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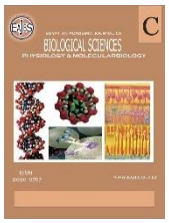

Evaluation of the Heavy Metals Pb, Cd, and Fe in Muscles, Liver, and Skin of *Mugil cephalus* (Mugilidae) from Tubrukharbor, Eastern Libya

Yousef K. A. Abdalhafid[1],Salma M. Aboubakr[2], Mousa M.Y.Kateesh[1] and Sayed M. Ali[1]

1-Faculty Science, Omar Al-Mukhtar University, Al Bayda, Libya

2-Faculty Science.OMar Al-Mukhtar University. Al-Qubba

E.Mail:salma1981sa@Gmail.com

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ABSTRACT

Heavy metal concentrations Lead Pb, Cadmium Cd, and Iron Fe) were determined in the muscles, liver, and skin of *Mugil cephalus* (Mugilidae) in Tobrukharbor, eastern Libya. The results revealed that the concentration of Pb reached high levels in the skin, while recorded low levels in the liver tissues. Pb level in the liver, skin, and muscle tissues of *Mugil cephalus* was more than the international standards. The high concentration of Fe recorded in the liver tissue, while, recorded its low concentration in the skin. Also, maximum levels of Cd were detected in the liver, while it attained their low level in the muscles. Generally, the level of Pb and Fe in muscle tissues of *Mugil cephalus* was more than the international standard and the level of Cd in muscle tissue of *Mugil cephalus* was lower than the general standard. On the other hand, heavy metals concentration levels in seawaterofTobrukharbor, eastern Libya, exhibited a high level for Fe then Pb comparing to the level of Cd. The relationship between size and weight of *Mugil cephalus* and the levels of each metal was studied.

INTRODUCTION

The effect of heavy metals pollution worldwide is considered one of the important problems in the last decades(Malik, *et al*.,2010). Human activities such as agriculture practices, industrialization, and an increase in population have further aggravated the situation (Giguere*et al.*,2004; Gupta,*et al.*,2009). Heavy metalsh ave the ability to bioaccumulate in aquatic ecosystems due to their potentially toxic effects(Miller, *et al.*, 2002; Censi,*et al.*, 2006). Some heavy metals such as copper and zinc are very important for metabolism, while Pb, Cd, and Fe have almost no role in living systems. On the other hand, they have dangerous effects on fish depending on their concentration. Coastal lagoons and harbor are considered a priority habitat, for exhibiting pollution by heavy metals, so, this study aims to the evaluation of lead, cadmium, and iron levels in the liver, muscles, and skin of *Mugil cephalus* (Mugilidae) from Tobrukharbor, eastern Libya.

MATERAILS AND METHODS

The Study Site:

Tobruk city lies on the coast of the East Mediterranean of the coast of Libya, extends from Bumba to the Egyptian border. The area of study extends along of Tubruk port eastern of Libya (long. 32°05' N 23°55' E , Fig. 1).

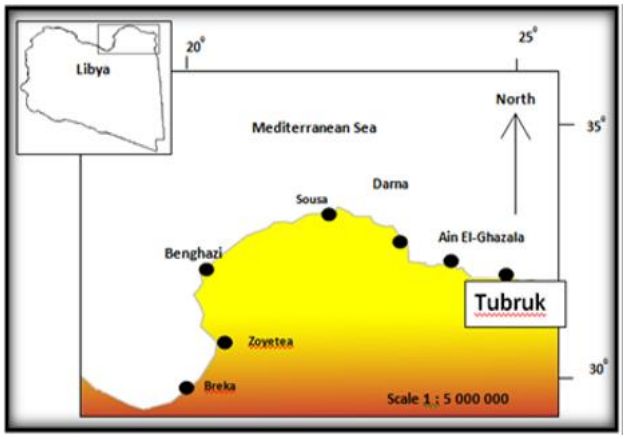

Fig.(1). Harbor of Tubruk

Fish Sampling:

Fifteen *M. cephalus* fish were collected from the Tubruk harbor between April to August 2016, then weight and length of fish were recorded to the nearest (millimeter/gram) and then all fish were dissected. To investigate the heavy metals variations in *Mugil cephalus* tissues, three different tissues were obtained from fish samples(liver, skin, and muscles).

Water sampling was done according to Salim (1987).

Tissue analysis and the procedure was carried out according to Pitor and Dragan (1996).

Water analysis and the procedure was achieved according to Salim (1987).

Statistical analysis was done with many tap differences with $p < 0.05$ were considered significant.

RESULTS

Length-Weight Relationship:

The relationship between length and weight(millimeter/gram) are illustrated in figure 2.

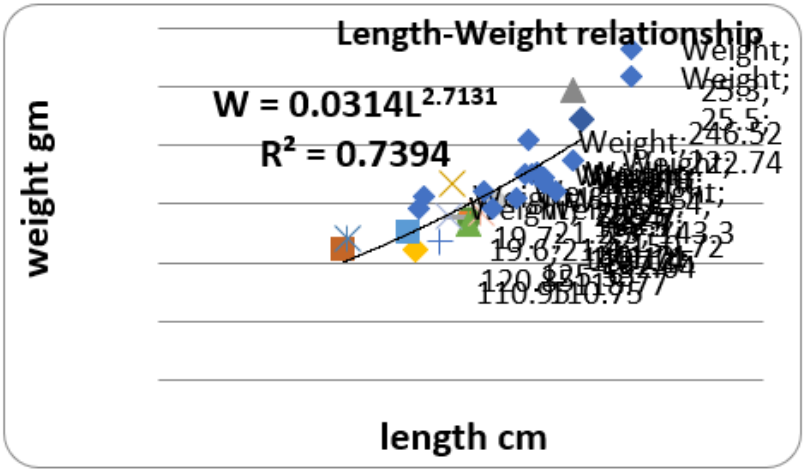

Fig.(2). Relationship between length and weight

Pb, Fe, and Cd in liver, skin, and muscle concentration levels, were tabulated (in ppm**)** in Table (1).

The Concentration of Pb (ppm):

The obtained results cleared that the maximum concentration level of Pb was observed in the skin while the concentration in the liver was low in comparison with those in muscles.

Generally, the concentration of Pb in the muscle tissue of *Mugil cephalus* was more than the international standard.

The Concentration of Fe (ppm):

The maximum concentration of Fe was observed in liver tissue, while, the concentration in the skin was low in

comparison with those in muscles. The concentration level of Fe in musculartissues of *Mugil cephalus* was more than the international standards.

The Concentration of Cd (ppm):

The maximum level of Cd was observed in the liver tissue while the level in muscles was lower in comparison with those in the skin. The concentration level recorded for Cd in muscle tissue of *Mugil cephalus* was clearly lower compared with the international standard.

Table 1: The concentration of Pb, Fe, and Cd (ppm)(mean ± SE) in liver, skin, and muscle tissues of *Mugil cephalus* in Tubruk, eastern Libya.

Heavy metals	Liver	Skin	Muscles
Pb	0.386.3±0.3	0.8797±0.02	0.6729±0.06
Fe	312.82±5.0	117. 46±3.37	236.14±12.37
Cd	0.046±0.0045	0.021±0.0011	0.018±0.0005

Table (2) illustrates the coefficients of correlations between levels of Pb in liver, skin, and muscles with length and weight of *Mugil cephalus*, no correlations recorded between length and weight compared to the level of Pb in the skin, while there is astrong negative correlation between weight and the concentration of Pb in muscles and there was no correlation between length and the concentration of Pb in muscles. On the other hand, there is astrong positive correlation between weight and concentration of Pb in theliver comparing to length.

Table 2: Coefficients of correlations between levels of Pb in liver, skin, and muscles of *M.cephalus* versus fish length and weight**.**

Tissue	Liver	Skin	Muscles
Length	0.221	-0.199	-0.161
Weight	0.602	-0.339	-0.505

Table (3) illustrates the coefficients of correlations between the concentration of Fe in liver, skin, and muscles compared to the length and weight of *Mugil cephalus*. There are no correlations between the concentration of Fe in liver, skin, and muscles compared to the length and compared to weight in the liver . while there is astrong negative correlation between levels of Fe and weight in skin and muscles.

Table 3: Coefficients of correlations between levels of Fe in liver, skin, and muscles of *M.cephalus* versus fish length and weight.

Tissue	Liver	Skin	Muscles
Length	-0.180	-0.176	-0.100
Weight	-0.033	-0.555	-0.527

Coefficients of Correlations Relationship Between Levels of Cd in Liver, Skin, and Muscles of *M.Cephalus* Versus Fish Length and Weight:

Table (4) illustrates the coefficients of correlations between concentrations of Cd in liver, skin, and muscles compared to the length and weight of *Mugil cephalus*, there are no correlations between concentrations of Cd in the liver, skin, and muscles compared to length and weight.

Table4: Coefficients of correlations between levels of Cd in liver, skin, and muscles of *M.cephalus*versus fish length and weight.

Tissue	Liver	Skin	Muscles
Length	0.255	0.005	0.146
Weight	0.115	-0.303	0.082

Table 5: Heavy metals: maximum permissible limit (MPL) in the fish muscle tissues (µg/g wet wt) international standards.

Metals	Pb	Fe	Cd	Reference
The present study	**0.672±0.06**	**236.14±12.37**	**0.0182±0.0005**	**The present study**
FAO (1983)	**0.5**		**0.05**	**FAO (45)**
FAO/WHO Limit	**0.5**		**0.5**	**FAO/WHO (50)**
WHO1989	**2**	**100**	**1**	**Mokhtar (52)**
European	**0.2**		**0.05**	**EC (49)**
Community England	**2**		**0.2**	**MAFF (48)**

Levels of the heavy metals Pb, Fe, and Cd (mean±standard error, ppm) in surface water of three sites within Tubruk harbor, eastern Libya, were presented in (Table 6).

Table 6: The concentration of the heavy metals (Pb, Fe, and Cd) in the water of Tubruk harbor eastern Libya revealed the occurrence of ahigh concentration of Iron then Lead comparing to the concentration of Cadmium.

Heavy metals	Site 1	Site 2	Site 3	Averages of the sites
Pb	0.91±0.005	1.02±0.008	1.10±0.007	1.011±0.005
Fe	244.8±0.59	280.7±0.33	331.7±0.28	285.79±2.461
Cd	0.02±0.001	0.03±0.0003	0.01±0.0001	0.028±0.0005

As shown in Table (7) heavy metals accumulation coefficient % (Indices of pollution) in liver, skin, and muscles of *Mugil cephalus* revealed higher levels of accumulation for Cd (164.28) and Fe (109.45) in the liver, then Pb(86.94) in skin and Fe (82.62) in muscles

Table7: Accumulation coefficient % of the studied heavy metals in the liver, skin, and muscles of *M. cephalus.*

Heavy metals	Liver	Skin	Muscle
Pb	38.18	86.94	66.55
Fe	109.45	41.10	82.62
Cd	164.28	75	64.28

DISCUSSION

According to the present results, the maximum level of Pb was showed in the skin, but, the concentration of Pb in liver tissue was lower in comparison with those in muscles, the level of Pb in liver, skin and muscle tissues of *Mugil cephalus* was more than the general international standard. While the maximum concentration of Fe was observed in the liver tissues, and the concentration level in the skin was lower in comparison with those in muscles. The level of Fe in muscle tissues of *Mugil cephalus* was more than the international standard. Furthermore, the maximum concentration level of Cd was observed in liver tissues while its level in the muscles was lower in comparison with those in the skin,. Generally, the concentration level of Cd in the muscle tissues of *Mugil cephalus* was clearly lower than the general international standard. Also, the relation between the size and weight of the examined fish and the concentration level of each heavy metal was determined. In general, in the muscles and liver, a linear relationship would best describe the data throughout the coefficient of correlation was not very high, and there was no significant correlation between the metal concentrations in the liver, skin, and muscles and the size of the individual fish.

The main sources of lead pollution in the seawater and ocean .the shipping, movement of ships, and the oil tanker accidents. In the present research, the maximum concentration level of Pb was recorded in the skin, this result agrees with many authors who have reported that the skin and gill tissues are especially characterized by a mucus layer on their outer surfaceslikeYılmaz,(Yilmaz,2005),who reported that. Pb levels reached high levels in the skin in *Mugil cephalus*, The occurrence of the mucus obviously affects the diffusion of water pollutants across the fish epidermis, serving as an effective barrier (Yilmaz,2005).

Unlike to Safahieh, *et al*., (Safahieh, *et al.*, 2011), Pb Concentration levels in muscle, liver, and gills in the Mullet fish, *Liza abu* from the Petrochemical Waste Receiving Creeks, Musa Estuary (Persian Gulf) were lower than the general standards. On the other hand, their study agreed with the attained results concerned with the concentration of Cd in muscle.

Similar findings were reported by Khidr and Dheina(2011), concerning heavy metal levels in thewater, fish, and plankton of Lake Manzala, Egypt, they found that the Pb concentration in the liver tissue was higher than the save limit particularly in the Gills but lower than the permissible limit in the muscle.

Muscles contained the lowest levels of the measured heavy metals. This result agreed with the findings of many researchers who have reported that fish muscles have a low tendency to accumulate the heavy metals which they are exposed (Blasco,*et al.*, 1998; Canlt&Kalay, 1998; khider&Dheina, 2011; Kamaruzzaman, *et al.*, 2011;Yilmaz, *2005*).

Cd one of the important heavy metals is most common environmental pollutants and a dangerous threat due to its toxicity, biomagnification, and bioaccumulation in the food chain, Cd toxicity for humans appears its harmful effects on some organs such as kidney, bones, lung, brain and central nervous system (Castro-Gonzalez&Mendez-Armenta, 2008).

Cd was the highest level in the liver. This result could be explained as the habitat of *Mugilcephalus*which live at the sea bottom, near to the sediment where different types of hazardous and toxic substances are accumulated (Ibrahim, *et al.*, 1999).

Because the liver is a target organ for storage and detoxification of the excess of heavy metals uptake by fish, high concentrations of metals are accumulated in it. The liver is a good indicator of water pollution with heavy metals since their levels accumulated in liver tissues are often proportional to those that occur in the environment. That is especially true for iron, copper, and cadmium, levels in the liver tissues which rapidly increase during exposure, and remain high for long periods of depuration, when other organs are being cleared (Dang&Wang, 2009).

Trace metals contamination in sediment can affect water quality and the bioaccumulation of metals in marine organisms, causing potential long-term implications on human health as well as the ecosystem. With the rapid growth of population, increasing heavy metals loads in aquatic ecosystems as a result of human activities has become a major global concern.

The accumulation of heavy metals in liver tissues is likely a result of its role in body metabolism, high levels of Cd and Fe in liver tissues are usually linked to natural binding proteins such as metallothioneins (MT), which act as an essential metal store (Cd and Fe) to fulfill enzymatic and other metabolic demands. In addition, iron tends to accumulate in the hepatic tissues due to the role of the liver in blood cells and hemoglobin synthesis. However, the liver also obtained high levels of non-essential metals such as cadmium; this could be explained by the ability of Cd to displace the normally MT-associated essential metals in hepatic tissues (Roesijadi, 1996, Amiard, *et al.*, 2006; Qadir&Malik, *2011*).

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