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Environmental Contamination and Toxicology

Lead and Copper Levels in Muscle Meat of Crucian Carp (*Carassius carassius*, L. 1758) from Yarseli Dam Lake, Turkey

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In recent years, industrial development and agricultural processes resulted in increases in levels of toxic metals in the environment, although relatively high concentrations can also occur naturally (Lopez Alonso et al. 2002). The contamination of freshwaters with a wide range of pollutants are a matter of concern because of the threat to public water supplies and damage caused to aquatic life (Uthe and Chou 1988).

The Yarseli Dam Lake was built on the Beyazcay river running through Altinozu, Hatay, Turkey. It is an important water supply for irrigation and also a fishing place for amateur and occasionally commercial fishing. Crucian carp (*Carassius carassius, L. 1758*) constitute a large fraction of the fish population consumed commonly by people in this region. The villagers around the lake have report mass death of fish populations for several years. In this study, particularly two heavy metals, lead and copper were selected for analysis, since the two metals appear to be potential pollutants in this area. The sources of lead and copper contaminations of Yarseli Dam Lake might include use of these two metals for plumbing, discharging industrial waste including batteries and also agricultural processes, such as use of pesticides. This study was undertaken to investigate the extent of lead and copper contamination in muscle of *Carassius carassius* cought from Yarseli Dam Lake. Seasonal variations of lead and copper were also evaluated.

MATERIALS AND METHODS

The fish samples were collected by using nets from Yarseli Dam Lake in Hatay, Turkey (Figure 1). A3 total of 40 samples evenly representing each of the four seasons (10 samples for each season) were collected from summer 2000 to summer 2001. The samples were transferred in plastic bags to the laboratory in refrigerated conditions and stored at -20 °C until heavy metal analysis were performed. All samples were thawed and fish lengths were measured. Fork length and the fresh weight of the samples were recorded prior to dissection. The mean fish length and weight collected for this study were 142.9±24.8 (range 110 to 205) mm and 97.1±47.2 (range 36 to 183) g, respectively.

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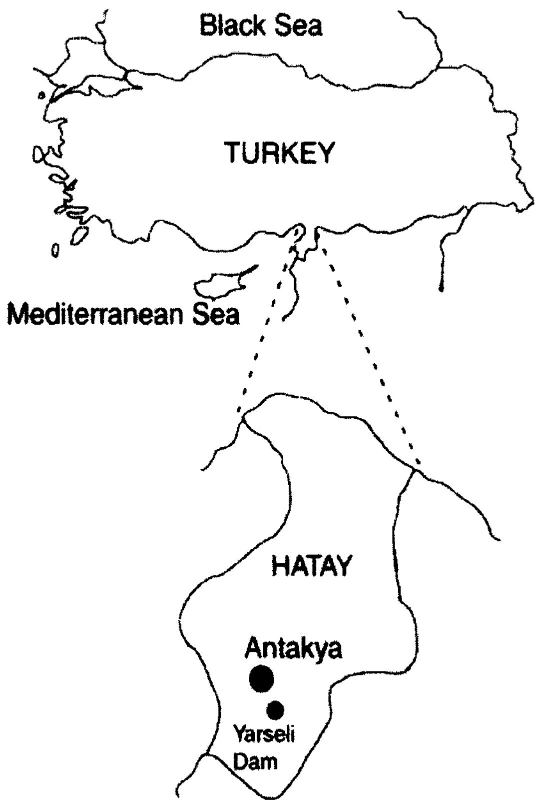

Figure 1. Sampling area of *Carassius carassius*, the Yarseli Dam Lake.

The levels of lead and copper in muscle of fish samples were measured following to the method of Stahr (1977). Briefly, 5 g of fish muscle was mixed with 10 mg magnesium acetate solution (as 2 mg/g), dried for 3 to 4 hours at 100 °C in incubator, and ashed for 6 to 8 h at 600 °C to eliminate the organics. After the ash was dissolved in 15 ml 2 N HCl, the concentrations of lead and copper were measured using an atomic absorption spectrophotometer (Shimadzu 5890, AAS) and the values were then given as mg metal/kg fresh weight (FW).

Data were analysed statistically using one way analysis of variance (ANOVA). When significant treatment effects were detected, Duncan's multiple range test was used to identify specific differences among treatment means at a probability level of 5%.

RESULTS AND DISCUSSION

The mean levels of lead and copper in muscle of *Carassius carassius* were 1.5±0.5 mg/kg and 4.3±1.2 mg/kg FW, respectively (Table 1). These levels of lead and copper are much higher than those from relatively clean waters in other

Table 1. Seasonal variations of lead and copper concentrations in muscle of *Carassius carassius* (mg/kg FW).

Seasons	Pb	Cu
Spring (n=10)	1.8 ±0.4 [a]	4.0 ±0.6
	(1.0-2.3)	(3.0-5.1)
Summer (n=10)	1.0±1.2 [b]	4.9 ±0.7
	(0.6-1.2)	(4.0-5.8)
Fall (n=10)	1.5 ±0.6 [a]	4.7 ±1.8
	(0.9-2.8)	(2.0-7.8)
Winter (n=10)	1.9 ±0.2 [a]	3.7 ±1.4
	(1.7-2.1)	(1.0-5.6)
Overall (n=40)	1.5±0.5	4.3±1.2
	(0.6-2.8)	(0.9-7.8)

[a,b] Means with in the same column with different letters are statistically significant ($p<0.05$).

Table 2. Lead and copper concentrations in muscle of *Carassius carassius* according to length (mg/kg FW).

Fish length (mm)	Pb	Cu
100-125 (n= 16)	1.3±0.4	4.0±0.5
	(0.6-2.0)	(3.0-4.7)
130-155 (n= 12)	1.6±0.4	4.2±0.9
	(1.0-1.9)	(3.0-5.8)
160-205 (n= 12)	1.5±0.3	4.9±1.7
	(1.1-2.0)	(1.0-7.8)

Table 3. Lead and copper concentrations in muscle of *Carassius carassius* according to weight (mg/kg FW).

Fish weight (g)	Pb	Cu
35-50 (n=13)	1.4±0.5	4.1±0.6
	(1.0-2.3)	(3.0-5.6)
50-130 (n=14)	1.6±0.6	4.3±1.0
	(0.6-2.8)	(2.7-5.6)
135-185 (n=13)	1.6±0.4	4.4±1.9
	(0.9-2.1)	(1.0-7.8)

areas (Falandysz 1986; Karadede and Unlu 2000; Kucuksezgin et al. 2001, 2002; Licata et al. 2003). Falandysz (1986) have reported that the low values for lead and copper in muscle of herring (*Clupea harengus*) netted in the Baltic Sea were 0.1 and 0.5 mg/kg FW, respectively. The copper levels in muscle of various fish species (*Acanthobrama marmid, Chalcalburnus mossulensis, Chondrostoma regium, Carasobarbus luteus, Capoetta trutta* and *Cyprinus carpio*) from Ataturk Dam Lake, Turkey, have been reported to be ranging from 0.8 to 2.3 mg/kg FW (Karadede and Unlu 2000). In the study given above, the lead level has been unmeasurably low. Their outcomes are lower than our results. Kucuksezgin et al. (2001, 2002) measured markedly low lead in muscle of *Mullus barbatus, Pagellus erythrinus, Merluccius merluccius, Diplodis annularis* and *Solea vulgaris* fish species from the Izmir Bay, Turkey, and Aegean Sea (range 0.01 to 0.94 mg/kg FW), which are much lower than that for *Carassius carassius*. Licata et al. (2003) studied heavy metal levels in muscle samples of mullets (*Liza aurata*) from lake Ganzirri, Sicily and found lead level to be 0.4 (range 0.3 to 0.6) mg/kg FW and copper level to be 2.8 (range 2.0 to 3.8) mg/kg FW, which were lower than our results.

On the other hand, the metal concentrations in the Yarseli Dam Lake are considerably lower than those found in the Tigris River (Turkey), Lake Tanganyika (Tanzania) and Lake Qarun (Egypt). The copper level found in the muscle of *Carassius carassius* in the present study is well below than that in muscle of *Cyprinion macrostomus* and *Garra rufa* fish species collected from the Tigris River, Turkey (75-271 mg/kg and 87-188 mg/kg FW, respectively) (Gumgum et al. 1994). In addition, in the same study, the lead concentration has been undetectably low. Chale (2002) has detected the mean values of lead and copper concentrations in muscle of various fish species (*Lates marie, Lates stappersii, Limnothrissa miodon, Stolothrissa tanganicae, Chrystysts* sp., *Raiamas moorei, Oreochromis* sp., *Alestes* sp.) in a range from 2.7 to 6.1 and 3.4 to 14.0 mg/kg FW, respectively, from Lake Tanganyika, Tanzania. The lead and copper levels in different kinds of fish species (*Tilapia* sp., *Mugil* sp., *Solea aegyptiaca* and *Penacus* sp.) range from 2.6 to 12.2 and from 0.2 to 5.7 mg/kg FW, respectively, from Lake Qarun, Egypt (Mansour and Sidky 2002). In last two studies, copper levels are comparable with that found in our study. Whereas, the lead levels are remarkably higher than that in the study presented here. The main sources of the various heavy metals in the fish could be from the metal present in water and sediments as reported (Gumgum et al. 1994; Chale 2002, Mansour and Sidky 2002). Further investigations of the heavy metal levels in water, sediment and fish from Yarseli Dam Lake are necessary to evaluate possible contamination sources.

The mean contents of the two metals in muscle of *Carassius carassius* examined were compared with the permissible limits recommended by Food and Agriculture Organization (FAO) (Anonymous 1983). The copper levels of all fish samples were below recommended limit (10.0 mg/kg FW, FAO). Whereas, lead content ranged from 0.6 to 2.8 (with a mean of 1.5±0.5) mg/kg FW. Although the mean value of the lead content does not seem to exceed the permissible limit (1.5 mg/kg FW, FAO), the maximum range does exceed the permissible limit, thus being a potential risk for the consumers.

The data on seasonal variations in lead and copper in fish muscle is given in Table 1. The lead and copper concentrations were the highest in winter and summer, respectively. There was a significant difference in lead concentration between summer and other seasons ($p<0.01$). This is in agreement with the report by Edwards et al. (2001). In that study, it was found that the concentrations of metals including lead and copper in muscles of fish species *Aldrichetta forsteri* and *Sillago schomburgkii* varied with season, with generally higher in winter samples from near industrial centres in South Australia. On the other hand, Mansour and Sidky (2002) found the lowest concentration of lead in the samples of the autumn season. However, in two different studies carried out by Kucuksezgin et al. (2001, 2002), no significant differences in the values among the various sampling periods have been observed for lead.

The levels of lead and copper as functions of length and weight were given in Table 2 and Table 3. Lead and copper concentrations in fish muscle were not related to fish length or weight. There have been different results showing, on one hand, in *Mullus barbatus*, a correlation between lead concentration and fork length (Kucuksezgin et al. 2001), on the other hand, in *Mullus barbatus, Pagellus erythrinus, Merluccius merluccius, Diplodus annularis and Solea vulgaris* fish species, no correlation between lead and fork length (Kucuksezgin et al. 2002).

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