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Full Length Research Paper

Seasonal variation of trace elements in muscle tissues of two commercially valuable freshwater fish species (*Silurus triostegus* and *Barbus grypus* Heckel, 1843) from Atatürk Dam Lake (Turkey)

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In this study, some trace metals (Pb, Cd, Hg, Cu, Zn and Fe) were seasonally determined in the muscle tissues of two commercially valuable freshwater fish species (*Silurus triostegus* and *Barbus grypus*, Heckel, 1843) from Atatürk Dam Lake. The obtained results showed that the average values of Fe (9.816 ± 0.390 µg/g) and Cu (1.343 ± 0.0.589 µg/g) in *B. grypus* were at the highest level in summer and autumn. However, Fe and Cu levels which are under detection limit in *S. triostegus* were not determined throughout the seasons. The highest Cd and Zn levels were measured in the summer for *S. triostegus* as 0.060 ± 0.000 and 9.696 ± 0.339 µg/g and for *B. grypus* as 0.039 ± 0.007 and 11.347±1.13 µg/g, respectively. The highest Pb levels were recorded in winter as 0.063 ± 0.002 and 0.301 ± 0.321 µg/g for *S. triostegus* and *B. Grypus*, respectively. The highest Hg levels were determined in Autumn for the two fish species (for *S. triostegus* as 0.093 ± 0.005 µg/g; for *B. grypus* as 0.057 ± 0.010 µg/g). In general, the avarage trace metal concentrations are similar to those previously observed in other fish species studied in Atatürk Dam Lake.

Key words: Trace element, *Silurus triostegus*, *Barbus grypus*, Atatürk Dam Lake.

INTRODUCTION

Aquatic systems are very sensitive to heavy metal pollutants. Determination of trace metal concentration in natural water system has received increasing attention for monitoring environmental pollution, due to the fact that some metals are not biodegradable and their presence in the food chain through a number of path ways may be accumulated in different organs of human beings or animals (Stainiskiene et al., 2006; Korai et al., 2008). Therefore, in order to maintain the quality of aquatic product, it is important to regularly monitor and evaluate the pollution levels in fish. In fact, heavy metals are natural trace components of the aquatic environment, but their levels have increased due to domestic, industrial, mining and agricultural activities. In other words, there are no toxic elements but only toxic concentrations. Water reservoirs are collectors of all materials spread by human, industrial and agricultural activities, and these penetrate into water reservoirs via atmosphere, drainage, soil waters and soil erosion (Stainiskiene et al., 2006). As the concentration of heavy metals in the environment increases, the metals inevitably enter the biogeochemical cycle and can cause damage to health or even death at increased concentrations (Bialy et al., 2005; Weher, 2008). Therefore, the aim of this work was to determine the concentrations of six heavy metals (Pb, Cd, Hg, Cu, Zn and Fe), seasonally in muscle tissue of two important economical freshwater fish species (*Silurus triostegus* and *Barbus grypus,*) collected from Atatürk Dam Lake (Turkey), and the result shall focus on the evaluation of environmental quality and consumer safety.

Atatürk Dam Lake is one of the largest earth-and-rock filled dams in the world, which is built on the Euphrates

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River in south-eastern Anatolia, Turkey, with a total area of 817 km^2. It is the biggest reservoir in Turkey and has a high fishing potential. It is used for irrigation and electrical energy production. About 28 fish species and subspecies belonging to eight families living in the Euphrates River and its dam lakes have been recorded (Oymak et al., 2001; Karadede et al., 2004; Oymak et al., 2009). *S. triostegus* and *B. grypus* were reported to be leading fish species in Atatürk Dam Lake with great importance in economy (Olgunoglu et al., 2009; Olgunoglu and Olgunoglu, 2011). Recently, agricultural and industrial developments as well as increase in population have substantially increased the contamination of the Atatürk Dam Lake (Karadede et al., 2004). For these reasons, it is important to determine the concentrations of heavy metals in these commercial fish in order to evaluate the possible risk of fish consumption in human health. There are only a few studies on heavy metal levels in the reservoir (Karadede and Ünlü, 1998, 2000; Karadede et al., 2004; Oymak et al., 2009; Alhas et al., 2009; Mol et al., 2010; Olgunoglu and Olgunoglu, 2011), especially its seasonal monitoring. The results obtained from this study will provide information for the background levels of metals in common fish species of the lake.

MATERIALS AND METHODS

S. triostegus and *B. grypus* used in this research were obtained seasonally from Atatürk Dam Lake in 2010 in the borders of Turkey (Figure 1) via fishing. Fish samples were stored in ice and transported to the laboratory on the same day. After removing the head, fins, scales and all inner organs, fish muscle was washed with distilled water, dried in filter paper and placed in a polyethylene bag and kept at -20°C until metal analysis and transported with ice to the Industrial Services Laboratories of TUBITAK–MAM (The Scientific and Technological Research Council of Turkey, Marmara Reasearch Centre). The samples were kept away from metallic materials to avoid contamination. Total number of 80 (5 pairs of *S. triostegus* and 5 pairs of *B. grypus*, in each season) fish samples were used in the research.

The concentrations of Pb, Cd, Hg, Cu, Zn and Fe in muscle tissue were determined according to atomic absorbtion spectrophotometric (AAS) method (AOAC) (2005). 0.5 g of fish muscle (wet weight) was weighed and placed in a teflon digestion vessel with 6 ml of concentrated (65%) nitric acid (HNO_3) and 1.5 ml 30% hydrogen peroxide (H_2O_2) and digested in a microwave digestion system (Milestone Ethos PLUS). The concentrations were expressed as µg/g wet weight of tissue in organisms. The accuracy and precision of our results were checked by analyzing standard reference material (BCR, FAPAS). The results indicated a good agreement between the certified and the analytical values as shown in Table 1.

SPSS 15.0 for Windows software was used for the statistical analysis of these six heavy metal content in different fish tissues by using multivariate ANOVA (one-way analysis of variance) and Duncan's test (95% significancy level) (Ebrahimi and Taherianfard, 2001; Turkmen et al., 2005a).

RESULTS

Concentration levels of six trace metals (Pb, Cd, Hg, Cu, Zn and Fe) were detected in muscle tissues of two fish species (*S. triostegus* and *B. grypus*) collected seasonally from Atatürk Dam Lake (Table 2). The highest Cd and Zn levels were recorded in summer for the two fish species. The highest Pb and Hg levels were recorded in winter and autumn, respectively. Fe and Cu levels which are under detection limit in *S. triostegus* were not determined throughout the seasons. However, Fe and Cu were at the highest level during summer and autumn mainly in *B. grypus*. The variation of measured trace metals (µg/g wet weight) in two fish species were between <0.003 and 0.063 for Pb; 0.034 and 0.060 for Cd; <0.001 and 0.093 for Hg; <0.106 and 1.343 for Cu; 6.005 and 11.347 for Zn, and <0.380 and 9.816 for Fe throughout the seasons.

DISCUSSION

Knowledge of heavy metal concentrations in fish muscle is important both with respect to nature management and human consumption of fish and to determine the most useful biomonitor species and the most polluted area (Barbieri et al., 2010; Karadede et al., 2004; Turkmen et al., 2005b). So, the maximum levels of Hg, Cd and Pb were proposed by Turkish Food Codex (2008) as 0.5, 0.05 and 0.3 µg/g, respectively for different fish species. The mean concentrations of these trace metals analysed in the muscle tissue of *S. triostegus* and *B. grypus* were lower than the maximum permitted concentrations proposed by Turkish Food Codex (2008) and by the EU (2005). In 2002, Turkish Food Codex had announced the maximum limit for Zn as 50 µg/g and Cu as 20 µg/g after new regulations in 2008, there is no maximum level specified for Zn and Cu in the fish species and seafood. Additionally, there are no guidelines on acceptable levels of Cu and Zn in fish suggested by EEC or FAO/WHO (Mol et al., 2010). However, Bekhit et al. (2008) reported the generally accepted level for Zn to be 5 µg/g for fish or 25 µg/g for certain seafood (example, lobtster).

It can be said that seasonal mean concentrations of Zn analysed in *S. triostegus* and *B. grypus* (7.794 ± 1.523 and 10.848 ± 0.386 µg/g, respectively) were quite in each season. Similar concentration of Zn in the muscle of *S. triostegus*, from Atatürk Dam Lake were reported as 10.94 µg/g by Karadede et al. (2004). In the same research, Karadede et al. (2004) determined the Cu levels as 4.27 µg/g. It was seen that our samples contained higher Cu than the data reported by the researchers. Fe is found in variable amounts of between 4.4 and 11 µg/g in several freshwater fish species and is reported to have an amount of 10.9 µg/g in *B. grypus* caught in the Atatürk Dam Lake according to a study carried out by Oymak et al. (2009). In our study, while the mean concentrations of Fe in *S. triostegus* were lower than reported values of several freshwater fish species by Oymak et al. (2009), the level of Fe in *B. grypus* (7.601 ± 0.975 to 9.816 ± 0.390 µg/g) was found to be

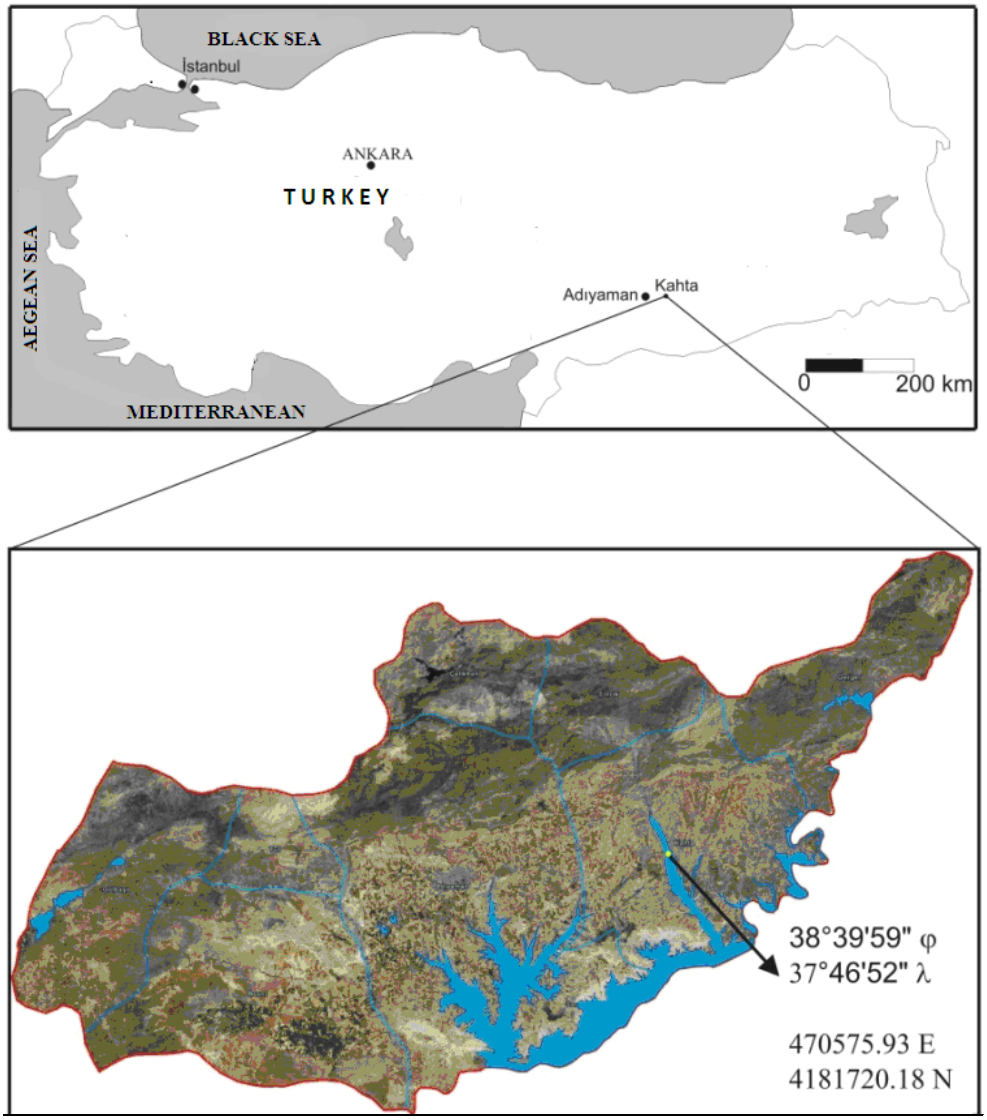

Figure 1. Sampling area.

Table 1. Certified metal concentration in reference material (µg/g).

Element	Certified value	Observed value
Hg	0.0723	0.0739
Cd	0.0527	0.0508
Cu	2.630	2.570
Zn	19.50	20.33
Pb	0.0107	0.0106
Fe	40.70	40.64

close to the value that was reported in the mentioned studies, regarding seasonal value changes. The reason why the Fe and Cu in *S. triostegus* were lower than that of the reported values in the study carried out by Karadede et al. (2004) and Oymak et al. (2009) is because of the seasonal changes (occurrence of dry, rainy and flood seasons), the rate of decomposition of dead organic materials and the chemical-physical characteristics of the sampling sites (Bialy et al., 2005; Karadede and Ünlü, 2007). With regards to Zn, Hg, Pb and Cd concentrations, except that of Fe and Cu, similar results were reported in a study carried out on several freshwater species from Atatürk Dam Lake (Mol et al., 2010).

Conclusion

This study provides primary information on the distribution of metal concentrations in the tissues of *S. triostegus* and *B. grypus* from Atatürk Dam Lake. It is

Table 2. Concentration of the trace metals (µg/g wet weight) in muscle tissue of *S. triostegus* and *B. grypus* in different seasons from Atatürk Dam Lake.

Metal	Season	*S. triostegus*	*B. grypus*
Pb	Summer	<0.003	<0.003
	Autumn	<0.003	<0.003
	Winter	0.063±0.002 (0.061-0.065)	0.031±0.002 (0.029-0.033)
	Spring	<0.003	<0.003
Cd	Summer	0.060 ± 0.000^{c} (0.060-0.060)	0.039 ± 0.007^{a} (0.033±0.048)
	Autumn	0.049 ± 0.035^{b} (0.045-0.052)	0.037 ± 0.012^{a} (0.030-0.052)
	Winter	0.049 ± 0.024^{b} (0.046-0.051)	0.036 ± 0.001^{a} (0.035-0.038)
	Spring	0.036 ± 0.017^{a} (0.034-0.038)	0.034 ± 0.007^{a} (0.030-0.043)
	Mean	0.043 ± 0.009^{x}	0.036 ± 0.002^{x}
Hg	Summer	0.086 ± 0.003^{b} (0.083-0.089)	0.027 ± 0.005^{a} (0.023-0.033)
	Autumn	0.093 ± 0.005^{b} (0.087-0.098)	0.057 ± 0.010^{b} (0.047-0.068)
	Winter	0.052 ± 0.005^{a} (0.046-0.057)	<0.001
	Spring	0.052 ± 0.005^{a} (0.046-0.057)	<0.001
	Mean	0.071±0.021	
Cu	Summer	<0.106	1.276 ± 0.979^{a} (0.608-2.400)
	Autumn	<0.106	1.343 ± 0.589^{a} (0.589-2.010)
	Winter	<0.106	0.676 ± 0.336^{a} (0.360-1.030)
	Spring	<0.106	1.043 ± 0.715^{a} (0.586-1.868)
	Mean	-	1.084±0.301
Zn	Summer	9.696 ± 0.339^{a} (9.320-9.978)	11.347 ± 1.135^{a} (10.669-12.658)
	Autumn	6.005 ± 0.294^{b} (5.695-6.281)	10.404 ± 1.860^{a} (9.210-12.548)
	Winter	7.474 ± 0.104^{c} (7.372-7.580)	10.848 ± 0.663^{a} (10.236-11.553)
	Spring	8.003 ± 0.203^{d} (7.774-8.163)	10.794 ± 2.036^{a} (9.589-13.145)
	Mean	7.794 ± 1.523^{x}	10.848 ± 0.386^{x}
Fe	Summer	<0.380	9.816 ± 0.390^{b} (9.365-10.048)
	Autumn	<0.380	8.381 ± 1.356^{ab} (6.989-9.698)
	Winter	<0.380	7.601 ± 0.975^{a} (6.599-8.547)
	Spring	<0.380	8.180 ± 1.358^{ab} (6.987-9.658
	Mean	-	8.494±0.941

Values are shown as means ± SD of triplicate measurements;within columns, values with different letters are significantly different at P<0.05 level; values in parentheses indicate the minimum and maximum levels.

notable that the values obtained in this study are similar to those obtained in previous study for the Atatürk Dam Lake. Based on the samples analyzed, heavy metal concentrations are not found in the edible parts of the fish, but there are deficiencies because there are no certain limits for some metals such as Fe, Cu and Zn in various countries. On the other hand, a potential danger may emerge in the future as a result of the domestic wastewaters, industrial developments and agricultural activities in this region. Periodically, studies are required to evaluate the ecological significance of the dams as well as monitor programs for the assessment and management of aquatic environment.

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REFERENCES

Alhas E, Oymak SA, Akın KH (2009). Heavy metal concentrations in two barb, *Barbus xanthopterus* and *Barbus rajanorum mystaceus* from Atatürk Dam Lake, Turkey. Environ. Monit. Assess. 148 (1-4): 11-18.

Association of Official Analytical Chemists (2005). Method 999.10. Official methods of analysis of AOAC. International methods 18th. Ed. AOAC International, Gaithersburg, MD,USA.

Barbieri E, Passos E de A, Aragão KAS, Santos DB, Garcia CAB (2010). Assessement to trace metal in catfish (*Catharopis spixii*) from sal river estuary, Aracaju, Satate of Sergipe, Brazil. Water Environ. Res. 82(12): 2301-2307.

Bekhit A El-Din A, Morton JD, Dawson CO (2008). Effect of processing conditions on trace elements in fish roe from six commercial New Zealand fish species. J. Agric. Food Chem. 56: 4846-4853.

Bialy AB El, Hamed SS, Moussa WM, Abd El-Hameed RK (2005). Spectroscopic determination of some trace elements as pollutants in fish. Egypt. J. Solids, 28(1): 151-161.

Ebrahimi M, Taherianfard M (2001). The effects of heavy metals exposure on reproductive systems of cyprinid fish from Kor River. Iran. J. Fish. Sci.10(1):13-24.

EU (2005). Official J. of the European Union, commission regulation (EC)No78/2005 of 19 January 2005 Amending Regulation (EC)No466/2001as regards heavy metals.

Karadede H, Ünlü E (1998). Investigation of the heavy metal accumulation in *Cyprinion macrostomus* Heckel, 1843, (Cyprinidae) from the Atatürk Dam Lake: XIV. Turkish Biol. Congress, 7-10 September, Samsun-Turkey.

Karadede H, Ünlü E (2000). Concentrations of some heavy metals in water, sediment and fish species from the Atatürk Dam Lake (Euphrates), Turkey. Chemosphere. 41: 1371-1376.

Karadede H, Oymak SA, Ünlü E (2004). Heavy metals in mullet, *Liza abu*, and catfish, *Silurus triostegus*, from the Atatürk Dam Lake (Euphrates), Turkey Environ. Int. 30:183-188.

Karadede AH, Ünlü E (2007). Heavy metal concentrations in water, sediment, fishand some benthic organisms from Tigris River, Turkey. Environ. Monit. Assess. 131: 323-337.

Korai AL, Sahato GA, Kazi TG, Lashari KH (2008). Lead concentrations in fresh water, muscle, gill and liver of *Catla catla* (Hamilton) from Keenjhar Lake. Pak. J. Anal. Environ. Chem. 9(1): 11-19.

Mol S, Özden Ö, Oymak SA (2010). Trace metal contents in fish species from Atatürk Dam Lake (Euphrates, Turkey). Turk. J. Fish. Aquat. Sci. 10: 209-213.

Olgunoğlu İA, Artar E, Olgunoğlu MP (2009). The fisheries situation and economic fish species caught in Adıyaman province. J. Agric. Fac. Hr. U. 13(2): 29-34 (in Turkish).

Olgunoğlu İA, Olgunoğlu MP, Artar E (2011). Seasonal changes in biochemical composition and meat yield of Shabut (*Barbus grypus*, Heckel 1843). Iran. J. Fish. Sci. 10(1): 183-189.

Oymak SA, Solak K, Ünlü E (2001). Some biological characteristics of *Silurus triostegus* Heckel, 1843 from Atatürk Dam Lake (Turkey). Turk. J. Zool. 25: 139-148.

Oymak SA, Akın HH, Doğan N (2009). Heavy metal in tissues of *Tor grypus* from Atatürk Dam Lake, Euphrates River-Turkey. Biologia, 64(1): 151-155.

Staniskiene B, Matusevicius P, Budreckiene R, Skibniewska KA (2006). Distribution of heavy metals in tissues of freshwater fish in Lithuania. Polish J. Environ. Stud. 15(4):585-591.

Turkish Food Codex (2002). The communique on maximum limits of contaminants in foodstuffs. (Communique No:2002/63).

Turkish Food Codex (2008). The communique on maximum limits of contaminants in foodstuffs. (Communique No: 2008/26).

Türkmen A, Türkmen M, Tepe Y (2005a) Biomonitoring of heavy metals from Iskenderun Bay using two bivalve species *Chama pacifica* Broderip, 1834 and O*strea stentina* Payraudeau. Turk. J. Fish Aquat. Sci. 5: 107-111.

Türkmen A, Türkmen M, Tepe Y, Akyurt I (2005b). Heavy metals in three commercially valuable fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey. Food Chem. 91: 167-172.

Weher- Al SM (2008). Levels of heavy metal Cd, Cu and Zn in three fish species collected from the Northern Jordan Valley, Jordan. Jordan J. Biol. Sci. 1(1): 41-46.