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Heavy Metal Concentrations in white Shrimp (Metapenaeus Affinis) and Their Contribution to Heavy Metals Exposure in Hormozgan Province (Iran)

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ABSTRACT

Heavy metals can be accumulated by marine organisms thought a variety of pathways, including respiration, adsorption and ingestion. The levels of heavy metals are known to increase drastically in marine environment through mainly anthropogenic activities. The objective of this study was to evaluate and compare the concentration of heavy metals, lead, nickel, iron and copper in muscle tissue of white shrimp *Metapenaeus affinis*. In three regions (Qeshm, Khamir port and Laft port) was conducted in the Hormozgan Province. Sampling was conducted in summer and winter 2015. After the captured biometric sample 180, were isolated muscle tissues. The preparation and analysis of samples was performed according to standard methods MOOPAM. The results show that the studied concentration in muscle tissue of white shrimp *Metapenaeus affinis*.at sample locations statistically significant difference shows. Also studied in terms of concentration in the muscle tissue of white shrimp in the study area between summer and winter statistically significant difference was observed (p<0/05). As both in summer and winter concentrations of lead, nickel, iron and copper in muscle tissue of white shrimp in Qeshm is greater than the other two regions. Meanwhile, the results of the study compared concentration in muscle tissue showed white shrimp with international standards. The studied concentration in muscle tissue of white shrimp in Qeshm, Khamir port and Laft port international standards is less than the limit. This indicates that the health of aquatic ecosystems contamination is not a problem.
KEYWORDS: Marine Organisms, White Shrimp (Metapenaeus Affinis), Heavy Metals, Hormozgan Province and Iran.

INTRODUCTION

In the recent years, world consumption of fish has increased simultaneously with the growing concern of their nutritional and therapeutic benefits. In addition to its important source of protein, fish typically have rich contents of essential minerals, vitamins and unsaturated fatty acids (Medeiros et al, 2012). However, fish are relatively situated at the top of the aquatic food chain; therefore, they normally can accumulate pollution from food, water and sediments (Yilmaz et al, 2007; Zhao et al., 2012). Among the pollutants, non-degradable pollutants (persistent pollutants) such as heavy metals in sediments and mud and sludge concentrated as potential marine pollution and at the same time accumulate in aquatic and body tissue and concentrated and fish consumption may be toxic to humans and severe adverse effects such as disorders of the nervous system, renal, genetic mutations, and so on to be created, It is of utmost importance. Among the heavy metals Pb, Ni, Fe, Zn and Cu indices, oil pollution and pollution from industrial activities in the marine ecosystem, the capacity of ecosystems to accept the changes in the environment and although, by its nature has the ability to cope with change but today it is clear that destruction has been the speed of natural regeneration, and the process for irreversible environmental degradation is growing, so measures to protect the environment should ponder (GanJavi et al, 2010). In addition, today one of the major concerns in the discharge of heavy metals into the marine environment is all over the world. In addition, is well established that heavy metals cause toxicity and accumulation of ecological significance are many, these elements have devastating effects on the marine ecosystem and species diversity (Agah et al, 2008). Lead one of four metals that have the most damaging effects on human health. Bio-synthesis of hemoglobin disorders and anemia, high blood pressure, kidney damage, miscarriage and preterm birth, nervous system disorders, brain damage, infertility in men, decreased learning

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ability and behavioral disorders and hyperactivity in children from the negative effects of increasing the concentration of lead in body (EPA, 1997). Nickel toxicity varies widely and is affected by salinity and the presence of other ions is placed. Industrial and commercial use of nickel- containing stainless steel, plating, painting and ceramics are Nickel also from anthropogenic sources enter the water system. Small amounts of nickel in people who are allergic to this heavy metal can cause severe inflammation of the skin (EPA, 1997). Zinc is one of the natural elements in building the body's cells and many enzymes and hormones involved. The metal body with many vital macromolecules are irreversibly linked and threatened to disrupt the biological activity of cells. Zinc also causes gastrointestinal disturbances such as nausea, vomiting, dry mouth, fever, headache and neurological disorders and respiratory diseases are also on the human body in high concentrations in the prostate, bone, muscle and liver accumulates (Merian, 1992). Copper natural entrance to the marine environment caused by the erosion of the cliffs is mine, is estimated at around 325000 tons per year. High levels of sea wage into the sea. Copper dissolved in seawater, mainly in the form of water with low salinity CaCo3 and is also seen as $Cu\ OH^{+}$. In addition, the complex organic molecules are formed. Copper metal originating from various industries and by phytoplankton enters the food chain (Babaei and Kermanshah, 2001). Iron is an important component of hemoglobin and transfer of blood and oxygen in the human body. If you do not hit the iron with body tissues or stay in them, causing conjunctivitis, inflammation problems in the choroid and retina. Normally, the body needs iron to 4 to 5 grams distributed in various tissues. The body's ability to excrete iron is not greater than 2 mg per day and hence excessive intake of iron accumulation in the target organ and primarily eats more than 30 milligrams per kilogram of iron can lead to toxicity and more than 250 to 300 mg kg leads to death (Babaei and Kermanshah, 2001). Today, aquaculture as one of the most useful animal protein has been proposed for providing food needs and protects the human health around the world. Because of the harmful effects of heavy metals that are toxic in small amounts in water resources management with continuous measurement will be necessary (Agbozu et al, 2007). Shrimp crustacean invertebrates which have different sizes. Shrimp are cold-blooded animals in accordance with the aquatic environment is the collection of physiological activities. Family shrimp Penaideh in tropical and subtropical waters around the world are to be found, shrimp, fish and economical valuable Persian Gulf and Oman Sea that have very high nutritional value. One of the most important species Penaideh shrimp, white shrimp is *Metapenaeus affinis*. Shrimp meat protein content of 23-18 percent. One of the most important economic shrimp aquaculture in waters south of the country (Ansari et al, 2005). The most important control methods, choice of different fish species widely to the physiological effects of heavy metals can be used (Obasohan, 2007). Thus, the concentration of heavy metals in the tissues of aquatic can be a prelude to detect the level of aquatic pollution (Dugo et al, 2006). Such as indicator species to measure the amount of pollution can be traced to the white shrimp *Metapenaeus affinis*.

MATERIALS AND METHODS

Heavy metals in marine systems are a global problem, since continuous exposure of marine organisms to their low concentrations may result in bioaccumulation, and subsequent transfer to man through the food web. Fish are good indicators for the long term monitoring of metal accumulation in the marine environment. Therefore, measurement and evaluation of a number of toxic elements and heavy metals (lead, nickel, iron, zinc and copper) in the muscle tissue of white shrimp are *Metapenaeus affinis* stations (Qeshm, Khamir port and Laft port) in the Persian Gulf was the basis for this study . After determining the three stations, in every season of every station, 30 types of white shrimp were sampled, so that were collected randomly in every season of collect 90 types and total two season 180 samples. After the biometrics, autopsy was performed and was isolated muscle tissue.so that for dry white shrimp muscle tissues put in the freeze dryer (VaCo5 model) at 40 - ° C for 8 to 10 hours.so after running out the time and ensure complete dry of muscle tissue, the samples are removed balloons and in the petri dishes were placed numbered (Moopam ., 1999). In order to digest the samples were ground with a porcelain mortar laboratory. the First, was measured (0.5gr) amount of dried samples tissue by" Sartorius scales"-made in Germany- with accuracy equivalent 0.001grams.The sample is poured shed into a microwave vial (ETHOS1, model) and after the addition of 7 ml of concentrated nitric acid 65% (after the using porcelain mortar any time, washed with nitric acid 5% and was completely rinse with distilled water) so 1 ml hydrogen peroxide (30%), closed the door's vials and those are placed in a special chamber, next transferred to the microwave (Moopam, 1999) and according to the order digest the sample. After digestion and cooling time, the samples were removed from the device and were pure through Whitman filter paper number 42. The content of the filter was washed with distilled water. So samples liquid ready discharged into the beakers and were dried in the laboratory's temperature. After dried, samples mixed through distilled water and samples deliver to the volume 50 with pure distilled water.So sample kept in polyethylene containers and stored at 4 ° C (to avoid any reduction in the volume). Obviously storage time should not be long and after digestion of the samples, they injected the atomic absorption and their actual chemical concentrations were calculated. The chemical digestion is based on accepted MOOPAM (Moopam, 1999). Data analysis was performed using SPSS 19 software and

analysis of means to help T- test were compared with the presence or absence of a significant difference at 95% (P <0.05) was determined. As well as charts and tables Excel2007 software was used.
With the heavy metal concentrations in white shrimp muscle can be calculated to estimate the risk of daily consumption. In order to assess the potential danger of these fish, the calculation of the daily intake for a dose for an adult of 70 kg of fish per week was calculated and the amount of the reference dose (RfD) of the EPA were compared. In fact, the RfD for a pollutant an estimate of the amount of daily exposure to pollutants by human population So that the life the person does not have a harmful effect. Intake of toxic metals by the individual depends entirely on the amount of food containing these metals. The amount of the water once a week and the amount per serving is eight ounces equivalent (228gr) was considered for a 70 kg adult. Accordingly, the daily intake was calculated for each of the metals (Burger and Gochfeld, 2005).

$$EDI = \frac{(C \times MS)}{BW}$$

(EDI), the estimated daily intake, MS is the meal size and C is the metal concentration (mg kg^{-1}) (w.w) and BW is the body weight. Based on the USEPA (1989) Guidance, we assumed that the ingestion dose is equal to the adsorbed contaminant dose and that cooking has no effect on the contaminants (Chien et al, 2002).

[III] RESULTS

Analysis of variance showed that the concentrations of lead, nickel, iron, zinc and copper in muscle tissue of white shrimp *Metapenaeus affinis* between regions Qeshm, Khamir port and Laft port in winter there is a significant difference (P< 0.05). As the studied concentration in the muscle of white shrimp in winter Qeshm higher rates than areas (Khamir port and Laft port) and the difference was statistically significant (P<0.05). (Table1).

Table1: Compares the Results of the Average of the Elements Nickel, Lead, Iron, Zinc and Copper in Muscle Tissue of Blue White Shrimp in winter in Qeshm, Khamir port and Laft port (Mean ± SD), (n = 30)

Index / Area	Qeshm	Khamir port	Laft port
Nickel (micrograms per gram)	0/71±0/04	0/40±0/04	**0/22±0/06**
Lead (micrograms per gram)	0/019±0/004	0/015±0/005	**0/010±0/002**
Zink (micrograms per gram)	55/4±1/88	48/3±1/08	**32/70±1/18**
Iron (micrograms per gram)	17/51±0/18	13/65±0/41	**10/33±0/20**
Cu (micrograms per gram)	0/551±0/04	0/475±0/02	**0/356±0/006**

The results of ANOVA showed that the concentrations of lead, nickel, iron, zinc and copper in muscle tissue of white shrimp *Metapenaeus affinis* between regions (Qeshm, Khamir port and Laft port) there was no statistically significant difference in summer (P<0.05). So in terms of concentration in the muscle tissue of white shrimp in the summer Qeshm higher rates than areas (Khamir port and Laft port), and the difference was statistically significant (P<0.05) (Table2). The results indicate that in all regions of concentration of heavy metals (lead, nickel, iron, zinc and copper) in summer than in winter (Table 3).

Table2: Compares the Results of the Average of the Elements Nickel, Lead, Iron, Zinc and Copper in Muscle Tissue of Blue White Shrimp in summer in Qeshm, Khamir port and Laft port (Mean ± SD), (n = 30)

Index / Area	Qeshm	Khamir port	Laft port
Nickel (micrograms per gram)	0/88±0/04	0/51±0/05	0/39±0/02
Lead (micrograms per gram)	0/029±0/005	0/021±0/001	0/016±0/003
Zink (micrograms per gram)	67/7±1/29	52/30±1/07	42/31±1/31
Iron (micrograms per gram)	20/36±0/20	17/25±0/29	15/81±0/27
Cu (micrograms per gram)	0/763±0/023	0/688±0/012	0/595±0/025

Table 3: Results of the Comparison of the Average Values of Nickel, Lead, Iron, Zinc and Copper in White Shrimp Muscle in Qeshm, Khamir port and Laft port in Summer and Winter (Mean ± SD),) (n = 30).

Laft port		Khamir port		Qeshm		Variable
summer	winter	summer	winter	summer	winter	
0/39±0/02	0/22±0/06	0/51±0/05	0/40±0/04	0/88±0/04	0/71±0/04	**Ni**
0/016±0/003	0/010±0/002	0/021±0/001	0/015±0/005	0/029±0/005	0/019±0/004	**Pb**
42/31±1/31	32/70±1/18	52/30±1/07	48/3±1/08	67/7±1/29	55/4±1/88	**Zn**
15/81±0/27	10/33±0/20	17/25±0/29	13/65±0/41	20/36±0/20	17/51±0/18	**Fe**
0/595±0/025	0/356±0/006	0/688±0/012	0/475±0/02	0/763±0/023	0/551±0/04	**Cu**

DISCUSSION

Exploration, extraction and transportation of oil in the Persian Gulf, in addition to direct contamination, due to large amounts of heavy metals, chemical pollution of the Gulf marine and aquatic life is (AL –Saleh and Shinwari, 2002). Also documented that the geographical locations and season of catch could lead to different metal concentrations even in the same fish species (Dural et al., 2007; Bahnasawy et al., 2009). Levent and Ayse test for determining the rate of accumulation of heavy metals copper, zinc, lead, cadmium in living tissue *Mytilus* Mediterranean coast of *Sinop* on the Black Sea oysters were done and the amount of heavy metal pollution on the coast were measured by atomic absorption. Determine the concentration of heavy metals was carried out at four stations that show significant differences in measured values. The difference in the metals and Havens local station that waste and scrap ships located in those areas. In addition, from a public health standpoint measured levels of heavy metals below permitted levels, and they do not create particular problems (Levent and Ayse, 1998). Chen showed significant differences in the concentrations of lead, cadmium, mercury, silver, copper and iron Chi-Ku Lagoon was found in samples from different regions. He also said that in areas where the origin of pollutants from sewage or fresh water input. Cadmium, mercury and copper were present in the environment, while the entrance to the remote areas of the mouth and go wetland reduced concentrations of these elements (Chen, 2002). Fabris and colleagues showed that the concentration of heavy metals such as arsenic, cadmium, iron, zinc and mercury in fish and lobster J. Edwardsis P. bassenis ground now and abalone H. rubra to the location where the fish live in it. Depends on the concentration of the species in different parts of the coastal waters of Victoria in Australia there is a significant difference, but a pattern and there was no consistent trend across regions at a concentration of heavy metals. There are significant differences between the concentrations of heavy metals in different areas can be discussed and not because of different management application, environmental conditions, evacuation of wastewater, the presence of industrial plants and aquaculture activities in the areas (Fabris et al, 2006). Turkmen and colleagues reported that concentrations of heavy metals in fish muscle, according to the area where the fish is caught. And according to the species of fish can be very diverse and vary, also showed. Although not different between the concentrations of heavy metals in different parts of sampling fish there are significant differences (Turkmen and colleagues, 2005). Meador and et al the concentration of three cadmium, mercury and lead in sediments and fish in several areas in Alaska and California have measured the results showed concentrations of lead and cadmium in sediments rural areas of California due to human activity is the because gasoline is increasing (Meador et al, 2005). A significant impact on aquatic habitats so that the concentration of heavy metals, heavy metals in organisms that live in the Gulf are less than the amount of heavy metals in the body of organisms in coastal waters and estuaries, bays and inlets are present (Al- Yousef et al, 2000). Unfortunately, in the discharge of sewage and solid waste and industrial development and dredging operations off the coast and ports, unloading of agricultural pesticides and fertilizers, as well as Persian Gulf oil extraction operations are heavily polluted with heavy metals and hydrocarbons is (Ashraf, 2005). More pollutants into aquatic systems are eventually are deposited in the sediment. Sediments, aquatic environments are a critical component for performance and nutrition provide habitat for many organisms and in many cases the accumulation of metals in sediments than in the water (Unlu et al, 2008). And semi-benthic benthic species vulnerable to contaminants in sediments and contaminants are water-soluble, this species also play a constructive role in this environment and therefore their demographic shifts affect all societies and threaten the balance of ecosystems (Cogun et al, 2006). Generally, the most important reasons for the high concentration of lead, nickel, zinc, copper and iron in muscle tissue in the white shrimp in Qeshm island compared to Khamir port and Laft port in various industries along the coast, discharge of industrial effluents and urban coastal waters is that their wastewater in a variety of heavy metals, and this increases the concentration of these metals. On the other hand there dhow building yards along the waterfront of the island and the use of color and anti-corrosion material (which contains zinc chromate and lead oxides area and finally moved to the coastal waters and adjacent areas and water pollution in this area are), too Boat traffic (tourism and fishing activities) and the presence of lead and nickel in gasoline and publish it in the air, then lead and nickel from combustion and quickly deposited on the soil, The nickel-containing sediments by rivers to the Persian

Gulf could also be other reasons for this increase. Fifteen mine soils are red, white, chalk, yellow sulfur, iron and within 11 km of the island. The most active are red mineral containing abundant iron as well as a micronized powder production plant of red soil cited Island. On the other hand pollution caused by vessels traffic, repairs them (given that most people trade jobs and trade, fishing, boat-building and agriculture) should also be considered.

The results of this study showed that the concentrations of the studied regions (Qeshm, Khamir port and Laft port) in summer than in white shrimp floats statistically significant difference. The concentration of heavy metals in the summer of aquatic organisms in the body often in locations in areas with industrial activities is free of contaminants and more (Mendil et al, 2010). Wong et al, with the amount of lead, cadmium, copper and zinc on the species *Perna viridis* in Hong Kong showed that the concentration of cadmium and copper all areas other than the significant difference in summer and winter there is significant (Wong et al, 2000). Dural and colleagues, experimenting with a variety of fish *Sparus aurata* showed that the concentration of cadmium, lead, zinc and arsenic in different seasons and also heavy metals in different organs is different (Dural et al, 2007). Hajihasani and Ghasemi, examined the emissions of nickel, chromium, cadmium, lead, copper and iron is paid crap. The results of data analysis showed a significant difference in the amount of heavy metals in between there, the average concentration of all parameters in the months of February, March, April and May, and in other months less than the standard limit is exceeded. Another important factor of increasing concentrations of heavy metals, salinity, which is more subject to climate change sea water in winter as in summer minimum and maximum amount of salt in sea water. There is a direct relationship between temperature and salinity suggests that with increasing temperature, salinity rises (Haji Hussain et al, 2001). Given that the air temperature in the hottest days of summer in August to 45 degrees Celsius, thereby also increasing the amount of evaporation and salinity. Because in some seasons, especially summer Persian Gulf under the influence of Oman Sea and other waters that are input to the conclusion of some metals due to variations in salinity and quicker to settle. The heavy metals are directly related to the amount of water salinity, possibly Another factor is the increasing amount of these metals in the summer (Kafilzadeh et al, 2001; Karbasi, 2000). Shrimp, fish and other creatures as function of ambient temperature is cool, and because of the drop in temperature in winter, these creatures are also experiencing lethargy and become less feeding out of their nests and most of the time prefers to remain in their nests. The more shrimp have a semi-hibernation during the winter. And the start of the season of heat and warming the water, they begin to crawl and eat them. Probably because it is less shrimp feed in winter, they eat more food in autumn and winter because due to reduced physical activity, metabolism decreases, and the same amount of food with limited fishing in winter lie is enough to live in the winter (Caran,1943). Due to less activity, less power and less availability of food and hibernate in winter than in summer in summer than in winter is the concentration of heavy metals.

The most important part is edible muscle tissue of fish that can directly impact on human health. Based on concentrations measured in terms of weight compared with existing standards (Table 4), was lower than the limit concentration, and muscle consumption of lobster in three regions of the Hormozgan province (Qeshm, Khamir Port and Laft Port) will not be a threat to the these metals have. Based on the tables (5, 6 and 7) in studied calculated values for the daily intake lower than the standard dose of EPA is that it suggests a dose (equivalent to 228 grams) of shrimp a week from a health standpoint no for a consumer does not ban adult.

Table 4: International Standards for Allowable Amounts of Nickel, Lead, Zinc, Iron and Copper (gμ/g) in Muscle Tissue

Reference	Cu	Fe	Zn	Ni	Pb	Metal / International standards
FAO/WHO, 2010	10	-	30	-	2.14	**FAO/WHO**
Pourang et al., 2004	10	-	35	-	1.5	**NHMRC**
Pourang et al., 2004	-	100	35	1	5	**FDA**

Table 5: Calculation of the Daily intake of Heavy Metals by Individuals in Exchange for a Serving per Week for a 70 kg Person (Qeshm)

Reference dose, the EPA (μg/kg/day)	The daily intake (μg/kg/day)	The metals (μg/kg /day) during a meal (about 228 g)	Metal concentrations in samples μg/g(w.w)	Metal
20	0.238	181.26	0.795	**Ni**
25	0.007	5.472	0.024	**Pb**
40	0.197	149.796	0.657	**Cu**
300	18.465	14033.4	61.55	**Zn**
500	5.679	4316.04	18.93	**Fe**

Table 6: Calculation of the Daily intake of Heavy Metals by Individuals in Exchange for a Serving per Week for a 70 kg Person (Khamir Port)

Reference dose, the EPA (µg/kg/day)	The daily intake (µg/kg/day)	The metals (µg / kg / day) during a meal (about 228 g)	Metal concentrations in samples µg/g(w.w)	Metal
20	0.136	103/74	0.455	**Ni**
25	0.005	4.104	0.018	**Pb**
40	0.174	132.468	0.581	**Cu**
300	15.09	11468.4	50.3	**Zn**
500	4.635	3522/6	15.45	**Fe**

Table 7: Calculation of the Daily intake of Heavy Metals by Individuals in Exchange for a Serving per Week for a 70 kg Person (Laft Port)

Reference dose, the EPA (µg/kg/day)	The daily intake (µg/kg/day)	The metals (µg / kg / day) during a meal (about 228 g)	Metal concentrations in samples µg/g(w.w)	Metal
20	0.091	69.54	0.305	**Ni**
25	0.003	2.964	0.013	**Pb**
40	0.142	108.3	0.475	**Cu**
300	11.25	8551/14	37.505	**Zn**
500	3.921	2979/96	13.07	**Fe**

In the first study to estimate the amount of entry and the risk of heavy metals nickel, lead, zinc, iron and copper were the shrimp. Results showed that all estimates of daily log metals is no danger in taking this species of fish found not consumers. It should be noted that in shrimp various other metals such as mercury and organic pollutants such as polyaromatic hydrocarbons, and accumulate. It is therefore essential that health authorities such as the Ministry of Health and other organizations in comprehensive background check estimate the amount of risk in different groups of consumers such as children and pregnant women do, and the accumulation of heavy metals in fish consumed annually carcinogenic and non-commercial and examine.

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