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Seasonal Variation of Heavy Metal Pollution (Pb, Cd, Ni) in *Pinctada radiata* from Persian Gulf, Iran

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ABSTRACT

Seasonal variations of three heavy metals (Pb,Cd, Ni) in *Pinctada radiata* have been conducted in Hendorabi and lavan Island from March 2011 to march 2013, edible oysters are best pollution indicator organism in aquatic environment. The soft tissue of *Pinctada radiata* and sediment was analyzed to detect some potentially toxic metals as Pb, Cd, Ni with a flame AAS and statistical analyses were performed with SPSS 18.0 for windows. dissolved and particulate heavy metals in Soft tissue of *pinctada radita* have recorded the highest concentration for Cd in hendorabi, and All measured metals followed this trend (Pd>Cd>Ni), while in *pinctada radita*, heavy metals showed no fluctuation with season. Even though the specie had concentration values below the WHO's legal limit, but we still keep an eye on the risk when we eat it. We also suggest that we can do further study to establish the bio monitoring Lavan and Hendorabi Island in pollution monitoring program.
KEY WORDS*:* Pinctada radiata, seasonal variation, heavy metal

INTRODUCTION

Heavy metal concentrations in the marine environment are the results of both natural and anthropogenic sources. The accumulation of heavy metals in waters and sediments affects various organisms in the environment (Blackmore et al. 2001; Storelli and Marcotrigiano 2001; Cogun et al. 2005).

Enormous quantities of noxious pollutants have been released into marine ecosystems over the last few decades. Among these pollutants, heavy metals represent major pollutants of the marine environment (Onen et al., 2011; Li et al., 2013). Cd, Pb and Ni are potentially toxic metals and the well-known Minamata disease, the Itai Itai disease and Saturnism have shown the severe effects of these toxic metals on human health. (Siu et al., 2004; Kumosani et al., 2013).The use of molluscs as biomonitors of heavy metals in coastal zones is well established (Rainbow and Philips, 1993). Although bivalve molluscs have been widely utilised as biomonitors (Goldberg *et al*., 1983). Bivalvia species especially have been used as biological indicator organisms to monitor marine environmental pollution by heavy metals and chemicals due to their own properties of inhabitation.

Factors known to influence metal concentrations and accumulation in these organisms include metal bioavailability, season of sampling, hydrodynamics of the environment, size, sex, and changes in tissue composition and reproductive cycle (Boyden and Phillips, 1981). Seasonal variations have been related to a great extent to seasonal changes in flesh weight during the development of gonadic tissues (Joiris *et al.*, 1998, 2000). Element concentrations in molluscs at the same location differ between different species and individuals due to species-specific ability/capacity to regulate or accumulate trace metals (Reinfelder *et al.*, 1997; Otchere *et al*., 2003). Most studies on marine environment, which have attempted to determine metals in animals, have focused on animals nearer the lower end of the food web. This is because these animals can be directly harvested for human or livestock consumption, can serve to transfer metals tropically to carnivores, and can modify the speciation, cycling, and transport of metals in marine systems. Lying in the second trophic level in the waters' ecosystem, mollusks have long been known to accumulate essential and non-essential elements in aquatic ecosystems (Dallinger and Rainbow, 1993). Studies concerning the accumulation and toxic effects of metals in bivalve mollusks were mostly focused on mussels in view of their wide geographic distribution, sedentary way of life, filter feeding behaviour, convenient size, ease of laboratory experimentation, considerable capacity for accumulation of a wide variety of toxic compounds in their tissues as well as high response to pollutants. One fundamental assumption and basis of biomonitoring programmes is that the concentration in the bivalves reflects the available levels of metals in the ambient environment. Mussels accumulate many chemicals due to their great filtration capacity and their contact with sediments, and concentrate metals in soft tissues, and hence serve as bioindicators of metal contamination (Nicholson, 2003a, b).

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In this study, heavy metal (Cd, Pb and Ni) contents in littoral sessile species of Bivalvia *(Pinctada radiata* Leach, 1814 and Brachidontes pharaonis Fischer, 1870) and the effect of season on these bivalves were investigated. Organisms were collected from Hendorabi and Lavan Island (Figure 1).

Pinctada radiata is a member of the family Pteriidae. One member of this family is the pearl oysters. They are 50 to 106 mm in length and are an Indo-Pacific species. First recorded from Cyprus in 1899 the species has spread in the Eastern Mediterranean. They live attached by their byssus to rocks or other hard substrates. They are fouling organisms.

MATERIALS AND METHODS

The geographical location of the island where the sample is collected, shown in Table 1. Due to the availability of different habitats of pearl oyster on the islands of Lavan and Hendorabi and random starting point sampling was started. About 240 *Pinctada radiata* samples of silimalar size were collected from march 2012till march 2013.

Table1. Location, number of samples analyzed (N), Shell length (mm) of oysters, and descriptions of sampling *Pinctada radiata* collected from Lavan and Hendorabi Island, Persian Gulf

No	Location	Latitude (N)	Longitude (E)	N	Shell length mean (mm)
1	Lavan	26° 47′	53° 20′	120	45.4
2	Hendorabi	26° 40′	53° 35′	120	48.6

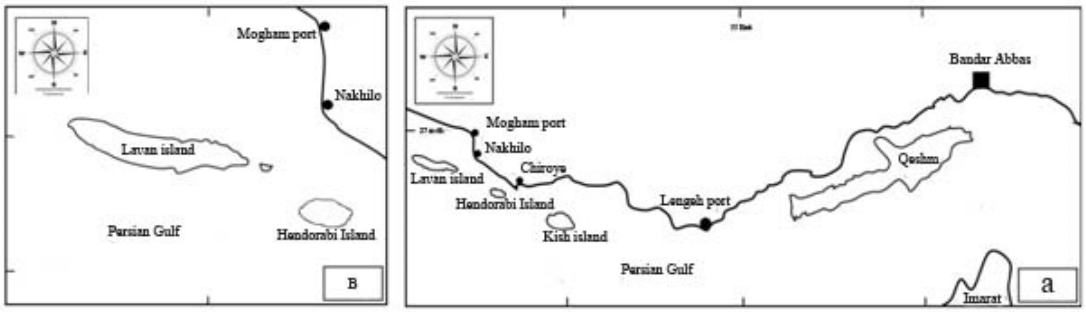

Figure 1. geographical location where sample collected (Lavan, Hendorabi Island)

After being sampled, the individuals were immediately stored in plastic bags and transported separately to the laboratory, where the calcareous shells were removed, and the visceral masses of all specimens were rinsed with abundant distilled water to remove sediments or surface debris. Because of the variability in the ability of mollusc tissues to accumulate pollutants (Bargagli *et al.*, 1986; Catsiki, 1986; Uthe & Chou, 1987), heavy metal contents were analyzed in tissues of *P. radiata*. The samples obtained were thereafter placed, separately, in a aven at 105°C for 24 hours. A total of 55 ash samples were obtained. The metal content of these samples was determined using Atomic absorption flame emission spectroscopy (AAS).

The laboratory apparatus were acid soaked (nitric acid) before the analysis. After acid soaked, it is rinsed thoroughly with tap water and distilled water to ensure any traces of cleaning reagents were removed. Finally, it is dried and stored in a clean place (Radojevic and Bashkin, 1999). The sediments were kept cool in icebox during the transportation to the laboratory (Al-Shiwafi et all, 2005; Jung et all, 2005). The surface sediments air-dried and after homogenization using pestle and mortar, it is passed through a 2-mm mesh screen and stored in polyethylene bags based on method used by Romic and Romic (2003) for further analysis. Before the determination of these heavy metals was conducted, the samples are digested using aqua regia digestion. Approximately 2g of each sample digested with 15 mL of aqua-regia (1: 3 HCl: HNO3) for 3-4h at 90oC. After cooling, the digested samples were filtered and kept in plastic bottles before the analysis. Radojevic and Bashkin (1999) stated that aqua regia has ability to extract all the metals in soil sample and widely used in most of the soil analysis. The samples were then analyzed for heavy metals and base cations using AAS with specific flame and wavelength (Atomic Absorption Spectrometer Model Perkin Elmer4100).

All statistical analyses were performed using SPSS version 18 for Windows. One-way ANOVA was carried out to assess significant differences between element concentrations in the study area, followed by multiple comparisons using the Duncan's multiple range test. The level of significance was set at $P < 0.05$

RESULTS AND DISCUSSION

Heavy metal contamination of the environment is recognized as a serious pollution problem mainly in marine aquatic bodies. Variability in metal concentrations of marine organism depends on many factors, both environmental and biological (Phillips 1990). From the results obtained the heavy metal accumulation in *Pinctada radiata* in the present analysis can be presented in descending order as follows: Pd>Cd>Ni in all the seasons in general. In the present study higher pollution of Lead and Cadmiun were found.

Table 2: Seasonal variation of trace metal con centrations ((µg g^{-1} dw) in *Pinctada radiata*

	Station	Pb	Cd	Ni
Spring	Hendorabi	16.75±1.6	17.5±2.5	5.16±0.51
	Lavan	25.1±0.62	17.5±0.6	5.61±0.82
Summer	Hendorabi	26.7±2.1	20±0.9	5.36±0.43
	Lavan	16.6±0.71	18.33±1.1	6.21±0.6
Autumn	Hendorabi	18.2±0.54	26.83±0.8	7.13±0.32
	Lavan	15.98±1.2	20.5±0.52	6.8±0.51
Winter	Hendorabi	15.68±2.5	21.8±2.3	7.66±0.74
	Lavan	20.93±0.8	18.83±0.36	6.86±0.85

Filter feeder oyster uptake dissolved metals ions in solution or in particular form, via food by filtering large volumes of water each day (Southgate P, et al, 2008) . There are many ways to maintain homeostasis of essential metals and detoxification of nonessential metals in bivalves' tissues including binding metals to low-molecular weight proteins, like metallothioneins and storing them in lysosomes or metal-containing granules, so that they can accumulate metals in their tissues several times higher than their ambient water (Marigomez I, 2002). The results of the correlation test between heavy metals concentration of sediment and soft tissue indicate the high correlation for all metals. Sediments act as sinks for toxic metals that enter the coastal areas from anthropogenic sources like industrial and urban run off; these contaminated sediments can be ingested by suspended filter feeder oysters and become a source of metals uptake (Sajwan KS, et al, 2008).

Mean concentrations and standard deviations were calculated for all samples collected each season from the two sampling stations. For each sampling station factor scores were calculated to investigate the conditions of each section of the stations subjected to heavy metal pollutions. Concentration of heavy metals did not show seasonal variation among study sites. Most of concentrations of measured metals were fluctuated during study period. Cd concentration ranged (26.8- 17.5 µg/g) in Hendorabi and lavan Island during march 2012till march 2013respectively, while Cd concentration has a highest value (26.8 µg/g) in Hendorabi Island during Autumn 2012 and lowest value (17.5 µg/g) in Hendorabi Island during spring 2012.

Pb concentration ranged (26.7- 16.68 µg/g) in Hendorabi and lavan Island during march 2012till march 2013respectively, while Cd concentration has a highest value (26.7 µg/g) in Hendorabi Island during summer 2012 and lowest value (16.68 µg/g) in Hendorabi Island during winter 2012. Ni concentration ranged (5.16- 7.66 µg/g) in Hendorabi and lavan Island during march 2012till march 2013respectively, while Cd concentration has a highest value (7.66 µg/g) in Hendorabi Island during winter 2012 and lowest value (5.16 µg/g) in Hendorabi Island during spring 2012.

Many parameters and factors have effects on heavy metals concentrations in aquatic ecosystems such as water temperature dissolved oxygen, salinity, pH, Sex and age, phase of life (Salman &Nasar,2014). Physiological conditions have also role in biomarkers response through season. The real reason for increasing of heavy metal concentrations in tissue of studies mollusc species in this study is due to their bioavailability; Metals increase with low alkalinity because low alkalinity may interfere with ionic transport across epithelia of tissue resulting in the net accumulation of unwanted trace elements in their tissue. In addition, physicochemical parameters may interfere with the rate of trace element uptake and accumulation by Mollusc species (Yap, Ismail, Tan & Omar, 2003). The variation of measured metal concentration in Molluscs in this study depends on season. In Table 3 Comparison of mean (±SD) or range of heavy metal concentrations (µg g−1 dry weight) in the soft tissues of the pearl oyster (*P. radiata*) from different areas of the world According to the correlations between Ni, Cd, Pb levels in sediments and soft tissue of *P. radiata*, this species can be suggested as a biomonitoring agent for coastal zone of Persian Gulf. The comparison of the soft tissue metals concentrations between the two stations showed higher accumulations in Hendorabi island samples. The higher mean concentrations of metals Ni (7.66 µg g^{-1}) in Hendorabi samples can be related to ship transport activities, and municipal and industrial waste disposal in this area.

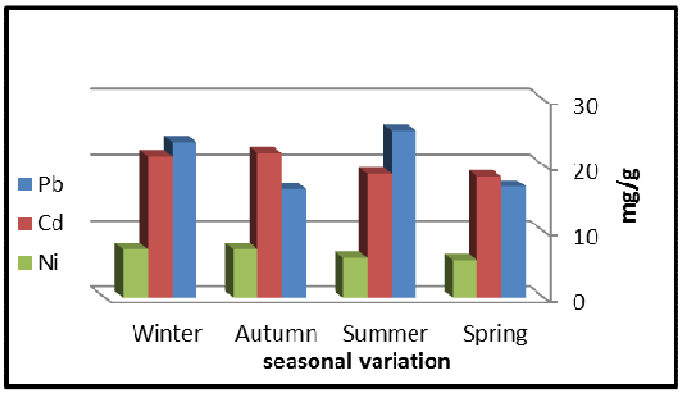

Figure 2. Seasonal variation on heavy metal (Pb, Cd,Ni) in Lavan, Hendorabi Island

Table 3: Comparison of mean (±SD) or range of heavy metal concentrations (µg g−1 dry weight) in the soft tissues of the pearl oyster (*P. radiata*) from different areas of the world

Geographical area	Analyzed tissues	Cd	Pb	Ni
Around the Lavan and Hendourabi Islands, Persian Gulf	G	0.7091±0.3533	<0.0001	5.856±5.943
Around the Lavan and Hendourabi Islands, Persian Gulf	M	0.5321±0.2106	<0.0001	2.670±1.224
Qatari pearl oyster beds, Palm Island, Persian Gulf	W	0.41±0.07	3.15±0.89	4.94±0.83
Qatari pearl oyster beds, Doha Harbour, Persian Gulf	W	0.85±0.18	4.79±1.61	6.18±1.96
Qatari pearl oyster beds, Halul Island, Persian Gulf	W	0.43±0.28	5.59±0.93	13.2±2.41
Akkuyu Bay, Eastern Mediterranean	W	0.0058*	-	-
Coastal areas of Bahrain, Persian Gulf	W	3.68–3.79	0.396–3.92	0.709*–0.884*
Bahrain, Persian Gulf	W	0.25*–3.8	1.25–14.0	0.2*–8.95
Coastal areas of Abu Dhabi, Persian Gulf	W	2.73	2.29	7.02
Coastal areas of Bahrain, Persian Gulf	W	0.9	5.9	3.7
Northern part of the Gulf of Suez	W	0.14*–1.21	0.14–3.60	ND*
Coastal areas of Kuwait, Persian Gulf	W	0.77–1.93	0.44–0.64	0.96*–1.33*

The concentrations, which are below the present study values, are marked by an asterisk
G gills, M muscle, W whole soft tissues, ND not detected (pouring et al., 2014)

Conclusion

The study showed no variation of heavy metals in season and molluscs species during study period. All measured metals followed this trend (Pd>Cd>Ni) the concentrations of heavy metals in Molluscs depends on water quality; food availability source of pollution and human activity. This evaluation can be monitored as a watch programmer and effective steps should be taken up by the government to rectify the pollution in these coastal areas. Various species of bivalves molluscs have been recognized as a useful tool for monitoring of heavy metals pollution. These organisms accumulate comparatively higher concentrations of metals because of their sedentary nature, both from water and sediment. The success of some Mollusc Bivalves, is due to some factors including their wide geographical distribution, abundance, sedentary, tolerance to environmental changes, high bioconcentration factors, population stability, and size, adaptability for field, cage and laboratory experiments. The Mollusca species under study may be used as a good bioindicator to aquatic pollution by heavy metals.

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