

## Concentration of heavy metals in liver and muscle tissue of *Liza aurata* in estuaries of the rivers Babolroud, Tajan and Gorganroud

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**ABSTRACT:** The present study was carried out in 2011 to measure concentration of heavy metals chromium and tin in liver and muscle tissue of *Liza aurata* (golden grey mullet) in estuaries of the rivers Babolroud, Tajan and Gorganroud. Accordingly, after sampling the target area and isolating muscle (18 samples) and liver (18 samples) tissues, they were digested and analyzed using Graphite Furnace Atomic Absorption Spectrometer (GFAAS). Then, the obtained data were analyzed statistically using Spss19. The results indicated that the concentration of the metals in liver was higher than the muscle tissue. The highest concentration was related to the tin metal in liver tissue of the golden grey mullet measured from Gorganroud Area while the lowest concentration was related to chromium reported from the estuary of Tajan River. A significant difference ( $P < 0.05$ ) was observed between the concentrations of chromium metal in liver and muscle tissue. No significant difference was recorded between the concentrations of tin metal in liver and muscle tissue of golden grey mullet ( $P > 0.05$ ). At the end, relationship between weight, length and average concentration of tin and chromium in liver and muscle tissue of golden grey mullet were analyzed by Pearson's test. A significant reverse linear correlation was found between concentration of tin and the weight ( $p < 0.05$ ).

**Keywords:** golden grey mullet; estuary; tin; chromium

### INTRODUCTION

The main purpose of this study was to investigate the impact of environmental pollutants such as heavy metals on aquatics, primarily in terms of public health. Human use of contaminated aquatic food resources can lead to many complications. Currently, marine products have a significant role in world food production. Revealing nutritional superiority of aquatics over other protein food products, their use is increasing day by day (Naseri *et al.*, 2006). Therefore, it is important to study the aquatic environment. Pollution is one of the most important issues in conserving marine environment and maintaining ecological balance of aquatic systems. The presence of heavy metals beyond the standard limit causes environmental issues for local residents and ecosystems. In a water column, heavy metals are initially absorbed by phytoplankton, bacteria, fungus and other small organisms. Then, they are eaten respectively by larger animals and eventually entered into human body (Syahgol, 2001). There have been many studies worldwide on accumulation of heavy metals in tissues of fish and other aquatics of which

can mention to researches conducted by Askari, 2011; Salimi, 2009; Pazuki, 2009; Badieli, 2008; Shahriari, 2005. In different environmental conditions, metals are absorbed by fish in various ways. Different parts of fish body that are in contact with the environment may be localized to transfer, sedimentation and accumulation of heavy metals. Special features of this group of metal have caused to be considered them as one of the world's most important pollutants (Golabesh, 2010). Metals are transferred in fish body and consequently, accumulate in different organs and tissues in a variety of different doses. It is worth noting that all metal adsorbed from the environment does not accumulate in the bodies of fish because they are able to regulate the metal concentration up to a certain extent. Metals can be excreted through gills, bile (by feces), kidneys and skin. Although, most of fish organs are susceptible to heavy metal toxicity, however, as a key member of metabolism, the main damage is imposed on liver (Jalali and Moshki, 2006). Changes in concentration of heavy metals in aquatic environments would lead to significant biological impacts on aquatic organisms, especially fish species. Considering the sequence of food

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chain in the world of living things, stability of heavy metals in the body of organisms and their transmission to the further rings of food chain, heavy metals have a significant impact on the survival of aquatics (Aminin and Sahafi, 1994).

Fish can absorb a certain amount of heavy metals from environment through the food chain or water. Excretion is the only way to remove metals from the body. Metals may be excreted through gills, intestine, liver, gallbladder or kidney. In this way, they can re-enter to the natural environment, perhaps to start a new cycle again. In this case, accumulation of heavy metals in fish and their destructive effects in human body are of great importance. Bio-accumulation of heavy metals is a leading cause of reduction reactions in fish body resulted in biochemical and morphological changes by creating free radicals. Low-concentration of these elements is essential for building vital molecules including oxygen, hemocyanin, etc. As a coenzyme, they also play a determinant role in reactions of vital body. However, if the amount of heavy metals in the environment exceeds a certain limit, for any reason, it will cause poisoning and harm living organisms, including fish (Jalali and Moshki, 2006). Aquatic contamination by heavy metals due to their stability and resistance is a noticeable note should be paid more attention (Mohammadi et al., 2000). Heavy metals can cause considerable changes in biogeochemical cycle and each, in turn, has its own adverse impacts in the body of living organisms. In this study, the concentration of two heavy metals tin and chromium in liver and muscle tissue of *Liza aurata* (golden grey mullet) was investigated in estuaries of the rivers Babolroud, Tajan and Gorganroud. Considering the role of *Liza aurata* in the lowlanders' economy of Golestan Province as well as no-adequate studies in Iran to ensure the fish health in terms of various pollutants, especially heavy metals, their fishing areas were investigated in this study.

## MATERIALS AND METHODS

In this research, sampling and testing procedures were exactly based on the standard method recommended for analyzing fish to determine trace elements (MOOPAM, 1999).

Nowadays, Gill nets are widely used for scientific sampling of aquatics. In this research, the samples were caught from considered stations using a trawl net. It should be mentioned that 6 fish were randomly caught from each estuary (Gorganroud, Babolroud and Tajan). Accordingly, a total number of 18 golden grey mullet (*Liza aurata*) were transported to the laboratory using a nice-containing flux. After washing the samples with distilled water in the laboratory, biometric measurements were

conducted to determine weight by means of a 0.001 m-precision digital scale and TL (total length) and fork length (FL) using a metric ruler with a precision of 0.1 cm.

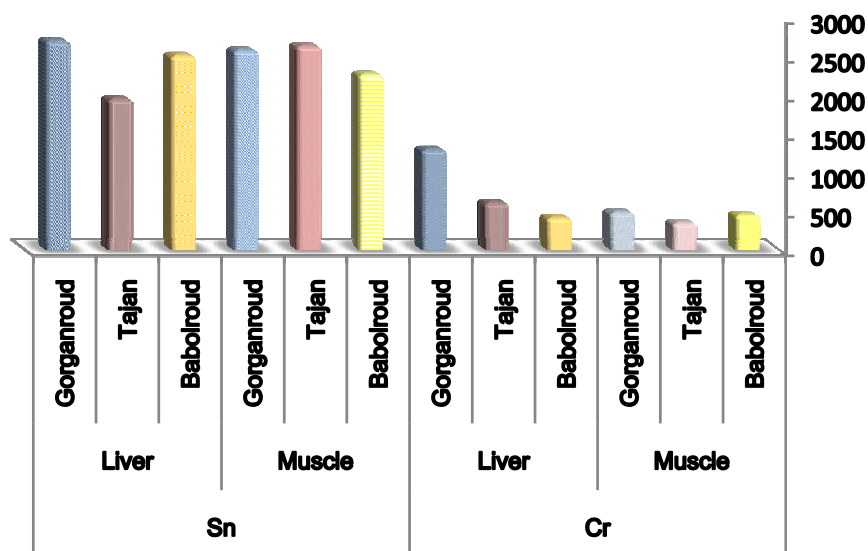
First, in order to achieve minimum possible error, all equipment used in the experiment process were washed in a tank containing 5% nitric acid for about 24 hours. Afterwards, they were washed twice with distilled water and used. Total digestion method was applied to prepare the samples. It is a commonly used method to determine trace elements of then utrients. After taking samples from each station, they were immediately transported to the laboratory. Afterwards, the required size of the pectoral muscle was isolated and weighted using a high precision 0.01 gram digital scale. The liver tissue was carefully separated and then, the Petri Dish containing the muscle tissues was transferred too ven at 105 °C for 24 h to dry, completely. After drying, the samples were weighted to specify percentage of water content in the tissues. After carefully weighing of the samples dried at oven, the samples were homogenized by powdering. For digestion in acid, 1 goof the homogenized samples was weighed carefully and poured into 50 ml beakers. Then, 10cc of concentrated nitric acid was added to each sample. The beakers were placed under the hood for 30 minutes until initial digestion was completed. The heater was set at 95 °C and the breakers were placed on the screen based on preparation sequence. In order to avoid ebullition of the solution, the beakers were shaken until reaching the boiling point. This procedure was repeated until the solution became relatively transparent. After 3-2 hours, the solution was heated by an electric heater to obtain a completely transparent solution. The solution was brought to volume using 50 ml volumetric flask. The plastic caps were fixed with nylon tubes. The containers containing the transparent solution were coded and transferred to the GFAAS for final analysis. In this study the Atomic Absorption Device, Model: spectra AA-200 was used.

## Statistical tests

In this study, for statistical analysis of the obtained data (the concentrations of chromium and tin in liver and muscle tissue of golden grey mullet), the values Mean  $\pm$  standard deviation ( $\bar{X} \pm SD$ ), the concentrations in the tissues and target areas were compared, descriptively. Subsequently, one-way ANOVA Test was performed in the environment of SPSS 19 Software to analyze the obtained data, quantitatively. Relationship between weight, length and average concentration of tin and chromium in liver and muscle tissue of golden grey mullet were analyzed by Pearson's test.

Table 1: Average concentration of heavy metals Cr and Sn (ppb, dry weight) in liver and muscle tissue of golden grey mullet in estuaries of the rivers Babolroud, Tajan and Gorganroud

Metal	Tissue	River	Mean Concentration	Standard Deviation
Chromium	Muscle	Babolroud	457	201
		Tajan	352	59
		Gorganroud	489	122
	Liver	Babolroud	420	279
		Tajan	611	101
		Gorganroud	1300	.
Tin	Muscle	Babolroud	2269	236
		Tajan	2636	177
		Gorganroud	2580	355
	Liver	Babolroud	2514	231
		Tajan	1951	289
		Gorganroud	2704	.

Fig. 1: Average concentration of the heavy metals Cr and Sn (ppb, dry weight) in liver and muscle tissue of *Liza aurata* in estuaries of the rivers Babolroud, Tajan and Gorganroud

## RESULTS AND DISCUSSION

As Table 1 suggests, the highest measured average value was related to tin in liver tissue of mullet reported from Gorganroud while the lowest average concentration was measured at muscle tissue of the fish taken from Tajan river estuary.

According to the results of Table 1, the highest average level of chromium metal equivalent to 1300 (ppb, dry weight) was found in the liver tissue of the

golden grey mullet taken from Gorganroud River while its lowest average concentration was equal to  $35 \pm 259$  (ppb, dry weight) reported from Tajan River. Fig. 1 demonstrates that there is no significant difference between the average values of chromium in liver and muscle tissue of golden grey mullet. According to Table 1, the highest average concentration of tin equivalent to 2704 ppb was related to the liver tissue of golden grey mullet

captured from Goranroud. The lowest average concentration of tin equal to  $1951 \pm 289$  was belonged to the muscle tissue of the fish taken from Tajan River. Fig. 1 shows that there is no significant difference between different concentrations of chromium in muscle tissue of golden grey mullet. There is a significant difference between the concentrations of the metals tin and chromium in liver tissue of the fish. Based on Table 1, the highest recorded concentration equal to  $2636 \pm 177$  ppb was related to the tin in the muscle tissue of the golden grey mullet captured from Tajan River. The lowest measured concentration equivalent to  $352 \pm 59$  ppb was related to the chromium in the muscle tissue of the golden grey mullet taken from Tajan River. According to Table 1, among the measured heavy metals in liver tissue of the golden grey mullet, the highest concentration equal to 2704 ppb was related to tin in Gorganroud River estuary while the lowest measured average equal to  $420 \pm 279$  was belonged to chromium in Babolroud river estuary. Fig. 1 shows a significant difference between chromium and tin concentrations of liver tissue in the studied areas. The ANOVA showed a significant difference for each of the metals in the study areas, separately ( $P < 0.05$ ). However, no significant difference was observed between tin concentrations at the estuaries of Gorganroud and Babolroud ( $P < 0.05$ ). According to Table 1, in Babolroud estuary, the highest measured average concentration equal to  $2514 \pm 331$  ppb was related to the tin metal in liver tissue while the lowest measured average concentration equivalent to  $420 \pm 279$  ppb was referred to the chromium metal in the muscle tissue. The ANOVA test results indicated no significant difference between tin and chromium in the liver and muscle tissues ( $P > 0.05$ ). As Table 1 suggests, in Tajan estuary, the highest ( $2636 \pm 177$  ppb) and lowest ( $352 \pm 59$  ppb) average concentrations were belonged to the tin in liver tissue and chromium in muscle tissue, respectively. Fig. 1 shows that there is a significant difference between the metals chromium and tin in muscle and liver tissues. This was confirmed by the results obtained from ANOVA Test ( $P < 0.05$ ). According to Table 1, in Gorganroud estuary, the highest (2704 ppb) and lowest ( $489 \pm 123$  ppb) average concentrations were respectively belonged to tin in the liver tissue and chromium in the muscle tissue. Fig. 1 reveals no significant difference between the metals tin and chromium in liver and muscle tissues which was approved by ANOVA test results. Relationship between weight, length and average concentration of tin and chromium tasted through Pearson Test indicated that there is no significant difference between the weight and length of the

golden grey mullet throughout the estuaries. However, it reveals a significant inverse linear relationship between tin concentration and the fish weight.

## CONCLUSION

Considering the tables and figures demonstrated in "Result and Discussion" as well as the standards presented by organizations such as Food and Agriculture (FAO) and World Health Organization (WHO) and also international environmental standards indicating the permissible limit of heavy metals in nutrients, the concentrations of tin and chromium were lower than the international standard levels. The obtained results of the present study indicated relative tin and chromium contamination of golden grey mullet in the target areas classified as "ecologically and environmentally sensitive areas" by Do E (Department of Environment of Iran). This is not promising for human health consuming of the fish. Literature reviews on changes in the considered heavy metals in Caspian Sea indicated an up-ward trend of contamination of these metals which creates concern for the region in terms of both ecological and public health. Therefore, the public health authorities must take necessary mitigation measures to stop polluting trend. Various factors involve in this matter of which can be pointed to industrial factories in Golestan Province that are no equipped with the industrial wastewater treatment plant, indiscriminate use of agricultural pesticides and chemical fertilizers resulted in soil and water contamination, particularly, in paddy fields of Golestan and Mazandaran, discharging water withdrawal from mines upstream of the rivers into the sea, motor boat transportation in the sea and the paint of boats. As figures and tables suggest, the tin metal was higher than the chromium in the target areas. Based on environmental toxicology, tin is categorized as a metal which in physical conditions, it has the potential to convert into active components causing various disorders, such as different diseases in humans and animals (Jalali and Moshki, 2006). Therefore it should be taken into consideration by the authorities to seek the root-cause of such an increase. Considering the values of the studies heavy metals presented in Table 2, it can be concluded that the metal even in the fish liver is higher than the muscle tissue. This is due to more accumulation capability of liver as active member and homeostasis center of the body. The chromium metal in liver samples was higher than the muscle tissue. However, such an up-ward trend is normal in tissues due to increased atomic mass of the metals and their settling in water.

Table 2: Standard levels of heavy metals in seafoods(ppb)

researcher's name	research title	research year	research result	The result of the present study,
Pazouki et al.	Measurement of heavy metals chromium and cadmium in skin and muscle tissues of gold energy mullet in the Caspian Sea (Anzali)	2009	Compared to the relevant international standards, the measured concentrations of the metals were lower than the standard limits, 430 ppb.	The metal chromium; concentration was lower than the standard limits
Shariati et al	Measuring the accumulation of the heavy metals lead, nickel and zinc in tissues of mullet fish in the Caspian Coast	2004	The maximum amount of lead was found in the liver and then in the gills, kidney and ovary	more accumulation in liver ,
Amini Ranjbar and Alizadeh	Concentration of heavy metals in muscle, spleen and intestine of three species of common carp, silver carp and grass carp	1998	The concentration of the studied metals in the edible tissue is lower than the spleen and gastrointestinal tract	It is worth noting that muscle tissue has lower amount of metals rather than liver
Veltman	Bioaccumulation in muscle tissue Ammo dytessp, Clupeaspp	2006	TBT 0/2mg/L Trip henyltin 0/4mg/L is expressed based.	Tin concentration in both tissues was above 0.2 mg or less than 0.4 mg/L

Table 3: Comparison with previous research, monitoring and research

Source	Sn	Cr	Standards and regions
Pourang et al., 2004	-	10000	WHO
"	-	10000	NHMRC
"	-	20	UK (MAFF)
"	-	996	Liza aurata muscle on the southern shores of the Caspian
GholamHosseinSanaei	200	50	ACGIH
Study	2270	458	Muscle (Liza aurata) in estuaries Babolroud
Study	2636	353	Muscle (Liza aurata) in the estuary Tajan
Study	2580	490	Muscle (Liza aurata) in estuaries Gorganroud
Study	2515	420	Liver (Liza aurata) in estuaries Babolroud
Study	1952	612	Liver (Liza aurata) in estuaries Tajan
Study	2704	1300	Liver (Liza aurata) in estuaries Gorganroud

Time is a very important factor in this case. In other words, the amount of the metals in sediment is strictly a function of weight, mass and time while in water, it is a function of present condition. Heavy metal concentration in fish is depended on age(fish life-long) and new contaminants. It is important to note that high levels of metals in the tissues can be highly disturbing whereas due the activity of the sea currents, newly deposited metals can be displaced and homogenized with aquatic environment and finally entered into the body of aquatics. Benthic-eating fish such as mullet can tolerate higher accumulation of these dangerous metals in their bodies. Consequently,

heavy metal contamination of the fish will follow by a serious danger to the health of the consumer.

#### Recommendations

- 1- Periodic, regional and multilateral monitoring of heavy metals in water and aquatics in the study area
- 2- Supporting regional and sectional researches on analyzing heavy metals
- 3- Conservation and Management of water resources and aquatics in the region and province
- 5- Creating a database at provincial level and cooperating with neighboring provinces of Caspian Sea in order to use its operation results

6- Study of sedimentation status of sea bed at commercial fishing are as in order to monitor sedimentation trend of heavy metal pollutants within the environmental time-series.

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