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Evaluation of Heavy Metals Concentration in Unshelled Periwinkles (*Tympanotonus fuscatus*) from Rumuolumeni Creek, River State, Niger Delta Nigeria

***[1]Nwaonyeche, N.C., [2]Chukwugozim-Umejuru, R.U., & [1]Agbonavbare, P.O.**
[1]Biology Department, Nigeria Maritime University Okerenkoko, Delta State.
[2]Biology Department, Ignatius Ajuru University of Education Rumuolumeni, Port Harcourt.

***Corresponding author email:** napoleonnwaonyeche@gmail.com

Abstract
The study evaluated concentration of heavy metals in periwinkle (*Tympanotonus fuscatus*) from Rumuolumeni Creek. Globally pollution is one of the major problems affecting our environment that led to loss of many raw materials and extinction of animals and plant species. A lot of oil drilling activities by oil companies takes place daily at the creek including use of fertilizers by the local farmer, farming within the creek. Considering the importance of periwinkle (*Tympanotonus fuscatus*) a source of protein that is widely used in the preparation of food in Rivers State. It is important that the concentration of these heavy metals are known to ascertain their edibility. Samples were collected from four different stations with different anthropogenic activities; the stations were Mordant Marine, Erico, Old police post and Eagle Cement. Periwinkles were handpicked into rubber container washed with the river water to remove mud and taken to the laboratory where water were boiled for 20minutes using a ring boiler and soaked the periwinkles inside it before unshelling it with needle. Dry tissue samples of periwinkles weighting 0.5g were digested with 0.45ml of concentrated nitric acid in a fume cupboard and water bath were switch on, to stabilize and attain 1000C using a water bath completely, digested samples were filtered using whatman paper while heavy metals concentration were analyzed using Atomic Absorption Spectrophotometer (AAS), model AA320N. Heavy metals analyzed were (zinc, lead, copper and nickel). The periwinkles at all the stations investigated for heavy metals showed the following results (zinc 41.72-59.97, lead 0.750-1.639, copper 64.23-115.50, Nickel 0.027-0.083) and all were compared with WHO permissible limits and all exceeded permissible limits of WHO except nickel. Conclusively the periwinkles at Rumuolumeni Creek are not healthy for consumption and the public should be alerted of the health risk in consuming the periwinkle from the creeks.

Keywords: Heavy metals; Periwinkle; Pollution; Rumuolumeni Creek; Shell**.**

Introduction

One of the edible sea food common in Niger Delta part of Nigeria is called periwinkle, There are different types and species of periwinkle in Africa and Nigeria in particular. The common type is the small black shell periwinkle. They are found in large quantities in riverine areas like Port-Harcourt, Bayelsa, Lagos, Delta and Akwa Ibom etc (Joseph et al., 2010). In this study our major concentration is on a particular type of periwinkle known scientifically as (*Tympanotonus fuscatus*),they are found in many Seas across the world, they are common found in many creek in Rivers state specially Rumuolumeni Creek. It can be used to prepare some delicacies for human consumption for instance, in Nigeria, this particular periwinkle (*Tympanotonus fuscatus*), is used in making several delicacies like, Okoro Soup, Edikang Ikong and Afang soup and recently, Periwinkle Sauce (Abu & Nwokoma, 2016). This delicious seafood is sumptuous to behold and provides a lot of health benefits such as Protein, calcium, rich in omega-3 fatty acids and very low in fat, periwinkle is not poisonous and it's best eaten when cooked (Bob-Manuel et al., 2016).

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The pollution that enters the water shore and estuaries creates serious problems causing extensive damage to the life and activities of the living aquatic organisms and even to mass mortality (Agwu et al.,2022). Among the pollutants accumulation, heavy metals in marine ecosystem is of global importance (Tacon & Metian 2020). Heavy metals contamination may have devastating effect on the aquatic organisms (Farombi et al., 2010). When the concentration of heavy metals such as lead, copper, zinc, nickel manganese etc exceeds the recommended limits, it could be deleterious to the body, most heavy metals are toxicants that could induce multiple organ damage (Freeman & Ovie 2017). For instance lead has the tendency to interfere with several enzymatic functions and physiological processes in the human body thereby affecting the nervous, reproductive, cellular and cardiac system (Owoh-Etete & Bob-Manuel., 2020). It is on this basis that this study aimed at investigating concentration of heavy metals in periwinkle (*Tympanotonus fuscatus*) from Rumuolumeni Creek to ascertain the healthfulness of the periwinkle for consumptions.

Heavy metals pollution is known to be the cause of various disease globally, such as the Minamata disease (organic mercury poisoning), Itai-Itai disease (cadmium poisoning), and air pollution related asthmas (Abu & Nwokoma, 2016). Marine ecosystems are highly complex, dynamic and subject to many internal and external relationship that are subject to change over time. Heavy metals are prone to accumulate in various organs of marine organisms, especially fish, which in turn may enter into the human metabolism through consumption of these organisms, causing serious health hazards (Siric et al.,2022). This makes fish (periwinkle) contamination by heavy metal a potential threat to human health.

Advancement in human lifestyle due to science and technology causes contamination of the environment. Heavy metals are one of such pollutants that may come from both natural and human activities. It could be a serious problem or threat because of their toxicity, long persistence, bioaccumulation and bio-magnification in the food chain (Mglsemena et al., 2017). The waste transports high levels of toxicants, especially the heavy metals which have the ability to accumulate in the basic food chain also move up to the trophic level. Heavy metals are important environmental pollutants and their toxicity is a challenge because of the ecological nutritional, environmental and evolutionary effects (Jaishankar et al., 2014). The direct contaminants that bring about pollution in water are pathogens, wide spectrum of chemicals and physical or sensory change e.g., increased temperature and water discoloration (Nwineawii et al., 2018).

Heavy metals can easily enter Niger Delta environment through anthropogenic activities. Mgbokor et al., (2011), listed some of these anthropogenic activities as industrial waste, chemical waste, mining; others include battery manufacturing, soldering, printing, refining, gasoline, electoral wiring, stained glass production and ceramic glazing. Environmental experts from UK, USA and Nigeria have rated the Niger Delta as the highest oil impacted environment and polluted region in the world (Mglsemena et al., 2017). The status of the Niger Delta area as the highest oil impacted region in the world could be explained and justified by the high level of hydrocarbon activity exploration/exploitation and the very poor environmental control standards, to control spills and other associated waste released into the environment (Ugoma et al.,2020). Additionally, there are rampant acts of sabotage of oil installation facilities that leads to release of enormous amount of crude into the environment (Freeman et al., 2017).

Metal pollutants such as Hg, Ni, Fe and Zn, are capable of bioaccumulating in the tissues of aquatic organisms. Heavy metals are accumulated by marine organisms to very high concentration in their tissues and hence their body concentration are easily measured (Ikejimba, 2014). Matsuo (2023) stated that the body content of a trace metal in any organism results from the net balance between the process of metal uptake and metal loss. The periwinkle (*Tympanotorous fuscatus) is* of high commercial and economic value in the Niger Delta region of Nigeria (Alagoa & Yabefa, 2019). It is commonly distributed and found in the mangrove stamps and intertidal zones of estuarine and marine water of the Niger Delta. Periwinkles are deposit feeders and bio-indicators of heavy metal and hydrocarbon pollution in the aquatic environments (Akien-Alli et al.,2021).

Periwinkle predominantly belong to three genera including, *Tympanotonus*, *pachymelania* and *merceneria* of the three genera, species of periwinkle that belong to the *tymponotous* and *pachymelania* genera are predominant in the Niger Delta region of Nigeria. The two predominant species of periwinkles (*Tympanotous* and *pachymelania*) are found in fresh and water interphase (brackish water) habitat and benthos of the Niger Delta (Agbugi & Abe 2022). But the two species are phenotypically different. For instance *pachymelania aurita* have sharp spines (which depend

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on the age of the species and broader aperture while the species *Tympanotonus fuscatus* has turreted, granular and spiny shells with tapering ends (Bob-Manuel,2012). Specifically, *Tympanotonus fuscatus* concentrate under the roots and decaying red mangrove trees and small collection of water during low tide. Their population depends on their quest for food and shelter. The flesh *of Tympanotonus fuscatus* is used in the preparation of delicacies in the Niger Delta region while the shell is used for construction works especially in coastal communities close to the mangroves (Adelakun et al., 2023). Being a source of food to several families, there is the need to assess the level of undesirable substances in their tissues due to level of environmental pollution in the aquatic ecosystem.

There are many ways heavy metals can diffuse into the environment and the body of living organism. One of the ways is through bioaccumulation. These trace elements called heavy metals are toxic because they are bio-accumulative in nature or in the system of living organisms where they are found. Bio-accumulation has to do with an increase in the chemical concentration in biological organisms overtime, when compared with environmental chemical concentration (Fashola et al., 2020). Compounds accumulated in living things anytime they are consumed and stored faster than they are broken down or eradicated, some of these substances can get into human body through bioconcentration and biomagnification. 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 (Kumari & Tripathi, 2020). Even if the environment does not have a high amount of toxin in it, soil can also accumulate certain heavy metal which can be transferred to the plants through bioconcentration, anytime human beings and other animals use such plants as a source of food or nutrients in their diet, it will affect their health or system (Prabagar et al., 2020).

Materials and Method

Description of the Study Area; This research investigation was carried out in Rumuolumeni Creek of Abio/Akpor local government area in Rivers State, Niger Delta Nigeria. In Ikwerre land, Rumuolumeni is one of important communities due to the presence of oil companies and their facilities operating daily in the area. This location was selected for this research investigation because, it is an industrial and busy area. It is made up of oil companies, full of business activities, sand dredging and staged with main campus of Ignatius Ajuru University of Education, which made the presence of her students to be common in this area. This creek can be accessed through the route of Wimpy to Tobia water side all in Rivers State. Using global positioning system (GPS), Rumuolumeni Creek can be accessed between the latitude 4.8 08916N and longitude 6.92 8917E. It has route with Choba River and Bonny Estuarine that makes it part of new Calabar River (Vincent-Akpu & Nwachukwu, 2016). The community indigenes are predominantly farmers and fishermen. The creek serves primarily for fishing, farming and transportation, as it linked to different communities in other local government areas in Rivers State.

Sampled Stations

Four sampling stations were established in Rumuolumeni Creek. Hand-held GPS equipment, Gramin extret were used for coordinate collection at the sampling stations. The coordinates were used to plot the map in each station (figure 1).

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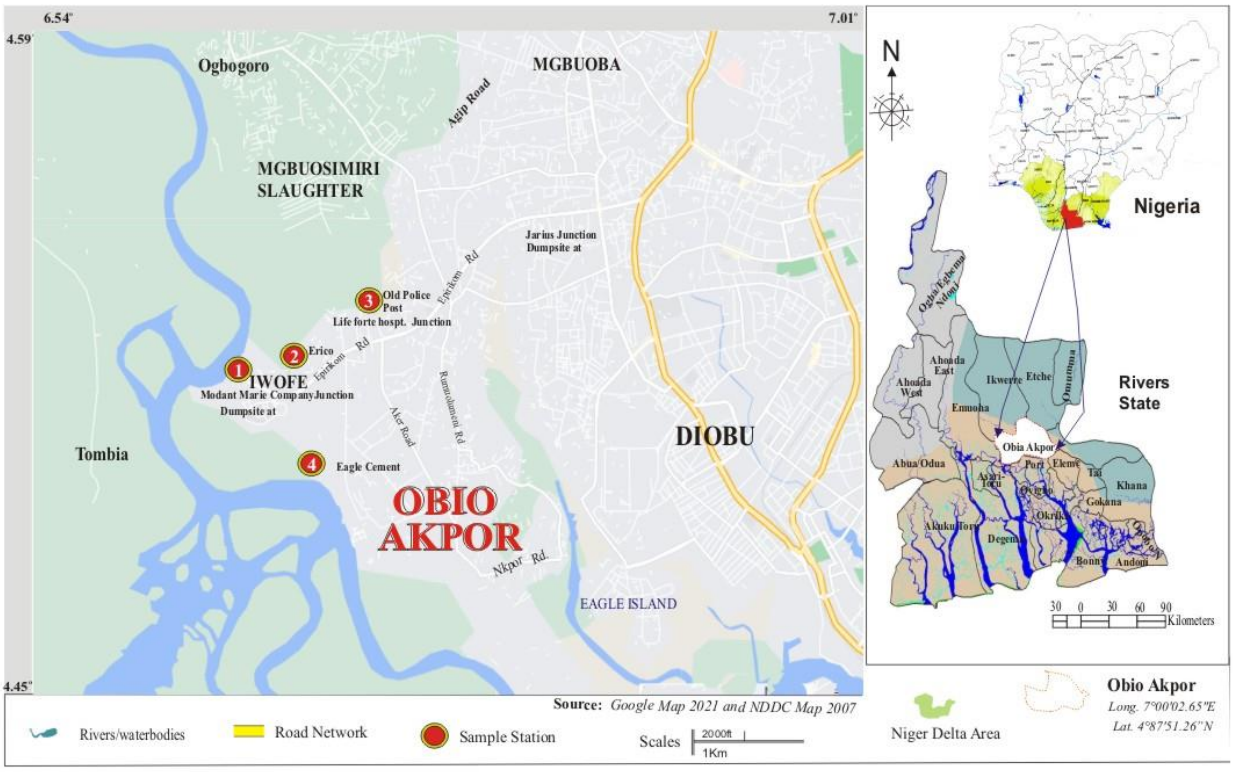

Figure 1 Showing Sampled Stations in the Study Area

Collection of the Periwinkle

The periwinkle was randomly collected by handpicking at the river bank/intertidal zone (sediment) from the four (4) stations; Mordant marine, Erico 2, Old police post and Eagle Cement at Rumuolumeni Creek from January-March into labelled containers and washed with the river water to remove mud then taken to Ignatius Ajuru University of Education biology laboratory for heavy metal analysis.

Sample preparation

A 500ml beaker weighing 17.0 was used to measure the shell periwinkle with an electronic weighing balance. Periwinkles that weighted 522.9 were turned into a bucket, water was added to cover the periwinkles and a ring boiler used to cook the periwinkles for 20mintes then the water was poured out and periwinkles were allowed to cool, with the aid of needle the periwinkles was unshelled. The tissue of the periwinkle was put into a 100ml.

Heavy Metal Analysis of Periwinkle

In the laboratory 2.0g of finely grounded samples were thoroughly mixed by shaking and 100ml of it were transferred into a glass beaker of 25ml volume, to which 5ml of concentrated nitric acid was added and heated to boil until the volume was reduced to about concentrated nitric acid increments of 5ml till all the residue was completely dissolved. It was transferred into a beaker labelled station 1 to station 4. To each of the beaker, 6ml of trioxonitrate (v) acid (HNO_3) was added and 2ml of perchloric acid then stirred. 30ml of distilled water was also added to each beaker, and was placed on the hot plate and heated for digestion to take place on the hot plate. After heating, the sample was allowed to cool and filter paper was used to filter each of the samples labelled station 1 to station 4. Then their filtrate was collected and the volume was made up of 50ml using deionized water. Then the sample was ready for Atomic Absorption Spectrophotometric analysis of heavy metals concentration in the periwinkle that came from the study area.

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Data Analysis

Origin-pro version 9.9.0225 package was used to analyze the results. Descriptive statistics analysis of variance (ANOVA) were used. Statistical Significance was assessed at 0.05 at probability levels using turkey tests.

Results

The result of this investigation were presented in table 1 and 2 respectively while Word Health Organization (WHO) permissible limit of heavy metals concentration in fish and other aquatic organisms were presented in table 3.

Table 1 Variation of Heavy Metals Concentration in the periwinkle (*Tympanotonos fuscatus*) from Mordant Marine to Eagle cement in the creek of Rumuolumeni.

Station	Heavy metals concentrations in the periwinkle samples			
	Zinc (Zn)	Lead (pb)	Copper (Cu)	Nickel (Ni)
Mordant marine	^{BC} 48.81±6.76	^{A}1.48±0.15	^{B} 86.78±8.97	^{D} 0.027±0.00
Erico 2	^{C} 41.72±5.78	^{B} 1.06±0.11	^{A} 105.87±10.95	^{B} 0.057±0.04
Old police post	^{A} 59.97±8.30	^{A}1.64±0.46	^{C} 64.23±6.65	^{C} 0.044±0.02
Eagle cement	^{AB} 51.39±7.11	^{B} 0.75±0.08	^{A} 115.50±11.95	^{A}0.083±0.04
P≤	**0.001**	**0.001**	**0.001**	**0,001**

Superscripts with the same alphabet are not significant difference (Turkey tests, ≤ 0.05)

Table 2. Monthly Variation of Heavy Metals Concentration in the periwinkle samples (*Tympanotonos fuscatus*) from Rumuolumeni Creek, January to March 2023.

Month	Heavy metals Concentration in the periwinkle samples			
	Zinc (Zn)	**Lead (pb)**	**Copper (Cu)**	**Nickel (Ni)**
January	^{B} 46.60±6.30	^{A} 1.09±0.37	^{B}97.38±21.42	^{B} 0.05±0.02
February	^{B}45.07±6.09	^{A} 1.23±0.42	^{AB} 80.48±17.71	^{B} 0.05±0.02
March	^{A} 59.75±8.07	^{A} 1.38±0.47	^{A} 101.43±22.32	^{A}0.06±0.02
P=	0.001	0.260	0.042	0.874

Superscripts with the same alphabet are not significant difference (Turkey tests, ≤ 0.05)

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Table 3 Comparison of the Grand Mean Variation of Heavy Metals Concentration in the periwinkle samples (*Tympanotonos fuscatus*) from Creek of Rumuolumeni, With WHO Permissible Limit.

Heavy Metal Concentration In the periwinkle	Grand mean value in the periwinkle samples (*Tympanotonos fuscatus*)	Permissible limit by WHO (2003)
Zinc (Zn)	50.47	40
Lead (pb)	1.23	0.5
Copper (Cu)	93.09	30.0
Nickel (Ni)	0.05	5

Discussion

In Niger Delta, sea food is one of their major sources of protein because it is easy to access in this region from time to time without seasonal limitations, these sea food includes shell and unshelled fishes such as Tilapia fish, catfish, crab, oysters, periwinkles etc.

One of the edible shell fishes that is easily accessible and cherished by people in Rivers State of Nigeria are periwinkles (*Tympanotonus fuscatus*), it is sources of protein, calcium and also used for important delicacies, such as traditional and occasional food. Periwinkles (*Tympanotonus fuscatus*) are always available, affordable and can be sourced throughout the year. At this study area people always pick periwinkles everyday both for consumption and for sell to earn a living, so knowing how healthy these periwinkles are for human consumption become necessary. In this study area zinc and copper have the highest concentrations of heavy metals in all the stations (Mordant marine, Erico, old police post and Eagle cement points of the creek). So the high concentration of zinc in the study area may be the present of commercial and industrial activities such as abattoirs within the creek. So the high concentrations of zinc in the creek may be as a result of commercial and industrial (slaughters) activities around the creek. Zinc batteries, plating of steel, 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 a result of steel fabrication, exploration activities, mining, farming and drain sludge within the creek (Alloway, 2013). Pb and Ni concentration were low, this is in consonance with the report of Wokoma (2014) on bioaccumulation at Sombreiro River. The result of this study shows an indication of pollution especially, when these metals had been classified as very toxic to aquatic life and relatively accessible. Table 3 shows World Health Organization permissible limits on heavy metals in shell fishes and other aquatic biota. The result from the tables shows the signs of contaminant in Nickel because Nickel concentrations were below WHO (2003) permissible limits, While zinc, copper and lead in periwinkles (*Tympanotonus fuscatus*),was above permissible limits of WHO (2003). This indicates that, consumption of periwinkles from the creek is not safe, and may serve as risk to human health of those who depend on it as their major source of food.

Conclusion

Heavy metals investigated were Zn, Pb, Cu and Ni, in unshelled periwinkles (*Tympanotonus fuscatus*), has provided dependable information and data on pollution status of the study area. The heavy metals concentration detected in respect to unshelled periwinkles (*Tympanotonus fuscatus*) samples from the study area was variables. The value shows that Zn, Pb and Cu were higher when compared to the value of Ni. Zn, Pb and Cu were above the permissible limits of world health organization while Ni was below WHO permissible limits, but shows sign of contamination, which can lead to pollution if immediate and appropriate measures are not taken to stop further contamination.

Base on the result available from this study, periwinkles from Rumuolumeni Creek is not healthy enough for human consumption since Zn, Pb and Cu are above WHO permissible limits.

This research should serve as a guide to future researchers, and environmental managers to protect aquatic lives and their environment by discouraging domestic, agricultural and anthropogenic input into the creek to avoid further contamination. As this can lead to environmental distortion or extinction of aquatic biota and risk the health of people consuming these fishery products from the creek.

Recommendations

The result of this investigations shows that periwinkles are all accumulated of the heavy metals (Zinc, Lead, Copper and Nickel). It is recommended that:

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Rivers State ministry of environmental and natural resources should ensure that policies on the state environment/ecological system are well carried out and bring to Justice Defaulters.

River State food agency should alert the public that consumption of periwinkle gotten from these stations is hazardous to health.

Dweller around the creek should be monitored and ensure that defaulters paid to the government in order to stop improper dispose of domestic waste into the river.

The government should ensure that illegal oil activities going on at these creeks should be stopped by all means using the agencies necessary to enforce it.

Companies sited around the creek should treat their waste properly before discharging into the water body.

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