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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (21): 3956-3959, 2007
ISSN 1028-8880

Concentration of Heavy Metals in Different Tissues of *Astacus leptodactylus* from Aras Dam of Iran

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Abstract: Due to different human activities in the vicinities of Aras dam, various pollutants such as heavy metals are entered into the reservoir and thus polluting the aquatic ecosystem. As a result, this heavy metal is accumulated in the tissues of *Astacus leptodoctylus*, which is considered as one the abundant species of crayfish that has got important food values and is of economic importance due to its export to other countries. In this research, the bioaccumulation of heavy metals in different tissues of this animal is taken into consideration. The concentration of Fe, Cu, Zn, Mn, Pb, Ni, Co and Cr among the tissues of female and male *Astacus leptodactylus* has been determined. The highest concentration of Cu and Fe was found in the gills and the highest level of Zn was found in hepatopancreas. Besides, the highest Mn concentration was recognized in exoskeleton. Furthermore, no significant difference was found between the male and female crayfish in the concentration of the heavy metals in their tissues, except for the concentration of some of the metals such as Fe in some of the tissues such as hepatopancreas.

Keywords: Heavy metals, *Astacus leptodactylus*, aras, bioaccumulation, concentration

INTRODUCTION

The reservoir of Aras dam, Located in the north west of Iran, is so valuable that is considered as one of great economical and ecological sources due to the vast variety of plants and aquatic animals in the region.

Due to the industrial, agricultural and urban activities in the areas in the neighborhood of the dam, a large amount of pollutants such as heavy metals are brought about to the reservoir of the dam by different nourishing rivers. Thus, such heavy metals are mixed with the other sediments and jeopardize the life of benthoses such as *Astacus leptodactylus* a lot of are considered as very valuable food sources. Ewing (2003) investigated that heavy metals had a lot of contribution in polluting the rivers and consequently the lake of Aras. The accumulation of different pollutants in water and sediments impose a great danger to *Astacus leptodactylus* and cause deposition of heavy metals inside different tissues of this precious domestic benthos of Aras dam. Considering nutritional, economical and exporting value of *Astacus leptodactylus* (Hossienpour and Karimpour 1999), it seems necessary to conduct a study to determine the rate of heavy metals inside different tissues, in particular muscles which are the edible parts of the crayfish. The concentration of heavy metals in some crustaceans was also investigated by different researchers such as *penaeus semisulcatus* (Pourang *et al*., 2004, 2005; Pourang, 1993; Kargin *et al*., 2001), *Penaeus vannamei* (Paez-Osuna and Tron-Mayen, 1996), *Spiny lobster* (Fukushima *et al*., 2001) *Astacus leptodactylos* (Riyahi *et al*., 2005; Kress *et al*., 1998), *Procambarus clarkii* (Santerre *et al*., 2001), *Pandalus borealis* (Zauke and Schmalenbach, 2005). This research has attempted to investigated the rate of heavy metals in the crayfish living in the reservoir of the Aras dam, which has not hitherto been investigated.

MATERIALS AND METHODS

Animals: Freshwater crayfish *Astacus leptodactylus* (wt. rang 55-65 g) obtained form Aras dam in springtime by special traps, respectively. They were kept in tank with aerated water at 10°C and then were transformed to the Lab in Urmia University. Only intermolt crayfish were used in this study.

Metals analyses: For estimating the heavy metals content, firstly different tissues such as gills, hepatopancreas, exoskeleton and muscle were excised from the experimental crayfishes and the tissues were placed in separate Petri dishes to dry at 105°C for 48 h in oven until

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the dried completely up. The dry tissues were homogenized with a ceramic mortar and were pestled. 0.5 g of the dried tissue was placed in separate digestion Flasks and nitric perchloric acid (2:1) mixture was added. The digestion Flasks were gradually brought to and kept at 120°C in an oven for 3 h unit all materials were dissolved and the digests were diluted with 0.4% of nitric acid. All the dissection instrument and glassware were acid washed and rinsed 0.4% nitric acid. Metal concentrations in samples were measured using atomic absorption spectrophotometer flame Emission Shimadzu (AA-670 Shimadza) (Riyahi, 2000).

Statistics: The data were analyzed by t-test and ANOVA using SPSS (version. 12) computer software and value of $p<0.05$ was considered to be significant.

RESULTS AND DISCUSSION

Concentration level of nine metals is exoskeleton, gills, hepatopancreas and tail and chelae muscle of females and males of *Astacus leptodactylus* were measured and presented in Table 1. The metals Zn, Cu and Fe were the most abundant elements in different biological materials analyzed; Mn and Pb showed variation depending on the tissue; whereas Cd was the least abundant element detected; Ni was consistently below the limit of analytical detection (4 μg g^{-1}) for all the tissues; Co and Cr were not found in any of the tissues.

The highest concentration of Zn in *Astacus leptodactylus* was found in hepatopancreas and the lowest in exoskeleton. Besides, the Zn concentration was found to be higher in gills as compared with the edible muscle in which that concentration was medium (Fig. 1 and 2). In comparison with other crustaceans, the tissue level of Zn was similar or higher. In general, the highest Cu concentration was found in hepatopancreas and gills and lowest in muscles (Fig. 1 and 2). Differences between the sexes in these two metals were noted. Fe concentration was the highest in calcified tissues, whereas the concentration decreased in gills, hepatopancreas and muscles, respectively (Fig. 1 and 2). The differences between the tissue in different sexes were noted only in hepatopancreas, i.e., males (156 μg g^{-1}) accumulated more Fe concentration in their tissues than females (77 μg g^{-1}) did. The highest Mn concentration was found in carapace and the lowest in edible flesh as is seen in the other crustaceans (Fig. 1 and 2) (Eisler, 1981).

Pb and Cd concentration level is in various tissues of *Astacus Leptodactylus* were found to be different and were arranged in a decreasing order:

Pb (male)- Exoskeleton > gills > hepatopancreas > muscle (Fig. 1)
Pb (female)- Gills > exoskeleton > hepatopancreas > muscle (Fig. 2)
Cd (male)- Exoskeleton > hepatopancreas > gills > muscle (chelae) (Fig. 1)
Cd (female)- Gills > exoskeleton > hepatopancreas > muscle (chelae) (Fig. 2)

There was not any significant difference between sexes in the quality concentration of Cd and Pb except for exoskeleton which females accumulated more Pb

Table 1: Concentration of heavy metals (μg g^{-1} dry weight) in tissues of *Astacus leptodactylus* from the Aras dam reservoir of west Azerbaijan

Sex	Fe	Mn	Cu	Cd	Pb	Zn	Ni	Co	Cr
Abdominal muscle									
Female	25.7±.8	7.1±0.7	36.0±60.7	0.0	0.6	125.0±16	NA	0	0
Male	21.9±3	5.9±0.8	36.4±2	0.0	1.2±0.6	132.0±20	NA	0	0
Muscle of chelae									
Female	31.00±9	10.2±0.1	18.4±2	1.72±0.3	5.0±0.2	221.9±18	NA	0	0
Male	21.00±1	7.2±0.1	26.1±2	1.16±0.7	5.0±0.2	219.0±18	NA	0	0
Gills									
Female	104.0±20	32.3±9	305.1±25	1.90±0.5	49.9.0±15	268.2±25	NA	0	0
Male	145.0±25	14.3±4	284.5±10	0.50±0.2	19.00±0.8	257.1±23	NA	0	0
Exoskeleton									
Female	107.4±15	40.7±2	65.0±5	1.78±0.1	45.26±0.6*	95.9±18	NA	0	0
Male	281.0±99	39.3±0.8	90.7±16	2.22±0.1	39.26±1.7	77.3±4	NA	0	0
Hepatopancreas									
Female	77.0±19*	25.9±4	145.8±21	1.62±0.7	2.1±0.4	527.3±54	NA	0	0
Male	156.0±16	20.1±3	325.0±41	0.81±0.6	1.1±0.5	456.6±48	NA	0	0

*Means differ significantly ($p<0.05$) between males and females, NA, Data unavailable, below the limit of analytical detection (4μg g^{-1}) For all the tissues. Data as mean±SE in dry weight

Table 2: Mean concentration of heavy metals (μg g^{-1} dry weight) in crayfish of Aras dam

Sex	Fe	Mn	Cu	Cd	Pb	Zn	Ni	Co	Cr
Female	345.1	116.2	570.9	7.02	98.36	1238.3	NA	0	0
Male	624.9	86.8	762.7	4.69	61.06	1142.0	NA	0	0

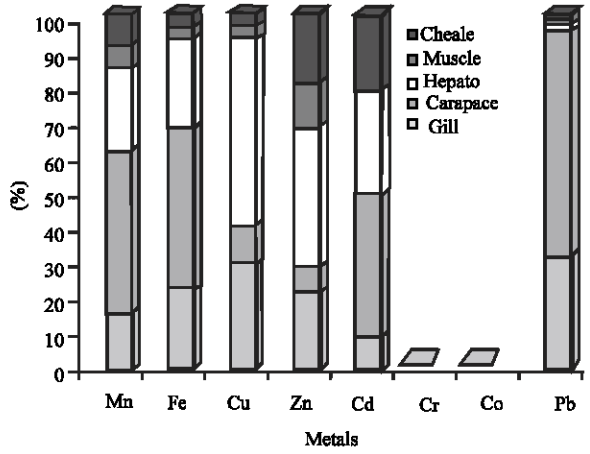

Fig. 1: Percentage distribution among the tissues of male *Astacus leptodactylus*

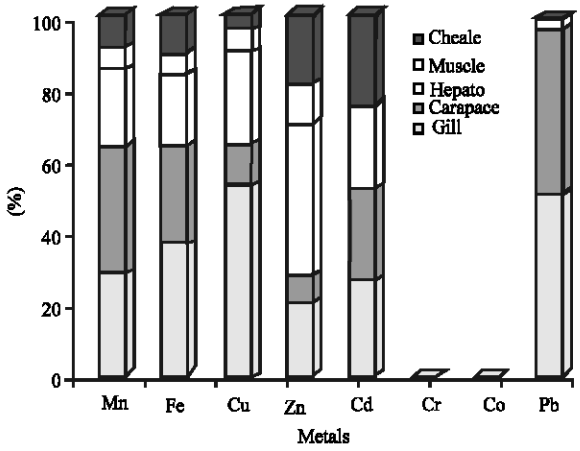

Fig. 2: Percentage distribution among the tissues of female *Astacus leptodactylus*

Table 3: Comparison of heavy metal content in muscle (edible tissue) of *Astacus leptoductylus* in Aras dam reservoir with ISIRI

Metals	Maximum of acceptable level in benthose consumed by human (μg g^{-1})	Current research in muscle of male (μg g^{-1})	Current research in muscle of female (μg g^{-1})
Pb	1.0	1.2	0.6
Cu	20.0	36.6	36.4
Fe	15.0	21.9	25.7
Zn	50.0	132.0	125*.0
Cd	0.1	0.0	0.0
Ni	0.5	NA	NA0
Cr	0.0	0.0	0.0
Co	0.0	0.0	0.0
Mn	-	5.9	7.0

NA<(4 μg g^{-1}), -The amount of Mn is not yet determined by ISIRI, *Amount of Zn is higher than acceptable level of standard level

concentration than males. The data obtained showed that in Aras crayfish heavy metals are generally accumulated +in the following sequence: Zn> Cu> Fe> Mn> Pb> Cd> Ni>Cr = Co (Table 2). Gills contained the highest concentration of Cu, Zn and Fe which may be attributed to the presence of adsorbed matter in the gills rather than to active biological uptake of metals (Szefer *et al*., 1990). The presence of a higher concentration quantity of Mn, Cu, Zn, Pb and Fe in the exoskeleton and heaptopancreas might indicate that these tissues were involved in the excretion of these metals (Macheviciene, 2002). The highest accumulation level in hepatopancreas of *Astacus leptodactylus* was probably due to the storage of the metabolizeable elements in the digestive gland (Nessim and Riad, 2003). Vogt and Quinito (1994) suggested that crustacean hepatopancreas combines various functions of the vertebrate liver, pancreas and intestines. Digestive gland is the prime site of nutrient absorption, metal storage and detoxication. F-cells of hepatopancreas of Decapoda have been regarded as the site of detoxication of certain metals, which are stored in supranuclear vacuole (Vogt and Quinitio, 1994). The elements, which were studied in *Astaus leptodactylus*, most heavy metals were found in hepatopancreas and gills in both sexes, while the lowest was found in muscles (Table 3). The difference in the rate of accumulation may be attributed to the proximity of the tissue than to the toxicant medium, physiological state of the tissue and the present of ligands in the tissues having an affinity to heavy metals (Jayakumar and Paul, 2006). The comparison of heavy metals content in the crayfish of Aras with the national standards of Iran (ISIRI, 2003) indicates that the amount of heavy metals: Pb. Cd, Ni, Co, Cr and Mn were lower than from the acceptable standard level and Fe, Cu were in the acceptable area of the standard level, but the amount of Zn was higher than acceptable level of standard level, according to the data, crayfish *Astacus leptodactylus* from Aras reservoir would be suitable as a food resource because of the low heavy metal content in their soft tissues. Consequently, it can economically be very useful for the region.

ACKNOWLEDGMENTS

I would like to thank the colleagues in the faculty of science for their cooperation. Appreciation also goes to Dr. M. Mohammadi who helped me revise and edit this study.

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