



Assessment of Heavy Metal Concentrations in the Gut and Muscle Tissues of Swimming Crabs (*Callinectes amnicola*) from Rumuolumeni Creek, Rivers State, Nigeria

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Abstract

The aim of this study was to assess heavy metals concentration in the gut and muscles of swimming crab (*Callinectes amnicola*). Four sampling stations were established, samples were collected from each, for a period of three months. Heavy metals investigated were Zn, Pb, Cu and Ni, the part of crab involved was gut and muscles, they were oven dried and Atomic Absorption Spectrophotometer (AAS) model AA320N, was used to analyze the concentration of heavy metals. Analysis of variance was used to calculate mean and standard deviation while statistical significance was assessed at 0.05 probability levels using Turkey tests. Heavy metals concentration results in the gut of *Callinectes amnicola* for the period of three months showed the following Zn 8.31 ± 2.33 to 9.69 ± 2.72 , Pb 0.19 ± 0.15 to 0.56 ± 0.46 , Cu 71.14 ± 17.49 to 89.53 ± 22.01 , Ni 0.02 ± 0.01 to 0.05 ± 0.03 while muscles were Zn 2.70 ± 0.76 to 3.15 ± 0.88 , Pb 0.42 ± 0.35 to 0.45 ± 0.37 , Cu 55.49 ± 13.64 to 58.30 ± 14.33 , Ni 0.02 ± 0.01 to 0.02 ± 0.01 . The available results were compared with standard limit of World Health Organization (2003). In the gut of *C. amnicola* Pb and Cu was above permissible limit of WHO, while in muscles only Cu was above the permissible limit of WHO, which shows more accumulation of heavy metals in the gut than the muscles. Since there are accumulations of heavy metals above permissible limits of WHO both in crab gut and muscles, as such its consumption poses health risk to consumers. It is recommended that people consuming crabs in Rumuolumeni Creek should do it with caution.

Keywords: Heavy Metals, Gut, Swimming Crab, Muscles, Rumuolumeni Creek.

Introduction

The changes in the environment caused by natural or artificial input of harmful contaminants into the environment are called pollution (Arimoro & Idoro, 2007). Generally pollution has done a great damage to our environment including human health, food and water. It has given rise to a lot of disease both curable and incurable once. It is importance to investigate our environment to know how healthy it is. Since our environment contribute majorly on our health, food, air etc.

Globally, pollution has been a great problem in our environment which led some organisms into extinction, but this pollution we are talking about today, did not just start immediately, it was a gradual process, from small element to contaminant, from contaminant to contamination where the carry capacity of the environment cannot sustain (Sumesh et al., 2017). Heavy metals are very important environmental pollutants which have the ability to bio-accumulation, they are among the most noxious pollutant in our natural environment due to their toxicity, persistence and bioaccumulation problems. Heavy metals are members of a loosely defined subset of elements that exhibits metallic properties. They include the transition metals, actinides and some metalloid. Many definitions have been put forward, some based on density, some on atomic number or atomic weight and some on chemical properties or toxicity. Based on density and toxicity, the term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic at low concentration (Celina & Aroloye, 2020).

Zinc is an essential mineral of exceptional biological and public health important, zinc deficiency affects about two million people in developing world and is associated with many diseases. In children it causes growth retardation, delayed sexual maturation, infection susceptibility and diarrhea, contributing to the death of about

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800,000 children worldwide in a year. (Vincent-Akpu & Yanadi, 2014). A zinc deficiency can increase the risk of various problems, such as delayed growth in children, loss of appetite, changes in taste, higher risk of infections, fertility problems, diarrhea, problems with wound healing, eye and skin lesions, problems with thinking (Alongi 2010).

Lead (Pb) is a soft, silvery white or grayish metal in Group 14 of the periodic table. Lead can remain in the environment as dust indefinitely. Lead in the environment arises from both natural and anthropogenic sources, lead is used in many engineering and chemical industry for manufacturing of lead batteries, pigments, paint and lead arsenic pesticides. Human beings are exposed to lead through drinking water, food, air, soil and dust from old paint containing lead. Children may be exposed to lead through contact with paint chips and dust from lead paint in buildings and homes that may have landed on windowsills, the floor, toys, etc. (Onojake et.al 2015).

Copper is a very common substance that occurs naturally in the environment and spreads through the environment through natural phenomena. Humans widely use copper, for instance it is applied in the industries and in agriculture. The production of copper has lifted over the last decades. Due to this, copper quantities in the environment have increased. (Lawal-Are, & Kusemiju, 2000). Generally it is assumed that the free hydrated copper ion (Cu^{2+}) together with copper hydroxyl species are the most toxic inorganic substances to marine organisms, both plants and animals readily accumulate copper (Agamy, 2012). Various species of fishes has recorded bio-accumulation factors that ranged between 100-26000. Copper may be toxic to some sensitive species of fishes and more to many invertebrates species as chronic copper has the capacity to damage kidney, gill, spleen and also drop the immune system (Siti et al., 2018).

Normally human get exposed to nickel through breathing polluted air, drinking and eating nickel contaminated substances such as food and water or smoking cigarette. Putting on some jewelries are another way of getting exposed to nickel (Singare & Sidky, 2012).

There are many ways heavy metals can diffuse into the environment and the body of living organism. One of the ways is through bioaccumulation (Zhang et al., 2010). Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in biological organism overtime, compared to the chemical concentration in the environment (Ali et al., 2017). In living things compounds are accumulated anytime they are taken up and stored faster than they are broken down or eradicated, some of these substances can get into human body through bioconcentration and biomagnification (Raymon et al., 2011). When toxin gets absorbed at a higher rate than the body can get rid of it, the organism is at the risk of chronic poisoning (Hartl, 2013).

Accumulation through the food chain can be devastating, when knowing how much toxins are in a certain habitats, for instance natural toxin are Algae blooms known as 'red tides' and ciguatera poisoning (coral reef algae poison). Red tide affect crabs, mudskipper and oysters when the filter feeds on the toxic plankton and ciguatera accumulates in coral fish when they eat algae (Hashem et al., 2017). Man-made toxin accumulation has a much greater effect on animal than natural toxin (Udoh & Jimmy, 2015). Humpback dolphins are classified as vulnerable, because of the amount of toxin the gets into the system, humpback dolphins live close to shore. Fish that live in this habitat have a lot of toxin in them that accumulate in the dolphin bladder (fact). The main problem with this, is that the females use their fat resources to create milk for their calves, so the milk will be full of toxin so the mothers are unknowingly feeding their calves poison. It is very important we investigate our environment and what living organisms (*Callinectes amnicola*) are feeding on to know, if it will help healthy lives or serve as poison to us and our generation to come. It is also important because it can alter our gene, whenever our gene is altered, the original species will go on extinct, which is very dangerous to us and our environment (Dhananjayan & Muralidhara, 2012).

Rumuolumeni Creek is one of the places, where fishermen have interest in fishing till date, people are still eating crabs (*Callinectes amnicola*) from Rumuolumeni Creek, without considering the effect of illegal refining on these aquatic lives, the level of accumulation of heavy metals and how it is going to affect their personal lives after eating it. Outside illegal refining other activities like sand dredging and agricultural activities are ongoing there daily, some of these farmers make use of nitrogenous fertilizers to help their crops to grow later some of these fertilizers found their way through runoff to aquatic bodies and partly through filtration to the ground. They enrich the nutrient levels of the water and result in eutrophication of the aquatic environment (Ekpete & Festus, 2013).

Callinectes amnicola (swimming crab) is well known crab with high nutritional values. It is rich in protein and contains all the essential amino acid in the right proportions and also contains a good selection of minerals. It is

also rich in fatty acid and contain omega three (3) which has favorable effects in the cognitive development. Omega three (3) present in crab (*Callinectes amnicola*) can reduce the risk of heart disease, high blood pressure (Fisayo & Azbuike, 2016). *C. amnicola* is economically important and also serves as a special delicacy, it is used as bait for catching mudskipper while the carapace is used in catching snail (Babatunde, 2008). *Callinectes amnicola* contain proteins that are superior to other proteins derived from meat, these nutrients in (Alloway.2013). The nutrients help to regulate the body processes which are essential for cell growth, maintenance and repair. *C. amnicola* can easily be gotten in the Rumuolumeni Creek with aid of crab trap using chicken head as the bait.

Materials and Methods

Description of the Study Area; The research investigation took place at Rumuolumeni Creek. Rumuolumeni Creek is located in Obio/Akpor local government area in Rivers State, Niger Delta part of Nigeria. Rumuolumeni community is one of the busy communities in Ikwerre land, with a lot of oil companies staged in the community and the Ignatius Ajuru University of Education (IAUE). Rumuolumeni Creek can be accessed via Tombia Waterside leading to Wimpy Junction all in Rivers State Nigeria. Using global positioning System (GPS) Rumuolumeni Creek can be located with following coordinates latitude 4.8 08916N and longitude 6.92 8917E.

The creek is part of the new Calabar River and has connection with Bonny Estuarine and Choba River (Vincent-Akpu & Nwachukwu, 2016). The primary occupation of Rumuolumeni indigenes are farming and fishing. This community creek serves primarily for fishing, subsistence agriculture and routes for transportation, as many communities from different local government areas are linked to the creek.

Sampled Stations

In the study area four sampling stations were established, samples were collected from each representative station and coordinate of the stations were also taken using Hand-Held GPS equipment Gramin extret . Map was plotted using the respective coordinate of each station (Figure 1).



Figure 1. Showing sampled stations in Rumuolumeni Creek.

Crab Sample Collection

The fishing gear that was used is crab trap, and chicken head was used as bait, immediately the catches were made the specimen were removed and placed in a small bucket well labelled before storing in a cooler containing ice block before it was sent to the laboratory for analysis.

Laboratory Analysis.

Heavy Metals Analysis in Swimming Crabs (*C amnicola*)

Wet digestion method was used, based on the analytical method for atomic absorption spectrometer (AAS) prior to use. The *C. amnicola* were preserved using low temperature, later the gut were extracted from the thorax while muscles was removed from chelled, swimming legs etc. 5g dry weight sample of each were put into 50ml beaker with 5ml of HNO₃ and 5ml of H₂SO₄. When the *C. amnicola* samples stopped reacting with HNO₃ and H₂SO₄ the beaker was placed on the hot plate and heated at 60°C for 30 minutes. After allowing The Beaker to cool, 10ml of HNO₃ were added and returned to the hot plate to be heated slowly at 120°C. The temperature was increased to 150°C and then the beaker was removed from the hot plate, when the samples turned black, the sample were allowed to cool before adding H₂O₂ until the sample is clear. The content of the beaker were transferred into a 50ml volumetric Flask and diluted to the mark with ultra-pure water. All the steps were performed in fume cupboard.

Data Analysis

The result of the samples was analyzed using origin-pro 9.9.0225 package .Mean and standard deviation was calculated using analysis of variance (ANOVA). Statistical significance was assessed at 0.05 probability levels using turkey tests.

Results

The result of this study was presented in tables (1 to 5). Table one and two describes the concentration of heavy metals in crabs gut and table three and four also describes heavy metals concentration in crab muscles based on location and months. While table five shows world health organization (WHO) permissible limits of heavy metals in the fish and other aquatic biota.

Table 1. Variation of Heavy Metals Concentration in the gut of *C. amnicola* in Rumuolumeni Creek within the sampling stations (Mordant Marine to Eagle Cement)

Station	Heavy Metals Concentration in the gut Samples			
	Zinc (Zn)	Lead(Pb)	Copper (Cu)	Nickel (Ni)
Mordant Marine	^B 9.50±0.64	^B 0.26±0.15	^C 73.39±7.55	^C 0.02±0.00
Erico 2	^D 5.86±0.31	^B 0.17±0.10	^D 56.67±5.84	^{BC} 0.02±0.01
Old police Post	^C 8.04±0.54	^B 0.10±0.06	^B 90.28±9.31	^B 0.03±0.01
Eagle Cement	^A 12.41±0.84	^A 0.73±0.43	^A 108.67±11.38	^A 0.06±0.02
p≤	0.001	0.001	0.001	0.001

Superscripts with the same alphabet are not significantly different (Turkey tests P≤ 0.05)

Table 2. Monthly Variation of Heavy Metals Concentration in the Gut of *C. amnicola* from Rumuolumeni Creek. (January to March 2023).

Month	Heavy Metals Concentration in the Gut Samples			
	Zinc (Zn)	Lead (Pb)	Copper (Cu)	Nickel (Ni)
January	^A 8.92±2.50	^B 0.19±0.16	^A 71.14±17.49	^B 0.02±0.01
February	^A 8.31±2.33	^B 0.19±0.15	^A 86.08±21.17	^{AB} 0.03±0.02
March	^A 9.69±2.72	^A 0.56±0.46	^A 89.53±22.01	^A 0.05±0.03

P=	0.414	0.004	0.077	0.018
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Superscripts with the same alphabet are not significantly different (Turkey tests $p \leq 0.05$)

Table 3. Variation of Heavy Metals Concentration in the Muscles Samples of *C. amnicola* in Rumuolumeni Creek within the Sampling Stations (Mordant Marine to Eagle Cement).

Station	Heavy metals Concentration in Muscles Samples			
	Zinc(Zn)	Lead(Pb)	Copper(Cu)	Nickel (Ni)
Mordant Marine	^B 3.09±0.21	^B 0.36±0.02	^C 50.84±1.09	^D 0.0±0.00
Erico 2	^D 1.91±0.13	^C 0.24±0.02	^D 39.26±0.87	^C 0.0±0.00
Old police Post	^C 2.61±0.17	^D 0.14±0.01	^B 62.54±1.31	^B 0.02±0.00
Eagle Cement	^A 4.06±0.27	^A 1.02±0.03	^A 75.29±2.18	^A 0.0±0.03
P≤	0.001	0.001	0.001	0.001

Superscripts with the same alphabet are not significantly different (Turkey tests $P \leq 0.05$)

Table 4. Monthly Variation of Heavy Metals Concentrations in Muscles Samples of *C. amnicola* from Rumuolumeni Creek. (January to March 2023).

Month	Heavy Metals Concentration in the Muscles of <i>C. amnicola</i>			
	Zinc (Zn)	Lead(Pb)	Copper (Cu)	Nickel (Ni)
January	^A 2.81±0.81	^A 0.42±0.35	^A 55.49±13.64	^A 0.02±0.01
February	^A 2.70±0.76	^A 0.44±0.36	^A 57.16±14.05	^A 0.02±0.01
March	^A 3.15±0.88	^A 0.45±0.37	^A 58.30±14.33	^A 0.02±0.01
P=	0.414	0.983	0.886	0.538

Superscripts with the same alphabet are not significantly different (Turkey tests. $P \leq 0.05$)

Table 5. Comparison of the Grand Mean Variation of Heavy Metal Concentrations in Gut and Muscles Samples from Rumuolumeni Creek, With WHO Permissible Limit.

Heavy Metals Concentration	Gut Grand mean values	Muscles Grand mean values	Permissible limit WHO(2003)
Zinc (Zn)	8.97	2.89	40
Lead (pb)	0.31	0.44	0.5
Copper (Cu)	82.25	56.98	30.0
Nickel (Ni)	0.03	0.02	0.05

Discussion

These are a lot of crabs in the creek of Niger Delta of Nigeria, some are edible while some are not but serves for medicinal purpose, sign of polluted environment which can be used to monitor the healthfulness of the environment etc. But one of the edible crab cherished by people in the study area is swimming crab (*Callinectes amnicola*), it is used for important delicacies such as fisher men's soup and major sources of protein and

calcium (Bob-Manuel et al., 2015). They are always available, affordable and can be sourced throughout the year (Edet, & Ubuo, 2013). The major parts of the this crab consume by those that like eating it frequently are chelled, carapace, and swimming legs which are majorly made up the muscles and gut(carapace). This is the primary factor that led into this investigation and made us to choose muscles and gut of the crab for heavy metals assessment. Also to know if they are eating crab or poison. In this study, the concentrations of zinc and copper were high in Mordant marine, Erico, old police post and Eagle cement points of the creek. So the high concentration of zinc in this study area may be as a result of industrial and commercial activities around the creek.

Zinc plating of steel, batteries and alloy, like brass in the surrounding environment may have contributed to the increase in zinc concentration in the creek while increase in copper concentration may be as result of mining, exploration activities, steel fabrication, farming and drain sludge within the creek (Alloway, 2013). Pb and Ni concentration were low, this agreed with the report of Wokoma (2014) on bioaccumulation at Sombreiro River. Between the muscles and gut, there was more bioaccumulation in gut than muscles this finding is in agreement with the result of Davies & Ekperusi (2021) on bioaccumulation at new Calabar River. The result of this study shows an indication of pollution particularly, when these metals are above permissible limit of standard organizations like world health organization (WHO) and had been classified as very toxic to aquatic life and relatively accessible. Table 5 shows those World Health Organization permissible limits of heavy metal in fish and other aquatic biota. The result from the tables shows the signs of contaminant in zinc and Nickel and they are below WHO (2003) permissible limits, While copper and lead in *Callinectes amnicola* were above permissible limits of WHO (2003), In Rumuolumeni Creek. These imply that the consumption of crab from the study area is not safe, and may serve as potential threat to human health of those who depend on it as their major source of food or protein.

Conclusion

The concentration of heavy metals assessed were Zn, Pb, Cu and Ni in the gut and muscles of *C. amnicola* has provided reliable data and information on the pollution status of the study area. The heavy metals concentration identified in the swimming crab samples were variables. The values of Zn and Cu were higher than the values of Pb and Ni. But Cu and Pb were above the permissible limits of World Health Organization while Zn and Ni were below WHO permissible limits in gut while in muscles only Cu is above the permissible limit. But both heavy metals concentration in gut and muscles samples shows signs of contamination, which can lead into pollution if proper measures are not taken immediately to stop further contaminations. Therefore crabs from the study area are not fit for human consumption since Cu and Pb concentrations were above recommended permissible limits safe for human consumption by World Health Organization. This founding or data can serve as a guide for researchers and environmental managers to safeguard marine organisms and discourage further input of anthropogenic waste into the creek, to avoid further environmental disturbance or extinction of aquatic biota. This may risk the health of those that fully depend on the fishery products from this creek as their sources of food.

Recommendations

Based on investigation of this study, it is necessary to recommend that

1. Residence of Rumuolumeni Creek should be educated and enlightened about the causes of environmental hazard from domestic waste while companies around the creek should be monitored and encouraged to carryout prosper waste management treatment measures before disposing waste into the creek.
2. Discharging of non-biodegradable waste into creek should be totally discouraged and People consuming crabs in the study area should do it with caution.

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