Accumulation of Cadmium and Lead in Muscle and Liver Tissues of *Auxis rochei* & *Euthynnus alletteratus* Caught in Marine Waters of Syria (Ras Al-Basit)

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Abstract:

This research aims to determine the traces of some heavy metals in tissues of liver and muscles of two marine commercial fish species caught from the Ras Albasit (Lattakia city beach - Syria) using Atomic Absorption Spectroscopy (Flame-AAS). The results showed the accumulation of the studied metal elements was higher in Little tunny *Euthynnus alletteratus* than their accumulation in Bullet tuna *Auxis rochei*. The concentrations of these element were higher in liver of the first species (Cd: 0.615 ± 0.05 mg/kg and Pb: 3.83 ± 0.349 mg/kg) than their concentration in the liver of second species (Cd: 0.531 ± 0.062 mg/kg and Pb: 3.683 ± 0.591 mg/kg). The same issue applies to the muscles of both species respectively: (Cd: 0.162 ± 0.024 mg/kg & Pb: 1.553 ± 0.129 mg/kg) and (Cd: 0.152 ± 0.012 mg/kg & Pb: 1.484 ± 0.170 mg/kg). The difference in the concentrations of these elements between the two studied fish species can be attributed to the different morphometric (Weight, Length) and age characteristics.

Keywords: Heavy metals, *Auxis rochei*, *Euthynnus alletteratus*, Syrian marine waters, Ras Al-Basit.

Introduction:

Industrial development and the increasing of various human activities have generally contributed in increasing the amounts of wastes in the environment, and have particularly increased wastes in the marine coastal zones. Trace metals arrive marine waters from rivers and air as a result of different human activities such as wastes from factories, excessive use of fertilizers, fungicides and pesticides, and from fossil fuel combustion processes (Rashed 2001; Al-Edreesi *et al.*, 2002; Kaitantzian *et al.*, 2013; Odumo *et al*., 2014; Dixit *et al*., 2015; Gutiérrez *et al*., 2016) in addition to its natural sources such as dust deposits, rock fragmentation and volcanoes (Papagiannis *et al*., 2004; Butu and Iguisi, 2013).

Some metal elements (such as Cu and Fe) - within specific concentrations- are necessary for the growth of organisms (Abadi *et al*., 2015), while others (such as Pb, Cd, and As) are toxic even if they are found in little concentrations (Hall 2002; Simon *et al*., 2011). Increasing concentrations of heavy metal elements in the marine environment (water, organisms and sediments) lead to serious environmental problems due to their accumulation in this resistant and non biodegradable environment (Sivaperumal *et al*., 2007). Therefore, aquatic organisms such as fish are used as bio-

indicators as they absorb these elements)in particular Cd, Pb are known for their accumulative behavior in aquatic ecosystems((Emami-Khansari *et al*., 2005) via two pathways: the gastrointestinal tract (exposure to diet) and the gill surface (exposure to water) (Ptashynski *et al*., 2002; Morgano *et al*., 2014; Łuczyńska 2018). As a result, accumulation of these pollutants in a high rate is mentioned in fish and their consumers, and this leads to a serious threat to ecosystems and human health (Tiimub and Afua, 2013; Arantes *et al*., 2016).

Many studies have relied on living organisms (Algae, Molluscs, Fish) as bioindicators of heavy metals contamination, including locally: Mohamad (2001); Ziada (2004); Saker, (2008); Laika *et al.*, (2016); Hammoud and Salama (2016); Akel, and Kara (2017); Soliman *et al*., (2021).

The importance of this research comes from determining the concentrations of the Cd and Pb elements which represent a reliable indicator of marine pollution in two commercial fish species of the Scombridae family (*Euthynnus alletteratus* & *Auxis rochei*) which is a main food resource of animal protein (Collette and Nauen, 1983; Collete 1986; Hattour 2000; Jasmine *et al*., 2013). These elements were studied in liver tissue as one of tissues specialized in storing these metals and detoxifying them, and in muscle tissues as a major site for absorbing heavy metals as they form the targeted part that used as a human food. This research is the first research which is applied on these fish species in the Syrian marine waters.

Materials and Methods:

Samples of two carnivorous fish species (*E. alletteratus* and *A. rochei* (Fig 1 & 2)) were collected during the full year 2021-2022, in a rate of once per a season (October2021- January, April, July 2022), from Ras Al-Baseet area – Syria (35º51'46"N, 35º48'12"E) (Fig. 3). Then they were transferred to the Animal Aquatic Environment laboratory - Faculty of Science and kept in the freezer at (-20ºC) until it was analyzed.

Tools and devices used:

-Atomic Absorption Spectrometer Varian 220 type (Higher Institute for Marine Research).
-Bleu M drying oven.
-Various Tests and glassware.
-An electric mixer.
-Sensitive scale 0.0001 g.

Chemicals used:

- Concentrated Nitric acid (65%) and Standard solutions of mineral elements (1000 mg/l).

Figure (1): *Euthynnus alletteratus* caught from Ras albasit – Syrian marine waters 2021-2022

Figure (2): *Auxis rochei* caught from Ras albasit – Syrian marine waters 2021-2022

Figure(3) : Site of study area (by Google Earth 2022)

Digestion of fish samples:

Weight of 2g was extracted from each sample (dry weight) and put in Polypropylene tubes for predigetion according to the reference methods used globally in the laboratories of the International Atomic Energy Agency (IAEA 2006). These methods follow the principle of predigetion of samples using 10ml of high-purity Nitric acid. Samples are left for an hour at room temperature, and the Polyethylene tubes are gently closed (incomplete closure), then placed in a water bath at boiling point for four hours until the predigetion process is completed. The samples were then cooled to the room temperature and diluted with double-distilled water to a volume of 50ml to be ready for measurement by the Atomic Absorption Device using flame technology according to the analytical conditions shown in Table (1).

Table (1): Analytical conditions of the Atomic Absorption Device (Varian 220) using flame technology

Element	Lamb type	Wave length (nm)	Lamb current intensity (mA)	Slit hole (nm)	Flame type
Pb	Hcl	217	10	0.2	Air-acetylene
Cd	Hcl	228.8	4	0.5	Air-acetylene

Results:

Concentrations of heavy elements (Cadmium and Lead) were recorded in the liver and muscles of the two fish species (*E. alletteratus* and *A. rochei*) caught from Ras al-Basit area – Syria. Accumulation levels of heavy metals in *E. alletteratus* were greater than their levels in *A .rochei*, especially in their liver tissues compared to their muscles, according to the following order: pb > cd.

Liver is usually used as a reference for analyzing tissue damage resulted from toxic environmental compounds (Amaral *et al*., 2002).

Seasonal changes in the concentration of studied heavy metal elements:

The results showed an increase in the total concentration of Pb in the *E. alletteratus* (1.677 mg/kg) in summer of 2022 and the lowest concentration (1.429 mg/kg) in the winter of 2022, while the highest concentration was recorded in the *A. rochei* (1.658 mg/kg) in fall of 2021, and the lowest was (1.309 mg/kg) in winter of 2022 (Fig. 4).

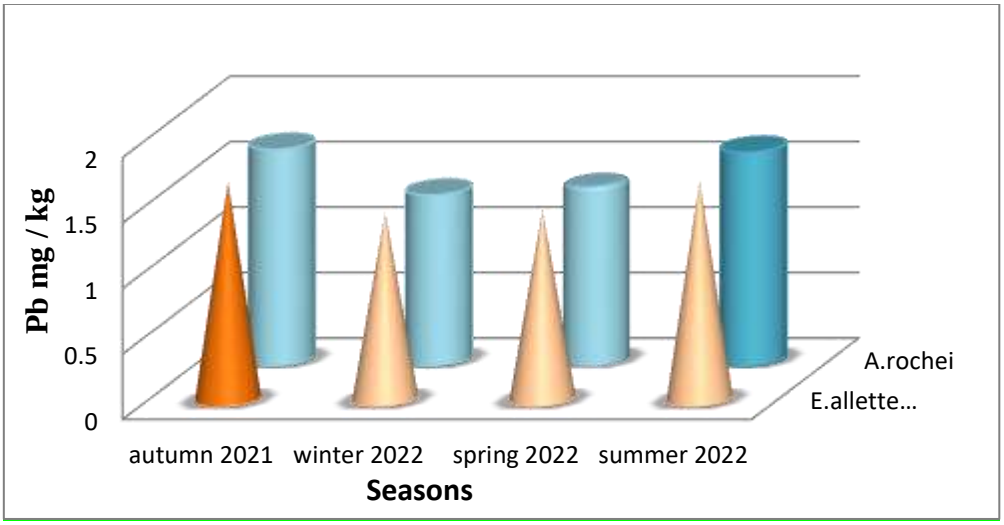

Figure (4): Lead concentration in *E. alletteratus* and *A. rochei* muscles caught during 2021-2022 in Syrian marine waters (Ras Al-Basit).

The highest concentration of Cd was recorded in *Euthynnus alletteratus* (0.189 mg/kg) in summer and the lowest concentration (0.130 mg/kg) in winter of 2022. The same was true for *A.rochei* (0.168 mg/kg) in summer, and the lowest was (0.139 mg/kg) in winter of 2022 (Fig. 5).

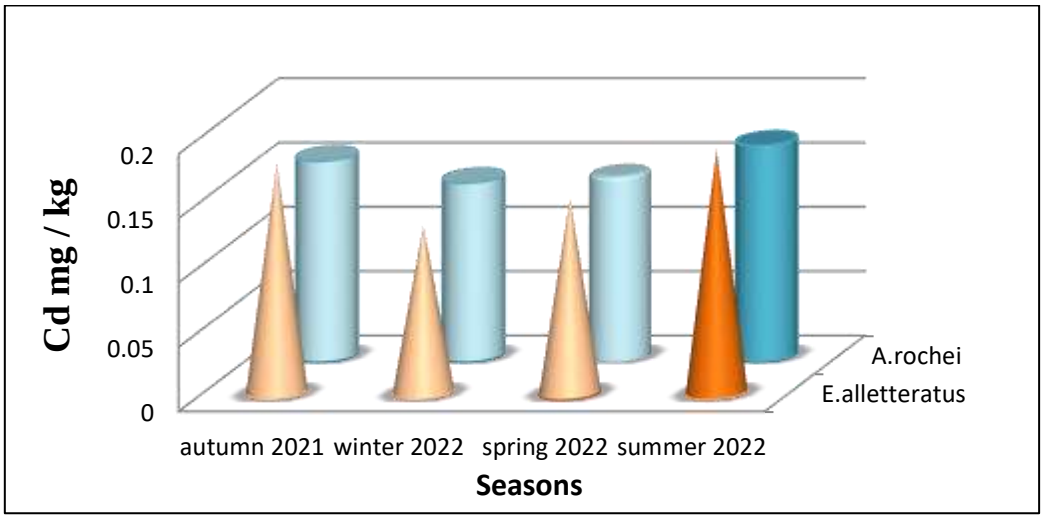

Figure (5): Cadmium concentration in *E. alletteratus* and *A. rochei* muscles caught during 2021-2022 in Syrian marine waters (Ras Al-Basit).

Clear seasonal changes were observed in Lead concentrations in the liver of studied fish, where the highest concentration was recorded in the *E. alletteratus* (4.242 mg/kg) in the summer and the lowest concentration (3.395 mg/kg) in the winter, compared to *A. rochei* (4.339 mg/kg) in the summer, and the lowest (3.107). mg/kg) in winter of 2022 (Fig. 6).

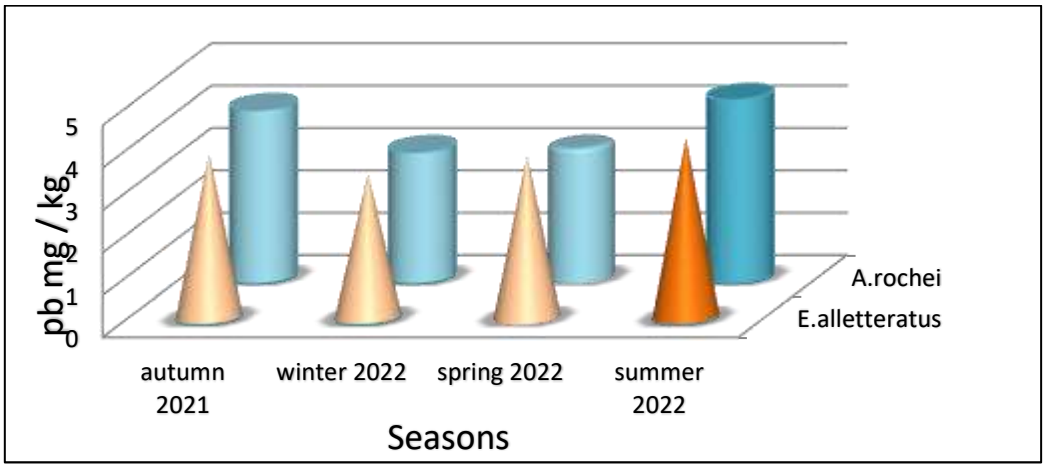

Figure (6): Lead concentration in *E.alletteratus* and *A.rochei* Liver caught during 2021-2022 in Syrian marine waters (Ras Al-Basit).

The highest concentrations of Cd were recorded in the liver of *E.alletteratus* (0.678 mg/kg) in summer, and the lowest concentration (0.556 mg/kg) in winter. The same case was true in the liver of *A.rochei* (0.593 mg/kg) in summer, and the lowest was (0.443 mg/kg) in winter (Fig. 7).

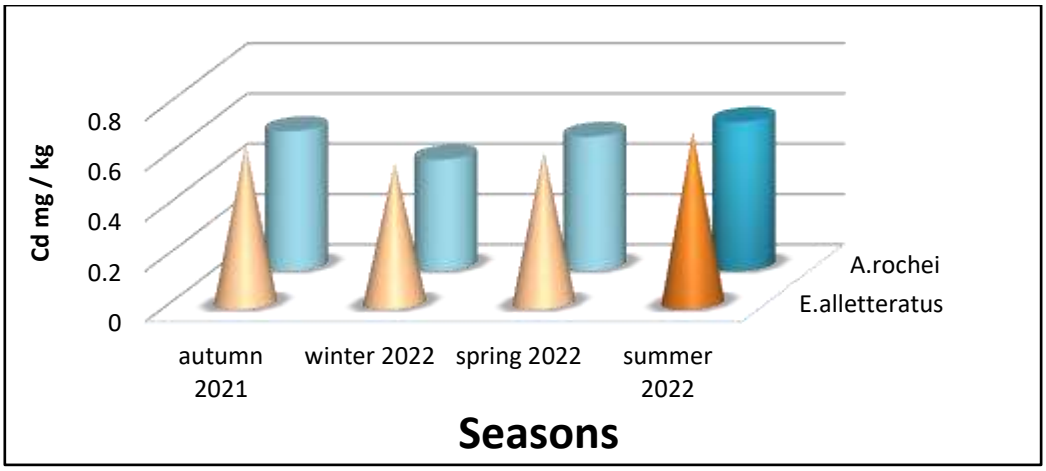

Figure (7):Cadmium concentration in *E.alletteratus* and *A.rochei* Liver caught during 2021-2022 in Syrian marine waters (Ras Al-Basit).

Discussion:

E. alletteratus and *A. rochei* are carnivorous fish, feeding mainly on other fish species (Hajjej *et al*., 2018), as the concentration of pollutants in predatory fish species is higher than in non-predatory fish species (Mortazavi and Sharifian, 2011). This explains why the Concentrations of these elements in the muscles and liver of *E. alletteratus* and *A. rochei* are high.

A significant increase in the concentrations of the studied elements was observed in the liver, as it is one of specialized tissues in storing toxins. The liver is often used as a reference for analyzing of tissue damage caused by toxic environmental compounds (Amaral *et al*., 2002). The accumulation of elements in the liver indicates to exposure of fish to pollution in previous periods, and this is confirmed by international studies (Mount and Stephan, 1967), while their accumulation in the muscles indicates to continuous exposure to pollutants in recent periods of time due to the increase of metabolism in these organs (Schulz and Martins- Junior, 2001).

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confirmed by international studies (Mount and Stephan, 1967), while their accumulation in the muscles indicates to continuous exposure to pollutants in recent periods of time due to the increase of metabolism in these organs (Schulz and Martins- Junior, 2001).

A clear variation was observed when comparing our results with other studies on the same fish species (Table 2), the differentiation in metal content of the fish tissues a mong the areas could be attributed to metabolic process, age, weight, health condition and food availability, as well as, the degree of water pollution and sources of pollution (Rauf et al., 2009), as the marine waters of the Syrian coast have been polluted because of industrial and agricultural activities and was exposed to the leakage of an oil slick from the two reservoirs of the Banias thermal station in the eighth month 2021.

Table (2): Metal concentrations in two organs of the examined *E. alletteratus* and *A. rochei* from Ras albasit – Syrian Coastal (2021-2022)

Species	Liver Mean ± SD		Muscles Mean ± SD		Space	References
	Cd (mg / kg)	Pb (mg/kg)	Cd (mg / kg)	Pb (mg / kg)		
	0.14	0.68	-	-	Libya	Hadeed 2017
	-	-	0.072	0.228	Libya	Abolghait and Garbaj, 2015
E.alletteratus	-	-	0.1>	0.20	Ghana, West Afriac	Asmah and Biney, 2014
	-	-	0.25	-	North Atlantic	Windom *et al.*, 1973
	0.20	0.806	0.0298	0.492	Algeria	Ansel and Benamar, 2018
	3-4	0.7-0.8	0.1<	0.4- 0.5	Mexico	Hall *et al.*, 1978
	0.615 ± 0.05	3.83 ± 0.349	0.162 ± 0,024	1.553 ± 0.129	Ras albasit – Syria	Current study, 2021-2022
A.rochei	8.59	<LOD	0.18	0.45	Almeria Bay	Ramos-Miras *et al.* 2019
	0.531 ± 0.062	3.68 ± 0.591	0.152 ± 0.012	1.484 ± 0.170	Ras albasit – Syria	Current study, 2021-2022

In comparison with the concentrations allowed globally according to (Table 3) for health safety, the results of the analysis of Cd and Pb levels in muscles of *E. alletteratus* and *A.rochei* caught in Syrian marine waters during 2021-2022 were within legal limits according to (WHO 1996; FAO 1983; FAO 1992), while they exceeded these limits according to European-Co mmission (2006).

Table (3): Legal limits of Cd and Pb (mg kg^{-1}) in fish.

References Element	WHO (1996)	FAO (1983)	FAO (1992)	European-Co mmission (2006)
Cd (mg / kg)	-	0.5	2	0.1
Pb (mg / kg)	2	0.5	2	0.30

Conclusions:

- The values of the bioaccumulation of Cadmium in the muscle and liver tissues of *E. alletteratus* and *A.rochei* caught in Ras Al-Baseet - Syrian marine waters 2021-2022 are higher than that of Lead.

- ❖ *E. alletteratus* concentrated of Cadmium and Lead in their muscles and liver more than *A.rochei*.
- ❖ Higher concentrations of Cadmium and Lead were recorded in the liver tissues of two studied fish species more than in their muscles.
- ❖ The concentrations of Cadmium and Lead in the muscle and liver tissues of *E. alletteratus and A.rochei* were the highest in the summer compared to the other seasons.

Recommendations:

1- Continuing to study the concentrations of heavy metals in other economical fish species, which in turn form an important part of marine food chains.

2- The need to apply legal related to the protection of the marine environment from various sources of pollutions.

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References

Abadi, D. R. V.; S. Dobaradaran; I. Nabipour; X. Lamani; M. Ravanipour; R. Tahmasebi; and S. Nazmara (2015). Comparative investigation of heavy metal, trace, and macro element contents in commercially valuable fish species harvested off from the Persian Gulf. Environ Sci Pollut Res. 22(9), 6670-6678. https://doi.org/10.1007/s11356-014-3852-1

Abolghait, S. K; and A. M. Garbaj (2015). Determination of cadmium, lead and mercury residual levels in meat of canned light tuna (*Katsuwonus pelamis* and *Thunnus albacares*) and fresh little tunny (Euthynnus alletteratus) in Libya. Open veterinary journal. 5(2), 130-137. https://doi.org/10.5455/OVJ.2015.v5.i2.p130

Akel, H.; Kara, A.; Ahmed, L. M. (2017). Determine of some of heavy metal in *Boops boops* in the coastal water of Lattakia. *Tishreen University Journal for Research and Scientific Studies - Biological Sciences*.39(1). 199-213.

Al-Edreesi, M. A. M; and M. A. Abdelmoneim.; H. T. Al-Saad.; H. M. A. Heba (2002). Heavy metal contents of some molluscs and crustaceans along Al-Hoodeidah Red Sea Coast of Yemen. Bull. Nat. Inst. Oceanogr. Fish., A.R.E. 28: 319- 331. http://un.uobasrah.edu.iq/papers/868.pdf.

Amaral, A. F.; N. Alvarado.; I. Marigomez.; R. Cunha.; K. Hylland., and M. Soto (2002). Autometallography and metallothionein immunohistochemistry in hepatocytes of turbot (*Scophthalmus maximus* L.) after exposure to cadmium and depuration treatment. Biomarkers. *7*(6), 491-500. https://doi.org/10.1080/1354750021000034843

Ansel, M. A; and N. Benamar (2018). Accumulation of heavy metals in muscle, liver, and gonads of little tunny (*Euthynnus alletteratus*) from the western region of Algeria. Environmental Science and Pollution Research. 25(32), 32640-32648. https://doi.org/10.1007/s11356-018-3254-x

Arantes, F. P.; L. A Savassi.; H. B. Santos.; M. V. Gomes; and N. Bazzoli (2016). Bioaccumulation of mercury, cadmium, zinc, chromium, and lead in muscle, liver, and spleen tissues of a large commercially valuable catfish species from Brazil. Anais da Academia Brasileira de Ciências. 88, 137 - 147. https://doi.org/10.1590/0001-3765201620140434

Asmah, R; and C. A. Biney (2014). Distribution of heavy metals in tissues and organs of tuna. Int. J. Fish. Aquat. Stud. 1, 82-86.

Butu, A. W; and E. O. Iguisi (2013). Concentration of heavy metals in sediment of river Kubanni, Zaria, Nigeria, Compr. J. Earth Environ. Sci. 2(1): 10-17.

Cevik, U. Ğ. U. R.;, B. Koz.; and Y. Makarovska (2010). Heavy metal analysis around Iskenderun Bay in Turkey. X-Ray Spectrometry: An International Journal. 39(3), 202-207. https://doi.org/10.1002/xrs.1250

Collette, B. B; and C. E. Nauen (1983). FAO species catalogue. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date.FAO Fisheries Synopsis. 125 (2), 137 p.

Collete, B. B. (1986). Scombridae. In: White head, P. J. P.; M-L. Bauchot.; J-C. Hureau.; J. Nielsen; and E. Tortonese (eds.). Fishes of the North-eastern Atlantic and the Mediterranea. Vol II, 981-997. UNESCO Paris.

Damiano, S.; P. Papetti; and P. Menesatti (2011). Accumulation of heavy metals to asses the healh status of swordfish in a comparative analysis of Mediterranean and Atlantic areas. Marine Pollution Bulletin. 62, 1920-1925. https://doi.org/10.1016/j.marpolbul.2011.04.028

Dixit, R.; D. Malaviya.; K. Pandiyan.;U. B. Singh.; A. Sahu.; R. Shukla; and D. Paul (2015). Bioremediation of heavy metals from soil and aquatic environment: an overview of principles and criteria of fundamental processes. Sustainability. 7(2), 2189–2212.

Dural, M.; M. Z. L. Göksu; and A. A. Özak (2007). Investigation of heavy metal levels in economically important fish species captured from the Tuzla lagoon. Food Chemistry. 102 (1) : 415 – 421 . https://doi.org/10.1016/j.foodchem.2006.03.001

Emami-Khansari, F.; M, Ghazi-Khansari; and M. Abdollahi (2005). Heavy metals content of canned tuna fish. Food Chem. 93: 293-296. https://doi.org/10.1016/j.foodchem.2004.09.025

European-Co mmission (2006). Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union. Downloaded from http://eur-lex.europa.eu/legal-content/en/NOT/?uri=CELEX32006R1881.

FAO (Food and Agriculture Organization) (1983) Compilation of legal limits for hazardous substances in fish and fishery products. FAO Fishery Circular. No. 464, 5-10. : http://www.fao.org/docrep/014/q5114e/q5114e.pdf (Accessed 28 May 2013).

FAO (1992) Committee for Inland Fisheries of Africa. Report of the third session of the working party on pollution and fisheries, Accra,Ghana. 25–29 November 1991, FAO fisheries report, no. 471, Rome, 43p.

FAO Fisheries Department. (1994) World review of highly migratory species and straddling stocks. FAO Fisheries Technical Papers. no. 337. Rome: FAO.

Gutiérrez, C.; C. Fernández.; M. Escuer.; R. Campos-Herrera.; M. E. Beltrán Rodríguez.; G. Carbonell (2016). Effect of soil properties, heavy metals and emerging contaminants in the soil nematodes diversity. Environ. Pollut. 213, 184–194.

Hadeed, H. (2017). Determination of some essential and toxic heavy metals in the liver tissue of four marine fish species from cost of Misurata, Libya. 1st National Conference on Marine and Groundwater Pollution (1st NCMGP-2017).

Hajjej, G.; H. Missaoui; and O. Jarboui (2018). Preliminary Stomach Contents Analysis of Bullet Tuna Auxis Rochei (Risso, 1810) In Tunisian Waters. Collect. Vol. Sci. Pap. ICCAT. 75(1), 86-94.

Hall, J. L. (2002). Cellular mechanisms for heavy metal toxification and tolerance. J Exp. Bot. 53:1-11.https://doi.org/10.1093/jexbot/53.366.1

Hall, R. A.; E. G. Zook.; and G. M. Meaburn (1978). National marine fisheries service survey of trace elements in the fishery resource. NOAA Technical Report NMFS SSRF-721, U.S. Department of Commerce, National Marine Fisheries Service. 313 p.

Hammoud, V. and Salama, L. (2016). Heavy metal concentrations in tissues of some commercially important imported fishes in Syria and its suitability for consumption. Journal of King Abdulaziz University: Science . Vol. 28 Issue 2, 41-52. 12 p.

Hattour, A. (2000). Contribution à l'étude des poissons pélagiques des eaux tunisiennes. Thèse de doctorat en sciences biologiques, Faculté des sciences de Tunis. 344 pp.

IAEA. (2006). Laboratory Procedure Book, Marine Environment Laboratory, Monaco.16- 45.

Jasmine, S.; P. Rohit.; E. M. Abdussamad.; K. P. Koya.;K. K. Joshi.; S. Kemparaju; and M.Sebastin (2013). Biology and fishery of the bullet tuna, Auxis rochei (Risso, 1810) in Indian waters. Indian Journal of Fisheries. 60(2), 13-20.

Kaitantzian, A.; E. Kelepertzis; and A. Kelepertsis (2013). Evaluation of the sources of contamination in the suburban area of Koropi–Markopoulo, Athens, Greece. Bull. Environ. Contam. Toxicol. 91, 23–28.

Laika, H. E.; Abbas, A. and Hriba,Y. (2016). Determination of the contents of some trace of Heavy metals (Cu, Cd, Pb) in marine algae from the coast of Banias . Tishreen University Journal - Basic Sciences Series. 38 (2), 1- 16 p.

Łuczyńska, J.; B. Paszczyk; and M. J. Łuczyński (2018). Fish as a bioindicator of heavy metals pollution in aquatic ecosystem of Pluszne Lake, Poland, and risk assessment for consumer's health. Ecotoxicol. Environ. Saf. 153: 60-67. https://doi.org/10.1016/j.ecoenv.2018.01.057

Maisano, M.; T. Cappello.;S. Oliva.; A. Natalotto.; A. Giannetto.; V. Parrino.; P. Battaglia.;, T. Romeo.; A. Salvo.; N. Spanò;and A. Maucer (2016). PCB and OCP accumulation and evidence of hepatic alteration in the Atlantic bluefin tuna, *Thunnus thynnus*, from the Mediterranean Sea. Mar Environ Res. 121:40-48. https://doi.org/10.1016/j.marenvres.2016.03.003

Mohamad, E. (2001). Determination of (Cd, As, Pb, Zn, Cr and Cu) in the flesh tissues of some kinds of marine beings at the shore of Lattakia city by AAS. Tishreen University Journal for Studies and Scientific Research-Basic Science, 23(10).

Morgano, M. A.; L. C. Rabonato.; R. F. Milani.; L. Miyagusku; and K. D. Quintaes (2014). As, Cd, Cr, Pb and Hg in seafood species used for sashimi and evaluation of dietary exposure. Food Control. 36: 24 - 29. https://doi.org/10.1016/j.foodcont.2013.07.036

Mortazavi, M. S; and S. Sharifian (2011). Mercury Bioaccumulation in Some Commercially Valuable Marine Organisms from Mosa Bay, Persian Gulf. Int. J. Environ. Res. 5(3): 757-762.

Mount, D. I.; and C, E. Stephan (1967). Amethod for Detecting Cadmium Poisoning in Fish. J. Of Wildlife Management. 31:1.

Odumo, B.; G. Carbonell.; H. Angeyo.; J. Patel.; M. Torrijos; and J. Rodríguez Martín (2014). Impact of gold mining associated with mercury contamination in soil, biota sediments and tailings in Kenya. Environ. Sci. Pollut. Res. 21, 12426–12435.

Papagiannis, I.; I. Kagalou.; J. Leonardos.; D. Petridis; and V. Kalfakakou (2004). Copper and zinc in four freshwater fish species from Lake Pamvotis (Greece). Environ. Int. 30: 357-362. DOI:10.1016/j.envint.2003.08.002

Ptashynski, M. D.; R. M. Pedlar.; R. E. Evans; C. L. Baron; and J. F. Klaverkamp (2002). Toxicology of dietary nickel in lake whitefish (Coregonus clupeaformis). Aquatic toxicology. 58 (3-4), 229-247. https://doi.org/10.1016/S0166-445X(01)00239-9

Ramos-Miras, J. J.; M. J. Sanchez-Muros.; E. Morote.; M. Torrijos.; C. Gil.; R. Zamani-Ahmadmahmoodi; and J. Martin (2019). Potentially toxic elements in commonly consumed fish species from the western Mediterranean Sea (Almería Bay): bioaccumulation in liver and muscle tissues in relation to biometric parameters. Science of the Total Environment. 671, 280-287. https://doi.org/10.1016/j.scitotenv.2019.03.359

Rashed, M. N. (2001). Cadmium and lead levels in fish (Tilapia nilotica) tissues as biological indicator for lake water pollution. Environ. Monit. Assess., 68 (1) : 75 - 89. https://doi.org/10.1023/A:1010739023662.

Rauf, A.; Javes, M. and Ubaidullah, M. (2009). Heavy Metal Levels in three major Carps (*CATLA CATLA*, *LABEO ROHITA* and *CIRRHINA MRIGALA*) from the river Ravi, Pakistan. Pakistan Vet. J., 2009, 29(1): 24-26.

Saker, F., AL- Masri, M., Saleh, M. (2008). Trace Heavy Metals Accumulation in Some Zoo Benthic Species of Banias Littoral Thermal Station, Tishreen University Journal for Research and Scientific Studies - Biological Sciences Series. 30 (5), 81 – 98 p**.**

Schulz, U. H; and H. Martins- Junior (2001). Astyana faseiatus As Bioindicator of Water Pollution of Rio Dos Sinos, Rs, Brazil. Braz. J. Biol. 61(4): 615-622. https://doi.org/10.1590/S1519-69842001000400010

Simon, D. F.; T. A. Davis.; M. T. Tercier - Waeber.; R. England; and K. J. Wilkinson (2011). Institute evaluation of cadmium biomarkers in green algae. Environ, Pollut. 159 : 2630 - 2636 https://doi.org/10.1016/j.envpol.2011.05.028

Sivaperumal, P.; T. V. Sankar; and P. G. Viswanathan Nair (2007). Heavy metal concentrations in fish, shellfish and fish products from internal markets of India vis-a-vis international standards. Food Chem. 102:612-620 https://doi.org/10.1016/j.foodchem.2006.05.041

Soliman, Y. Saad, A. Hammoud, V. and Capape, C. H. (2021). Heavy Metal Concentrations in Tissues of Red Mullet, *Mullus barbatus* (Mullidae) from the Syrian Coast (Eastern Mediterranean Sea). Annals for Istrian and Mediterranean Studies Ser. hist. nat, 31 (2). 243-250.

Tiimub, B. M. and M. A. D. Afua (2013). Determination of selected heavy metals and Iron concentration in two common fish species in Densu River at Weija District in Grater Accra region of Ghana. American international journal of biology. 1(1), 45-55

WHO (World Health Organization) (1996). Health criteria other supporting information. In: Guidelines for Drinking Water Quality. Geneva. 2: 31- 388.

Windom, H.; R. Stickney.; R. Smith.; D. White; and F. Taylor (1973). Arsenic, cadmium, copper, mercury, and zinc in some species of North Atlantic finfish. Journal of the Fisheries Board of Canada. 30(2), 275-279. https://doi.org/10.1139/f73-045

Ziada, M. A. (2004-2005). preliminary study of the level of pollution of some heavy metals in plants in some industrial areas in the Syrian coast". Thesis prepared to obtain a diploma in postgraduate studies, Faculty of Agriculture, *Tishreen University*, ,90.

تراكم الكادميوم والرصاص في أنسجة كبد وعضلات البلميدا العريضة *Euthynnus alletteratus* والبلميدا المبرومة *Auxis rochei* المصطادة في المياه البحرية السورية (رأس البسيط)

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الملخص:

يركز هذا البحث على تحديد نزر بعض العناصر المعدنية الثقيلة (الكادميوم Cd والرصاص Pb) في أنسجة كبد وعضلات نوعين من الأسماك الاقتصادية البحرية (البلميدا العريضة *Euthynnus alletteratus* والبلميدا المبرومة *Auxis rochei*) المصطادة من منطقة رأس البسيط (شاطئ مدينة اللاذقية – سورية) وذلك باستخدام مطيافية الامتصاص الذري (تقانة اللهب Flame-AAS). أظهرت النتائج تراكم العناصر المعدنية المدروسة في الكبد مقارنة مع العضلات, حيث لوحظ ارتفاع التراكيز في كبد النوع الأول (Cd: 0.615 ± 0.05 mg/kg and Pb: 3.83±0.349 mg/kg) مقارنة مع تركيزها في النوع الثاني (Cd: 0.531 ± 0.062 mg/kg and Pb: 3.683 ± 0.591 mg/kg)، وكذلك الأمر بالنسبة للعضلات في كلا النوعين على التوالي: (Cd: 0.162 ± 0.024 mg/kg and Pb: 1.553 ± 0.129 mg/kg) و (Cd: 0.152 ± 0.012 mg/kg and Pb: 1.484 ± 0.170 mg/kg). يُمكن أن يُعزى اختلاف تراكيز هذه العناصر بين النوعين السمكيين المدروسين إلى اختلاف الصفات المورفومترية (طول ووزن) والعمرية.

الكلمات المفتاحية: المعادن الثقيلة، بلميدا عريضة، بلميدا مبرومة، المياه البحرية السورية (رأس البسيط).