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Determination of mercury, cadmium, arsenic and lead in muscle and liver of *Liza dussumieri* from the Persian Gulf, Iran

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Abstract

The present study was carried out to investigate contamination of heavy metals Mercury, Cadmium, Arsenic and Lead in liver and muscle of *Liza dussumieri* from Persian Gulf, Iran, in 2012. Heavy metal levels in fish samples were analyzed by Perkin Elmer 4100 atomic absorption. This study concentration of heavy metals Hg, As, Cd and Pb in muscle and liver of *Liza dussumieri* significant difference ($P<0.05$). The mean estimated concentrations for Hg, Cd and As in the present study in samples from Boshehr were higher than in Deylam. Level of Pb in muscle of *Liza dussumieri* from Deylam were higher in Boshehr, Pb concentration in liver (0.498 ± 0.014 $mgKg^{-1}$) of *Liza dussumieri* from Boshehr were higher in Deylam. The mean estimated concentrations for Hg, Cd and Pb in the present study were lower than international Standards for these metals as declare by the World Health Organization, Ministry of Agriculture, Fisheries and Food (UK), Food and Agriculture Organization (FAO) and National Health & Medical Research Council (Australia).

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Introduction

The Persian Gulf is located in the south and south east of Iran with average area and depth of 240,000 km^2 and 35 m, respectively. The Persian Gulf is characterized by warm and saline water and is a shallow sea such as the Baltic and North Sea. The depth of the Persian Gulf decreases from east to west with maximum depth of 90 m in the strait of Hormoze (Agah *et al*., 2009; Agah *et al*., 2012).

The contamination by heavy metal is one of real problem which human was exposed, can cause harmful effect on air,water,soil, plant and human health. Industrial waste , chemical structure of land and metal of mining can be considered as source of heavy metal pollution in aquatic environment (Turkmen and Ciminli, 2007; Vinodhini and Narayanan, 2008). Marine organisms, in general, accumulate contaminants from the environment and therefore have been broadly used in marine pollution monitoring studies. Heavy metals discharged into the marine environment can damage both marine species diversity and ecosystems, due to their toxicity and accumulative behaviour (Sivaperumal *et al.,* 2007).

The heavy metals are from the pollutants which create too much problems in aquatic ecosystems for aquatics and human (Askary Sary *et al*., 2012; Javaheri Baboli and Velayatzadeh, 2013). Heavy metal pollution of aquatic environment has become a great concern in recent years. HMs can have toxic effects on organs (Macfarlane and Burchettt, 2000). 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 (Canli and Atli, 2003). Heavy metals still play an important role as pollutants affecting aquatic systems (Merian, 1991).

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 (Rashed, 2001; Canli and Atli, 2003; Fernandes *et al*., 2008). 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 (Celik and Oehlenschlager, 2007; Schroeder, 1973).

This matter that, importance of the heavy metals measuring related to two important subjects which are aquatics ecosystem management and human helth (Romeo *et al*., 1999; Jordao *et al*., 2002), the present study was carried out to determine the level of Mercury, Cadmium, Arsenic and Lead in muscle and Liver of *Liza dussumieri* from Boshehr and Deylam Port areas, located on the north of Persian Gulf. Both city have direct connection to Persian Gulf. The fish and fish products for the people in those ports are generally catched. No data exist on Mercury, Cadmium, Arsenic and Lead levels in this fish from mentioned areas.

Material and methods

Sampling

The *Liza dussumieri* in this study were collected 36 samples by local fisherman from the north Persian Gulf (Iran, Boshehr and Deylam Port areas) took place twice in 2012. 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 (UNEP, 1991). Total fish weight and length were measured to the millomete and gram.

Apparatus

A Perkin-Elmer, model 4100 ZL atomic absorption spectrophotometer, equipped with a GTA Graphite furnace, was used. Pyrolytic-coated graphite tubes with a platform were used and signals were measured as peak areas. The instrument setting and furnace programmes for analysis of Cadmium, Arsenic and Lead metals are described.

Perkin Elmer Analyst 4100 model AAS equipped with MHS 15 CVAAS system was used for mercury determination. A hallow cathode lamp operating at 6 mA was used and a spectral bandwidth of 0.7 nm was selected to isolate the 253.7 nm mercury line. $NaBH_4$ (1.5%) (w/v) in NaOH (0.5%) (w/v) was used as reducing agent. The analytical measurement was based on peak height. Reading time and argon flow rate was selected as 10 s and 50 ml min-1. Milestone Ethos D microwave (Sorisole-Bg, Italy) closed system (maximum pressure 1,450 psi, maximum temperature 300◦C) was used.

Reagents

All reagents were of analytical reagent grade unless otherwise stated. Double distilled water was used for the preparation of solution. All the plastic and glass ware were soaked in nitric acid for 15 min and rinsed with deionized water before use. The stock solutions of metals (1000 mgl^{-1}) were obtained by dissolving appropriate salts of the corresponding metals (E. merk) and further diluted prior to use. High purity Argon was used as inert gasted prior to use.

Chemical analyses (Wet-ashing)

The samples were solubilized using high-pressure decomposition vessels, commonly known as a digestion bomb. A sample (1gr) was placed in to Teflon container and 5 ml of concentrated HNO_3 was added. The system was heated to 130° C for 90 min and finally diluted to 25 ml with deionized water. The sample solution was clear. A blank digest was carried out in the same way. Zinc and Lead metals were determined against aqueous standards.

Statistical analysis

Analysis of variance (ANOVA) was run for all the collected data for fish samples different using SPSS (16 version) computer programs. Mean values of each parameter were compared using Fisher's protected least tests with significance levels of 5% were conducted on each metal to test for significant differences between sites. All statistical analyses were conducted using the Office Excel 2003 software package.

Results and discussion

Determination metals

Concentration levels of metals Hg, As, Cd and Pb in muscle and liver of *Liza dussumieri* were measured and presented in Table 1. Concentrations of metals are presentedin µg Kg^{-1} wet weight unless otherwise mentioned. This study concentration of heavy metals Hg, As, Cd and Pb in muscle and liver of *Liza dussumieri* significant difference between ($P<0.05$). The distribution patterns of metals Hg, As, Cd and Pb in tissues of *Liza dussumieri* follows the order: liver> muscle (Fig. 1,2).The mean estimated concentrations for Hg, Cd and As in the present study in samples from Boshehr were higher than in Deylam. Level of Pb in muscle of *Liza dussumieri* from Deylam were higher than in Boshehr, but concentration of Pb in liver of *Liza dussumieri* from Boshehr were higher than in Deylam. 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 (Ashraf *et al*., 2006). 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 liver (Heath, 1987).

Table 1. The mean Hg, As, Cd and Pb ($mgKg^{-1}$) in muscle and liver of *Liza dussumieri* from the north Persian Gulf (Iran, Boshehr and Deylam Port).

Location	tissue	Mercury	Arsenic	Cadmium	Lead
Boshehr	muscle	0.072 ± 0.007^a	0.151 ± 0.028^a	0.201 ± 0.009^a	0.362 ± 0.013^a
	liver	0.092 ± 0.005^b	0.255 ± 0.007^b	0.299 ± 0.008^b	0.498 ± 0.014^b
Deylam	muscle	0.062 ± 0.006^c	0.136 ± 0.010^c	0.164 ± 0.011^c	0.376 ± 0.018^c
	liver	0.073 ± 0.006^a	0.176 ± 0.004^d	0.211 ± 0.009^d	0.428 ± 0.005^d
	max	0.100	0.266	0.312	0.520
	min	0.051	0.111	0.148	0.302

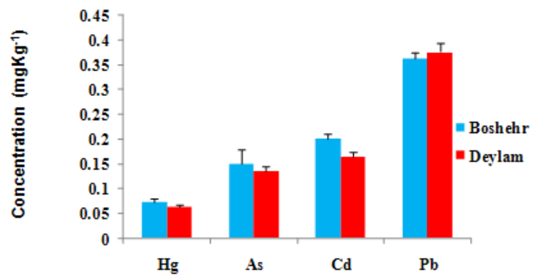

Fig. 1. Heavy metal concentrations (mg Kg^{-1}) in muscle of *Liza dussumieri* from the north Persian Gulf (Iran, Boshehr and Deylam Port).

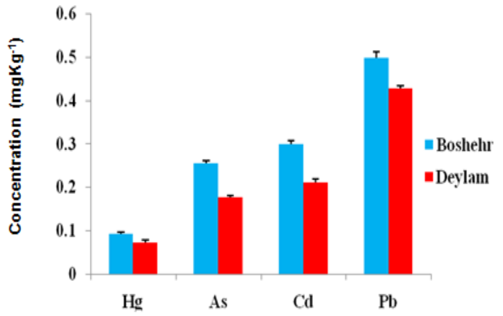

Fig. 2. Heavy metal concentrations (mg Kg^{-1}) in liver of *Liza dussumieri* from the north Persian Gulf (Iran, Boshehr and Deylam Port).

Comparison of International Standards

It is known that arsenic, mercury, lead and cadmium are the most commonly distributed environmental metal poisons (Askary Sary and Velayatzadeh, 2012). They are accumulated in human tissues and may be the cause of some diseases (Rodriguez *et al.*, 2003; Yilmaz *et al.*, 2007). The mean estimated concentrations for Hg, Cd and Pb in the present study were lower than international Standards for these metals as declare by the World Health Organization, Ministry of Agriculture, Fisheries and Food (UK), Food and Agriculture Organization (FAO) and National Health & Medical Research Council (Australia) (Fig. 3). Concentrations of As in this study were lower than international Standards Ministry of Agriculture, Fisheries and Food (UK) and National Health & Medical Research Council (Australia), but the As higher than World Health Organization (WHO) (Fig. 4).

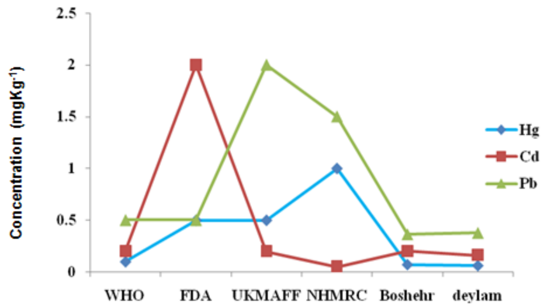

Fig. 3. Comparison of Hg, Cd and Pb concentrations ($mgKg^{-1}$) in muscle of *Liza dussumieri* with standards (World Health Organization, U.S. Food and Drug Administration, Ministry of Agriculture, Fisheries & Food (UK), National Health & Medical Research Council (Australia), Food and Agriculture Organization).

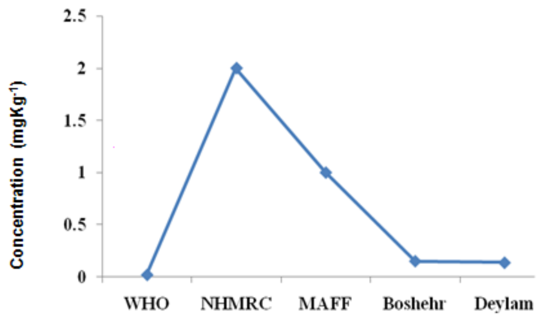

Fig. 4. Comparison of Arsenic concentrations ($mgKg^{-1}$) in muscle of *Liza dussumieri* from the north Persian Gulf (Iran, Boshehr and Deylam Port) with standards.

Comparison of heavy metals

There are various studies on the heavy metal levels in fish from different waters. In this study minimum metal levels were found as 0.051 (Hg), 0.148 (Cd), 0.302 (Pb), 0.111 (As) $mgKg^{-1}$ww and maximum metal levels were found as 0.100 (Hg), 0.312 (Cd), 0.520 (Pb), 0.266 (AS) mg Kg^{-1} ww. Minimum metal levels in *Liza abu* were found as 17.80 (Hg), 258 (Cd), 732 (Pb), 623.66 (Mn), 240.66 μgKg^{-1}dw, (Cu), 8.07 (Zn), 11.81mg Kg^{-1} dw (Fe), and maximum metal levels were found as 29.66 (Hg), 518.66 (Cd), 1057.66 (Pb), 696 (Mn), 369.33 µg Kg^{-1} dw (Cu), 10.62 (Zn), 13.26 mg Kg^{-1} dw (Fe) (Askary Sary *et al.*, 2012). Minimal accumulation and storage of heavy metals in these families by Usero *et al.*, (2003) on fish (*Liza 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 (*Liza abu*) in Lake Ataturk, Turkmen *et al.* (2010) on fish (*Liza carinata*) is proven (Usero *et al.*, 2003; Filazi *et al.*, 2003; Karadede *et al.*, 2004; Turkmen *et al.*, 2010).

The observed variability of heavy metal levels in different species depends on feeding habits (Romeo *et al.* 1999), ecological needs, metabolism (Canli and Furness, 1993), age, size and length of the fish (Linde *et al.*, 1998) and their habitats (Canli and Atli, 2003; Tuzen and Soylak, 2007).

Oymak *et al.*, (2009) studied the heavy metal levels in kidney, liver, gill and muscle of *Tor grypus* and Maaboodi *et al.*, (2011) studied the concentration of Zn and Pb in liver of Carrassius, *Cyprinus carpio*, *C. aculeate* and *C. damasciana* which concentration of Zn were higher than Pb. Also, Turkmen *et al.*, (2010) 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 Zn were higher than Pb. The levels of Zn in all tissues were higher than the Pb levels, as Zn is present in many enzymes throughout the fish's body (Oymak *et al.*, 2009).

In this study concentrations of Hg, As, Cd and Pb in liver of *Liza dussumieri* higher than muscle. Muscle tissue is the main edible fish part and can directly influence human health. Lead enters into the body with gill cells and especially is accumulated in gills and the later aim organs are liver and muscle (Sadeghi-Rad, 1997). Level of mercury in liver of *Liza parsia* was higher than muscle (Saha *et al.*, 2006), also concentration of heavy metals (Hg, Cd, Pb, Cu, Zn, Fe and Mn) in liver of *Liza abu* was higher than muscle (Askary Sary *et al.*, 2012). In other study such as *Mugil auratus* (Filazi *et al.*, 2003), *Sparus auratus, Trigla cuculus, Sardina pilchardus*, *Mugil cephalus*, *Atherina hepsetus*, *Scomberesox saurus* (Canli and Alti, 2003), *Serranus scriba*, *Epinephelus costae*, *Cephalopholis nigri* and *Pseudupenaeus prayensis* (Romeo *et al.*, 1999), *Scomberomorus guttatus*, *Scomberomorus commerson* and *Otolithes ruber* (Askary Sary and Velayatzadeh, 2012), *Barbus xanthopterus* (Mohammadi *et al.*, 2012), *Barbus grypus* and *Barbus xanthopterus* (Mohammadi *et al.*, 2011) concentrations of heavy metals in liver was higher than muscle.

In this research concentrations of heavy metals (mean±SD) Hg, As, Cd and Pb in muscle and liver of *Liza dussumieri* from Boshehr seaport were higher than in *Liza dussumieri* from Deylam seaport ($P<0.05$), except for concentration of Pb that in muscle of *Liza dussumieri* from Deylam seaport were higher than in muscle of *Liza dussumieri* from Boshehr seaport ($P<0.05$). depending upon the type of fish tissues and locations (Mohammadi *et al.* 2012). Alhas *et al.*, (2009) reported that in *Barbus xanthopterus* and *Barbus rajanorum mystaceus* in Ataturk Dam Lake, Turkey, heavy metal concentrations in gill and liver were maximum, while these concentrations were the least in muscle. Oymak *et al.*, (2009) has reported the concentrations of Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn in liver and muscle of *Tor grypus* in Ataturk Dam Lake, Turkey. Malik *et al.*, (2010) determined the concentrations of Pb, Cd, Zn, Ni, Cu, Cr and Hg in liver and muscle of *Labeo rohita* and *Ctenopharyngodon idella* in the Lake of

Bhopal, India. In different reports it was showed that the concentrations of heavy metals in liver were higher than muscle.

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