Global Veterinaria 9 (3): 329-333, 2012
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2012.9.3.6554

Study of Heavy Metals (Pb and Cd) Concentration in Liver and Muscle Tissues of *Rutilus frisii Kutum*, Kamenskii, 1901 in Mazandaran Province

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Abstract: Current study has been focused on concentration of two heavy metals, Lead (Pb) and Cadmium (Cd), in the liver and muscle tissues of the Caspian Kutum, *Rutilus frisii Kutum*. This subspecies has been collected randomly between Mahmoud Abad and Sari in the Caspian Sea Basin. Heavy metals studied at this research are hazardous substances in the environment. Fork length, weight and length-weight relationship of samples were measured. The length and weight of Kutum ranged from 25 to 48.1 cm and 336 to 1146 g respectively. The highest level of bioaccumulation obtained for Pb in liver tissue (0.809 µg/g) from Fereidounkenar and the lowest level obtained for Cd in muscle tissue (0.038 µg/g) belongs to Koliver station. Results of linear regression analysis showed that, there were significant relationships between the Cd contents in both liver and muscle tissues and the fish size. Comparison of heavy metal contents in both liver and muscle tissues showed that the bioaccumulation of heavy metals in liver tissue is higher than muscle. Comparisons showed that the range of Cd and Pb content in fish body is below of the international limited amounts given for these hazardous substances.

Key words: Lead · Cadmium · Kutum · Caspian Sea

INTRODUCTION

Nowadays marine products play a great role in human’s food. There is an up growing consumption of seafoods due to increasing public awareness about their preponderance to other protein materials [1]. Heavy metal pollution of aquatic ecosystems and consequently accumulation of these heavy metals in aquatic organism tissues is one of recent concerns in seafood industries. Presence of pollutants in aquatic ecosystems is a result of natural processes and human activities. Although small amounts of some heavy metals such as copper, zinc and iron are urgent for the metabolism of aquatic organisms as well as human bodies, some others such as cadmium, Lead and mercury are harmful for living organisms even in small amounts [2]. So far researches have been shown that zinc, cadmium, mercury and Lead are known as pollutants for aquatic ecosystems and harmful for human’s health. The Caspian Sea classified as the world's largest lake or a full-fledged sea. Caspian Sea is a rich source of various aquatic living organisms such as fishes and crustaceans [3]. Therefore, Caspian Sea products supply almost the whole seafood protein sources of the people in northern and northwestern regions of Iran.

One of the main sources of pollution in Caspian Sea is extraction and transportation of oil throughout the sea. Another source of pollution is many cities and industries which are surrounded the Caspian Sea. Pollution from these cities and industries enter the Caspian Sea either directly or through rivers [4]. The Caspian Kutum, *Rutilus frisii Kutum* is a migratory anadromous fish which is generally accepted as a Caspian Sea subspecies [5]. Kutum is an edible carp from Caspian Sea and researches on the economics of its culture for its future development have been done [6]. Therefore focusing on the content of heavy metals in the fish body tissues which is reflecting the measure of water pollution from one side and its harm for consumers and the fish population itself, on the other side, is considerable.

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MATERIALS AND METHODS

Samples were caught from twelve stations of Mazandaran Province randomly from Caspian Sea Basin. Sampling was made monthly from October 2009 till March 2010. Fork length and weight of captured fish were measured. Liver and muscle tissues were detached. They preserved in 25°C temperature and laboratory dishes were washed with 10% nitric acid and sterilized in 60°C heat temperature for 24 hours. Tissues were washed with distilled water and then dried in 60°C temperature for 48 hours. In order to chemical lyses, 8 ml of nitric acid 65% was added to 1 g of each dried tissues. Solutions were heated up to 100°C temperature. 4 ml perchloric acid was added after cooling. The preparation procedure is inspired from Honda method [7]. Digested specimens were filtered by filter paper and prepared for measuring their atomic absorption. Atomic absorption was performed by flame atomic absorption spectrophotometer model THERMO M5. Statistical analysis of data was carried out with the statistical package for the social sciences (SPSS) and the linear model of regression with the maximum likelihood of 95% was performed.

RESULTS

The mean length and weight of Kutum in twelve stations in of Mazandaran Province have been shown separately (Table 1). Sampling was made monthly from October 2009 till March 2010. Fork length and weight of captured fish were measured.The mean length ranged from 25 to 48.1 cm and the mean weight ranged from 336 to1146 g (Table 1). Collected samples from various stations were nearly in the same size range but the highest size can be seen for Shahed (length=40.9 cm and weight=1068.1g). Analyzing length-weight relationship showed a high significant relationship between the length and weight of Rutilus frisii Kutum (R values ranged between 0.92 to 0.98). The mean values of Pb in liver and muscle tissues and Cd in liver and muscle tissues were obtained 0.126-0.809, 0.068-0.415 and 0.154-0.364, 0.038-0.211 µg/g respectively (Table 2). The highest concentration was obtained for Pb in liver (0.809 µg/g) from Fereidounkenar and Cd in muscle from Koliver had the lowest concentration (0.38 µg/g). Generally concentration of heavy metals in liver was significantly higher than their concentration in muscle. Results of linear regression analysis showed that, there were significant positive relationships between the Cd contents in both liver and muscle tissue and the fish size (Table 3).

DISCUSSION

Study showed that the bioaccumulation of Pb is higher than Cd in tissues. Bioaccumulation of heavy metals in liver and muscle tissues did not differ significantly depend on the sampling stations except for the content of Cd in liver from Jahan Nama and Fereidounkenar, the content of Cd in muscle from Jahan Nama and Koliver and content of Pb in liver and muscle from Fereidounkenar. Comparison of heavy metal contents in both liver and muscle tissues showed that the bioaccumulation of heavy metals in liver tissue is higher than muscle. Cd and Pb contents obtained (0.03-0.3 µg/g) and (0.06-0.8 µg/g) respectively, are below the Legal limits of hazardous substances for human and environmental health [8, 9].

Table 1: Average of fork length and weight of *Rutilus frisii Kutum* in Iranian waters of the Caspian Sea

		Fork Length (cm)			Weight (g)			
Stations	N	Mean	Max	Min	Mean	Max	Min	R Value
Jahan Nama	30	35	39.7	25	583.9	604	396	0.95
Karegar	30	38.1	43.4	33	759.5	973	525.5	0.96
Azadegan	30	33.6	37.2	26.7	521.2	734.4	362.3	0.95
Shahid Beheshty	30	43.5	47.1	33.4	865.9	1100	398.7	0.98
Koliver	30	44.2	46	30.3	1004	925.1	693.7	0.97
Azadi	30	39.4	44.7	33.8	695	770.1	464.2	0.94
Azadi Larim	30	43.8	48.1	33	845.5	1023	760	0.96
Karfon	30	40.26	47.3	38.5	881.6	983.5	628.3	0.98
Khoram mahmood Abad	30	41.2	42.9	36.6	783.2	876	542.5	0.92
Freidonkenar	30	38.9	45.6	32.1	754.5	953	336	0.95
Bishe Kola	30	40.8	44.6	35.3	920	1146	524.5	0.98
Shahed	30	40.9	46	29	1068.1	1124	632	0.97

N, number; FL, fork length; SD, standard deviation, W, weight.

Table 2: Heavy metal analysis in the different organs of Kutum fish, *Rutilus frisii Kutum*, (µg/g-dw) from 12 stations in Caspian Sea

	Liver concentration		Muscle Concentration	
Stations & Heavy metals	Mean	SD	Mean	SD
Jahan Nama				
Pb	0.295[b]	±0.11636	0.118[b]	±0.07495
cd	0.356[a]	±0.15443	0.211[a]	±0.08987
Karegar				
Pb	0.176[b]	±0.14191	0.125[b]	±0.06346
cd	0.211[b]	±0.17848	0.076[b]	±0.04949
Azadegan				
Pb	0.161[b]	±0.09012	0.068[b]	±0.05959
cd	0.231[b]	±0.14372	0.111[b]	±0.07062
Shahid Beheshty				
Pb	0.195[b]	±0.08430	0.269[b]	±0.33456
cd	0.228[b]	±0.09558	0.165[b]	±0.03188
Koliver				
Pb	0.265[b]	±0.07435	0.161[b]	±0.09544
cd	0.201[b]	±0.21394	0.038[a]	±0.06630
Azadi				
Pb	0.573[b]	±0.14369	0.224[b]	±0.08631
cd	0.314[b]	±0.15291	0.192[b]	±0.07336
Azadi Larim				
Pb	0.661[b]	±0.17829	0.270[b]	±0.11116
cd	0.188[b]	±0.11905	0.144[b]	±0.04644
Karfon				
Pb	0.715[b]	±0.13582	0.233[b]	±0.06523
cd	0.247[b]	±11934	0.062[b]	±0.07861
Khoram Mahmood Abad				
Pb	0.399[b]	±0.12197	0.153[b]	±0.08084
cd	0.216[b]	±0.08947	0.077[b]	±0.10005
Freidounkenar				
Pb	0.809[a]	±0.11532	0.415[a]	±0.16926
cd	0.364[a]	±0.23543	0.054[b]	±0.07569
Bishe Kola				
Pb	0.210[b]	±0.15635	0.163[b]	±0.12455
cd	0.279[b]	±0.11289	0.068[b]	±0.05420
Shahed				
Pb	0.126[b]	±0.08527	0.117[b]	±0.07304
cd	0.154[b]	±0.09442	0.054[b]	±0.08932

a: concentration of metals in different tissues are statistically significant $p < 0.005$

b: concentration of metals in different tissues are not statistically significant among means $p < 0.005$

Table 3: The relationships between heavy metal concentrations and total fish lengths and weights in the liver and muscle tissues of the Kutum fish, *Rutilus frisii Kutum*, from Caspian Sea

		Liver		Muscle	
Tissue	Data	Cadmium	Lead	Cadmium	Lead
Length	DF	122	122	122	122
	Equation	Y=39.406+(-1.325)X	Y=38.59+1.272 X	Y=39.648+(-4.935)X	Y=38.957+0.314X
	R value	. 42[b]	.069[a]	.531[b]	.127[a]
Weight	Df	122	122	121	122
	Equation	Y=812+(-262.3)Z	Y=743.91+7.972Z	Y=829.632+(-714.11)Z	Y=747.714+(-1.982)Z
	R value	.198[b]	.010[a]	.309[b]	.019[a]

a: values are statistically significant at $p < 0.005$

b: values are not statistically significant at $p < 0.005$

Heavy metal concentrations in the tissues of freshwater fishes vary considerably among different reported studies [10-13]. The differences might be as a result of their capacity to induce metal-binding proteins such as metallothionein that may be related to the differences in ecological needs, swimming behaviors and the metabolic activities among different fish species and also differences in metal concentrations and chemical characteristics of water from which fish were sampled, metabolism and feeding patterns of fish and the season in which studies were carried out might be considerable as reasons for these differences [14]. The higher levels of trace elements such as lead in liver relative to other tissues may be attributed to the affinity or strong coordination of metallothionein protein with this element [15]. Maximum concentration of metals in liver than other tissues is obtained from other studies [16- 18].

Results showed that there were positive relationships between fish sizes and the concentration of Cadmium in the fish body whereas concentration of lead in fish body did not depend on body size. According to Widianarko *et al.* [19] it can be indicated that body concentration of lead is regulated and maintained at a certain concentration. There are some reports of positive or negative relationships between the concentration of heavy metals and fish size [20-23]. There are not many researches on the heavy metal effects on Caspian Sea Kutum but a recent study on the effect of lead nitrate on the survival rate and growth performance of this subspecies [24]. According to Abel [25] theory, heavy metals are not only vulnerable for fish populations but also for the sea food consumers.

Heavy metals studied in this research are hazardous substances in the environment. In addition, lead is the heaviest and the most toxic spreading element in the environment and will find in aquatic systems in high amounts. Intake of this substance by consumers will lead to nervous system and behavioral malfunction. Cadmium is another hazardous substance which may be absorbs in a high amount by food and may affect the host body to skeletal problems, bronchitis, Emphysema, anemia and the kidney stone [26]. Hence, a scientific detoxification method is essential to improve the health of these economic fish in stressed environmental conditions

ACKNOWLEDGMENTS

This study was performed by cooperation of Iranian Fisheries Research Organization

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