



## Heavy Metal Levels in Some Fish Species Sold at Retail in Elazığ

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In this study, the levels of cadmium, lead, copper, zinc and iron in rainbow trout (*Oncorhynchus mykiss*), common carp (*Cyprinus carpio*), gilthead seabream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) sold in Elazığ fish market were determined. A total of 60 fish samples (15 samples for each fish species) were analyzed using atomic absorption spectrometer. Average levels of cadmium and lead in the samples, except rainbow trout, were found higher than the maximum acceptable levels established by Turkish Food Codex while levels of copper, zinc and iron in the samples were below. Among the four types of fish samples analyzed, the highest levels of cadmium, copper, zinc and iron were found in common carp while the highest level of lead was in sea bass. According to our results, 50 of 60 (83.3%) fish samples analyzed were not acceptable for human consumption.

**Key Words:** Heavy metal, rainbow trout, common carp, gilthead seabream, sea bass.

### Elazığ'da Perakende Satılan Bazı Balıklarda Ağır Metal Düzeyleri

Çalışmada, Elazığ balık pazarında satılan gökkuşuğu alabalığı (*Oncorhynchus mykiss*), sazan (*Cyprinus carpio*), çipura (*Sparus aurata*) ve levreklerde (*Dicentrarchus labrax*) kadmiyum, kurşun, bakır, çinko ve demir düzeyleri belirlenmiştir. Toplam 60 balık örneğinin (her balık türü için 15 örnek) ağır metal düzeyleri atomik absorpsiyon spektrometresi kullanılarak incelendi. Gökkuşuğu alabalığı hariç, balık örneklerinin ortalama kadmiyum ve kurşun miktarları Türk Gıda Kodeksi tarafından belirtilen maksimum kabul edilebilir düzeyin üzerinde bulunurken, bakır, çinko ve demir düzeyleri maksimum kabul edilebilir düzeyin altında bulundu. Analiz edilen dört balık türü arasında en yüksek kadmiyum, bakır, çinko ve demir oranı sazan balığında bulunurken, en yüksek kurşun düzeyi levreklerde tespit edildi. Sonuçlarımıza göre, analiz edilen 60 balık örneğinin 50'si (%83.3) insan tüketimine uygun değildi.

**Anahtar Kelimeler:** Ağır metal, gökkuşuğu alabalığı, sazan, çipura, levrek.

### Introduction

Fish is a significant part of the human diet since it provides low cholesterol, high-value protein and essential nutritional components such as  $\omega$ -3 long chain polyunsaturated fatty acids (1, 2). However, the benefits of fish consumption may be offset by the presence of toxic metals in fish meat. Metals such as iron (Fe), copper (Cu) and zinc (Zn) are essential metals since they play important roles in various biological systems, whereas lead (Pb) and cadmium (Cd) are well-known toxic metals (3, 4). Cadmium poisoning causes deadly itai-itai disease (5), and it is classified as Class 1 "The agent (mixture) is carcinogenic to humans" (6). Lead toxicity causes blood enzyme changes, anemia, hyperactivity, neurological disorders, coma and death (7, 8). Copper and zinc, although they are essential trace metals, exhibit toxic effects in excessively high concentrations (9). Obviously, it is important to determine the heavy metal contents of fish in order to evaluate the potential risk of fish consumption.

The Keban Dam, which is a hydroelectric dam on the river Euphrates, is located in Elazığ. Keban Dam Lake has a surface area of 675 square kilometers. As well as various industry organizations, Maden Eastern Chrome Company, Ergani Copper Mines and Keban lead deposits are located around the Elazığ province. The presence of those plants contributes to pollution of Keban Dam Lake and Euphrates with heavy metals. Rainbow trout (*Oncorhynchus mykiss*) is a commonly farmed freshwater fish species in the Euphrates, and common carp (*Cyprinus carpio*) is a commonly caught fish species in Keban Dam Lake. Marine fish species are transported to Elazığ from Black Sea or Mediterranean Sea because Elazığ has not connection to any sea coast.

Levels of heavy metals in fish species have been reported by many researchers (10-19). The maximum acceptable metal levels for cadmium, lead, copper and zinc are 0.05, 0.3, 20, 50 mg kg<sup>-1</sup>, respectively in Turkish Food Codex (20), while there is no limit established for iron in fish and fishery products.

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In the present study, we analyzed two types of marine fish [gilthead seabream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*)] and two types of freshwater fish [common carp (*Cyprinus carpio*) and rainbow trout (*Oncorhynchus mykiss*)], commonly sold in Elazığ, for the levels of cadmium (Cd), lead (Pb), copper (Cu) zinc (Zn) and iron (Fe).

## Material and Methods

**Collection of samples:** Between March and April 2011, a total of 60 fish samples (15 farmed rainbow trout, 15 common carp, 15 sea bass and 15 gilthead sea bream) were collected from fish markets in Elazığ. The weight of fish samples were between 230 – 300 g. The fish samples were transferred to the laboratory and kept in a freezer (-20°C) until analyzed.

**Analytical procedure:** For mineral analysis, muscle tissue of fish samples was wet digested with HNO<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> in a microwave (Mars-5 Cem Corporation). The amounts of cadmium, lead, copper, zinc and iron were determined by atomic absorption spectrometer (Perkin –Elmer AA 800). The levels of the metals were determined against standards. The standards were prepared from the stock-standard solution for Cd (VHG LABS 5% HNO<sub>3</sub>, 1.007 µg/ml single element AA standard), Pb (VHG LABS 5% HNO<sub>3</sub>, 1.002µg/ml single element AA standard), Cu (VHG LABS 5% HNO<sub>3</sub>, 1.007 µg/mL single element AA standard), Zn (VHG LABS 5% HNO<sub>3</sub>, 1.000 µg/mL single element AA standard) and Fe (VHG LABS 5% HNO<sub>3</sub>, 1.005 µg/mL single element AA standard). All procedures used for determining heavy metal levels of fish samples were carried out according to the method of AOAC (21). Data obtained from the analysis was presented as descriptive statistic. Mean, maximum and minimum values regarding the mineral concentrations were calculated using Microsoft Office Excell 2007 Software.

## Results

The levels of heavy metals determined in the fish samples are shown in Tables 1 to 5.

The average levels of Cd in fish samples were presented in Table 1. The minimum, maximum and average levels of Cd in rainbow trout were found as 0.01, 0.07 and 0.03 mg kg<sup>-1</sup>. Four of 15 (26.6%) samples exceeded the maximum acceptable limit reported in the Turkish Food Codex. The highest-average levels were found as 0.16, 0.13 and 0.11 mg kg<sup>-1</sup> in common carp, gilthead seabream and sea bass, respectively. The levels of Cd in all samples (100%) of common carp, gilthead seabream and sea bass analyzed in this study notably exceeded the limit of Turkish Food Codex.

The average levels of Pb in rainbow trout, common carp, gilthead seabream and sea bass were 0.30, 0.38, 0.29 and 0.75 mg kg<sup>-1</sup>, respectively (Table 2). Six fish samples (40%) for rainbow trout, six fish samples (40%) for gilthead seabream and 10 fish samples (66.6%) for common carp exceeded the limit, while all of the sea bass samples (100%) were above the maximum acceptable limit.

The lowest-average level of Cu was found in rainbow trout as 0.49 mg kg<sup>-1</sup>. The average levels of Cu in common carp, gilthead seabream and sea bass was 1.13, 1.03 and 1.10 mg kg<sup>-1</sup>, respectively (Table 3). All fish samples (100%) analyzed in this study were notably below the maximum acceptable limit reported in the Turkish Food Codex.

The average levels of Zn in rainbow trout, common carp, gilthead seabream and sea bass were 6.39, 14.13, 5.37 and 7.82 mg kg<sup>-1</sup>, respectively (Table 4). None of the fish samples analyzed exceeded the limit.

**Table 1.** Cd concentration of fish samples (mg kg<sup>-1</sup> wet weight)

Fish samples	Mean	Minimum	Maximum
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	0.03 ± 0.02	0.01	0.07
Common carp ( <i>Cyprinus carpio</i> )	0.16 ± 0.04	0.06	0.25
Gilthead seabream ( <i>Sparus aurata</i> )	0.13 ± 0.04	0.09	0.18
Sea bass ( <i>Dicentrarchus labrax</i> )	0.11 ± 0.02	0.08	0.14

**Table 2.** Pb concentration of fish samples (mg kg<sup>-1</sup> wet weight)

Fish samples	Mean	Minimum	Maximum
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	0.30 ± 0.23	0.03	0.76
Common carp ( <i>Cyprinus carpio</i> )	0.38 ± 0.22	0.02	0.73
Gilthead seabream ( <i>Sparus aurata</i> )	0.29 ± 0.13	0.09	0.44
Sea bass ( <i>Dicentrarchus labrax</i> )	0.75 ± 0.17	0.50	1.18

**Table 3.** Cu concentration of fish samples (mg kg<sup>-1</sup> wet weight).

Fish samples	Mean	Minimum	Maximum
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	0.49 ± 0.19	0.11	0.78
Common carp ( <i>Cyprinus carpio</i> )	1.13 ± 0.26	0.80	1.78
Gilthead seabream ( <i>Sparus aurata</i> )	1.03 ± 0.09	0.90	1.19
Sea bass ( <i>Dicentrarchus labrax</i> )	1.10 ± 0.36	0.70	1.88

**Table 4.** Zn concentration of fish samples (mg kg<sup>-1</sup> wet weight).

Fish samples	Mean	Minimum	Maximum
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	6.39 ± 1.56	3.99	10.16
Common carp ( <i>Cyprinus carpio</i> )	14.13 ± 3.12	9.45	20.21
Gilthead seabream ( <i>Sparus aurata</i> )	5.37 ± 0.42	4.96	6.27
Sea bass ( <i>Dicentrarchus labrax</i> )	7.82 ± 1.88	5.52	12.1

**Table 5.** Fe concentration of fish samples (mg kg<sup>-1</sup> wet weight).

Fish samples	Mean	Minimum	Maximum
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	3.10 ± 0.83	2.00	4.46
Common carp ( <i>Cyprinus carpio</i> )	12.66 ± 8.11	3.70	23.64
Gilthead seabream ( <i>Sparus aurata</i> )	1.39 ± 0.52	0.85	2.42
Sea bass ( <i>Dicentrarchus labrax</i> )	3.28 ± 2.08	1.70	8.51

The average levels of Fe in fish samples were presented in Table 5. The lowest- and highest-average levels of Fe were found in gilthead seabream and common carp as 1.39 and 12.66 mg kg<sup>-1</sup>, respectively. The average Fe levels of rainbow trout and sea bass were 3.10 and 3.28 mg kg<sup>-1</sup>, respectively. No limits were established for Fe in fish and fishery products in the Turkish Food Codex.

## Discussion

The levels of heavy metals found in fish species in various studies generally vary depending on the various factors such as fish species, size, age, the region where fish was caught, seasonal changes, analytical methodology etc. Thus, the mean values obtained in the present study were compared with other literature data referring to the same species of fish in Turkey.

Cadmium is one of the most toxic metals for human and may cause kidney dysfunction, skeletal damage and reproductive deficiencies (22). Common carp samples analyzed in this study showed 3.2 fold higher levels than the limit accepted in Turkish Food Codex, and gilthead seabream and sea bass were 2.6 and 2.2 fold higher, respectively. Our finding regarding Cd concentration in rainbow trout is in agreement with the findings of Şireli et al. (23) and Çelik et al. (24), who found lower concentration of Cd in rainbow trout than the maximum acceptable limit. Göksu et al. (25) reported the Cd level of common carp as 0.46 mg kg<sup>-1</sup>, which is higher than our result. In a study carried out by Türkmen et al. (26),

the levels of Cd in gilthead seabream and sea bass were determined as 0.30 and 0.10 mg kg<sup>-1</sup>, respectively. These results are above the maximum acceptable limit similar to those in our study.

It is known that lead is a health-endangering metal for human. The average levels of Pb in common carp and sea bass samples were found above the maximum acceptable limit, while rainbow trout and gilthead seabream were in the permissible levels for human consumption in terms of Pb level. Our findings for common carp and sea bass were higher than the findings of Ersoy et al. (27), Mendil et al. (28) and Türkmen et al. (26) who found lower Pb concentration than the legal limits. In another study carried out by Mol et al. (29), it was reported that Pb did not determined in the muscle of common carp. As for rainbow trout and gilthead seabream, our Pb values were lower than the findings of Çelik et al. (24) and Türkmen et al. (26) who found higher Pb concentration than the legal limits.

Copper is an essential micro-nutrient and not toxic for humans in low levels (30). Cu levels presented in this study are in agreement with values reported by many researchers (12, 26, 28, 29, 31). Their findings regarding the levels of Cu in rainbow trout, common carp, gilthead seabream and sea bass have showed that Cu levels in fish samples is quite below the maximum acceptable limit, similar to those in our study.

Zinc is found in almost every cell and in a wide variety of foods, and it is known to be involved in most metabolic pathways in humans (28). Among the fish

species analyzed in this study, the highest Zn content was found in common carp, with 14.13 mg kg<sup>-1</sup>. This finding is quite higher than the finding of Göksu et al., (25) who found 0.84 mg kg<sup>-1</sup> Zn level in common carp. Our findings for rainbow trout, gilthead seabream and sea bass were close to the findings of Gokoglu et al., (12), Çelik and Oehlschläger (31), Çelik et al. (24) and Türkmen et al. (26).

Iron is an essential mineral for life. It is known that adequate iron in a diet is very important for normal regulation of various metabolic pathways (28, 30). In our study, the highest Fe level was found in common carp. This level is 6.5 fold higher than the finding of Göksu et al. (25), who found 1.93 mg kg<sup>-1</sup> Fe level in common carp caught from the Seyhan Dam Lake in southern of Turkey. Our finding regarding the concentration of Fe in rainbow trout was close the finding of Gokoglu et al. (12) and Çelik et al. (24). In a study carried out by Türkmen et al. (26), the average levels of Fe in gilthead seabream and sea bass were reported as 38.9 and 28.9 mg kg<sup>-1</sup>, respectively. These levels are higher than our results.

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