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HEAVY METAL CONCENTRATIONS IN TURBOT (*SCOPHTHALMUS MAXIMUS*) FROM BULGARIAN BLACK SEA COAST

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ABSTRACT

Turbot (*Scophthalmus maximus, Linnaeus* 1758) is a marine bottom fish and is considered to be one of the most commercialy valuable species in Black Sea. The aim of this survey was to determine the heavy metal concentrations in turbot tissue from the Bulgarian part of the sea. Samples were collected during the fishing season between June and September in 2020 from Varna and Burgas regions. Metals were determined using ICP-MS (Inductively Coupled Plasma - Mass Spectrometry). The order of the levels of the heavy metals in the fish samples was Zn > Al > Mn > As > Hg > Pb = Cd from Varna and Zn > Al > As >Mn > Hg > Pb = Cd from Burgas. The current data demonstrated higher concentrations of Mn and Zn from Varna. According to the obtained results Pb, Cd, Hg levels in the tested turbot samples were within the limits set by the EC regulations.

Key words: heavy metals, *Scophthalmus maximus*, turbot, Black Sea.

Introduction

Fish is a valuable source of many nutrients, especially proteins and fatty acids. Its consumption can be associated with a positive impact on human health (Stancheva, 2018). However increased heavy metal levels in hydrobionts poses potential health hazard. According to Elbeshti et al. (2018) the bioaccumulation of heavy metals suppose to be much higher in fish compared to water or sediment. In this regard, the subject of many ecological studies was the pollution of marine ecosystems and heavy metals accumulation in various bioindicator organisms (Bat et al., 2009; Jitar et al., 2013).

Figure 1: Turbot (*Scophthalmus maximus*)
(https://agrozona.bg/ucheni-registriraha-razlichni-hibridi-na-esetrovi-ribi-zastrashavashti-bioraznoobrazieto-v/)

The turbot (Fig. 1) belonging to the demersal fish of the family *Scophthalmidae* is one of the most valuable species in the Black Sea (Tserkova et al., 2017).

It is known in the taxonomic classifications with various names such as *Scophthalmus maximus* (Linnaeus, 1758), *Scophthalmus maeoticus* (Pallas, 1814) or *Psetta maxima maeotica* (Pallas, 1814) (Petrea et al., 2020). Due to some species peculiarities in the way of life of flatfish like the lack of migration over long distances, this demersal fish is a valuable bioindicator in terms of heavy metal pollution in the Black Sea (Simionov et al., 2019). In addition, according to Lacerda et al. (2020) and da Silva et al. (2020) demersal fish accumulate large amounts of pollutants

compared to pelagic species. For these reasons the concentration of heavy metals in the edible parts of the Black Sea turbot has been intensively studied (Bat et al., 2006, Das et al., 2009, Ergonul and Altinda, 2014).

Materials and methods

Study Area

The fish used in the current study were Scophthalmus maximus and the samples were collected from June to September 2020 from commercial catches at two locations in Black Sea along Bulgarian coastal area, Varna and Burgas (Fig.2).

Figure 2: Bulgarian Black Sea region (http://www.obzor-galeria.com/obzor_city.htm).

Samples preparation and determination of heavy metal levels

The fish samples were taken randomly and only consumable sizes were used. They were thoroughly washed with ultra-pure water and then the specimens were measured for total length. The mean lengths of Scophthalmus maximus was 38±5 cm.

Metal analysis in turbot was performed after homogenization (Vortex homogenizer), followed by microwave-assisted acid digestion procedure (ETHOS UP High-performance Microwave diges-

tion system, Milestone Inc). After digested with nitric acid an appropriate spectroscopy determination with Inductively coupled plasma mass spectrometry (ICP-MS, Thermo Fisher TM) was carried out.

Results and Discussion

The aim of this study was to determine the levels of heavy metals As, Pb, Cd, Hg, Mn, Zn and Al in tissues of *Scophthalmus maximus* caught from areas of the Bulgarian Black Sea coast.

Table 1 presented the obtained data which in order of their concentrations were as followed: Zn > Al > Mn > As > Hg > Pb = Cd from Varna and Zn > Al > As >Mn > Hg > Pb = Cd from Burgas.

Table 1: Heavy metal concentrations (mg/kg wet weight) in tissues of turbot from Bulgarian Black Sea coast

Element	Unit	Varna region	Burgas region	Permissible values
As (X±SD)	mg/kg w.w	0,86 ± 0,09	1,49 ± 0,03	-
Pb (X±SD)	mg/kg w.w	< 0,05*	< 0,05*	0,30
Cd (X±SD)	mg/kg w.w	< 0,05*	< 0,05*	0,05
Hg (X±SD)	mg/kg w.w	0,15 ± 0,02	0,20 ± 0,04	0,5
Mn (X±SD)	mg/kg w.w	2,27 ± 0,23	< 0,5*	-
Zn (X±SD)	mg/kg w.w	6,58 ± 0,66	1,82 ± 0.36	-
Al (X±SD)	mg/kg w.w	< 10,0*	< 10,.0*	-

**Method detection limits; ** p < 0.05*

Zn is an essential trace element for all life organisms (Barak and Helmke 1993, Plum et al 2010). However, the high intake of it can become prerequisite for intoxication (Agnew and Slesinger 2021). In both regions Zn is the chemical element with the highest concentration, as for the region of Varna it was 3,6 times higher compared to the Burgas region. The current results were in accordance with Bat et al. (2012) and Tüzen (2009) which found that zinc was the element with the highest levels in the analyzed fish samples from the Turkish part of the Black Sea. The arsenic values were in higher quantities in the turbot caught from Burgas. The obtained levels for manganese showed higher values in the samples from the southern region and those for aluminum were below the detection limits for both of the studied areas. The levels of lead, cadmium and mercury were below the permissible levels according to European and national legislation, and this trend applied to samples taken from both Black Sea regions (Regulation № 1881/2006)

Table 2 presented reference data on the levels of heavy metals in turbot tissues caught from different parts of the Black Sea.

Table 2: Some heavy metal mean values in *Scophthalmus maximus* tissue from Black Sea area (mg/kg, wet weight)

Heavy metals (mg/kg)	Area	Mean value	Reference
Hg	Turkey	0,017±0,003	Bat et al. 2019
	Turkey	0,065±0,004	Das et al. 2009
Cd	Turkey	0,011 ±0,004	Bat et al. 2019
	Turkey	<0,02	Das et al. 2009
	Turkey	<0,02	Bat et al. 2017
	Turkey	0,27	Bat et al. 2006
	Turkey	0,10± 0,01	Tüzen 2009
	Turkey	0,02	Nisbet et al. 2010
	Turkey	0,022±0,007	Bat et al. 2012
	Turkey	0,10 ± 0,01	Bat et al. 2012
	Romania	0,60	Bat et al. 2012
Zn			
	Turkey	45,2 ± 2,7	Bat et al. 2012
	Turkey	24,83±1,71	Nisbet et al. 2010
	Romania	12,18 ± 2,95	Simionov et al. 2019
Pb	Turkey	0,73±0,21	Nisbet et al. 2010
Mn	Turkey	3,26±0,32	Nisbet et al. 2010
	Romania	0,17 ± 0,05	Simionov et al. 2019
As	Romania	3,81 ±1,12	Simionov et al. 2019

The analyzed data indicated exceeding the standards for cadmium (0,05 mg/kg w.w) and lead (0,3 mg/kg w.w) specified in European (Regulation № 1881/2006) and Turkish legislation (Turkish Food Codex, 2009). Cadmium is a highly toxic chemical element which accumulation in the body could lead to severe kidney and liver damage (Kara et al., 2004). According to Bat et al. (2012) the levels of Cd in *Psetta maxima* from the Romanian coast (0,60 mg/kg) exceeded many times the maximum permissible concentrations of 0,05 mg/kg w.w. The results of Nisbet et al. (2010) showed that the levels of Pb in turbot were also above the permissible values. All of the above demonstrated the significant seasonal and species features in the heavy metal concentration.

Some authors also reported a direct relationship between the bioconcentration of heavy metals with fish gender and the type of tested tissues (Simionov et al., 2019). Higher concentrations in male individuals from the Romanian coast was detected, as well as higher levels of Ca, Mg, Na, Ni, As, Zn and Cd in the tail fin, liver and intestine, compared to muscle tissue.

Tables 1 and 2 showed that our results for mercury levels were similar to those found for the Turkish region with no exceedances of the maximum permissible concentrations.

The element with the highest concentrations for the Black Sea region of both Romania and Turkey was zinc (tabl. 2) which were much higher compared to the current results for Bulgarian

area. Manganese concentration from the Bulgarian Black Sea coast was 43,6% lower compared to those found by Nisbet et al. (2010) for the Turkish coast and 92,5% higher than those reported by Simionov et al., (2019) for the Romanian coast. Unlike manganese, arsenic also showed higher levels from the Romanian region (3,81 ± 1,12 mg kg).

Conclusion

The element with the highest concentrations in the samples studied in present study was Zn. In general, it is not accurate to determine which of the studied areas was more polluted, as the values of the chemical elements varied. Based on the results, we can conclude that the levels of lead, cadmium and mercury did not exceed the maximum allowable concentrations and the consumption of turbot did not pose a risk to human health.

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