus River is 1165000 Sq. km and in Pakistan with Latitude: 24.3121 and Longitude: 67.7637. Its gradient slope is almost not more than five kilo meters. The sites of Indus river from south Punjab was properly surveyed for the fish sampling and different sites of Ghazi Ghat was finalised for the fish sampling. The sampling of fish was made in different intervals of the year 2021 (from January 2021 to December 2021) and different size range of the fish samples were collected for the experiments. The most suitable sampling method was adopted for the sampling procedure (Steel *et al.*, 1996). The map of the sampling area was elaborated in the Figure 1. 50 samples of *Cirrhinus mrigala* was collected from the sampling area in different intervals by focusing on the *Cirrhinus mrigala* fish species. The same specie was identified on spot by observing their phenotypical characters like bilateral symmetrical, width of head was found equal to the length behind the eyes, presence of one pair of barbells, deeply forked caudal fin and black tinged ventral and anal fins with golden ayes and streamlined body. The depth of the body was almost equal to the length of the head with broad and transverse mouth (Figure 1). The captured fish samples were properly packed in the oxygen filled polythene containers and transported to the fisheries laboratory in division of zoology.

The morphometric including length and weight of the samples was measured and samples were placed in the weighed aluminium foils with proper labelling. The fish samples were dried properly in the oven. The samples were weighed regularly to get the constant weight of the fish. After the complete removal of the water components from the samples these were grinded properly. The powder form of sample was properly ashed in the temperature range of  $700^{\circ}C$  in electric furnace by placing it in the crucibles. The ash particles were dissolved and digested in the diluted solution of the 1% ( $HNO_3$ ) nitric acid. The digestion was continued until the transparent solution was not obtained. After the complete digestion the samples were filtered by using Whatman filter paper and filtered samples were run on the flame atomic absorption

spectrophotometer (FAAS) (Perkin Elmer, Analyst 400) to identify the existence of different metals in the samples by using their respective lamps. The major focus was to identify the existence of Zinc (Zn), Copper (Cu), Lead (Pb), Arsenic (As) and Mercury (Hg) among the all samples.

### STATISTICALLY ANALYSIS:

The data obtained from the analysis was statistically observed by using the ANOVA test and significant and non-significant values were determined with regression and correlation studies as well by using MS-Excel.



**Figure 2:** Map image of the sampling area

### RESULTS AND DISCUSSION

This study showed that a metal named as Zinc (Zn) was found in the maximum concentration than other metals. The maximum value recorded in zinc 3.22 ppm and the concentration of the arsenic was found in the same ratio of the zinc i.e., 2.01. While the concentration of lead and copper was found in the similar reduced concentrations of mean values i.e., 0.1478 and 0.1374 (Table 1). The same values were also recorded in the study of Chatta *et al.*, 2016. The same concentrations were found when these metals were studied in the different regions of the Lahore, Pakistan where different carp fish species were collected from the different regions of the city and same concentrations were noted by using AAS (Mehmood *et al.*, 2020). The increased concentration of the Zinc and As is due to the accumulation of these elements from the discharge of industrial waste which is directly inserted into the Indus River. The international limits of the metals are explained in the Table 03. These limits are verified and are considered as the admissible limits of the concerned elements.

**Table 1:** Mean  $\pm$  S.D metals concentrations found in *Cirrihinus mrigala* collected from Indus River south Punjab Pakistan.

Species: <i>Cirrihinus mrigala</i>		Range ( $\mu\text{g/g}$ )	
Name of Metal	Mean $\pm$ S.D.	Minimum	Maximum
Zn	1.9596 $\pm$ 0.336	1.43	3.22
As	2.0162 $\pm$ 0.228	1.54	2.45
Pb	0.1478 $\pm$ 0.026	0.09	0.2
Cu	0.1374 $\pm$ 0.0342	0.04	0.19
Hg	BDL	BDL	BDL

**BDL**=Below detectable Limit

The concentration of the metals in the fish samples were detected and only mercury was found below the detectable limit while other elements were found in the measurable limit. The values of lead and copper were also found in normal limit while the concentration of zinc and arsenic was greater in the fish samples as compared to the other metals. The openness of metallic particles past as far as possible, in the oceanic environment has brought about the collection of higher amounts of metals in herbivorous fish species (Jabeen, 2011). Be that as it may, huge heightening of metals in savage fish species showed bio-amplification of this large number of metals further up the trophic level (Eimers *et al.*, 2001). The non-significant  $p > 0.05$  findings were noted with correlations (Table 2).

**Table 2:** Regression parameters of log wet body weight (g) comparatively with the presence of metals ( $\mu\text{g}$ ) for *Cirrhinus mrigala*

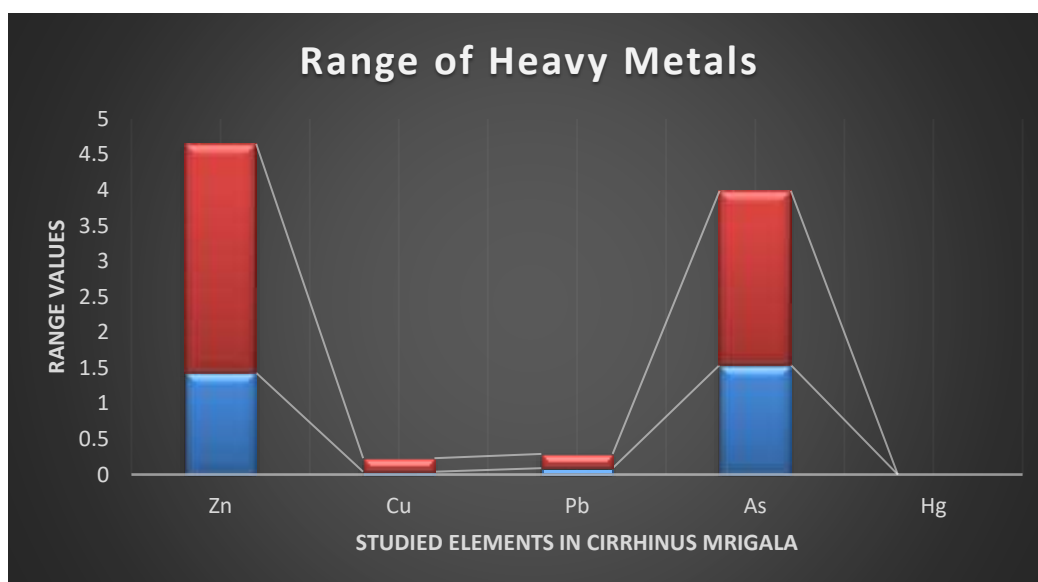
Wet body weight (g)	Metal	$r^2$	a	b	S.E (b)	t value (b=1)
221.5 – 537.9	Zn	0.003813	1.870014	0.00036	0.339235	0.428621
	As	0.042282	2.218478	-0.00081	0.225527	-1.45573
	Pb	0.000292	0.149685	-7.6E-06	0.02584	-0.11839
	Cu	0.000557	0.140889	-1.4E-05	0.03462	-0.16357
	Hg	BDL	BDL	BDL	BDL	BDL

BDL-Below detectable limit, \*Significant Level ( $p > 0.05$ )

**Table 3:** List of metals with the international limits

Name of Agency	Name of Metals					
	Zn	Cu	Hg	As	Pb	Reference
WHO	40	30	-	-	2	WHO 1989
FAO	30	60	-	-	0.5 – 6	FAO 1983
European Union Limit	-	10	-	-	0.1	EU 2001
England	50	20	-	-	2	MAFF 2000

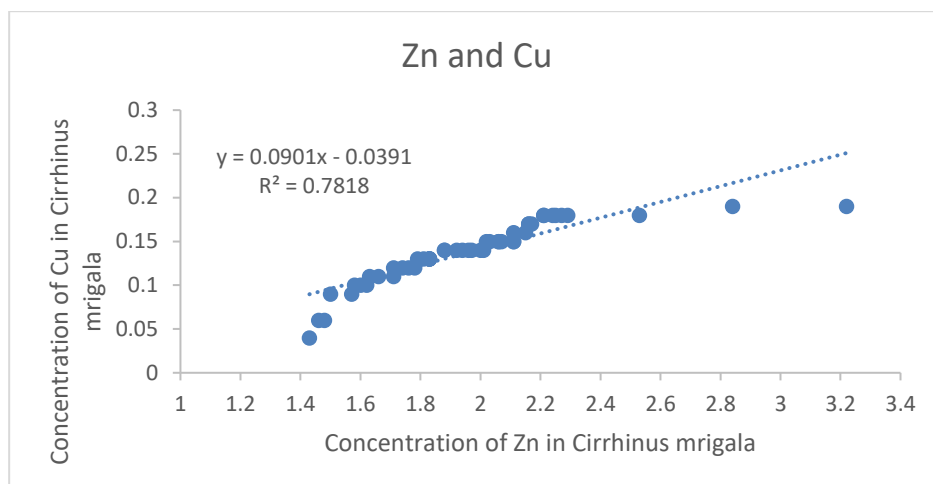
The regression parameters showed the non-significant relationship of all metals with wet body weight. While the concentration of Mercury was less than the detectable limit. Correlation between body weight and the metals is not found in any case and same non-significant relationship was also noted with different species of the carp and not nay morphometric relationship was found with metals and all of those species (Santhana *et al.*, 2021).



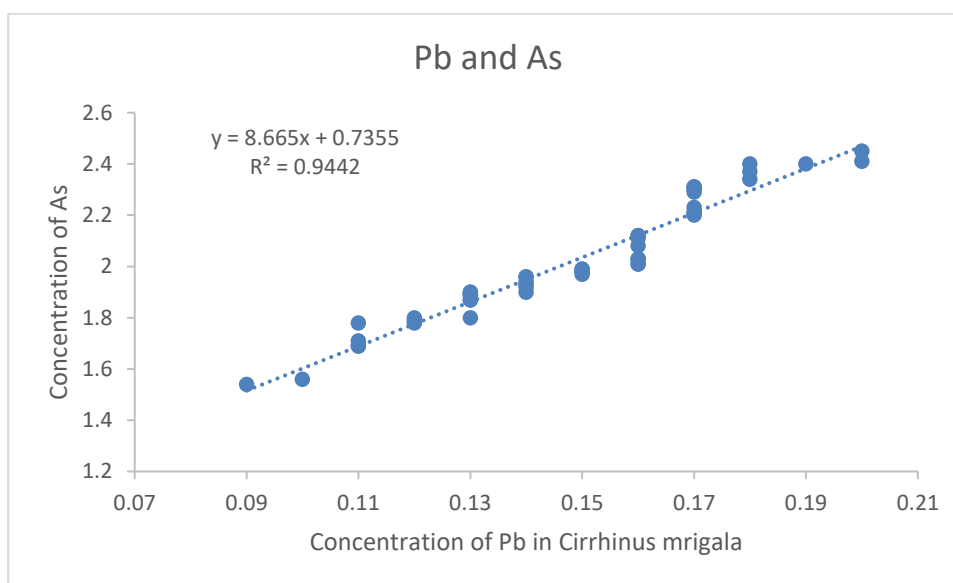
**Figure 3:** Range values of the studied elements in *Cirrhinus mrigala*

The range values of the studied metals were presented in the Figure 3. It was noted that the similar values were found among the different species.

Copper is the most important element in the fish body causes the toxicity. It accumulated in the gills of fish and reduces its growth and having negative effect over the user of the fish as well. This study was also formulated to study the concentration of copper in the fish and the increased concentration of the copper was noted among the fish species. However this concentration was less than the existence of other metals and same increased concentration of copper was recorded in the wild samples of *Oreochromis niloticus*. This may be that the contamination of the copper in Indus River was less than other metals (Akan *et al.*, 2012).



**Figure 4:** Correlation between concentration of Zn and Cu in *Cirrhinus mrigala*



**Figure 5:** Correlation between concentration of Pb and As in *Cirrhinus mrigala*

Zinc is an essential metal. It is obtained from many sources and it also have important role in the growth and development but the increased concentration of zinc causes reduced fertility. It effect the gonads and reduce sperm production in male. Very high concentration of zinc is considered in toxic limit which is too much high. However, its normal concentration is beneficial for the living things. The correlation between the concentration of Zn and Cu, and Pb and As was described with the graph (Figure 4 - 5). The highest concentration of Zn (3.22) was noted in the studied samples among all samples (ICES, 2006). The same concentrating was also noted among the gills of the species of Indus River. FAO guideline gave the limit of 30 µg/g and current value is much reduced and under the admissible limit of the FAO (1983).

Bioaccumulation of the metals is directly linked with the metabolic activities of the body. They bind with the liver and effect the production of protein in the body (Zhao *et al.*, 2012). That's why other researchers reported the high concentration of the metals in the fish body. The accumulation patterns obtained in this study were in the decreasing order of Zn > As > Pb > Cu > Hg. In this study, the concentration of the metals is different and lower in some cases from the other studies this may because the samples were collected in different time intervals with changed fishing spots. This also affects the bioaccumulation of the metals in the body. If the same sampling area is selected than it may have chances of having the same accumulation of the elements in the all organs of the fish. The concentration of arsenic is also increasing in the nature and it is a carcinogenic element and destroying the environment also. It is producing in large amount and directly expelled in the river and a biggest threat to the life (Rahman *et al.*, 2012). The increased concentration of the arsenic in the present study (2.45) is because of the discharge of toxic elements directly in to the aquatic environment.

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