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# Cadmium, Iron, Lead and Mercury Bioaccumulation in Abu Mullet, *Liza abu*, Different Tissues from Karoun and Karkheh Rivers, Khozestan, Iran

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**Abstract** Lead, mercury, cadmium and iron concentration in following tissues: muscle, liver and gill of *Liza abu* in Karoun and Kharkheh were measured. Karoun and Kharkheh are important rivers in Iran. Significant variation in metal values were evaluated using Student's *t* test at $p < 0.05$. Result showed that maximum concentration of metals were recorded in gill tissues. Iron concentration was higher than lead, cadmium and mercury in different organs ($p < 0.05$). The level of metals Cd, Hg, Fe in different tissues of Karoun river was higher than Karkheh river ($p < 0.05$). Metals level in different tissue were upper than WHO standard.

**Keywords** Metals · *Liza abu* · Karoun · Karkheh

Karoun and Karkheh are important rivers in the southern part of Iran. Karoun river is the largest river in Iran and has an area of 60,500 km$^2$ with an average annual discharge of 18,700 mcm, also Dez river is one of the watery river in Iran and has an area of 21,100 km$^2$ with an average annual discharge of 7,396 million m$^3$ (Mohammadi et al. 2011). Sub-lethal pollution of heavy metal is one of human destructive influence on the aquatic environment, which results in chronic stress conditions that have negative effect on the aquatic life. In aquatic ecosystem, heavy metals have received considerable attention due to their toxicity and accumulation in biota and fish. In fish, the toxic effects of metals may influence physiological functions, individual growth rates, reproduction and mortality (Farag et al. 1995). Heavy metals enter fish bodies through three following ways; body surface, gill or the digestive tract (Pourang 1995). Food may also be an important source of heavy metals accumulation in fish (Clearwater et al. 2000) due to polluted water, sediments and potentially leading to bio magnification, the increase of pollutants to the food chain. Fish are located at the top of aquatic food chain and may concentrate large amounts of some metals from the water. Metal bioaccumulation is largely attributed to differences in uptake and depuration period for various metals in different fish species (Tawari-Fufeyin and Ekaye 2007). Karadede-Akin and Ünlü (2007) measured heavy metals in water, sediment, fish and benthos in Tigris river from Turkey, results showed that heavy metal concentrations in fish could be measured as an indicator of contamination in the aquatic environment. *Liza abu* is from Mugilidae family, which are marine fishes in the coastal waters and the brackish waters of tropical and temperate regions and are present in all oceans. Some of them live in fresh water. *L. abu* is present only in fresh waters and estuaries (Karadede-Akin and Ünlü 2007). In Iran, despite extensive water resources, especially in the southern coast and extensive use of seafood so far little research have been done in the field of measuring heavy metals in different organs of fish in the Khouzetan Province. So according to undesirable long term effects of heavy metals on health and the possibility of entering of these pollutants into the life cycle, in this study the accumulation of following heavy metals, cadmium, lead, mercury and iron were evaluated in the tissues of *L. abu* from Karoun and Karkheh.

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## Materials and Methods

The concentration of heavy metals cadmium, lead, mercury and iron were measured in the muscle, gills and liver of (*L. abu*) caught by gillnet from downstream of Karoun (Integrated fish around Azadegan) and Karkheh (Village near Shavur) rivers of Khouzestan in winter 2009. Seventy-two samples were collected from each river. After capture, fish were placed in plastic bags and transported to the laboratory in freezer bags with ice. The mean length and weight were measured which ranged from minimum to maximum value as 163.3 ± 11.7 mm for length and 47.77 ± 12.01 g for weight of *L. abu* in Karoun river and the corresponding values in Karkheh river were measured as 165.2 ± 7.2 mm for length and 86 ± 6.28 g for weight. Total body length (mm) and weight (g) were recorded for fishes. After biometry, fish were immediately frozen at −20°C. All samples were cut into pieces and labeled, and then all sampling procedures were carried out according to internationally recognized guidelines (UNEP 1991). Fish samples for metals were put into 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 their 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 4 h at 100°C with 5 mL ultrapure nitric acid (65%, Merck). Metals analysis: Cd, Ni and Pb were measured by graphite furnace atomic absorption spectrophotometer (Perkin-Elmer, 4100 ZL). Hg concentration was determined with a Perkin–Elmer MHS-FIAS coupled to a Perkin–Elmer 4100 ZL spectrophotometer. Results were expressed as mg/kg dry weight. 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 Mohammadi et al. (2011)]. For each matrix, analyses of three blank samples were performed along with the samples. Quality control was assured by the analysis of reagent blank and procedural blanks. Data were analyzed statistically with SPSS 17 software. Paired samples t-test was used to compare differences between samples. A $p$ value less of 0.05 was considered statistically significant.

## Results and Discussion

The average concentration of heavy metals were measured in Karun and Karkheh and according to the result, the minimum and maximum average of heavy metals were measured in muscle and gill respectively. The results showed a positive linear relationship in following heavy metal concentrations: lead, mercury and cadmium in muscle, liver and gills in Karun river ($p < 0.05$) which same situation was observed between corresponding values in Karkheh River. No significant difference was observed between Lead concentrations in muscle and liver, but significant difference was observed in Lead concentration in muscle and liver were with its corresponding values in gills ($p < 0.05$). The average metal concentrations of lead, mercury, cadmium and Iron in muscle, liver and gills of *L. abu* were showed in Table 1 and their comparison with heavy metals (mg $kg^{-1}$dry weight) in muscle of *(L. abu*) with WHO, FDA, MAFF, NFA, NHMRC standard were presented in Table 2.

Metals based on their target organs of its metabolic activity were selected. This point, caused in the accumulation of metals in tissues such as liver and kidney in comparison with muscle (low metabolic) activity should be interpreted. Liver and gills are considered good indicators in terms of long-term exposure to heavy metals due to the position of tissues, metabolism of metals (Filazi et al. 2003). Most of fish organs are sensitive against toxicity of heavy metals. In this study muscle tissues due to their important role in human nutrition and the need to ensure the safety for consumption, gill tissues due to their rules in respiration and osmotic balance and liver due to being a member that main metabolism and major injuries will endure in, were chosen (Pourang 1995).In this study, the highest metal concentrations in fish in (*L. abu*) Karoun and Karkheh river observed in gill tissue. High metal concentrations in gill tissue may be due to specific physiological function of this organ in respiration and osmotic balance. Oymak et al. (2009) on the fish in (*Tor grypus*) Ataturk dam lake on the Euphrates River in Turkey, Yilmaz et al. in (2007), on the freshwater fish (*Tilapia, Oreochromis aureus*). With results based on the maximum uptake of heavy metals in the body conforms to the gills (Oymak et al. 2009; Yilmaz et al. 2007).

Metal concentrations were higher in liver than muscles, because muscles are not the primary storage location, heavy metals are stored in the liver first and then are transferred to the muscle. Muscle tissue are usually with the lowest levels of heavy metals in fish (Al-Yousuf et al. 2000).

In this study, the lowest biological accumulation of metals in fish (*L. abu*) from Karun and Karkheh rivers were observed in muscle tissue. Research results Yilmaz et al. (2007) on fish (*Lepornis gibbosus, Leuciscus cephalus*), Chi et al. (2007) on fish (*Cyprinus Carpio*, *Carassius auratus*) in Lake Tayhu in China, Pierre on water, sediment and fish in Lake Madivala in Bngalur and Kanatakata,

**Table 1** Concentrations of metals (mg kg$^{-1}$dry weight) in various tissues of *(L. abu)* in Karoun and Karkheh rivers, Khoozestan, Iran

| Tissues | River | Cd | Pb | Fe | Hg |
|---|---|---|---|---|---|
| Gill | Karoun | $0.54 \pm 0.26^{a}$ | $1.08 \pm 0.12^{a}$ | $14.04 \pm 0.08^{a}$ | $0.027 \pm 0.002^{a}$ |
| | Karkheh | $0.288 \pm 0.01^{b}$ | $0.77 \pm 0.01^{b}$ | $13.26 \pm 0.20^{a}$ | $0.019 \pm 0.000^{b}$ |
| Liver | Karoun | $0.52 \pm 0.03^{a}$ | $1.03 \pm 0.13^{a}$ | $13.5 \pm 0.11^{a}$ | $0.026 \pm 0.002^{a}$ |
| | Karkheh | $0.28 \pm 0.01^{b}$ | $0.74 \pm 0.01^{b}$ | $12.86 \pm 0.25^{a}$ | $0.018 \pm 0.001^{b}$ |
| Muscle | Karoun | $0.49 \pm 0.02^{a}$ | $0.97 \pm 0.14^{a}$ | $13.08 \pm 0.20^{a}$ | $0.024 \pm 0.001^{a}$ |
| | Karkheh | $0.25 \pm 0.01^{b}$ | $0.73 \pm 0.01^{b}$ | $12.06 \pm 0.68^{a}$ | $0.017 \pm 0.001^{b}$ |

Data were presented as means ± S.E[a, b] $p < 0.05$, significantly different in each tissue between two rivers

**Table 2** Comparison of metals (mgkg$^{-1}$dry weight) in muscle of *(L. abu)* in comparison with WHO, FDA, MAFF, NFA, NHMRC standards in Karoun and Karkheh rivers, Khoozestan, Iran

| Species | River | Cd | Pb | Hg | Fe |
|---|---|---|---|---|---|
| (*L. abu*) | Karoun | $0.84 \pm 0.08^{a}$ | $1.75 \pm 0.10^{a}$ | $0.46 \pm 0.05^{a}$ | $0.73 \pm 0.06^{a}$ |
| | Dez | $1.09 \pm 0.01^{b}$ | $1.29 \pm 0.06^{b}$ | $0.85 \pm 0.05^{b}$ | $0.90 \pm 0.03^{b}$ |
| | Karoun | $1.67 \pm 0.05^{a}$ | $2.37 \pm 0.42^{a}$ | $1.15 \pm 0.08^{a}$ | $1.28 \pm 0.06^{a}$ |
| | Dez | $0.79 \pm 0.06^{b}$ | $0.95 \pm 0.10^{b}$ | $0.59 \pm 0.01^{b}$ | $0.77 \pm 0.14^{b}$ |
| WHO standard | | $0.2^{c}$ | $0.5^{c}$ | $0.1^{c}$ | – |
| FDA standard | | $2^{a}$ | – | $0.1–0.5^{c}$ | $0.5^{c}$ |
| MAFF standard | | $0.2^{c}$ | $2^{c}$ | – | – |
| NFA standard | | $0.2^{c}$ | – | – | – |
| NHMRC standard | | $0.05^{c}$ | $1.5^{c}$ | $1^{c}$ | – |

[a, b, c] $p < 0.05$, significantly different in muscle of (*L. abu*) in comparison with WHO(World Health Organization) standard. FDA (U.S. Food and Drug Administration). MAFF (Ministry of Agriculture Fisheries, & Food (UK). NFA[National Health & Medical Research Council (Australia)]. NHMRC (National Food Authority, Food Standard)Reference: WHO (1985); Collings et al. (1996); Darmono and Denton (1990)

Oymak et al. (2009) on fish in (*Tor grypus*) Ataturk dam lake on the Euphrates River in Turkey, Edem chritopher et al. (2009) on fish (*Orechromis nilotica*) and Nwani et al. (2010) on freshwater fish Afiko ecosystem in Nigeria.With results based on a minimum amount of uptake of heavy metals in limb muscles is consistent (Yilmaz et al. 2007; Chi et al. 2007; Oymak et al. 2009; Nwani et al. 2010).

Among the metals (cadmium, lead, mercury and iron), iron had the highest concentration. Research results Turkmen and colleagues (2008) on the Gar fish (*Belone belone*) and Bluefish (*Pomatouomus saltarix*) in the waters of Turkey, Turkmen et al. (2010) on fish tissue Yelkoma wetlands in Turkey, with results based on metallic iron magnitude in comparison with other metals are consistent (Turkmen et al. 2010). In this study, mercury in comparison with other metal had the lowest concentration. Alinnor and Obiji (2010) in a sample of fish in the Nworie river in Pakistan with the research findings regarding low compared with mercury metal Other metals are consistent (Alinnor and Obiji 2010).

Comparison of cadmium, lead, mercury and lead in fish muscle (*L. abu*) from Karun and Karkheh rivers with international standards indicate Above-normal levels of cadmium metal in comparison with world standards WHO NFA NHMRC UK (MAF) and low concentrations of this metal was FDA standards. Lead metal levels higher than international standards and WHO world standard was lower than UK (MAFF) and NHMRC. Iron metal concentration was higher than FDA standards The concentration of mercury was lower than world standard WHO and FDA. In this study, cadmium and lead concentration in fish muscle (*L. abu*) Karoun and Karkheh rivers in the limit of World Health Organization (UK (MAFF), NFA, WHO, HMRC) and the (WHO)was higher, which results Tuzen (2009) on 10 fish species from the Black Sea, is consistent (Tuzen 2009; WHO 1985; Collings et al. 1996; Darmono and Denton 1990).

Any change in the process of absorption and accumulation of heavy metals in fish can be effective due to various factors such as aquatic type, element type, tissue, sex, weight and age of aquatic, food habits fish Fyryvlvzhyk characteristics, ecological characteristics and environmental conditions and the physical and chemical properties such as hardness of water environment, pH, temperature, nutrients and fish growth (Mohammadi et al. 2011). Minimal accumulation and storage of heavy metals in these families by Usero et al. (2003) on fish (*L. auratus*) in the southern Atlantic coast of Spain, Filazi et al. (2003) on fish (*Mugil auratus*) in the Black Sea Turkey, Karadede et al. (2004) on fish (*L. abu*) in Lake Ataturk, Turkmen et al.

(2010) on fish (*L. carinata*) is proven (Usero et al. 2003; Filazi et al. 2003; Karadede et al. 2004; Turkmen et al. 2010).

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