Determination of heavy metals in *Liza abu* from Karkheh and Bahmanshir Rivers in Khoozestan from Iran

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**ABSTRACT**

*Liza abu* is a species of the Mugilidae family from rivers in Khoozestan Province of Iran. The present study was carried out to investigate contamination of heavy metals (Hg, Cd, Pb, Cu, Zn, Fe and Mn) in gill, liver and muscle in *Liza abu* from Karkheh and Bahmanshir rivers in Khoozestan, Iran, in winter 2010. Heavy metal levels in fish samples were analyzed by Perkin Elmer 4100 atomic absorption. The results show that the highest Hg, Cd, Pb, Cu, Mn, Zn and Fe concentrations in fish samples were 29.66, 518.66, 1057.66, 369.33, 696 µg/Kg/dw, 10.62, 13.26 mgKg⁻¹dw. The highest and lowest concentration of heavy metals in tissues was done gill and muscle of *Liza abu*. Also, concentrations of heavy metals (mean±SD) in muscle, liver and gill of *Liza abu* from Bahmanshir river were higher than in *Liza abu* from Karkheh river (P<0.05), except for concentration of Fe that in *Liza abu* from Karkheh river were higher than in *Liza abu* from Bahmanshir river (P<0.05). The mean estimated concentrations for Cd, Hg, Cu and Zn in the present study were lower the International Standards for these metals as declare by the World Health Organization (WHO), Environmental Protection Agency (EPA) and Food and Drug Administration (FDA), but Pb higher than FAO and FDA.

**Key words:** Heavy metal, *Liza abu*, Karkheh, Bahmanshir, Khoozestan, Iran

**Introduction**

Fish are a major part of the human diet and it is therefore not surprising that numerous studies have been carried out on metal pollution in different species of edible fish [17,18,29]. Fish, apart of being a good source of digestible protein vitamins, minerals and polyunsaturated fatty acids (PUFA), [1,27,15] are also an important source of heavy metals.

Heavy metals still play an important role as pollutants affecting aquatic systems [24]. Some of the metals found in the fish might be essential as they play important role in biological system of the fish as well as in human being, some of them may also be toxic as might cause a serious damage in human health even in trace amount at a certain limit. The common heavy metals that are found in fish include copper, iron, copper, zinc and manganese, mercury, lead and cadmium [30,5,11,26]. Toxic elements can be very harmful even at low concentration when ingested over a long time period. The essential metals can also produce toxic effects when the metal intake is excessively elevated [7,34].

Heavy metal pollution of aquatic environment has become a great concern in recent years. HMs can have toxic effects on organs [20]. Heavy metals have the tendency to accumulate in various organs of marine organisms, especially fish, which in turn may enter into the human metabolism through consumption causing serious health hazards. Iron, copper, zinc and manganese are essential metals while, mercury, lead and cadmium are toxic metals [6].

The Khouzestan province has great water sources such as small and big rivers which involve about 33 percent of total water sources of Iran. Karoon, Dez, Karkheh and Bahmanshir are some of the major and important rivers in Khouzestan province those, one of the endemic species of these rivers is *Liza abu*. *Liza abu* [13] is a species of the Mugilidae family that goes to the sea for the completion of its reproduction cycle. This matter that, importance of the heavy metals measuring rate to two important subjects which are aquatics ecosystem management and human helth, this study was done with assessed of heavy metals in tissues of the liver, gill and muscle *Liza abu* in the Karoon, Dez, Karkheh and Bahmanshir Rivers.

**Materials and Methods**

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Fish samples were caught with river gill net from two rivers down stream of Karkheh and Bahmanshir rivers of Khoozestan, Iran. 126 samples each of two rivers were collected winter 2010. After capture, fishes were placed in plastic bags and transported to the laboratory in freezer bags with ice. samples were cut into pieces and labeled, and then all sampling procedures were carried out according to internationally recognized guidelines [38]. Total body length (mm) and weight (g) were recorded for fishes. The average length and weight of fish samples are presented in Table1.

Fish samples for heavy metals were put onto a dissection tray and thawed at room temperature. They were dissected using stainless steel scalpels and Teflon forceps using a laminar flow bench. In parallel gill, liver and a part of the muscle (dorsal muscle without skin) were removed and transferred in polypropylene vials. Subsequently, samples were put into an oven to dry at 90°C and reached constant weights in the oven. Before acid digestion, a porcelain mortar was employed to grind and homogenize the dry tissue samples. Aliquots of approximately 1 g dried gill, liver and muscle were digested in Teflon beakers for 12 h at room temperature, and then for 4h at 100°C with 5 ml ultrapure nitric acid (65%, Merck). Heavy metals analysis: Cd, Ni and Pb were measured by graphite furnace atomic absorption spectrophotometry (Perkin-Elmer, 4100 ZL ). Hg concentration was determined with a Perkin-Elmer MHS-FIAS coupled to a Perkin–Elmer 4100 ZL spectrophotometer. Results are expressed as mg/kg. The analytical procedure was checked using reference material (MESS-1, the National Center of Canada and CRM 277, the Community Bureau of Reference, Brussels, Belgium and details were in [31,2]. Data Statistics were performed using SPSS17 software. Paired sample T-Test was used to compare differences between samples. A P-value less of 0.05 was considered statistically significant [44].

Table 1: Mean length and weight of the species (Liza abu) examined in present study

<table>
<thead>
<tr>
<th>river</th>
<th>The number of samples</th>
<th>Length±SD (cm)</th>
<th>Weight±SD (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahmanshir</td>
<td>36</td>
<td>19.77±0.87</td>
<td>104±9.94</td>
</tr>
<tr>
<td>Karkheh</td>
<td>36</td>
<td>16.52±0.72</td>
<td>86±6.28</td>
</tr>
</tbody>
</table>

Results:

Concentration levels of seven metals in muscle, liver and gill of Liza abu were measured and presented in table2. Concentrations of metals are presented in μg Kg⁻¹ dry weight unless otherwise mentioned.

Table 2: The concentrations of heavy metals in tissues of Liza abu (Hg, Cd, Pb, Mn, Cu, μgKg⁻¹ and Zn, Fe, mgKg⁻¹) (mean±SD)

<table>
<thead>
<tr>
<th>tissues metals</th>
<th>Karkheh</th>
<th>Bahmanshir</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Muscle</td>
<td>Liver</td>
</tr>
<tr>
<td>mercury</td>
<td>17.80±1.17</td>
<td>18.43±1.04</td>
</tr>
<tr>
<td>Cadmium</td>
<td>258±13</td>
<td>280±15.52</td>
</tr>
<tr>
<td>Lead</td>
<td>732±10.53</td>
<td>764±10.39</td>
</tr>
<tr>
<td>Manganese</td>
<td>623.66±30.61</td>
<td>640.33±25.57</td>
</tr>
<tr>
<td>Copper</td>
<td>240.66±13.05</td>
<td>269.66±5.03</td>
</tr>
<tr>
<td>Zinc</td>
<td>8.07±0.42</td>
<td>8.24±1.58</td>
</tr>
<tr>
<td>Iron</td>
<td>12.06±0.68</td>
<td>12.86±0.25</td>
</tr>
</tbody>
</table>

a: non-significant differences at p=0.05
b: significant differences at p<0.05

The mean estimated concentrations for Cd, Hg, Cu, Pb and Zn in the present study were lower the International Standards (table 3)for these metals as declare by the World Health Organization (WHO), Environmental Protection Agency (EPA) and Food and Drug Administration (FDA).

Table 3: The tolerable values of some heavy metals in the fish (mgkg⁻¹)

<table>
<thead>
<tr>
<th>Standards</th>
<th>Cd</th>
<th>Pb</th>
<th>Zn</th>
<th>Hg</th>
<th>Cu</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO¹</td>
<td>0.2</td>
<td>2</td>
<td>-</td>
<td>0.5</td>
<td>30</td>
<td>WHO,1996</td>
</tr>
<tr>
<td>FDA²</td>
<td>2</td>
<td>0.5</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
<td>Chen and Chen,2001</td>
</tr>
<tr>
<td>UK(MAFF)³</td>
<td>0.2</td>
<td>2</td>
<td>50</td>
<td>0.5</td>
<td>20</td>
<td>MAFF 1995</td>
</tr>
<tr>
<td>NHMRC⁴</td>
<td>0.05</td>
<td>1.5</td>
<td>150</td>
<td>1</td>
<td>10</td>
<td>Chen and Chen,2001</td>
</tr>
<tr>
<td>FAO⁵</td>
<td>0.5</td>
<td>0.5</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>FAO 1983</td>
</tr>
<tr>
<td>This study</td>
<td>258-518.66</td>
<td>732-1057.66</td>
<td>8.07-10.62</td>
<td>0.017-0.029</td>
<td>240.66-369.33</td>
<td></td>
</tr>
</tbody>
</table>

¹- World Health Organization
²- U.S. Food and Drug Administration
³- Ministry of Agriculture, Fisheries & Food (UK)
⁴- National Health & Medical Research Council (Australia)
⁵- Food and Agriculture Organization
Discussion:

The highest and lowest concentration of heavy metals in tissues was done gill and muscle of Liza abu. The distribution patterns of Hg, Cd, Pb, Mn, Cu, Zn and Fe in tissues of Liza abu from Karkheh and Bahmanshir rivers follows the order: gill> liver> muscle. Heavy metal concentrations were higher in the gill and liver, when compared with muscle. Heavy metal levels varied no significantly in different tissues of the same Liza abu. Particularly, Fe and Zn concentrations were very high in the liver, gill and muscle. Gills and livers were chosen as target organs for assessing metal accumulation. The concentrations of metals in gills [13].

Estimation of the levels of various elements in different fish species as a measure of environmental pollution has been of great concern over decades. A variable range of different metal concentrations has been observed by various researchers worldwide [3]. The absorption of metals on to the gill surface, as the first target for pollutants in water, could also be an important influence in the total metal levels of the gill [14]. The metals Fe and Hg were the highest and lowest in tissues of Liza abu. Distribution patterns of metal concentrations in the gill, liver and muscle of Liza abu from Karkheh and bahmanshir rivers follows the order: Fe>Zn>Pb>Mn>Cd>Cu>Hg. There are various studies on the heavy metal levels in fish from different waters. Oymak et al. [27] studied the heavy metal levels in kidney, liver, gill and muscle of Tor grypus which concentration of Fe and Zn were higher than other metals. Also, Turkmen et al. [35] studied the heavy metal levels in muscle, liver, gonad, and gill of gilthead seabream (Sparus aurata), European seabass (Dicentrarchus labrax), and keeled mullet (Liza carinata) which concentration of Fe and Zn were higher than other metals. The levels of Fe and Zn in all tissues were higher than the Cu and Mn levels, as Zn is present in many enzymes and Fe is used to transport oxygen throughout the fish’s body [28].

The concentrations of Hg, Cd, Pb, Mn, Cu and Zn in gill, liver and muscle of Liza abu from Bahmanshir river were higher than in Liza abu from Karkheh river (P<0.05), except the concentration of Fe that in Liza abu from Karkheh river was higher than in Liza abu from Bahmanshir river (P>0.05) (Table 2).

The concentrations of Hg, Cd, Pb, Mn, Cu and Zn in gill, liver and muscle of Liza abu from Bahmanshir river were higher than in Liza abu from Karkheh river (P>0.05). Metal concentration in the gills could be due to the element complexing with the mucus, which is impossible to remove completely from between the lamellae, before tissue is prepared for analysis. Thus high concentration of various metals can be observed there [14].

The concentrations of Pb in gill, liver and muscle of Liza abu from Bahmanshir river were higher than in Liza abu from Karkheh river (P>0.05), The Pb values in fish species were found to be in range of 0.068–0.874 mgg-1. These values were lower than those reported earlier in fish species of different lakes [4,22]. Turkish acceptable limits and EU limits were 0.4 mgg-1. The range of international standards for Pb in fish is 0.5–10 mgg-1 [9, 35, 43].

Manganese is of low toxicity, it has a considerable biological significance and seems to accumulate in certain fish species [10, 41]. Manganese is one of vital important essential trace element, it is a structure component of some enzymes and active the actions of some enzymes [37]. This study the concentrations of Mn in gill, liver and muscle of Liza abu from Bahmanshir river were higher than in Liza abu from Karkheh river (P<0.05), while Average Mn content of different tissues varied from 0.11 to 24.23 lg g⁻¹ in Leuciscus cephalus and 1.07–12.43 lg g⁻¹ in Lepomis gibbosus. Our results of Mn content in the samples were higher than the results reported by Mendil et al. [22] for fish species in lakes of Tokat. However, the concentration of Mn obtained in present study was lower than those given for Silurus triostegus and Liza abu from Ataturk Dam Lake [16].

It is known that arsenic, mercury, lead and cadmium are the most commonly distributed environmental metal poisons [31]. They are accumulated in human tissues and may be the cause of some diseases [32,43]. Ahmad et al. [1] reported that among five metals (Pb, Cd, Ni, Cu, Cr) studied Pb concentration was the highest in Gudusia chapra of Buriganga river, Bangladesh, that the result of our study was similar to the above result. The Pb finds its way in rivers through the discharge of industrial waste waters, such as from painting, dyeing, battery manufacturing units and oil refineries etc. Pb also enters the rivers both from terrestrial sources and atmosphere and the atmospheric input of Pb aerosols can be substantial [25].

In this study minimum metal levels were found as 17.80 (Hg), 258 (Cd), 732 (Pb), 623.66 (Mn), 240.66 µKg⁻¹ dw, (Cu), 8.07 (Zn), 11.81 mg Kg⁻¹ dw (Fe), and minimum metal levels were found as 29.66 (Hg), 518.66 (Cd), 1057.66 (Pb), 696 (Mn), 369.33 µKg⁻¹ dw (Cu), 10.62 (Zn), 13.26 mgKg⁻¹ dw (Fe). Minimum and maximum concentrations in milligrams per kilogram for fish livers in literature were reported as 10.27-19.74 for Zn, 0.101-2.785 for Cu, ND (Not determined)-0.649 for Hg, ND-0.236 for Pb and Cd was not determined [25]. The observed variability of heavy metal levels in different species depends on feeding habits [33], ecological needs, metabolism [5], age, size and length of the fish [18] and their habitats [6,37].

Conclusions:
The level of the taken into consideration metal were shown no significant differences between the tissues throughout in *Liza abu*. Levels of metals found in the tissues of *Liza abu* from Bahmanshir were higher than those found in *Liza abu* from Dez. The order of the metal concentrations found in muscle, liver and gill tissues of both species were Fe > Zn > Pb > Mn > Cd > Cu > Hg.

Also, concentrations of heavy metals (mean±SD) in muscle, liver and gill of *Liza abu* from Bahmanshir river were higher than in *Liza abu* from Karkheh river (P>0.05), except for concentration of Fe that in *Liza abu* from Karkheh river were higher than in *Liza abu* from Bahmanshir river (P>0.05). Results in this study showed accumulation of Hg and Cd was lower than FDA standard but accumulation of Pb higher than WHO standard.

References


