Bull. Nat. Inst. Oceanogr. & Fish., A.R.E. 1994. 20 (1): 69 - 82

LEVEL OF Cd, Pb, Cu AND Zn IN MUGIL SEHELI FROM SUEZ BAY; "NORTHERN PART OF THE GULF OF SUEZ, EGYPT"

BY

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Key Words: Heavy metals, Mugil seheli, Red Sea.

ABSTRACT

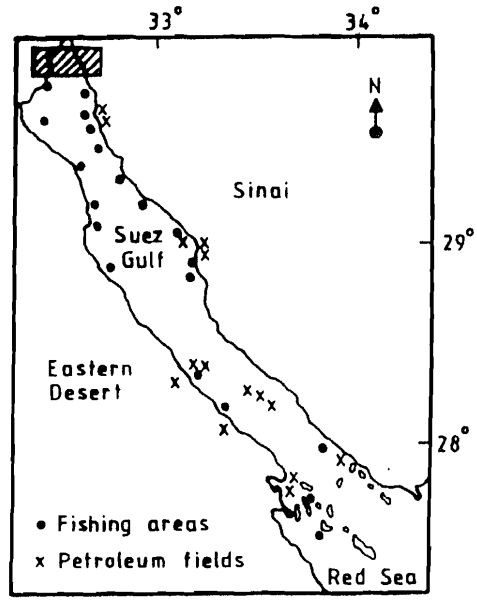
The concentrations of Cd, Pb, Cu and Zn in muscle, gills, liver, gonads, skin, bone and brain of Mugil seheli seasonally caught during 1991-1992 from Suez Bay were determined by flame atomic absorption spectrophometry (AAS).

The results reveal that the level of these metals in the muscle was the least than in the other tissues. Also, the concentration of the metals showed organ-and metal - specific accumulation as high concentration of Cd and Pb were consistently recorded in hard tissues as gills, skin and bone, while Cu and Zn were accumulated in liver and gonads respectively.

INTRODUCTION

The Suez Bay area is subjected to pollution due to different activities lying on its northern side as shown in Figures (1A & 1B). These are four different industries in addition to domestic waste effluents of Suez City and ship's oil refuse. The effluents from these sources are normally contaminated with metals. Usually, for surveillance or monitoring of water quality in areas exposed to pollution with heavy metals, their concentrations in indigenous aquatic organisms can be used as a good indicator for the water quality (Roth & Hornung, 1977).

Mugil seheli, one of the main commercial fish (non - migrated fish) in Suez Bay. It is a marine filter - feeding fish and was used as indicator organism in the present study. The concentration level of Cd, Pb, Cu and Zn were determined in different tissues of this species which seasonally caught from Suez Bay.



"After Awad et.al., 1983"

Figure 1(A): Location map of the study area.

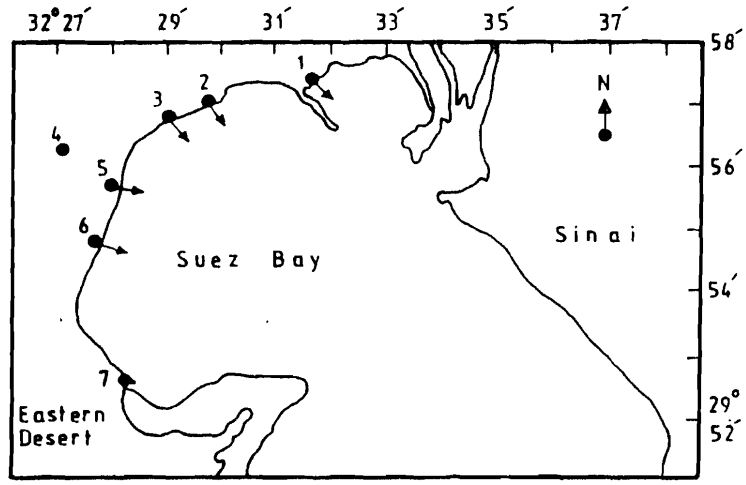


Figure 1(B): Location of the effluent sites in "Suez Bay"
1- Nasr Petroleum Company
2- Suez Oil Producing Company
3- Municipal Sewage
4- Fertilizer Company
5- Power Station
6- National Institute of Oceanography & Fisheries.
7- Ataka main fish-landing port.

The Suez Bay is a shallow extension of the Suez Gulf, roughly elliptic in shape, with its major axis in the NE-SW direction. The average length along the major axis is 13.2 Km, it's average width along the minor axis is 8.8 km. The mean depth is about 10 m and the horizontal surface area is 77.13 km^2. As mentioned before, the City of Suez and its major industries occupy the northern side of the bay and Ataka is the main Fish-Landing Port of Suez Gulf. The annual yield of the Gulf is about 17000 tonnes, which consists of 11000 taken by purse - seine, 5000 by trawl and 600 tonnes by long and hand-lines (El-Moselhy, 1993).

MATERIALS AND METHODS

Fish samples were caught with gill nets from Suez Bay during the period from spring 1991 to winter 1992. Each sample was weighted and measured before dissection for separating the different organs; muscle, gills, liver, gonads (male and female together), skin, bone and brain. The composite samples of each organ (about ten fishes for each season) were stored in polyethylene bags in a deep freezer (-20 °C) until time of analysis.

The preparation of sub-samples (about 1 g from the composite sample) were carried out according to Bernhard, (1976). The soft tissues were digested in concentrated HNO_3 only, but the hard tissues were digested in concentrated HNO_3 and $HClO_4$. The digested samples were then diluted with deionized water to known volume before measurements of the metals using flame atomic absorption spectrophotometer (AAS, Buck Scientific, Model 200 A). To assure precision, a parallel experiments using standard samples has been also carried out. The results were expressed in (ug/g) ppm wet weight. Total lipids in fish organs were also determined, according to knight, et. al., (1972), one time during winter 1992.

RESULTS

The biometric analysis of Mugil seheli fishes are shown in Table (1). Some physical and chemical characteristics of the discharged waters from the different sites around Suez Bay are present in Table (2). The companies give usfalse informations about the quantities of discharged waters and could not put it in Table (2). On the other hand, it is clear from Table (2), that the dissolved oxygen concentrations of domestic effluents and Fertilizer Producing Company is nil, which is due to the consumption of oxygen through oxidation of reduced nitrogen forms (nitrification) and organic matters. Also, oil pollution causes a depletion of dissolved oxygen in seawater as shown in its concentrations for El-Nasr Petroleum Company and Suez Oil Producing Company (1.18 and 0.12 mg O_2/L) respectively.

Table (1): Biometric analysis of Mugil seheli caught from Suez Bay.

Fish	No. of Fish	Total weight (g)	Total length (cm)	Fork length (cm)	Standard length (Cm)
Mugil seheli	41	26.3-71.0 (31.4)	12.8-18.9 (15.2)	11.7-17.0 (13.9)	10.3-14.8 (12.2)

N.B. : Data in parentheses are mean values.

Table (2): Some physical and chemical characteristics of the discharged waters from different sites around Suez Bay.

Parameter / Company	Dissolved O2 mg/L	Water Temperature. oC	Salinity %	pH	Cadmium*		Lead*		Copper*		Zinc*	
					Diss.+	Part.+	Diss.+	Part.+	Diss.+	Part.+	Diss.+	Part.+
El-Nasr Petroleum C.	1.18	26.00	23.06	7.65	0.56	0.33	4.91	1.50	10.17	2.24	149.37	77.66
Suez Oil Producing C.	0.12	29.00	21.89	7.65	0.12	0.11	3.41	1.13	15.05	1.42	41.62	78.42
Municipal Sewage	0.00	27.00	7.41	7.48	1.66	0.22	6.41	9.76	8.41	6.31	118.90	59.71
Fertilizer Producing C	0.00	26.00	2.47	7.76	1.44	0.44	9.41	2.25	15.46	8.95	149.90	3.12
Power Station	5.02	30.00	30.47	8.16	1.00	0.33	7.91	7.91	27.26	14.44	127.51	26.05

* Analytical laboratories of the companies.
\+ Values of dissolved and particulate heavy metals are in ppb.

The concentrations of metals (dissolved or particulate) in the discharged waters of companies are appeared to be in higher levels than the concentrations in seawater (Abdelmoneim, 1994). Therefore, these metal concentrations will increase directly in the seawater and consequently increase the heavy metal contents of these fishes which alive in it (Table, 2).

The analytical results are listed in Table (3) and illustrated by Fig. (2) which shows the seasonal variations in concentrations of Cd, Pb, Cu and Zn in the different organs of Mugil seheli.

Cadmium :

Bone had the highest contents which ranged from 0.79 ppm in autumn to 0.99 ppm in summer, with annual average of 0.89 ppm. The lowest annual average of Cd was recorded for muscle (0.13 ppm).

Lead :

The mean wet weight concentration in the fish organs fluctuated between 0.39 ppm in muscle and 5.19 ppm in bone. Gills and bone recorded maximum annual average of lead with values of 4.58 and 4.40 ppm respectively.

Copper :

Copper, its maximum value (29.03 ppm) in gonads was recorded is spring. On the other hand, the maximum annual average value was recorded in liver (18.30 ppm), whereas the minimum value was in the muscle (0.59 ppm), Table (3).

Zinc :

Zinc values were highest in gonads and skin with respective annual average 86.96 and 79.88 ppm, while the lowest value was recorded in muscle (15.28 ppm).

Total Lipids :

Table (4) shows the content of total lipids in different organs of Mugil seheli. Skin and bone recorded the highest content of lipids (10.15 & 10.74 g %, respectively), while gonads recorded the lowest content (1.18 9 %).

Table (3): Average concentrations (ppm wet weight) and standard errors of Cd, Pb, Cu and Zn in the different tissues of Mugil seheli from Suez Bay.

Metal	Organ	Season				Annual Mean
		Spring	Summer	Autumn	Winter	
Cadmium	Muscle	0.10 ± 0.04	0.16 ± 0.06	0.12 ± 0.06	0.16 ± 0.05	0.13*
	Gills	0.28 ± 0.05	0.49 ± 0.06	0.38 ± 0.03	0.44 ± 0.05	0.45
	Liver	0.27 ± 0.03	0.23 ± 0.06	0.11 ± 0.05	0.17 ± 0.05	0.19
	Gonads	0.32 ± 0.06	0.03 ±	0.32 ± 0.03	0.18 ± 0.04	0.21
	Skin	0.48 ± 0.07	0.42 ± 0.06	0.48 ± 0.06	0.48 ± 0.06	0.44
	Bone	0.90 ± 0.04	0.99 ± 0.06	0.79 ± 0.08	0.91 ± 0.06	0.89**
	Brain	0.48 ± 0.07	0.01 ±	0.0045	0.20 ± 0.06	0.17
Lead	Muscle	0.71 ± 0.20	0.52 ± 0.21	0.45 + 0.15	0.39 ± 0.12	0.54*
	Gills	2.96 ± 0.43	3.76 ± 0.70	3.86 + 0.38	1.32 ± 0.25	4.58**
	Liver	1.93 ± 0.14	0.63 ± 0.14	1.20 + 0.33	0.59 ± 0.14	1.09
	Gonads	0.98 ± 0.13	1.18	1.41	0.55 ± 0.14	1.03
	Skin	5.02 ± 1.22	1.41 ± 0.27	2.74 + 0.30	3.16 ± 1.92	3.08
	Bone	3.73 ± 0.43	5.19 ± 0.46	4.34 + 0.34	4.34 ± 0.28	4.40
	Brain	1.98 ± 0.94	2.36	2.01 + 0.17	1.71 ± 0.19	2.01
Copper	Muscle	0.48 ± 0.14	0.77 ± 0.16	0.22 + 0.03	0.53 ± 0.07	0.59*
	Gills	1.75 ± 0.21	2.40 ± 0.33	0.44 + 0.06	1.52 ± 0.28	1.53
	Liver	28.84 ± 5.40	19.60 ± 7.79	2.76 + 1.13	22.0 ± 16.4	18.30**
	Gonads	29.03 ± 9.03	3.95	0.41 + 0.08	0.91 ± 0.12	8.57
	Skin	1.35 ± 0.16	1.68 ± 0.42	0.65 + 0.21	1.15 ± 0.20	1.21
	Bone	1.55 ± 0.19	1.80 ± 0.18	0.43 + 0.06	1.80 ± 0.45	1.40
	Brain	3.27 ± 0.44	6.01	1.16 + 0.17	2.36 ± 0.14	3.20
Zinc	Muscle	16.20 ± 7.53	12.95 ± 3.90	17.17 + 2.03	14.80 ± 4.62	15.28*
	Gills	20.96 ± 2.80	40.40 ± 5.60	44.64 + 3.43	30.94 ± 1.92	34.23
	Liver	32.18 ± 5.35	23.05 ± 3.20	25.95 + 1.85	22.58 ± 4.47	28.69
	Gonads	59.58 ± 11.04	136.60	58.95 + 13.92	65.72 ± 3.70	86.96**
	Skin	70.50 ± 4.35	62.28 ± 4.94	118.2 + 6.74	68.71 ± 2.49	79.88
	Bone	21.57 ± 3.12	28.87 ± 3.07	46.68 + 2.12	27.57 ± 2.49	31.17
	Brain	78.08 ± 25.12	35.39	23.85 + 3.33	14.99 ± 5.57	42.25

* Minimum Values ** Maximum Values

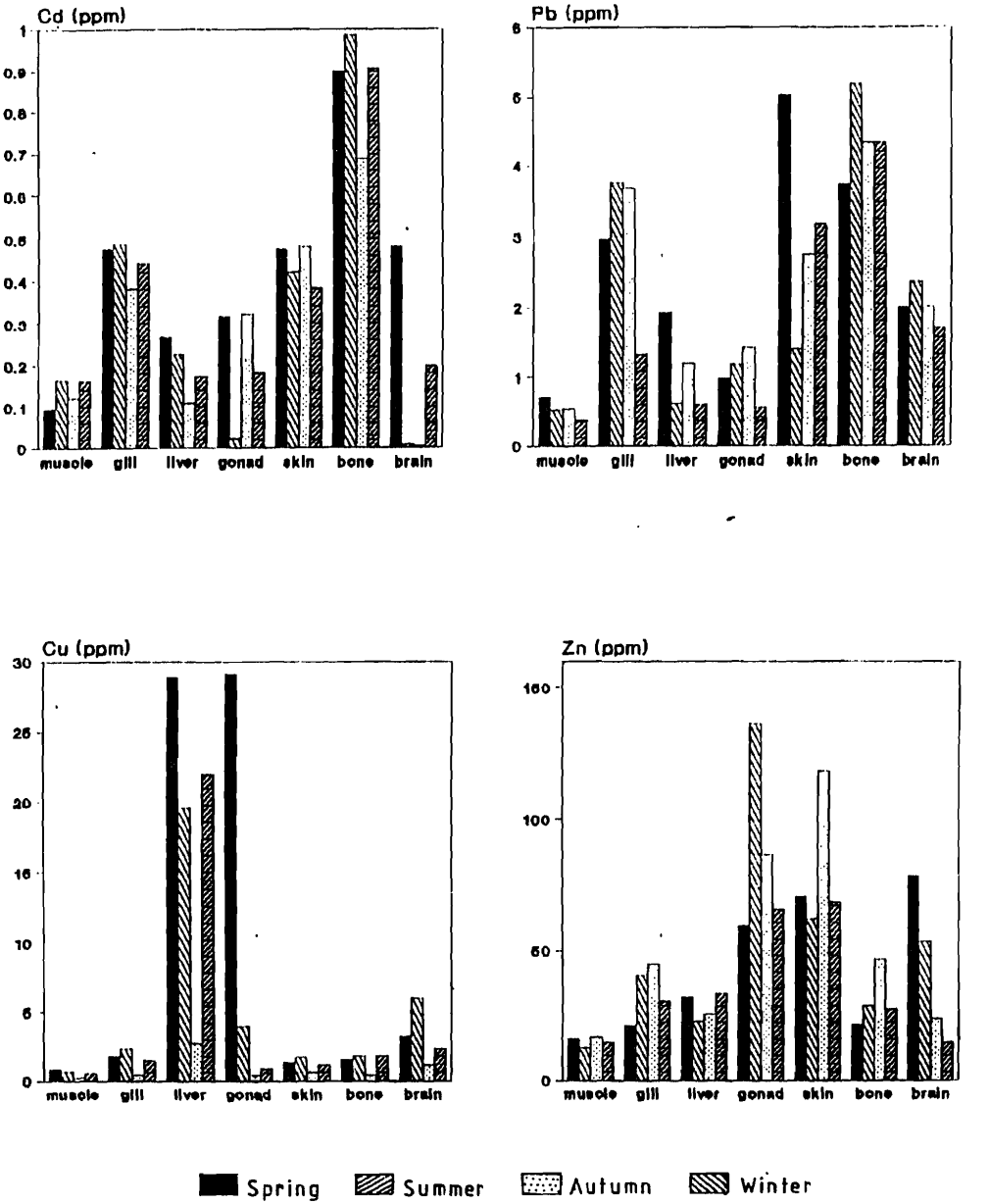


Figure 2: Seasonal variation of Cd, Pb, Cu and Zn in Mugil seheli.

Table (4): Total Lipid contents in organs of (Mugil seheli g %).

Organs	Muscle	Gills	Gonads	Liver	Skin	Bone	Brain
Total Lipids	2.23	2.10	1.18-	6.19	10.15+	10.74+	7.43

- Minimum value + Maximum values

Table (5): Comparison between heavy metals concentrations (mean values) in muscles of Mugil spp. from different sites in Egypt and other parts of the world (ppm wet weight).

Location	Cd	Pb	Cu	Zn	References
Bloubery Strand, South Africa	-	-	-	(-) 4.10	Van As et al., 1973.
Port Durnford, South Africa	0.08	0.71	0.75	-	Connell et al., 1975.
Umegeni Estuary, South Africa	-	-	0.39	4.70	Connell et al., 1975.
Umhlatuana, South Africa	-	-	0.63	4.70	Connell et al., 1975.
Swartkops Estuary, South Africa	(-) 0.06	1.32	0.28	4.43	Oliff & Turner, 1976.
Red Sea Al-Hurgada, Egypt,	-	(+) 7.14	(+) 6.75	(+) 15.56	Abdel-Salam, 1981.
Mediterranean Sea, Izmir Bay, Turkey,	(+) 0.17-0.26	2.90-3.20	0.60-1.11	-	Uysal & Tuncer,1982*.
Suez Canal, Ismailia, Egypt	-	3.62	-	13.04	El-Deek, et. al.,1994a.
Mediterranean Sea, Alexandria, Egypt.	-	2.24	(-) 0.26	-	Emara, et. al., 1993.
Red Sea, Al-Hurgada, Egypt,	-	0.75	0.65	-	Emara, et. al., 1993.
El-Mex Bay, West of Alexandria, Egypt.	0.07	0.55	0.52	4.18	Abdelmoneim, et al.,1994
Suez Bay, Red Sea Egypt.	0.13	(-) 0.54	0.59	15.28	Present Study

* Range Values
(+) Mean Values (maximum)
(-) Mean Values (minimum)

DISCUSSION

According to the literature, heavy metal concentrations are extremely variable in different marine and freshwater organisms (Roberts, 1976; Forstner & Prosi, 1979), depending on the geochemical background and the level of pollution of the given area. Also, the species variations in metals content may depend on the fish activity with respect to uptake of metals from the environment, the feeding mechanism and amount of lipids present in its organs, which vary from one organ to another.

According to the lipids content in fish tissues, the concentrations of studied metals are mostly higher in skin, and bone which are fatty organs as shown in Table (4). Most of metals are usually stored in fatty tissues (Hoar & Randall, 1969). This observation is agreed with that noticed earlier by several authors (Bryan, 1973; Andereotis & Papadopoulou, 1980; El-Nady, 1981).

Fujise et al., (1988) indicated that some metals showed organ - and metal - specific accumulations, and recorded high concentrations of lead and zinc in hard tissues of Dall's Porpoise (marine mammals) as skin and bone. In our results, the highest concentrations of lead and cadmium were observed in hard tissues not only in skin and bone but also in gills. The highest copper was in the liver, while the highest value for zinc was in gonads and skin.

To study the relationships between metals, zinc was chosen to normalize the data. Plots of the metal versus metal / zinc are shown in Fig. (3). It can be shown that most values fall close to the straight line. This demonstrates a direct relationship between zinc and other metals. This result is in agreement with the result which recorded by Hornung & Ramelow, (1987).

Table (5) shows the levels of the studied metals in muscles of Mugil seheli (Present Study) and at different sites in Egypt and other parts of the world. It is easy to notice that, cadmium level (0.13 ppm) falls within the range for the other data present in the table. The lead value is considerably (0.54 ppm) lower than that found in other areas. Copper (0.59 ppm) is nearly similar to that the recently recorded for Red Sea (Hurgada) and higher than that obtained from the Mediterranean Sea (Alexandria). For zinc, the average result for zinc (15.28 ppm) which obtained from the present study is nearly similar to that measured in the Red Sea (Abdel-Salam, 1981) and Suez Canal (El-Deek, et al., 1994a). Most of the heavy metals results which recorded by Abdel-Salam, (1981) is quite high, especially for lead and copper.

Finally, the muscle distribution pattern of heavy metals in Mugil seheli agreed well with those of other fishes of the Red Sea except zinc (Table, 6).

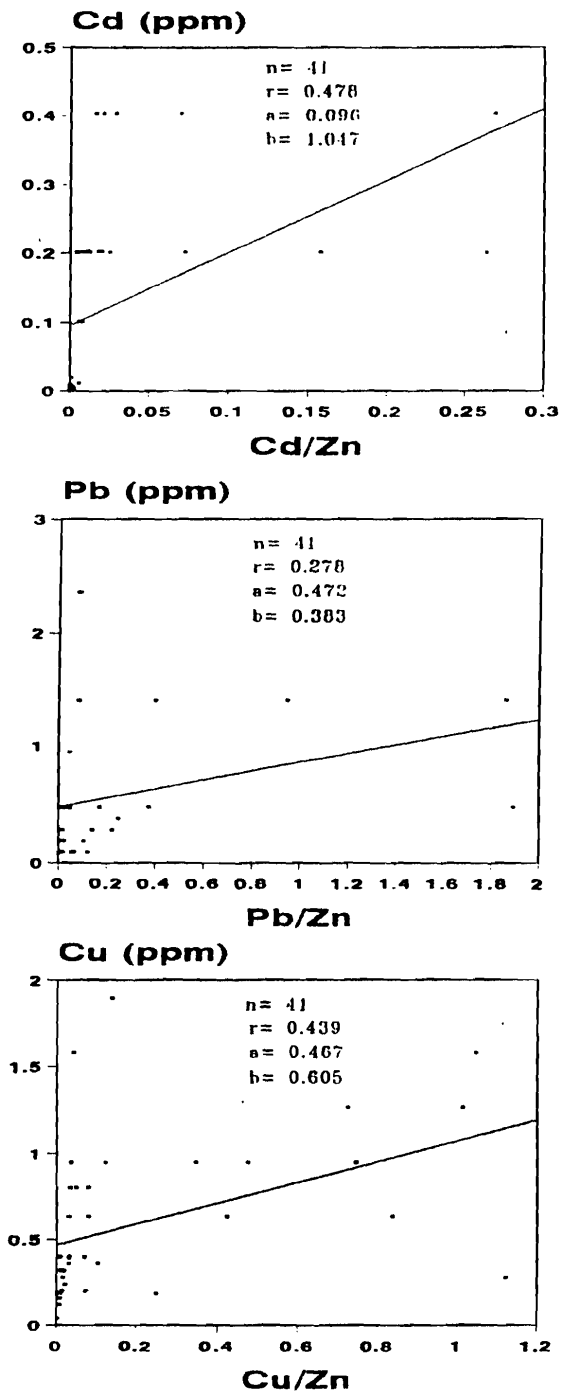


Figure 3: Relationship between metal and metal/zinc in muscle of Mugil seheli.

Table (6): Mean Concentrations of heavy metals in muscles of Red Sea Fishes Fishes (ppm wet weight)

Species	Cd	Pb	Cu	Zn	References
Mugil spp.	-	7.14	6.75	15.56	Abdel-Salam, 1981
Lethrinus spp.	0.45	0.89	0.40	-	Abdelmoneim & El-Deek., 1992
Siganus spp.	-	0.62	0.34	-	Emara et al., 1993.
Cephalopholis spp.	-	0.84	0.71	-	Emara et al., 1993.
Liza ramada	-	0.26	0.68	-	Emara et al., 1993.
Mugil cephalus	-	0.75	0.64	-	Emara et al., 1993.
Epinephelus spp.	0.17	0.53	0.66	3.37	Emara et al., 1993.
Epinephelus spp.	-	-	0.55	4.57	El-Deek, et al., 1994b.
Mugil seheli	0.13	0.54	0.59	15.28	Present Study.

CONCLUSION

From above it is easy to mention that the edible part fish has consistently low level of all heavy metals studied. It is advisable to the consumers to avoid eating other organs rather than flesh (muscle). The level of these metals in the different organs of this fish species is comparable and mostly less than that in fishes from less contaminated areas, reflecting acceptable water quality in Suez Bay.

On the other hand, concentration of heavy metals showed organ - and metal - specific accumulations, as high concentrations of Cd and Pb are found in hard tissues as gills, skin and bone. While, Cu and Zn are high accumulated in soft tissues as liver and gonads respectively.

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