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Determination of Heavy Metals (Hg, Cd, Pb and Cu) in *Carasobarbus luteus* in Karun River, Iran

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Abstract: The present study was carried out to investigate the contamination of heavy metals Hg, Cd, Pb and Cu in liver and muscle of *Carasobarbus luteus* in Karun River from Iran, 2012. Heavy metal levels in fish samples were analyzed by Perkin Elmer 4100 zl atomic absorption. The results showed that the highest concentration of Hg, Cd, Pb and Cu in tissues was found in liver of *Carasobarbus luteus*. The lowest concentration of Hg, Cd, Pb and Cu in tissues was found in muscle of *Carasobarbus luteus*. Concentrations of Hg, Cd and Pb in muscle and liver of *Carasobarbus luteus* from Karun River of Ahvaz were higher than in Aghili ($P<0.05$), except for concentration of Cu that in *Carasobarbus luteus* from Aghili were higher than in Ahvaz ($P<0.05$). The mean estimated concentrations for Hg, Pb and Cu in the present study were lower than international standards for these metals as declare by the Ministry of Agriculture, Fisheries and Food, Food and Agriculture Organization and National Health & Medical Research Council, but concentrations of Cd were higher than international standards.

Key words: Heavy Metal · Muscle · Liver · *Carasobarbus luteus* · Karun River

INTRODUCTION

Karun River is the largest river in Iran and has an area of 60,500 Km^2 and an average annual discharge of 18,700 million m^3. This river system supplies the water demands of 16 cities, several villages, thousands hectares of agricultural lands and several hydropower plants [1, 2].

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. In recent years, fish lipids have also assumed great nutritional significance, because of their high polyunsaturated fatty acid levels and good source of digestible protein, vitamins, minerals [3-6].

Heavy metal [HMs] pollution of aquatic environment has become a great concern in recent years. HMs can have toxic effects on organs [7]. 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 [8]. Heavy metals still play an important role as pollutants affecting aquatic systems [9]. 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 [10-12]. 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 [13].

This matter that, importance of the heavy metals measuring relate to two important subjects which are aquatics ecosystem management and human health,

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the present study was carried out to determine the level of Hg, Cd, Pb and Cu in liver and muscle samples *Carasobarbus luteus* in Karun river from Iran. The fish and fish products for the people in those ports are generally catch and carried by local vehicles from the Ahvaz and Aghili area. It should be noted that fish species are considered to be a heavy metals part of the diet in the region. The main objective of this study was to determinate the contents of Hg, Cd, Pb and Cu in liver and muscle samples *Carasobarbus luteus* in Karun River from Iran, in order to assess fish quality and to assess the health risk for humans.

MATERIALS AND METHODS

Sampling: The *Carasobarbus luteus* in this study were collected 162 samples of farmed fishes in downstream (Aghili or station 1) and upstream (Ahvaz or station 2) of Karun River from Iran of Ahvaz and Aghili area, 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 [14]. The mean weight (g) and length (cm) were measured of total fish (Table 1).

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.

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 (1g) 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. Mercury, cadmium lead and copper metals were determined against aqueous standards [15, 16].

Table 1: Mean length and weight of the studied *Carasobarbus luteus*

Area	The number of samples	Length ±SD (cm)	Weight ±SD (g)
Ahvaz	81	13.04±1.86	31.53±3.78
Aghili	81	13.83±1.29	39.40±4.23

Table 2: Concentrations of heavy metals in muscle and liver of *Carasobarbus luteus* ($mgKg^1$)

Area	Heavy metal	Muscle	Liver
	mercury	$0.079±0.02^b$	$0.091±0.01^b$
Aghili	cadmium	$0.46±0.03^b$	$0.60±0.02^b$
(station 1)	lead	$0.84±0.03^b$	$1.19±0.01^b$
	copper	$0.49±0.02^b$	$0.72±0.03^b$
	mercury	$0.12±0.02^b$	$0.13±0.07^b$
Ahvaz	cadmium	$0.60±0.03^b$	$0.71±0.03^b$
(station 2)	lead	$1.30±0.03^b$	$2.41±0.21^b$
	copper	$0.29±0.02^b$	$0.37±0.03^b$

a: non-significant differences at P>0.05, b: significant differences at P<0.05

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 (Table 2). All statistical analyses were conducted using the Office Excel 2003 software package.

RESULTS

Concentration levels of metals Hg, Cd, Pb and Cu in muscle and liver of *Carasobarbus luteus* were measured and presented in Table 2. Concentrations of metals are presented in mg Kg^{-1} dry weight unless otherwise mentioned. The highest concentration of Hg, Cd, Pb and Cu in tissues was found in liver of *Carasobarbus luteus*. The lowest concentration of Hg, Cd, Pb and Cu in tissues was found in muscle of *Carasobarbus luteus* (Table 2). The distribution patterns of Hg, Cd, Pb and Cu in tissues of *Carasobarbus luteus* in Karun River of Ahvaz and Aghili follows the order: liver> muscle. Concentrations of Hg, Cd and Pb in muscle and liver of *Carasobarbus luteus* from Karun River of Ahvaz were higher than in Aghili (P<0.05), except for concentration of Cu that in *Carasobarbus luteus* from Aghili were higher than in Ahvaz (P<0.05) (Figures 1, 2).

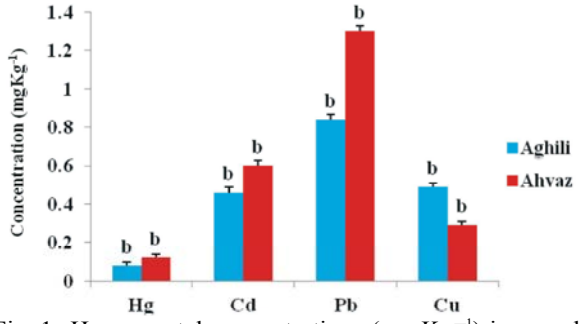

Fig. 1: Heavy metal concentrations (mg Kg^{-1}) in muscle of *Carasobarbus luteus* from the karun River, Iran (a: non-significant differences at P>0.05, b: significant differences at P<0.05)

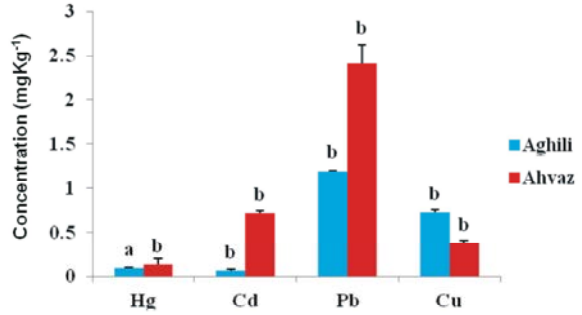

Fig. 2: Heavy metal concentrations (mg Kg^{-1}) in liver of *Carasobarbus luteus* from the karun River, Iran (a: non-significant differences at P>0.05, b: significant differences at P<0.05)

DISCUSSION

Distribution patterns of metal concentrations in the liver and muscle of *Carasobarbus luteus* from Karun River follows the sequence: Pb>Cd>Cu>Hg. Heavy metal concentrations were higher in the liver, when compared with muscle. Livers were chosen as target organs for assessing metal accumulation [17-19]. Estimation of the levels of various elements in different fish species as a measure of environmental pollution has been of great concern over decades. 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 [21].

There are various studies on the heavy metal levels in fish from different waters [20]. Minimal accumulation and storage of heavy metals in these families by Usero *et al*. [22] on fish (*Liza auratus*) in the southern Atlantic coast of Spain, Filazi *et al*. [23] on fish (*Mugil auratus*) in the Black Sea Turkey, Karadede *et al*. [24] on fish (*Liza abu*) in Lake Ataturk, Turkmen *et al*. [25] on fish (*Liza carinata*) is proven. The observed variability of heavy metal levels in different species depends on feeding habits [17], ecological needs, metabolism [26], age, size and length of the fish [27] and their habitats [8, 28]. Oymak *et al.* [29] studied the heavy metal levels in kidney, liver, gill and muscle of *Tor grypus* and Maaboodi *et al*. [30] 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.* [25] 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 [29].

In this study concentrations of Hg, Cd, Pb and Cu in liver of *Carasobarbus luteus* 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. In other study, concentrations of Hg, As, Cd and Pb in liver of *Liza dussumieri* were higher than muscle [15]. Level of mercury in liver of *Liza parsia* was higher than muscle [31], also concentration of heavy metals (Hg, Cd, Pb, Cu, Zn, Fe and Mn) in liver of *Liza abu* was higher than muscle [32]. In other study such as *Mugil auratus* [23], *Sparus auratus, Trigla cuculus, Sardina pilchardus*, *Mugil cephalus*, *Atherina hepsetus*, *Scomberesox saurus* [8], *Serranus scriba*, *Epinephelus costae*, *Cephalopholis nigri* and *Pseudupenaeus prayensis* [17], *Scomberomorus guttatus*, *Scomberomorus commerson* and *Otolithes ruber* [33], *Barbus grypus* and *Barbus xanthopterus* [1] concentrations of heavy metals in liver was higher than muscle.

Concentrations of Hg, Cd and Pb in muscle and liver of *Carasobarbus luteus* from Karun river of Ahvaz were higher than in Aghili (P<0.05), except for concentration of Cu that in *Carasobarbus luteus* from Aghili were higher than in Ahvaz (P<0.05). Also the other 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) [15]. The absorption and accumulation of heavy metals in the fishes is different, according to locations and organs [34-36]. Alhas *et al*.

Table 3: Comparison of Hg, Cd, Pb and Cu concentrations ($mgKg^{-1}$) in muscle of *Carasobarbus luteus* with standards

Standards	Hg	Cd	Pb	Cu	References
WHO	0.5	0.2	2	30	[38]
FDA	0.5	2	0.5	-	[39]
UK (MAFF)	0.5	0.2	2	20	[40]
NHMRC	1	0.05	1.5	10	[39]
This study	0.079-0.12	0.46-0.6	0.84-1.3	0.29-0.49	-

[37] reported that in *Barbus xanthopterus* and *Barbus rajanorum mystaceus* in Ataturk Dam Lake, Turkey, heavy metal concentrations in gill and liver were the maximum, while these concentrations were the least in muscle. Oymak *et al*. [29] 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. In different reports it was showed that the concentrations of heavy metals in liver were higher than muscle.

The mean estimated concentrations for Hg, Pb and Cu in the present study were lower than international standards for these metals as declare by the Ministry of Agriculture, Fisheries and Food (UK), Food and Agriculture Organization (FAO) and National Health & Medical Research Council (Australia). Concentrations of Cd in this study were higher than international standards World Health Organization (WHO), Ministry of Agriculture, Fisheries and Food (UK) and National Health & Medical Research Council (Australia), but the Pb concentrations were higher than Food and Agriculture Organization (FAO) and U.S. Food and Drug Administration (FDA) (Table 3).

CONCLUSION

The obtained results showed that the highest concentration of Hg, Cd, Pb and Cu in tissues was found in liver of *Carasobarbus luteus*. The lowest concentration of Hg, Cd, Pb and Cu in tissues was found in muscle of *Carasobarbus luteus*. Concentrations of Hg, Cd and Pb in muscle and liver of *Carasobarbus luteus* from Karun River of Ahvaz were higher than in Aghili ($P<0.05$), except for concentration of Cu that in *Carasobarbus luteus* from Aghili were higher than in Ahvaz ($P<0.05$).

REFERENCES

1. Mohammadi, M., A. Askary Sary and M. Khodadadi, 2011. Determination of heavy metals in two barbs, *Barbus grypus* and *Barbus xanthopterus* in Karoon and Dez Rivers, Khuzestan, Iran. Bulletin of Environmental Contamination and Toxicology, 87(2): 158-162.
2. Askary Sary, A. and M. Beheshti, 2011. Cadmium, Iron, Lead and Mercury Bioaccumulation in Abu Mullet, *Liza abu*, Different Tissues from Karoun and Karkheh Rivers, Khozestan, Iran. Bulletin of Environmental Contamination and Toxicology, 88(2): 158-161.
3. Prudente, M., E.Y. Kim, S. Tanabe and R. Tatsukawa, 1997. Metal levels in some commercial fish species from Manila Bay, the Philippines. Marine Pollution Bulletin, 34(8): 671-674.
4. Puwastien, P., K. Judprasong, E. Kettwan, K. Vasanachitt, Y. Nakngamanong and L. Bhattacharjee, 1999. Proximate composition of raw and cooked Thai freshwater and marine fish. Journal of Food Composition and Analysis, 12: 9-16.
5. Kucuksezgin, F., O. Altayl, E. Uluturhan and A. Kontas, 2001. Trace metal and organochlorine residue levels in red mullet (*Mullus barbatus*) from the Eastern Aegean, Turkey. Water Research, 35(9): 2327-2332.
6. Lewis, M.A., G.I. Scott, D.W. Bearden, R.L. Quarles and M. James, 2002. Fish tissue quality in near-coastal areas of the Gulf of Mexico receiving point source discharges. Sciences of the Total Environment, 284: 249-261.
7. Ikem, A. and N.O. Egiebor, 2005. Assessment of trace elements in canned fishes (mackerel, tuna, salmon, sardines and herrings) marketed in Georgia and Alabama (United States of America). Journal of Food Composition Analytic, 18: 771-787.
8. Canli, M. and G. Atli, 2003. The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. Environment Pollution, 121(1): 129-36.
9. Merian, E., 1991. Metals and their Compounds in Environment and Life. Occurrence, Analysis and Biological Relevance. New York, Verlag Chemie Weinheim.
10. Rashed, M.N., 2001. Monitoring of environmental heavy metals in fish from Nasser Lake. Environmental International, 27: 27-33.
11. Munoz-Olivas, R. and C. Camara, 2001. Speciation related to human health. In: Ebdon, L., Pitts, L., Cornelis, R., Crews, H., Donard, O.F.X., Quevauviller, P. (Eds.), Trace Element Speciation for Environment, Food and Health. The Royal Society of Chemistry, pp: 331-353.

12. Fernandes, C., A. Fontainhas-Fernandes, D. Cabral and M.A. Salgado, 2008. Heavy metals in water, sediment and tissues of *Liza saliens* from Esmoriz–Paramos lagoon, Portugal. Environment Monitoring and Assessment, 136: 267-275.
13. Celik, U. and J. Oehlenschlager, 2007. High contents of cadmium, lead, zinc and copper in popular fishery products sold in Turkish supermarkets. Food Control, 18: 258-261.
14. UNEP, 1991. Sampling of selected marine organisms and sample preparation for the analysis of chlorinated hydrocarbons Reference Methods for Marine Pollution Studies No. 12. Rev. 2. UNEP. Nairobi. 17.
15. Velayatzadeh, M., A. Askary Sary and H. Hoseinzadeh Sahafi, 2014. Determination of Mercury, Cadmium, Arsenic and Lead in muscle and Liver of *Liza dussumieri* from the Persian Gulf, Iran. Journal of Biodiversity and Environmental Sciences, 5(3): 227-234.
16. Javaheri Baboli, M. and M. Velayatzadeh, 2013. Determination of heavy metals and trace elements in the muscles of marine shrimp, *Fenneropenaeus merguiensis* from Persian Gulf, Iran. The Journal of Animal and Plant Sciences, 23(3): 786-791.
17. Romeo, M., Y. Siau, Z. Sidoumou and M. Gnassia-Barelli, 1999. Heavy metal distribution in different fish species from the Mauritania coast. Science of the Total Environment, 232: 169-175.
18. Rodriguez, V.M., M.E. Jimenez-Capdeville and M. Giordano, 2003. The effects of arsenic exposure on the nervous system. Toxicology Letters, 145(1): 1-18.
19. Tuzen, M., 2009. Toxic and essential trace elemental contents in fish species from the Black Sea, Turkey. Journal of Food and Chemical Toxicology, 47(9): 2302-2307.
20. Ashraf, W., Z.A. Seddigi, M. Abulkibash and M. Khalid, 2006. Levels of selected metals in canned fish consumed in Kingdom of Saudi Arabia. Environmental Monitoring and Assessment, 117(1): 271-279.
21. Heath, A.G., 1987. Water Pollution and Fish Physiology. CRC Press, Florida, USA, pp: 245.
22. Usero, J., C. Izquierdo, J. Morillo and I. Gracia, 2003. Heavy metals in fish (*Solea vulgaris*, *Anguilla Anguilla* and *Liza aurata*) from salt marshes on the southern Atlantic coast of Spain. Environment International, 29: 949-956.
23. Filazi, A., K. Baskaya and C. Kum, 2003. Metal concentration in tissues of the Black Sea fish *Mugil auratus* from Sinop-Icliman, Turkey. Human and Experimental Toxicology, 22: 85-87.
24. Karadede, H., S.A. Oymak and E. Unlu, 2004. Heavy metals in mullet, *Liza abu* and cat fish, *Silurus triostegus*, from the Ataturk Dam Lake (Euphrates), Turkey. Environment International, 30: 183-188.
25. Turkmen, A., M. Turkmen, Y. Tepe and M. Cekic, 2010. Metals in tissues of fish from Yelkoma Lagoon, northeastern Mediterranean. Environmental Monitoring and Assessment, 168: 223-230.
26. Canli, M. and R.W. Furness, 1993. Toxicity of heavy metals dissolved in seawater and influences of sex and size on metal accumulation and tissue distribution in the Norway lobster *Nephrops norvegicus*. Marine Environment Research, 36: 217-236.
27. Linde, A.R., S. Sanchez-Galan, J.I. Izquierdo, P. Arribas, E. Maranon and E. Garcya-Vazquez, 1998. Brown Trout as biomonitor of heavy metal pollution: effect of age on the reliability of the assessment. Ecotoxicological and Environmental Safety, 40: 120-125.
28. Tuzen, M. and M. Soylak, 2007. Determination of trace metals in canned fish marketed in Turkey. Food Chemistry, 101(4): 1378-1382.
29. Oymak, S.A., H. Karadede-Akin and N. Dogan, 2009. Heavy metal in tissues of *Tor grypus* from Ataturk Dam Lake, Euphrates River-Turkey. Biologia, 64(1): 151-155.
30. Maaboodi, H., S. Jamili and H. Maddani, 2011. Accumulation of heavy metals (Lead and Zinc) in the Liver of some edible fishes in Zayandeh-rood. Research Journal of Environmental Sciences, 5(3): 295-301.
31. Saha, M., S.K. Sarkar and B. Bhattacharya, 2006. Interspecific variation in heavy metal body concentrations in biota of Sunderban mangrove wetland, northeast India. Environment International, 32: 203-207.
32. Askary Sary, A., M. Velayatzadeh and M. Beheshti, 2012. Determination of heavy metals in *Liza abu* from Karkheh and Bahmanshir Rivers in Khoozestan from Iran. Advances in Environmental Biology, 6(2): 578-582.
33. Askary Sary, A. and M. Velayatzadeh, 2012. Lead and Zinc levels in *Scomberomorus guttatus*, *Scomberomorus commerson* and *Otolithes ruber* from Hendijan, Iran. Advances in Environmental Biology, 6(2): 843-848.

34. Shumka, S., O.T. Andlund, P. Aleksi and I. Dervishi, 2014. Heavy Metal Concentrations in Tissues of Freshwater Fishes in a Central River System of Albania. World Journal of Fish and Marine Sciences, 6(2): 131-135.
35. Inayat, I., A.I. Batool, M.F. Rehman, N.H.N.A Ali and S.H. Jabeen, 2014. Seasonal Bioaccumulation of Heavy Metals in the Right and Left gills of Edible Fishes. World Journal of Fish and Marine Sciences, 6(2): 195-200.
36. Rahman, M.A., F.H. Shikha, M.I. Hossain, M. Asadujjaman, N. Nahar and M.M. Rahman, 2014. Comparative Study on Proximate Composition and Heavy Metal Concentration of *Amblypharyngodon mola* and *Channa punctatus* Collected from Pond Water and Open Water. American-Eurasian Journal of Toxicological Sciences, 6(4): 131-135.
37. Alhas, E., S.A. Oymak and H.K. Akin, 2009. Heavy metal concentrations in two barb, *Barbus xanthopterus* and *Barbus rajanorum mystaceus* from Ataturk Dam Lake, Turkey. Journal of Environmental Monitoring and Assessment, 148(4): 11-18.
38. WHO, 1996. Health criteria other supporting information. In: Guidelines for Drinking Water Quality, vol. 2, 2nd ed., pp. 31-388, Geneva.
39. Chen, Y.C. and M.H. Chen, 2001. Heavy metal concentrations in nine species of fishes caught in coastal waters off Ann-Ping, S.W. Taiwan. Journal of Food and Drug Analysis, 9: 107-114.
40. MAFF, 1998. Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1995 and 1996. Aquatic Environment Monitoring Report No. 51. CEFAS is an Executive Agency of the Ministry of Agriculture, Fisheries and Food (MAFF) formerly the Directorate of Fisheries Research, pp: 116.