Int. J. Mar. Sci. Eng., 1(1), 51-58, Autumn 2011

A survey on the accumulation of heavy metals as indicator of oil pollution index (Vanadium and Nickel) in bivalve rock oyster (*Saccostrea cucullata*) in Qeshm Island coasts

*A. Mashinchian Moradi, *M. Jalali Mosallam, M. R. Fatemi*

Marin Biology Department -Graduate School of Marine Science and Technology- Islamic Azad University (Science & research) Branch – Tehran,I.R.Iran

Received 23 June 2011; revised 11 July 2011; accepted 30 August 2011

ABSTRACT: In this study, the amount of nickel and vanadium elements in the soft tissues of rock oysters (Saccostrea cuculata) and sea water from coastal areas of Qeshm Island, the biggest island of Persian Gulf located in the south of Iran, were measured to evaluate the contamination of the aquatic environment and organisms. Following the bioassay, weighing and chemical digestion of the samples, finally the amount of nickel and vanadium in the soft tissues of the oysters and sea water samples were measured via the ICP system. The results indicated that the average concentration of nickel and vanadium found in the sea water were respectively: 15.7 and 37.9 micro grams per liter and in the soft tissues of oyster: 2.44 and 1.91 mg per kg respectively. In comparison with the FDA and WHO standards, only the concentration of nickel in the soft tissues of oysters was in a permitted level, and the rest exceeded the permitted levels. The average concentration of metals in the north side of the island were more than that found in south of the island but this difference was not statistically significant ($p > 0.05$).

Keywords: *contamination, roky oyster, rocky coasts, nickel, vanadium, Qeshm Island*

INTRODUCTION

Persian Gulf is one of the world's most important connecting ways in relation to oil exploitation and transport, which due to improper arrangements is considered among the most contaminated aquatic regions of the world. The southern coasts and islands of Iran located in this area are constantly exposed to various pollutants entering into the marin environment due to human activities and oil transfers(Shah Hosseini, 1993; Jafari Valadani, 1997). The island of Qeshm is the largest in the Persian Gulf in North and East (Fig. 1).
Coasts of this island habitat of are resort to a variety of aquatic organisms among which rocky oysters can be cited (Bolukbashi, 2001). Since entry and accumulation of pollutants in water and sediments cause uptake by aquatic organisms (such as oysters), then are exposed to various pollutants and accumulation of heavy elements (Afyooni and Dabiri, 2000).
Behbahani (1995) has conducted a research suggesting pollution from heavy metals must be kept under control.
considering the nutritional and economical value of rock oyster, it is essential to determine the amount and absorption of heavy metals in them and compare the results with international standards, so that appropriate strategies are proposed to prevent the destruction of marine ecosystems and important profitable organisms of the region (Behbahani, 1995; Sahafi, 2000).

*Corresponding Author Email: *mojganjalali_mo@yahoo.com*

MATERIALS & METHODS

Sampling was carried out during a week-long period, 23rd-27th of February ,2010 from the coastal waters island of Qeshm samples of rock oyster were collected using hammer and chisel (MOOPAM, 1999; Behbahani, 1995). After preliminary studies on the natural habitat of oysters (BU and Olayan, 2006). random sampling of oysters(up to 20) in each station (Table 1) was performed (Fig. 1).
After sampling, the water samples were acidified by nitric acid at the site and preserved in packs in temperature 4 ° C. The oyster samples were coded

and kept in ice boxes at a temperature of -18 ° C and transferred to the laboratory. All stages of sampling and sample preparation followed MOOPAM (1999) instructions

Following the bioassay (total weight, wet tissues weight, dry tissues weight, and shell length) the muscles of the oyster samples were removed and dried at the temperature of 105 ° C, then the samples were powdered. An amount of 1 g of dried samples were homogenized then carefully weighted and poured into a 100 ml test tube, and then 10 ml of concentrated nitric acid were added to the samples. 2 milliliters of hydrogen peroxide (H_2O_2) were also added to all of the samples and they were placed under the hood for half to an hour in the lab temperature.

(Since acidic conditions should be the same for all samples, for samples of less than 0/5 g, 5 ml acid and 1 ml of hydrogen peroxide were added.) Then the samples were heated under the hood on the heater temperature to 90 degrees for 3 hours to be fully resolved in the acid.

After preparation, heavy metals nickel and vanadium in the samples were analyzed by ICP device and the concentration of these elements were determined. The biological accumulation factor using the formula BCF = the metal concentration in the oyster / the metal concentration in water was calculated by means of spss software and statistical tests, Pearson correlation coefficient between metal concentrations in muscles and water were investigated.

RESULTS AND DISCUSSION

The results of analysis of the oyster muscles and sea water samples are shown in the Tables 2 and 3. Bio-aCcumulation Factor (BCF) of two metals (Nickel and Vanadium) is indicated in Table 4.

The results show the highest pollution levels in sea water, regarding metals vanadium and nickel (the standard levels for the above-mentioned metals are available at Table 5 on page 6), respectively at stations 4 and 7 and the lowest water pollution was measured at station 9. The highest level of pollution of soft tissues of oysters to vanadium and nickel was detected respectively at stations 6 and 9 and the lowest pollution in station 2.Average concentration and biological accumulation of studied compounds are illustrated in Figs . 2-7.

Comparison between the values of nickel and vanadium in water and muscles of the oysters with WHO and FDA standards are displayed in Table 5. The results of Pearson correlation test between concentrations of heavy metals nickel and vanadium in water and oyster is shown in Table 6.

Oysters are easily used in marine monitoring works and are being tested for levels of hydrocarbons, heavy metals and other pollutants (karande et al., 1993; Sadiq et al., 1985).

The results indicated the highest water pollution at stations 4 and 7 and the lowest water pollution at station

Fig. 1: Location of the sampling stations in Qeshm Island

Table 1: Sampling stations profile; inclusive of stations name and their geographical location

Row	Station Name	Geographical location	Longitude and Latitude	Presence of the Oyster in the Area
1	Cinema Darya	South Coast	N26 57 11.32 E56 16 38.66	*
2	Simin Beach	South Coast	N26 55 38 E56 13 47.4	*
3	Bioteknolozhi	South Coast	N26 51 26 E56 0.8 54.8	*
4	Sheeb deraaz	South Coast	N26 41 8 E55 55 10.8	-
5	Salakh	South Coast	N26 41 51.2 E55 47 18.3	-
6	Basaeidoo	North Coast	N26 35 31.5 E55 16 26.5	*
7	Western Chahoo	North Coast	N26 41 39.4 E55 29 6.1	*
8	South Laft	North Coast	N26 55 41.5 E55 48 46	*
9	West Kave Pier	North Coast	N26 56 15 E55 57 31.54	*

Table 2: Average concentrations of nickel and vanadium in sea water (μg/l)

Station Name	Station Number	Average Concentrations of Nickel in Water (ppb)	Average Concentrations of Vanadium in Water (ppb)
Cinema Darya	1	14.65	36.93
Simin Beach	2	14.39	38.64
Bioteknolozhi	3	20	39.32
Sheeb deraaz	4	7.08	39.49
Salakh	5	2.62	37.74
The Average Concentration in the South of the Island		11.748	38.51
Basaeidoo	6	11.74	39.6
Western Chahoo	7	56.54	37.41
South Laft	8	14.02	38.41
West Kave Dock	9	0.61	34.53
The Average Concentration in the North of the Island		20.72	37.48
	Average	15.73	37.91
	Minimum	0.61	34.53
	Maximum	56.54	39.94
	Standard Deviation	16.51	1.66

Table 3: Average concentrations of nickel and vanadium in oyster soft tissues mg/kg(Dry weight)

Station Name	Number of the Samples	Station Number	Average Concentration of Nickel in Oyster (ppm)	Average Concentration of Vanadium in Oyster (ppm)
Cinema Darya	20	1	2.08	1.40
Simin Beach	20	2	2.95	1.35
Bioteknolozhi	20	3	1.66	0.55
The Average Concentration in the South of the Island			2.32	1.10
Basaeidoo	20	6	3.02	0.94
Western Chahoo	20	7	2.19	0.96
South Laft	20	8	2.59	3.19
West Kave Dock	20	9	2.57	4.96
The Average Concentration in the North of the Island			2.59	2.51
Average			2.44	1.91
Minimum			1.66	0.55
Maximum			3.02	4.97
Standard Deviation			0.49	1.59

Table 4: Biological accumulation factor (BCF) of nickel and vanadium in soft tissues of rock oysters

Station Name	Station Number	Nickel (BCF)	Vanadium (BCF)
Cinema Darya	1	142.04	37.95
Simin Beach	2	204.89	35.06
Bioteknolozhi	3	83.21	14.1
Basaeidoo	6	257.28	23.96
Western Chahoo	7	38.75	25.7
South Laft	8	184.71	83.05
Mean		151.8	36.6
Minimum		38.75	14.1
Maximum		42779.16	143.72

Table 5: Comparison of the average value of the results obtained in this study with levels of WHO1 and FDA2 regulations and standards

		Nickel in Seawater (Micrograms per Liter)	Nickel in Seafood (Mg per Kg)	Vanadium in Seawter (Micrograms per Liter)	Vanadium in Seafood (Micrograms per Liter)
References	WHO	0.5-2	-	0.2-29	0.32 Range 0.19-0.50
	FDA	-	80	-	0.1-0.3
Recent Research	Water	15.73	-	37.9	-
	Oyster's Soft Tissues	-	2.44	-	1.91

1 - World Health Organization

2 - Food & Drug Administration

Table 6: Pearson correlation test results between concentrations of nickel and vanadium in water samples and oyster

Nickel in Water and Oyster	Correlation Coefficient	r =- 0.35 Samples reverse
	Significance Level (p)	0.435
Vanadium in Water and Oyster	Correlation Coefficient	r =- 0.76 Reverse Strong
	Significance Level (p)	0.047
Nickel and Vanadium in Water	Correlation Coefficient	r =0.17 Direct Very Weak
	Significance Level (p)	0.718
Nickel and Vanadium in Oyster	Correlation Coefficient	r =0.25 Direct Very Weak
	Significance Level (p)	0.574

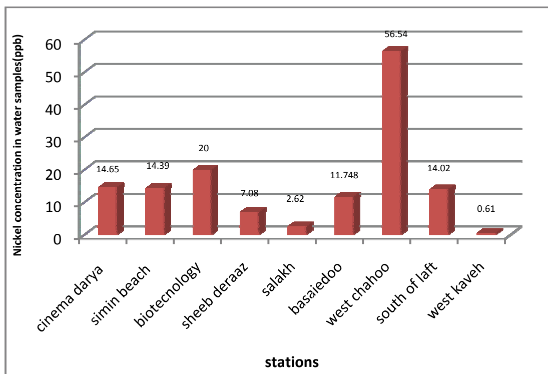


Fig. 2: Nickel concentrations in water samples

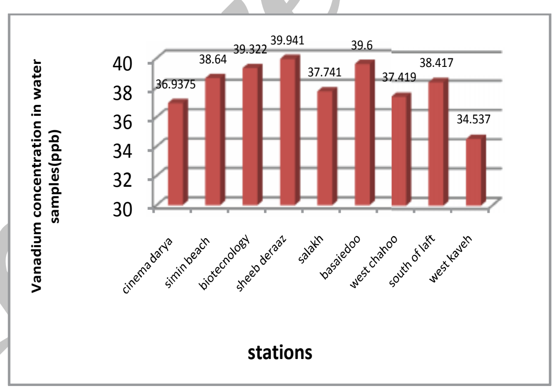


Fig. 3: Vanadium concentrations in water samples

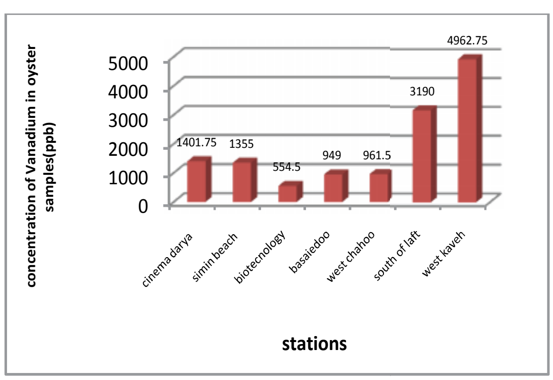


Fig. 4: Nickel concentrations in oyster samples

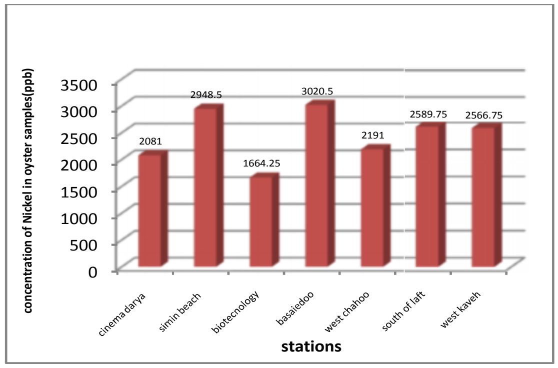
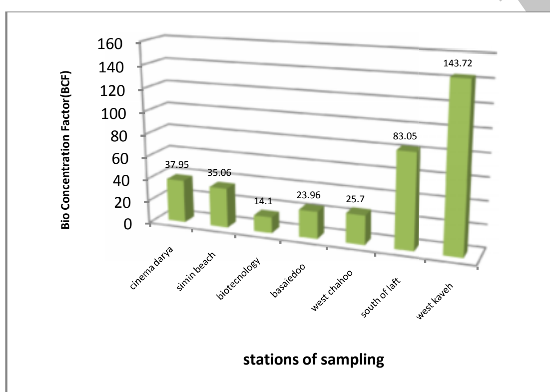


Fig. 5: Concentration of vanadium in oyster samples



*The coefficient value in the West Kave Dock Station is a hundred times downsized

Fig. 6: Graphs of the biological accumulation factor of nickel

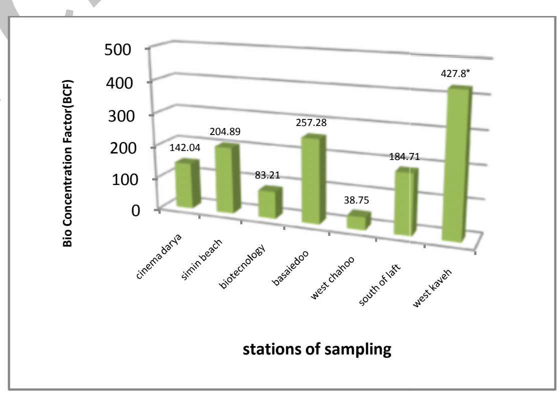


Fig. 7: Graphs of the biological accumulation factor of vanadium

9 also the highest pollution in the oysters at stations 6 and 9 and the lowest in station 2. It shall be noted that in comparing the northern with the southern coastal stations, there was no significant difference.

In a research study carried out in 2005 on the oysters in Hormozgan Province coastal areas, the average concentration of nickel and vanadium were respectively 32.6 and 77.0 mg per kg in muscles, which was higher compared with the standard levels (Mortazavi et al., 1997).

In comparing that research to the present study, the concentration of nickel was lower, but that of the vanadium is higher.

In December 1999 a research was conducted in France (François et al., 2004) and the concentrations of nickel and vanadium in the soft tissues of oyster Crassostreagigas were as follows: Nickel concentration: 1.2 ± 0.5 micrograms per g, Vanadium concentration: 3.2 micrograms per g. But in Saccosterea cuculla the nickel concentration of 2.44 mg per kg and vanadium concentration of 1.91 mg per kg was obtained (François et al., 2004).

In a survey carried out in March 2003 in Naval Research Laboratory in California, the concentration of vanadium in sea water doubled the nickel concentration which in comparison with recent research, it is quite consistent (Rileya and Taylor, 2003).

The highest average rate in the soft tissues of oysters was detected in station 9, namely "West Kave Dock" where it is a dock to transport oil. Since these oysters lived in the rocky parts of the coasts, they are constantly exposed to water currents. What we learned in local investigations, confirmed the oil transportation in the northern coasts; which due to a series of leaks, significant amounts of oil seep out into the sea and coastal ecosystems. On the other hand, releases unbalanced atmosphere and high water turbulence causes the collision of water with the rocky coasts; so large quantities of pollutants associated with water are brought to shore. As the water crashes the rocks, the oysters surely absorb and accumulate some of these elements. Accordingly, the oysters can be considered as biological markers (Roger and Jihn, 1994; Anon, 2000).

Above-normal levels of heavy metals nickel and vanadium in the study should be attributed to the relatively high amount of oil pollution in the region, particularly in the Strait of Hormuz (Jafari Valadani, 1997; Bolukbashi, 2001).

As a filter feeder, the bivalve rock oyster shows a strong ability to concentrate and accumulate the said metals. The metal concentrations in the soft tissues of these organisms are several times higher than their concentration in the nearby waters.

Results of Biological aCcumulation Factor (BCF) is illustrated in Table 5. The results indicate the lowest average biological accumulation in nickel in station 7 (Western Chahoo) and the highest in station 9 (West Kave Dock). The biological accumulation in nickel was more than vanadium, but in comparing the northern with southern stations, no significant difference was observed.

In station 7(Western Chahoo) the lowest levels was observed in ranking. One of the main reasons is it's proximity to the mangrove forests. Because the mangroves can absorb significant amounts of pollutants and decrease level in the environment (Bolukbashi, 2001).

Most bio-accumulation was observd in the station 9 (West Kave Dock); the reason might be oil transport and a relative high level of pollution in the region.

Comparison of heavy metals derived from oysters with the FDA and WHO standards (Table 6) indicate that the present nickel and vanadium elements in water are higher than acceptable limits. It shall be noted that the amount of nickel is nearly in a tolerable range for oysters; if this situation is not kept under control, the level of this element will certainly exceed the acceptable limits (Shahin Poor, 1993).

Compared with the standards, the results show highly increased levels for heavy metals. The concentration of vanadium has been even increased several times.

CONCLUSION

This study shows that in bivalve rock oyster due to the potential ability for accumulation using concentration of metals can be considered a good biological indicator to study the contamination of the coasts. There are also findings indicating relatively large amounts of nickel and vanadium contamination in Qeshm Island coasts, and shows the need for continuous monitoring and control of pollutants in the environment.

ACKNOWLEDGMENTS

The author appreciate Tehran Azad University of Research and Science branch for the financial support of this study.

REFERENCES

Afyooni, M., (2000). Environment, water, soil, and air pollution. Arkan Press, Esfahan, 318.

Anon, a., (2000). World Health Organization (WHO); Guidelines for Drinking water Quality; Recommendation; W.H.O. Genera Switzerland; 1, 130.

Behbahani, A. H., (1995). The amounts of alterations trend of seven heavy metals in two dominant bivalve species of oyster and a pearl oyster via spectrometry method; MA thesis in sea chemistry; Islamic Azad University, Shomal Branch, p. 180.

Bolukbashi, A., (2001). the untouched oyster of Persian Gulf (Qeshm Island); Cultural- Research Department; second edition; Tehran.

BU, A. H.; Olayan, M. N. V., (2006). subrahamanam, Acceumulayion of copper, nickel, leal and zinc by snail, Lunella coronayus and pearl oyster, pinctada radiate from the kuwaite coast before and after the Gulf war oil pill.

Dabiri, M., (2000). Environment, water, soil, air, and noise pollution; Ettehad Press, 400.

Hosseinian, M., (1991). Toxic metals and environmental

pollution. S T journal of Iran's Water., 14 (100). 103- 108.
Jafari Valadani, A., (1997). Persian Gulf Ecology and the Pollutant Sources. the First Conference of Marine Geology of Iran. 282 - 296.
Jamili, sh., (1995). Quality test of petroleum hydrocarbons in water and sediments and oysters of northeastern Persian Gulf; scientific information report.
karande, A. A.; Ganti, s. s.; Udhyakumar, M., (1993). Toxicity of Tributilein to some Bivalve species journal of Mrain siences.
Mortazavi, S.; Esmaeili Sari, A.; Riahi Bakhtiari A., (1997). to determine the ratio of nickel and vanadium resulting from oil contamination in pearl oysters Pinctada radiate and oysters Saccosterea cucullat in the coastlines of Hormozgan Province.
MOOPAM., (1999). Manual of oceanographic observation and pollution analysis ethods, ROPME, Kuwait
François, J.; Chiffoleau1, a.; Chauvaud. L.; Amouroux, D.; Barats, A., (2004). Nickel and vanadium contamination of benthic invertebrates following the “Erika” wreck, , Aurélie Dufour1, 64053 Pau Cedex 9, France Received 10 February Accepted 26 May.
Shahin Poor, Sh., (1993). of crude oil toxicity on pearl oysters in Persian Gulf and to determine the mechanism of oil pollution on the concentration of hemi- lymph free amino acids. MA thesis; Islamic Azad University, Branch. 210.
Roger, N. R.; jihn, D. B., (1994). Environmental Analysis. john wiley and sons, N.Y . 263.
Van Loon, J. C.; (1980). Analytic Atomic Absorption Spectroscopy. Academic press; N. Y. 355.
Sadiq, M.; Zaidi, T. H., (1985). Metal concentration in pearl oyster pinctada radiate, collected from Saudi Arabian coast of the Persian Gulf; Bull. Environ contemn. Toxic-co. l42.
Szefer, p. I.; Kuta, k.; kushiyma, s., (1999). Distribution of Trace Metal in the pacific oyster Grassostereagigas and Grabs from the East Coast of kyusha Iland Japan; Bulletin of Environmental contamination and Toxicology. New York; USA.
Shah Hosseini, E., (1993). Winds and waves of the Persian Gulf the port and the sea. 43- 44. 86 - 89.
Sahafi, H; Daghughi, B; Rameshi, H(2000); Persian Gulf Mollusks Atlas; Iranian Fisheries Research Institute; Fisheries Research Centre of Arabian Sea.
Rileya, J. P.; Taylor, D., (2003). The concentrations of cadmium, copper, iron, manganese, molybdenum, nickel, vanadium and zinc in part of the tropical north-east Atlantic ocean.

How to cite this article: (Harvard style)
Mashinchian Moradi, A.; Jalali Mosallam, M.; Fatemi, M. R., (2011). A survey on the accumulation of heavy metals as indicator of oil pollution index (Vanadium and Nickel) in bivalve rock oyster (Saccostrea cucullata) in Qeshm Island coasts. Int. J. Mar. Sci. Eng., 1(1), 51-58.