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Concentrations of Nickel in Sediment and Periwinkle of Eagle Island River, Port Harcourt

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Authors' contributions

This work was carried out in collaboration between all authors. Author AFC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ER and OH managed the analyses of the study. Author NL managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study was carried out in Eagle Island River, located in Mgbuosimini community, Port Harcourt, Nigeria. In this study, the concentration of Nickel (Ni) in sediments and periwinkles (*Tympanotonos fuscatus*) were determined from 25 sampling stations in Eagle Island River. The portion of the periwinkle that was assayed was the edible part. The assay was carried out using Atomic Absorption Spectrophotometer (AAS). The mean±SD of Ni concentrations in sediments and periwinkles were 2.77±1.05 mg/kg and 6.25±1.98 mg/kg respectively. The mean concentration of Ni was higher in periwinkles than in sediments. The correlation coefficient between Ni concentrations in sediment and periwinkle was 32.7%. Following the increasing industrial activities and waste disposal in the water body, the need to regularly determine the concentrations of this heavy metal in the water, aquatic lives and sediments is imperative in order to uphold environmental and human health protection.

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1. INTRODUCTION

The increasing contamination of our environment with heavy metals is a growing concern in our society and calls for the attention of everyone towards environmental protection. About 35 metals are known to cause both occupational and residential hazard - 23 of these metals are heavy metals and include; antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc. The growing concern of heavy metal pollution in our water body and aquatic lives is not just explained on the fact that they are indestructible but many of them have toxic effect in human life [1,2]. Since heavy metals are indestructible, they bio-accumulate and become potentially toxic to man [3,4]. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Small amount of Nickel are needed by human to produce red blood cells, however, in excessive amounts, they can become mildly toxic [5]. Short term exposure to nickel is not known to cause any health problems but long term exposure can decrease body weight, heart, liver injury and skin irritation although nickel concentration does not significantly magnify along food chains. Sediments are important sinks for various pollutants like heavy metals and they play a significant role in the remobilization of contaminants in the aquatic environment. Heavy metal contaminants form complexes with other compounds and settle to the bottom where they become ingested by plants and animals. Periwinkles are bottom dwellers, that is, they live in the sediment. They carry out their biological activities in the sediment, so they could easily absorb or ingest heavy metals in the sediments. Aquatic organisms can be considered as one of the most significant indicators in water for the estimation of metal pollution level. Heavy metal contamination in rivers is one of the major environmental issues in fast growing cities because maintenance of water quality and sanitation infra-structure do not necessarily increase along with population and urbanization growth especially in developing countries.

In this study, we focused on Nickel levels in water sediments and periwinkles.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Eagle Island River located at Mgbuosimini community, Rumueme, Mile 4, Port Harcourt, Rivers State, Nigeria. The study area from which sediments and periwinkles were collected was the Mgbuosimini axis of the river, extending from the community market water bank to Rivers State University in Diobu,

Map 1. Map showing study area (Eagle Island River)

Port Harcourt. The Eagle Island is located on the South-West of Port Harcourt and bounded on the North by the Rivers State University in Nkpolu-Oroworukwo area of Diobu. The river is a brackish water influenced by tidal fluxes. It has mangrove vegetation. The surrounding terrestrial environment is marked with various human activities such as saw milling of timber, waste disposal and frequent defecation.

The portion of the river in a rectangular box with a pointed arrow represents the portion of the river studied.

2.2 Sample Collection Method`

25 plastic containers were labelled 1 to 25. Each of the labelled containers represented a sampling station. Sediments from 25 sampling stations in Eagle Island River were collected using a clean dry plastic container and put into their rightly labelled containers. The depth of sediment scooped was at 10 cm. The sediment collected at this depth appeared as suspended load consisting of particles suspended on the bottom. They consists of generally finer, smaller particles. Periwinkles from each station were picked alongside and kept in the rightly labelled container. That is, each labelled container representing a sampling station contained both sediment and periwinkles from the sampling station. The sample containers were covered to prevent periwinkles from escaping to other containers.

2.3 Sample Preparation

2.3.1 Preparation of sediment

The sediments of all the stations were air-dried. After then the samples were powdered using a glass mortar until fine particles were obtained. The powder was sieved using a 160 ug diameter sieve. 1 gram of the sieved powder was weighed using an electronic weighing balance. The weighed powder was transferred into a beaker and 3 ml of trioxonitrate(v) acid (HNO_3) was added followed by 1 ml of hydrochloric acid (HCl) with 25 ml of distilled water. The mixture was heated for 1 hour using a hot plate. After heating, the mixture was allowed to cool. The cooled mixture was filtered using a funnel and filter paper. The filtrate was made up to 50 ml with deionized water. Then the sample was assayed for Ni concentration using Nickel hollow cathode lamp in an Atomic Absorption Spectrophotometer [6,7].

2.3.2 Preparation of periwinkle

The periwinkles of each sampling station were cracked to obtain their tissue (edible part). The tissue samples separated were rinsed with distilled water and allowed to air dry. After then, the tissue samples for each station were blended to powder form for 10 minutes using a laboratory blender and transferred into different containers and labelled accordingly. For each sample, 2 grams of the powdered periwinkle was weighed using an electronic weighing machine and the weighed powder was transferred into a beaker and labelled accordingly. Into each of the beaker was added 6ml of trioxonitrate(v) acid (HNO_3) and 2 ml of perchloric acid was added and stirred, then 30 ml of distilled water was also added. Each beaker was placed on a hot plate and heated for digestion. Then the samples were allowed to cool. With a funnel and filter paper, the cooled mixture was filtered and the filtrated collected. The volume of the filtrate collected was made up to 50 ml with deionized water. Then the sample was assayed for Ni concentration using Nickel hollow cathode lamp in an Atomic Absorption Spectrophotometer [8].

2.4 Statistical Analysis

The correlation coefficient between Ni in sediment and Ni in periwinkle was determined using Pearson's correlation analysis to determine the level of relationship between Ni in sediment and Ni in periwinkle. T test was used to determine if there was a significant difference between the two groups. Data collected were recorded in Microsoft Excel spreadsheet and were analysed using SPSS 21.0 for graphical analysis.

3. RESULTS

Table 1 shows the mean±SD of nickel in sediments and periwinkles sampled from 25 sampling stations. Also, it shows the t-test result presented as p-value < 0.05. The correlation coefficient was equally presented on the table as 32.7%.

Fig. 1 shows the concentrations of nickel in sediments and periwinkles sampled from 25 sampling stations.

Table 1. Nickel concentration in sediment and periwinkles

Samples	mean±SD (mg/kg)	P-val	Correlation coefficient
Sediment	2.77±1.05	<0.05	32.7%
Periwinkle	6.25±1.98		

N=25

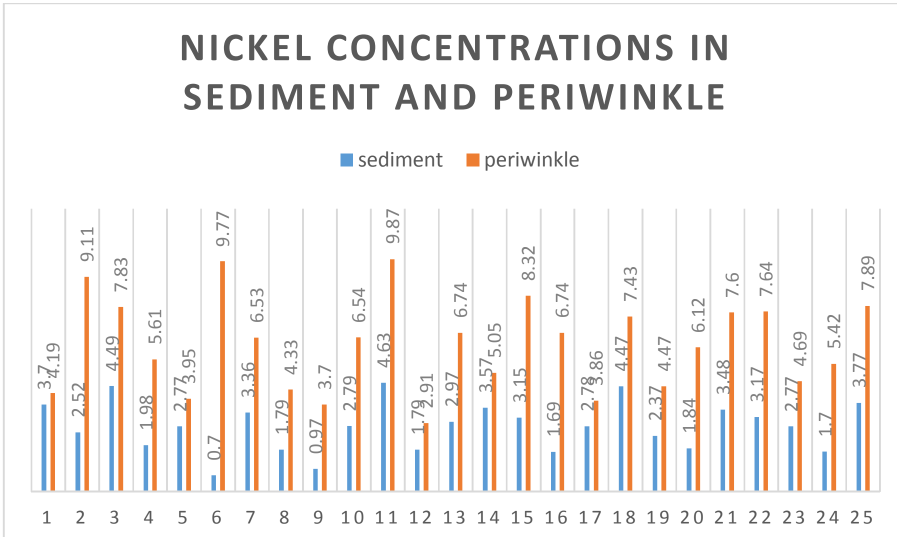

Fig. 1. Nickel concentrations in sediment and periwinkle

4. DISCUSSION

The result presented in Table 1 showed that nickel was higher in periwinkles than in sediments. This was due to the fact that periwinkles constantly feed from the heavy metal contaminated-sediment over a long period of time and therefore leaving a greater concentration of the metal to accumulate in the body. This finding is in agreement with other work [9]. The concentration of nickel in sediment was 2.77±1.05 mg/kg and in periwinkle was 6.25±1.98 mg/kg due to the chronic exposure of periwinkle to the sediment and this work is in consonance with the work carried out in other studies [10]. The results obtained when compared with tolerable values of heavy metals in aquatic organism showed that nickel concentration obtained in this study was well above the tolerable value. The results obtained from this study showed that nickel was 6.25±1.98 mg/kg in periwinkle and 2.77±1.05 mg/kg in sediment while the tolerable value for nickel is 0.60 mg/kg in aquatic organism [10]. So nickel level in Eagle Island River was far above the tolerable value and this can pose a great threat to the environment and human lives that interact regularly with the environment. Owing to the fact that nickel was significantly higher in periwinkle may imply that other aquatic lives may be affected also. The graph presented in Fig. 1 showed that nickel level was higher in periwinkles than in sediments. Reason could be that nickel got stored up in the periwinkle tissue over time, although nickel is not known to bioaccumulate in a large extent along the food chain but chronic exposure can lead to increase in body tissue. Since periwinkles feed and live in the sediment, the body tissue would accumulate nickel over time even though not in a large extent. Hence, there should be a variation in nickel concentration in sediments and periwinkles. Chronic exposure of nickel can cause nickel toxicity in man, which will in turn precipitate the following; genotoxicty, developmental toxicity, carcinogenicity, haemototoxicity, immunotoxicity, neurotoxicity, reproductive toxicity, liver injury, lungs disorder, kidney impairment and oxidative stress. A similar work was conducted in the Eagle Island River and the heavy metal level obtained in that study showed a higher concentration well above the tolerable value in aquatic life [11]. This study is in agreement with the work. There was a significant difference between the nickel level in periwinkle and that in sediment at P-value <0.05. But there was a weak positive correlation between the sediment and periwinkle nickel levels. The correlation coefficient was 32.7%. This level of correlation is in agreement with many studies that confirmed that nickel does not bio-accumulate in a large extent in animals. Finally, quite a good number of factors may have contributed to the contamination of the Eagle Island River; geological weathering, industrial processing, metallic waste disposal and other solid waste.

5. CONCLUSION

This work has showed the need for urgent attention in development of policies that will encourage environmental protection. Nickel concentration was well above the tolerable limit and if not appropriately managed will impact negatively in the health of humans who depend on aquatic lives for food within the environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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