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Trace metals content in shore crabs (*Cardisoma Guanhumi*) from coastal area of Port Harcourt City, Rivers State, Nigeria

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ABSTRACT

A survey into the concentration and distribution of arsenic (As), lead (Pb), nickel (Ni), copper (Cu), cadmium (Cd), calcium (Ca), sodium (Na) and manganese (Mn) in tissues of crab (Cardisoma guanhumi) was investigated. Crab samples were collected from three sites for the period of three months. The samples were prepared by acid digestion and analyzed by Atomic Absorption Spectrophotometer model F7102. The results obtained revealed that in location 1 elements had the following mean concentrations: As (0.333±0.124µg/g), Pb(0.095±0.072µg/g), Ni(1.42±1.03µg/g), Cu(2.61±1.21µg/g), Cd(0.055±0.001µg/g), Ca(1141±1021µg/g), Na(1289.00±1102µg/g), Mn(3.36±2.14µg/g), location 2: As (0.253±0.211µg/g), Pb(0.074±0.152µg/g), Ni(2.45±105µg/g), Cu(2.51±2.03µg/g), Cd(0.001±0.001µg/g), Ca(1663±1172µg/g), Na(1384±1240µg/g), Mn(3.836±2.116µg/g) and location 3, As (0.234±0.121µg/g), Pb(0.01±0.00µg/g), Ni(2.08±1.09µg/g), Cd(0.01±0.00µg/g), Ca(1140.3±1021.1µg/g), Na(1715.6±1502.3µg/g), and Mn(2.68±2.72µg/g). The levels of trace metals were significant at p<0.05 levels in tissues of shore crabs from the three sites. The results showed that the essential elements occurred more abundantly than the non-essential trace elements and the main source of the element was domestic rather than industrial activities. BCFs was determined for all the element and Mn had the highest bioconcentration factors. The results also showed that mean levels of trace metals Pb, Cu and Cd were below WHO and US standards set for food and drugs administration. Hence consumption of crabs (Cardisoma guanhumi) from the study area will not pose any health threat except for As, Ni and Mn.

Keywords: Bioaccumulation, trace elements, anthropogenic, crab, tissues.

INTRODUCTION

The natural ecosystem is adversely affected by many human activities such as road construction, mining, discharged of waste and garbage from domestic and industrial effluents. These wastes may contain substances that can bioaccumulate in the tissue of plants and animals above desired levels [1,2,3]. According to [4] wastewaters emanate from four primary sources including municipal sewage, industrial, agricultural runoff, storm-water and urban runoffs. These sources of waste terminate in the surface and ground water and pollute the water with organic, toxic materials, heavy metals, and plant nutrients such as nitrogen and phosphorus from farmland. The industrial effluents also changes the color, temperature, pH, alkalinity, salinity of the affected water body [5,6,7]. Unlike other pollutants trace metals accumulates in the environment unnoticed until the effects is seen either when the affected plants or animal is consumed. This type of incident occurred in Japan where many people died as a result of consumption of fish contaminated with methylmercury [8-10]. Most metals have important industrial application such as in the manufacture of pesticides, batteries, alloys, electroplated metal parts, textiles, dyes, and steel. However, some are nutritionally essential for a healthy life examples are iron, copper, zinc and manganese. These elements, or some form of them are commonly found naturally in food stuff meat, fish , poultry, grains and cereals, in fruits and vegetables, and in commercially available multivitamin products [11].

According to [12], arsenic compounds were used to treat wood to prevent rot. The arsenic leaches out into soil and rubs off the wood on to people or animals. Arsenic also occurs in soil from smelters and some pesticides, special glass, semi-conductors, some paint, dye, soap and drugs. In humans, arsenic is known to cause lung and skin cancer, nausea, diarrhea, vomiting, peripheral nervous system problem [12,13]. In the Niger Delta area of Nigeria, several studies have been carried out on fauna and flora and the results revealed low concentrations of the heavy metals such as Pb, Hg and Cd [2,8,14]. Aquatic organism such as crab, oyster, shrimps and periwinkle are sources of protein and essential elements such as calcium, sodium, manganese, and iron. However, studies have shown that these aquatic organisms contained elevated levels of trace metals and continuous consumption by human may lead to diseases and sickness. It is in this regard that this study is carried out on crab to determine the levels of trace metals in various tissues of crab from the coastal area of Port Harcourt City where lots of human activities occurs.

MATERIALS AND METHODS

Study Area: Port Harcourt City is located in the Niger Delta area south-south Nigeria. The city habour many companies such as Eleme Petrochemical, Port Harcourt Refinery, Indomie, Plastic, brewery, oil and gas free zone Onne, oil location owned by shell British Petroleum and Agip and the giant Liquefied Natural Gas (LNG) Bonny. In the coastal area of Port Harcourt, there are many Jetties that ships, and cargo oil tankers load and off load crude oil and other petroleum products. Some common Jetties in the coastal area of Port Harcourt are Marine base, Abonnema Wharf, Aker base, and Iwofe. These Jetties are commonly contaminated with petroleum products, industrial effluents and debris carried in drains from hinterland. Aquatic organisms such as mudskippers, periwinkles, oysters and crabs are found around these jetties and are caught by fishermen and consumed by the inhabitants of the area.

Sampling: Some crabs (*cardisoma guanhumi*) of similar sizes were caught with local trap and net while others were caught in holes by the shore of the coast. The samples were caught from April 2014 to August 2014 at the interval of two months from three sites namely: Iwofe, Abonnema Wharf and Marine base jetties. To avoid crab bite, they were killed, washed with water at each site and were placed in a cooler packed with ice blocks. On the other hand, the surface water were collected from each site as recommended by[15] and few drops of 2ml HNO_3 were added immediately, this was done to prevent precipitation of metal ions. The samples were labeled according to each location and were taken to the laboratory and stored in a refrigerator.

Sample Preparation: The legs and gills were removed by hand while the shells were opened and the muscles were removed with the aid of a sharp stainless knife. The samples were dried separately at 60^0C for 2h and homogenized with mortar and pestle. This procedure was repeated for the three samples. Precisely 5.0g of ground samples were digested according to the method recommended by [16] for 30 minutes in a fume cupboard.

The water samples were preconcentrated by solvent extraction using ammonia pyrolydine dithiocarbamate (APDC) and methyl isobutyl ketone (MIBK) as the organic solvent. The prepared crabs and water samples were analyzed using atomic absorption spectrophotometer model F7102. Bioconcentration factors (BCF) were calculated according to [17], using the formula.

BCF = metal concentration in organism/metal concentration in water

RESULTS AND DISCUSSION

The mean levels of trace elements in the tissues of shore crabs are shown in Tables 1, 2 and 3 respectively. The mean concentration of all the trace elements were significant at $P<0.05$ probability levels. The results in table 1 revealed that all the elements had variable concentrations in different tissues examined. Elevated mean levels of sodium (Na), calcium (Ca) and manganese (Mn) were recorded in the gills when compared to Cu, Ni, Pb, Cd, and As. In any aquatic organism gills are used for respiration and filtering of water to obtained food and in the process particulate materials are adsorbed on the surface. At site 1 (Iwofe Jetty), sodium (Na) recorded the highest mean levels of the trace metals. The relative abundance of the trace elements at site 1 (Table 1) occurred in the order Na> Ca> Mn> Cu> Ni> Pb> As > Cd which were 1167±1451 µg/g, 1135±1128, 373±282µg/g, 2.73±2.33µg/g, 1.450±1.321µg/g, 0.143±0.031 µg/g, 0.01±0.01 and 0.001 ±0.001µg/g respectively.

Table 1 (Site 1): Mean levels of trace metals in tissue of shore crab (*Cardisoma guanhumi*) from Iwofe Jetty in µg/g

Metal	Gills	Muscles	Carapace
As	0.34±0.21	0.32±0.27	0.33±0.302
Pb	0.143±0.03	0.02±0.01	0.120±0.103
Ni	1.450±1.32	1.42±1.07	1.40±1.09
Cu	2.725±2.333	2.711±2.44	2.40±2.35
Cd	0.001±0.001	0.003±0.03	0.001±0.001
Ca	1135±1128	1132±1301	156±1421
Na	1167±1451	1512±1432	1188±1741
Mn	3.73±2.82	3.11±2.90	3.25±3.05

Table 2 (Site 2): Mean levels of trace metals in tissue of shore crab (*Cardisoma guanhumi*) from Abonnema Wharf Jetty in µg/g

Metal	Gills	Muscles	Carapace
As	0.42±0.39	0.22±0.21	0.12±0.08
Pb	0.102±0.02	0.02±0.01	0.10±0.21
Ni	2.41±1.43	1.72±1.22	3.24±1.80
Cu	2.84±262	1.94±0.88	2.84±1.77
Cd	0.01±0.12	0.01±0.01	0.01±0.01
Ca	1390±1340	1702±1320	1807±1705
Na	1290±1632	1190±1182	1972±1163
Mn	3.94±2.95	3.35±1.43	4.22±3.08

Table 3 (Site 3): Mean levels of trace metals in tissue of shore crab (*Cardisoma guanhumi*) from Marine base Jetty in µg/g

Metal	Gills	Muscles	Carapace
As	0.011±0.20	0.25±0.11	0.34±0.13
Pb	0.01±0.02	0.01±0.01	0.02±0.01
Ni	2.02±2.00	2.32±2.11	1.92±0.24
Cu	2.84±2.37	3.24±2.05	2.93±3.01
Cd	BDL	0.01±0.01	BDL
Ca	1145±1156	1138±1121	1802±1711
Na	1743±1521	1602±1325	1138±1121
Mn	3.84±2.54	4.11±3.42	3.11±3.01

Table 4: Mean levels of trace metals in water from three sites in mg/L

Metal	Site		
	Iwofe	Abonnema Wharf	Marine Base
Pb	**0.11±0.10**	0.01±0.11	0.01±0.10
Ni	1.20±1.09	0.27±0.08	1.65±0.11
Cu	0.25±0.15	1.05±0.12	1.21±0.97
Cd	BDL	BDL	BDL
Ca	1142±1340	1104±1512	1349±1095
Na	1298±1132	1091±1087	1972±1802
Mn	2.95±1.45	2.11±2.01	5.30±3.45
As	0.01±0.01	0.10±0.01	0.12±0.15

BDL = Below detection limit

Table 5: Bioaccumulation factors for trace elements

Site	Pb	Ni	Cu	Cd	Ca	Na	Mn	As
Iwofe	28.9	38.0	7.22	BDL	3.10	3.41	50.00	7.7
Abonnema Wharf	6.91	0.01	6.25	0.01	378	3.64	7.52	7.6
Marine base	3.0	2.00	4.49	BDL	2.80	2.74	9.14	5.2

Similar trend of trace metals occurred in the gills tissue at sites 2 (Abonnema Wharf) and 3 (Marine base). The results showed that essential elements Mn, Na, Ca and Cu occurred more abundant than the non-essential elements, Ni, Cd, As, and Pb in the gills samples from sites 1, 2 ,3 which corresponds to Table 1,2, and 3 respectively. Similar result was obtained by[18] in the study of some metals in a polyculture freshwater pond. They reported higher levels of sodium when compared to potassium in some fish parts for *C. Carpio* and *O. niloticus*, however, a different trend was observed in *C. gariepines*. The results obtained in this study agreed with those reported by [14,17,19]. However, values lower than those reported by [3,20] in shore organisms were observed in this study.

The mean levels of trace metals in the gills were slightly higher than the levels obtained in water Table 1, and Table 4 respectively. The higher concentrations recorded in the gills when compared to the levels in water may be as a result of bioaccumulation of these metals over a long period. Aquatic organisms are always in contact with water and in this process food and other particulate matter are absorbed through the gills and more metal are obtained in the process [21,22,23]. The mean levels of trace metals in the muscles are shown in Table 1, 2, and 3. Table 1 revealed that there was variation in the levels of the various metals in the different tissues examined. There was no significant difference at $p<0.05$ in the mean levels of trace metals Pb, Ni, Cu, Cd, Na, Ca, As, Mn in the muscles tissue in Table 1, 2, and 3 respectively. At site 1 (Table 1), Na recorded the highest mean concentration of 1512.00 ±1442µg/g while Cd had the least mean concentration of 0.001±0.001µg/g. Similar trend of results were obtained in table 2. Elevated levels of Na were obtained because the element occurs naturally in the environment and is required by every living organism. However, Pb, As, Ni and Hg are often distributed in crude oil, battery, agriculture and in pesticide [12,18]. At site 3 (Marine base) the non-essential trace elements are distributed because this site is closest to the Port Harcourt refinery, where crude oil pipe line transverse. Similar results of trace metal levels were reported in earlier studies in two species of crabs from intertidal flat of New Calabar River, [24] and from other aquatic organisms [6,8,10,11]. However, higher results were reported by[3,20], from Taiwan and Turkey Rivers respectively. At site 2 (Abonnema Wharf) is the site of industrial activities, where dredging companies operate to enable ship and cargo to anchor. Thus, this site had the highest mean levels of trace metals in the carapace of the organism. There was a strong correlationship between the levels of trace metals in the gills, carapace and muscles at $p<0.05$ at this site.

Table 6: International standards set by WHO & USFDA

Metal	WHO		USFDA	
	Water(mg/L)	Food (µ/g)	Water(mg/L)	Food(µg/g)
Asenic (As)	0.01	6.0	0.05	6.0
Lead (Pb)	0.01		-	6.0
Nickel (Ni)	0.15	NA		-
Copper (Cu)	0.05	NA	1.00	NA
Cadmium (Cd)	0.05	NA	0.05	2.0
Calcium (Ca)	NA	NA	NA	NA
Sodium (Na)	200	NA	NA	NA
Manganese (Mn)	0.05	NA	0.05	NA

NA = not available

The results obtained revealed that carapace from the three (sites) Table 1, 2, and 3 respectively had the highest mean levels of trace metals when compared to the levels in the gills and muscles. From the three sites (Table 1, 2, 3) the elements occurred in the order Na>Ca>Mn>Cu>Ni>Pb>As>Cd. The results reveals that the distribution of trace elements in the crabs (*Cardisoma guahumi*) occurred in the order carapace>gills> muscles. Similar results of higher concentrations of trace elements in the shell than in the muscles were also reported [14,19,26], where higher levels of Pb was recorded in the shell of fish than in soft tissues. The results in carapace revealed that Cu recorded the fourth highest mean levels of trace metals in Table 1, 2, and 3 respectively. Fish muscles normally contains low concentration of Cu even at high levels of Cu exposure, muscles do not reflect increases in the external environment. In contrast, the gills tissue of fish tends to concentrate Cu from the water. However, the results obtained in this study were lower than those obtained by [20]. They reported the following mean range, Cu (18.7 – 41.6µg/g), Pb (1.01-1.12µg/g), Ni (1.46-5.92µg/g). Low levels of some of these metals are due to the fact that some aquatic animals can regulate their body burden [27]. Crabs *(Carcinus maenus)* can regulate its body level of Zn after exposure to seawater containing 500 times the normal concentration of Zn, with the concentration by 2 and 4 factors respectively [28]. Bioconcentration factors (BCFs) for all the metal where determined using the mean concentration of the metals in the muscles and in the water (environment) at each site. The highest BCFs of Mn (50.00) was obtained at Iwofe Jetty and the order of BCFs from this site (Iwofe Jetty) was Mn>Ni>Pb>Cu>Na>Ca>As>Cd Table 5. Mn recorded the highest bioaccumulation factor at the three sites and Cd had the lowest. It was expected that the levels of trace metals in the study area would have been high, since the area is prone to pollution by natural and human activities. On the contrary, low levels of trace metals were obtained at all the sites. There are many sources of trace metals that would have polluted the area and these include paints, materials from preserved word and batteries that are washed from hinterland to the creeks and shores of the study area. The mean levels of trace elements obtained in this study were below the maximum permissible levels (MPL) set by the US food and drug. Administration and WHO levels. This showeds that the levels of trace metals obtained in shore crab (*Cardsoma Guanhumi*) will not constitute any health hazard at the moment.

CONCLUSION

The results revealed that low levels of trace metals were obtained in all the shore crabs and water samples. The relative abundance of the elements in the studied organism shore crab (*Cardisoma guahumi)* occurred in the order Na>Ca>Mn>Cu>Ni>As>Pb>Cd in all the sites while the order of bioaccumulation of trace elements in the tissue was carapace > gill > muscles. However, low levels of non-essentials metals were obtained when compared to essential elements, this showed that the main source of pollution is domestic instead of industrial activities. Shore crabs have great potential for the biomonitoring of trace metals levels in the shore of Iwofe, Marine base and Abonnema Wharf jetties of the coast of Port Harcourt City which is under pressure of activities of oil and gas companies operating around the area. In order to maintain the present status of trace metals levels in the study area the following procedures should be strictly adhered to:

(i) Inhabitants of the area should minimize dumping of effluents and waste directly into the creeks and shore of Port Harcourt City.
(ii) The Oil companies operating in the area should be encouraged to adopt low and non-waste technologies (LNWT).
(iii) More studies on the levels of trace metals and other pollutants should be conducted on other aquatic organism found commonly within the shores of Port Harcourt City.

REFERENCES

[1] C. A. R. Silva, P. S. Rainbow, and B. D. Smith, *Hydrobiologia*, **2003**, 501, 199-206.
[2] E. C. Okafor, and K. Opuene, *Intern. J. Environ. Sci. Tech,* **2006**, *3(4): 381-389.*
[3] A. L. Tuna, F. Yitmaz, A. Demirak, and N. Ozdemir, *Environ.l Monit. and Assess.,* **2007** *125: 47-57.*
[4] F. H. Nielsen, *Biol. Trace Element Res.* **1990**, *26(27): 599-611.*
[5] T. G. Miller, and W. C. Mackay, *Water Res,* **1980**, *14: 129-133.*
[6] P. A. Felts, and A. G. Heath, *J. Fish Biol*. **1984**, 25: 445-453.
[7] O. J. Aderinola, E. O. Clarke, O. M. Olarinmoye, V. Kusemiju, and M. A. Anatekhai, *American-Eurasian J. Agric and Environ Sci*. **2009**, 5(5):609-617.
[8] B. C. O. Okoye,). *Intern, J. Environ. Stud,* **1991**, 37:285-292.
[9] Olowoyo, D.N. *Nigeria. America Journal of food and nutrition,* **2011**, 1(3): 102-108.
[10] A. B. Andem, U. U. Udofia, K. A. Okorafor, and U. U. George, *Green Journal of Biological Sci* **2013**, 3(7): 253-259.
[11] S. S. Asaolu, and O. Olaofe, *Bio. Sci. Res. Commu.* **2004** *16:33-39.*
[12]B. Narayana, T. Cherian, M. Matthew, and C. Pasha, *Indian Journal of chemical technology*, 2006, 13: 36-40.
[13] America Water Works Association (AWWA) (**1992**). Water quality and treatment, 83.
[14]S. E. Kakulu, O. Osibanjo, and S. O. Ajayi, *Environment International,* **1987**, 13:247-251.
[15]C. E. Zobell, and B. F. Brown, *J. Mar Res*. 5: 178-184.
[16]APHA (**1990**). Standard methods for the examination of water and waste water 20th Edition American Public Health Association.
[17] D. S. Abolude, O. A. Davies, and D. W. Avong, *Intern. J. Anim. and Veterinary Advances,* **2009**, 1(2): 54-58.
[18}I. A. Emmanuel, J. A. Niyi, E. F. Moyinoluwu, and O. T. Victor, *Aquaculture* **1996**, 147: 203-214.
[19]I. C. Howard, U. U. Gabriel, and M. Horsfall, *European Journal of Scientific Research* 24(4): 468-476.
[20]Y. Hsiao-Chien, C. I-Miny, C. Ping, and W. Wei-Hsien, *Monit* Assess, **2009**, 153:103-109.
[21]J. H. J. Van Vuuren, H. A. Du Prez, V. Wepener, A. Adendorff, I. E. J. Barahooru, *Water Res. Commission, Pretoria WRC.* **1999**, *Report No. 608/1/99.*
[22] S. S. Ovuru, and J. F. Alfred-Ockiya, *Global J. Pure and Appl Sci,* **2001**, *7(4):* 637-640.
[23]J. G. Ayenimo, C. E. Adeyinwo, I. A. Amoo, and F. I. Odukudu, *J. App. Sci,* **2005**, *5(5): 813-815.*
[24]F. Kpee, *Journal of Engineering, Science and technology,* **2009**, 2(1): 19-27.
[25] C. M. A. Iwegbue, G. E. Nwanjei, and I. O. Eguavoen, *Adv. Nat. Appl. Sci. Res,* **2004**, 2(1): 77-82.
[26]W. B. Dambo, andi. K. E. Ekweozor, *Nig.a J. App Sc and Environ Mgt.* **2000**, 4(2): 101-108.
[27]S. W. Fowler, *Marine environmental resource,* **1990**, 29. 1-64.

[28]M. Abubakar, and S. Garba, *Best J*. **2006**, 4: 47-80.