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The Comparison of Heavy Metals Concentrations in Different Organs of *Liza aurata* Inhabiting in Southern Part of Caspian Sea

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Abstract: In this study, Fe, Cu, Cd, Ni, Cr, Pb and Zn contents were determined in liver, gill and muscle of commercial fish specie (*Liza aurata*) that collected during April 2011 from the southern part of Caspian Sea (Mazandaran province) north of Iran. The levels of heavy metals were measured by atomic absorption spectrophotometry by flame atomic absorption after digestion of the samples. The concentrations of Cu, Cd, Fe and Zn were found to follow the order: liver >gill >muscle while the Ni, Cr and Pb level follows the sequence: gill>liver> muscle. The maximum concentrations of heavy metals were found in liver tissue of fish species, while the lowest concentrations were recorded in muscles tissue. The values of the heavy metals detected in the fish muscles were within the permissible limits except Pb.

Key words: Heavy metals · Liver · Gill · Muscle · Caspian Sea · Liza aurata

INTRODUCTION

Caspian Sea is located in the southeastern part of Europe at its border with Asia between 30°-47°N and 46.5°-55°E, with an elevation approximately 27.3m below sea level. The surface area of sea is 378,400km^2, with a basin volume of 78,170km^3. It has an average water depth of 210m and a maximum depth of 1025m [1]. Fish have been found as a good indicator for heavy metal contamination in aquatic systems because; they are lived in different trophic levels with different sizes and ages. Other studies detected the levels of some heavy metals in water, sediment and several organs of fish species collected from Abu-Zabal Lakes [2-5]. In addition, fish are located at the end of the aquatic food chain and may accumulate metals and pass them to human beings through food causing chronic or acute diseases [6]. The investigations of the nutrient position and toxic potential of food are an integral part of any dietary evaluation as a means of protecting human health [7, 8].

Among the numerous of organic and inorganic substances released into aquatic ecosystems, heavy metals have received considerable attention due to their different toxicity and potential bioaccumulation in different aquatic species [9-12]. It is known that a numbers of metals ions are essential for biological processes. Essential heavy metals are absolutely required by an organism to grow and complete its life cycle, become toxic when its concentration levels exceed those required for correct nutritional response by factors varying [13-16]. Meanwhile, some other metals such as Pb, Hg and Cd are toxic at quite low concentrations [17-20]. Lead and cadmium accumulated in autotrophic aquatic organisms through water and up take by macrophytes and fish and may pose a threat to human health. The increase of these heavy metal levels cause toxicity of aquatic biota [21]. The total areas of Caspian Sea are about 371,000 km^2 that lies between the Caucasus mountains and northern part of Iran. The salinity of Caspian Sea waters ranges from 4 pp_t in the northern parts to almost 13 ppt in the southern parts [22, 23]. This Sea is an enclosed system-environment without an outlet, various pollutants due to effluents from coastal catchments areas and leakage from offshore oil production and land-based sources have accumulated in Caspian Sea [22]. The mullet feeds on periphyton, detritus and small invertebrates. Thelarge quantities of soil may also be found in the intestines of the fish. *L. aurata*, like other species of mullet, is euryhaline (from freshwater to 38 ppt salinity and eurythermic (from 3 to 35°C) *L. aurata* is one of the commercially fish species the sea [24].

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The main objective of this study was to evaluate the concentrations of heavy metals (Cu, Cd, Cr, Fe, Ni, Pb and Zn) in certain tissues (liver, gills and muscle) of fish species *L. aurata* collected from inhabiting Caspian Sea, Iran, to compare with other selected areas in fish muscle for human health.

MATERIALS AND METHODS

At the present study, 16 samples of fish [*L. aurata*] were collected during April 2011 in southern part of Caspian Sea [north of Iran] with latitudes 36°N and longitudes 53°E, respectively. The total length (TL) and weight (W) were measured with accuracy about 1.0 mm and 0.001g, respectively. The samples preparations and analysis were carried out according to the procedure that described by [25, 26] Methods. A piece of liver, gill and muscle were taken, placed in separately pre-weighed acid cleaned flasks, dried at 80ºC using an oven, digested on a hot plate using nitric acid and perchloric acid (2:1). All samples were digested and then filtered by acid-resistant filter paper and made up to a known volume (20 ml) with distilled water. Fro determination of heavy metals concentration by using Atomic absorption flame spectrophotometer and graphite furnace atomic absorption spectrophotometer. The statistical analysis of data were carried out by using SPSS program. one-way ANOVA was employed to find the significant difference of heavy metals concentration in fish organs and the Tukey pair wise test for multiple comparisons was used to assess differences between the organs.

RESULTS AND DISCUSSION

The length and weight of *L. aurata* were varied from 14.0 to 37.0 cm and 39.0 to 219.0 g with average of (24.1±6.2) cm and (104.1±57.4) g, respectively. The concentrations of Cu, Cd, Cr, Fe, Ni, Pb and Zn in different organs such as gills, liver and muscle of the *L. aurata* from the Iranian coastal waters are presented in Table 2. As results showed that the concentrations of Cu, Cd, Fe and Zn were found to follow the order: liver> gill> muscle while the Ni, Cr and Pb level follows the sequence: gill> liver> muscle. The concentration of heavy were measured in different organs of all fish samples were highly significant ($P<0.05$; except for Cr; Table 2). The maximum concentrations of heavy metals were found in liver while the lowest levels of the metals were recorded in muscle. The concentrations of metals were in the orders: Fe> Cu> Zn> Pb> Cd> Ni> Cr in the liver and Fe> Zn> Cu> Pb> Ni> Cr> Cd in the gill and muscle, respectively.

The results showed that different metals are accumulated at different concentrations in the various organs of fish was observed. A numbers of studies

Table 1: The mean and standard deviations of total length (cm), Total weight (g) and Total length (cm) of fish *Liza aurata* from the Caspian Sea

Parameters	Mean(S.D.)	Min-Max	Numbers of Samples
Total length (cm)	24.06±6.213	11-37	16
Total weight (g)	104.06±57.390	39-219	16

Table 2: Concentrations (mean ± S.D μg g^{-1} dry weight) of metals in the liver, gill and muscle of *Liza aurata* of fish from southern part of Caspian Sea n=16

Metal	Liver	Gill	Muscle	F value	Sig
Cu	160.39±40.01	5.53±1.01	4.54±1.07	240.9	0.001
Cd	1.07±0.68	0.90±0.59	0.35±0.23	7.7	0.001
Cr	0.92±0.36	0.99±0.38	0.74±0.33	2.1	0.139
Fe	415.35±223.97	371.52±222.44	67.52±33.53	17.1	0.001
Ni	1.01±0.38	1.43±0.36	0.73±0.32	16.1	0.001
Pb	2.60±0.76	3.61±0.70	1.50±0.53	39.9	0.000
Zn	78.97±29.93	60.14±26.60	13.69±7.23	32.7	0.000

Table 3: Comparison of present values with other selected areas in fish muscle

Metal	This work (μg.g^{-1})	Literature values (μg.g^{-1})	References
Cu	3.33-6.91	3.40-5.88; 30	[37]
Cd	0.11-0.93	1.07-1.34; 0.5	[37]
Cr	0.18-1.08	1.28-1.60; 1.03-1.79	[37]
Fe	31.47-122.31	59.6-73.4; 29.10-93.60	[37]
Ni	0.18-1.11	1.21; 4.25-6.07; 0.32-1.72	[37]
Pb	0.43-2.33	0.821; 0.59; 0.5	[43]
Zn	3.15-26.07	16.1-31.4; 8.99-21.80; 40	[37, 43]

[10, 27] shown that the difference levels of accumulation in the different organs of a fish can primarily be attributed to the differences in the physiological role of each organ. Those conclusions support the results of this study. Meanwhile, regulatory ability behavior and feeding habits are other factors that influence the accumulation differences in the different organs [6, 12].

At the present study, the concentration of heavy metals in gill organ of fish was more than other organs such as liver, while muscles appeared to be the least preferred site for the bioaccumulation of metals as the lowest metal concentrations were detected in this tissue (Table 2). Some of researches [28-30] shown that the higher concentrations of heavy metals in gills could be due to the element complexion with the mucus that is impossible to completely remove from the gill lamellae before tissue is prepared for analysis. Other researches [31-33] shown that the concentrations of heavy metals were always lowest in the muscle and highest in the gill and liver. This is probably due to their physiological roles in fish metabolism. Furthermore, Ni recorded its highest concentration in gills and liver and its lowest concentration in muscle in *L. aurata* (Table 2). A comparison with a standard report [34] shown that the gill organ was highest accumulation with Pb (Table 2). Also, in fish livers of heavy metals were accumulates relatively higher amounts with [34] that compared of Table 2. At the present study, the concentration of Fe, Cu and Zn were relatively higher than other metals in liver. A numbers reports [35-38] shown that the ability of metaltionine to connect with heavy metals were not at the same levels for all metals because some metals have the highest ability to bind with other metals. On the other hand, Cr was less than the other metals in the liver (Table 2). Thus, the concentrations of Cr in both liver and gill were not consistently higher than in muscle ($P>0.05$). The higher accumulation in liver may alter the levels of various biochemical parameters in liver. The numerous studies have shown that the concentrations of heavy metal are higher than in liver when compared to other fish organs [39-41]. However, others reports [7, 42, 43] shown that the liver tissues in fish are more often recommended as an environmental indicator of water pollution than other fish organs. On the other hand, some of researches [4, 32, 44, 45] shown that the fish and other vertebrate proteins have metal binding, such as liver metaltionina. These proteins bind metals causing liver to accumulate more metals than other organs.

The muscle is one of the ultimate parts for heavy metal accumulation. To accomplish this task the results indicate that Fe, Cu and Zn accumulation was relatively higher than other metals in muscle (Table 2); in additional according to the results presented in the Table 2 distribution pattern of Cd was in the decreasing order of liver> gills> muscle [46, 47]. Furthermore, the results of study were lesser than the concentrations of metals in muscles than those in other organs examined. Other studies [30, 32, 48] were reported that the lesser concentrations of metals in the muscles than those in the livers and gills. Meanwhile, according to the results presented in Table 3, the concentrations levels of Fe, Cu, Cd, Ni, Cr and Zn in muscles of studied fishes were lower than the permissible limits, while concentrations level of Pb was higher than in other metals of other selected areas.

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