JASEM ISSN 1119-8362

Full-text Available Online at www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. December, 2007
Vol. 11(4) 51 - 54

Bioconcentration factors of heavy metals in tropical crab *(carcinus sp)* from River Aponwe, Ado-Ekiti, Nigeria

FALUSI B.A.[1*] and OLANIPEKUN E.O. [2].

1 Department of Chemistry, School of Nursing, Ado-Ekiti, P.M.B. 5405, Ado-Ekiti, Nigeria. Tel: 080380625O6. E-mail: deledoncattle@yahoo.com. 2. Department of Chemistry, University of Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Nigeria. Tel: 08033907371.*

ABSTRACT: The bioconcentration factors (BCF) of heavy metals in the tissues of tropical crab (*Carcinus sp*) obtained from River Aponwe in Ado-Ekiti, Nigeria, were determined. Nine heavy metals (As, Cd, Cu, Hg, Mn, Ni, Pb, Se and Zn) were studied. Tissues from the chest region as well as from the appendages were collected and their bioconcentration factors separately determined. The bioconcentration factors obtained for the various heavy metals in the chest region and the appendages are respectively as follows: As (0.50, 0.40). Cd (3.75, 3.00); Cu (1.83, 1.71); Hg (0.83, 0.50); Mn (0.15, 0.14); Ni (0.11, 0.09), Pb (0.20, 0.19); Se (0.37, 0.38) and Zn (5.00, 4.89). Bioconcentration factors obtained for As, Hg, Mn, Ni, Pb and Se were all less than 1.00 implying no bio-accumulation. However, bioconcentration factors greater than 1.00 obtained for Cu, Cd and Zn evidently indicated that the metals were highly bio-accumulated and bio-magnified. Zn with the highest bioconcentration factors was the most bio-accumulated and bio-magnified of all the metals studied. There is a growing concern about the physiological and behavioural effects of environmental trace metals in human population. Toxicities of heavy metals at high levels of exposures are well known, but of a major concern is the possibility that continual exposure to relatively low levels of these metals through regular consumption of the crabs may entail adverse health effects. @ JASEM

Living organisms require trace amounts of some heavy metals, including iron, cobalt, copper, manganese, molybdenum, strontium, vanadium and zinc. Excessive levels of these metals, however, can be detrimental to living organisms. Other heavy metals such as cadmium, lead and mercury have no known beneficial effect on organisms, and their accumulation over time in the bodies of mammals can cause serious illness (Hawkes, 1997). Water sediments and the biota are generally metal reservoirs in aquatic environments. The concentrations of heavy metals in water may vary considerably depending on annual and seasonal fluctuations (Warren, 1981). Bower (1979) noted that the extent of accumulation in biota is dependent on the chemical effects of the metal, its tendency to bind to particular materials and on the lipid content and composition of the biological tissues. Various activities by man in recent years have increased the quantity and distribution of heavy metals in the atmosphere, land and water bodies. The extent of this wide spread but diffused contamination has raised concern about their hazards on plants, animals and humans.

Tropical crab (*Carcinus sp*) belongs to the phylum; arthropoda which make up about three quarters of living animal species. The fleshy tissues of the animal are consumed by man as protein supplement when cooked. However, fleshy tissues of crabs are good accumulators of heavy metals and the nutritional implication of this is that consumers of the animal may be exposed to heavy metal toxicity if bio-accumulation results due to regular consumption (Goyer, 1995). Several different studies have been carried out on the determination of levels of heavy metals and their effects in aquatic organisms (Ogindo, 2001; Olaifa et al, 2004; Ako and Salihu, 2004) and particularly in crab (Krishnan, 1992; Mortimer and Miller, 1994; Heslin, 1995; Mremi and Machiwa, 2003; Otchere, 2003). Despite the many studies carried out on heavy metals in crabs, scanty information is available on the bioconcentration factors (BCF) of heavy metals in crab samples. Consequently, the current work was carried out to determine the BCF values of heavy metals in tropical crab in order to know whether or not the metals are bio-accumulated in the tissues of the animal collected at the bank of River Aponwe, Ado-Ekiti (Nigeria) so as to protect the consumers of the animal from exposure to heavy metal toxicity as a result of regular consumption.

MATERIALS AND METHODS

Sample Collection

Ten fresh (life) samples of crab used for analysis were randomly collected directly, by hand picking, from their holes at the bank of River Aponwe, a shallow, narrow, but all seasons river, located at Ado Ekiti, Nigeria. Sediment samples were also randomly collected for analysis from the river bank at the same spots as the crab samples. The crabs were kept in a bucket containing the river water and transported to the laboratory until dissection took place.

* Corresponding author: Falusi B.A.

Sample Preparation

The soil sediment samples were sun dried for one week and the dried samples were pulverized into fine powders using laboratory mortar and pestle. The pulverized samples were stored in polythene bags and clearly labeled. Representative sample was finally made for the sediment samples and labeled SRA.

The crabs were removed from the river water; washed with tap water; rinsed thoroughly with distilled water and were dissected using surgical knife. Tissues from the chest region and the appendages were separately extracted. The tissue from the chest was labeled A_1, while that from the appendages was labeled A_2. The tissues were placed in clean watch glasses and were oven dried at 105^0C for 1 hour and later cooled in the desiccators.

Chemical Analysis of Crab Samples.

2.0g of each dried crab tissue was weighed into empty clean beaker with cover. The sample was digested in 5.0ml of distilled water and 3.0ml of concentrated sulphuric acid on a hot plate until the digest neared 5.0ml when the beaker was removed from the hot plate and allowed to cool slightly. Another 3.0ml of concentrated nitric acid was then added and the sample was gently heated on a hot plate for additional 15 minutes. The beaker was removed, allowed to cool, and another 2.0ml of distilled water and 3.0ml of 30% hydrogen peroxide (H_2O_2) was added. The beaker was heated until the effervescence from the H_2O_2 ceased. Another 3.0ml of H_2O_2 was added and the beaker was heated until only about 2.5ml remained. The beaker was removed from the hot plate and the digest was diluted with distilled water and filtered through Whatman No1 filter paper. The residue was washed with distilled water thoroughly and the combined wash and filtrate was made up to mark in a 100ml volumetric flask with distilled water. The solution was stored in clean labeled plastic containers until analysis (Heslin, 1995).

Chemical Analysis of Sediment Sample.

2.0g of the dried sample of soil sediments was weighed into a clean beaker and a mixture of concentrated nitric and hydrochloric acids (3:1) were added. The contents were digested on a hot plate for 11/2hours. The digest was cooled and filtered through Whatman No1 filter paper. The residue was thoroughly washed with distilled water and the combined filtrate and wash was made up to mark in a 100ml volumetric flask with distilled water. The solution was stored in clean labeled plastic container until analysis (Alloway and Ayres, 1990). Heavy metals in the samples were determined using Alpha 4 Serial Number 4200 model of flame atomic absorption spectrophotometer. The determination of mercury in the samples was performed by employing ICP-AES (Varian Liberty Series II), using a VGA accessory. Duplicate analyses were carried out on the samples of crab tissues and soil sediments.

The bioconcentration factors (BCF) of the heavy metals in the crab samples were obtained using equation1 (Vassiliki and Konstantina, 1984).

$$BCF = \frac{C_{org}}{C_{sed}} \quad \text{(1)}$$

Where BCF = bioconcentration factor;

C_{org}= concentration of metal in the organism;

C_{sed} = Concentration of the same metal in the ambient environment, soil sediment in this case.

Statistical Analysis

The coefficient of variation was calculated to determine whether or not the BCF obtained for the various heavy metals in the two tissues of the tropical crab were significantly different from one another.

RESULTS AND DISCUSSION

The average concentrations of metals in the tissues (chest and appendage) of the crab and the soil sediment samples are presented in Table 1.

Table 1: Average metal concentrations (mg/kg) of samples of crab tissues and soil sediment.

Metals	A_1	A_2	Mean	SD	SRA
As	0.75	0.60	0.68	0.11	1.50
Cd	0.08	0.06	0.07	0.01	0.02
Cu	29.18	27.26	28.22	1.36	15.98
Hg	0.13	0.08	0.11	0.04	0.15
Mn	15.20	14.80	15.00	0.28	103.56
Ni	1.75	1.56	1.66	0.13	16.54
Pb	5.60	5.44	5.52	0.11	27.86
Se	0.37	0.39	0.38	0.01	1.02
Zn	5.00	4.89	4.95	0.08	1.00

Note:
A1= tissues from the chest region of the crab samples;
A2= tissues from the appendages of the crab samples;
SRA = soil sediments from River Aponwe;
SD = standard deviation.

The bioconcentration factors of the heavy metals in the tissues of the crab samples are recorded in Table 2.

* Corresponding author: Falusi B.A.

Table 2: Bioconcentration factors (BCF) of heavy metals in tissues of crab samples.

Metals	A_1	A_2	Mean	SD	CV	%CV
As	0.50	0.40	0.450	0.071	0.158	15.78
Cd	3.75	3.00	3.375	0.530	0.157	15.70
Cu	1.83	1.71	1.770	0.085	0.048	4.80
Hg	0.83	0.50	0.665	0.233	0.350	35.04
Mn	0.15	0.14	0.145	0.007	0.048	4.80
Ni	0.11	0.09	0.100	0.014	0.140	14.00
Pb	0.20	0.19	0.195	0.007	0.036	3.59
Se	0.37	0.38	0.375	0.007	0.019	1.87
Zn	5.00	4.89	4.945	0.078	0.016	1.58

Note:
CV = Coefficient of variation
%CV = Percentage coefficient of variation.

From the results in Table 1, it can be observed that very low concentrations of between 0.06 - 0.75mg/kg were obtained for arsenic (As), cadmium (Cd), mercury (Hg) and selenium (Se). Values obtained for these metals, though very low, may however pose serious danger to consumers of the crab samples, because, apart from Se, other metals have severe toxic effects on most organisms (Fergusson, 1990). A range of concentrations of
1.50 - 5.60 mg/kg was obtained for nickel (Ni), lead (Pb), and Zinc (Zn). A mean value of 5.52 mg/kg obtained for Pb was considered high due to its relative toxicity. High levels of Pb in the samples were probably due to contamination of the studied river by the activities of car wash operators located in the area. Zn is an essential micronutrient; hence a 4.95 mg/kg average concentration obtained in the tissues of the crabs was not alarming. A very high range of concentrations of between 14.80 - 29.18 mg/kg was obtained for copper (Cu) and manganese (Mn) in the tissues analyzed. Both metals are essential micronutrients. Of all the metals analyzed, Cd has the lowest mean concentration of 0.07 mg/kg, while Cu with a mean value of 28.22mg/kg has the highest concentration in the tissues of the crab samples.

Generally, concentration of heavy metals in the tissues obtained from the appendages were lower than those obtained from the chest region and therefore suggested that higher accumulation of the metals occurred in the chest region than in the appendages of the crab samples. There is a growing concern about the physiological and behavioural effects of environmental trace metals in human population. The toxicities of most heavy metals at high levels of exposures are well known, but the concern of today is the possibility that continual exposure to relatively low levels of these metals by the regular consumption of the analyzed crab samples as source of protein may entail adverse health effects (Koller, et al., 1992).

The biconcentration factors (BCF) of heavy metals in the tissues from the chest and appendage regions of the crab samples are presented in Table 2. For most metals, a BCF value of less than 1.00 is usually expected; otherwise, bio-accumulation of the metals by organisms will occur (Vassiliki and Konstantina, 1984). From the results obtained, it was observed that As, Hg, Mn, Ni, Pb and Se have BCF values ranging from 0.09 - 0.83, which are considered normal since they are less than 1.00. Cu has BCF values of
1.71 - 1.83; Cd has a 3.00 - 3.75 BCF values, while Zn has the highest values of 4.89 - 5.00. All these values were considered too high when compared with the highest value of 1.00 expected for any metal. The high BCF values obtained for Cu, Cd and Zn therefore indicated that the metals were highly bio-accumulated and bio-magnified in the tissues. All the metals studied, except Se, have higher accumulation in the tissue obtained from the chest region than those obtained from the appendages as indicated in Table 2 for their BCF.

For all the BCF values shown in Table 2, the coefficient of variation (CV) were generally observed to be very low with maximum of 0.350 (or 35.04%) obtained for mercury (Hg) while zinc (Zn) with 0.016 (or 1.58%) has the least CV. These results showed that the BCF of the heavy metals in the two tissues from the crab samples were very close.

CONCLUSION

The BCF obtained for As, Hg, Mn, Ni, Pb and Se were less than 1.00 and were considered normal. The BCF obtained for Cu, Cd and Zn were however greater than 1.00 indicating that they were highly bio-accumulated and bio-magnified in the tissues of the crab samples. Zn has the highest BCF and was therefore, the most bio-magnified of all the metals studied. Furthermore, higher bio-accumulation of all the metals, except Se, occurred in the chest relative to the appendages of the crab samples. Very close values of BCF of the heavy metals were obtained in the two tissues from the crab samples.

* Corresponding author: Falusi B.A.

REFERENCES

Ako, P A; Salihu, S O (2004). Studies on some Major and Trace Metals in Smoked and Oven-dried Fish. Jour of Applied Sciences and Environmental Management, 8 (2): 5-9.

Alloway, B J; Ayres, D C (1990). Chemical Principle of Environmental Pollution. Blackie Academic and Professional. Chapman and Hall, Glasgow, UK. pp 140-142.

Bower, H J (1979). Heavy metals in the sediments of foundary cover cold spring. New York; Environ. Sci. Technol., 13, 683-689.

Fergusson, J E (1990). The Heavy Elements; Chemistry, Environmental Impact and Health Effects. Pergamon Press, Oxford. pp 40-43.

Goyer, R A (1995). Nutrition and metal toxicity. Am. J. Clin. Nutr., 61, 32-40.

Hawkes, S J (1997). What is a Heavy Metal? Jour.Chem. Edu., 74:1374.

Heslin, L B (1995). Cadmium, Chromium and Lead Accumulation in the Tissues of the Blue Crab (*Callinectes sapides*). Master's Thesis, Southern Louisiana University.

Koller, K; Brown, T; Spurgeon, A; Levy, L (2004). Recent development in the low level exposure and intellectual impairment in children. Environ. Health Perspect., 112(9), 987-994.

Krishnan, S (1992). Heavy metal concentration in the Fiddler crabs inhabited the Adyar estuary and back water. Rec. Zool Surv. India. 9 (30): 421-425.

Mortimer, M R; Miller, G J (1994). Susceptibility of Larval and Juvenile Instars of the sand crab, *Portunus pelagicus*, to sea water contaminated by Cr, Ni, or Cu. Aust Jour Mar Freshwater Res, 45:1107-1121.

Mremi, S D; Machiwa, J F (2003). Heavy metal contamination of mangrove sediments and the associated biota in Dares Salaam, Tanzania. Tanz. Jour of Sci, 29 (1): 61-76.

Ogindo, B A (2001). Heavy Metal Pollutants and their Concentrations in Fish (*Barbus sp*) in Sosiani River, Kenya. Discovery and Innovation, 13 (3): 178-183.

Olaifa, F E; Olaifa, A K; Adelaja, A A; Owolabi, A G (2004). Heavy Metal Contamination of *Clarias gariepinus* (African Cat Fish) from a lake and fish farm in Ibadan, Nigeria. African Jour of Biomedical Research, 7 (3): 145-148.

Otchere, F A (2003). Heavy metals concentration and burden in the bivalves (*Anadara senilis*, Crassostrea *tulipa* and *Perna pernal)* from lagoons in Ghana. Model to describe mechanism of accumulation/excretion. African Jour of Biotech, 2 (9): 280-287.

Vassiliki, K; Konstantina, A D (1984). Transfer Factors of Heavy Metals in Aquatic Organisms of Different Trophic Levels. Bull Envir. Contam. Toxicol.

Warren, I D (1981). Contamination of sediments by lead, cadmium, and zinc. A review: Environ. Pollut., 2, 401-436.

* Corresponding author: Falusi B.A.