***Original Research Article***

# Assessment of Some Physicochemical Parameters in some seafoods found in Borokiri, Trans-Amadi, Eagle Island and Iwofe swamps, Rivers State Nigeria



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## ABSTRACT

**Aim:** To assess the levels of heavy metals (cadmium, lead, chromium, copper), and pH in periwinkles, whelks, oysters, sediment, and water found in some swamps in Rivers State

**Study design:** Analytical Cross-sectional study

**Place and Duration of Study:**Borokiri, Trans-Amadi, Eagle Island and Iwofe swamps, Rivers State Nigeria, between June and December 2022.

**Methodology:**Samples were collected from four different swamps in Rivers State: Iwofe, Eagle-Island, Trans-Amadi, and Borokiri swamps. Eagle-Island and Iwofe swamps are in Obio/Apkor LGA, while Trans-Amadi and Borokiri swamps are in Port Harcourt LGA. The solid samples were ground to powdered form to attain homogenous particles. Each sample was weighed, recorded and the concentrations of metals in the samples were determined. Five hundred (500) milligrams each of the ground samples were weighed and put into a crucible, 20 ml aqua regia (comprising 15 ml HCI and 5 ml HNO3) was added to digest the sample. Heavy metals in the digested samples were analyzed using GBC XplorAA Atomic absorption spectrophotometer (AAS). Where the concentrations were calculated using Beer-Lambert's law. The statistical analysis was done using GraphPad Prism version 8.0.2 of Apple Macintosh HD Big Sur (version 11.0). Descriptive statistical tools such as mean & standard deviation (SD) were used. ANOVA was used to compare means of more than two groups for inferential evaluation, with Tukey's multiple comparison test to check for mean difference between multiple groups. The probability (p) value less than 0.05 ($P<0.05$) was used and considered statistically significant.

**Results:**The results showed that the mean concentrations of cadmium, copper, and lead (0.001 ± 0.0001mg/l, 0.16 ± 0.07mg/l, and 0.01±0.003 mg/l respectively) were below the standard limit set by the World Health Organization (WHO), while chromium exceeded this limit, and the pH was also within acceptable range. From the results observed in the sediments and the tissue samples, the level of cadmium was below the standard limit set by WHO. However, chromium, copper, and lead had concentrations that were above the WHO recommended limit

**Conclusion:**Campaigns need to be launched to educate the public about the risks to health posed by improper disposing of household and municipal waste, industrial effluents, and pipelines, as well as the toxicity of heavy metals.


*Keywords: Physicochemical Parameters, seafoods,Borokiri, Trans-Amadi, Eagle Island,Iwofe swamps, Rivers State Nigeria*

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## 1. INTRODUCTION

Seafood are edible aquatic animals, comprising both freshwater and saltwater organisms but excluding mammals. Humans use the majority of harmless aquatic organisms for food. Even foods that have the potential to damage consumers, like some blowfish, can be prepared safely. After cereals, fish and other seafood may be the most important diet for humans, providing 15% of the world's population's protein needs [1]. Shellfish are animals that dwell in water and have a shell or shell-like exterior. They can be divided into two groups: crustaceans and mollusks. Crustaceans include Shrimp, Crayfish, Crab, and Lobster, while Clams, Scallops, Oysters, and Mussels are examples of Mollusks [2].Most shellfish live in saltwater, but the name also refers to species found in freshwater.

Natural elements with a high atomic weight and a density at least five times greater than that of water are known as heavy metals. Their widespread distribution in the environment as a result of their numerous industrial, residential, agricultural, medical, and technical applications has raised questions about their possible consequences on both human health and the environment. The dose, method of exposure, chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals, all affect how hazardous they are. Arsenic (As), cadmium (Cd), chromium (Cr), lead (Pd) are among the priority metals of public health concern due to their high degree of toxicity. Even at low concentrations, these metallic elements are known to cause damage to various organs and are regarded as systemic toxins [3].

With its creeks and tributaries, the Niger Delta region is home to a diverse range of biotopes, many of which are dominated by significant tracts of mangrove swamp forest. However, this area, with its intricate ecological structure, is subjected to pollution of the environment caused by industrial exploration of crude oil and industrial activities. As a result of this, pollution discharge (hydrocarbons and heavy metals) capable of polluting land and bodies of water are being released into the environment [4]. Heavy metals have been shown to have a negative impact on biological processes in general, and they may have an impact on the nutritional and biological status of sea foods. Seafood is a rich source of nutrients; however, the nutritional value of these organisms may vary depending on their environment. These important food sources are a major part of the diet in Nigeria's Niger Delta region, where they are traditionally cooked without removing the shells before consumption, and these organisms may be contaminated with heavy metals that are harmful to the environment, children's, pregnant women's, and even the general public's health. Many people in Nigeria's Niger Delta region consume sea foods harvested from various water bodies with a history of crude oil spillage and other industrial activities. Heavy metals are high priority pollutants due to their high toxicity and persistence in the environment. These metals, in the form of inorganic compounds derived from natural and anthropogenic sources, are constantly entering the aquatic ecosystem and posing a serious threat to the food chain[4].

Cadmium, chromium, and lead are among the priority metals of public health significance due to their high toxicity. These metallic elements are considered systemic toxicants that have been shown to cause organ damage at low levels of exposure. According to the US Environmental Protection Agency and the International Agency for Research on Cancer, they are also classified as human carcinogens (known or probable) [3]. Copper (Cu) is possibly unsafe when taken in larger amounts. Kidney failure and death can occur with as little as 1 gram of copper sulfate. Although heavy metals are naturally occurring elements found throughout the earth's crust, most environmental contamination and human exposure are caused by anthropogenic activities such as mining and smelting, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds. Metal corrosion, atmospheric deposition, soil erosion of metal ions and heavy metal leaching, sediment re-suspension, and metal evaporation from water resources to soil and

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ground water can all cause environmental contamination. Oil pollution and oil bunkering have also been reported to contribute significantly to heavy metal pollution. Owing to the effect of some of these heavy metals in the body, all these anthropogenic activities causing the accumulation of these harmful heavy metals in the environment should be curtailed, and the waste be managed properly.

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Seafood is an excellent source of cardio protective fatty acids docosahexaenoic (DHA) and eicosapentaenoic (EPA). As a result, many public health authorities recommend eating at least 1-2 servings of seafood per week to prevent diet-related chronic diseases. Unfortunately, anthropogenic environmental impacts (such as industry, agriculture, and mining) significantly increase naturally occurring heavy metal levels in the environment, including the marine ecosystem. As a result, marine organisms (seafood) can accumulate these metals to potentially toxic levels. Fish and other seafood are frequently one of the primary sources of metal exposure in the general population. Foods containing toxic metals above permissible levels are considered harmful to human health and are prohibited from trade under many national and international regulations.

The following are some of the harmful side effects of heavy metals: lower cognitive function (Pb, Hg), decreased reproductive potential (Cd, Pb), kidney failure and death (Cu), hypertension (Cd), neurological abnormalities (Hg, Pb), teratogenic effects (Hg), and malignancies (Cd).The aim of the study was to assess the levels of heavy metals (cadmium, lead, chromium, copper), and pH in periwinkles, whelks, oysters, sediment, and water found in some swamps in Rivers State

## 2. MATERIALS AND METHODS

### 2.1 Study Location

The study was carried out in Trans-Amadi, Borokiri, Iwofe, and Eagle Island swamps in Port Harcourt Metropolis, Port Harcourt and Obio Akpor Local Government Areas, Port Harcourt, Rivers State. Port Harcourt is the capital of Rivers State in the Niger Delta area of the South-South Geopolitical Zone of Nigeria. It is located within latitude 4°492 273N and longitude 7°2´ 1"E. The landing sites were Trans-Amadi, Borokiri, Iwofe and Eagle Island swamps. Shelled seafood were collected from the swamps in the landing site. Port Harcourt local government area (4°46´40"N 7°1´20"E) is one of the Local Government Areas in the state. Its administrative seat is in Port Harcourt. Although the local government consists of two different ethnic groups, the Ikwerre and Ogbulom (Abuloma). Obio-Akpor is a local government area in the metropolis of Port Harcourt (4°49´56"N 6°59´12"E), one of the major centres of economic activities in Nigeria, and one of the major cities of the Niger Delta, located in Rivers State. Obio-Akpor has its headquarters at Rumuodomaya and it is peopled by the Ikwerre. Some of the swamps in Rivers State are heavily polluted with refuse dump and illegal refinery waste with human settlement. Iwofe waterside, lies at latitude 4°49´4"N and 6°57´24"E, and was heavily polluted with illegal refinery waste.

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### 2.2 Study Design

The study design used was an analytical cross-sectional study design. Some Periwinkle, Oyster, and Whelk and soil samples were randomly selected from Borokiri. Water and soil samples were randomly collected in Trans-Amadi, Iwofe, and Eagle Island. These samples didn't undergo any prior preparation, purification or treatment. Six (6) periwinkles were collected from three (3) different sites in the mud of Borokiri when there was low tide, six oysters were also collected with the wood to which they were adhered to, and 6 whelk samples were collected from the same location as the periwinkle, all from Borokiri swamp. Water samples from the locations were collected using plastic bottles and the soil samples were collected using black cellophane bags.

## 2.3 Sample Collection and Preparation

The periwinkles and whelks were collected from mud at Borokiri swamp, while the oysters were collected stuck to wood from the same location, soil samples were also collected from Borokiri swamp to assess some heavy metals and pH. Soil and water samples were collected from Eagle Island, Iwofe, and Trans-Amadi to assess the same heavy metals and pH.

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## 2.4 Experimental Methods and Procedures

### 2.4.1 Estimation of Heavy Metals

*2.4.1.1 Method: Atomic Absorption Spectrometry (AAS)*

*Principle*

This principle is based on flame absorption rather than flame emission. Metal atoms absorb strongly at discrete characteristic wavelengths which coincide with their emission spectra. The solution of the sample is converted into an aerosol which is injected into a flame which then converts the sample into atomic and molecular vapour. The atomic vapour absorbs radiation from a hollow cathode lamp at specific wavelengths. This beam then traverses the flame and is focused on the entrance slit of a monochromator, which is set to read the intensity of the chosen spectral line. Light with this wavelength is absorbed by the metal in the flame and the degree of absorption is a function of the concentration of the metal in the sample [5].

*2.4.1.2 Heavy Metal Detection in the Water Sample*

The metals (i.e. Cadmium, Chromium, Copper and Lead) were analyzed using GBC XplorAA Atomic Absorption Spectrophotometer instrument (made in Australia) by direct aspiration of the water samples as stated in the operation manual [6,7].Set of three standards were analyzed alongside the samples, with one serving as quality control.

*2.4.1.3 Heavy Metal Detection in the Sediment*

Five hundred milligrams of air dried and crushed sediment sample was weighed into a crucible and 20 ml aqua regia (comprising 15 ml HCl and 5 ml HNO3) was added. The mixture was digested till the volume was reduced to about 5 ml. About 20 ml distilled water was added, the mixture was filtered through Whatman No. 42 filter paper into a 50ml volumetric flask and diluted to volume with distilled water [8]. Subsequently, analysis for the metals (i.e. Cadmium, Chromium.Copper and Lead) were done using GBC XplorAA Atomic Absorption Spectrophotometer instrument as stated in theOperational Manual [6]. Set of three standards were analyzed alongside the samples, with one serving as quality control. Where necessary, the sample was diluted and the dilution factor noted.

*2.4.1.4 Heavy Metal Detection in the Tissue sample*

The Oyster, Periwinkle and Whelk samples were collected, and labeled appropriately and stored in a refrigerator at 4°C. When they were ready to be used the samples were oven-dried at 105°C and grinded to powder.One gram of each sample was weighed into a porcelain dish and 20 ml aqua regia (comprising 15 ml HCl and 5 ml HNO) was added. The mixture was digested till the volume was reduced to about 5 ml. About 20 ml distilled water was added, the mixture was filtered through Whatman No. 42 filter paper into a 50ml volumetric flask and diluted to volume with distilled water [8].

Subsequently, the metals (Cadmium, Chromium, Copper and Lead) were analyzed using GBC XplorAA atomic absorption spectrophotometer instrument as stated in the Operational

Manual [6]. Set of three standards were analyzed alongside the samples, with one serving as quality control.

*2.4.1.5 pH Detection*

Ten (10) grams of ground samples were measured and poured into a plastic container. Twenty-five (25) milliliters of distilled water were measured and poured into the samples. Using a spatula the mixture was stirred for 15 minutes, and the pH of the samples were measured using a pH meter. The water samples were measured directly using a pH meter.

### 3.6 Statistical Analysis

GraphPad Prism version 8.0.2 of Apple Macintosh HD Big Sur (version 11.0) statistical package was used for data analysis. Descriptive statistical tools such as mean & standard deviation (SD) were used. ANOVA was used to compare means of more than two groups for inferential evaluation, with Tukey's multiple comparison test to check for mean difference between multiple groups. The probability (p) value less than 0.05 ($P<0.05$) was used and considered statistically significant.

## 3. RESULTS AND DISCUSSION

**Table 1: Comparison of Heavy Metals Water Sample Based on Location of the samples**

| Location/Parameter | Cad mg/l | Cr mg/l | Cu mg/l | Pb mg/l | pH mg/l |
|---|---|---|---|---|---|
| **Iwofe (N=3)** | 0.001 ± 0.0001 | 1.56 ± 0.18 | 0.007± 0.004 | 0.01 ± 0.003 | 7.30± 0.27 |
| **Eagle Island (N=3)** | 0.001± 0.0001 | 1.53 ± 0.36 | 0.16 ± 0.07* | 0.01± 0.003 | 7.20 ± 0.23* |
| **Trans-Amadi (N=3)** | 0.001 ± 0.0001 | 1.33± 0.12 | 0.04± 0.03* | 0.01± 0.003 | 6.50± 0.07* |
| **F-value** | 1.000 | 0.752 | 9.642 | 1.000 | 13.240 |
| **P-value** | 0.421 | 0.511 | 0.013 | 0.421 | 0.006 |
| **Remark** | NS | NS | S | NS | S |

***Key:***
*S = significant difference*
*NS = No significant difference*
**= Significant difference when mean between Trans-Amadi and Eagle Island were compared (Tukey's multiple comparison)*

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**Table 2: Comparison of Heavy Metals in the Sediment Based on Location of the Samples**

| Location/Parameter | Cad (mg/kg) | Cr (mg/kg) | Cu (mg/kg) | Pb (mg/kg) | pH |
|---|---|---|---|---|---|
| **1 Iwofe (N=3)** | 0.001± 0.0001 | 145.5 ± 12.43 | 18.70 ± 2.30 | 0.01± 0.003 | 4.97 ± 0.47 |
| **2 Eagle Island (N=3)** | 0.001 ± 0.0001 | 124.4 ± 5.80 | 23.50 ± 0.76[1] | 11.40 ± 0.35[1] | 5.18 ± 0.36 |
| **3Trans-Amadi (N=3)** | 0.001± 0.0001 | 165.2 ± 2.10 | 27.30 ± 0.20[1,2] | 0.01± 0.003[2] | 6.13 ± 0.18[2,3] |
| **4 Borokiri (N=3)** | 0.001± 0.0001 | 696.2 ± 902.4 | 14.70 ± 0.56[1,2,3] | 0.01± 0.003[2] | - |
| **F-value** | 1.000 | 1.123 | 58.56 | 3243 | 9.082 |
| **P-value** | 0.441 | 0.395 | <0.0001 | <0.0001 | 0.015 |
| **Remark** | NS | NS | S | S | |

***Key:***
*S = significant difference*
*NS = no significant difference*
*The means are significant when the groups are compared with the numbers placed as superscript (Tukey's multiple comparison).*

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**Table3: Comparison of Heavy Metals in Tissue samples Based on Location of the Samples**

| Tissue/Parameter | Cad (mg/kg) | Cr (mg/kg) | Cu (mg/kg) | Pb (mg/kg) | pH |
|---|---|---|---|---|---|
| **1 Oysters (N=3)** | 0.001 ± 0.0001 | 146.4 ± 1.60 | 111.3 ± 4.40 | 0.01± 0.003 | 7.3 ± 0.53 |
| **2 Periwinkle (N=3)** | 0.001± 0.0001 | 184.7 ± 3.06 | 196.0 ± 2.50$^{1}$ | 33.60 ± 1.50$^{1}$ | 7.1 ± 0.32 |
| **3 Whelk (N=3)** | 0.001± 0.0001 | 171.9 ± 4.71 | 577.4 ± 7.52$^{1,2}$ | 0.01± 0.003$^{2}$ | 6.7 ± 1.10 |
| **F-value** | 1.000 | 100.20 | 6753 | 1504 | 0.5152 |
| **P-value** | 0.421 | <0.0001 | <0.0001 | <0.0001 | 0.6216 |
| **Remark** | NS | S | S | S | |

***Key:***
*S = significant difference*
*NS = no significant difference*
*The mean are significant when the groups are compared with the numbers placed as superscript (Tukey's multiple comparison).*

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The aim of the study was to assess the levels of heavy metals (Cd, Pb, Cr, and Cu) and pH in periwinkles, whelks, oysters, sediment, and water samples found in some swamps in Rivers State. The results from this study, as presented in tables 1 and 2, and 3, showed that cadmium, chromium, copper (Cu), and lead were present in all the water, sediment and tissue samples at varying concentrations. The presence of these heavy metals in the seafood, sediment, and water samples could be because of crude oil spills, illegal bunkering operations, and industrial waste released into these water bodies and environment. These metals found in this study correspond with the metals found in another study in Rivers State by Otitoju et al.[9].All water samples collected from the different locations contained a similar and very low concentration of cadmium (0.001 ± 0.0001 mg/l). The water samples had low concentrations of cadmium probably because cadmium leaches into the soil from the water and accumulates in the organism [10]. This value is lower than the recommended limit (0.003mg/l) set by the World Health Organization (WHO) as reported by Kakulu et al.[11].
This finding from this study does not correspond to the finding from Elekima et al. [12]. and Abu et al.[13]. carried out in Eagle Island, Iwofe, Borokiri, and Bodo creeks in Rivers State using mudskipper, periwinkle and shrimp; and found that the concentration of cadmium exceeded the recommended limit set by WHO. There were insignificant differences in the concentration of chromium in the water samples across the different locations, with the highest concentration found at Iwofe swamp (1.56 ± 0.18mg/l), and the lowest concentration found in Trans-Amadi (1.33 ± 0.12mg/l). These concentrations are greater than the recommended limit of chromium in water by WHO (0.05-0.1mg/l).

Chromium, one of the most prevalent and widespread metal pollutants in the environment, enters the aquatic system through the effluents of industries like rubber, electroplating, dyeing, printing, photographic printing, textiles, tanneries, mining, and stainless steel and electroplating manufacturing. We can thus assume that the difference in levels of industrialization in these locations is to blame for the differences in chromium levels observed in the water samples. There was a significant difference (p value = 0.01) among the concentration of copper observed for the 3 locations. However, Eagle Island swamp had the highest concentration of Cu (0.16 ± 0.07 mg/l), while Trans-Amadi had the lowest concentration of copper (0.04 ± 0.03mg/l), and these ranges generally fall below the World Health Organization (2003) limits of 1.2 mg/l for food and sea foods. The 3 locations had slightly undetectable concentrations of lead (0.001 mg/kg) which fall below the recommended limit of 0.01mg/l set by WHO[14] for seafood, but however, upon comparison of the concentration of lead for the different locations, significant differences (p value = 0.42) were found for comparison between Eagle Island swamp and Trans-Amadi swamp.

Lead (Pb) has been reported to be associated with crude-oil exploration, pipeline transportation, corrosion inhibition as well as many industrial processes [15]. High levels of Pb in foods can induce abdominal pains, drowsiness, vomiting, convulsion kidney and reproductive system malfunction [16]. The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) stipulates the weekly intake of Cd and Pb for adults at

0.42 to 0.49 and 1.5 to 1.7 mg/kg body weight, respectively. From our results, the concentration of Cd and Pb in the samples were lower than the recommended range by FAO and WHO [14]. Therefore, these metals may not pose serious health risks to consumers at short term of exposure but could be in the long run.The lowest pH value was observed in the water sample from Trans-Amadi swamp (6.50 ± 0.07). When the water sample from Trans-Amadi swamp was compared with the other locations, a significant difference (p value = 0.006) was observed between Trans-Amadi and Eagle Island swamps.

For sediments from the different locations, cadmium was also slightly undetectable, with no difference in the mean concentration across the different locations (0.001 ± 0.0001mg/kg). There were differences in the concentration of chromium observed, with the highest concentration found in Borokiri swamp (696.2 ± 902.4 mg/kg), and the least concentration found in Eagle Island Swamp (124.4 ± 5.80mg/kg). However, these differences were statistically insignificant. Borokirirelates to the industrial wastes from Trans-Amadi through various channels and drainages, and in addition, it is closely associated with the Okirika oil field and the activities of crude oil business at Marine Base, Port Harcourt, which could be a pointer to the high level of chromium observed in Borokiri.

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Significant differences were found for copper and lead in the different locations. The highest concentration of copper was found in Trans-Amadi swamp (27.30 ± 0.20mg/kg), and the lowest concentration was found in Iwofe swamp (18.70 ± 2.30mg/kg). When compared with each other, significant differences (p value <0.0001) were found between Iwofe and Eagle Island, Iwofe and Trans-Amadi, and Trans-Amadi and Borokiri. The high levels of copper observed in Trans-Amadi could be due to the industrial activities that occur in that area. Trans-Amadi industrial layout is an area mapped out by Rivers State government for industrial activities in Port Harcourt metropolis. For lead, a significantly high concentration was observed in Eagle Island (11.40 ± 0.35mg/kg), while the other locations had considerably lower concentration (0.01 ± 0.003mg/kg). The high concentration of lead in Eagle Island could also be attributed to the industrial activities that occur in that area, leading to the release of industrial waste into the water body. From the results observed in the sediments in table 2, the level of cadmium fell below the standard limit set by WHO (0.5mg/kg). However, chromium, copper, and lead had concentrations that fell above the recommended limit according to WHO (3.0mg/kg, 0.6mg/kg, and 2.0mg/kg respectively).

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The sediments were observed to have an acidic pH with mean values of 4.97 ± 0.47 mg/kg, 5.18 ± 0.36 mg/kg, and 6.13 ± 0.18 mg/kg for Iwofe, Eagle Island, and Trans-Amadi respectively. The differences were statistically significant (p value = 0.02). This acidic pH observed could be because of the climate and vegetation of the area and the parent material and weathering processes that act on the soil.For each of the tissue samples, cadmium was present in a very low concentration (0.001 ± 0.0001mg/kg). This range is below the recommended range for cadmium, by WHO (0.5-1.0mg/kg). The concentration of Cadmium falling below the WHO recommended limit as seen in our study does not concur with finding from the study by Elekima et al. [12]. and Abu et al.[13]., who found the concentration of cadmium exceeding the WHO recommended limit, with periwinkle having the highest level of cadmium from their study. Significant differences across the samples were observed for chromium, copper, and lead. Chromium was found in the highest concentration in periwinkles (184.7 ± 3.06mg/kg), and the least concentration was found in Oysters (146.4 ± 1.60mg/kg). These concentrations were far above the recommended limit by WHO which is 3.0mg/kg [14].

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The highest concentration of copper was found in whelks (577.4 ± 7.52mg/kg) and the least was found in Oysters (111.3 ± 4.40mg/kg), which is also far greater than the recommended limit set by the WHO (0.6mg/kg) [14]. There was also a significant difference when the concentration of copper in oysters was individually compared with those of periwinkle and

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whelk. The concentration of lead in oysters and whelks was negligible, however there was a significantly high concentration of lead in periwinkle (33.60 ± 1.50mg/kg), which is above the standard limit (2.0mg/kg) set by WHO. This high concentration of lead in periwinkle agrees with the study by Elekima et al., [12] and with the reports of Nwaichi et al.[17]. They also reported a high level of lead in periwinkles above the WHO permissible limits in Borokiriswamp. Another study in Rivers State reported that the highest concentration of heavy metals was found in periwinkles.

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These findings reveal that sea foods are highly concentrated with heavy metals, and the highest concentration of heavy metals were always found in periwinkle, therefore consumption of these seafoods can lead to acute heavy metal toxicity, which have been reported to be responsible for several ailments including chronic neurological disturbances in fetuses and children, cancer, memory loss, and in some cases, kidney damage [18]. The difference in the levels of heavy metals in the different species of seafoods could be attributed to their life cycle, behavioral patterns, habitat, and feeding habit of the species[19]. The highest levels of lead observed in periwinkles could be attributed mainly to their feeding habit. This species feeds mainly from sediments and particulate matters. Therefore, they are more exposed or tend to easily bio-accumulate these heavy metals.The high levels of heavy metals seen in this study could also be affected by seasonal changes in the environment. This seafoodwas collected during the rainy season between September and October. Therefore, the increase seen in this seafood may also be attributed to the leaching from pesticides sprayed on agricultural products, improper disposal of materials containing these products which find their way into the water bodies and thus contaminating them. The pH of the seafood had mean values of 7.3 ± 0.53 mg/kg, 7.1 ± 0.32 mg/kg, and 6.7 ± 1.10 mg/kg. However, the differences were not statistically significant. This pH value fell within permissible limit [14].

## 4. CONCLUSION

The findings imply that seafood is highly concentrated with heavy metals, which could possibly pose health risks to Rivers State residents as consumers due to its bio-accumulative tendencies over a prolonged period. The cadmium concentrations were within the WHO-acceptable limits for seafood. Chromium, copper, and lead levels in this seafood, however, were higher than those allowed by the WHO. It is quite evident that crude oil spills, illegal bunkering operations, and industrial waste released into these water bodies have negatively impacted common seafood consumed by Nigerians, and as a result, they may pose a serious threat not only to aquatic organisms or the environment, but also to people who frequently consume this seafood in Rivers State.

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