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HEAVY METAL CONTENTS OF SOME MOLLUSCS AND CRUSTACEANS ALONG AL-HODEIDAH RED SEA COAST OF YEMEN

BY

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ABSTRACT

Zn, Cu, Cd, Pb, Cr, Ni, Fe and Mn were analyzed in the muscles of 3 molluscs and 2 crustaceans species which collected from Al-Hodeidah region (SE Red Sea Coast of Yemen).

Low levels of these metals were detected in the two groups of marine animals, but in general, molluscs samples showed the lowest levels of metals.

Finally both of them appears to be useful tool as a bio-indicator for most of the metals studied. On the basis of the recommended standards for metals in the edible tissues they are low enough to cause any public health problems.

INTRODUCTION

The environmental pollution represents a major problem in both developed and un-developing countries. Yemen is one of these countries, which suffers from pollution (Heba, *et al.*, 2000).

There are numerous types of pollutants such as organic materials, major ions and heavy metals which could be introduced to the aquatic environment as a result of urbanization, industrialization and agricultural activities (Al-Khafaji, 1996).

Heavy metals are natural constituents of all environment including the marine ecosystems. Because of their environmental persistence, they have almost no toxicity at low concentration but their ability to be incorporated into food chain it is possible to be concentrated by aquatic organisms (Windom, *et al.*, 1991).

They are usually divided into two subclasses. The first include: Co, Cu, Fe, Mn and Zn which are essential for the correct functioning of biochemical processes, while Hg, Cd, Cr and Pb belong to the second sub-class of metals without any established

biological function and includes the more important contaminants in the aquatic environment (Al-Tace, 1999).

Metals in minerals and rocks are generally harmless and only become potentially toxic when they dissolve in water. They enter into the environment by weathering of rocks, leaching of soils and vegetation, and volcanic activity. Human activities introduce metals to the environment by mining, smelting, combustion of fossil fuel, and industrial wastes disposal (Al-Shawafi, 1997). Most of metal loads is transported by water in a dissolved or particulate state and most of them reaches the ocean via rivers or land runoff (Mourad, 1996). Also rain waters carries significant amounts of Cd, Cu, Zn and especially Pb from the atmosphere to the oceans (Abdelmoneim, 1994).

Heavy metal can be stored and detoxified marine organisms either by a compartment process within membrane-limited vesicles or by binding to specific proteins (Boilis, *et al.*, 1984; FAO/ UNEP, 1992). They exist in all creatures, fauna and flora of some aquatic environments have the ability to accumulate heavy metal in their tissues to high levels above the normal concentrations of the marine environment.

The Main Objective of the Study:

As previously mentioned that there is a lack of informations about the heavy metal levels in the different marine organisms (Fish, Molluscs and Crustaceans) especially in the Yemen coasts. Al-Hodeidah City is considered to be one of the most important marine harbours in the Southeast Red Sea. This area is exposed to several kinds of anthropogenic activities which discharged directly to the Red Sea. Therefore, the present study is aimed to:

To assess if the concentration of the heavy metals which accumulated in marine organisms particularly the edible ones (Crustaceas and Mollusca) has reached to undesirable level, hazard to public health or not.

MATERIALS AND METHODS

Samples of organisms were collected in winter and summer 2001 from 3 sites located on the Red Sea coast of Yemen (Al-Hodeidah region). Fig. (1).

1. Molluscs:

Three species of molluscs were collected during the period of study namely: *Tibia insulaechorab, Stromus fasciatus* and *Murex ternispina.* Each composite sample consisted of at least 10 uniform size (muscles only) were oven-dried and grinded prior to analysis.

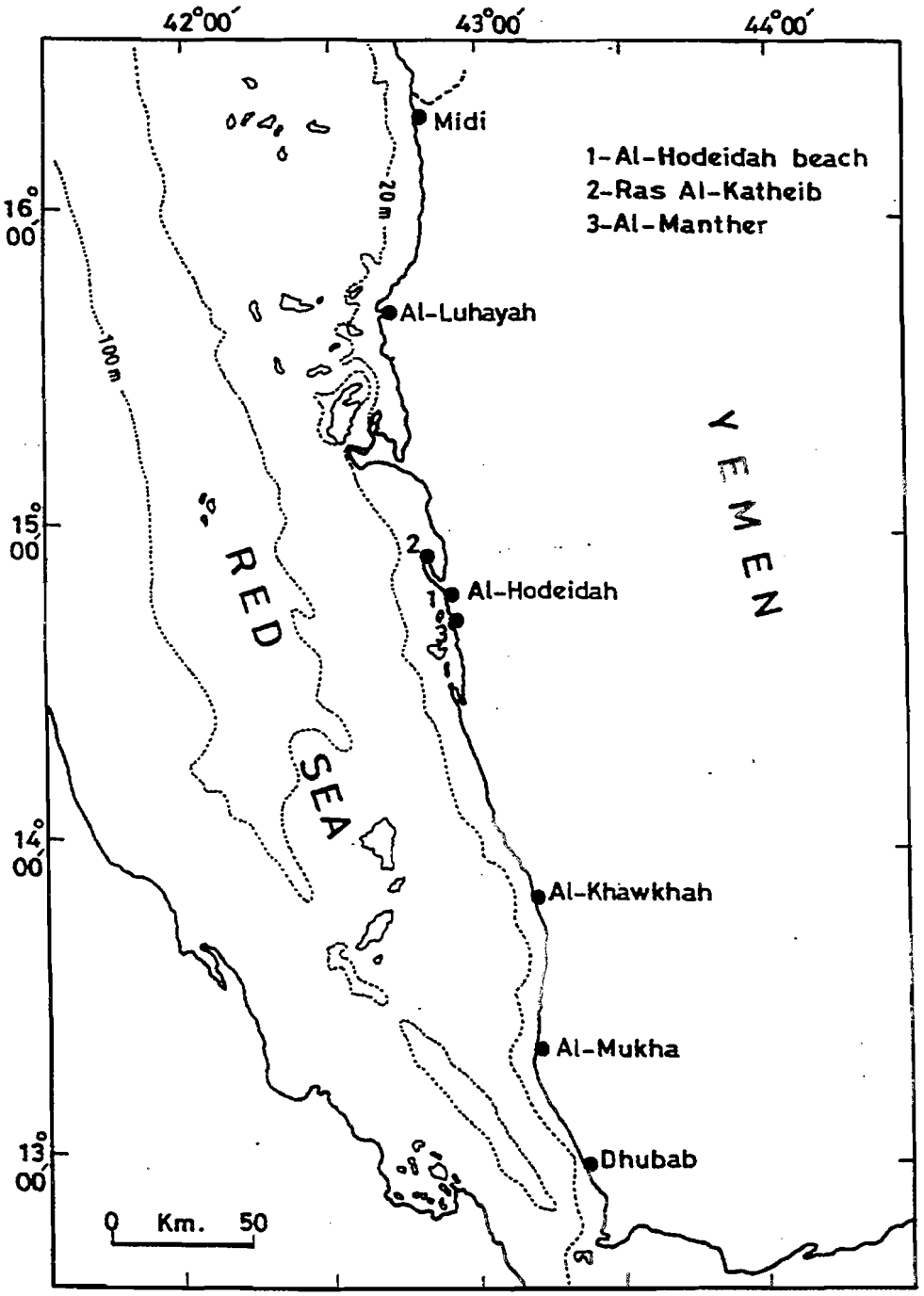

Fig.(1): Map shows the coastal area around Al-Hodeidah city.

2. Crustaceans:

Two species of crustaceans, the shrimp *Penaeus semisulcatus* and crab (Abo Makas) *Portunus pelagicus*. The fresh muscles of each species were oven-dried and grinded before analysis.

The analyses were carried out according to FAO/UNEP (1992); FAO (1994). In this procedure, an exact weight of dry samples were placed in teflon cups and 4 ml of Analar concentrated nitric acid was added to each sample. The cups were covered and placed on the steel-block which was closed tightly. The samples allowed to digested at room temperature overnight, then digestion was faciliated using a hot plate at 100°C for two hours. The samples were cooled to room temperature and transferred to 25-ml volumetric flask. If the solution was not clear, it was reheated for another 60 min. at 100°C. The concentrations of heavy metals: Zn, Cu, Cr, Cd, Fe, Mn, Ni and Pb were measured with a Perkin-Elmer 2380 atomic absorption spectrophotometer. Results were expressed in μg/g dry wt. of the tissue (muscle).

RESULTS AND DISCUSSION

Heavy metals in Molluscs and Crustaceans:

The levels of heavy metals (Zn, Cu, Cd, Pb, Cr, Ni, Fe and Mn) in three molluscs species: (*Tibia insulaechorab, Stromus fasciatus* and *Murex ternispina*) and two species of crustaceans namely: The shrimp *Penaeus semisulats* and the crab *Portunus pelagicus* are shown in Table (1).

Zinc:

(Table 1) shows that, the mean concentration of Zn in *Tibia insulaechorab, Stromus fasciatus, Murex ternispina, Penaeus semisulats* and *Portunus pelagicus* in the winter were: 30.00, 13.00, 25.00, 20.00 and 18.00 (μg/g dry wt), while in summer were: 17.00, 29.50, 13.30, 15.54 and 29.30 (μg/g dry wt) respectively. Also from this table, the highest level 30.00 (μg/g dry wt) were recorded in *Tibia insulaechorab* in winter and the lowest 13.00 (μg/g dry wt) was detected in *Stromus fasciatus* in the same season. The seasonal variations of mollusks species showed that, the higher concentrations were in winter when compared with summer, except in *Stromus fasciatus* and *Portunus pelagicus*.

Copper:

As shown in (Table 1), the concentrations of Cu in *Tibia insulaechorab, Stromus fasciatus, Murex ternispina, Penacus semisulats* and *Portunus pelagicus* were: 4.00, 3.60, 1.90, 4.00 and 3.00 (μg/g dry wt) in winter while in summer, the mean concentration of Cu found in the same species were: 11.13, 8.78, 8.25, 6.49 and 10.96 (μg/g dry wt) respectively.

Table (1): Range and mean concentrations ± SE of heavy metals (µg/g dry weight) in molluscs and crustaceans samples collected from Al-Hodeidah Red Sea Coast of Yemen

Species		Season	Zn	Cu	Cd	Pb	Cr	Ni	Fe	Mn
I	Range	W	29.50 - 30.50	3.98 - 4.01	2.99 - 3.01	2.09 - 2.11	1.58 - 1.61	1.59 - 1.61	7.18 - 7.22	2.09 - 2.11
		S	16.70 - 17.20	11.11 - 11.15	0.55 - 0.65	2.79 - 2.84	1.53 - 1.58	0.24 - 0.28	5.53 - 5.60	0.82 - 0.87
	Mean	W	30.00 ± 0.223	4.00 ± 0.005	3.00 ± 0.003	2.10 ± 0.004	1.60 ± 0.007	1.60 ± 0.004	7.20 ± 0.007	2.10 ± 0.003
		S	17.00 ± 0.152	11.13 ± 0.011	0.60 ± 0.028	2.82 ± 0.015	1.56 ± 0.015	0.26 ± 0.007	5.56 ± 0.015	0.84 ± 0.015
II	Range	W	12.70 - 13.30	3.59 - 3.61	2.98 - 3.01	1.49 - 1.51	1.58 - 1.61	1.49 - 1.51	6.99 - 7.01	1.19 - 1.21
		S	9.20 - 29.80	8.76 - 8.80	3.15 - 3.25	3.46 - 3.49	1.94 - 1.98	0.30 - 0.34	11.12 - 11.16	1.00 - 1.02
	Mean	W	13.00 ± 0.109	3.60 ± 0.003	3.00 ± 0.005	1.50 ± 0.003	1.60 ± 0.005	1.50 ± 0.004	7.00 ± 0.007	1.20 ± 0.003
		S	29.50 ± 0.173	8.78 ± 0.015	3.20 ± 0.028	3.48 ± 0.01	1.96 ± 0.011	0.32 ± 0.007	11.14 ± 0.015	1.01 ± 0.005
III	Range	W	24.10 - 29.90	1.89 -1.92	1.99 - 2.01	1.19 - 1.21	1.19 - 1.51	1.49 - 1.51	5.48 - 5.51	0.49 - 0.52
		S	13.00 - 13.60	8.23 - 8.27	4.00 - 4.30	2.70 - 3.10	2.85 - 3.00	0.27 - 0.29	8.88 - 9.92	0.93 - 0.98
	Mean	W	25.00 ± 0.392	1.90 ± 0.007	2.00 ± 0.003	1.20 ± 0.004	1.20 ± 0.003	1.50 ± 0.003	5.50 ± 0.005	0.50 ± 0.005
		S	13.30 ± 0.173	8.25 ± 0.011	4.15 ± 0.10	2.90 - 0.115	2.91 ± 0.044	0.28 ± 0.003	9.24 ± 0.343	0.90 ± 0.015
IV	Range	W	19.90 - 20.00	3.99 - 4.01	3.59 - 3.61	2.29 - 2.32	1.79 - 1.81	1.98 - 2.02	7.79 - 7.82	2.19 - 2.21
		S	14.75 - 15.95	6.46 - 6.52	3.70 - 3.90	3.24 - 3.28	2.20 - 2.30	1.47 - 1.51	11.35 - 11.41	0.23 - 0.27
	Mean	W	20.00 ± 0.044	4.00 ± 0.004	3.60 ± 0.004	2.30 ± 0.005	1.80 ± 0.004	2.00 ± 0.006	7.80 ± 0.005	2.20 ± 0.004
		S	15.54 ± 0.391	6.49 ± 0.017	3.80 ± 0.054	3.26 ± 0.011	2.25 ± 0.028	1.49 ± 0.006	11.39 ± 0.017	0.25 ± 0.011
V	Range	W	17.80 - 18.20	2.98 - 3.02	2.48 2.52	1.99 - 2.01	1.29 - 1.32	1.38 - 1.42	6.19 - 6.21	1.49 - 1.51
		S	29.00 - 29.50	10.94 - 10.98	4.50 - 4.70	3.50 - 3.57	2.17 - 2.38	1.28 - 1.32	5.90 - 5.94	0.85 - 0.97
	Mean	W	18.00 ± 0.007	3.00 ± 0.007	2.50 ± 0.007	2.00 ± 0.004	1.30 ± 0.005	1.40 ± 0.007	6.20 ± 0.003	1.50 ± 0.003
		S	29.30 ± 0.152	10.96 ± 0.011	4.60 ± 0.057	3.53 ± 0.02	2.30 ± 0.065	1.30 ± 0.007	5.92 ± 0.011	0.90 ± 0.036

I = *Tibia insulaechorab*
II = *Stromus fasciatus*
III = *Murex ternispina*
} Molluscs,

IV = *Penaeus semisulcats*
V = *Portunus pelagicus*
} Crustaceans

W = Winter S = Summer

It is also found, the highest value 11.13 (µg/g dry wt) was recorded in *Tibia insulaechorab* in summer, and the lowest one 1.90 (µg/g dry wt) was in *Murex ternispina* in winter. Regarding to seasonal variation it was found that there were higher concentrations of the Cu in sum mer compared with its concentration in winter.

Cadmium:

The mean concentrations of Cd in both molluscs and crustaceans under taken species this study the values were: 3.00, 3.00, 2.00, 3.60 and 2.50 (µg/g dry wt) in winter, and 0.60, 3.20, 4.20, 3.80 and 4.60 (µg/g dry wt) in summer respectively.The highest value 4.20 (µg/g dry wt) in in *Murex ternispina* and the lowest one 0.60 (µg/g dry wt) in *Tibia insulaechorab* in summer. Similarly, the high concentration was found in summer when compared with winter. The only exception was found in *Tibia insulaechorab* (Table 1).

Lead:

The mean concentrations of Pb in the above mentioned species have values 2.10, 1.50, 1.20, 2.30 and 2.00 in winter and 2.82, 3.48, 2.90, 3.26 and 3.53 (µg/g dry wt) in summer respectively.The highest value 3.53 (µg/g dry wt) in *Murex ternispina* in summer and the lowest one 1.20 (µg/g dry wt) in *Murex ternispina* in winter (Table 1).

Chromium:

The mean concentrations of Cr were detected in molluscs and crustaceans is shown in (Table, 1) were: 1.60, 1.60, 1.20, 1.80 and 1.30 (µg/g dry wt) in winter, and 1.56, 1.96, 2.91, 2.25 and 2.3 (µg/g dry wt) in summer respectively.The highest value 2.91 (µg/g dry wt) was found in *Murex ternispina* in summer, at the lowest one 1.20 (µg/g dry wt) in winter. The seasonal variations was found to be of higher concentration in summer than in winter. The only exception was in *Tibia insulaechorab* (Table 1).

Nickel:

Similarly, (Table 1) includes, the mean concentrations of Ni in muscles of *Tibia insulaechorab*, *Stromus fasciatus, Murex ternispina*, *Penaeus semisulcats* and *Portunus pelagicus* (1.60, 1.50, 1.50, 2.00 and 1.40 µg/g dry wt) in winter and (0.26, 0.32, 0.28, 1.49 and 1.30 µg/g dry wt) in summer respectively. The highest value (2.00 µg/g dry wt) was recorded in the muscles of *Penaeus semisulcats* in winter, and the lowest one (0.26 µg/g dry wt) was recorded in *Tibia insulaechorab* in summer.

Iron:

(Table 1) shows the mean concentrations of Fe which detected in *Tibia insulaechorab*, *Stromus fasciatus*, *Murex ternispina* and *Penaeus semisulcats* and *Portunus pelagicus*. (7.20, 7.00, 5.50, 7.80 and 6.20 µg/g dry wt) were recorded in winter and (5.56, 11.14, 9.24, 11.39 and 5.92 µg/g dry wt) in summer respectively.

The highest value (11.39 µg/g dry wt) was measured in *Penaeus semisulcats* in summer and the lowest one (5.50 µg/g dry wt) in *Murex ternispina* in winter.

Manganese:

The mean concentrations of Mn in the previously mentioned species which were: 2.10, 1.20, 0.50, 2.20 and 1.50 (µg/g dry wt) in winter, and 0.84, 1.01, 0.90, 0.25 and 0.90 (µg/g dry wt) in summer respectively.The highest concentrations of 2.20 (µg/g dry wt) in the muscles of *Penaeus semisulcats* were found in winter, and lowest concentrations of 0.25 (µg/g dry wt) in *Penaeus semisulcats* in summer also. The only exception was found in *Murex ternispina* (Table 1).

Generally, the three species of molluscs and the two species of crustaceans showed that the concentration of Zn seem to be the highest one when compared with other elements. While among the molluscs *Tibia insulaechorab* acquired the highest concentration. However, the crab *Portunus pelagicus*, had the highest concentrations of Zn when compared with the majority of tested crustacean species.However, the concentrations of Cu and Fe could be given the second order after Zn. It was found that *Tibia insulaechorab* and *Portunus pelagicus* have the highest concentration of Cu among the other while species *Penaeus semisulcats* and *Stromus fasciatus* acquired the highest concentrations of Fe among all examined species.

Although, Cd and Pb concentrations in all samples show significant differences, however, the only exception was found that Cd in the *Tibia insulaechorab* in summer. The highest concentrations of Cd and Pb may be due to the high content of lipid in these species e.g. age and other physiological factors (Heba and Al-Mudaffer, 2000). While *Murex ternispina* had the highest concentration of Cd among the other species. However, *Penaeus semisulcats* and *Stromus fasciatus* had the highest concentrations of Pb among the remaining species.The lower concentrations of Ni and Mn observed in this study might be attributed to the lower population and industrial activities. The same conclusion have been recently recorded by (Heba and Al-Mudaffer, 2000).

For comparing (Table 2), Hashim, *et al.*, (1994) studied the levels of heavy metals in Pearl Oyster *Pinctada radiata* from Bahrain. They found that, the seasonal distribution of metals in oysters and waters increased during the hot summer months. Our findings nearly gave the same result. Pastor *et al.*, (1994), determined the levels of Cd and Pb in 31 different species of marine organisms (Molluscs and Crustaceans) from the Spanish Mediterranean shores. The concentrations of these metals were compared in different marine organisms in order to describe their potential as bio-indicators for pollution.

Moreover, the levels of heavy metals concentration in molluscs and crustaceans species in this study is compared with other values of the world. It was found that the results which obtained from this investigation are within the range of the other studies in the different regions of the world (Tables 2, 3).

Finally, the correlation between the different heavy metals in crustaceans and molluscs are shown in Table (4). From this table, it clear that there are some highly positive correlation between metals (Cu with Pb; Cr with Cd and Pb). Also, a positive correlation is found between Cu with Cr; Fe with Pb and Cr. On the other hand, there are a negative correlation between Ni with Cu and Pb.

CONCLUSION

Aquatic biota are particularly a good indicators for heavy metals pollution but some time the different species have different affinities for certain metals uptake.The differences found in the concentration of metals among the various biological biotic species reflect, no local environmental differences, but could be attributed to specific species mechanisms.

If we comparing our findings with the other areas, heavy metals pollution in Al-Hodeidah coast is still localized with pronouncedly low levels.Finally, monitoring program is needed and further studies are also necessary in the near future in order to follow up the fate of discharged effluents into the marine ecosystem. This study is considered as a preliminary step for initiating a good management program for this important area in Yemen.

Table (2): Comparison between range and mean concentrations (µg/g dry weight) of heavy metals in molluscs samples from Al-Hodeidah Red Sea Coast of Yemen with other values in the world

Location	Zn	Cu	Cd	Pb	Species	References
Gulf La speiza, Italy	203 - 379	6.90 - 33.0	2.00 - 6.80	----	*Mytilus gallaprovincialis*	Capelli *et al.*, (1978)
Barcelona coast Spain	-	6.87* - 76.80*	0.26* - 0.54*	7.60* - 178.00*	*Mytilus galloprovincialis*	Obilos, *et al.*, (1980)
Gdansk bay, Poland Baltic Sea	130.00	11.50	180	17.00	*Mya arenaria*	Poiter, (1986)
SE Mediterranean Sea Alexandria coast, Egypt	39.00	28.30	-	13.50	*Donax tranculus*	Ghazaly, (1988b)
NW Mediterranean Sea, Spanish coast, Spain	-	-	3.50*	0.38*	*Murex brandaris*	Pastor, *et al.*, (1994)
	-	-	0.4*	0.98*	*Patella caerulea*	
	-	-	0.22*	0.74*	*Mytilus galloprovincialis*	
	-	-	0.04*	0.36*	*Donax vittatus*	
Arabian Gulf, Bahrain	8.70 - 383.80	1.41 - 1.63	0.90 - 2.48	5.90 - 7.64	*Pinctada radiata*	Hashim, *et al.*, (1994)
Ensenada del popellon Lagoon, Mexico	140.50	9.32	1.63	----	*Mytilus strigata*	Peaz, *et al.*, (1994)
South Australia	124 - 282	3.00 - 4.80	1.30 - 4.30	0.60 - 24.00	*Mytilus edulis*	Richardson, *et al.*, (1994
Aden Gulf, Yemen	10.20 - 120.30	2.10 - 25.30	0.60 - 1.90	9.80 - 23.70	*Tivela ponderosa*	Heba, *et al.*, (2000)
Al-Hodeidah Red Sea Coast, Yemen	17.00 - 30.00	4.0 - 11.13	0.60 - 3.00	2.10 - 2.82	*Tibia insulaechorab*	Present study
Al-Hodeidah Coast, Yemen	13.00 - 29.50	3.60 - 8.78	3.00 - 3.20	1.50 - 3.48	*Stromus fasciatus*	Present study
Al-Hodeidah Coast, Yemen	13.30 - 25.00	1.90 - 8.25	2.00 - 4.15	1.20 - 2.90	*Murex ternispina*	Present study

* =µg/g fresh wt.

Table (3): Comparison between mean concentrations (μg/g dry weight) of heavy metals in crustaceans samples from Al-Hodeidah Red Sea Coast of Yemen with other values in the world

Location	Zn	Cu	Cd	Pb	Species	References
SE Mediterranean Sea Alexandria Coast, Egypt	18.60	33.40	14.60	1.30	*Penaeus kerathurus*	Ghazaly, (1988a)
	30.30	39.10	12.20	2.10	*Parapenaeus longirostris*	
	19.50	25.00	18.20	2.20	*Portunus pelagicus*	
NW Mediterranean Sea, Spanish coast, Spain	-	-	0.08*	0.16*	*Aristeomorpha antennatus A. foliacea*	Pastor, *et al,* (1994)
	-	-	0.04*	0.06*	*Penaeus kerathurus*	
SE Red Sea, Al-Hodeidah Coast, Yemen	17.77	5.25	3.70	2.78	*Penaeus semisulcats*	Present Study
	23.65	6.98	3.55	2.77	*Portunus pelagicus*	Present Study

* =μg/g fresh wt.

Table (4): The correlation coefficient between heavy metal in mollusks and crustaceans sample

Metals	Zn	Cu	Cd	Pb	Cr	Ni	Fe	Mn
Zn	1.00	----	----	----	----	----	----	----
Cu	0.096	1.00	----	----	----	----	----	----
Cd	-0.306	0.211	1.00	----	----	----	----	----
Pb	0.185	0.851**	0.274	1.00	----	----	----	----
Cr	-0.178	0.578*	0.834**	0.703**	1.00	----	----	----
Ni	0.094	-0.704**	-0.348	-0.498+	-0.391	1.00	----	----
Fe	-0.091	0.165	0.356	0.543*	0.570*	-.226	1.00	----
Mn	0.213	-0.348	-0.094	-0.268	-0.248	0.406	-0.206	1.00

** P = 0.01
* P = 0.05
+ P < 0.05

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