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RESEARCH ARTICLE

Accumulation of Nonessential Potentially Toxic Trace Elements (PTEs) in the Some Economically Important Seafood Species of Mediterranean

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Summary

This study was conducted to determine the levels of some nonessential potentially toxic trace elements (PTEs) (Ag, Al, As, Ni, Sn) of some economically important seafood species *(Mullus barbatus*, Linnaeus, 1758, *Mugil cephalus,* Linnaeus, 1758, *Panaeus semisulcatus,* De Haan, 1844) caught in the Gulf of Antalya Mediterranean Sea by using ICP-OES (Inductively Coupled Plasma-Optic Emission Spectrophotometer). The averages and the standard deviations of the results of the samples were determined as Ag (0.030±0.017 mg/kg), Al (12.163±7.298 mg/kg), As (0.269±0.121 mg/kg), Ni (0.084±0.067 mg/kg), Sn (0.022±0.003 mg/kg) for the Red Mullet *(M. barbatus)*, Ag (0.038±0.024 mg/kg), Al (11.120±4.019 mg/kg), As (0.140±0.082 mg/kg), Ni (0.060±0.050 mg/kg), Sn (0.022±0.003 mg/kg) for the Grey Mullet *(M. cephalus)*, Ag (0.032±0.029mg/kg), Al (20.924±9.829 mg/kg), As (0.249±0.116 mg/kg), Ni (0.124±0.102 mg/kg), Sn (0.026±0.004 mg/kg) for the Green Tiger Prawn *(P. semisulcatus)*. The determined levels of trace elements were below the available daily intake limits except Al. Also evaluation of other studies conducted in the Gulf of Antalya, Al levels are higher. These results showed that, although increasing the legal rules about environmental pollution, seafood species which caught from the Gulf are exposed to Al in a higher rate.

Keywords: *Gulf of Antalya, Mediterranean Sea, Potentially toxic trace element, Seefood*

Akdeniz'in Bazı Ekonomik Deniz Ürünü Türlerinde Esansiyel Olmayan Potansiyel Toksik İz Elementlerin Birikimi

Özet

Bu çalışma Akdeniz Antalya Körfezi'nde avlanan ekonomik öneme sahip bazı deniz ürünleri türlerindeki *(Mullus barbatus,* Linnaeus, 1758, *Mugil cephalus,* Linnaeus, 1758, *Panaeus semisulcatus,* De Haan, 1844) bazı esansiyel olmayan potansiyel toksik iz elementlerin (PTEs) birikim düzeylerinin ICP-OES (İndüktif Eşleşmiş Plazma-Optik Emisyon Spektrometresi) kullanılarak belirlenmesi için yapılmıştır. Örneklere ait belirlenen sonuçların ortalama ve standart sapmaları Barbunya *(M. barbatus)* için Ag (0.030±0.017 mg/kg), Al (12.163±7.298 mg/kg), As (0.269±0.121 mg/kg), Ni (0.084±0.067 mg/kg), Sn (0.022±0.003 mg/kg) olarak; Kefal *(M. cephalus)* için Ag (0.038±0.024 mg/kg), Al (11.120±4.019 mg/kg), As (0.140±0.082 mg/kg), Ni (0.060±0.050 mg/kg), Sn (0.022±0.003 mg/kg) olarak ve Yeşil Kaplan Karidesi *(P. semisulcatus)* için Ag (0.032±0.029 mg/kg), Al (20.924±9.829 mg/kg), As (0.249±0.116 mg/kg), Ni (0.124±0.102 mg/kg), Sn (0.026±0.004 mg/kg) olarak belirlenmiştir. İz elemetlerin belirlenen düzeyleri Al dışındakilerde ulaşılabilen günlük alım limitlerinin altında kalmıştır. Ayrıca Antalya Körfezi'nde yapılmış diğer çalışmalar değerlendirildiğinde Al düzeyleri yüksektir. Bu sonuçlar çevre kirliliği konusundaki yasal yaptırımların artmasına rağmen körfezden avlanan deniz ürünlerinin Al'a yüksek oranda mağruz kaldığını göstermiştir.

Anahtar sözcükler: *Akdeniz; Antalya Körfezi; Deniz ürünü; Potansiyel toksik iz element*

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INTRODUCTION

Intense human activities (urbanisation, tourism, coastal population, agriculture, maritime traffic, industry, nuclear power stations, mining and the influence of fisheries) in regions surrounding enclosed and semi-enclosed seas such as the Mediterranean Sea always produce, in the long term, a strong environmental impact in the form of coastal and marine degradation and a heightened risk of more serious damage [1-4]. There is a large range of different activities scattered all around the Mediterranean basin and a number of hot-spots are concentrated mainly in the north-east like *Gulf of Antalya*, generated by tourism, urbanization, agriculture, industry and commercial harbours [5,6]. The degree and extent of heavy metal pollution has been one of the main topics studied in environmental geochemistry [7]. The term *heavy metal* has been widely used and inadequately described in scientific literature over the past two decades. The term is often defined as metals and metalloids that have been associated with contamination or potential toxicity to an environment. However, there is no authoritative definition of this term in the relevant literature and recommended a new classification based on the periodic table that reflects an understanding of the chemical basis of toxicity [8]. However, no such a classification has been accepted at this time. Therefore, to use the term *potentially toxic elements* would be more scientific instead of the term *heavy metals*. When a heavy metal enters a food web, organisms can react to its bioavailability in different ways. Some organisms may discriminate against the uptake of one or more potentially toxic metals. Others may incorporate the metal(s) in their soft or hard parts in proportion to the concentration(s) in the growth environments, excreting any excess. Still other organisms may be tolerant of heavy metals and will accumulate concentrations greatly in excess amounts in a growth environment without any damage. Once a metal is incorporated, it is distributed to tissues (muscle) and organs (kidney, lung) [9,10]. Although excretion typically occurs through the kidneys and digestive tract, metals tend to persist in sites like the liver, bones, and kidneys for years or decades. Individual variability in vulnerability to metal toxicity remains a subject of investigation. Low-level metals exposure likely contributes to chronic disease and impaired functioning [9]. Non-essential elements where human toxicity has been reported includes Pb, Cd, Hg, As, Al, Ba, Li, Pt, Te, Ti, Sb, Be, Ga, In, V, Ni, Sr, Sn, Ge, Ag, Au, Bi, Tl, and U [11,12]. Determination the levels of trace elements is extremely important in terms of despite are needed for some physiological process but are toxic over specific doses on this processes, uses to determine the extent of exposure to environmental pollution, gives information about the body nutrisiyonel status, plays a role in the diagnosis and treatment of some diseases its relationship with occupational diseases. As mentioned above, determination trace elements levels is a methot for used to in order to understand with which concentrations organisms exposed to environmental pollution. The increase in the amount of environmentally induced diseases parallel with increasing environmental pollution as a result of developing technology, industrialization and urbanization is extremely worryingin [13].

The present study was conducted to determine the levels of some nonessential potentially toxic trace elements (Ag, Al, As, Ni, Sn) of some economically important seafood caught in the Gulf of Antalya Mediterranean Sea.

MATERIAL and METHODS

Sampling and Study Areas

In this study, 35 Red Mullet Red *(Mullus barbatus*, L., 1758), 35 Grey Mullet *(Mugil cephalus*, L., 1758) and 35 Green Tiger Prawn *(Panaeus semisulcatus*, De Haan, 1844) species collected and used for analysis which caught in the Gulf of Antalya Mediterranean Sea. Total 105 samples of muscle tissues nonessential potentially toxic trace elements (Ag, Al, As, Ni, Sn) levels were determined. The fish and prawn samples collected between 2011-2012 from Kemer, Center of Antalya, Manavgat, Alanya and Gazipaşa stations. After fish and prawns height and weight measure, muscle tissues were taken with sterile dissection tools. And the samples were stored in plastic bags and kept at -20°C in deep freezer until analyzed.

Trace Element Analysis

In order to prevent contamination of samples, all the materials used in study were washed in HNO_3 (10%) and dried (70°C). 0.5 g of homogenized each sample get into porcelain crucibles and were mixed with 0.5 ml magnesium acetate (2 mg/g). After dryed at 100°C for 3-4 h, the samples were ashed at 600°C for 6-8 h. The ash was extracted with nitric acid (HNO_3) 2N and was diluted to 15 ml. This filtrate content of trace elements were analyzed by using ICP-OES according to the EPA metot 200.7 [14]. The accuracy of the instrument was periodically checked with a known standard. Calibration curves were prepared using dilutions of stock solutions. The results were read three times and the mean values and the relative standard deviations were computed.

Statistical Analysis

Data are statistically analysed using the statistics software (SPSS® 17.0.0) by one-way analysis of variance (ANOVA) and presented as min-max values and mean ± standard deviation (SD) *(Table 1)*. When significant treatment effects were detected, DUNCAN'S multiple range test was used to identify specific differences between the metal accumulation means at a probability level of $P<0.05$.

RESULTS

The averages and the standard deviations of the results of the samples were determined as Ag (0.030±0.017 mg/kg), Al (12.163±7.298 mg/kg), As (0.269±0.121 mg/kg), Ni (0.084±0.067 mg/kg), Sn (0.022±0.003 mg/kg) for the Red Mullet *(M. barbatus)*, Ag (0.038±0.024 mg/kg), Al (11.120±4.019 mg/kg), As (0.140±0.082 mg/kg), Ni (0.060±0.050 mg/kg), Sn (0.022±0.003 mg/kg) for the Grey Mullet *(M., cephalus)*, Ag (0.032±0.029 mg/kg), Al (20.924±9.829 mg/kg), As (0.249±0.116 mg/kg), Ni (0.124±0.102 mg/kg), Sn (0.026±0.004 mg/kg) for the Green Tiger Prawn *(P. semisulcatus)*. The results are shown in *Table 1* as the average, standard deviation, minimum and maximum values of nonessential potentially toxic trace element concentrations in the muscle tissues of Red Mullet *(Mullus barbatus)*, Grey Mullet *(Mugil cephalus)* and Green Tiger Prawn *(Panaeus semisulcatus)*.

DISCUSSION

It was concluded that determined Ag, Al, As, Ni, Sn, levels of Red Mullet (*M. barbatus*), Grey Mullet *(M. cephalus)* and Green Tiger Prawn *(P. semisulcatus)* caught in the Gulf of Antalya Mediterranean Sea generally were below the other studies of Mediterranean *(Table 2)*. Al, Ni levels of

Tablo 1. *Nonesansiyel toksik iz elementlerin konsantrasyonları (mg/kg)*
Table 1. *Concentrations of nonessential potentially toxic trace elements (mg/kg)*

Element	Species		
	Red Mullet *(Mullus barbatus)* **Mean±SD Min. – Max.**	**Grey Mullet *(Mugil cephalus)*** **Mean±SD Min. – Max.**	**Green Tiger Prawn *(Panaeus semisulcatus)*** **Mean±SD Min. – Max.**
Silver (Ag)	0.030±0.017 0.006-0.070	0.038±0.024 0.006-0.131	0.032±0.029 0.006-0.169
Aluminum (Al)	12.163±7.298 6.890-41.600	11.120±4.019 6.610-22.300	20.924±9.829 8.570-49.900
Arsenic (As)	0.269±0.121 0.61-0.563	0.140±0.082 0.042-0.391	0.249±0.116 0.102-0.562
Nickel (Ni)	0.084±0.067 0.021-0.336	0.060±0.050 0.018-0.295	0.124±0.102 0.032-0.524
Tin (Sn)	0.022±0.003 0.016-0.031	0.022±0.003 0.014-0.032	0.026±0.004 0.018-0.039

Tablo 2. *Diğer çalışmalarda belirlenen nonesansiyel PTEs konsantrasyonları*
Table 2. *Determinated nonessential PTEs concentrations in other studies*

Species	Element	Concentration	Location	Reference
Mullus barbatus	Al	6.67 mg/kg	Gulf of İskenderun, Turkey	[15]
	Ni	LOD		
	As	27.01 ppm	Channel of Sicily, Italy	[16]
	Ni	0.042 ppm		
	As	10.35-23.71mg/kg	Iberian, Spain	[17]
	Al	6.676 µg/g	Gulf of İskenderun, Turkey	[18]
	Ni	0.001 µg/g		
	Al	2.60 µg/g	West Black Sea Coasts, Turkey	[19]
	Ni	0.63 µg/g		
	Al	8.384 µg/g	Black Sea and Mediterranean Coast, Turkey	[20]
	Ni	0.663 µg/g		
Penaeus semisulcatus	Ag	1.5-2.8 µg/g	Gulf of İskenderun, Turkey	[21]
	Ni	0.6-3.6 µg/g		
Mugil cephalus	Ni	0.73-1.34 µg/g		[22]
	As	3.0 µg/g	Lake Macquarie, Australia	[23]
	Al	1.273 mg/kg	Gulf of İskenderun, Turkey	[24]
	Ni	1.174 mg/kg		
	Ni	0.61 mg/kg	Northern East Mediterranean, Turkey	[25]
	As	4.18 µg/g	Anpin Horbor, Taiwan	[26]
Mugil spp.	Ni	2 µg/g	Red sea, Iran	[17]

Red Mullet *(M. barbatus)* were exceeded levels of some other studies [15,18]. The Ag concentrations found in muscle tissue of Green Tiger Prawn *(P. semisulcatus)* is lower than the other study done in the Northern East Mediterranean Sea [18]. The Al concentrations found in muscle tissue of Red Mullet *(M. barbatus)* and Grey Mullet *(M. cephalus)* are higher than the other study done in the Mediterranean Sea and the Black Sea [15,18-20,25]. The As concentrations found in muscle tissue of Red Mullet *(M. barbatus)* and Grey Mullet *(M. cephalus)* are lower than the other study done in the Mediterranean Sea and the others [16,17,23,26]. The Ni concentrations found in muscle tissue of Red Mullet *(M. barbatus)* and Green Tiger Prawn *(P. semisulcatus)* are higher [15,16,18-20], Grey Mullet *(M. cephalus)* fall in the range of studies done in the Mediterranean Sea and others, or are lower [22,24,25,27]. Evaluation of other studies conducted in the Gulf of Antalya, Al levels are higher. These results showed that, although increasing the legal rules about pollution, seafood which caught from the Gulf are exposed to Al in a higher rate. Green Tiger Prawn *(P. semisulcatus)* Al levels are determined as over the tolerable intake (6 mg/day for children and 6-14 mg/day for teenagers and adults) and Red Mullet *(M. barbatus)*, Grey Mullet *(M. cephalus)* Al levels determined as closed. Red Mullet *(M. barbatus)* and Green Tiger Prawn *(P. semisulcatus)* As levels are determined as closed the tolerable intake (0.015 mg/kg b.w.) [28]. Differences between the nonessential potentially toxic trace elements levels of seafood species is due to their habitats. Red Mullet *(M. barbatus)* (demersal) (As) and Green Tiger Prawn *(P. semisulcatus)* (benthic) (Al, Ni, Sn) are live and feed on or near the bottom of the sea. Therefore exposed to more intense and accumulate the nonessential potentially toxic trace elements is understood. The study results showed that; deterrmined levels of trace elements were below the legal limits and available daily intake limits.

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