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Effects of oil contamination on nickel concentration in muscle tissues of *Brachirus orientalis* in Persian Gulf waters

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Abstract

In order to examine and compare nickel accumulation levels in muscle tissues of *Brachirus orientalis* in Persian Gulf waters (Bushehr province region), sampling the fish was done in both Bushehr and Asalouyeh stations during the summer 2013. After biometry, muscle tissues of the samples were separated and chemical digestion was done. Nickel accumulation levels in tissues were measured by using graphite furnace atomic absorption instrument. Based on the obtained results, mean concentrations of Nickel in muscle tissues were 1.378 ± 1.656 mgkg⁻¹ dw in Bushehr station and 2.208 ± 2.445 mgkg⁻¹ dw in Asalouyeh station, and it indicated no statistically significant differences between the two stations ($P > 0.05$). The obtained concentrations and analysis done indicate that based on the WHO standard, the amount of nickel was higher than the standard levels and its use poses risks to human.

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Introduction

Heavy metals are non-biodegradable materials having significant mobility through food chains and are also potentially toxic to organisms (Chen and Chen., 1999). They are discharged into the marine environment through various anthropogenic resources such as petrochemical wastewaters, agricultural and mineral runoffs, the transport of oil and domestic wastewater (Karadede *et al.*, 2004). Heavy metals are available in aquatic environments, especially in coastal regions and their release in the environment is due to the rapid overgrowth of industry as well as human and urban populations (Thiyagarajan *et al.*., 2012).

Marine organisms, including fish, clams, mollusk, barnacles and the other aquatic animals accumulate the existing contaminants in their different tissues, according to the existing metal concentrations during the water, exposure period in the contaminated environment and the other environmental factors of water like salinity, PH, hardness and temperature. (Kalay *et al.*, 1999; Canli and Atli., 2003; Saei-Dehkordi *et al.*, 2010; Saei-Dehkordi and Fallah., 2011; Mortazavi and Sharifian, 2012). Biological and ecological factors such as size, sex (Al-Yousuf *et al.*, 2000), ecological needs, habitat, feeding habits (Bustamante *et al.*., 2008), and season (Navarro *et al.*, 2006) have various and significant influences on bioaccumulation and metal bioavailability.

Among animal species, fishes are apt to absorb these metals and their harmful influences and have high absorption levels of these metals because of long exposure to the contaminants (Olaifa *et al.*, 2004). Metals are constantly entering the aquatic environment through nature and anthropogenic resources and due to their toxicity, extensive permanency in the environment, bioaccumulation and bio-magnification in food chains, these metals are considered as a serious threat for human health (Papagiannis *et al.*, 2004). Heavy metal contamination chain nearly always follows the

following cycle: industry, atmosphere, soil, water, phytoplankton, zooplankton, fish and human (Mendil *et al.*, 2010; Askary Sary and Mohammadi., 2012). Fishes which are usually located in the last levels of aquatic food chains are considered as a main passageway of metals for the transference to human bodies (Svensson *et al.*, 1992; Abdolapour Monikh *et al.*, 2004).

Persian Gulf is a shallow-water basin with an average depth of 35-40 meters and an area about 240 km². This area is connected to the international waters via Hormuz strait (Annon., 1995; Banat *et al.*, 1998; Saeidi *et al.*, 2008).

Water exchange time is between three to five years in this basin that show the pollutants remain in the Persian Gulf for a significant period. The north parts of the Persian Gulf are much more influenced by pollutants due to the shallowness, limited rotation, salinity and high temperature (Saeed *et al.*, 1995; Sheppard *et al.*, 2010). On the other hand, according to the occurrence of various environmental events in this region during the recent years, including the largest world oil spill in 1991, ship traffic, transference and oil contamination entering as well as oil spills, this region is suffering a crisis. Generally it was specified that about 30 percent of the total world oil transference is done in Persian Gulf (Pourang *et al.*, 2005). Therefore, the objective of this study is to measure the nickel levels in muscle tissues of *Brachirus orientalis* in Persian Gulf waters (Bushehr province region) and compare with the international standards.

Materials and methods

Study area

Bushehr is located in 28°55'19.84" N and 50°50'4.76" E of southwestern Iran and on the edge of the Persian Gulf. Asalouyeh is located in 28°28'24.48" N and 52°36'49.79" E on the edge of the Persian Gulf, 300 kms east of Bushehr and 570 kms west of Bandar Abbas and has a distance of 100

Sampling

Sample preparation

to prevent them absorbing air moisture. Acid digestion is performed to release all metal connections with tissues. In this regard, 1 g dried and constant tissues were transferred into a beaker and 10 ml concentrated nitric acid were added to digest the dish contents and the samples were placed in the room temperature for 30 minutes until the primary digestion was done. Then the samples were heated in a heater located under the hood having a steam system in a temperature of 90° C to be dried. When the samples were cooled and reached the environment temperature, they were sieved from a 45 mm Whatman filter paper and were transferred to 25 ml dishes and were reached the necessary volume. Finally, the samples were transferred into lidded polyethylene dishes to be injected into the instrument (MOOPAM., 1999). A graphite furnace atomic absorption instrument was used to measure the nickel metal levels.

One sample Kolmogorov-Smirnov test in SPSS®18 was used to check the validity of the data normalization. Then, one way sample T-test was used to check interactions between heavy metals and stations. Data have been presented in diagrams as Mean±SDs with 95% of the confidence interval. Excel software was used to draw diagrams (Zar., 1999).

Biometric results

Biometric results indicated that mean weight in Bushehr was higher in comparison to Asalouyeh station. Mean weight in Bushehr was 358.96 g and mean weight in Asalouyeh was 212.38 g. Biometric results are presented in Table 1 and 2.

	Mean	SD	Min	Max
Total weight	358.96	259.8	129.7	931.5
Total length	27.81	5.48	21	39
Standard length	24.57	5	19.1	35

Table 2. Biometric results of *Brachirus orientalis* in Asalouyeh station (cm; N=10).

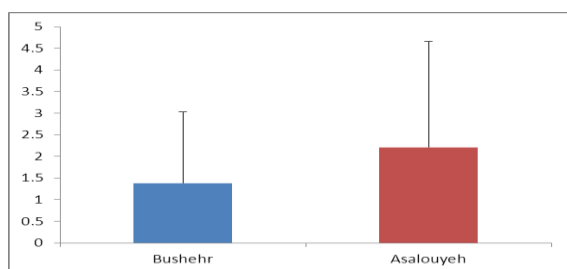
	Mean	SD	Min	Max
Total weight	212.38	31.99	165.2	255.4
Total length	27.05	1.36	25	29
Standard length	22.79	0.96	21.8	24.5

Table 3. Correlation between length and weight indices in *Brachirus orientalis* in Bushehr and Asalouyeh.

	R	R ²	Sig
Bushehr	0.982	0.964	0.000
Asalouyeh	0.937	0.877	0.000

Nickel concentration

The obtained results show that the lowest and the highest nickel concentration levels in muscle tissues in Bushehr station was equal to 0.27 and 5.375 mgkg⁻¹ dw and in Asalouyeh was 0.55 and 6.875 mgkg⁻¹ dw, respectively. According to the obtained statistical results mean and standard deviation (SD) with the confidence interval in 95% level of nickel in Bushehr station was 1.378±1.656 mgkg⁻¹ dw and in Asalouyeh station was 2.208±2.445 mgkg⁻¹ dw. Based on T-test analysis, no significant differences were observed between nickel levels in muscle tissues in both stations (P=0.395). Fig.2. indicates Nickel levels in muscle tissues in both Bushehr and Asalouyeh stations.

**Fig. 2.** Comparison of Nickel levels in muscle tissues of *Brachirus orientalis* in Bushehr and Asalouyeh stations.

Based on the obtained concentrations and comparison done it as specified that based on WHO standard, the amount of nickel in *Brachirus*

orientalis tissues was higher than the standard permissible levels.

Table 4. Comparison of Nickel concentrations in muscle tissues of *Brachirus orientalis* with WHO standards (mgkg⁻¹).

Standard	Nickel
WHO (FAO, 1976)	0.2
<i>Brachirus orientalis</i> , Bushehr	1.378
<i>Brachirus orientalis</i> , Asalouyeh	2.208

Discussion

Fishes are one of the important food resources for human beings and are considered as one of indicators of contamination in their living place. Due to this, they should receive special attention in order to control the ecosystem contamination as well as food qualities. Heavy metal concentrations in fish depend on the various factors such as food behaviors and habits, trophic status, metal resources, the organism distance from the contamination resource, bio-magnification and bio-diminishing of metals, food availability, temperature, physical and chemical properties, water and seasonal variations (Belinsky *et al.*, 1996; Olsson., 1998; Shah and Altindag., 2005; Fatih Fidan *et al.*, 2008).

The results of this study generally showed that the measured nickel levels in both Bushehr and Asalouyeh stations didn't have significant differences. Bushehr which is a fishing region is also a place for mooring the fishing boats. Beside this fishing pier, the Bushehr nuclear power station, the customs, and the National Shrimp Research Institute was located. The National Shrimp Research Institute has some shrimp farming pools and its discharge drainage is directly discharged into the sea. In Asalouyeh station, in addition to the fishing pier which is located near Asalouyeh city, the largest world gas and oil installations, South Pars oil particular region are located there influencing the environment directly and indirectly. All installations of the South Pars region located near the Asalouyeh city and pier are located along the shoreline due to

the location of oil and gas fields in the sea and also several oil rigs are located on the sea near it. Examination of the obtained results shows that the nickel levels in tissues of *Brochirus orientalis* in Asalouyeh station (2.208 ± 2.445) and Bushehr station (1.378 ± 1.656) are higher than the international permissible levels. Nickel is widely spread in the environment and its concentration is a function of fossil fuel and its meaning from the oil fields and refineries. In other words we can say that the highest concentrations of nickel in sediments are mainly caused by human sources such as ship traffic, oil tankers, petroleum and industrial and domestic wastewaters (De Astudillo *et al.*, 2005; Pourang *et al.*, 2005; Beg *et al.*, 2001).

Nickel toxicity is divided into 4 groups: (1) allergy (2) cancer (3) respiratory disorders (which all these three cases are caused by industrial activities) and (4) iatrogenic poisoning (Amundsen *et al.*, 2007).

World Health Organization (WHO) hasn't specified the bearable absorption amount of nickel. The environment Protection Agency of the United States (EPA) suggested the maximum permissible concentrations, 20 mg kg^{-1} per day and the maximum bearable daily mean $1/2 \text{ mg}$ for a 60 kg person. However, this amount causes skin inflammation in people having greater sensitivity to Nickel (Esmaeili Sari., 2002). Based on the studies which are done by Mashinchian Moradi (Mashinchian Moradi, 1993) in Hormuz strait and areas around the Persian Gulf, elements like nickel in these regions have mines under the Oceanic crust. Thus, another important and significant reason for the high amounts of mean nickel concentrations is its crust origin. Moreover, the Persian Gulf has caused various contaminations by petroleum spillage in the Persian Gulf aquatic ecosystem due to its huge oil and gas resources, ship traffic and abundant oil tankers and refinery activities. De Mora *et al.* (2004) examined the nickel concentrations in south sediments of the Oman sea found that the segments of the coasts have high concentrations of nickel. These researchers found that nickel in sediments of these regions has mainly

natural origins which have introduced Ophiolites stone in bed as its origin. Nickel combinations have rather high toxicity and this toxicity increases in the presence of zinc. Nickel is accumulated in fish livers, gills, kidneys and muscles (Van-Doijn, 2000).

Eslami *et al.* (2012) determined the concentrations of some heavy metals in muscle tissues of *Rutilus frisii Kutum* in Tajan river. The results indicated that the nickel metal levels in muscle tissues were equal to $2.650 \pm 0.094 \text{ } \mu\text{gg}^{-1}$ which this metal along with lead which are among non-essential metals had higher levels in muscles in comparison to essential metals. Moreover, the existing nickel levels in muscle tissues were higher than the international standards.

According to the results of the study of Fatih Fidan *et al.* (2008) which was done on the heavy metal concentration levels in muscle tissues, gills and livers of *Carassius Carassius* in Eber lake in Turkey, the highest concentration levels of nickel in muscle were related to the winter season with the amount of $0.12 \pm 0.03 \text{ } \mu\text{gg}^{-1}$ fish weight. In addition, Alkan *et al.* (2012) in the study on heavy metal levels in spices including *Mullus barbatus ponticus* and *Merlangius merlangus euxinus* in southwestern region of the Black sea, calculated the nickel levels in spices *Mullus barbatus ponticus* $0.02\text{-}0.67 \text{ } \mu\text{gg}^{-1}$ and in species *Merlangius merlangus euxinus* $0.01\text{-}0.71 \text{ } \mu\text{gg}^{-1}$ respectively.

Table 5. Comparison of Nickel concentrations in the present study with the other researches (mg kg^{-1}).

Refrence	Ni	Region	Species
Pourang <i>et al.</i> , 2005	1.56	Northern Persian Gulf	<i>Epinephelus coioides</i>
Pourang <i>et al.</i> , 2005	1.2-14.5	Northern Persian Gulf	<i>Solea elongates</i>
Pourang <i>et al.</i> , 2005	0/1-5.8	Northern Persian Gulf	<i>Psettodes erumei</i>
Bu-Olayan., 1996	3.6	Persian Gulf, Kuwait shores	<i>Solea bleekeri</i>

Bu-Olayan., 1996	2.3	Persian Gulf, Kuwait shores	<i>Gastrophysus lunaris</i>
Bu-Olayan., 1996	4.7	Persian Gulf, Kuwait shores	<i>Acanthopagarus latus</i>
Bu-Olayan., 1996	0.9	Persian Gulf, Kuwait shores	<i>Mugil macrolepis</i>
Bu-Olayan., 1996	20.4	Persian Gulf, Kuwait shores	<i>Sillego sihana</i>
Ashraf., 2005	1.62	Eastern shores of Saudi Arabia	<i>Epinephelus microdon</i>
Abdolahpour Monikh <i>et al</i> ., 2012	4.32	Musa estuary	<i>Johnius belangerii</i>
Abdolahpour Monikh <i>et al</i> ., 2012	6.27	Musa estuary	<i>Euryglossa orientalis</i>
Abdolahpour Monikh <i>et al</i> ., 2012	3.41	Musa estuary	<i>Cynoglossus arel</i>
Fatih fidan <i>et al</i> , 2008	0.05-0.12	Eber lake, Turkey	<i>Carassius carassius</i>
Alkan <i>et al</i> ., 2012	0.02-0.67	Black sea	<i>Bullus barbatus ponticus</i>
Alkan <i>et al</i> ., 2012	0.01-0.71	Black sea	<i>Merlangius merlangus euxinus</i>
Current study	1.378	Persian Gulf, Bushehr	<i>Brachirus orientalis</i>
Current study	2.208	Persian Gulf, Asalouyeh	<i>Brachirus orientalis</i>

Based on the obtained concentrations and the performed comparisons it was specified that according to the WHO standards, the amount of nickel in muscles of *Brachirus orientalis* were higher than the standard permissible levels. Therefore, based on this research finding, we can conclude that the Persian Gulf environment has high oil contamination so that nickel which is one of the oil metals is accumulated higher than the international standard rates in the studied fish muscles, and if it is used by human beings, it will certainly cause some harm for them.

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