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Assessment of the Impacts of Some Physico-Chemical Parameters in Some Seafoods Found Around Elele Swamps and Rivers of Niger-Delta Region, Nigeria

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Abstract

Both terrestrial and aquatic environments in Nigeria's Niger-delta region are becoming more contaminated with heavy metals as a result of increased urbanisation and crude oil exploration. The study's objectives were to measure the levels of heavy metals (cadmium, lead, chromium, copper) and pH in various seafoods, including periwinkles, whelks, oysters, crabs, crayfish, and some fish species, as well as the levels of sediments in the water bodies found around some swamps and rivers in Elele and its surroundings. Additionally, the study sought to ascertain the relationship between the levels or concentrations of heavy metals and the seafoods' capacity to reproduce over time. The study also sought to determine the pH and levels of heavy metals (Cd, Pb, Cr, and Cu) in periwinkles, whelks, crabs, crayfish, water snails, some fish species, and oysters, as well as sediments and water samples found in some swamps and rivers in the Niger-Delta region of Nigeria. It also sought to ascertain the concentrations of heavy metals at which oxidative stress can occur and result in a complete alteration of their chromosomes and DNA structures. One of the study's conclusions demonstrated that as time went on, the pH of the seafoods' internal environment increased in tandem with even a small rise in the heavy metal levels, resulting in more oxidative damage. The study also looked at the likelihood of a correlation between the levels of heavy metals in tissue samples from specific seafood species and the species' capacity for long-term reproduction. The results also demonstrated that the reproduction potentials or capacities of the seafoods decreased over time as the tissue concentrations of the heavy metals increased in their bodies (even when they were within the standard range set by the WHO). This likely explains why some seafoods eventually go extinct. The Iwofe, Elele, Rumuji, Ibaa, Alimini, Trans-Amadi, Eagle Island, and Borokiri wetlands and rivers were among the various locations from where the samples were gathered. Samples of sediment were processed into powder in order to create uniform particles. Weighing and recording each sample allowed us to calculate the heavy metal concentrations. Each of the 500 milligramme ground samples was weighed and placed in a crucible. To dissolve the samples, 20 millilitres of aqua regia—which contains 15 millilitres of HCI and 5 millilitres of HNO3—was added. The GBC XplorAA Atomic Absorption Spectrophotometer (AAS) was used to analyse the heavy metals present in the dissolved samples. Beer-Lambert's law was used to compute the concentrations. The Apple Macintosh's GraphPad Prism version 8.0.2 was used to do the statistical study. The mean and standard deviation (SD), two descriptive statistical measures, were employed. For inferential evaluation, the means of more than two groups were compared using ANOVA, and mean differences between multiple groups were examined using Tukey's multiple comparison test. For statistical significance, a probability (p) value of less than 0.05 ($P<0.05$) was employed. Co-relating linkages were also done using Pearson's Product Moment. The water sample from the Trans-Amadi wetland has the lowest pH (6.50 ± 0.07). There was a significant difference (p value = 0.006) between the water samples from Trans-Amadi, Elele, and Eagle Island marshes when compared to the other locations.

Keywords: Assessment, Impacts, Physico-Chemical Parameters, Heavy Metals, Seafoods, Health Effects, Reproduction Capacities and Potentials, Sediments, Locations.

INTRODUCTION

Seafoods are edible aquatic animals, comprising both freshwater and saltwater organisms but excluding mammals. Most innocuous aquatic creatures are consumed by humans. It is possible to safely prepare foods that could harm people, such as blowfish. Fish and other seafood may be the most important food for humans after cereals, as they provide 15% of the protein required by the global population. [1]

Animals with a shell or shell-like exterior that live in water are called shellfish. They fall into two categories: molluscs and crustaceans. Molluscs include things like clams, scallops, oysters, and mussels, whereas crustaceans include things like prawns, crayfish, crabs, and lobster. [2]

Although the majority of shellfish inhabit saltwater, species located in freshwater are often referred to by this moniker. Heavy metals are natural elements that have a high atomic weight and a density that is at least five times higher than that of water. Because of their many industrial, residential, agricultural, medical, and technical uses, they are widely distributed in the environment, raising concerns about potential effects on human health and the environment. The harmful nature of these contaminated seafoods is demonstrated by the dose, mode of exposure, chemical species, age, gender, genetics, reproduction, and nutritional state of those exposed. Because of their high level of toxicity, arsenic (As), cadmium (Cd), chromium (Cr), and lead (Pd) are among the priority metals of public health concern. These metallic elements are considered systemic toxicants and are known to harm multiple organs even at low concentrations [3].

The Niger Delta region is home to a wide variety of biotopes, many of which are dominated by huge tracts of mangrove swamp forests, together with its streams and tributaries. However, industrial operations and crude oil extraction have resulted in environmental damage in this region, which has a complex ecological structure. This leads to the release of pollutants into the environment, such as heavy metals and hydrocarbons, which can contaminate land and water bodies [4].

Heavy metals have been demonstrated to have a deleterious impact on biological processes in general, and they may have an impact on the nutritional and biological state of sea foods. Although seafood is a great source of nutrients, the nutritional value of these creatures might change according on their surroundings [5]. These vital food sources make up a significant portion of the diet in the Niger Delta region of Nigeria, where they are typically eaten raw or cooked without the shells removed, as in the case of some crayfish species. These organisms may contain heavy metals that are bad for the environment, the health of children, the reproductive systems of pregnant and lactating women, and even the general public. Sea foods that have been taken from diverse water bodies with a history of crude oil spills and other industrial operations are consumed in significant amounts by a vast number of people in the Niger Delta region of Nigeria. Heavy metals are high priority pollutants because of their extreme toxicity and persistence in the environment. These metals are a major concern to the food chains because they are continuously entering the aquatic ecosystem as inorganic compounds that come from both natural and man-made sources [6].

Because of their severe toxicity, cadmium, chromium, and lead are among the priority metals of public health concern. At low exposure levels, these metallic elements have been demonstrated to cause organ damage, making them systemic toxicants. Environmental contamination can result from metal corrosion, air deposition, soil erosion of metal ions and heavy metal leaching, sediment re-suspension, and metal evaporation from water resources to soil and ground water [7,8]. Heavy metal pollution has also been found to be greatly influenced by oil pollution and oil bunkering. All of the anthropogenic activities that contribute to the buildup of these dangerous heavy metals in the environment should be reduced, and the waste should be appropriately managed, because of the impact that some of these metals have on the body.

MATERIALS AND METHODS

Study Design

The study design used was a cross-sectional study design.

Study Area:

The study was carried out in Elele and its environments- Alimini, Ibaa, Rumuji, Trans-Amadi, Borokiri, Iwofe, and Eagle Island swamps and rivers in Ikwere-Obio and Portharcort metropolis in Rivers state. Port Harcourt is the capital of Rivers state in the Niger-Delta region of the South-South Geopolitical Zone of Nigeria.

Ethical Consideration

Approval for this work was obtained from the ethical committee of the post graduate school, Imo State University, Owerri.

Collection and Preparation

The crayfish, crabs and some species of fish were collected from Alimini, Elele, Ibaa and Borokiri, while periwinkles, oysters, water snails and whelks were collected stuck to woods from the same location, soil samples were also collected from Borokiri swamp, Ibaa, and Rumuji to assess some heavy metals and pH. Soil and water samples were collected from Elele, Iwofe, Eagle Island and Trans-Amadi to assess the same heavy metals and pH.

Experimental Methods and Procedures

Estimation of Heavy Metals

Method: GBC XplorAA Atomic Absorption Spectrometry (AAS)

Principle: This principle is based on flame or light absorption rather than flame/light emission. Metal atoms absorb light strongly at discrete characteristic wavelengths which coincide with their emission spectra. A solution of the sample is converted into an aerosol which is injected into a flame/light which then converts the sample into an 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

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

pH Detection

The pH of the samples were measured using a pH meter. The water samples were measured directly using a pH meter.

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. Whereas Pearson's Correlation Coeficient (r) was used to correlate the levels or amounts of heavy metals in tissue samples of seafoods and their reproduction capacities or population over time. The probability (p) value less than 0.05 ($P<0.05$ for Tukey's multiple comparison test) & =/> 1.0 for Pearson's Correlation Coefficient were used and considered statistically significant.

RESULTS

Comparison of Heavy Metals Found in Water Samples Based on Locations of the Samples

From table 4.1, the mean ± S.D values for Cadmium (Cad) at Iwofe, Elele, Eagle Island and Trans-Amadi were 0.001 ± 0.0001 mg/l, 0.001 ± 0.0001mg/l, and 0.001 ± 0.0001mg/l respectively. The result also showed that the mean ± S.D values for Chromium (Cr) at Trans-Amadi, and Iwofe were 1.33± 0.12mg/l, and 1.56 ± 0.18mg/l respectively. For Copper (Cu) at Iwofe, and Eagle Island the results were 0.007± 0.004mg/l, and 0.16 ± 0.07mg/l respectively. The mean values for Lead (Pd) at Iwofe, Elele, Eagle Island and Trans-Amadi were 0.01 ± 0.003mg/l, 0.01 ± 0.003mg/l, and 0.01 ± 0.003mg/l respectively. The mean ± S.D values for pH at Trans-Amadi, and Iwofe were respectively 7.30± 0.27mg/l, and 6.50± 0.07 mg/l. Significant differences were found when the copper content (for Iwofe, Eagle Island, Elele, and Trans-Amadi, and pH for Iwofe, Elele-Eagle Island, and Trans-Amadi) were compared, while there was no significant difference for the different locations for cadmium, lead, and chromium.

Table 4.1: 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/Elele (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)

Comparison of Heavy Metals in the sediments/soil Based on Location of the Samples

For table 4.2, the mean ± S.D. values for cadmium Iwofe, Elele, Eagle Island, Trans-Amadi, and Borokiri were 0.001± 0.0001mg/kg, 0.001 ± 0.0001 mg/kg, 0.001 ± 0.0001 mg/kg, and 0.001 ± 0.0001 mg/kg respectively. The result also showed that the mean ± S.D values for Chromium (Cr) at Eagle Island and Borokiri were 124.4 ± 5.80 mg/kg, and 696.2 ± 902.4 mg/kg respectively. For Copper (Cu) at Borokiri and Trans-Amadi the results were 14.70 ± 0.56mg/kg, and 27.30 ± 0.20

mg/kg respectively. The mean ± S.D values for Lead (Pd) at Iwofe, Borokiri and Trans-Amadi were 0.01 ± 0.003 mg/kg, 0.01 ± 0.003 mg/kg, and 0.01 ± 0.003 mg/kg respectively and Eagle Island was 11.40 ± 0.35 mg/kg. Our findings showed significant differences for copper and lead when the means ±S.D were compared for Iwofe, Eagle Island, Trans-Amadi, and Borokiri. However, there was no significant difference for cadmium and chromium.

Table 4.2: Comparison of Heavy Metals in the Sediment/Soil Based on Location of the Samples

Location/Parameter	Cad (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	pH
1 Iwofe & Elele (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	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).

Comparison of Heavy Metal levels in the Tissue Samples of seafoods Based on Location of the Samples

From table 4.3, the mean ± S.D values for Cadmium (Cad) Oyster, fish, periwinkle, crab, snail, crayfish, and Whelk were 0.001± 0.0001mg/kg, 0.001 ± 0.0001 mg/kg, and 0.001 ± 0.0001 mg/kg respectively. The result also showed that the mean ± S.D values for Chromium (Cr) for Oyster, crab, crayfish, and Periwinkle were 146.4 ± 1.60 mg/kg, and 184.7 ± 3.06 mg/kg respectively. For Copper (Cu) in Oyster, fish, and Whelk the results were 184.7 ± 3.06 mg/kg, and 577.4 ± 7.52 mg/kg respectively. The mean ± S.D values for Lead (Pd) for Oyster, fish, crab, and Whelk were 0.01 ± 0.003 mg/kg, and 0.01 ± 0.003 mg/kg respectively, and Periwinkle was 33.60 ± 1.50 mg/kg. Significant differences were found for Chromium and Copper and Lead for oyster, periwinkle, crab, crayfish, and whelk. While no significant difference was found for cadmium.

The mean are significant when the groups are compared with the numbers placed as superscript (Tukey's multiple comparison).

Table 4.3: Comparison of Heavy Metal levels in the Tissue Samples of seafoods Based on Location of the Samples

Tissue/Parameter	Cad (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	pH
1. Oyster (N=3)	0.001±0.0001	146.4±1.60	111.3±4.40	0.01±0.003	7.3
2. Periwinkle(N=3)	0.001±0.0001	184.7±3.06	096.0±2.50	33.60±1.50	7.1
3. Whelk(N=3)	0.001±0.0001	171.9±4.71	577.4±7.52	0.01±0.003	6.7
4. Fish(N=3)	1.000±0.0001	100.20±3.06	6753±4.40	1504±1.50	0.51
P-Value	0.421	<0.0001	<0.0001	<0.0001	0.42

Key:
S = significant difference
NS = no significant difference

Table 4.4: examining the relationship between heavy metals in tissue samples and reproduction capacities of seafoods over time based on location of samples

2023 (x)

Tissue/Parameter	Cad (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	pH
1. crayfish	0.001 0.050	146.4 0.050	111.3 2.00	0.01 0.05	7.3
2. Rumuji/ Elele/ Alimini/ Ibaa	0.870	35.48	0.96	0.17	7.1
3. water Snail	0.960	35.48	1.140	0.17	6.7
Tilapia	0.80	17.06	0.12	0.02	5.5
Catfish	0.240	17.06	0.16	0.16	5.5

Crab	0.800	0.130	0.75	0.10	6.6
Periwinkle	0.800	0.130	0.75	0.08 6.5	
	4.100	0.13	0.75	0.08 5.7	
2024 (y)					
Snake heads	0.05	0.05	2.00	0.05 7.8	
Water snail	3.61	0.21	0.46	0.38 7.5	
Pompon fish	3.61	0.21	0.46	0.38 7.6	
Tilapia	1.57	0.29	1.90	0.45 7.6	
Ibaa/Rumuji	1.57	0.29	1.90	0.45 7.6	
	0.26	0.60	0.87	0.03 7.3	
	0.26	0.60	0.87	0.03 7.2	
	0.16	2.49	0.96	0.02 7.9	
	0.16	2.49	0.96	0.02 7.9	

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, and Pearson's Correlation Coefficient).

DISCUSSIONS

The study's objectives were to measure the levels of heavy metals (Cd, Pb, Cr, and Cu) and pH in periwinkles, whelks, crabs, crayfish, water snails, some fish species, and oysters, as well as sediments and water samples found in some swamps and rivers in the Niger-Delta region of Nigeria. It also sought to ascertain the concentrations of heavy metals at which oxidative stress can occur, altering or disrupting the internal environments of these seafoods, as well as completely altering their chromosomes and DNA structures. One of the results of the earlier study by [9] showed that the quantities of heavy metals found in some seafood were within the WHO's acceptable range. One of the study's conclusions, however, was that over the course of nine months, there were some minor variations in the heavy metal concentrations. These variations were accompanied by a corresponding rise in the pH of the seafood's internal environment, which resulted in additional oxidative stress. The study also looked at the likelihood of a correlation between the levels of heavy metals in tissue samples from specific seafood species and the species' capacity for long-term reproduction. The levels or tissue concentrations of heavy metals found in the bodies of the seafoods over a nine-month period were displayed in Table 4.4 (x- 2023 data set) and (y- 2024 data set), where the study looked at the levels or concentrations of the heavy metals absorbed into the bodies of the seafoods collected on a monthly basis. The results showed that the reproduction potentials or capacities of the seafoods decreased over time as the tissue concentrations of the heavy metals in their bodies increased (even when they were within the WHO-established standard range). This likely explains why some of the seafoods eventually become extinct.

All of the water samples, sediments, and tissue samples had varied amounts of cadmium, chromium, copper (Cu), and lead, according to the study's findings, which are shown in tables 4.1, 4.2, 4.3, and 4.4. The presence of these heavy metals in the seafood, sediments, and water samples could be as a result of crude oil spills, illegal bunkering operations, vandalization of oil pipelines, and industrial wastes, plus agricultural wastes dumped into these water bodies and environment. The metals discovered in this investigation match those discovered in a different study conducted in Rivers State by [10].

Cadmium concentrations in all water samples taken from the various locations were comparable and extremely low (0.001 ± 0.0001 mg/l). The low cadmium concentration in the water samples was likely caused by cadmium seeping into the soil from the water and building up in the organism [11]. This number is lower than the recommended limit (0.003mg/l) set by the World Health Organization (WHO) as stated by [12]. This study's results are consistent with the research by [13]. It does not, however, align with the results of [14], which used mudskipper, periwinkle, and shrimp to test the Elele-Eagle Island, Iwofe, Borokiri, and Bodo streams in Rivers State and discovered that the cadmium concentration was higher than the WHO-recommended threshold.

The chromium concentrations in the water samples from the various sites varied negligibly; the highest quantities were discovered at Iwofe swamp (1.56 ± 0.18 mg/l), while the lowest concentrations were found in Trans-Amadi (1.33 ± 0.12 mg/l). These levels exceed the WHO's recommended limit of 0.05–0.1 mg/l of chromium in water. The wastewater from industries such as rubber, electroplating, dyeing, printing, photographic printing, textiles, tanneries, mining, and the production of stainless steel and electroplating releases chromium, one of the most common and pervasive metal pollutants in the environment, into the aquatic system. Therefore, we can presume that the variations in chromium levels found in the water samples are caused by the varying degrees of industrialisation in different areas. The concentrations of copper found in the three locations varied significantly (p value = 0.01).

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 fell within the World Health Organization recommendations of 1.2 mg/l for food and marine foods. The lead concentrations in the three sites were marginally undetectable (0.001 mg/kg), which is below the WHO-recommended limit of 0.01 mg/l for seafood. However, when the lead concentrations in the various sites were compared, significant differences (p value = 0.42) were discovered between Eagle Island swamp and Trans-Amadi swamp.

Lead (Pb) has been linked to numerous industrial processes, pipeline transportation, corrosion inhibition, and crude oil exploration [15]. Abdominal aches, fatigue, vomiting, convulsions, and problems with the kidneys and reproductive system can all be caused by high amounts of lead in food [16]. Adults should consume 0.42 to 0.49 mg of Cd and 1.5 to 1.7 mg of Pb per kilogramme of body weight each week, according to the Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO), respectively. According to our findings, the samples' Cd and Pb concentrations were below the level that is advised by [17]. As a result, consumers may not be at immediate risk for major health problems from these metals, but they may be in the long run.

The water sample from the Trans-Amadi wetland has the lowest pH (6.50 ± 0.07). There was a significant difference (p value = 0.006) between the water samples from Trans-Amadi, Elele, and Eagle Island marshes when compared to the other locations. Cadmium was also somewhat undetectable in the sediments from the various locations, with the mean concentration (0.001 ± 0.0001 mg/kg) being the same for all the locations. Chromium concentrations varied; Borokiri swamp had the highest concentration (696.2 ± 902.4 mg/kg), while Elele-Eagle Island swamp had the lowest value (124.4 ± 5.80 mg/kg). These variations were not statistically significant, though. Through a number of channels and drainages, Borokiri is connected to the industrial wastes from Trans-Amadi. Additionally, it is closely linked to the Okirika oil field and the crude oil business operations at Marine Base, Port Harcourt, which may indicate that Borokiri has a high chromium content. Lead and copper showed notable variations in the various locales. Iwofe marsh had the lowest concentration of copper (18.70 ± 2.30 mg/kg), whereas Trans-Amadi swamp had the greatest value (27.30 ± 0.20 mg/kg). Iwofe and Elele-Eagle Island, Iwofe and Trans-Amadi, and Trans-Amadi and Borokiri were all found to differ significantly from one another (p value <0.0001). The industrial operations that take place in Trans-Amadi may be the cause of the elevated copper levels found there. The Rivers State government drew out the Trans-Amadi industrial layout for industrial activity in the city of Port Harcourt. Eagle Island showed a notably elevated concentration of lead (11.40 ± 0.35 mg/kg), but the concentrations in the other locations were significantly lower (0.01 ± 0.003 mg/kg). The high percentage of lead in Eagle Island could also be related to the industrial activities that occur in that area, leading to the leakage of industrial pollutants into the water body. According to the findings in table 4.2, the cadmium content of the sediments was below the WHO-established standard limit of 0.5 mg/kg. However, the amounts of lead, copper, and chromium were higher than the WHO-recommended threshold of 2.0 mg/kg, 0.6 mg/kg, and 3.0 mg/kg, respectively. 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 Transamadi, respectively, the sediments were found to have an acidic pH. A p-value of 0.02 indicated that the differences were statistically significant. The local climate, vegetation, parent material, and weathering processes that affect the soil could all contribute to the observed acidic pH. Cadmium was found in very small amounts (0.001 ± 0.0001 mg/kg) in each tissue sample. This level falls short of the WHO's recommended limit of 0.5–1.0 mg/kg for cadmium. The results of the study by [18], which revealed that the concentration of cadmium exceeded the WHO suggested limit and that periwinkle had the highest amount of cadmium, do not support the findings of our study, which showed that the concentration of cadmium was within the WHO recommended limit. For lead, copper, and chromium, there were notable variations among the samples. Chromium was detected in the highest quantity in periwinkles (184.7 ± 3.06mg/kg), and the least concentration was found in Oysters (146.4 ± 1.60mg/kg). These levels were significantly higher than the WHO-recommended threshold of 3.0 mg/kg [19].

Whelks had the highest copper concentration (577.4 ± 7.52 mg/kg), while oysters had the lowest (111.3 ± 4.40 mg/kg), both of which are significantly higher than the WHO-recommended limit of 0.6 mg/kg. When the copper concentrations in oysters, periwinkle, and whelk were analysed separately, there was also a notable difference. Lead concentrations in oysters and whelks were quite low, whereas periwinkles had a very high lead concentration (33.60 ± 1.50 mg/kg), over the WHO guideline limit of 2.0 mg/kg. This elevated lead content in periwinkle is consistent with the findings of [20] and [21]. Additionally, they noted that the periwinkle in Borokiri wetland had a high amount of lead above the WHO-permissible levels. Periwinkles had the highest quantity of heavy metals, according to another study conducted in Rivers State [22, 23].

CONCLUSION

Using a cross-sectional research design that allowed for multiple testing tools at the same time, the study's goals were to determine the levels of heavy metals (Cd, Pb, Cr, and Cu) and pH in periwinkles, whelks, crabs, crayfish, water snails, and some fish species and oysters, as well as sediments and water samples found in some swamps and rivers found around Elele of the Niger-Delta region of Nigeria. It also sought to ascertain the concentrations of the heavy metals that can cause oxidative stress, alter or disrupt the homeostasis of these seafoods' internal environments, as well as cause complete modifications of their chromosomes and DNA structures. One of the results of the earlier investigation showed that the amounts of heavy metals found in some seafood falling inside the WHO-recommended acceptable limit. One of the study's conclusions, however, was that over the course of nine months, there were some minor variations in the heavy metal concentrations. These variations were accompanied by a corresponding rise in the pH of the seafood's internal environment, which resulted in additional oxidative stress. The study also looked at the likelihood of a correlation between the levels of heavy metals in tissue samples from specific seafood species and the species' capacity for long-term reproduction. The levels or tissue concentrations of heavy metals found in the bodies of the seafoods over a nine-month period were displayed in Table 4.4 (x- 2023 data set) and (y- 2024 data set), where the study looked at the levels or concentrations of the heavy metals absorbed into the bodies of the seafoods collected on a monthly basis. The results showed that the reproduction potentials or capacities of the seafoods decreased over time as the tissue concentrations of the heavy metals in their bodies increased (even when they were within the WHO-established standard range). This likely explains why some of the seafoods eventually become extinct.

The results suggest that seafood is heavily contaminated with heavy metals, which may be harmful to consumers in Rivers State because of its long-term bioaccumulative tendencies. The WHO-acceptable limits for seafood were met by the cadmium contents. However, the amounts of lead, copper, and chromium in these shellfish above WHO limits. 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 these seafoods in the Niger-Delta region.

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