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Original Contribution

HEAVY METAL CONCENTRATIONS IN ROCK OYSTER *SOCOSTREA CUCULLATA* FROM IRANIAN COASTS OF THE OMAN SEA

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Abstract
Heavy metals are persistent pollutants in aquatic ecosystems. They are not biodegradable and due to this property they can enter food chains or accumulate in aquatic invertebrates. Marin bivalves, such as oysters are usually used for biomonitoring and evaluating of the ecosystems health. This study was carried out to measure Cu, Pb and Ni concentrations in soft and hard tissues of rock oyster distributed in intertidal zone of Iranian coasts along the Oman Sea. Oysters were collected from five different stations and digested using concentrated nitric acid and metal concentrations were measured using Atomic Absorption Spectrophotometer. Results showed that Cu, Pb and Ni concentrations in the soft tissues ranged from 84.96 to 371.16 µg/g, 3.83 to 5.26 µg/g and 6.05 to 7.19 µg/g respectively. Similarly metal concentrations in the shells ranged from 14.16 to 16.67 µg/g, 11.30 to 14.92 µg/g, and 5.47 to 7.97 µg/g. concentrations of Cu in soft tissue was found to be much more higher than shells, while Pb concentrations in shells was higher than the soft tissues, suggesting that metals accumulations in different tissues is dependent to their essentiality to the oyster. Generally, metals concentration in the soft tissues of studied oyster was found to be higher than available standards. From the results, regular and more detailed monitoring studies in the study area are recommended.

Key word: heavy metal, *Saccostrea cucullata*, intertidal zone, Oman Sea, Atomic absorption spectrofotomiter, Cu, Pb, Ni

INTRODUCTION

Heavy metals enter marine ecosystems by different processes such as mining, volcanic activities, river discharges and atmospheric deposits. They are not bio-degradable and are classified as persistent components of ecosystems (1). Dissolved metals might be taken up by living organisms and accumulate in their tissues (2). Heavy metal accumulation by aquatic organisms is considered as a non-reversible processes in many cases, and this phenomenon could result in biomagnifications of metals in upper trophic levels. Consumption of metal rich organisms could transfer biomagnified metals to human (3-4) and threat human health as well. (5).

Chemical analysis is a common method for measuring of the pollutants in aquatic ecosystems, however such kinds of analysis require continuous sampling and of analysis which are very expensive. In order to determine weather an existing contamination caused any pollution problem or not, there is a need for biomonitoring studies (6). Biomonitors are in contact with their surrounding environment and could reflect any change in heavy metals level occurred in their habitat (7). Mollusks, especially bivalves have been considered as very good biomonitor agents for heavy metals in marine ecosystems (8-10). Bivalves are benthic filter and com accumulates heavy metals in their tissue. They are resistant to physicochemical changes of their environment and tolerate sever environmental conditions. They are also widely distributed in aquatic ecosystems and process simple body structure. Many bivalves do not regulate the level of some metals within their body and are valuable food items for human being. On the other hand many studies have indicated that there is a direct correlation between heavy metals concentration in their tissues and their surrounding environment. All above mentioned characteristics caused bivalves to be considered as good biomonitor

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agents for heavy metal monitoring in aquatic ecosystems (11-15).

Development of human activities along Chabahar coasts have caused this area to be exposed to different kinds of pollutants specially heavy metals. Water discharge by boats and ships, marine transportation and ballast water discharges are main source of pollutants in some locations like Chabahar, Tiss, shahid Beheshti and shahid kalantari ports, while a food factory waste water, industrial and agricultural discharges and dredging are another sources of pollution in some other areas (16). Although bivalves specially *S. cucullata* are widely distributed in this area, but there is a lack of information related to heavy metal content of them. This study was carried out to determine heavy metals (Cu, Pb and Ni) concentrations in soft and hard tissues of *S. cucullata* as an estimation of metals bioavailability in the studied area.

MATERIALS AND METHODS

Study area

Five different stations were studied along Chabahar coasts from Guatr bay to Tiss port **(Figure 1)**. The position and the name of each station and the main human activities in each station are shown in **Table 1**.

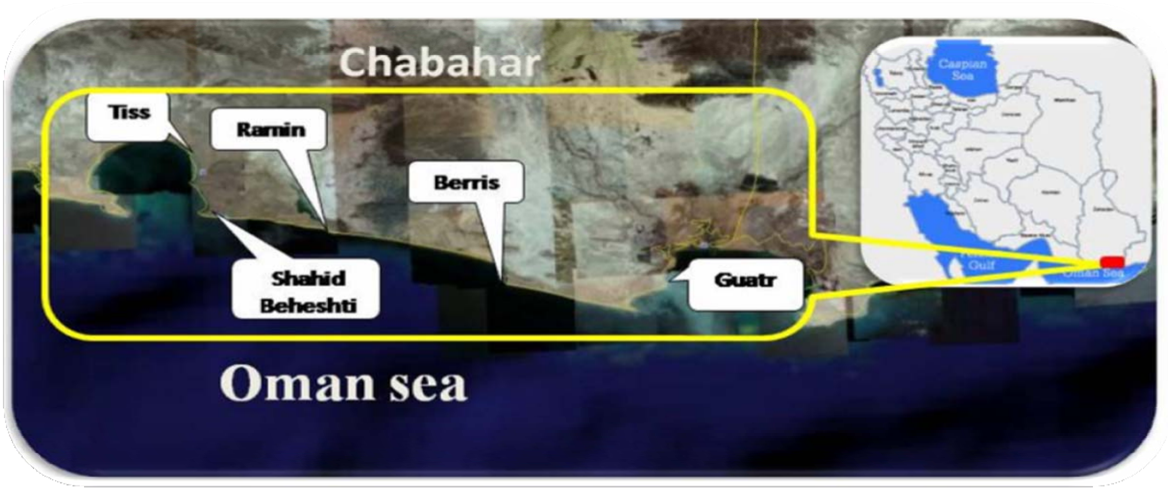

Figure 1. Map showing study area

Table 1. *Position of stations along Chabahar coasts*

station	latitudes	Sources of heavy metal input
Guatr	*" 3/9 ' 30° 61 E* *" 1/53 ' 9 25 N*	Aquaculture and Fishing boats
Beris	*" 6/5 ' 10.3 ° 61 E* *" 55/7 ' 8 ° 25 N*	Port, transportation, food industries, aquaculture, domestic discharges
Ramin	*" 50 ' 44 ° 60 E* *" 3/9 ' 16° 25 N*	Port, transportation, food industries, aquaculture, domestic discharges
Shahid Beheshti	*" 7/12 ' 37 ° 60 E* *" 92/9 ' 21 ° 25 N*	Domestic discharges, Port and transportation
Tiss	*" 5/21 ' 37 ° 60 E* *" 2/39 ' 17 ° 25 N*	Agriculture, aquaculture, domestic discharges

Sampling

Samples of oyster were taken during low tide in February 2007. Thirty oysters of the same size (7.65 to 9.1 cm) were collected from each station. Stainless steel hammer and Rod were used to separate oysters from their surrounding cliffs. The separated and collected oysters were placed in polyethylene containers and transferred to laboratory using Ice box. All of debris's were removed from the shell in laboratory. After washing with double distilled water, the oysters were freezed and in -20c^0 freezer until next step (17).

Sample preparation

In order to dry samples, they were taken from freezer and were placed in laboratory to melt their ice. Soft tissues were separated from the shells using stainless steel knife and both soft and hard tissues were oven dried at 80^{0}C for 3 days until constant weight was obtained (17). The dried samples from each station were then pooled together in order to obtain sufficient amount of tissues for metal analysis. They were powdered using glass mortar and were stored in polyethylene pill boxes until digestion. The oyster shells were also washed using %0.5 nitric acid and oven dried. They then were pooled and powdered and stored as the same procedure as for soft tissues (18).

Heavy metal analysis

Heavy metal analysis for both tissues was performed with the same method. Samples of 1 g from each tissue were digested in pure nitric acid (%65-merck). The samples were predigested first for 1 hour in 40 ^{0}C and then digestion was continued for 3 hours in 140 ^{0}C (19). After digestion, the samples were cooled in laboratory temperature and diluted to certain volume using double distilled water and filtered by filter paper (Whattman 42μ). Heavy metals analysis was performed using an air-acetylene atomic absorption spectrophotometer Unicom model 919.

Data analysis

All data were tested for normal distribution first. In order to compare heavy metal concentrations in soft tissue and shell t-test was used. One way analysis of Variance (ANOVA) was used to find any significant difference between metals concentration in different stations. If significant difference was observed, Turkey post hoc test was used to determine different stations.

RESULTS

Heavy metals analysis in soft tissues and the shell of the oyster revealed that metals accumulation in both studied tissues was performed with the same pattern, although there was no significant difference between Pb and Ni levels in the soft tissue. Results also showed that Cu concentration in soft tissues of oysters was 289.93±30.84, 102.45 ±9.14, 371.1±44.05, 84.96±17.23 , and 195.32±19.65 μg/g for Guatr, Berris, Ramin, Shahid Beheshti and Tiss respectively. Comparison between Cu concentrations in soft tissues showed significant difference between different stations ($P<0.05$). The maximum Cu content of soft tissues was found in Ramin, while the minimum was found in Shahid Beheshti accordingly **(Figure 2)**.

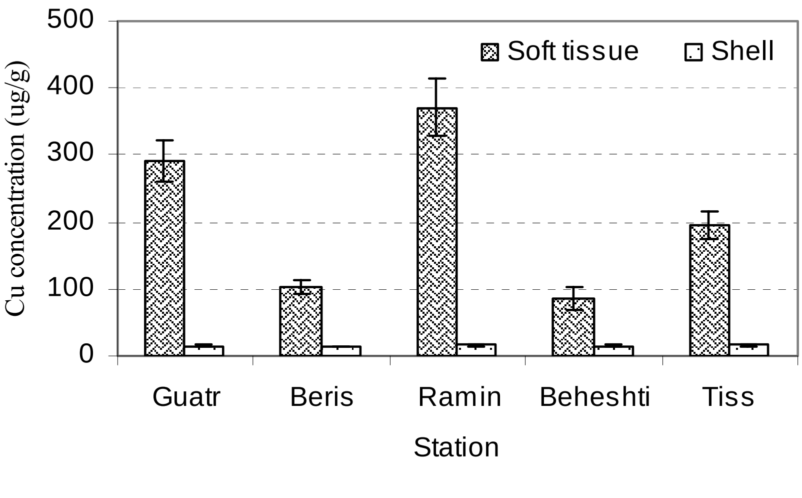

Figure 2. Cu concentration in soft tissue and shell of Oyster *S. cucullata*

The shells contained less amount of Cu compared to the soft tissue. Mean Cu concentration in the shells was 14.92±1.90, 13.83±1.12, 16.67±1.27, 14.16±1.57 and 15.88±1.55 for Guatr, Berris, Ramin, Shahid Beheshti and Tiss respectively. Significant difference was found between Cu concentrations in the shells from different stations ($P<0.05$). Like soft tissue the highest Cu concentration in the shells was found in

Ramin on the contrary the lowest Cu concentration was found in Berris. No significant correlation was found between Cu concentrations in different tissues.

The concentration of Pb in soft tissues of oysters collected from Guatr, Berris, Ramin, Shahid Beheshti and Tiss was 3.83±1.71, 4.26±1.97, 5.26±1.13, 4.70±1.01 and 4.70±0.96 respectively. The difference between Pb concentrations in different stations was significant ($P<0.05$). Therefore the highest Pb level was found in Ramin while the lowest was found in Guatr **(Figure 3)**.

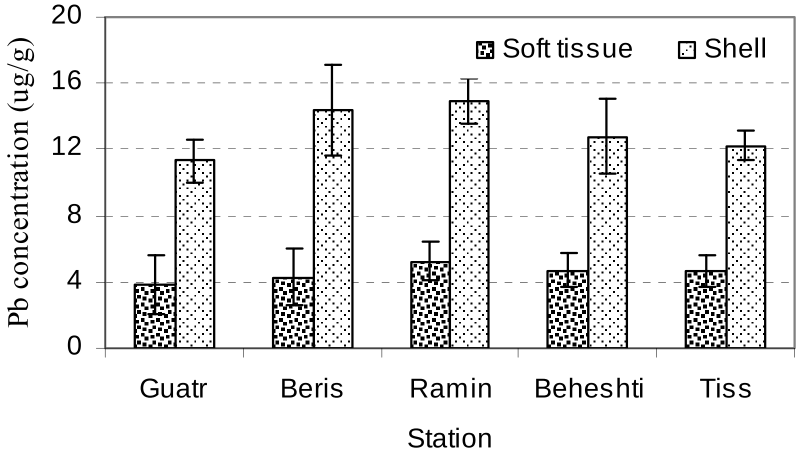

Figure 3. Pb concentration in soft tissue and shell of Oyster *S. cucullata*

Pb concentrations in shell were found to be higher than soft tissue. It was 11.30±1.35, 14.37±2.76, 15.92±1.36, 12.79±2.21 and 12.23±0.85 respectively. Same as soft tissue significant difference was found between Pb levels in the shells collected from different stations and again the highest Pb concentration was belong to Ramin while the lowest was belong to Guatr.

Ni concentrations in soft tissues from different station was found to be significantly different ($P<0.05$). It was 6.40±0.62, 7.19±0.75, 6.94±0.75, 6.07±0.56 and 6.05±0.56 μg/g for Guatr, Berris, Ramin, Shahid Beheshti and Tiss respectively. The maximum Ni level was found in Berris and the minimum was found in Shahid Beheshti. Ni concentration in the shells from different stations was also significantly different ($P<0.05$). Ni concentration in the shell was 5.47±1.28, 7.97±0.48, 7.09±0.71, 6.74±1.24, and 6.09±0.85 μg/g for Guatr, Berris, Ramin, Shahid Beheshti and Tiss respectively. The maximum Ni concentration was found in Berris and the minimum was found in Guatr accordingly **(Figure 4)**.

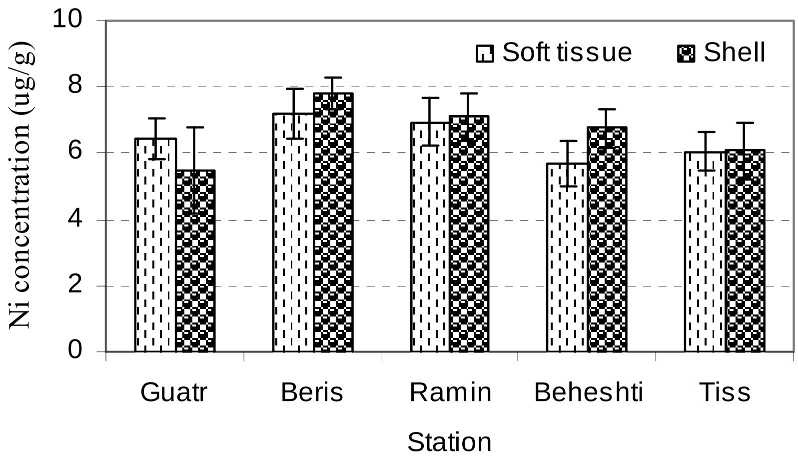

Figure 4. Ni concentration in soft tissue and shell of Oyster *S. cucullata*

DISCUSSION

Results indicated that the pattern of metals accumulation in the soft tissue and the shell of oyster *S. cucullata*,were more or less similar (Cu>Pb>Ni). The orders of metal accumulation in both studied tissues were similar to the finding of previous studies on heavy metal concentrations in bivalves (20-23).

Cu concentration was found to be more in the soft tissues (about 6 to 22 times higher than its level in the shell). Unlike Cu, the concentration of Pb in the shell was about 3 times higher than soft tissues. However Ni concentration between two studied tissues was not significantly different. Cu is known as an essential metal for aquatic organisms (9). These animals use Cu to make haemocyanin which serves as respiratory pigment for bivalves (24). The pattern of metal accumulation in the tissues suggests that animal probably conserves and keeps Cu within its body. While in the case of Pb the condition is reverse. Pb has not any known function in the body of invertebrates (25). Therefore it seems that oyster has no tendency to accumulate the high concentration of Pb in its body. Pb in the ionic form has more to be inclined accumulate in calcareous tissues. The only agreement against the using of oyster shells as a biomonitoring material is the direct adsorption of metals on to the shell surfaces of the oysters. This is because the oyster layer of the shell (periostracum) is in a direct contact with its environmental seawater whereas the soft tissues are within the shell (18). Cravo *et al*., suggested that mollusk species might use their shell for sequestration of a part of up-taken heavy metals. This could be a part of detoxification process of non-essential and excess essential metals which takes part in mollusks (26).

This study indicated that oysters from Ramin contained the highest levels of Pb and Cu among other studied stations. This finding could be due to more availability of mentioned metals in this station. Intense transportation, fishing boats activities, aquaculture being used as residence area and waste discharges in this station could be the most important factors affecting metals level in this area. Zwolsman *et al.,* suggested that low distance between mountain and sea could be an important factor affecting metals concentration in coastal area. The same condition exists in station Ramin where the mountain is very close to the sea (27).

Oysters from station Guatr were found to accumulate lower concentration of metals within both their soft and hard tissues. This shows lower metal bioavailability in that station. In this area human activities and industrial development are lower compared to other stations in the studied area. This means that metals from anthropogenic source are less present in the environment therefore the availability of metals to oysters is minimum in this station. Another factor which could affect metals availability in the aquatic ecosystem is variation in physicochemical properties of the environment. De Mora *et al*., studying metals concentration in *S. cucullata* found that oysters from more polluted stations contained less amount of Ni in their body. They suggested that this reverse observation in related to change in physicochemical parameters of the studied stations (20).

Result of the present study is compared to others in table 2. According to the results mean Cu concentration in the soft tissues of *S. cucullata* found in this study was very close to previous studies and falls within their range. Although Cu and Ni concentration does not seem to be problematic in terms of human consumption, yet caution should be made about their consumption since Pb level in their soft tissue is considerable.

CONCLUSION

This study showed that *S. cucullata* accumulates different metal in body tissues with different pattern. The pattern of metal accumulation could be related to the biological role of that metal in the body. Essential metals are mostly accumulate in soft tissues while, non-essential or less essential ones mostly goes to the shell. Shell tissue might be act as a site for metal deposit. Generally Cu concentration in *S. cucullata* was found to be quite high but this could be related to essentiality of Cu. Therefore it seems that oyster has no tendency to accumulate the high concentration of Pb in its body. The concentration of Ni in soft tissue was moderate which means Ni availability in the studied area is not very high. While metal concentrations in the tissues of oysters collected from Ramin were found to be higher among other stations, the level of metals in *S. cucullata* steal is not critical. Pb concentrations in the soft tissue indicate considerable availability of this metal for *S. cucullata*. Therefore regular monitoring study is needed to be performed especially in the case of Pb. More detailed study is recommended to evaluate *S. cucullata* as biomonitor agent for metal pollution in Chabahar coasts.

Table2. *Comparision of metals concentrations in S. cucullata from Chabahar coasts with some other species from different parts of the world*

Spicies	Location	Cu	Pb	Ni	Refrence
Pinctata margaritifera	Basque coast (North Spain)	417	4.25	4.96	28
Crassostrea rizophora	Potengi estuary (Brazil)	49	---	2.08	29
Crassostrea gigas	Meditranian coasts	55	0.2	---	30
Crassostrea gigas	Ussurigsky bay (Spain)	250.1	0.9-3	---	31
Crassostrea gigas	Amursky bay (Japan)	249.1	33.55	1.8-3	22
Crassostrea gigas	Morrocan bay (North Atlantic)	24.1	6.7	47.4	10
Saccostrea camercialis	Australian coasts	70	2.9	---	32
Saccostrea virginica	Hong kong coasts	422	---	---	3
Saccostrea virginaca	Hong kong coasts	120	4	2.5	33
Saccostrea cucullata	China coasts	332	11.6	8.80	23
Saccostrea cucullata	Hong Kong coasts	223.93	3.8	3.95	34
Saccostrea cucullata	Hong Kong coasts	323	- - -	- - -	3
Saccostrea cucullata	Qatar coasts	63.8	0.25	1.12	20
Saccostrea cucullata	Oman coasts	276	0.67	3.14	20
Saccostrea cucullata	Oman coasts	232	2.2	1.69	21
Saccostrea cucullata	Persian Golf	- - -	- - -	6.33	35
Saccostrea cucullata	Hormoz island Iran	203.5	- - -	8.9	36
Saccostrea cucullata	**Chabahar coasts**	**208.86**	**4.55**	**6.45**	**Present study**

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