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Assessment in Terms of Human Health Some Heavy Metals Concentrations Determined in *Dicentrarchus labrax* (Linnaeus, 1758) and *Sparus aurata* (Linnaeus, 1758) Marketed in Sinop (Turkey)

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Levent BAT*, Ayşah ÖZTEKİN, Elif ARICI

Hydrobiology Department, Fisheries Faculty, University of Sinop, TURKEY

****e-mail**: leventbat@gmail.com*

Abstract: Mercury (Hg), cadmium (Cd), lead (Pb), copper (Cu) and zinc (Zn) levels in European sea bass *Dicentrarchus labrax* (Linnaeus, 1758) and gilthead sea bream *Sparus aurata* Linnaeus, 1758 that are commercially sold on the Sinop fish markets were appraised. Selected heavy metals were assayed in edible tissues of the sampled fish, using an Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The results are expressed in mg (kg wet wt.) $^{-1}$. In both fish species, Cu was detected in higher concentrations, followed by Cu. The means of metal concentrations in *D. labrax* were 0.03±0.008 mg (kg wet wt.) $^{-1}$ for Hg; 0.009±0.001 mg (kg wet wt.) $^{-1}$ for Cd; 0.06±0.02 mg (kg wet wt.) $^{-1}$ for Pb; 0.42±0.09 mg (kg wet wt.) $^{-1}$ for Cu and 9.2±3.1 mg (kg wet wt.) $^{-1}$ for Zn. Whereas the means of metal concentrations in *S. aurata* were 0.02±0.006 mg (kg wet wt.) $^{-1}$ for Hg; 0.01±0.009 mg (kg wet wt.) $^{-1}$ for Cd; 0.04±0.011 mg (kg wet wt.) $^{-1}$ for Pb; 0.69±0.11 mg (kg wet wt.) $^{-1}$ for Cu and 8.5±2.3 mg (kg wet wt.) $^{-1}$ for Zn. None of the metals in European sea bass and gilthead sea bream were not above the permissible values.

Keywords: *Dicentrarchus labrax, Sparus aurata,* Sinop fish market, heavy metals

Sinop'ta (Türkiye) Satışa Sunulan *Dicentrarchus labrax* (Linnaeus, 1758) ve *Sparus aurata* (Linnaeus 1758)'da Bazı Ağır Metal Konsantrasyonlarının İnsan Sağlığı Açısından Değerlendirilmesi

Özet: Sinop balık pazarında ticari olarak satışa sunulan Avrupa deniz levreği- *Dicentrarchus labrax* (Linnaeus, 1758) ve çipuranın- *Sparus aurata* Linnaeus, 1758, cıva (Hg), kadmiyum (Cd), kurşun (Pb), bakır (Cu) ve çinko (Zn) seviyeleri değerlendirilmiştir. Seçilen ağır metaller, örnek alınan balıkların yenilebilir dokularında İndüktif Olarak Birleştirilmiş Plazma Kütle Spektrometresi (ICP-MS) kullanılarak analiz edilmiştir. Sonuçlar, mg (kg yaş ağırlık)$^{-1}$ cinsinden ifade edilmiştir. Her iki balık türünde de Zn daha yüksek konsantrasyonlarda tespit edilmiş ve bunu Cu izlemiştir. *D. labrax* türünde metal konsantrasyonları ortalama Hg için 0,03±0,008 mg (kg yaş ağırlık)$^{-1}$; Cd için 0,009±0,001 mg (kg yaş ağırlık)$^{-1}$; Pb için 0,06±0,02 mg (kg yaş ağırlık)$^{-1}$; Cu için 0,42±0,09 mg (kg yaş ağırlık)$^{-1}$ ve Zn için 9,2±3,1 mg (kg yaş ağırlık)$^{-1}$ olarak bulunmuştur. *S. aurata* türünde ise, metal konsantrasyonları ortalama Hg için 0,02±0,006 mg (kg yaş ağırlık)$^{-1}$; Cd için 0,01±0,009 mg (kg yaş ağırlık)$^{-1}$; Pb için 0,04±0,011 mg (kg yaş ağırlık)$^{-1}$; Cu için 0,69±0,11 mg (kg yaş ağırlık)$^{-1}$ Zn için 8,5±2,3 mg (kg yaş ağırlık)$^{-1}$ olarak bulunmuştur. Avrupa deniz levreği ve çipura için ağır metallerin hiçbiri izin verilen değerlerin üzerinde bulunmamıştır.

Anahtar kelimeler: *Dicentrarchus labrax, Sparus aurata,* Sinop balık pazarı, ağır metaller

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1. INTRODUCTION

The continuous existence of heavy metals in industrial wastes and notable bioaccumulation in commercial fishes make them important environmental concern. The heavy metals are not biodegradable and have the ability to accumulate in the marine coastal environment consequently make them hazards to people who consumed as sources of food. In a review, Bat (2014) showed that fish are widely used as bio-indicator to evaluate the health of marine ecosystems.

Fishery has an important place in the economy of Sinop Province of Turkey (Bat et al., 2013). European Food Safety Authority (EFSA, 2015) suggested that fish is a source of energy and protein with high biological value. In point of health risk, the tolerable weekly intakes were evaluated by means of references for edible tissues of fishes consumed by human. The yearly amount of fish consumed is 6.2 kg person^{-1} in 2015 (TUIK, 2016), which

are equal to about 17 g day^{-1} for Turkey. However, there is a large variation in the amount of fish consumed across regions in Turkey and age groups, as well as in the type of species eaten. In Turkey, people who live in the coastal cities including Sinop Province eat more than those this average amount.

This study was aimed at detecting heavy metals (Hg, Cd, Pb, Cu and Zn) in edible muscles of European sea bass and gilthead sea bream from fish markets of Sinop Province.

2. MATERIAL AND METHODS

Fish specimens of European sea bass and gilthead sea bream, used for the present study, were naturally caught from Sinop coasts of the Black Sea during the fishing season of 2015 and were obtained from fish market in Sinop. The fish samples were taken randomly then labelled and were preserved using ice box and transported to the main laboratory. For metal analysis, sampled European sea bass and gilthead sea bream individuals were measured and first washed with tap water and then rinsed in distilled water. All samples were stored in deep frozen at -21°C until analysis. Hg, Cd, Pb, Cu and Zn analysis in edible tissues of the samples was made by m-AOAC 999.10- ICP/MS technique by validated Environment Industrial Analysis Laboratory Services Trade Company (TÜRKAK Test TS EN ISO IEC 17025 AB-0364-T). The mean heavy metal weekly intake was calculated as following formula: Heavy metals intake level = mean heavy metal content X consumption of fish per person/ body wt. IBM SPSS Statistics version 21 software is used for statistical calculations. The concentrations are expressed in mg (kg wet wt.)$^{-1}$.

3. RESULTS AND DISCUSSION

Mean values of the heavy metal concentration in the edible tissues of sampled fish species are displayed in Figure 1. In this study the concentrations of measured heavy metals decrease in the order of Zn > Cu > Pb > Hg > Cd. However, Yabanli et al. (2012), found in the fillets of the same species, the mean concentrations of toxic elements decreased as Hg > Pb > Cd.

Metal levels in edible tissues of European sea bass and gilthead sea bream individuals from Sinop markets showed differences. The means of metal concentrations in *D. labrax* were 0.03±0.008 mg (kg wet wt.)$^{-1}$ for Hg; 0.009±0.001 mg (kg wet wt.)$^{-1}$ for Cd; 0.06±0.02 mg (kg wet wt.)$^{-1}$ for Pb; 0.42±0.09 mg (kg wet wt.)$^{-1}$ for Cu and 9.2±3.1 mg (kg wet wt.)$^{-1}$ for Zn. However the means of metal concentrations in *S. aurata* were 0.02±0.006 mg (kg wet wt.)$^{-1}$ for Hg; 0.01±0.009 mg (kg wet wt.)$^{-1}$ for Cd; 0.04±0.011 mg (kg wet wt.)$^{-1}$ for Pb; 0.69±0.11 mg (kg wet wt.)$^{-1}$ for Cu and 8.5±2.3 mg (kg wet wt.)$^{-1}$ for Zn. Current European Commission Regulation and Turkish Food Codex allowed the maximum Hg, Cd and Pb limits in the edible tissues of fish as 0.5, 0.05 and 0.3 mg (kg wet wt.)$^{-1}$, respectively. European Commission Regulation has no legislation for essential metals, but Turkish Legislation states the maximum permitted limits of Cu and Zn as 20 and 50 mg (kg wet wt.)$^{-1}$, respectively. None of the metals in European sea bass and gilthead sea bream were not above the permissible values in the current study.

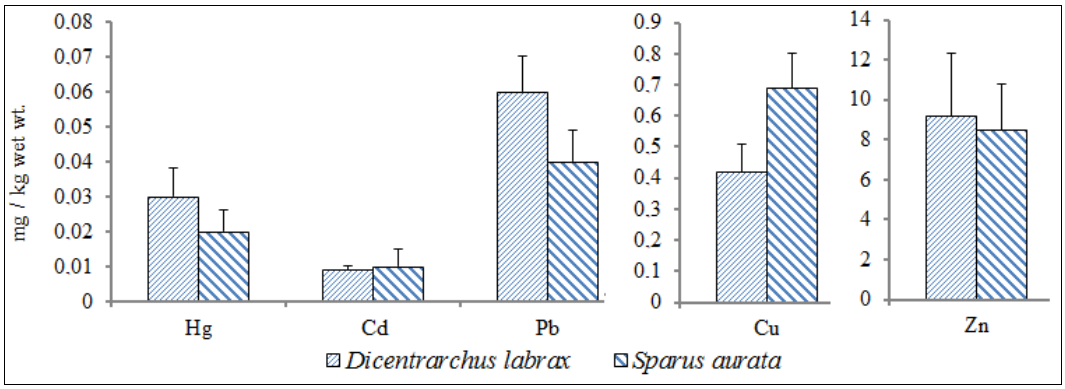

Figure 1. Tissue concentration ± standard deviation of Hg, Cd, Pb, Cu and Zn levels in the edible tissues of European sea bass and gilthead sea bream from fish market of Sinop Province.

In the current study, cadmium showed the least accumulation in fish. The mean Cd concentration measured in our study is considerably lower than those in reported by Dural et al. (2006); and muscle tissues was found as 0.092 mg kg^{-1} for European sea bass and 0.120 mg kg^{-1} for gilthead sea bream, Alasalvar et al. (2002); 0.270 mg kg^{-1} for cultured European sea bass, Yabanli et al. (2012); 0.00792 mg kg^{-1} for European sea bass, and 0.00988 mg kg^{-1} for gilthead sea bream. These results (Yabanli et al., 2012; Dural et al., 2006; Alasalvar et al., 2002) were much more higher than the recommended legal limits of Cd [0.05 mg (kg wet wt.) $^{-1}$] of the European Union for people consumption.

Similarly, Hg levels in these species were lower than those in reported by Yabanli et al. (2012); 0.09765±0.01726 mg kg^{-1} for European sea bass fillet and 0.07490±0.01343 mg kg^{-1} for gilthead sea bream fillet. However, these values were lower than the recommended legal limits of Hg [0.5 mg (kg wet wt.)$^{-1}$] of the European Union for people consumption.

The mean Pb amounts of European sea bass and gilthead sea bream of the current study are also much lower than those reported in the literature (1.03 mg kg^{-1} for European sea bass, Alasalvar et al. (2002); 0.48 mg kg^{-1} for European sea bass, Türkmen et al. (2009); 0.62 mg/kg for gilthead sea bream, Uluozlu et al. (2007); 7.33 mg kg^{-1} for gilthead sea bream, Yılmaz (2005), and similar to the literature by Yabanli et al. (2012); 0.05769±0.02846 mgkg^{-1} for European sea bass fillet and higher than those in gilthead sea bream fillet (0.02789±0.00708 mg kg^{-1}).

Fish are constantly at the top of food chain in marine environment and may be accumulated big quantities of some metals from the surrounding water. Therefore it is very important to know heavy metal concentrations in fish with respect to marine environment health and human consumption of fish.

The permissible weekly intake of heavy metals as Provisional Tolerable Weekly Intake (PTWI), are set by the Food and Agriculture Organization/World Health Organization (FAO/WHO) Joint Expert Committee on Food Additives (JECFA) (FAO/WHO, 2010; 2011). PTWI is the capacity amount of a pollutant to which a person can be subjected per week over a vita without an unacceptable risk of health effects. The estimated daily intake (EDI) and estimated weekly intake (EWI) in the current study were estimated and showed in Table 1. Intake estimates were expressed as mg (kg body wt.) $^{-1}$ weekly and daily.

Table 1. Estimated Weekly Intakes (EWI) and Estimated Daily Intakes (EDI) of heavy metals in edible tissues of *D. labrax* and *S. aurata* from fish market of Sinop Province.

Metals	PTWI[a]	PTWI[b]	PTDI[c]	EWI[d] (EDI)[e]	
				D. labrax	***S. aurata***
Zn	7	490	70	1.0948 (0.1564)	1.0115 (0.1445)
Cu	3.5	245	35	0.050 (0.0071)	0.082 (0.012)
Pb	0.025	1.75	0.25	0.00714 (0.001)	0.0476 (0.00068)
Hg	0.004	0.28	0.04	0.00357 (0.00051)	0.00238 (0.00034)
Cd	0.007	0.49	0.07	0.0011 (0.00016)	0.00119 (0.00017)

[a]PTWI (Provisional Tolerable Weekly Intake) in mg/week/70 kg body wt. [b]PTWI for 70 kg adult person (mg/week/70 kg body wt.) [c]PTDI (Permissible Tolerable Daily Intake) (mg/day/70 kg body wt.) [d]EWI (Estimated Weekly Intake) (mg/week/ kg body wt.) [e]EDI (Estimated Daily Intake) (mg/day/ kg body wt.)

The calculated amounts of Hg, Cd, Pb, Cu and Zn in the current study were much lower than the allowable limits by European Community Regulation (EU) and Turkish guidelines. The estimated EDIs of all metals via consumption of the fish species by Turkish people in the southern of the Black Sea were well below the permissible tolerable daily intake for 70 kg person set by FAO/WHO. Thus, it can be suggested that no problems on human health would be emerged at present from the consumption of the edible tissues of *D. labrax* and *S. aurata* from fish market of Sinop Province.

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