Measurement the heavy metals content (Cd, Ni and Pb) in the muscle tissue of *Psettodes erumei* and *Psettodes erumei* of the Qeshm Island (Persian Gulf)

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Abstract

This study conducted to determine the amount of the heavy metals such as Cd, Ni, and Pb in the muscle tissue of Hoof benthic fish (*Psettodes erumei*) and urban pelagic fish () in Qeshm Island in the north of the Persian Gulf. Overall, the heavy metal content *Lethrinus nebulosus* of 30 tissue samples was randomly measured by atomic absorption spectrometer. The mean amount of Cd (0.16± 0.002) and Ni(0.56± 0.03) in benthic Hoof was significantly greater than that in the Urban pelagic fish while the concentration of (29.64± 3.72) in urban pelagic fish was higher than that in the Hoof tissue samples ($P<0.05$). Our results showed that the concentration of the three measured heavy metals in the fishes studied was less than the standard levels proposed by WHO and FAO.

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Introduction

Fish as a valuable source of nutritional requirement constitutes one of the main feeding items for many people around the world. It is also highly recommended for pregnant women thanks to its Omega-3 rich content necessary for embryo’s brain development. In spite of such a valuable source of micro- and macro-nutrients, anthropogenic water pollution around the world has raised new concerns about the consumption of fish. The amount of heavy metals is continuously increasing in different ecosystems through anthropogenic activities such as agricultural practices, urbanization, and industrialization (Giguere, Campbell, Hare, McDonald & Rasmussen 2004; Gupta, Rai, Pandey & Sharma 2009) especially in aquatic ecosystem. Bioaccumulation and biomagnification of especially toxic metals is a growing concern for scientists and is turning to an important worldwide problem (Malik, Biswas, Qureeshi, Borana & Virha 2010). Many investigations have proved that some dangerous heavy metals and toxins can be magnified along the food chains and reach high levels in top predators such as big fishes and carnivore birds (Nehring, Nisson & Minasian 1979; Marquenie 1985; Babel & Kurniawan, 2004; Sahebi & Emtyazjoo 2011). Other investigations have also proved that these metals can be deposited and magnified in sedimentary and aquatic biomass (Linnik & Zubenko 2000). Some of these metals can reach a harmful level in the upper trophic levels (Agah, Leermakers, Elskens, Fatemi & Baeyens 2009). However, biomagnification of metals along aquatic trophic food chains has not been proved for many metals (Gerhardt 1992). For example, toxicity of some heavy metals such as Cd, Fe, Zn, and Pb is related to water pH (Gerhardt 1992). Comparing the amount of heavy metals accumulated in muscle tissue of different fish species showed that the accumulation of heavy metals in pelagic species is lower than that in carnivorous benthic species (Romeo, Siau, Sidoumou & Gnassiabarelli 1999; Agusa, Kunito, Yasunaga, Iwata, Subramanian Ismail & Tanabe 2005; Cogun Yuzereroglu, Kargin & Firat 2005). ***L. nebulosus*** as an urban pelagic fish and ***P. erumei*** as a benthic species are two valuable commercial species in Southern Iran. The main objective of the present study was to determine and compare the concentration of Pb, Cd, and Ni in two commercial fish species in Qeshm Island in north of Persia Gulf with global accepted standards.

Material and Methods

Sampling and Analysis

Specimens were sampled from the area near the Hormoz Canyon in the Persian Gulf (N 26^{o}, 30´ and E 56^{o}, 16´). Over the 7 days of sampling in May 2014, totally 30 samples of studied fishes were sampled which were then weighed and

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transferred to laboratory in a cool box on the same day and frozen at (-20 C°) before dissection (Tepe & Turkmenand 2008). After defrosting in the laboratory, each sample was weighed to the nearest 0. 1 g, put onto petri dishes and placed in the dryer at 105°C. After obtaining the stable weight, the samples were ashed at 450°C, then they were digested in 2 mL of 65% nitric acid and the entire solution was diluted to 10 mL with deionized water. The samples thus prepared were analyzed with the flame atomic absorption spectrometer. The results were presented as concentrations in µg g^{-1} of dry weight. The normal distribution of data was checked with Kolmogorov-Smirnov test. In case of non-normal data distribution, we used Mann-Whitney U and Kruskall-Wallis H tests to investigate the significant differences in the concentration of the heavy metals (Cd, Pb and Ni) between the two species studied. SPSS software package v. 20 was used for statistical analysis**.** Bioaccumulation factor was determined according to (Demina, Serebryakova, Ladygina, Rogova, Zgoda & Korzhenevskyi 2009) as:

$$C(\text{mg/kg}) = \frac{GS \times V}{W}$$

In this equation C is referred to the concentration obtained from the device (mg kg^{-1} or µg kg^{-1}), GS is the metal concentration in the solution gained from digestion process, V is equal to the final solution volume (50 mL) and finally W is the dried sample weight. Statistical variation analysis and correlation coefficient (r) were also obtained.

Results

In the following table (Table 1), the morphometric characteristics of the studied fish species are presented. Mean concentration of the Pb, Cd, and Ni are summarized in Table 2.

Table 1 Mean weight and body length of the studied species

	Variable	Mean	SD	Min	Max
P. erumei	Total Length (cm)	41.53	1.19	35	50
	Weight (gr)	959.33	59.88	620	1420
L. nebulosus	Total Length (cm)	42.33	0.54	38	45
	Weight (gr)	1054.67	52.75	740	1400

Table 2 Mean concentration of Pb, Ni and Cd in *P. erumei (n*=15*) and L. nebulosus (n*=15*)*

	L. nebulosus	***P. erumei***	***L. nebulosus***	***P. erumei.***	***L. nebulosus***	***P. erumei***
variable	**Cd**		**Ni**		**Pb**	
Mean	0.06	0.16	0.29	0.56	29.64	3.23
Max	0.20	0.19	0.52	0.80	61	4.65
Min	0.02	0.15	0.10	0.35	4.55	1.40
SD	0.01	0.002	0.03	0.03	3.72	0.24

Comparing the mean value of the measured heavy metals between two species by t-student analysis indicated that the mean concentration of Cd and Ni is significantly higher in ***P. erumei*** than that in ***L. nebulosus*** ($P<0.001$), while the concentration of Pb shows reverse situation ($P<0.001$) (Table 3). Linear Regression Analysis showed that there was a significant relationship between Cd content and ***P. erumei*** weight (t= 3.48, R^2=0.48). Low regression coefficient (R^2=0.11 and 0.04 for ***P. erumei*** and ***L. nebulosus***, respectively) indicated that there was no considerable relationship between Ni concentration and the weight of the two species. The same results were obtained for Pb concentration and ***L. nebulosus*** (R^2=0.33). Comparing our results with those of the globally accepted standards showed that the amount of Pb, Ni, and Cd was below the standards and fortunately, these species were safe feeding items regarding the three heavy metals (Table 4). The mean concentrations of the metals followed the sequence of Pb<Ni<Cd for the soft tissues of the two fish species under study.

Table 3 T-student analysis results in comparing measured heavy metal content between two fish species

Variables	Mean ±SE (*P. erumei*)	Mean ±SE (*L. nebulosus*)	P
Weight/g	5424.67± 52.75	959.33 ± 59.88	0.10
Length/cm	42.33 ±0.54	41.53 ± 1.19	0.54
Cd/ µg	0.16 ±0.002	0.06± 0.01	< 0.001

Ni/ µg	0.56 ±0.03	0.29 ±0.03	< 0.001
Pb/ µg	3.23±0.24	29.64±3.72	< 0.001

Table 4 Comparing mean concentration of three measured heavy metals by globally accepted standard levels (µg/g wet weight)

Organizations	Cd	Ni	Pb	References
Food and Agriculture Organization (FAO)	0.5	-	0.5	Collete & Nauen (1983)
World Health Organization (WHO)	0.2	0.4	1.5-0.5	Biney & Ameyibor (1992)
EC	0.50	-	0.2	European Commission (2005)
Food and Drug Administration (FDA)	1	-	5	Chen *et al* (2001)
National Health and Medical Research Council (NHMRC)3	0.05	-	1.5	Darmono & Denton (1990)
UKMAFF	0.2	-	2	MAFF,(1995)
New Zealand	1	-	2	Nauen,(1983)
Hong Kong	2	-	6	Nauen,(1983)
Switzerland	0.1	-	1	Nauen,(1983)
Denmark	-	-	2	Huss,(1994)
P. erumei	0.16	0.56	3.23	Current study, (2014)
L. nebulosus	0.06	0.29	29.64	Current study, (2014)

Discussion

The metal concentrations measured reflect a clear influence of anthropogenic activities; additionally, the effective exposure of organisms to different metals may be influenced by either changes in metal speciation or the relative distribution of metals between particles of different sizes and densities (Tepe & Turkmen2006). The observed difference of heavy metal concentration between the two fishes studied is due to the feeding behavior of these organisms (Madkour 2012). Higher amount of Cd and Ni in *P. erumei* as a benthic species can also be related to the sediments of the heavy metal contents. Investigations showed that heavy metal concentration increased in the particulate phase of the sediments due to an increase in the level of the matter suspended by erosive process or soil drift from near land and rise of continental slop (Rainbow 2007), as well as the tendency of heavy metals to adsorption on particulate matter surface in water column (Demina *et al.* 2009). Investigations performed on the sediment of the content of heavy metals by different researchers showed that the amount of heavy metals of (Cd, Ni, and Pb) made the sediments a potential source for heavy metal pollution and transportation of these metals to aquatic system through food chain (Ardalan, Khoshkhoo, Rabbani & Moini 2004). Higher concentration of heavy metals in sediments rather than in water was observed in different studies and the major deposits of metals in some cases held more than 99 percent of the total amount of the metal present in the aquatic system (Netpae & Phalaraksh 2009). Other study showed heavy metal concentration of edible pelagic fishes in Mauritania shores were significantly lower than that in benthic species (Romeo *et al.* 1999) or the accumulation of heavy metals was higher in carnivorous fishes than that in herbivore ones (Agusa *et al.* 2005). Others compared the content of heavy metals in benthic *Solea solea* with that in pelagic *Sparus aurata* and came out with higher amount of the metals in pelagic one (Cogun *et al* 2005). These findings were related to the metabolic activity and feeding behavior of the species (Cogun, Yuzereroglu, Firat, Gok & Kargin 2006; Barone, GiacominelliStuffler & Storelli 2013). Our results are also in agreement with these investigations, since the amount of the measured heavy metals was higher in benthic species than that in pelagic one. We suggest that the concentration of other metals such Hg, Cr, Fe, Mn, Fe, Cu, Zn, and Co especially in different seasons can provide valuable results.

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References

Agah H., Leermakers M., Elskens M., Fatemi S.M. & Baeyens W. **(** 2009) Accumulation of trace metals in the muscle and liver tissues of five species from the Persian Gulf. *Journal of Environmental Monitoring and Assessment* 157, 499-514.

Agusa T., Kunito T., Yasunaga G.H., Iwata A., Subramanian Ismail A. & Tanabe S**. (**2005) Concentrations of trace elements in marine fish and its risk assessment in Malaysia. *Journal of Marine Pollution* 51, 896 - 911.

Ardalan A.A., Khoshkhoo Z., Rabbani M. & Moini S**.** (2004) Comparative study for heavy metals concentration (Zn, Cu, Pb, Cd, and Hg) in water, sediments and soft tissue of Anzali lagoon Anodont (*Anodonta cygnea*) sampled in two seasons, Autumn and Spring. *Pajouhesh and Sazandegi* 73, 103-113. (In Persian).

Babel S. & Kurniawan T.A. (2004) Cr removal from synthetic wastewater using coconut shell charcoal and commercial activated carbon modified with oxidizing agents and/ or chitosan. *Chemosphere* 54, 951-967.

Barone G., GiacominelliStuffler R & Storelli S. (2013) Comparative study on trace metal

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accumulation in the liver of two fish species (Torpedinidae): Concentration–size relationship. *Ecotoxicology and Environmental Safety* 97, 73-77.

Biney C.A. & Ameyibor E**.** (1992) Trace Metal Concentrations in the Pink Shrimp *Penaeus notialis* from the Coast of Ghana. Water, *Air, and Soil Pollution* 63, 273-279.

Chen M**.** **(**2001) Bioavailability and Bioequivalence: An FDA Regulatory Overview. *Pharmaceutical Research* 12, 1645-165.

Cogun H.Y., Yuzereroglu T.A., Kargin F. & Firat O. (2005) Seasonal variation and tissue distribution of heavy metals in shrimp and fish species from the Yumurtalik coast of Iskenderun Gulf, Mediterranean*. Journal of Environmental Contamination and Toxicology* 75, 707- 713.

Cogun H.Y., Yuzereroglu T.A., Firat O., Gok G. & Kargin F. (2006) Metal concentrations in fish species from the Northeast Mediterranean Sea. *Journal of Environmental Monitoring and Assessment* 121, 431- 438.

Collete B.B. & Nauen C.E**.** **(**1983) Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. *FAO Species Catalog* 2.

Darmono D. & Denton G.W**.** **(**1990) Heavy metal concentrations in the banana prawn, *Penaeus merguiensis* and leader prawn, *P. monodon*, in the Townsville Region of Australia. *Bulletin of Environmental Contamination Toxicology* 44, 479-486.

Demina I., Serebryakova M.V., Ladygina V.G., Rogova M.A., Zgoda V.G. & Korzhenevskyi D.A. (2009) Proteome of the bacterium *Mycoplasma gallisepticum*. *Biochemistry* 74, 165–174.

European Commission (E.C.) (2005) As regards heavy metals. *Official Journal of the European*.

Gerhardt A. **(**1992) Effects of subacute doses of iron on *Leptophlebia marginata* (Insecta: Ephemerooptera). *Freshwater Biology* 27, 79-84.

Giguere A., Campbell P.C., Hare L., McDonald D.G. & Rasmussen J.B**.** (2004) Influence of lake chemistry and fish age on cadmium, copper and zinc concentrations in various organs of indigenous yellow perch (*Perca flavescens*). *Canadian Journal of Fisheries and Aquatic Sciences* 61, 702-716.

Gupta A., Rai DK., Pandey RS. & Sharma B**. (** 2009) Analysis of some heavy metals in the riverine water, sediment and fish from river Ganges at Allahabad. *Environment Monitoring Assess* 157, 449-458.

Huss H.H. (1994) Assurance of Seafood Quality. *FAO Fisheries Technical Paper*, 334.

Linnik P.M. & Zubenko I.B. (2000) Role of bottom sediments in the secondary pollution of aquatic environments by heavy-metal compounds. Lakes and Reservoirs. *Research and Management* 5, 11-21.

Madkour N.K. (2012) The beneficial role of celery oil in lowering of di (2-ethylhexyl) phthalate-induced testicular damage. *Toxicological Industrial Health*53, 112-118.

MAF F. (1995) Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea. Aquatic Environment Monitoring. *Directorate of Fisheries Research* 44, 220-225.

Malik N., Biswas A.K., Qureeshi T.A., Borana K. & Virha R. (2010) Bioaccumulation of heavy metals in fish tissues of a freshwater lake of Bhopal. *Environmental Monitoring Assessment* 160, 267-276.

Marquenie JM. (1985) Bioavailability of micro-pollutants. *Environmental Technological Letters* 6, 351–358.

Nauen C.E. (1983) Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products. *FAO Fisheries Circular*, 764.

Nehring B.R., Nisson R. & Minasian G. (1979) Reliability of aqua tic insects versus water samples as measures of aquatic lead pollution. *Bulletin of Environmental Contamination and toxicology* 22, 10 –108.

Netpae T. & Phalaraksh C. (2009) Water quality and heavy metal monitoring in water, sediments, and tissues of Corbicula sp. From Bung Boraphet Reservoir, Thailand. Chiang Mai. *Journal of Science* 36, 395-402.

Rainbow P.S. (2007) Trace metal bioaccumulation: *Models, metabolic availability and toxicity. Environment International* 33, 576-582.

Romeo M., Siau Y., Sidoumou Z. & Gnassiabarelli M. (1999) Heavy metal distribution in different fish species from the Mauritania coast. *Journal of Scientific Total Environment* 232, 169-75.

Sahebi Z. & Emtyazjoo M. (2011) Permissible consumption limits of mercury, cadmium and lead existed in *Otolithes ruber*: *Advances Environmental Biology* 5, 920-928.

Tepe Y. & Turkmenand T.A. (2008) Assessment of heavy metals in two commercial fish species of four Turkish seas. *Journal of Environmental Monitoring and Assessment* 146, 277-284.

بررسی میزان غلضت فلزات سنگین (کادمیوم، نیکل و سرب) در بافت ماهیچه دو گونه از ماهیان پرمصرف جزیره قشم (خلیج فارس)

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چکیده

در این پژوهش میزان فلزات سنگینی مثل کادمیوم، نیکل و سرب در بافت عضله کفشک ماهی (*Psettodes erumei*) و ماهی شهری پلاژیک (*Lethrinus nebulosus*) جزیره قشم، واقع در شمال خلیج فارس مورد بررسی قرار گرفت. میزان فلزات سنگین سی بافت عضله که به طور تصادفی جمع آوری شده بود با دستگاه جذب اتمی اندازه گیری شد. نتایج حاکی از آن بود که میزان کادمیوم (0.16 ±0.002) و نیکل (0.56±0.03) درکفشک ماهی به طور معناداری بیشتر از ماهی شهری پلاژیک بود در حالی که غلضت سرب (29.64±3.72) در ماهی شهری بالاتر از کفشک ماهی ثبت گردید (P>0.05). نتایج این پژوهش حاکی از آن است که سه فلز سنگین بررسی شده در هر سه گونه ماهی مطالعه شده کمتر از استانداردهای ارائه شده از سوی WHO و FAO می باشد.

کلمات کلیدی: استانداردهای بهداشتی، آلودگی آب، خلیج فارس، جزیره قشم، ایران

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