2011 2nd International Conference on Environmental Engineering and Applications
IPCBEE vol.17 (2011) © (2011) IACSIT Press, Singapore

Heavy metal Concentration in Belanger's Croaker Fish, *Johnius belangerii* from Petrochemical Waste Receiving Estuary in the Persian Gulf, Iran

Alireza safahieh[+], Mohammad Taghi Ronagh, Fazel Abdolahpur Monikh, Ahmad Savari and Abdolmajid Doraghi

Department of Marine Biology, Faculty of Marine Sciences and Oceanography, Khorramshahr Marine Science and Technology University, Khorramshahr, Iran

Abstract. Musa Estuary is receives various type of discharges such as petrochemical, industrial and urban waste, it also is a habitat for *Johnius belangerii*. This study was carried out to determine heavy metal concentrations in *J. belangerii*. Fish samples were taken from 5 creeks and acid digested for their heavy metal contents. Results showed that the highest level of Cd, Co, Cu, Ni and Pb was 7.21, 1.08, 1.12, 2.72 and 4.57 in liver, 1.88, 1.04, 2.09, 9.43 and 6.83 in gill and 0.14, ND, 5.61, 2.43 and 3.78 in muscle respectively. The level of heavy metals in muscle was lower than WHO standard, however the level of metals in fish were decreased by the increase of distance from PETZON. It is suggested that biomonitoring of contaminants in this estuary could serve as a good estimate of environmental health.

Keywords: Musa Estuary, Heavy metals, *Johnius belangerii*, Persian Gulf

1. Introduction

Essential and non-essential heavy metals may appear as potentially harmful elements for most aquatic and terrestrial organisms at some concentration of uptake. Environmental factors such as pH, salinity, DO and temperature [6, 5] as well as ecological factors such as sex, size and feed habit play significant roles in heavy metal accumulation in aquatic organisms [11, 2]. Fish is considered as an appropriate bio-indicator for metals concentration in aquatic ecosystem [4], because it could concentrate large amount of some metals in their tissues [15]. On the other hand heavy metals accumulation by fish may result in high level of metals intake by human consumers which, finally leads to several injuries.

Located in the northwest of the Persian Gulf, Musa Estuary is subjected to different anthropogenic activities such as petrochemical industries, ships and oil tankers traffic which are potential sources of heavy metals input in to the seawater. One the other hand, this Estuary is an important area in terms of fishing within the Iranian coasts of the Persian Gulf. Belanger's Croaker, *Johnius belangerii* is widely distributed in Musa Estuary branches and constitutes a considerable portion of the annual catch of the local fishermen. It is widely used by local people. Heavy metal accumulation by fishes with high annual catch may contribute in health problems those who consume them. Since the information concerning heavy metal accumulation in Musa estuary is scarce this study was carried out to determine the concentration of Cd, Co, Cu, Ni and Pb in muscle, liver and gill tissue of *Johnius belangerii* collected from different creeks of the Musa Estuary.

[+] Corresponding author. Tel.: + +98-632-4234403; fax: +98-632-4234403
E-mail address: a.Safahieh@Kmsu.ac.ir.

2. Materials and Methods

2.1. Study area

The samples of fish were collected from five different creeks along Musa Estuary (Persian Gulf) during August 2010. The sampling stations were chosen in Khor-Ghazale, Khor-Ahmadi, Khor-Jafari, Khor-Zangi and Khor-Ghanam (fig. 1).

2.2. Sampling and Sample preparation

Using trawl net, 20 fish samples from the same size were collected from each creek. Fish were transferred to the laboratory using icebox and kept frozen at -20 ^{o}C prior to analysis. Fish were thawed in room temperature before analysis and their tissues, including muscle, liver and gill were obtained and oven dried at 90 ^{o}C for 12 hour until constant weight was obtained. One gram of muscle, 0.5 gram of liver and gill were digested in concentrated nitric acid. The remaining digested solution was made up to certain volume with double distilled water. To determine the metals in the samples, a GBC (Savant AA Sigma) flame atomic absorption spectrometer (AAS) was used. All chemical regents were analytical reagent grade (Merck). The glassware and plastic container were acid washed with nitric acid 10% and rinsed with double distilled water before use. To avoid samples contamination and check the accuracy of the method, blank samples and CRM (Dorm-2, muscle of Dogfish, National Research Council of Canada) were analysed. The recovery values for all metals were satisfactory and were fallen between 90% to 113%.

2.2. Data analysis

Significant differences between heavy metals concentration in various stations, determined using One-Way analysis of variance (ANOVA) followed by Duncan post hoc test ($p < 0.05$).

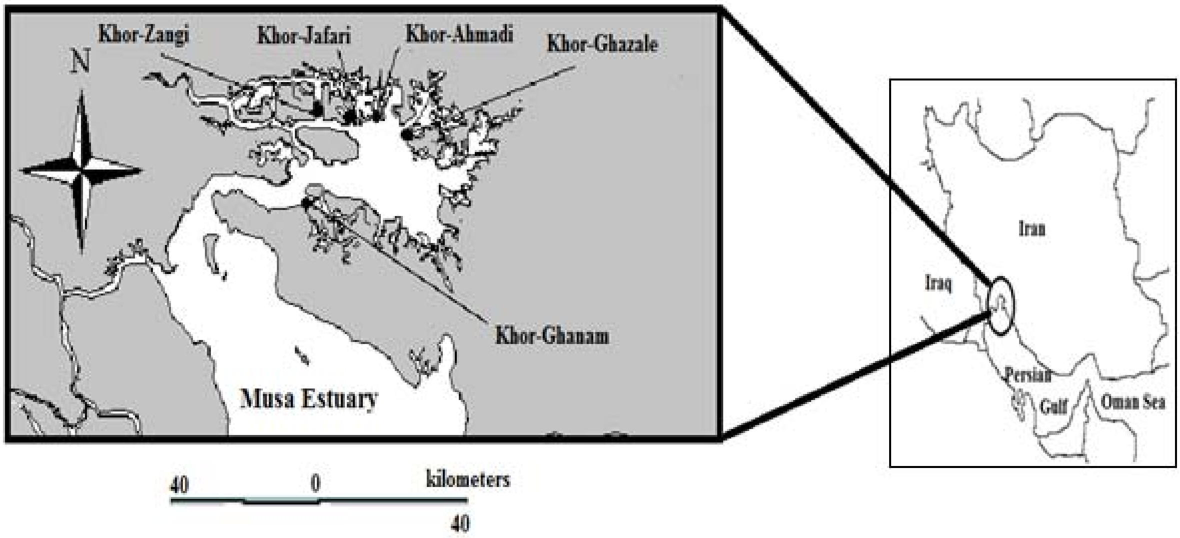

Fig. 1. A map showing of study area

3. Results

The average concentrations of studied heavy metals (µg/g dw) in muscle are shown in table 1. The concentration of Co in muscle was below the detection limit of the AAS. There were significant differences between the concentration of Cu and Pb in fish from different stations. The highest level of Cu (5.61 µg/g) and Pb (3.78 µg/g) was measured in the fish from Khor-Jafari. The average concentration of the metals in liver are shown in Table 2. Significant differences were obtained for the concentration of Cd, Cu and Pb in liver among different stations. The maximum concentration of Cd (7.21 µg/g), Cu (12.32 µg/g) and Pb (4.57 µg/g) was found in the liver of fish from Khor-Zangi, Khor-Jafari and Khor-Ghazale respectively. Table 3 shows the concentrations mean of heavy metal in gill tissue. There were significant differences between concentrations of Cd, Ni and Pb in gill of fish from different creeks. The highest level of Cd (1.88 µg/g), Ni (9.43 µg/g) and Pb (6.83 µg/g) was recorded in fish from Khor-Zangi, Khor-Ghazale and Khor-Zangi respectively.

Research indicated that each tissue has a special capacity for heavy metals metal accumulation (fig. 2). The order of metal accumulation in different tissues was as follows: liver > gill > muscle for Cd, liver > gill > muscle for Co, liver > muscle > gill for Cu, gill > liver > muscle for Ni and gill > liver > muscle for Pb.

Table 1 Heavy metal concentration in liver (µg/g dw)

Location	Cd	Co	Cu	Ni	Pb
Khor-Ghazale	0.09 ± 0.20	ND	1.62 ± 0.07^{a}	2.04 ± 0.29	1.58 ± 0.20^{ab}
Khor-Ahmadi	0.13 ± 0.03	ND	3.59 ± 0.04^{b}	2.16 ± 0.55	2.42 ± 0.38^{bc}
Khor-Jafari	0.08 ± 0.02	ND	5.61 ± 0.80^{c}	2.43 ± 0.57	3.78 ± 0.76^{c}
Khor-Zangi	0.14 ± 0.03	ND	1.68 ± 0.18^{a}	2.10 ± 0.52	2.98 ± 0.61^{bc}
Khor-Ghanam	0.10 ± 0.02	ND	1.53 ± 0.02^{a}	1.19 ± 0.37	0.59 ± 0.05^{a}

^{a,b,c} Show differences among creeks, ND= Not detected.

Table 2 Heavy metal concentration in liver (µg/g dw)

Location	Cd	Co	Cu	Ni	Pb
Khor-Ghazale	2.38 ± 0.42^{ab}	0.94 ± 0.12	4.31 ± 0.32^{b}	2.39 ± 0.29	4.57 ± 0.35^{b}
Khor-Ahmadi	1.09 ± 0.33^{a}	1.08 ± 0.28	10.75 ± 1.21^{c}	2.72 ± 0.33	3.08 ± 0.41^{ab}
Khor-Jafari	1.8 ± 0.37^{a}	1.03 ± 0.21	12.32 ± 1.76^{c}	2.53 ± 0.12	3.97 ± 0.47^{b}
Khor-Zangi	7.21 ± 1.2^{c}	0.98 ± 0.19	5.12 ± 0.45^{b}	2.27 ± 0.14	3.31 ± 0.22^{ab}
Khor-Ghanam	4.23 ± 0.44^{b}	0.91 ± 0.12	1.76 ± 0.42^{a}	2.53 ± 0.15	2.64 ± 0.38^{a}

^{a,b,c} Show differences among creeks

Table 3 Heavy metal concentration in gill (µg/g dw)

Location	Cd	Co	Cu	Ni	Pb
Khor-Ghazale	0.97 ± 0.04^{ab}	0.91 ± 0.02	2.04 ± 0.25	9.43 ± 1.04^{c}	5.71 ± 1.06^{b}
Khor-Ahmadi	0.92 ± 0.04^{ab}	0.83 ± 0.03	1.94 ± 0.19	7.89 ± 1.12^{b}	5.33 ± 1.26^{b}
Khor-Jafari	1.32 ± 0.11^{ab}	1.04 ± 0.1	2.09 ± 0.43	6.74 ± 1.26^{b}	6.83 ± 1.48^{c}
Khor-Zangi	1.88 ± 0.13^{b}	0.86 ± 0.02	1.37 ± 0.38	1.63 ± 0.21^{a}	6.62 ± 1.43^{c}
Khor-Ghanam	0.73 ± 0.03^{a}	0.8 ± 0.01	1.04 ± 0.26	6.82 ± 1.33^{b}	2.57 ± 0.32^{a}

^{a,b,c} Show differences among creeks

4. Discussion

Heavy metals determined in *J. belangerii* tissues showed different concentrations among station. The significant differences, which observed between metals concentrations in the same tissues from different creeks, indicate that there are different sources for heavy metals input along Musa Estuary. In addition, physicochemical factors of the water from which fish were caught may vary among studied creeks. The high concentration of some metals that are recorded in Khor-Jafari could be related to the effluent discharge from petrochemical units and Immam port [9]. A big branch of Khor-Jafari has been dried by PETZON (petrochemical special economic zone) and now serves as an effluent receiving pond, where refined wastes are discharged before releasing into the seawater. The high concentration of Ni that was measured in Khor-

Ghazale might be due to heavy traffic of oil tankers in this creek. Among the studied creeks, Khor-Ghanam was found to be less polluted compared to other creeks. This creek is relatively far from contamination sources in Musa Estuary. Therefore, few amounts of contaminants could reach this area.

This study revealed that metal accumulation in gill and liver occurs in higher magnitude than what appeared in the muscle. This is a usual finding which is also reported by several investigation [13, 5, 1]. Because of the presence of high level of metallothionein protein, liver tissue acts as a target organ for heavy metal detoxification [14, 8, 2, 1]. Gills act as the main sit for entry of different kinds of contaminants such as heavy metals. Therefore, heavy metals could appear in a high level in liver and gill tissues compared to muscle. Comparison of heavy metals in edible part (muscle) of fish (a wet wt. dry wt ratio of 0.3) with WHO [12] showed that the highest level of Cu and Pb in this tissue was below the permissible limits provided by WHO, (1996) (Cu= 30 mg/kg and Pb= 2 mg/kg).

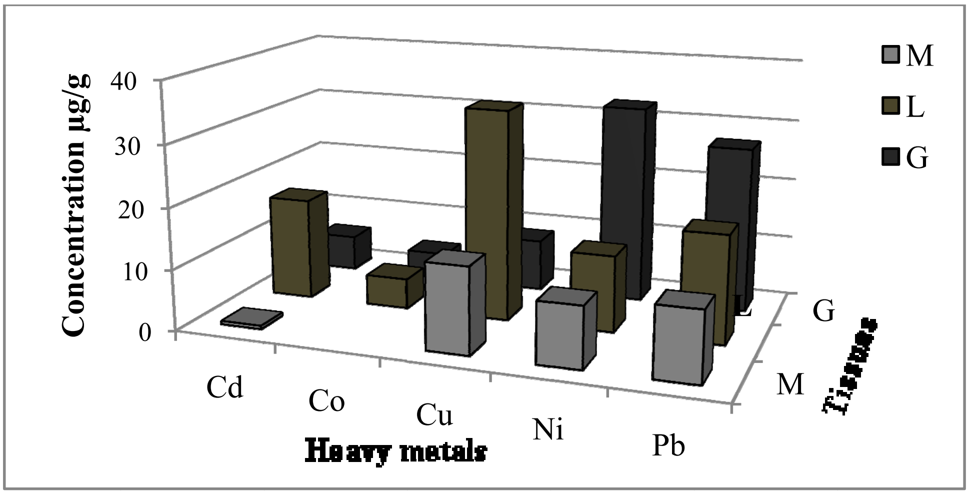

Fig. 2. Heavy metals concentration in different tissues of *Johnius belangerii*

5. Conclusion

Heavy metals concentration in tissues of *J. belangerii* from Khor-Jafari creek was higher than those fishes from other studied creeks. This was presumably happened due to short distance between the mentioned creek and petrochemical units. Heavy metals contamination in muscle tissue was lower than liver or gills. It also was lower than WHO standard for human consumption. Biomonitoring of heavy metals in potentially contaminated estuaries could serve as useful tools for awareness of environmental health.

6. Acknowledgements

This study was supported by Fajr Petrochemical Complex, Mahshahr, Iran and Khorramshahr Marine Science and Technology University.

7. References

[1] M.H. Al-Yousuf, M.S. El-Shahawi, S.M. Al-Ghais. Trace metals in liver, skin and muscle of *Lethrinus lentjan* fish species in relation to body length and sex. *The Science of the Total Environment*. 2000, 256: 87-94.

[2] M. Canli, G.z. Atli. The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. *Environmental Pollution*. 2003, 121: 129–136.

[3] D. Caussy, M. Gochfeld, E. Gurzau, C. Neagu, H. Ruedel. Lessons from case studies of metals: investigating exposure, bioavailability, and risk. *Ecotoxicology and Environmental Safety*. 2003, 56: 45-51.

[4] J.L. Domingo, A. Bocio, R. Martı-Cid, J. M. Llobet. Benefits and risks of fish consumption Part II. RIBEPEIX, a computer program to optimize the balance between the intake of omega-3 fatty acids and chemical contaminants. *Toxicology*. 2007, 230: 227-233.

[5] M. Dural, M. Ziya Lugal Goksu, A.A. Ozak. Investigation of heavy metal levels in economically important fish species captured from the Tuzla lagoon. *Food Chemistry*.2007, 102: 415–421.

[6] S. Eastwood, P. Couture. Seasonal variations in condition and liver metal concentrations of yellow perch (*Perca fla_escens*) from a metal-contaminated environment. *Aquatic Toxicology*. 2002, 58: 43–56.

[7] F. Henry, R. Amara, L. Courcot, D. Lacouture, M.-L. Bertho. Heavy metals in four fish species from the French coast of the Eastern English Channel and Southern Bight of the North Sea. *Environment International*. 2004, 30: 675– 683.

[8] L.D. Kraemer, P.G.C. Campbell, L. Hare. Seasonal variations in hepatic Cd and Cu concentrations and in the sub-cellular distribution of these metals in juvenile yellow perch (*Perca flavescens*). *Environmental Pollution*. 2006, 142: 313-325.

[9] N. Mooraki, A. Esmaeli Sari, M. Soltani, T. Valinassab. Spatial distribution and assemblage structure of macrobenthos in a tidal creek in relation to industrial activities. *International Journal of Environmental Science and Technology*. 2009, 6: 651-662.

[10] I. Papagiannis, I. Kagaloub, J. Leonardosc, D. Petridisd, V. Kalfakakoua. Copper and zinc in four freshwater fish species from Lake Pamvotis (Greece). *Environment International*. 2004, 30: 357– 362.

[11] A. Turkmen, M. Tu¨rkmen, Y.ı. Tepe, I. Akyurt. Heavy metals in thre commercially valuable fish species from _Iskenderun Bay, Northern East Mediterranean Sea, Turkey. *Food Chemistry*. 2005, 91: 167–172.

[12] M. Tuzen. Toxic and essential trace elemental contents in fish species from the Black Sea, Turkey.*Food and Chemical Toxicology*. 2009, 47: 1785–1790.

[13] J. Usero, C. Izquierdo, J. Morillo, I. Gracia. Heavy metals in fish (*Solea vulgaris*, *Anguilla anguilla* and *Liza aurata*) from salt marshes on the southern Atlantic coast of Spain. *Environment International*. 2003, 29: 949– 956.

[14] A.B. Yılmaz. Levels of heavy metals (Fe, Cu, Ni, Cr, Pb and Zn) in tissue of *Mugil cephalus* and *Trachurus mediterraneus* from Iskenderun Bay, Turkey. *Environmental Research*. 2003, 92: 277–281.

[15] F. Yılmaz , N. Ozdemir, A. Demirak , A. Levent. Tuna Heavy metal levels in two fish species *Leuciscus cephalus* and *Lepomis gibbosus*. *Food Chemistry*. 2007, 100: 830–835.