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Full Length Research Paper

Levels of copper in liver, muscle and gill tissues in *Capoeta trutta* (Heckel, 1843) from Munzur River, Turkey

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Heavy metal pollution of waters is a major environmental problem. Due to their toxicity, long persistence, bioaccumulative and nonbiodegradable properties in the food chain, heavy metals constitute a core group of aquatic pollutants. *Capoeta trutta* is an economically important fish and the object of significant commercial fishery in the Munzur River. Levels of Cu were measured in samples of the muscle, gill and liver tissues of *C. trutta* from Munzur River. In liver copper levels were higher at Station I (6.15 mg kg^{-1}) polluted by domestic waste than Station II (5.48 mg kg^{-1}) (P<0.05). The highest copper level (7.25 mg kg^{-1}) was measured in muscle tissue at Station II. There was found no statically differences between stations in gill and muscle (P>0.05). It is suggested that ecological condition of freshwater fish and contamination levels in Munzur River must be regularly monitored.

Key words: Munzur River, copper, *Capoeta trutta,* domestic sewage.

INTRODUCTION

Contamination of freshwater fish with heavy metals is a recognized environmental problem (Staniskiene et al., 2006). The major sources of contamination in surface water can be traced to industrial discharges, domestic waste disposal and application of agrochemicals on farmlands (Kennicutt et al., 1992).

Among the various pollutants, heavy metals, in particular, are widespread contaminants released into aquatic systems from numerous anthropogenic sources. Some metals are known to be toxic even at low concentrations, including arsenic, cadmium, mercury and lead (Le et al., 2009). Others, such as copper and cobalt, are known to be essential elements and play important roles in biological metabolism at very low concentrations (Le et al., 2009) and either an excess or deficit can disturb biochemical functions in both humans and animals (Gulec et al., 2011). Heavy metals, unlike organic pollutants, cannot be chemically degraded or biodegraded by microorganisms. Thus, their content has steadily increased in soils and subsequently accumulated in plants, animals, and even in humans (Che et al., 2006). The pollutants like heavy metals after entering into aquatic environment accumulate in tissues and organs of aquatic organisms. The amount of absorption and assembling depends on ecological, physical, chemical and biological condition and the kind of element and physiology of organisms (Jaffar et al., 1988). The concentration of any pollutant in any given tissue therefore depends on its rate of absorption and the dynamic processes associated with its elimination by the fish (Al-Kahtani, 2009). Pollution/pollutant enters fish through five main routes: Via food or non-food particles, gills, oral consumption of water and the skin. On absorption, the pollutant is carried in blood stream to either a storage point or to the liver for transformation

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and/or storage. Pollutants transformed in the liver, may be stored there or excreted in bile or transported to other excretory organs such as gills or kidneys for elimination or stored in fat, which is an extra hepatic tissue (Heath, 1991; Nussev et al., 2000; Al-Kahtani, 2009).

Heavy metals cause the mutation in fish inner organs, disturb immune reactions, change blood parameters, reduce an organism's adaptation qualities, vitality, resistance to diseases. Loss of fry and degeneration and diminution of valuable varieties of fish are observed as a result of heavy metals pollution (Alabaster and Lloyd, 1994; Bird et al., 1998; Blasco et al., 1999; Kime, 1999).

Usually, many toxic compounds affect organisms in nature at the same time, each of them having a specific effect on physical and chemical processes that influence an organism's condition and reactions. Therefore, in order to maintain the quality of food it is important to regularly monitor and evaluate the pollution levels in fish as well as in water reservoirs (Staniskiene et al., 2006).

Copper is needed in trace amounts for carrying out vital functions in animal organisms (Cousins, 1985). Also, copper is used in alloys, chemical catalyzers, dyes and algaecides as a raw material (Torres et al., 1987). Discharge of copper from these sources without any treatment increases its concentration in aquatic environments and hence shows its toxic action for aquatic organisms (Stagg and Shuttleworth, 1982; Lauran and McDonald, 1985).

Capoeta trutta is an economically important fish and the object of significant commercial fishery in Munzur River. The purpose of this work was to evaluate copper concentrations in liver, muscle and gill tissues of *C. trutta* collected from two sites (Station I and II) of Munzur River of Tunceli, Turkey.

MATERIALS AND METHODS

Copper level was measured in samples of the liver, muscle and gill tissues in *C. trutta* from Munzur River. *C. trutta* samples were captured from two sites in Munzur River on April 2010 (Figure 1). Station I is a polluted site by domestic sewage discharge. Although there is discharge point of domestic sewage, Station II is unpolluted site.

Fish were captured with net (n = 10 in each station), placed in plastic bags, and anaesthetized immediately 0.7 g L^{-1} benzocaine dissolved in ethyl alcohol (Sardella et al., 2004) for deep sedation (Altun and Danabas, 2006) and transported to the laboratory in freezer bags with ice. For chemical assays, liver, muscle and gill tissues were removed and stored -80ºC until the assay.

Reagents

All reagents used were of analytical reagent grade. Throughout the analytical work, doubly distilled water was used. All glass apparatus were kept permanently full with 1.0 mol L^{-1} nitric acid when not in use. The microwave digestion procedure was chosen for the samples because of more accurate with respect to time than wet digestion. In the digestion and extraction procedures, concentrated nitric acid (65%, Merck, Darmstadt, Germany) was used. The stock solutions (1000 mg L^{-1}) were prepared by dissolving its nitrate salts in 1.0 mol L^{-1} nitric acid.

Apparatus

A Perkin Elmer AAnalyst 800 atomic absorption spectrometer with deuterium background corrector was used. For flame measurements a lamp and an air–acetylene flame were used. Cu which was measured was carried out in an air/acetylene flame (Table 1).

RESULTS AND DISCUSSION

The mean copper values in fish tissues varied from 5.48 to 7.25 mg kg^{-1} (Table 2). The maximum copper level permitted for fish is 20 mg kg^{-1} according to Turkish Food Codex (Anonymous, 2008). Copper levels in analyzed fish samples were found to be lower than the permitted limits.

Kennicutt et al. (1992) reported that one of the major sources of contamination in surface water can be traced to domestic waste disposal. Similarly at Station I polluted domestic waste copper level was higher in liver than that observed in Station II. There was statistically difference in liver tissue at two sites ($P<0.05$) and not muscle and gills ($P>0.05$).

Biomonitoring, which was used in this study, is still a new approach. Gills and liver are chosen as target organs for assessing metal accumulation. The heavy metal concentration in tissues reflects past exposure via water and/or food demonstrating the current situation of the animals before toxicity in affecting the ecological balance of populations in the aquatic environment (Forstner and Wittmann, 1983).

In another study, Cu concentrations of muscle and liver were found in the range of 0.06-0.16 µg g^{-1} and 28.5-80.0 µg g^{-1} (Onsanit et al. (2010). Copper concentrations in liver were higher than that related by. In Bangladesh, muscles of three species of fish, *Tilapia nilotica*, *Cirrhina mrigala* and *Clarias batrachus*, were analyzed and maximum Cu concentration was determined as 6.12 µg g^{-1} dry weights (Begum et al., 2005), similar to our findings.

The concentrations of heavy metal were found generally higher in the liver and gills than in the gonad and muscle tissues in three species; *Dicentrachus labrax, Sparus arata* and *Mugil cephalus* (Dural et al., 2005). According to these authors the levels of heavy metals were higher in *Mugil cephalus*. But, copper concentrations in muscle were higher than liver and gills, in our study. Fish are capable in synthesizing lipid in their liver and in secreting it to their muscle (Ando et al., 1993). *Capoeta trutta* accumulates lipid in muscle in reproduction season (June to September). They can accumulate heavy metals in lipid and consequently more copper accumulation in this period.

Fish absorbs metals through ingestion of water or contaminated food. Heavy metals have been shown to undergo bioaccumulation in the tissue of aquatic

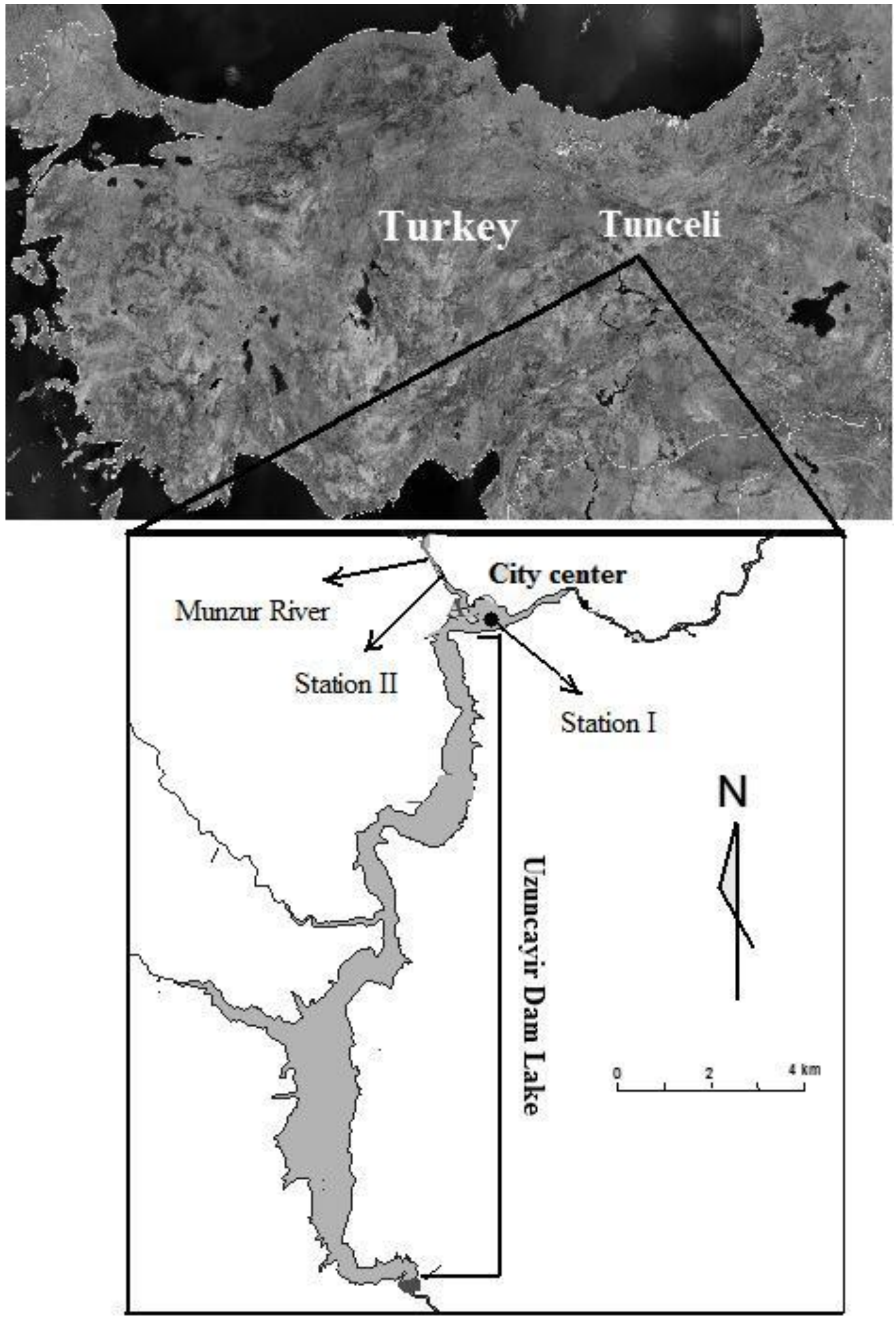

Figure 1. Map of sampling site on Munzur River, Tunceli, Turkey.

Table 1. Instrumental conditions of Copper.

Element	Acetylene (L min^{-1})	Air (L min^{-1})	Wavelength (nm)	Slit width (nm)
Cu	2	17	324.8	0.7

organisms. On consumption of fish and other aquatic organisms these metals become transferred to human (Akan et al., 2009). This research showed that copper concentrations in liver, muscle and gills were lower than the maximum levels set by law.

In conclusion, Munzur River is one of the most important water reservoirs of the region, because of having a great potential aquaculture and fisheries activities. It may

Table 2. Copper level (mg kg^{-1}) in liver, muscle and gills in *Capoeta trutta* (Heckel, 1843) from Munzur River, Tunceli, Turkey.

	Liver (n = 10)	**Muscle (n = 10)**	**Gill (n = 10)**
Station I	6.15±0.17	6.87±0.32	6.03±0.24
Station II	5.48±0.22	7.25±0.30	6.65±0.21
P value	0.029*	0.39	0.085

*Statistically different according to independent T test (P<0.05).

be stated that in order to evaluate the ecological condition of freshwater fish, the contamination levels in Munzur River must be regularly monitored.

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