Heavy Metal Levels in tow Species of Fish Gray Mullet (البوري الرمادي) and Scomber. Trachurus (الساورو) Captured from Western Black Sea Turkey

Nuri Mohamed Ahmed Elderwish
College of Medical Technology – Misurata

الملخص

في هده الدراسة تم تحديد بعض المعادن الثقيلة وهي الكادميوم ،النحاس، الحديد، الزنك ،النيكل ،المنغنيز ،النحاس في نوعين من الاسماك الاقتصادية وهما البوري الرمادي والساورو، تم جمع العينات من أماكن مختلفة بالساحل الغربي للبحر الأسود في تركيا وبعد أجراء التحليل المختبرية والاحصائية للعينات، أظهرت النتائج عدم وجود فروق معنويه بين الاسماك المدروسة في Zn ، Ni، Mn، Pb حيث كانت قيمة مستوى المعنوية ($p > 0.05$) و هناك فروق ذات دلالة معنويه بين الاسماك المدروسة في Cd, Fe, Cu حيث كانت قيمة مستوى المعنوية ($p < 0.05$) ،كما أظهرت النتائج عدم وجود فروق معنوية بين المواسم في Cu, Mn حيث كانت قيمة مستوى المعنوية ($p > 0.05$) و هناك فروق ذات دلالة معنويه بين المواسم في Zn , Ni, Cd, Fe, Pb حيث كانت قيمة مستوى المعنوية ($p < 0.05$) ، يمكن القول أن التلوث بالمعادن الثقيلة بالساحل الغربي للبحر الأسود في تركيا لم يصل إلى مستويات خطيرة بعد ، من أهداف الدراسة معرفة مدى التراكم الموسمي للمعادن بعضلات الاسماك وتحليل ومقارنة المعادن الثقيلة في بعض الأسماك الاقتصادية بالساحل الغربي للبحر الأسود في تركيا، أخيرًا ، نوصى بشدة إجراء دراسات تلوث مماثلة على فترات منتظمة وإبلاغ السلطات المختصة بشكل روتيني .

Abstract

In this study Heavy metals concentrations cadmium (Cd), zinc (Zn), copper(Cu), iron (Fe), nickel (Ni), lead (Pd) and manganese (Mn) were determined in two species of fish Gray Mullet (البوري الرمادي) and Scomber. Trachurus, the samples were collected from Western Black Sea Turkey , After performing the n(الساورو) ecessary laboratory analysis and statistical analysis the results showed that there were no significant differences between two study fish in Zn , Ni, Mn ,Pb, where the value of the observed level of significance was ($p>0.05$), there were significant differences between the study fish in Cd, Fe, Cu,

where the value of the observed level of significance was ($p<0.05$), The results of the heavy metal analysis no significant differences between seasons in Cu, Mn, where the value of the observed level of significance was ($p>0.05$), there were significant differences between seasons in Zn , Ni, Cd, Fe, Pb where the value of the observed level of significance was ($p<0.05$), it can be said that heavy metal pollution in the Western Black Sea Turkey has not reached a dangerous leveles yet, aims of the study Extent of seasonal accumulation of heavy metals in the studied fish and Comparison and analysis of heavy metals in sediment and economic fish species in western Black Sea coast. Finally, it is highly recommended that similar pollution studies should be carried out at regular intervals and reported routinely to the competent authorities.
Key words: Gray Mullet and Scomber Trachurus, Western Black

Introduction

There is no doubt that an aquatic environment pollution whit heavy metal has a significant impact in pollution over the last decade (MacFarlane , Burchett, 2000), (Öztürk et al., 2009) the toxic effect and ability to bio accumulate in aquatic ecosystem of heavy metals so they have particular concern Among environmental pollutants (Censi et al., 2006) . The Fishes have Important position in the aquatic pollution studies, due to considered as a main part of human diet and they play Icrucial roles in establishing water equality (Domingo et al., 2007),(Safahieh et al., 2011). The uptake and accumulation of metal in Fish are affected by the environmental factors (Kock et al 1996),(Jezierska, and Witeska, 2006). Fish are heavily exposed by Heavy metals pollution Due to living and feeding in the aquatic environments In addition they cannot escape from the detrimental effects of pollutants (Yarsan & Yipel 2013), (Saleh & Marie 2015).Fish in comparison with invertebrates are not only more sensitive to many toxicants but also they are a convenient test subject for indication of ecosystem health (Zaki et al., 2014), Heavy metals are produced by a variety of anthropogenic and natural sources (Bauvais et al., 2015) . Heavy metal pollution In aquatic environments are Resulted by industrial waste products or via wastewater treatment plants, also by geologic weathering, direct atmospheric deposition or through the municipal, residential ,discharge of agricultural (Demirak et al., 2006), (Camps o et al., 2015).Coal burning is one of the most important anthropogenic emission sources of an important source of a number of Heavy metals (Wagner & Boman, 2003). The pollution of

metalloids and heavy metals in sediment and water , when occurring in higher concentrations, is a dangerous threat due to of their ,long persistence , toxicity and bioaccumulation in the food chain (Eisler, 1993), (Has-Schön et al., 2006), In aquatic systems the Fishes are considered to be most significant biomonitors for the estimation of metal pollution concentrations (Rashed, 2001),(Authman, 2008). Fish are located at the end of the aquatic food chain and may pass them to human beings through food due to accumulating heavy metals causing acute or chronic diseases (Al-Yousuf et al., 2000).Studies from the laboratory works and field showed that accumulation of heavy metals in tissue is mainly dependent on exposure period and water concentrations of metals although some other environmental factors such as oxygen concentration ,water temperature, hardness, pH, alkalinity, salinity may affect and play significant roles in metal's accumulation and toxicity to fish (Benaduce et al., 2008), (Jitar et al., 2014), also, there are several factors that affect the accumulation of heavy metals in the tissues as age and size, feeding habits, their life cycle, and the season of capture (Kime et al., 1996), (Aydin-Onen et al., 2015). Fish have the ability to uptake heavy metals indirectly from other organisms such as invertebrates, small fish, and aquatic vegetation or directly from the water (Polat et al., 2016),(Authman et al., 2015).

aims of the study

- Identify the sources of pollution by heavy metal in western Black Sea coast Turkey
- Comparison of heavy metals concentrations in some economic fish species in western Black Sea coast Turkey.
- Extent of seasonal accumulation of heavy metals in the fish in western Black Sea coast Turkey
- Identify effects of heavy metals on western Black Sea ecosystems

Sampling

Samples of fish were randomly acquired in local fishermen from cities across the coastal waters of Western Black Sea Turkey ,All the fish species were sampled from Autumn winter Spring and summer seasons of 2016 /2017, then fish samples were transported to the laboratory in a thermos flask with ice on the same day (Yılmaz et al., 2005)

Gray mullet

Scomber. trachurus

Sample Analysis

All samples were cuted Approximately 5 g samples of muscle (edible parts), from each fish The tissue samples with deionized water, weighed and stored at -20 ° C in polyethylene bags ,then samples were dried by the drying device under the temperature of 100 ° C, after that, All samples were analysed three times for Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn by ICP/OES Optima 2010-Perkin Elmer which is a fast multi-element technique. There is a dilution factor 200 for all samples. There fore, the results obtained were multiplied by 200 and all results were divided by 1000 and converted to ppm. (Zheng 2006).

Statistical Analysis

All statistical analyses were performed with SPSS .V24 version for Windows..

The comparison between two types of fish was studied by T-test for the two independent samples and the comparison between the seasons of the study data was studied by one way ANOVA.

Results and Discussion

Table 1. Comparison between Cu (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	8.22975	6.397542	1.846811	0.001	There is a difference
Scomber trachurus	12	24.82608	11.769252	3.397490		

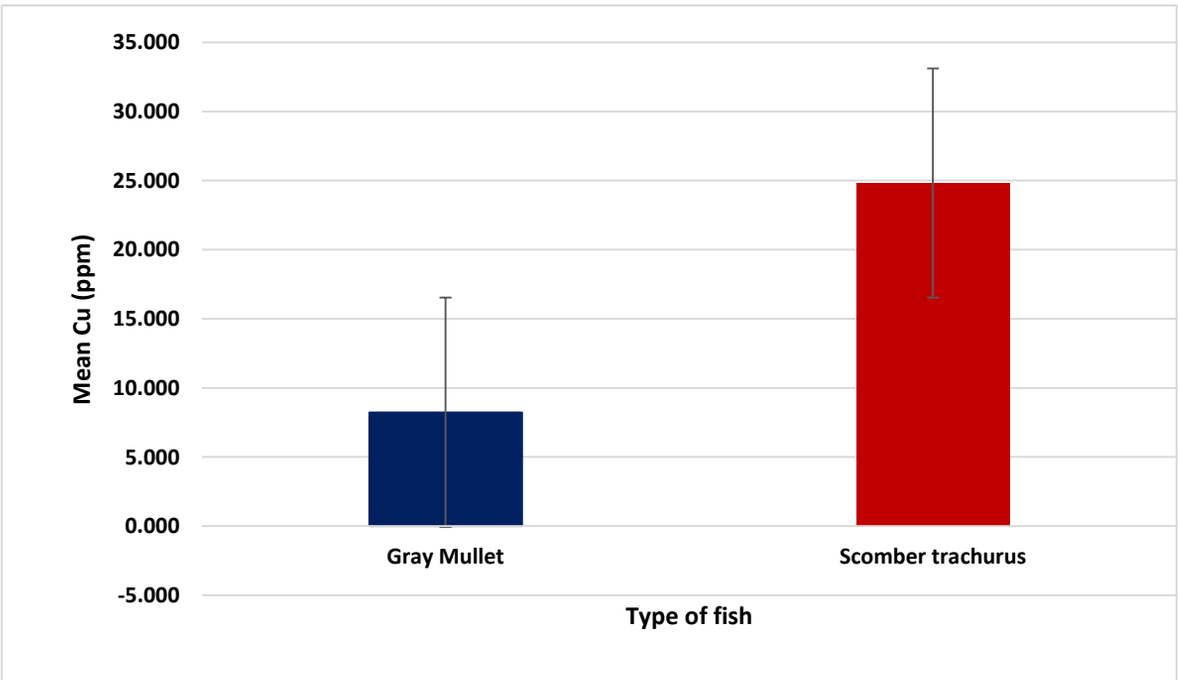


Figure.1

Table 2. Comparison between Zn (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	530.99000	255.325734	73.706191	0.133	There is no differences
Scomber trachurus	12	384.73108	200.316456	57.826380		

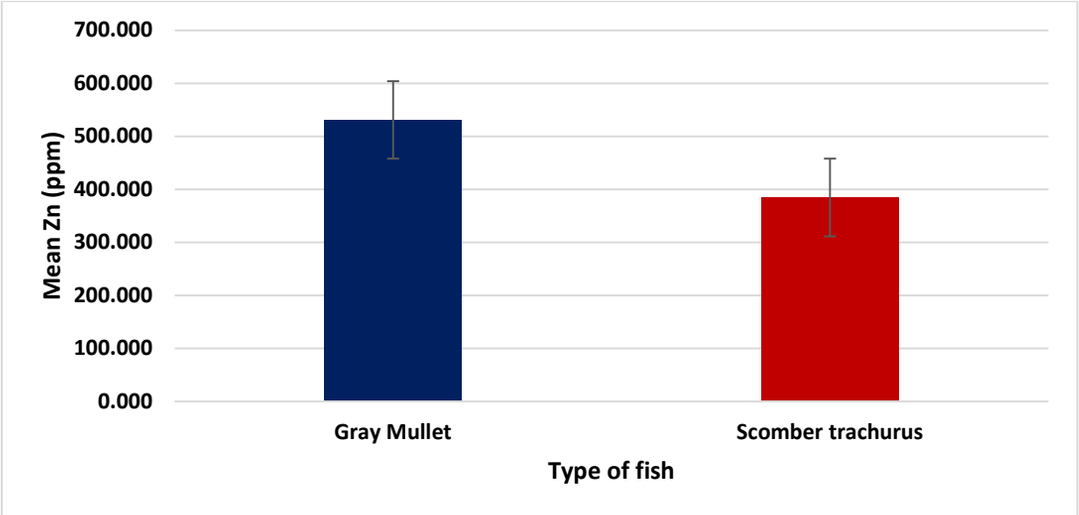


Figure2

Table 3. Comparison between Ni (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	2.92050	1.522099	.439392	0.900	There is no differences
Scomber trachurus	12	2.83433	1.789566	.516603		

.

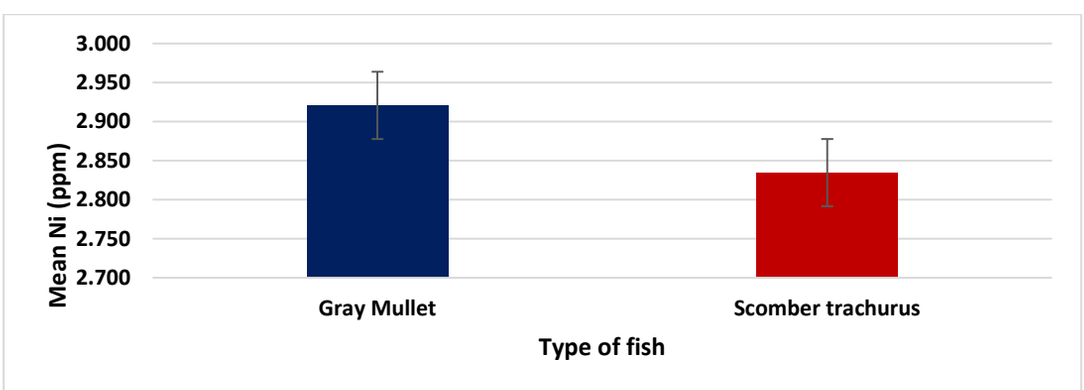


Figure 3

Table 4. Comparison between Fe (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	944.37883	464.201427	134.003410	0.009	There is adifference
Scomber trachurus	12	486.72942	281.149805	81.160958		

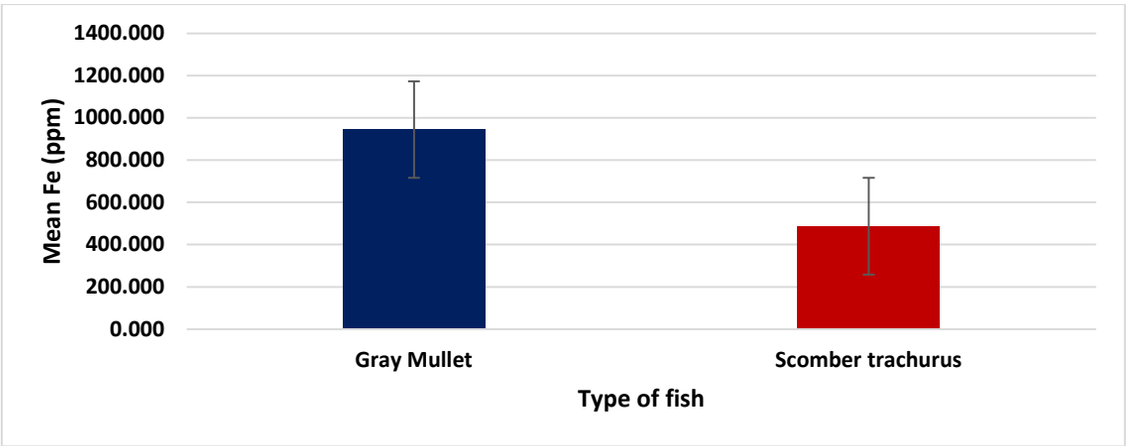


Figure 4.

Table 5. Comparison between Mn (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	52.93042	41.303282	11.923231	0.244	There is no differences
Scomber trachurus	12	28.37633	57.791022	16.682831		

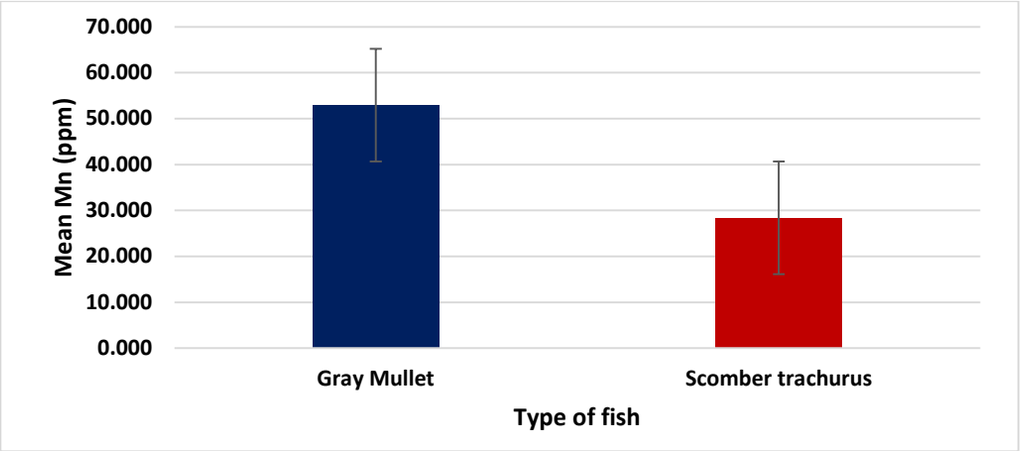


Figure 5.

Table 6. Comparison between Pb (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	3.14675	2.642728	.762890	0.446	There is no differences
Scomber trachurus	12	2.29758	2.722721	.785982		

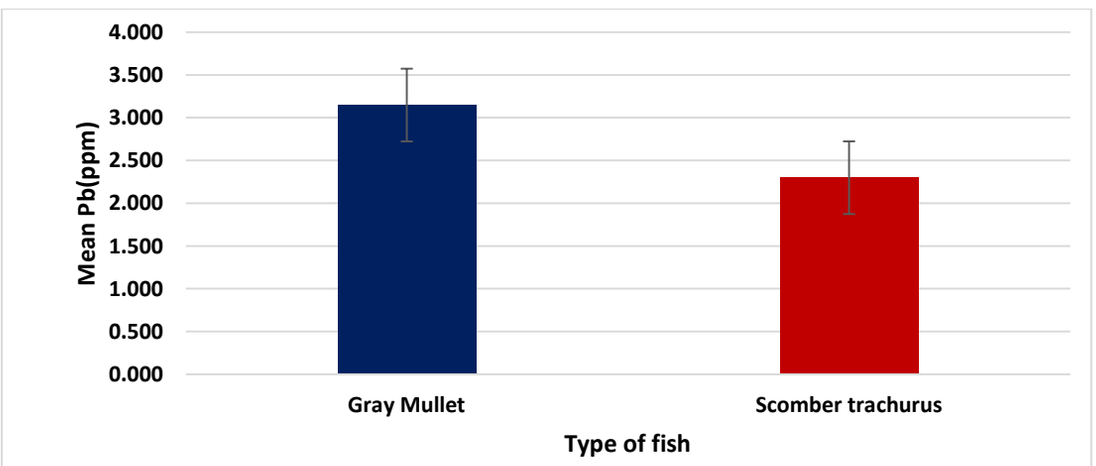


Figure 6

Table 7. Comparison between Cd (ppm) in the two study fish

Type of fish	samples	Mean	Std. Deviation	Std. Error Mean	P-value	Differences
Gray Mullet	12	1.25292	1.002757	.289471	0.013	There is adifference
Scomber trachurus	12	.39642	.200521	.057885		

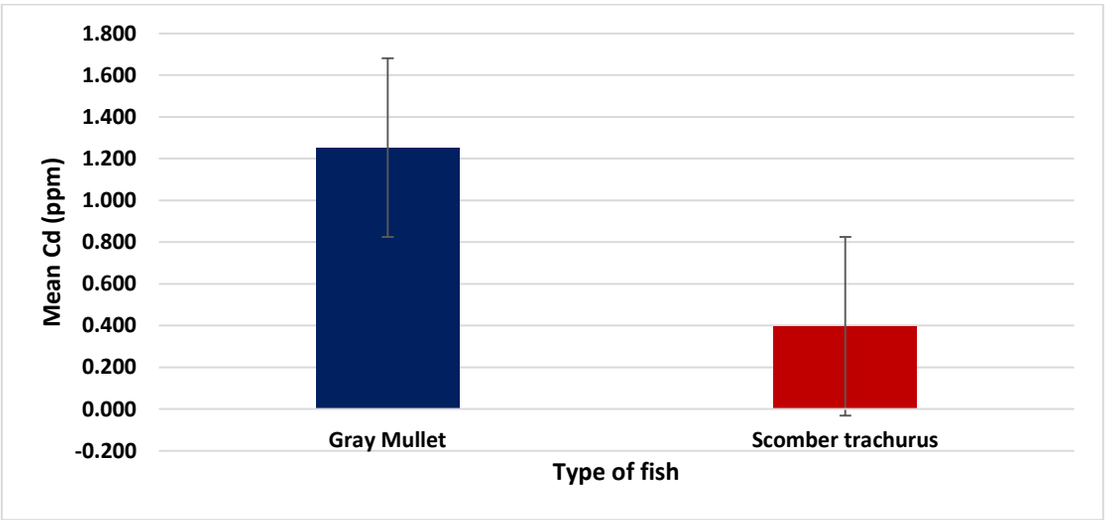


Figure 7

Table 8. Comparison between Cu (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is no differences	0.237	1.948361	4.772490	11.66517	6	Autumn
		5.654973	13.851797	13.68400	6	Winter
		5.203699	12.746407	15.30200	6	Spring
		5.951874	14.579053	25.46050	6	Summer

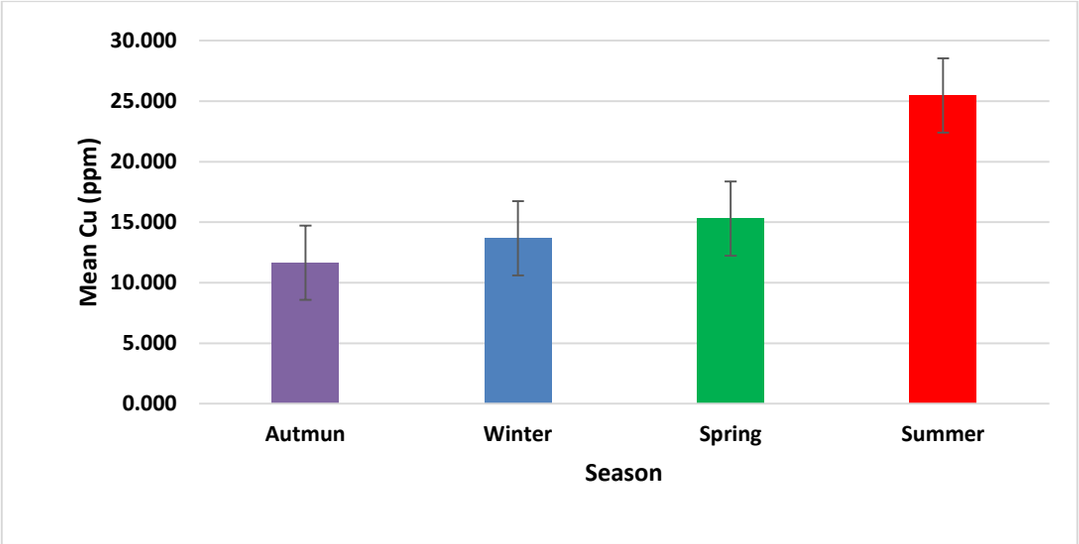


Figure 8

Table 9. Comparison between Zn (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is differences	0.001	21.836867	53.489183	172.26233	6	Autumn
		107.109407	262.363393	501.86500	6	Winter
		32.538726	79.703277	634.54217	6	Spring
		78.104532	191.316250	522.77267	6	Summer

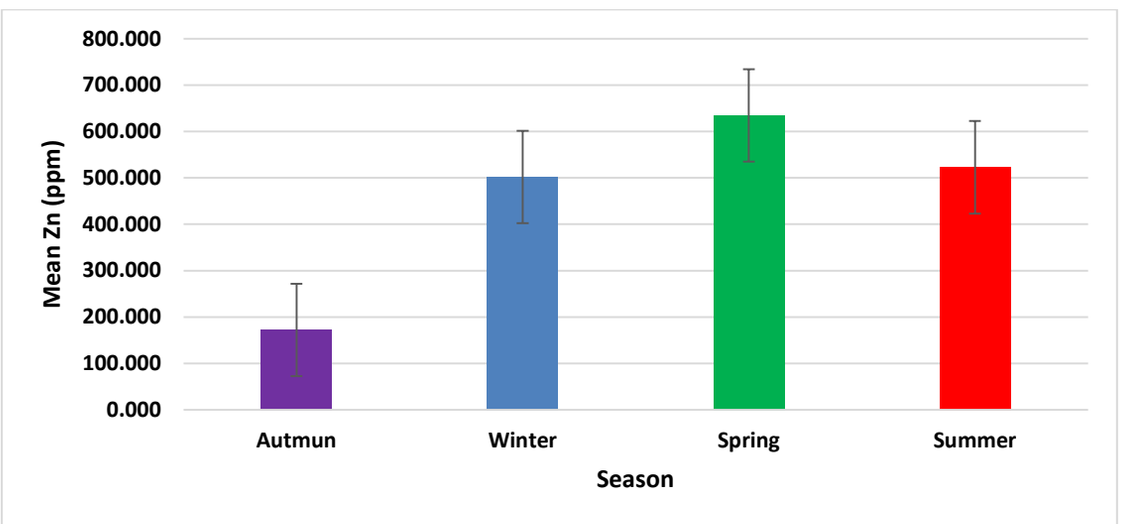


Figure.9.

Table 10. Comparison between Ni (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is differences	0.001	.345989	.847496	3.05117	6	Autumn
		.758684	1.858388	4.51367	6	Winter
		.022735	.055688	3.01600	6	Spring
		.157085	.384778	.92883	6	Summer

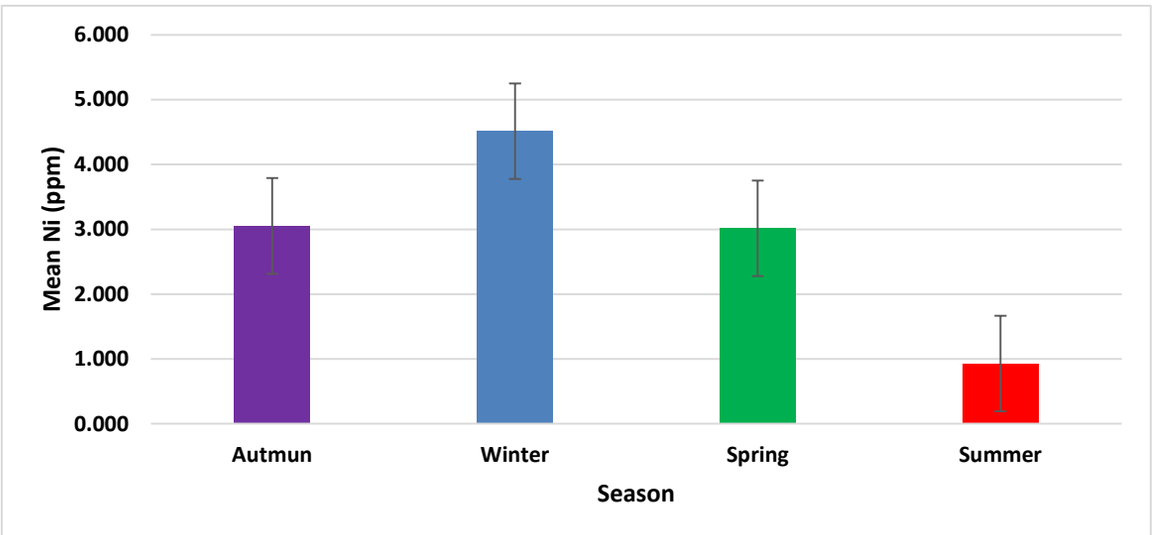
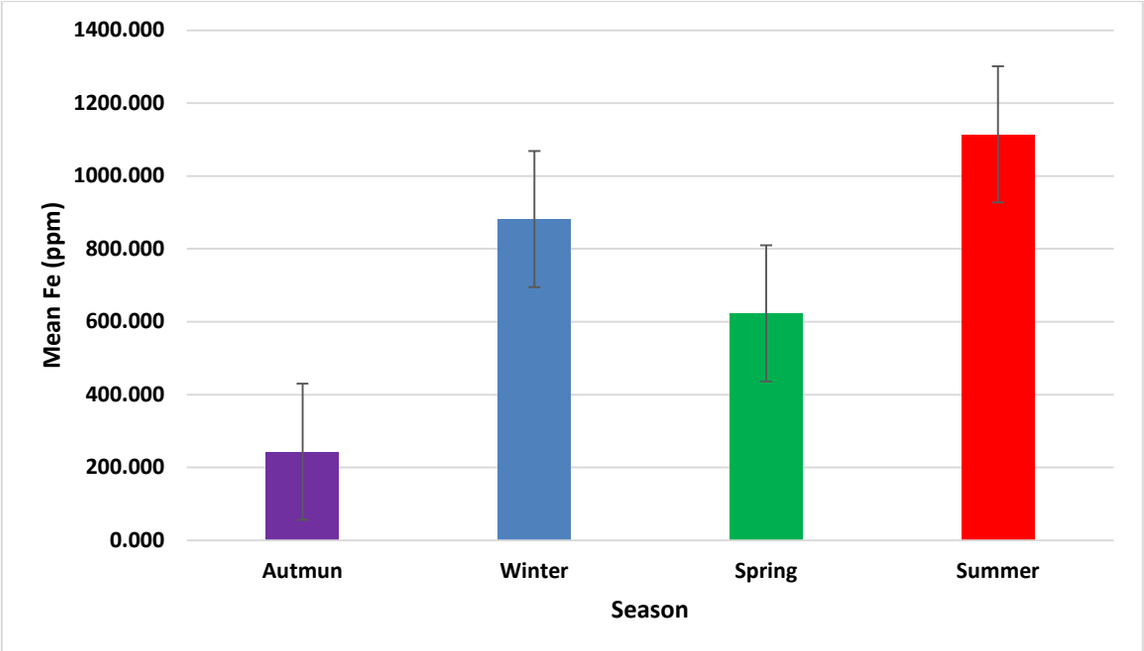


Figure 10.

Table 11. Comparison between Fe (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is differences	0.001	14.496323	35.508594	243.04817	6	Autumn
		228.082937	558.686814	882.14317	6	Winter
		84.951507	208.087845	622.73950	6	Spring
		81.917628	200.656390	1114.28567	6	Summer



Figure,11

Table 12. Comparison between Mn (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is no differences	0.633	35.068781	85.900619	35.66000	6	Autumn
		10.513788	25.753415	34.63983	6	Winter
		6.620784	16.217542	27.84983	6	Spring
		20.690744	50.681766	64.46383	6	Summer

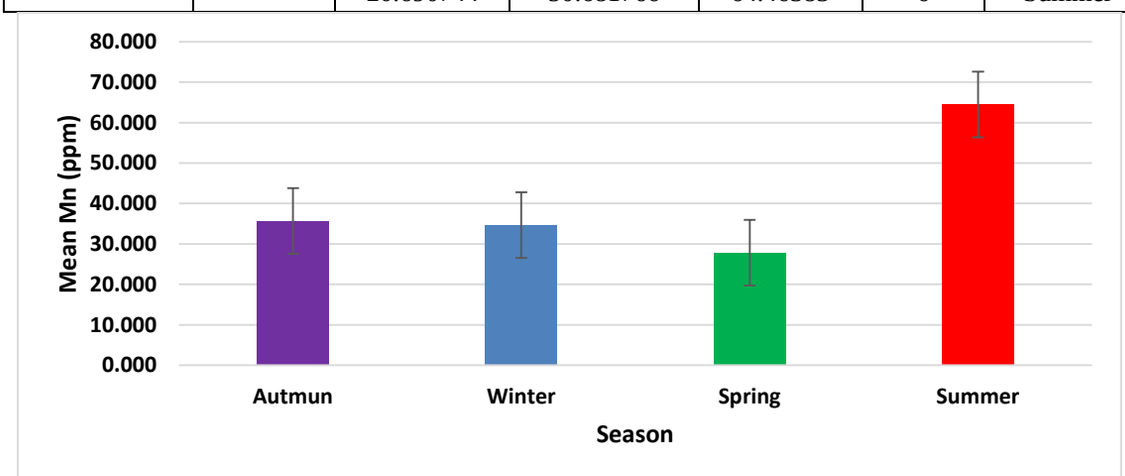


Figure 12.

Table 13. Comparison between Pb (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is differences	0.001	.422178	1.034120	6.19100	6	Autumn
		.144284	.353423	.53583	6	Winter
		1.038249	2.543179	3.22183	6	Spring
		.313779	.768598	.94000	6	Summer

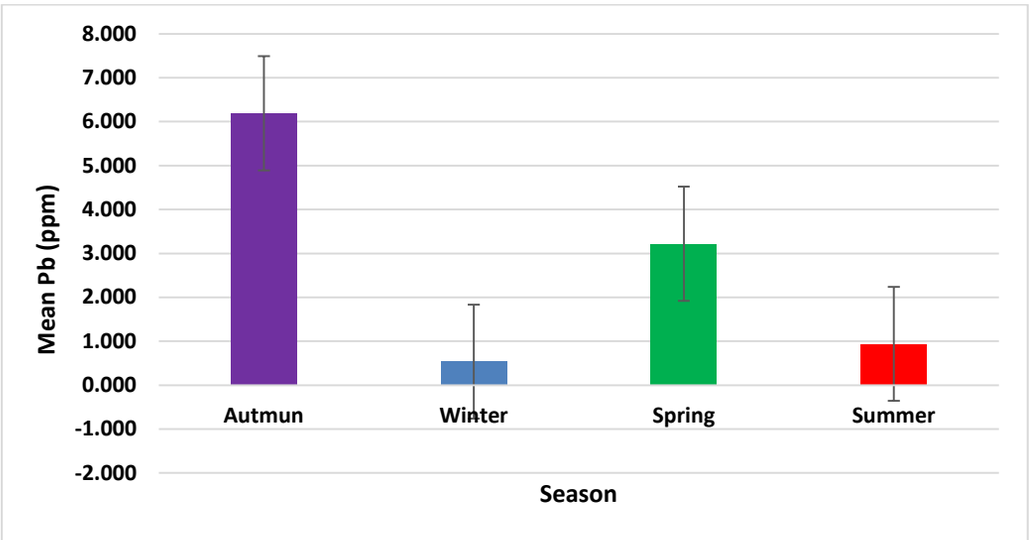


Figure 13.

Table 14. Comparison between Cd (ppm) in the seasons

Differences	P-value	Std. Error Mean	Std. Deviation	Mean	N	Season
There is differences	0.020	.014398	.035267	.25517	6	Autumn
		.090549	.221798	.49767	6	Winter
		.553787	1.356497	1.57200	6	Spring
		.112529	.275638	.97383	6	Summer

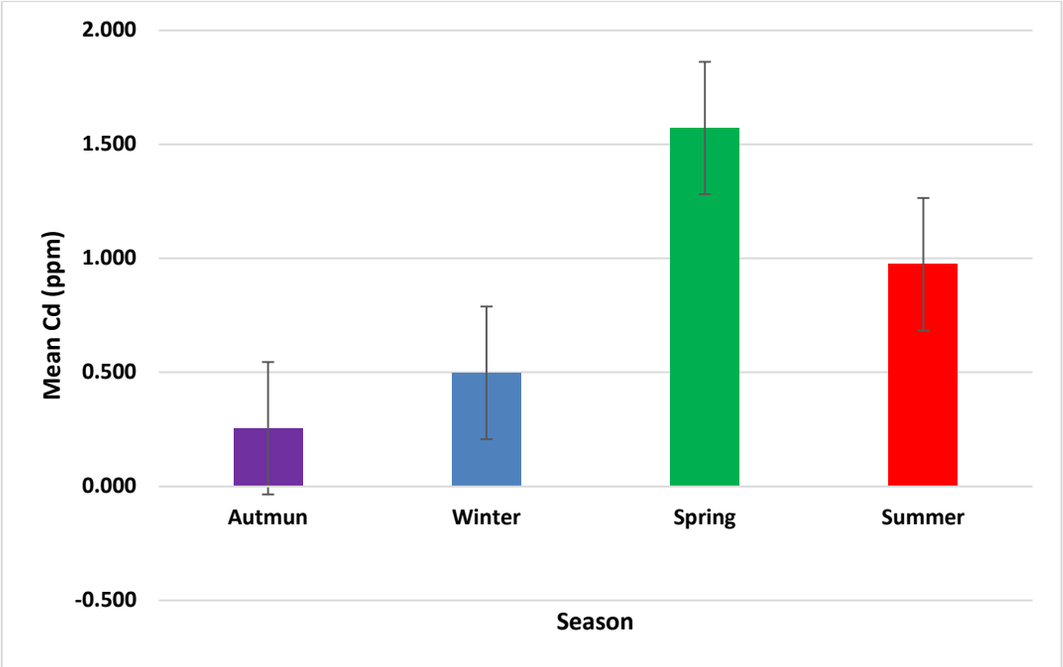


Figure 14.

Results and Discussion

Tables (1 , 4 , and 7) describe measures the comparison between two types of fish for (Cu, Fe and Cd) in all seasons, the results showed that there were significant differences between the two types of fish in this elements where the value of the observed level of significance was ($p<0.05$), tables (2, 3, 5 and 6) describe measures the comparison between the two types of fish for (Zn, Ni, Mn and Pb) in all seasons, the results showed that there were no significant differences between the two types of fish in this elements where the value of the observed level of significance was ($p>0.05$), also the results have shown that all the concentrations of heavy metals in Gray Mullet were higher than of Scomber. Trachurus except the concentration of Cu. these results are in agreement with the study by (Stancheva et al.,2014) where study shown the levels of some heavy metal in gray mullet higher than the other fish species but in within the recommended legal limits also has that due to variations in feeding habits, habitats and behaviour of species (Kargin 1996) , the levels of heavy metals found in fish the benthic were always higher than those found in fish the pelagic that , copper,cadmium, zinc and mercury concentrations in edible

muscles of pelagic fish species are lower than for benthic fish species also pointed out (Romeo et al,1999), the results of samples in all seasons within the order of Fe> Zn> Mn>Cu> Ni> Pb> Cd, this study shown the highest Fe concentration in Gray Mullet (1392.1 ppm) in Winter and the lowest concentration(275.30 ppm) in Autumn, this may be due to the iron component absorbed by plankton and marine plants to be used in biological processes (chakraborty et al., 2014), High Fe absorption causes excessed Fe to be stored in the organs, eventually leading to iron overload. Results achieved in this study were in good agreement with other reported data from the literature(Stancheva et al., 2014), in addition, the results showed the Cd concentrations more decrease throughout the all seasons and in the two types of fish than that of other heavy metals , it has highly toxic Chronic effects on human health may occur as a result of its accumulation in liver, bones, blood,kidney and muscle (WHO 2019), Tables (9,10,11,13, and 14) describe measures the comparison between seasons for (Zn, Ni, Fe, Pb and Cd), the results showed that there were significant differences between seasons in this elements where the value of the observed level of significance was ($p<0.05$), tables (8 , 12) describe measures the comparison between seasons for (Cu , Mn), the results showed that there were no significant differences between the two types of fish in this elements where the value of the observed level of significance was ($p>0.05$), the results have indicated an increase in the concentrations (Cu,Fe) in Summer , (Zn, Cd) in Spring , Ni in Winter , Pb in Autumn, Mean concentrations of heavy metals in seasons in two types of fish were as follows Fe> Zn > Mn >Cu >Ni > Pd > Cd, concentrations of heavy metal in tissue of fish relatively higher during the colder months with a peak around March–April, coinciding with the spawning period (Mubiana et al., 2005). heavy metal accumulation in spring and winter seasons was higher than in the other season, this high level accumulation could be due to heavy rainfall during these seasons, which increases the metal content of water by washing down the agricultural wastes(Dural et al., 2007). length and weight chemical and physical status of water can play a role in the tissue accumulation of metals ,also Seasonal changes of metal concentrations in fish may result from intrinsic factors such as growth cycle and reproductive cycle and from changes in water temperature(Jezierska & Witeska, 2001) A number of studies have shown that various factors such as season can play a role in the tissue accumulation of metals (Kargın, 1996)

Conclusions

Heavy metals (Cd, Ni, Cu, Mn, Zn, Fe and Pb) were determined in tow Species of fish Gray Mullet and Scomber. Trachurus Captured from Western Black Sea Turkey, Among the seven metals under study iron showed the highest level of accumulation the results showed the Cd concentrations more decrease throughout the all seasons and in the two types of fish than other heavy metals, the results showed a variation in heavy metal concentrations during all seasons the results Seemingly depend on biological specificity of the fish and seasonal changes , Although that the results obtained do not show any form of danger but the possibility of deleterious effects after long period, general, this type of pollution detection studies should be done frequently, and routine reporting should also be conducted in order to take necessary measures to decision mechanisms..

References

Al-Yousuf, M. H., El-Shahawi, M. S., & Al-Ghais, S. M. (2000). Trace metals in liver, skin and muscle of Lethrinus lentjan fish species in relation to body length and sex. Science of the total environment, 256(2-3), 87-94

Authman, M. M. N. (2008). Oreochromis niloticus as a biomonitor of heavy metal pollution with emphasis on potential risk and relation to some biological aspects. Global Veterinaria, 2(3), 104-109.

Authman, M. M., Zaki, M. S., Khallaf, E. A., & Abbas, H. H. (2015). Use of fish as bio-indicator of the effects of heavy metals pollution. Journal of Aquaculture Research & Development, 6(4), 1-13

Aydin-Onen, S., Kucuksezgin, F., Kocak, F., & Açik, S. (2015). Assessment of heavy metal contamination in Hediste diversicolor (OF Müller, 1776), Mugil cephalus (Linnaeus, 1758), and surface sediments of Bafa Lake (Eastern Aegean) . Environmental Science and Pollution Research, 22(11), 8702-8718.

Bauvais, C., Zirah, S., Piette, L., Chaspoul, F., Domart-Coulon, I., Chapon, V., & Bourguet-Kondracki, M. L. (2015). Sponging up metals: bacteria associated with the marine sponge Spongia officinalis. Marine Environmental Research, 104, 20-30.

Benaduce, A. P. S., Kochhann, D., Flores, E. M., Dressler, V. L., & Baldisserotto, B. (2008). Toxicity of cadmium for silver catfish Rhamdia quelen (Heptapteridae) embryos and larvae at different alkalinities. Archives of environmental contamination and toxicology, 54(2), 274-282.

Campos Garcia, J., Martinez, D. S. T., Alves, O. L., Leonardo, A. F. G., Barbieri, E. (2015) Ecotoxicological effects of carbofuran and oxidised multiwalled carbon

nanotubes on the freshwater fish Nile tilapia: Nanotubes enhance pesticide ecotoxicity. Ecotoxicology and Environmental Safety, 111, 131-137

Censi, P. A. O. L. O., Spoto, S. E., Saiano, F. I. L. I. P. P. O., Sprovieri, M., Mazzola, S., Nardone, G., ... & Ottonello, D. (2006). Heavy metals in coastal water systems. A case study from the northwestern Gulf of Thailand. Chemosphere, 64(7), 1167- 1176.

Chakraborty, S., Bhattacharya, T., Singh, G., & Maity, J. P. (2014). Benthic macroalgae as biological indicators of heavy metal pollution in the marine environments: A biomonitoring approach for pollution assessment. Ecotoxicology and environmental safety, 100, 61-68

Demirak, A., Yilmaz, F., Tuna, A. L., & Ozdemir, N. (2006). Heavy metals in water, sediment and tissues of Leuciscus cephalus from a stream in southwestern Turkey. Chemosphere, 63(9), 1451-1458.

Domingo, J. L., Bocio, A., Martí-Cid, R., & Llobet, J. M. (2007). Benefits and risks of fish consumption: Part II. RIBEPEIX, a computer program to optimize the balance between the intake of omega-3 fatty acids and chemical contaminants. Toxicology, 230(2-3), 227-233.

Dural, M., Göksu, M. Z. L., & Özak, A. A. (2007). Investigation of heavy metal levels in economically important fish species captured from the Tuzla lagoon. Food chemistry, 102(1), 415-421.

Eisler, R. (1993). Zinc hazards to fish, wildlife, and invertebrates: a synoptic review (No. 26). US Department of the Interior, Fish and Wildlife Service.

Has-Schön, E., Bogut, I., & Strelec, I. (2006). Heavy metal profile in five fish species included in human diet, domiciled in the end flow of River Neretva (Croatia). Archives of environmental contamination and toxicology, 50(4), 545-551.

Jezierska, B., & Witeska, M. (2006). The metal uptake and accumulation in fish living in polluted waters. In Soil and water pollution monitoring, protection and remediation (pp. 107-114). Springer, Dordrecht

Jitar O, Teodosiu C, Oros A, Plavan G, Nicoara M (2014) Bioaccumulation of heavy metals in marine organisms from the Romanian sector of the Black Sea. N. Biotechnol. 2014 Dec 9. pii: S1871-6784(14)02197-9. doi: 10.1016/j. nbt.2014.11.004..

Kargin, F. (1996). Seasonal changes in levels of heavy metals in tissues of Mullus barbatus and Sparus aurata collected from Iskenderun Gulf (Turkey). Water, Air, and Soil Pollution, 90(3), 557-562.

Kime, D. E., Ebrahimi, M., Nysten, K., Roelants, I., Rurangwa, E., Moore, H. D. M., & Ollevier, F. (1996). Use of computer assisted sperm analysis (CASA) for monitoring the effects of pollution on sperm quality of fish; application to the effects f heavy metals. Aquatic toxicology, 36(3-4), 223-237.

Köck, G., Triendl, M., & Hofer, R. (1996). Seasonal patterns of metal accumulation in Arctic char (Salvelinus alpinus) from an oligotrophic Alpine lake related to temperature. Canadian Journal of Fisheries and Aquatic Sciences, 53(4), 780-786.

MacFarlane, G. R., & Burchett, M. D. (2000). Cellular distribution of copper, lead and zinc in the grey mangrove, Avicennia marina (Forsk.) Vierh. Aquatic botany, 68(1), 45-59.

Roméo, M., Siau, Y., Sidoumou, Z., & Gnassia-Barelli, M. (1999). Heavy metal distribution in different fish species from the Mauritania coast. Science of the total environment, 232(3), 169-175.

Mubiana, V. K., Qadah, D., Meys, J., & Blust, R. (2005). Temporal and spatial trends in heavymetal concentrations in the marine mussel Mytilus edulis from the Western Scheldt estuary (The Netherlands). Hydrobiologia, 540(1), 169-180.

Öztürk, M., Özözen, G., Minareci, O., & Minareci, E. (2009). Determination of heavy metals in fish, water and sediments of Avsar Dam Lake in Turkey. Journal of Environmental Health Science & Engineering, 6(2), 73-

Polat, F., Akın, Ş., Yıldırım, A., & Dal, T. (2016). The effects of point pollutants-originated heavy metals (lead, copper, iron, and cadmium) on fish living in Yeşilırmak River, Turkey. Toxicology and industrial health, 32(8), 14381449.

Rashed, M. N. (2001). Monitoring of environmental heavy metals in fish from Nasser Lake. Environment international, 27(1), 27-33.

Safahieh, A., Monikh, F. A., Savari, A., & Doraghi, A. (2011). Heavy metals concentration in Mullet Fish, Liza abu from petrochemical waste receiving creeks, Musa Estuary (Persian Gulf). Journal of Environmental Protection, 2(09), 1218.

Saleh, Y. S., & Marie, M. A. S. (2015). Assessment of metal contamination in water, sediment, and tissues of Arius thalassinus fish from the Red Sea coast of Yemen and the potential human risk assessment. Environmental Science and Pollution Research, 22(7), 5481- 5490.

Stancheva, M., Makedonski, L., & Peycheva, K. (2014). Determination of heavy metal concentrations of most consumed fish species from Bulgarian Black Sea coast. Bulg Chem Commun, 46(1), 195-203.

Wagner, A., & Boman, J. (2003). Biomonitoring of trace elements in muscle and liver tissue of freshwater fish. Spectrochimica Acta Part BAtomic Spectroscopy, 58(12), 2215- 2226

World Health Organization. (2019). Preventing disease through healthy environments: Exposure to cadmium: A major public health concern (No. WHO/CED/PHE/EPE/19.4. 3). World Health Organization.

Yarsan, E., & Yipel, M. (2013). The important terms of marine pollution "biomarkers and biomonitoring, bioaccumulation, bioconcentration, biomagnification". J Mol Biomark Diagn S, 1(2).

Yılmaz.F ,. Nedim. O,. Zdemir b,. Demirak.A and Tuna.A,(2005), Heavy metal levels in two fish species Leuciscus cephalus and Lepomis gibbosus, Food Chemistry 100 (2007) 830–835.

Zaki, M. S., Authman, M. M., Hammam, A. M. M., & Shalaby, S. I. (2014). Aquatic environmental pollution in the Egyptian countryside and its effect on fish production. Life Science Journal, 11(9), 1024- 1029.

Zheng, B. (2006). China's Peaceful Rise: Speeches of Zheng Bijian 1997-2005. Brookings Institution Press.