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Investigation on Heavy (Non Essential) Metal Concentration in Potamon ebonyicum (Mud Crab) at Ebonyi River Basin Nigeria

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Abstract Waste discharge and emissions from mining and stone crushing industries in Ebonyi River basin were released to the environment by diffusion, and through the tributaries of the river. Pollution of terrestrial and aquatic habitats in the river basin with non essential metals and bioaccumulation in the aquatic organisms were suspected. Some heavy metals such as cadmium and lead are known to be very dangerous and potentially very harmful to life forms even when they are found in trace amount. An investigation was therefore conducted to determine concentration of chromium (Cr), lead (Pb) and cadmium (Cd) in intact male and female crabs in the month of May, to attempt to use them as bioindicators, and to ensure that they were safe for consumption. The results showed that Cr was not detected in the crab. The order of concentration dominance irrespective of sex was as follows: Cr < Pd < Cd. Bioaccumulation level for Pb and Cd were below the critical (<100) index limit. The crab (P. ebonyicum) could serve as indicator of heavy metal pollution in aquatic environment. They were however safe for consumption as the metal concentration was below FAO/WHO permissible limits. Regular investigation would enhance adequate protection of the aquatic habitats and steady supply of safe, edible organisms.

Keywords: *bioaccumulation, mud crab, heavy metal, Ebonyi state, river basin*

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1. Introduction

Shell fish are nutritionally rich in various minerals and high quality protein that are precious to human [1,2,3]. Crabs and other edible crustaceans such as shrimps, prawns, cray fishes and lobsters are major sources of essential macro and micro elements such as phosphorus, potassium, calcium, iron, magnesium, copper, manganese, zinc and iodine [4,5]. Non essential metals such as lead (Pb) and cadmium (Cd) have attracted great attention for their different toxic effects on aquatic organisms [6]. At low levels of concentration in organisms, non essential metals have no beneficial effect and accumulation over time can create adverse conditions due to competition for binding sites with the essential metals [7]. When essential metal accumulate excessively in the aquatic ecosystem, they can also produce toxic effects, which tend to be more complicated than that of non essential metals [8]. The metals are very important pollutants in the aquatic ecosystem and many organisms are potential accumulators of high levels from their environment. They enter shell fish through food, oral consumption of water and skin [9]. The shell fish including crustaceans are widely consumed by humans [10] and also very useful in the monitoring of metal pollution [11].

Mud crab, a decapod crutacean is delicacy at Ebonyi river basin in south east Nigeria (Pers. obs.). There is relative abundance of P. ebonyicum (recently quoted crab species) in the basin [12]. Although crab aquaculture has not taken off in the area, cultivability and feeding in captivity have been successfully studied [12,13]. Mining for Pb and granite around the river basin is an ongoing economic activity, which can make the pollutants readily available to aquatic organisms. Data on concentration levels of non essential metals in the crab species are not available. This study therefore aimed to determine accumulation levels of Pb, Cd and Cr in the male and female crab and compare them with food safety standards for human consumption.

2. Materials and Methods

Samples of the mud crab (P. ebonyicum) used for the study, were collected in the month of May 2017 from the banks of Ebia stream, one of the tributaries of Ebonyi river. The river is located in Ebonyi State, one of the five states making up the south east geopolitical zone of Nigeria with Abakaliki as capital. The state is located at latitude 6^{o} 15' 18" N, longitude 8^{o} 05' 55" E with total area of 5,533 Km^2. The crab samples were collected at different points along the stream using the methods of

Akpaniteaku [14]: Edible insect fixed on tiny flexible stick as attractant was lowered into the crab hole, and movement of the gear signaled that the bait had been caught. Catching of the crab was from the back by carefully holding the pincers steady.

They were transported dry in plastic bucket to the analytical laboratory. The crab samples, 3 males and 3 females having uniform sizes were randomly selected for analysis. 20ml aqua-regia (concentrated mixture of 65 ml nitric acid, 8 ml perchloric acid and 2ml of sulphuric acid) was each poured into separate beakers containing the male and female crab. They were boiled on a heating mantle for 10 minutes and allowed to cool. They were each made up to 50 ml with distilled water, and then filtered. The filterate were analysed for heavy metals using Varian AA240 Atomic Absorption Spectrophoto meter (AAS) according to methods of America Public Health Association (APHA) [15]. Working principle of AAS is based on the sample being aspirated into the flame and atomized when the AAS's light beam is directed through the flame into the monochromater and unto the detector that measures the amount of light absorbed by the atomized element in the flame. Metals have their own characteristic absorption wavelength therefore a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wave length absorbed is proportional to the concentration of the element in the sample.

Heavy metal pollution index (HPI) was modified to calculate accumulation index and compare accumulation levels of metal in the samples. In the modification, values for accumulated metal irrespective of sex of the crab were used for calculation. Product of the modified HPI was multiplied by 100.

$$\text{HPI}\ (\text{HAI}) = (\text{M}_1\text{x}\ \text{M}_2\text{---x}\ \text{Mn})\,1/n.$$

HAI is metal accumulation index i.e. HPI modified

$$\text{HAI} = \left[(\text{M}_1 x M_2\text{---x}\text{Mn})\,1/\text{n}\right]100$$

Where Mn is still the concentration expressed in $mgkg^{-1}$ of investigated metals in the samples.

3. Results and Discussion

The Concentration of non essential metals in the body of the male and female crab as $mgkg^{-1}$ is presented in Figure 1. The level of accumulation was from 0.00 to 1.42 $mgkg^{-1}$. Out of the three heavy metals (Pb, Cd and Cr) under investigation, two (Pb and Cd were detected. Toxicology fact sheet [16] reported that Pb could accumulate in fish and shell fish, and contamination would arise as a result of environmental emissions.

The concentration range for Pb was 0.35 $mgkg^{-1}$ to 0.51$mgkg^{-1}$. Higher range of concentration for Pb (3.49 $mgkg^{-1}$ to 11.49 $mgkg^{-1}$) than in the present study was reported by Abdel-Salam and Hamdi [9]. The level of Pb accumulation was higher in the males than in the females. Behavioural pattern of the males may seem to be responsible for the accumulation levels. Akpaniteaku and Emmanuel [17] reported that female crabs could be more active and mobile during the month of May to July. According to Akpaniteaku [14] males were more abundant between March and May than in other months, which may seem to synchronize with the period of this sampling. The male crabs were more abundant in the periurban than in the rural habitat [17]. Edible muscles of crab species accumulated more of Pb than in the shrimp species [9]. In the present study, it could be inferred that P. ebonyicum irrespective of sex has greater capacity to accumulate Cd than Pb (Figure 2). The males however seem to be more vulnerable to Cd than the females. According to Toxicology Fact Sheet [16] highest levels of Cd were recorded in mussels, oysters and scallops. Perhaps shells of these aquatic organisms were responsible for higher concentration of the metal than in the crabs.

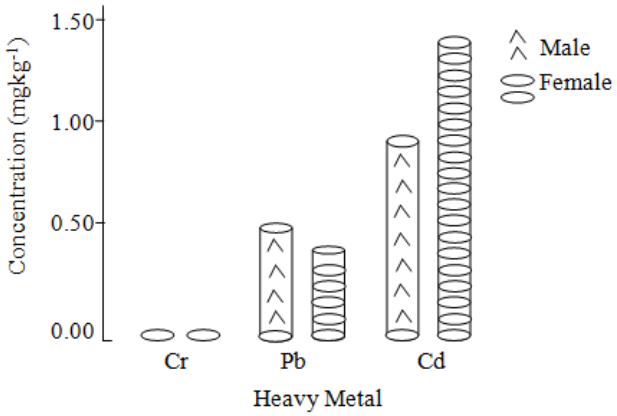

Figure 1. Bioaccumulation of chromium, lead and cadmuim in male and female mud crab (Potamon ebonyicum) collected from Ebonyi River Basin in May 2017

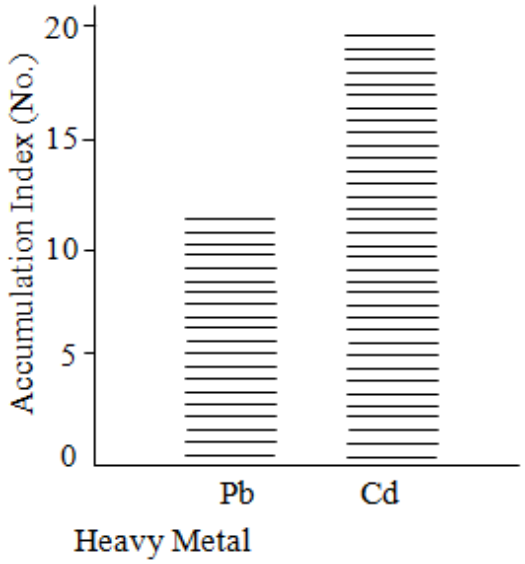

Figure 2. Metal accumulation index for lead and cadmium in Potamon ebonyicum during the month of May at Ebonyi River Basin Nigeria

The metal accumulation index revealed that accumulation levels in the male and female crabs were below the critical (<100) index limit. The relatively low concentration of Pb in the present study seems to be in agreement with capacity of decapods to actively release the metal (Pb) into the environment [10]. Brown shrimp Crangon crangon (edible decapods crustacean) has proved to be useful in the monitoring of Cd, Zn and Cu [18]. In the present study, Ebonyi mud crab (P. ebonyicum) may have

proved to be useful in the monitoring of Cr, Pd and Cd in the river basin.

4. Conclusion

The study on concentration of some heavy metals in the mud crab (P. ebonyicum) at Ebonyi River basin revealed that aquatic organisms have been contaminated. Bioaccumulation levels of Pb and Cd were below the critical index limit of metal pollution. The metal concentration was within FAO/WHO (codex alimentarius) maximum permissible limits.

Owing to the season of the analysis, there is possibility that Cr will be found in other aquatic organisms and the environment. Catching of crabs for consumption at the basin could be safer during the rainy season than other period, because some of the accumulated metals would have been diluted. The concentration of Pb and Cd in P. ebonyicum could serve as bioindicator of heavy metal contamination in Ebonyi River basin. As mining and stone crushing are ongoing activities in the basin, regular investigation should be carried out to determine food-safety status of aquatic organisms. The industries should establish mitigating facilities at every point of discharge to reduce the level of contaminants of life forms in the river basin.

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