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Investigation of Zinc, Copper, Lead and Cadmium Accumulation in the Tissues of *Sander lucioperca* (L., 1758) Living in Hirfanlı Dam Lake, Turkey

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Abstract This study, some metals (zinc, copper, lead and cadmium) were analyzed in liver, muscle and gills of *Sander lucioperca* (Linnaeus, 1758) caught from the Hirfanlı Dam Lake in December 2007. The highest concentrations were found in liver (zinc:32.5 μg/g, lead:10.73 μg/g, copper:5.85 μg/g, cadmium:0.76 μg/g) of *Sander lucioperca*. It was seen that the accumulation of zinc, lead and cadmium primarily took place in liver followed by muscles and gills. It was observed that copper is mainly accumulated in liver followed by gill and mucsles.

Keywords Accumulation · *Sander lucioperca* · Metal · Hirfanlı Dam Lake

The zander (*Sander lucioperca*) is one of the more important wild fishes in the freshwaters of Turkey, the catch amounting to about 1,852 ton/year of the end of 2004 (Fisheries Statistics 2004).

Most of pollutants are discharged into the environment every day. Of these, metals are regarded as one of the most serious pollutants of the aquatics environment because of their environmental persistence and tendency to be concentrated in aquatic organisms (Schüürmann and Markert 1998). Biomonitoring of trace elements is essential to assess ecosystem health (Mico et al. 2006; Al-Khashman 2007). Metal can be categorized as: potentialy toxic (aliminium, arsenic, cadmium, antimony lead, mercury) probably essential like nickel vanadium, cobalt and essential like copper, zinc, selenium etc. (Szentmihalyi and Then 2007; Yalcin et al. 2008).

Fish samples are considered to be one of the most indicative factors, in freshwater systems, for the estimination of trace metals pollution potential (Papagiannis et al. 2004). Therefor, many studies have been conducted and published metal accumulation in fish (Canlı and Atli 2003; Demirak et al. 2006; Fernandes et al. 2007; Yıldırım et al. 2009; Öksüz et al. 2009; Ozturk et al. 2009; Kensova et al. 2010).

The aim of the present study is to evaluate metal levels (zinc, copper, lead and cadmium) in muscle, liver and gill of zander (*Sander lucioperca*) from the Hirfanlı Dam Lake.

Materials and Methods

Hirfanlı Dam Lake is located on river Kızılırmak at 70 km in the south of Kırıkkale. Its altitude is 856 m from the sea level (Fig. 1). Today it is also used for irrigation and fishing. The depth, length and width of the lake are 58 m, 90 and 15 km respectively. The turbidity changes between 2 and 6 m (DSİ 1968).

During the study, 10 fish samples (*Sander lucioperca*) were collected from Hirfanlı Dam Lake. The length and weight (min-max) of the fish were 226.2–350.6 mm and 225.4–460.5 g. The fish were obtained from the dam lake and immediately transported to the laboratory. Approximately 2 g of the epaxial muscle on the dorsal surface of the fish, the entire liver and gills from each sample were dissected washed with distilled water, dried in filter paper, weighted, packed in polyethylene bags and kept at −30°C until analysis. The samples that were weighted before 5 mL nitric acid (65%) and 1 mL hydrogen peroxide were placed into the digestion bombs and digested in a

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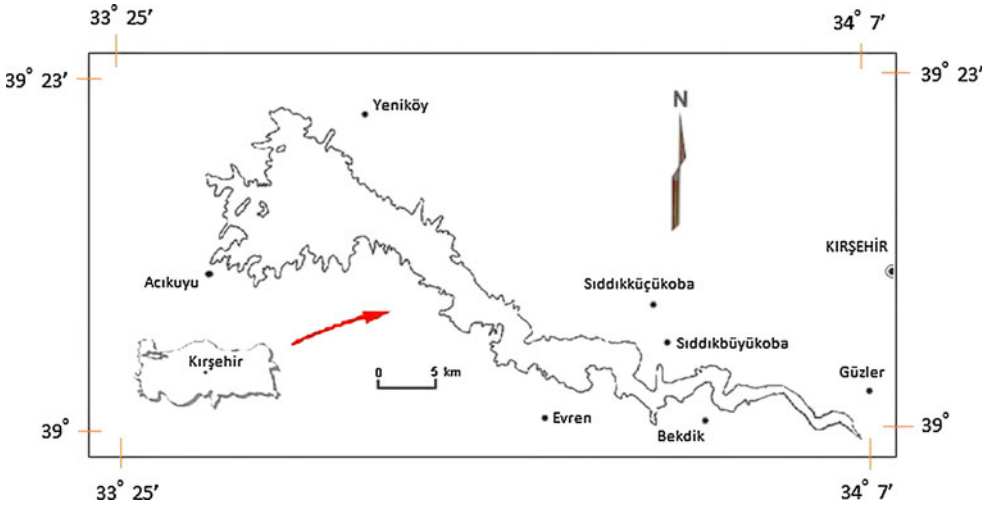

Fig. 1 Hirfanlı Dam Lake

microwave digestion system. Digestion of samples were cooled to room temperature and diluted to 25 mL with high-quality deionized water (Tekin-Ozan and Kır 2006).

The metal analysis of samples (zinc, lead, copper and cadmium) were carried out by using Atomic Absorption Spectrometer Analyst 800. Typical detection limit were 0.018, 0.035, 0.012 and 0.025 μg/mL for zinc, copper, lead and cadmium. Statistical analysis of data was carried out using SPSS for Windows V.15 (SPSS statistical package program). Student's *t* test is used to assess whether metal concentrations varied significantly among tissues (a, b). Data shown in different letters are significant at the 0.01 level.

Results and Discussion

The highest and lowest accumulation levels of the metals in *Sander lucioperca* living in Hirfanlı Dam Lake are as follows; zinc: 2.02 μg/g in muscles and 32.5 μg/g in liver, copper: 0.02 μg/g in gills and 5.85 μg/g in liver, lead: 0.005 μg/g in gills and 10.73 μg/g in liver; cadmium: 0.001 μg/g in gills and 0.76 μg/g in liver. It is clear that these metals are predominantly accumulated in liver. The highest amount of accumulation is observed for Zn and the lowest amount of accumulation is observed for Cd (Table 1).

The highest concentrations were found in liver (Zn:32.5 μg/g, Pb:10.73 μg/g, Cu:5.85 μg/g, Cd:0.76 μg/g) of *Sander lucioperca*. Metal concentrations were found to decrease in sequence of the *Sander lucioperca* samples, in the muscle and gill Zn > Cu > Pb > Cd > ; in the liver Zn > Pb > Cu > Cd.

Zn levels were higher than those reported in the literature (Öksüz et al. 2009, Yıldırım et al. 2009). Cu and Pb values were higher than those reported previously (Öksüz et al. 2009, Yıldırım et al. 2009). Cd values are lower than those reported previously (Yıldırım et al. 2009).

It is very diffucult to compare metal concentrations, even between the same tissues, for two different species due to variations in feeding habits, dissimilarities in the

Table 1 Metal concentration found in different tissues of *Sander lucioperca* (μg/g dry weight)

	Zn	Cu	Pb	Cd
Muscle				
Min	2.02	0.05	0.21	0.12
Max	10.53	1.83	0.72	0.62
X ± SD	$5.34^{a} \pm 2.53$	$0.65^{a} \pm 0.55$	$0.40^{a} \pm 0.24$	$0.25^{a} \pm 0.18$
Gill				
Min	0.93	0.02	0.01	0.01
Max	13.06	1.6	0.21	0.1
X ± SD	$4.18^{a} \pm 3.35$	$0.66^{ab} \pm 0.46$	$0.08^{b} \pm 0.07$	$0.03^{b} \pm 0.03$
Liver				
Min	3.21	1.02	0.21	0.03
Max	32.5	5.85	10.73	0.76
X ± SD	$11.36^{a} \pm 10.07$	$3.19^{c} \pm 1.73$	$4.32^{c} \pm 3.92$	$0.42^{ab} \pm 0.3$

X ± SD: mean ± standard deviation. Data shown with different letters are statistically significant at the $p < 0.01$

aquatic environmental concerning the type and level of water pollution (Papagiannis et al. 2004).

The investigation of the Cu, Zn, Pb and Cd in *Mullus barbatus*, *Mugil cephalus*, *Trachurus trachurus*, *Pagellus acarne*, *Dicentrarchus labrax*, *Sparus auratus*, *Sardinella aurita*, *Boops boops*, *Scomber japonicus* and *Solea solea* caught in Antalya Bay showed that the organ where the highest amount or acculation observed was liver and the metal which was observed in highest an lowest amounts were Zn and Cd. The muscle concentrations of Cu, Zn and Pb in *Mugil cephalus* caught in İskenderun Bay were 1.39, 47.75 and 10.02 μg/kg (in wet weight). Karadede and Ünlü (2000) found the order of the organs where Cu and Zn are accumulated most in *Acanthobrama marmid*, *Chalcalburnus mossulensis*, *Chondrostoma regium*, *Carasobarbus luteus*, *Capoeta trutta* and *Cyprinus carpio* living in Atatürk Dam Lake as liver > gills > muscles. They reported that maximum Cu accumulation in carp took place in liver, kidneys and gonads while the lowest accumulation levels were observed in muscles. It was also reported that Pb accumulation in liver and muscles of *Cyprinus carpio* was higher than the other organs. The metal analyses of the tissues of *Cyprinus carpio*, *Barbus capito* and *Chondrostoma regium* living in Seyhan River revealed the fact that accumulation levels in liver and gills are higher than the other organs. The accumulation of Cd, Pb and Zn *Leuciscus cephalus* living in Dipsiz stream were observed to be higher in gills than in muscles and the opposite was the case for Cu (Demirak et al. 2006).

Zn and Cu levels in *Sander lucioperca* living in Hirfanlı Dam Lake were found to be with in the acceptable limits (Anonymous 2002). However although Pb and Cd values were with in the acceptable limits in gills they are a little bit above the limit in muscles and livers. We can therefore conclude that the *Sander lucioperca* living in Hirfanlı Dam Lake is affected by Pb and Cd pollution.

The maximum acceptable metal concenration levels laid down in Turkish Food Codex for Cd, Pb,, Zn and Cu are 0.005, 0.2, 50, 20 mg kg^{-1}, respectively (Anonymous 2002). Pb and Cd levels especially in liver and muscle tissues were higher than the limit values.

The results of this study supplied valuable information on the metal levels in *Sander lucioperca* from the Hirfanlı Dam Lake. Pb and Cd levels especially in liver and muscle tissues were higher than the limit values. The present study shows that precautions need to be taken in order to prevent future metal pollution. Otherwise, these pollution can be dangerous for fish and human health.

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References

Al-Khashman OA (2007) Determination of metal accumulation in deposited street dusts in Amman. Jordan. Environ Geochem Health 29:1–10

Anonymous (2002) Turkish Food Codex, Gıda maddelerinde belirli bulaşanların maksimum seviyelerinin belirlenmesi hk tebliğ. No:2002/63, pp 151 (in Turkish)

Canlı M, Atli G (2003) The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. Environ Politics 121:129–136

Demirak A, Yılmaz F, Tuna AL, Özdemir N (2006) Heavy metals in water, sediment and tissues of *Leuciscus cephalus* from a stream in southwestern Turkey. Chemosphere 63:1451–1458

DSİ (1968) Hirfanlı Baraj Gölü Lim (in Turkish). Etüd Raporu. Ankara

Fernandes C, Fontaínhas-Fernandes A, Peixoto F, Salgado MA (2007) Bioaccumulation of heavy metals in Liza saliens from the Esmoriz–Paramos coastal lagoon, Portugal. Ecotoxicol Environ Safety 66(3):426–431

Fisheries Statistics (2004) Quantity of caught fresh-water products. State Institute of Statistics Prime Ministry, Ankara, p 59

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

Kensova R, Celechovska O, Doubravova J, Svobodova Z (2010) Concentrations of metals in tissues of fish from the Věstonice reservoir. Acta Vet Brno 79:335–345

Mico C, Peris M, Sanchez J, Recatala L (2006) Heavy metal content of agricultural soils in a Mediterranean semiarid area: the Segura River Valley (Alicante, Spain). Spanish J Agric Res 4(4):363–372

Öksüz A, Küçükgülmez A, Diler A, Çelik M, Koyuncu E (2009) A comparison of the chemical composition of Zander (*Sander Lucioperca*) living in different lakes of Turkey. J Muscle Foods 20:420–427

Ozturk M, Ozozen G, Minareci O, Minareci E (2009) Determination of heavy metals in fish, water and sediments of Avsar Dam Lake in Turkey. Iranian J Environ Health Sci Eng 6(2):73–80

Papagiannis I, Kagalou I, Leonardos J, Petridis D, Kalfakaou V (2004) Copper and zinc in four freshwater fish species from Lake Pamvotis (Greece). Environ Int 30:357–362

Schüürmann G, Markert B (1998) Ecotoxicology: ecological fundamentals, chemical exposure, and biological effects. Wiley/Spektrum Akademischer Verlag, New York/Heidelberg

Szentmihalyi K, Then M (2007) Examination of microelements in medicinal plants of the carpathian basin. Acta Alimentar 36:231–236

Tekin-Ozan S, Kır I (2006) Concentrations of some heavy metals in organs of two fish species from the Beyşehir Lake, Turkey. Fresen Environ Bull 15(6):530–534

Yalcin MG, Aydin O, Elhatip H (2008) Heavy metal contents and the water quality of Karasu Creek in Niğde, Turkey. Environ Monit Assess 137(1–3):169–178

Yıldırım Y, Gönülalan Z, Narin İ, Soylak M (2009) Evaluation of trace heavy metal levels of some fish species sold at retail in Kayseri, Turkey. Environ Monit Assess 149:223–228