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Annals of Biological Research, 2012, 3 (3):1593-1599
(http://scholarsresearchlibrary.com/archive.html)

Annals of Biological Research
Scholars Research Library
ISSN 0976-1233
CODEN (USA): ABRNBW

Determination of Heavy Metals (Cd, Pb, Hg and Fe) in Two Commercial Shrimps in Northern of Hormoz Strait

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ABSTRACT

*This study was carried out to detect the concentration of heavy metals in the muscle of two shrimp species (*Metapenaeus affinis *and* Feneropenaeus merguiensis*) in north side of Hormoz strait in four seasons(Winter 2009- Autumn2010). Al samples of each species (including 15 male shrimps and also15 female shrimps) have been collected at each season. All samples were analyzed for Cd, Pb, and Fe, concentrations by inductively coupled plasma-atomic emission spectrometry (ICP-AES) and for Hg by LECO AMA254 Advanced Mercury Analyzer. In this study , the highest concentration(Total mean concentration In term of µg/g dry weight) of heavy metals in* F. merguiensis *in male for Hg,Fe,Cd and Pb was 0.15,17.9,0.09 and 0.55 µg/g respectively and for female concentration of Hg,Fe,Cd and Pb was 0.17, 16.8 , 0.1 and 0.45 µg/g respectively.Heavy metlas concentration in male of* M. affinis *was 0.25 , 29.98 , 0.13 and 2.05 µg/g for Hg,Fe,Cd and Pb respectively.concentration of Hg,Fe,Cd and Pb in female of* M. affinis *was 0.25 , 19.69 , 0.14 and 2.02 µg/g respectively. Also, the comparison of our results with the International standards showed that the concentration of Hg, Fe, Cd and Pb in the two shrimp species (*M. affinis *and* F. merguiensis*) is less than the authorized range of WHO, FDA and EPA standards, hence the consumption of these shrimps is without encumbrance.*

Keywords: Heavy metals, Shrimp, Hormoz starit, Iran.

INTRODUCTION

The consumption of aquatic animals is increasing due to the increase in population and appearing their role on preventing and curing many of the diseases in recent decades [1, 2]. This activity leads to more fish catchments and therefore decreases in fish population. On one hand, new

methods and instrument for fishing and on the other hand increase and discharge of pollution of water body have adverse effect on fish reservoir thus, aquaculture as a reliable and programmable method in order to meet the ever-increasing demands of people has been considered by most of the countries all around the world including Iran. Nowadays, a wide range of animals and plants are depend on aquatic resources has been classified into cultured aquatics and each has allocated a special stand in this increasing industry [3]. Iran is surrounded by the sea from the north and the south and has many domestic rivers, lakes and basins. These water body prepared good situations for living of hundreds kinds of aquatic animals that can use some of them as human food such as fish , muscle , crab and shrimp which involve considerable supplies of protein. heavy metals Contamination in on local, regional and global scales, have been intensively studied in recent years, due to the fact that metals are persistent, toxic, tend to bioaccumulation, and they pose a risk to humans and ecosystems [4,5].The main reason for this kind of water pollution is the increasing in discharge of west water from urban area and agriculture activity and industrial wastewater to the coastal zone from rivers and non-point sources, especially in developing countries. Metal contamination can have adverse effects on marine organisms only after metal uptake and accumulation [6].The concentration of heavy metals in aquatic organisms in water body depend on local geology, local addition from mining and industrial activity waste water discharge and/or globally distributed pollution. Fishes are often at the top of the aquatic food chain and may concentrate large quantity of heavy metals from the water [7].Contamination of aquatic ecosystems with heavy metals has seriously increased worldwide attention, and a lot of studies have been published on the heavy metals in the aquatic environment [8].The present study has been conducted to determine Cd, Pb, Hg, and Fe concentrations in the muscle of 2 shrimp species in Hormoz Strait in north coastal areas of Persian Gulf.

MATERIALS AND METHODS

Site selection

Sampling sites was selected of an area that has a high importance as one of the most significant habitats of shrimp, and in its nearby, industries and fishing is the main profession of people in which mineral contaminants indirectly enter the coastal waters via sewage, fishing raft and commuting oil-tankers from the region.

Sampling

All shrimp samples(including 15 male and female shrimps from every species) were randomly collected by trawl net in depth of 5-25 meters at each season with 3 time in order to achieve the project's goals. Body weight and length of shrimps were measured prior to dissection.

Sample preparation

Shrimp samples, were transferred to the laboratory in a thermos flask with ice in an isolated box on the same day [9]. Approximately 5g of samples muscle (edible parts) from each sample were dissected, wash with de-ionized water, weighted and then packed in polyethylene bags and stored at -20° C prior to analysis. All of the samples were dried at 60° C for 48 h in laboratory oven [10].

All glassware's was cleaned prior using by soaking in 10% v/v HNO_3 for 12h and then rinsed with ultra-pure water. Between 0.2 to 0.4 g of dried sample material were weighted and then digested in acid-cleaned Teflon beaker with 5ml of ultra-pure nitric acid (65%v/v). Typical microwave digester operated for 30-40 min at a target digestion temperature at 200°C and after then allowed for 1h to cooling. Digested samples transferred to a graduated plastic test tube and brought up to volume (50ml) with Mili-Q-water [11]. All samples were analyzed three times for Cd (cadmium), Pb (Lead), Fe (Iron), by inductively coupled plasma-atomic emission spectrometry (ICP-AES) and for Hg (Mercury) by LECO AMA254 Advanced Mercury Analyzer.

Statistical analysis were done by using the method of one-way variance analysis method for study for examining existence and non-existence of significant difference at the level of 5% between total mean concentration of metals with SPSS software(Version 11.5).

RESULTS

The shrimp species biometry showed in table1, 2.The resulting outcomes of analyzing the concentration of heavy metals in the two shrimp species represent that the highest concentration of its related to iron (Fe) and the lowest concentration to (Cd)cadmium.

The highest concentration in *Penaeus merguiensis* was Fe and the Pb, Hg and Cd following it and have less concentration (Cd<Hg<Pb<Fe).these heavy metals have same pattern in *Metapenaeus affinis* (Cd< Hg< Pb <Fe).

The highest concentration of Hg in two sexes in *F. merguiensis* was observed at summer which have not a significant difference ($p<0.05$) compare to autumn season, and the lowest concentration it was also in spring. The highest concentration of Fe in male of *F. merguiensis* has been recorded in winter and in female in autumn. The lowest concentration of Fe in this species at both male and female observed in spring which has not significant difference with summer ($p<0.05$). also the lowest concentration of cadmium at both male and female of *F. merguiensis* observed in spring and the highest concentration of it in male in summer and in female seen in autumn that their difference was significant ($p<0.05$). also the highest concentration of Pb in both male and female of *F. merguiensis* observed in summer and its lowest concentration in male in winter and in female was in spring and summer which they had significant difference($p<0.05$).

In *M. affinis* the highest concentration of Hg in male observed in autumn and in female in summer, the lowest concentration observed in male at winter and in female at spring. which their difference was significant as well ($p<0.05$).the highest concentration of Fe recorded in male of *M. affinis* in winter, in female in spring and the lowest concentration of Fe in male was observed in summer and in female in autumn which in male has a significant difference but for female correlation was not significant ($p<0.05$). The highest concentration of Cd was in male in summer and the lowest concentration was in spring showed significant differences. In female also the highest concentration was recorded in summer and the lowest concentration in spring that their difference was significant as well ($p<0.05$). also the highest concentration of Pb in male

of *M. affinis* was observed in autumn and the lowest concentration in spring that their difference was also significant and in female that most amount was recorded in summer and the lowest concentration of it in spring which their difference was significant ($p<0.05$).

DISCUSSION

Because of some special characteristics of shrimps such as feed habit (detritus), live in bottom (Benthic environment) and direct contact by polluted sediment have more potential to increase heavy metals concentration in their tissue and usually recorded more concentration than other aquatic organism in many study.

The biological and ecological responses to certain pollutants (organic and inorganic) may vary from changes at the population/community level, to organ/tissue, and even to molecular level [12].it is also notable that the difference in the concentration of various metals in *M. affinis* than F. *merguiensis* related to the numerous elements such as age, size and weight, diet and their habitat [13] ecological needs, metabolism [14]. The main reason for low heavy metals concentration in *F.merguienis* than *M. affinis* is related to living habitat and feeding ground, since the *F.merguienis* lives in upper bottom and feeds on the one food levels in food chains than *M.* affinis. On the other hand *F.merguienis* does not plunge into the bottom, but lives near the deposits of bottom [15]. Due to biological elements and life cycle of *M. affinis*, has more dependency to bottom. Therefore, on this basis the concentration of the examined heavy metals (Hg, Fe ,Cd and Fe) at the present study in *M. affinis* is more than *F. merguiensis* which represents the more dependency of this species on bottom in proportion. The highest concentration was on dry seasons in this region (spring and summer) may be because of high evaporation rate in Persian Gulf.

Table 1 biometry Results of (*fenneropenaeus merguiensis*).

Spring	Summer	Autumn	Winter	
total length(L±SD)				
10.5±1.4	12.4±1.8	13.2±0.8	11.6±1.6	**Male**
11.7±1.5	13.2±1.4	13.7±1.1	12.1±0.9	**Female**
Weight(W±SD)				
12±1.9	14.4±1.7	15.7±0.9	13.2±1.3	**Male**
13±0.6	15.6±1.1	17.3±1.4	13.9±0.5	**Female**

L: the mean of total length (cm) *W: the mean of body weight (g)*

Generally, according to the results and according to regional conditions such as high evaporation, semi-closed, wastewater discharge, and etc. and compared to other regions, Persian Gulf in the critical condition that requires more attention and control of its pollutants.

the mean concentration of the Hg in *p. semisulcatus* muscle 0.76, *F. merguiensis* 0.08 , *M. affinis* 0.1 , and *M. stylifora* 0.5 mg in North side of Hormoz strait was measured by Namayande, 2001,which seems that it is due to the biological elements, life cycle and also more dependency on bottom. The concentration of Hg also at the muscle of *p. semisulcatus* was more than *F.*

merguiensis that this is also due to preferring mud bottom, excavation behavior and their biological and physiological elements [16].

Table 2 biometry Results of (*Metapenaeis affinis*)

Spring	Summer	Autumn	Winter	
total length(L±SD)				
10.5±1.4	12.4±1.8	13.2±0.8	11.6±1.6	**Male**
11.7±1.5	13.2±1.4	13.7±1.1	12.1±0.9	**Female**
Weight(W±SD)				
12±1.9	14.4±1.7	15.7±0.9	13.2±1.3	**Male**
13±0.6	15.6±1.1	17.3±1.4	13.9±0.5	**Female**
Spring	**Summer**	**Autumn**	**Winter**	
total length(L±SD)				
13.4±0.8	12.3±0.4	14.7±1.1	13.2±1.1	**Male**
16.1±1.0	15.6±1.5	20.6±1.7	14.4±0.6	**Female**
Weight(W±SD)				
28.5±5.8	20.5±1.5	38.1±3.1	25.8±3.5	**Male**
51.5±6.9	46.7±11.2	81.4±10.6	37.1±4.7	**Female**

Table 3 the mean concentration and standard deviation of Hg, Fe, Cd, and Pb in shrimp *F. merguiensis* (In term of µg/g dry weight)

Heavy metal	gender	Winter	Autumn	Summer	Spring
Hg	**Male**	0.1 ± 0.05^{a}	0.2 ± 0.01^{b}	0.2 ± 0.06^{b}	0.1 ± 0.05^{a}
	Female	0.2 ± 0.02^{b}	0.2 ± 0.03^{b}	0.2 ± 0.04^{b}	0.1 ± 0.02^{a}
Fe	**Male**	33.2 ± 13.7^{c}	21.6 ± 3.9^{b}	10.8 ± 7.0^{a}	6.0 ± 1.7^{a}
	Female	22.9 ± 5.8^{b}	24.8 ± 9.2^{b}	12.6 ± 8.8^{ab}	6.9 ± 1.7^{a}
Cd	**Male**	0.08 ± 0.01^{a}	0.10 ± 0.04^{b}	0.11 ± 0.02^{b}	0.07 ± 0.03^{a}
	Female	0.09 ± 0.04^{a}	0.12 ± 0.05^{b}	0.11 ± 0.04^{b}	0.08 ± 0.04^{a}
pb	**Male**	0.4 ± 0.0^{a}	0.6 ± 0.1^{ab}	0.7 ± 0.3^{b}	0.5 ± 0.3^{a}
	Female	0.3 ± 0.0^{a}	0.5 ± 0.1^{a}	0.7 ± 0.1^{b}	0.3 ± 0.0^{a}

The numbers in one line with different words have significant difference ($p<0.05$)

Table 4 the mean concentration and standard deviation of Hg, Fe, Cd, and Pb in shrimp *m. affinis* (In term of µg/g dry weight)

Heavy metal	gender	Winter	Autumn	Summer	Spring
Hg	**Male**	0.2 ± 0.01^{a}	0.3 ± 0.05^{b}	0.3 ± 0.04^{b}	0.2 ± 0.02^{a}
	Female	0.2 ± 0.09^{b}	0.3 ± 0.04^{b}	0.3 ± 0.08^{b}	0.2 ± 0.06^{a}
Fe	**Male**	44.2 ± 7.7^{b}	36.2 ± 12.0^{b}	19.4 ± 5.7^{a}	20.13 ± 14.81^{a}
	Female	19.2 ± 11.1^{a}	18.7 ± 1.8^{a}	19.7 ± 3.2^{a}	21.17 ± 9.16^{a}
Cd	**Male**	0.12 ± 0.03^{a}	0.14 ± 0.04^{b}	0.15 ± 0.05^{b}	0.11 ± 0.06^{a}
	Female	0.13 ± 0.07^{a}	0.15 ± 0.06^{b}	0.16 ± 0.07^{b}	0.12 ± 0.05^{a}
pb	**Male**	2.3 ± 0.3^{b}	2.6 ± 0.4^{b}	2.1 ± 0.1^{b}	1.2 ± 0.5^{a}
	Female	1.8 ± 0.2^{b}	2.2 ± 0.2^{b}	2.3 ± 0.1^{b}	1.8 ± 0.0^{a}

The numbers in one line with different words have significant difference ($p<0.05$)

Comparing our results to some other researches in other countries, shows generally our results is more than others. About comparing to standards values, Hg concentration is near the EPA and

WHO and FDA standard values.Cd concentration is a little more than EPA and FDA standards and Pb is less than EPA and FDA standard values. (table5).

Table 5 comparing between results of this study with same in other regions

Species	Study area	Hg	Fe	Cd	Pb
Penaeus merguiensis	Persian Gulf,Qeshm Island(17)		17.77	0.07	
Metapenaeus affinis	Persian Gulf,Qeshm Island(17)		22.15	0.11	
Penaeus merguiensis	Persian Gulf,Hormozgan Province(18)		78.97		ND
Metapenaeus affinis	Persian Gulf,Hormozgan Province(18)		173.5		ND
Penaeus merguiensis	Australia(19)		0.76	0.05	
Penaeus merguiensis	Australia(19)		0.61	0.68	
Penaeus merguiensis	Persain Gulf,Qatar(20)				
Our study(*F.merguienis)*	Persian Gulf,Hormozgan Province	0.16	17.35	0.5	0.09
Our study(*M.affinis*)	Persian Gulf,Hormozgan Province	0.5	24.83	1.01	0.13
EPA standard		0.5		1	1
FDA standar		1-0.5		1	5
WHO standard		0.5			

CONCLUSION

In this study the results of measuring Fe, Hg, Cd and Pb at both species showed that the concentration of Fe in comparison with other metals had the highest concentration in both species and cadmium also has the lowest concentration. The total mean concentration of the heavy metals (Hg, Fe, Cd and Fe) at the present study in *M. affinis* was more than *F. merguiensis* which represents the more dependency of this species on bottom in proportion.The metal content is species- dependent, with some species showed high concentration of metals, and some showed low concentration. The metal concentrations in the shrimp muscle tissue were also time-dependent, with residues much higher during the rainy season. The comparison of the results of this study with existing standards showed that the concentration of Hg, Cd and Pb at both *F. merguiensis* and *M. affinis* under studied is less than the authorized rang of WHO, FDA and EPA standards, thus the consumption of these shrimps is without encumbrance.

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