
*Asian Journal of Fisheries and Aquatic Research*

*5(1): 1-6, 2019; Article no.AJFAR.50360*

# Assessment of Some Heavy Metal Content of Dried Crayfish Sold in Creek Road Market, Borokiri, Port Harcourt, Nigeria

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author HAW designed the study, wrote the protocol, literature searches and supervised the research. Author ESB performed the statistical analysis. Author ICO managed sample collections. All authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/AJFAR/2019/v5i130068
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Complete Peer review History: https://sdiarticle4.com/review-history/50360

***Original Research Article***

***Received 11 August 2019***
***Accepted 18 October 2019***
***Published 18 November 2019***

## ABSTRACT

Heavy metals are elements that contaminate seafood and make them harmful to human health when present in quantities that are higher than the permissible limit. This study was conducted to determine some heavy metals such as lead and mercury contained in dried crayfish gotten from three different locations (Oron, Ataba and Nembe town in Akwa Ibom, Rivers and Bayelsa State respectively) and sold in the Creek Road Market, Borokiri, Port Harcourt, Rivers State. The dried crayfish samples were purchased randomly from marketers in the market. 5g of the dried crayfish

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samples with its different organs (Gills, muscle tissues) were ground into powdered form and digested with $HNO_3$ using standard procedures and analysed for lead and mercury using the micro plasma atomic emission spectrophotometric analyser. The results showed that Lead content in the dried crayfish from Oron, Ataba and Nembe were 0.140 ± 0.014 mg/kg, 0.040 ± 0.014 mg/kg and 0.016 ± 0.002 mg/kg respectively while for Mercury content, Oron crayfish contained 5.136 ± 0.017 mg/kg, Ataba 3.744 ± 0.017 mg/kg and Nembe 3.948 ± 0.023mg/kg. The mean values in the three different crayfish samples were significantly different ($p<0.05$). This result shows that the lead content present in the dried crayfish are within the permissible limit of 1 mg/kg as indicated by FAO hence safe for consumption purposes with no expected form of toxicity and health implication to consumers whereas for mercury content, the level was found to be above the permissible limit.

*Keywords: Crayfish; lead; mercury; seafood; heavy metals.*

## 1. INTRODUCTION

Sea-foods are defined as the various living organisms found in the ocean and are classified into two; shellfish (e.g. oysters, missile, lobster, prawn, crabs and shrimp) and fish [1]. It is an excellent source of protein and its low calorific value makes it a healthier alternative to red meats or poultry as it is also rich in vitamins A, E, C and D as well as calcium (Ca) and iron (Fe) [1]. Crayfish (*Decapoda reptania*) have their skeleton on the outside instead of the inside and it's called an exoskeleton and this outer skeleton is one of the features that give shrimp their unusual look [2]. Crayfish and other sea-foods are low in sodium hence it is beneficial for those who have to restrict the intake of sodium. Its nutrients include vitamins, fat-soluble A, D, E and K and water-soluble (C and B complex) [3]. Unlike persistent organic pollutants, metals accumulate in protein tissues and bone rather than in fat or animals [4]. The chain of contamination of these metals and metalloid follows a cyclical order: industry, atmosphere, land, water, phytoplankton, zooplankton, fish and humans [5].

Noticeable Industrial, urban and agricultural waste discharges contaminate the surfaces and sediments of the water in the world [6]. Also, anthropogenic influences on aquatic habitats, especially arising from increased industrialization have heightened research on the safe level of seafood by heavy metals among others which have continued to pose environmental hazard [7]. Therefore, it's necessary to issue alerts on the rising consumption of contaminated seafood, however, they are ignored by the public at large who continue consuming without taking into account the serious long-term health consequences [8].

Trace element can be soluble in water and react with organic matter forming complexes and chelates which increase its solubility, availability and disposal [9]. When these heavy metals are released into the water, they can bioaccumulate into aquatic organisms based on the environmental conditions, water cycle, seasoned variation, pH, micro-organisms, sediment reduction and oxidation potential [10]. When the sedimentation takes place, the metal compounds migrate from the abiotic environment into aquatic organisms and are subsequently introduced and accumulated in the marine food chain [11]; predators exhibit the highest concentration [12]. Accumulation of metal in the tissues of the organism depends mainly on water concentrations, bioavailability and crayfish tropic position [13]. Crayfish contaminated with these heavy metals such as mercury (Hg), cadmium (Cd), lead (Pb) and arsenic (As), pose a major threat to human health [14]. They get into humans through diet, which poses a risk to people who consume 8-12 ounce of crayfish per week [15].

Rivers State is located on 4.8581$^0$N and 6.9209ºE in the southern Niger Delta of Nigeria. It is one of the top-ranked oil-producing states in Nigeria. Most of the crayfish sold in the city market are bought from some of the oil-producing communities in Rivers State and their nearby neighbouring states. The incessant disposal of wastes from illegal bunkering and refineries and abandoned well-heads in these regions pose a great environmental threat to the aquatic ecosystem. The pollution of the aquatic environment by heavy metals and successive uptake in the aquatic food chain also poses a hazard to the human population [16]. The aquatic environment has been reported to be grossly affected by increased human activities [17,18]. The concentration of the heavy metals observed in Nigerian waters such as lead, zinc, nickel, cadmium and iron has been reported to be well above acceptable and permissible level [19]. There is a dearth of literature on the levels of heavy metals in the crayfish (*Decapoda reptania*) popularly sold and consumed in Rivers State and the Niger Delta. Therefore, it was necessary to investigate the level of lead and mercury in the crayfish (*Decapoda reptania*) sold in Markets in Rivers State, Nigeria.

## 2. MATERIALS AND METHODS

The crayfish (*Decapoda reptania*) are usually brought into Port Harcourt from different locations and sold in various markets within Port Harcourt. For this study, different dried crayfish samples from Nembe in Bayelsa state, Oron in Akwa Ibom state and Ataba in Rivers State which were sold in Creek Road market, Borokiri, in Port Harcourt were purchased from selected distributors and carefully packaged into three different pre-labelled bags. The dried crayfish samples were randomly selected. Five samples of the dried crayfish were collected each from the three locations making a total number of fifteen samples for analysis. The map showing the site of Creek road market is showed in Fig. 1.

### 2.1 Digestion of Samples

An acid digestion procedure was used for sample preparation for the determination of the elements in the dried crayfish. The sample was dried to a constant weight at 80ºC for two days in acid-washed Petri plates in an oven. When samples reached constant weight, the samples were allowed to cool in the desiccators and crushed into a fine powder by using a porcelain mortar and pestle. 5 g of sample (dry weight) was weighed into a digestion tube. 5 ml of $HNO_3$ and 5 ml of $H_2SO_4$ was added to the sample and the reaction was allowed to proceed. When the reaction slowed, the tubes were placed in a hot-block digestion apparatus and heated at a low temperature (60ºC) for 30mins. They were then removed from the hot block and allowed to cool after which 10 ml of $HNO_3$ was added and the tubes were returned to the digestion rack and heated slowly to 120ºC until the temperature increased to 150ºC. The tubes were removed when the samples became black and allowed to cool. After cooling, 1 ml of $H_2O_2$ was added causing a vigorous reaction to occur. After this, the tubes were returned to the block and the $H_2O_2$ was repeatedly added until the samples became clear. At this point, the tubes were removed and the volume was made up to 50 ml with deionized water.

Most elements can be determined directly; however, to determine lead and mercury, solvent extraction was used to concentrate these elements. 40 ml of the digest was taken and made up to 100 ml followed by addition of 5 ml of ammonium pyrrolidine dithiocarbonate (APDC) and 50 ml of methyl isobutyl ketone (MIBK) and shaken vigorously for 5 mins. Lead and mercury in the MIBK phase were determined in duplicate readings for each sample using the Micro Plasma Atomic Emission Spectrophotometric analyser (Agilent MP-AES 4210 Model) by aspirating the MIBK layer directly into the air-acetylene flame. Standards that have been prepared in MIBK were treated in the same way as samples ensuring that the standards contain the same amount of acid as the samples, especially sulfuric acid ($H_2SO_4$).

### 2.2 Statistical Analysis

The data obtained were analysed using Graph Pad Prism 7.4 version. Heavy metal values are presented as means and standard deviation. One-way analysis of variance (ANOVA) was used to compare the means amongst the samples and the Tukey test of multiple comparison was used to compare variation in means among the sample data. Values were considered significant at $P<0.05$.

## 3. RESULTS AND DISCUSSION

The concentration of mercury and lead in the dried crayfish (*Decapoda reptania*) samples gotten from Ataba, Nembe and Oron are stated in Table 1. The mean ± SD of mercury concentration in crayfish sample from Ataba is 3.744 ± 0.017 mg/kg while that from Nembe and Oron are 3.948 ± 0.023 mg/kg and 5.136 ± 0.017 mg/kg respectively. The mean ± SD of lead concentration in the dried crayfish samples from Ataba, Nembe and Oron area are 0.040 ± 0.014 mg/kg, 0.016 ± 0.002 mg/kg, 0.140 ± 0.014 mg/kg respectively.

Regions of high Industrial activities are potential areas of heavy metal pollution. The Niger Delta area having several oil companies and recording high anthropogenic activities made it a potential site for the analysis of lead and mercury as most of the industrial effluents are discharged into the sea where these crayfish are caught. Heavy

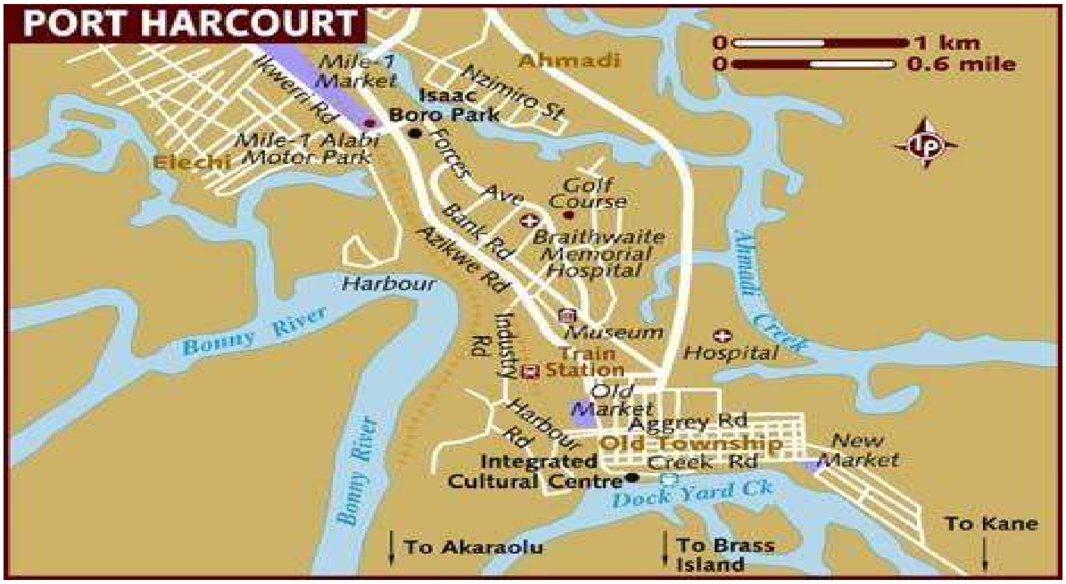


**Fig. 1. Site map of Creek Road market, Borokiri, Port Harcourt, Rivers State**

**Table 1. Mean ± SD of mercury and lead concentration in dried crayfish samples from Ataba, Nembe and Oron**

| Sample Location | Mercury Hg (mg/kg) | Lead Pb (mg/kg) |
|---|---|---|
| Ataba Crayfish | 3.744 ± 0.017[a] | 0.040 ± 0.014[a] |
| Nembe Crayfish | 3.948 ± 0.023[b] | 0.016 ± 0.002[b] |
| Oron Crayfish | 5.136 ± 0.017[c] | 0.140 ± 0.014[c] |
| F – Value | 9755 | 164 |
| P – Value | <0.0001 | <0.0001 |
| Remark | S | S |

*Key: Means with different superscripts are significantly different from each other. N=5, S-Significant*

metals represent the chemical residues which have a role in animal and human health. These are cumulative poisons causing injury to health through progressive and irreversible accumulation as a result of ingestion of repeated small amounts [20,21]. The European legislation limit of 0.6 mg/kg has been set for heavy metals residues [22]. However, from this study, the levels of mercury observed in the dried crayfish samples were far above this limit while the level for lead in the dried crayfish sold in Creek Road market was within the range <0.001 – 0.3 mg/L.

Lead is an element which is much used in modern industry [23]. It's probably a result of metal introduced into the environment via emission from agricultural machinery, petroleum exploration activities and automobile [24]. The concentrations of lead detected in the selected crayfish samples were found to be 0.040 ± 0.014mg/kg, 0.016 ± 0.002mg/kg and 0.140 ± 0.014mg/kg for Ataba crayfish, Nembe crayfish and Oron crayfish respectively. However, our study showed that the concentration of lead in the selected crayfish sold in the Creek Road market, Borokiri, Port Harcourt did not exceed the permissible limit of 1mg/kg [25]. Although [26] reported a higher level of lead exceeding permissible limits in raw and cooked muscles of crayfish, [27] stated that different concentration of lead was obtained from different organs and are ranged from 0.25mg/kg to 0.69mg/kg in all organs.

The accumulation of mercury in the tissue and gills of crayfish results from the ability of the crayfish to use the gills to filter water and food in the interface of the sediment thereby retaining some quantities of metals along with the food [28]. The concentration of mercury in the dried crayfish from the three selected locations was found to be 3.744 ± 0.01mg/kg, 3.948 ± 0.023mg/kg and 5.136 ± 0.017mg/kg for Ataba, Nembe and Oron respectively. This study also showed that the concentration of mercury in the crayfish from the selected locations sold in Creek Road Market, Borokiri did exceed the permissible limit of 1 mg/kg [25]. This result, however, agrees with the result obtained in a study conducted by [29], where high mercury level of 3.01 mg/kg was found in crayfish and other seafood from contaminated Mediterranean Sea surrounding Lampedu Island [30].

However, the observation that the concentrations of lead in the crayfish samples from the selected locations in the Niger Delta did not exceed the permissible limit [25]. It could be attributed to the fact that these crayfish are usually harvested by fishermen from the Atlantic Ocean where the effects of anthropogenic pollution of the aquatic environment, sewage disposal, industrial waste disposal, reduction in the use of pesticides and inorganic fertilizers in agricultural practice are minimal. Whereas for mercury, the level was above the permissible limit creating a concern for health hazard through bioaccumulation in consumers of these sea food.

## 4. CONCLUSION

Mercury concentrations were found to be higher in the dried crayfish samples sold in the market which were consumed by the population who lives in the Niger Delta area, Nigeria. Though the health implication of the level for lead might be minimal, because they do not exceed the permissible levels by Food and Agriculture Organization and World Health Organization. However, continuous enforcement and application of environmental laws are advised to avoid increased anthropogenic pollution and heavy metal contamination of the aquatic bodies.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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