Cellular and Molecular Biology
E-ISSN : 1165-158X / P-ISSN : 0145-5680
www.cellmolbiol.org
C M B Association Publisher

Original Research

Determination of some heavy metals in *Mastacembelus mastacembelus* (Banks & Solander, 1794) in terms of public health

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Received February 28, 2017; **Accepted** April 6, 2017; **Published** May 20, 2017

Doi: http://dx.doi.org/10.14715/cmb/2017.63.5.1

Abstract: In this study, the accumulation of some heavy metals in spiny eel (*Mastacembelus mastacembelus* Banks and Solander, 1794) living in Karakaya Dam Lake was determined and human health risk of this fish when consumed as food was examined. For this purpose, the amounts of copper (Cu), chromium (Cr), cadmium(Cd), iron (Fe), zinc (Zn) in water samples and in the muscle tissues of the fishes were determined. The amounts of heavy metals showed differences in the muscle tissues of *Mastacembelus mastacembelus* according to weight, length, sex and age groups of fish. In conclusion the amounts of heavy metals in the flesh of spiny eels were found lower than that recommended by EPA, WHO, FAO and TFC.

Key words: *Mastacembelus mastacembelus*; Heavy metals; Muscle; Accumulation.

Introduction

Concern about the effects of anthropogenic pollution on the freshwater ecosystems is growing. Heavy metals from man-made pollution sources are continually released into aquatic ecosystems. Contamination of heavy metals is a serious threat because of their toxicity long persistence, bioaccumulation and biomagnification in the food chain (1). Fishes can be considered as one of the most significant indicators in freshwater systems for the estimation of metal pollution level (2).

Freshwater lakes support many life forms, provide recreation and game fishing to the communities, and it is also a good source of water for drinking water production by manicipal water works. Eating of fish is known to provide nutritional benefits to humans. Apart from being a good source of protein, fish is known to contain omega-3 fatty acids that help reduce the risk of certain types of cancer and cardiovascular disease. Fish consumption is a major route of chemical exposure for humans and most importantly, children are more at risk because of their greater intestinal absorptions. Elevated body burden levels of contaminants, developmental deficits and neurologic problems in children of some fish-consuming parents, nervous system dysfunction in adults, and disturbances in reproductive parameters have also been published (3). Trace metal concentrations tested in stationary fish was used as an environmental indicator in water areas affected by human activities and as a monitoring technique for assessing the efficiency of control measures (4).

In this study, the accumulation of some heavy metals in spiny eel (*Mastacembelus mastacembelus*) living in Karakaya Dam Lake was determined and human health risk of this fish when consumed as food was examined.

Materials and Methods

Description of working site

Karakaya Dam Lake (Figure 1) is the third largest dam lake on the River Euphrates (in respect to the surface area of lake) right after Keban Dam Lake and Karakaya Dam is situated 166 km downstream Keban Dam, in the locality of Seki Bağları, near the county of Çüngüş of Diyarbakır province. Apart from Euphrates as the main river, Sultansuyu, Tohma Brook, and other small brooks and streams join Karakaya Dam Lake (5).

Reagents and apparatus

All reagents were of analytical grade unless otherwise stated. Distilled water was used for the preparation of solutions. All the plastic and glassware were cleaned by soaking, with contact, overnight 0.1 N nitric acid solution and then rinsed with distilled water prior to use. HNO3 used for digestion are supplied by Merck. The concentrations of heavy metals were determined by ICP (Perkin Elmer Optima 5300 DV).

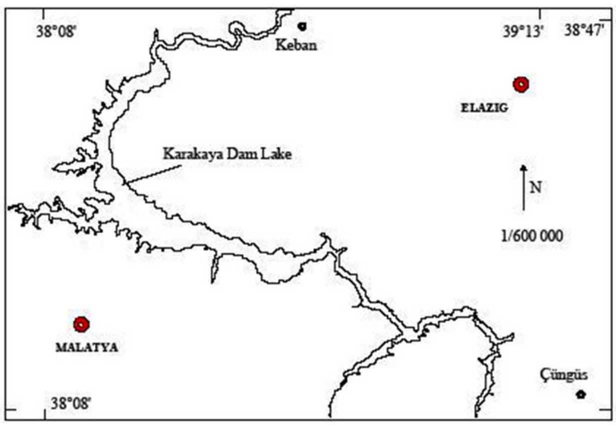

Figure 1. Karakaya Dam Lake, Malatya-Turkey (6).

Blank preparation

At each step of the digestion processes of the samples acid blanks were done using an identical procedure to ensure that the samples and chemicals used were not contaminated. They contain the same digestion reagents as the real samples with the same acid ratios but without fish sample. After digestion, acid blanks were treated as samples and diluted with the same factor. They were analysed by ICP before real samples and their values were subtracted to check the equipment to read only the exact values of heavy metals in real samples. Each set of digested samples had its own acid blank and was corrected by using its blank sample.

Fish obtain and analysis

Fish samples were caught from Karakaya Dam Lake by gill net. Captured fish were immediately transported to the laboratory in a freezer bag with ice. Total length and weight were measured to the nearest millimetre and gram before dissection, and then 10 g homogenized muscle (cleaned from skin) samples were taken from 44 fish. They were individually transferred to 4 ml glass vials previously washed (with 0.1 N nitric acid), dried, and weighed and then they were dried in an oven for 24 hours at 105 ºC and kept in a desiccator for a few days until constant weight was obtained. Vials were again weighed to obtain dry weight of tissues, and then samples were digested on a hot plate by adding 2 ml suprapure nitric acid (65%, Merck, Whitehouse Station, New Jersey). Digested samples were kept at room temperature for 24 hours and then diluted to 50 ml with deionised distilled water. Standard solutions for calibration graphs were prepared. Blanks were also prepared using the procedure as above, but without the samples. Diluted samples and blank solutions were analysed by ICP for determination of Cu, Cr, Cd, Fe and Zn levels (7). The ages of fishes were determined with vertebrae.

Statistical analysis

Microsoft Office Excel 2007 and SPSS 12.0 package programs were used to get the statistical analysis (t-test and one-way ANOVA-Duncan). Also GraphPad Prisim 7 program was used to graph of the data obtained during the research.

Results and Discussion

The amount of heavy metals in water samples

In the water samples, the concentration of Cu, Cr, Cd, Fe and Zn were 0.0033, 0.0011, 0.0053, 0.2483 and 0.0136 mg L^{-1} respectively. By comparing measured concentrations of metals with water quality standards, it was found that all metal concentrations were lowest than the permissible limits (Table 1).

Heavy metals in fish

Only Cu, Cr, Cd, Fe and Zn were detected in the muscle samples analysed. In this study, the order in relation to the concentration of heavy metal in the muscle was found as Fe>Zn>Cu>Cd>Cr (Figure 2) . The order of some heavy metals in the muscle of some fish species was found as Zn>Cu>Pb>Cd for *Liza aurata* from Lake Manzala (9), Fe>Pb>Cd>Cu>Ni for fish from Upper Lake and Fe>Ni>Cu>Cd>Pb for fish from Shahpura Lake (10), Zn>Hg>As>Cu for *Silurus triostegus*, Zn>Hg>As>Cu for *Aspius vorax*, Zn>Cu>As>Pb for *Cyprinus carpio*, Zn>Cu>As>Hg for *Carasobarbus luteus*, Zn>Cu>As for *Capoeta trutta*, Zn>Cu>Hg>As for *Chalcalburnus mossulensis*, Zn>Cu>As>Pb>Hg for *Acanthobrama marmid* (11). In general, our findings showed similarity with the findings of these researches.

Heavy metal accumulation in muscle increased with fish size (Figure 3 and 4). These increase were found significant (P<0.05). Similar results were found for *Tilapia zilli* (12), *Luciobarbus xanthopterus* (13), *Capoeta trutta* (14) and *Cyprinus carpio* (15).

Some studies stated that accumulation of heavy metals in fish change not only according to the size and sex of fish. But also it was controlled by specific uptake, detoxification and elimination mechanisms, depends on

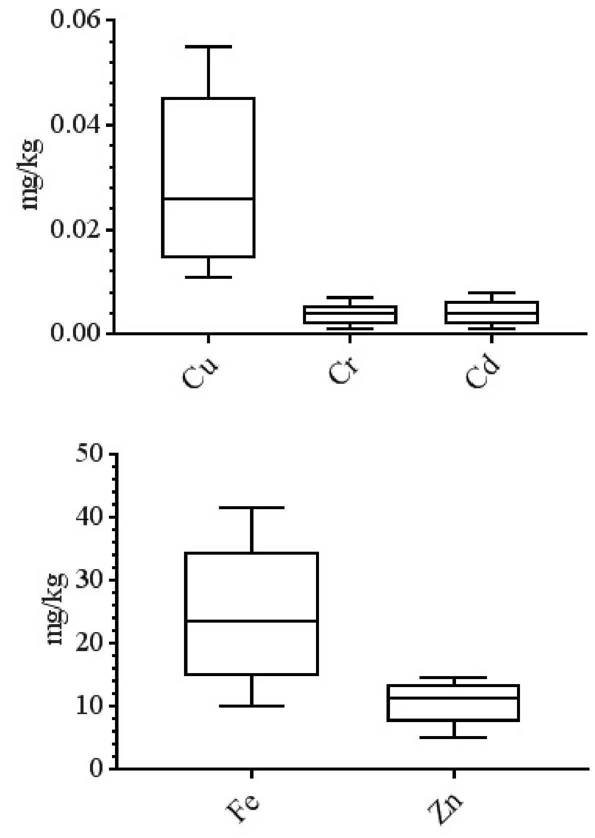

Figure 2. Box-Whisker diagram dissemination of some heavy metals concentration in muscle of *M. mastacembelus*.

Table 1. Heavy metals concentration in the water and acceptable values suggested by USEPA (8).

	Cu	Cr	Cd	Fe	Zn
Heavy metal concentrations (mg L^{-1})	0.0033	0.0011	0.0053	0.2483	0.0136
Permissible limits (mg L^{-1})					
MC	0.013	0.57	0.002	-	0.12
CC	0.009	0.074	0.00025	1	0.12

MC: Maximum concentrations CC: Continuously concentrations.

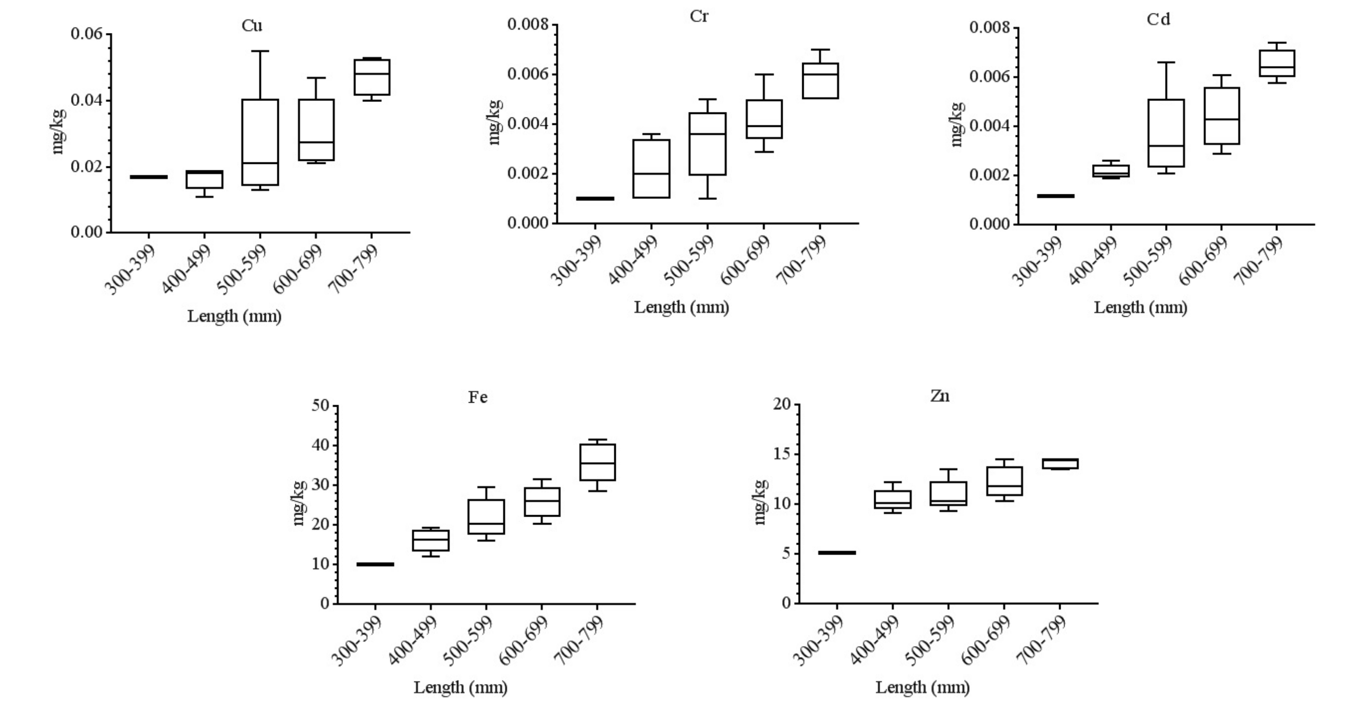

Figure 3. Some heavy metals in muscle tissue of *M. mastacembelus* in relation to fish length.

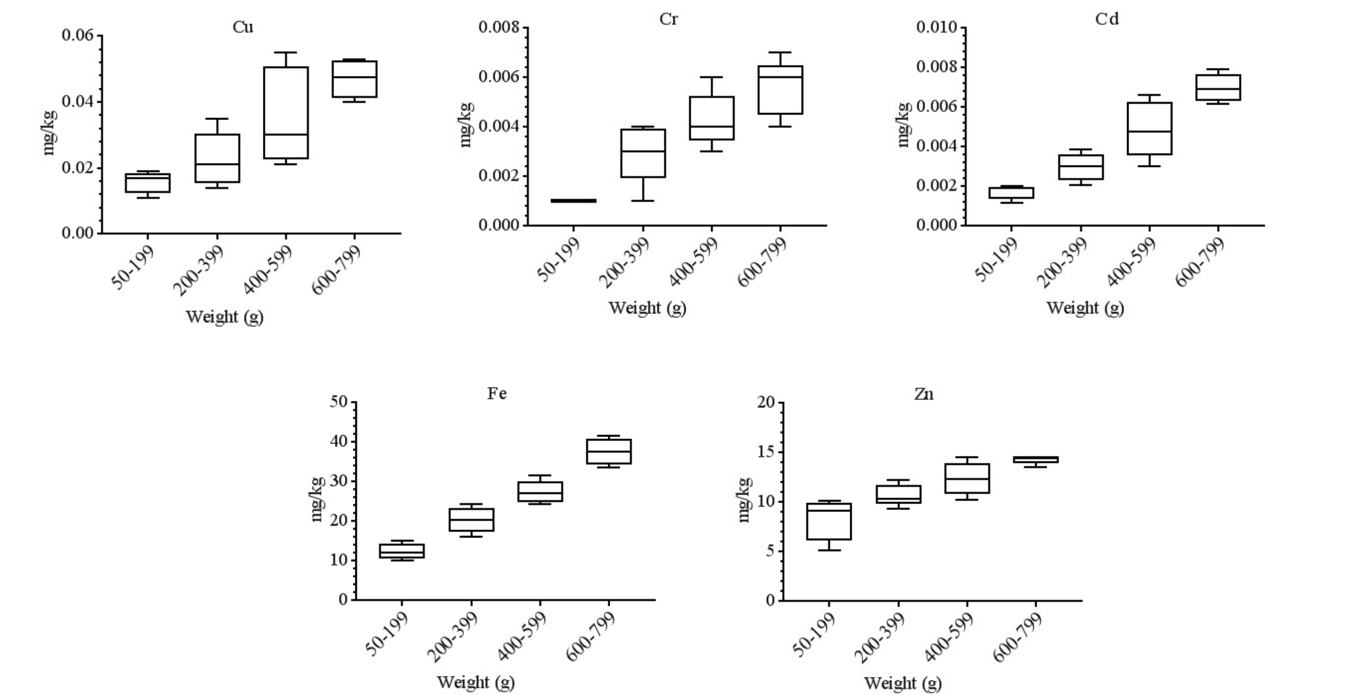

Figure 4. Some heavy metals in muscle tissue of *M. mastacembelus* in relation to fish weight.

the size-specific metabolic rate of organisms (16).

The effect of sex on the level of the tested metals was also examined (Figure 5). Although the concentration of all metals analysed in muscle tissue of male fish were found to be higher than those of female fish, the differences were statistically significant ($P<0.05$). According to Dusukcan *et al.* (13) Cu and Fe elements are found in higher levels in muscle tissues of male *L. xanthopterus.* Also Canpolat *et al.* (15) found that Cu and Fe concentration is more in male fish compared to the female fish.

These results clearly show that accumulation levels of heavy metals in the tissues change according to the habitat and fish species. The heavy metal accumulation in tissues are much higher than the level of changes in the environment and concentrations are changeable according to the type and the concentration of the metal, water quality, species of the organism, season, age and nutrition type (17). The concentration rates of all elements determined in *M. mastacembelus* muscle tissues differs according to the weight and this shows that heavy metal accumulation level changes according to the weight groups. The lowest level of concentration of all elements in the muscles of *M. mastacembelus* was found in 50-199 g in weight group. The highest level of concentration of all elements in the muscles of *M. mastacembelus* was found in 600-799 g in weight group. When length is taken into account the lowest concentration of all elements for *M. mastacembelus* was found in 300-399 mm in length group. The highest level of

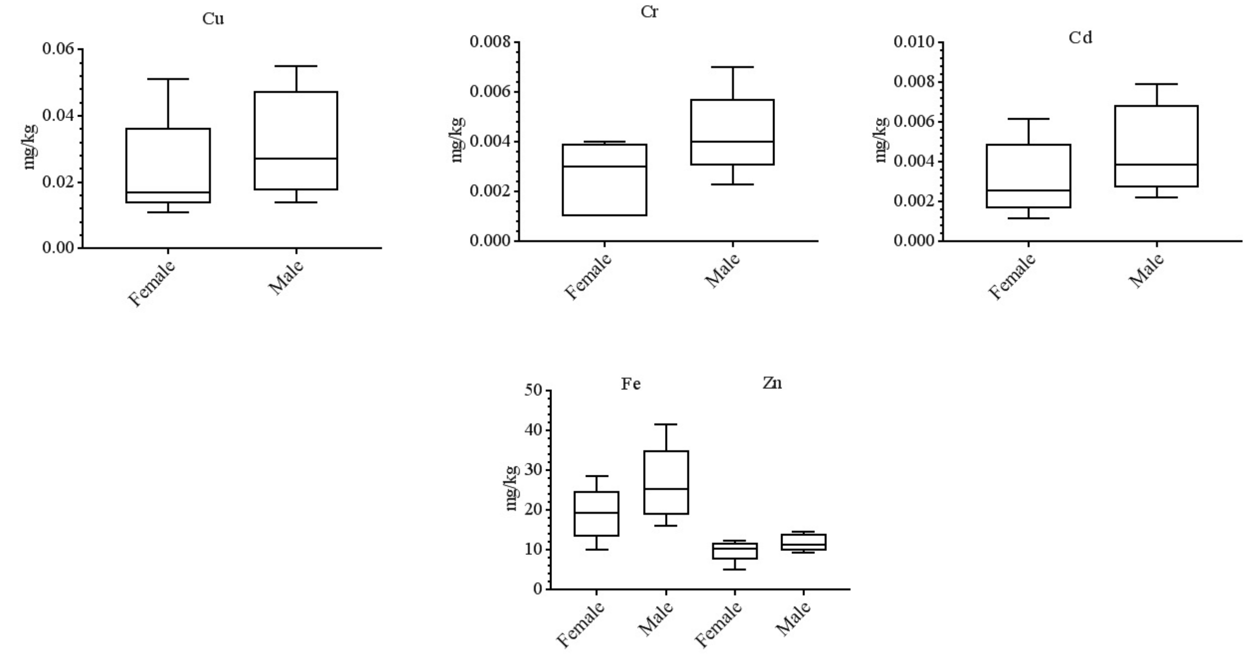

Figure 5. Some heavy metals in muscle tissue of *M. mastacembelus* in relation to fish sex.

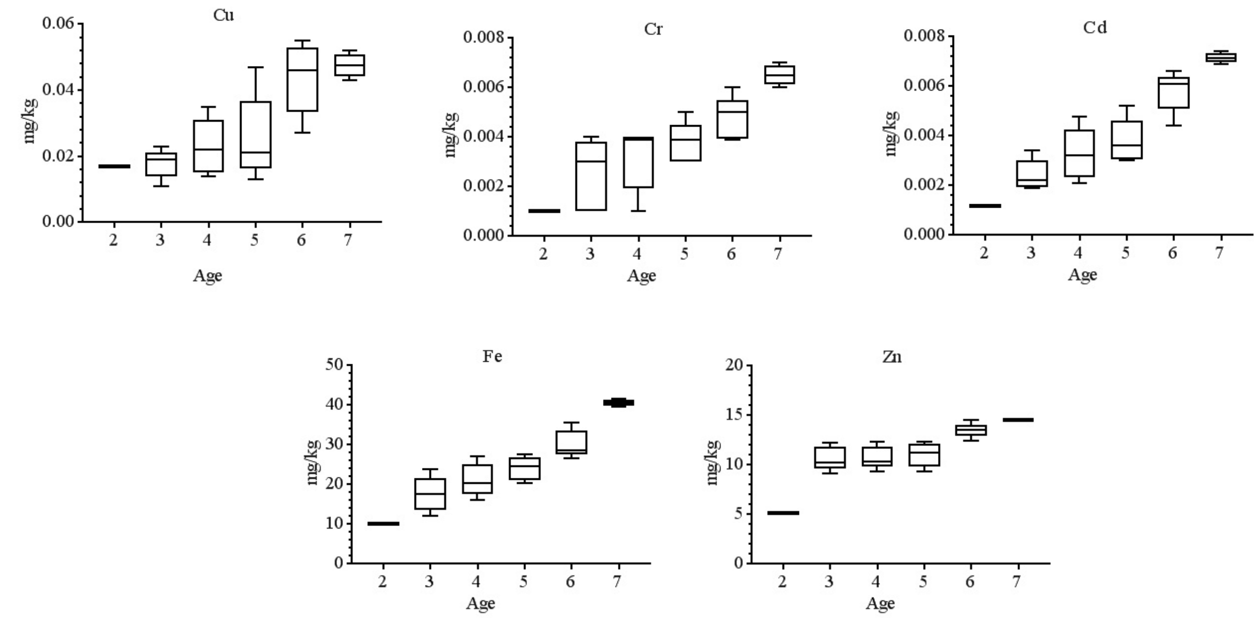

Figure 6. Some heavy metals in muscle tissue of *M. mastacembelus* in relation to fish age.

concentration of all elements in the muscles of *M. mastacembelus* was found in 700-799 mm in length group. As a result it is found that all elements accumulation in the muscle of *M. mastacembelus* changes according to the weight and length groups.

The relationship between fish ages and heavy metal levels in muscle tissue was also determined (Figure 6). The effect of fish age on heavy metals accumulation showed a similar pattern to those of fish weight and length. Generally, the level of all metals analysed increased with fish age. Very strong relationships between fish age and heavy metal levels were found (R^2= 0.87 for Cu, R^2= 0.96 for Cr, R^2= 0.96 for Cd, R^2= 0.96 for Fe and R^2= 0.84 for Zn).

The concentrations of heavy metals in some fish species examined by some researches were compared with the present study in Table 2.

The variability in heavy metal levels in different species depends on feeding habits (21), ecological needs (22), metabolism (23) and biological aspects of fish (24), age, size, reproductive cycle, and swimming patterns (25).

In conclusion there was a clear difference between the concentrations of heavy metals within muscle tissue of the fish. Heavy metals pollution affects not only aquatic organisms, but also public health as a result of bioaccumulation in food chain. Our results show that heavy metal levels in the muscle samples taken from *M. mastacembelus* caught from Karakaya Dam Lake were under the dangerous limits given by EPA (26), WHO (27), FAO (28) and TFC (29) and there is no any risk for public health by eating of *M. mastacembelus* (Table 3).

Acknowledgements
We would like to present many thanks to Firat University Scientific Research Projects Coordination Office (FUBAP) supporting this study as the project number 1432.

Table 2. Some heavy metal concentrations (mg/kg) determined in the muscle tissue of *M. mastacembelus* and some fish species.

Fish species	Zn	Fe	Cu	Cr	Cd	References
M. mastacembelus	11.50	24.24	0.028	0.0036	0.0040	This study
L. xanthopterus	10.49-49.12	12.04-69.16	0.30-1.88			Dusukcan *et al.* (13)
C. trutta	7.00-27.88	10.67-38.36	0.34-0.92			Eroğlu *et al.* (14)
C. carpio	6.8-14.65	4.67-10.83	0.23-0.74			Canpolat *et al.* (15)
A. marmid	3.18	9.31	13.28			Calta and Canpolat (18)
C. carpio	2.83	19.02	27.87			
C. regium	3.13	22.51	38.66			
O. niloticus		0.80	1.41	0.01	<0.01	Kanayochukwu *et al.* (19)
T. zilli		1.97	1.04	0.40	0.03	
S. niloticus		2.84	3.80	0.40	0.14	
C. gariepinus		18.01	10.80	0.80	0.20	
E. timbriata		6.20	1.85	0.42	0.10	
A. vorax	10.536	18.367	0.009			Canpolat *et al*. (20)

Table 3. Heavy metal concentration in the muscle tissue of *M. mastacembelus* and acceptable values suggested by EPA (26), WHO (27), FAO (28) and Turkish Food Codex (TFC) (29).

	Heavy metals				
	Cu	**Fe**	**Zn**	**Cr**	**Cd**
EPA (26) (mg kg^{-1})	54	410	410	4.1	1.4
WHO (27) (mg/kg^{-1})	3	146	10-75	0.15	0.18
FAO (28) (mg/kg^{-1})	10.0	-	150	-	0.2
TFC (29) (mg/kg^{-1})	20	-	50	-	0.05
*PL (mg/day)	3	43	60	-	0.1**
M. mastacembelus (mg/kg^{-1})	0.028	24.24	11.50	0.0036	0.0040

*PL: Permissible limits (wet wt.) according to FAO/WHO (30), **µg/g.

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