Assessment of Heavy Metals in Prawn (*Macrobrachium macrobrachium*) along selected stations of New Calabar River, Rivers State, Nigeria

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ABSTRACT

This study was conducted to assess the level of heavy metals in Prawn (*Macrobrachium macrobrachium*) in selected stations of New Calabar River. Samples were collected from these stations (Eagle Island, Iwofe, Ogbogoro and Choba) and analyzed for Lead, Chromium, Nickel and Zinc content using Atomic Absorption Spectrophotometry. The results were also compared with the permissible limits given by World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA).

The result for Chromium in Prawn tissue ranges from 0 mg/l to 1.00 mg/l and highest value of 1.10 mg/l was observed in station 1. The result for Lead ranges from 0 mg/l to 0.08 mg/l and highest value of 2.21 mg/l was observed in station 2. The result for Nickel ranges from 0.01 mg/l to 0.02 mg/l and highest value of 0.24 mg/l was observed in station 1. The result for Zinc ranges from 0 mg/l to 0.06 mg/l and highest value of 2.12 mg/l was observed in station 1. The values of these heavy metals (zinc, lead, nickel, and chromium) showed that the New Calabar River is contaminated with heavy metals.

The key recommendation is that strict compliance to regulatory standards on limits of effluents by anthropogenic activities and industries located along the stretch of the river should be enforced by the relevant regulatory bodies such as National Environmental Standard Regulatory Agency of Nigeria (NESREA) and Federal Environmental Protection Agency (FEPA).

(Keywords: heavy metals, prawn, environmental pollution)

INTRODUCTION

It has been observed in recent times that the role the environment plays in a nation's development process cannot be relegated to the background. Apart from being the physical surrounding for natural habitats, the environment provides the basis for human exploits for agricultural, industrial, commercial, technological and tourism development of a society. For this and several other reasons, environmental issues now occupy the center stage in academic discourse and other public gatherings both at the national and international levels (Deekae, 2009).

The river is subjected to effluent discharge from industries sited along its banks. Among environmental pollutants; metals are of particular concern because of their potential toxic effect and ability to bio-accumulate in aquatic ecosystem (Censi, et al, 2006).

The term pollution generally refers to alteration of the natural physico-chemical characteristics of an entity, medium or matter as a result of the presence of substances or compounds that are not supposed to be present in it or that are present in quantities and qualities that would limit the natural balance of the particular entity, medium or matter (Akankali. 2012).

Environmental concerns have gradually come to be viewed not in isolation, but in relation to social and economic development. Besides, it is now fully recognized that no country can afford to ignore the good management and protection of her environment and resources, which form the basis for development (UN-Water, 2018).

Pollution of the aquatic environment with heavy metals has become a worldwide problem. Metals are high priority pollutants because of their

relatively high toxicity, persistence, and ability to be bio--accumulated in aquatic biota. These metals are released from domestic, industrial, and other man-made activities and have become matters of concern over the last few decades (NEDECO, 2009).

Water is essential for our wellbeing and a healthy life. Unfortunately, polluted water and air are common throughout the world (EPA, 2015). Polluted water consists of industrial discharged effluents, sewage water, rainwater runoff, and pollutants by agriculture or households. These cause damage to human health or the environment, additionally, this water pollution affects the health and quality of soils and vegetation (Goel, 2006).

The effects of water pollution are said to be the leading cause of death for humans across the globe, moreover, water pollution affects our oceans, lakes, rivers, and drinking water, making it a widespread and global concern (Moss, 2008). Improper management of solid waste is one of the main causes of environmental pollution, also land pollution is one of the major forms of environmental catastrophes our world is facing today (Newton, 2008).

In the view of World Health Organization (2000), the environment is considered polluted when it is altered in composition or condition directly or indirectly as a result of activities of man so that it becomes less suitable for animals. Heavy metal industries have produced wastes that are deposited into landfills without special precautions (Ogwueleka, 2003). Fish and other marine animals living in polluted waters tend to accumulate heavy metals in the tissues.

Generally, accumulation of heavy metals by marine animals depends on several factors. These factors include metal concentration, duration of exposure, means of metal uptake, environmental conditions like temperature, pH, hardness and salinity, and intrinsic factors like fish age, feeding, and habitats (Caeiro, et al., 2005).

The New Calabar River is among the important water resources in the Niger delta region of southern Nigeria. The water serves as a source of livelihood for the artisanal fishermen in areas around Choba axis, as one of their important fishing grounds. There are several industries and maritime activities located within Choba axis of New Calabar River. Examples include waste discharges from industry, natural deposits. Any water contaminated with heavy metals is considered unsuitable as human potable water or for animal husbandry, irrigation, aquaculture purposes irrigation and even recreation. Humans are therefore in turn exposed to heavy metals by consuming contaminated plants, resulting in various biochemical disorders through the process known as bioaccumulation and biomagnification.

Prawn, particularly of the Macrobrachium Family are the most abundant, cheap and accessible source of protein in the study area, as such its contamination can easily affect humans which is the ultimate consumers. The study is therefore designed to determine the levels of bio-accumulation of heavy metals (Lead, Zinc, Nickel, and Chromium) in *Macrobrachium macrobrachium* muscular tissue and compare the values with the permissible limits for WHO/FEPA.

MATERIALS AND METHODS

Study Area

The New Calabar River is located within Port Harcourt, Rivers State, Nigeria. The river lies between coordinates; Latitude: 4°49'4''N; Longitude: 6°57'24''E. The New Calabar River is located on the eastern flank of the Niger Delta River System, in Rivers State. (NDES, 2003).The river received effluents such as agricultural run-off from farmlands and oil spill from Nigeria Agip Oil Company oil wells and flow stations located within the bank of the river. New Calabar River is very important to the local dwellers because of its economic value, as it used for recreational activities and fishing which is the major occupation of the native.

Sampling Stations

Four sampling stations along the New Calabar River were established for this work. They are station 1- Eagle Island, station 2- Iwofe, station 3- Ogbogoro, and station 4- Choba.

Sample Collection, Storage, and Preservation

Forty (40) specimens of *Macrobrachium macrobrachium* were obtained from different stations of New Calabar River by fishermen using barrier trap (with non-return valve) between September, 2019 and December, 2019, which includes two months of rainy season (September and October) and two months of dry season (November and December). The specimens were

washed in flowing water to remove adhering dirt and specimens were stored immediately in a cooler, in order to ensure that the physical properties of the samples are maintained while they were transported to the laboratory for analysis.

Sample Treatment for Analysis

The frozen *Macrobrachium macrobrachium* samples were allowed be to melt at room temperature (i.e., 27ºC). The samples were homogenized after drying in an oven at 105ºC. The head regions of the samples were separated from the abdomen and digested according to APHA (1985) and FAO/SIDA (1986).

The flesh for metal analyses was taken from the left dorso-ventral muscle of the samples, the dried samples were crushed in a small mortar using pestle to a homogenized powder. The dried powder was heated in a muffle furnace temperature of 6,300 C for 3 hours. The ash dissolved in 10 ml of concentrated hydrochloric acid and allowed to digest for 5 min by adding perchloric acid and concentrated nitric acid. Each digested sample was analyzed for metal concentration using an Atomic Absorption Spectrophotometer (Unican 969). All Levels of metals (Cr, Pd, Zn, and Ni) were expressed in mg/g dry weight.

Statistical analysis

Full detail of result analysis was done with descriptive statistics (mean, range and standard deviation) to present data for heavy metals in *Macrobrachium macrobrachium*.

RESULTS AND DISCUSSION

Chromium (Cr)

Chromium level in Prawn tissues varied within 0 mg/l to 1.00 mg/l. the highest value of 1.10 mg/l was observed in station 1 in the month of September while the lowest value 0 mg/l was in station 2 in all months. Mean values per station were between 0±0 mg/l in station 2 to 0.15±0.46 mg/l in station 1 (Table 1).

Statistical analysis showed slight significant difference among stations. This was showed with DMR as being in station 2.

Lead (Pb)

The Prawn tissue showed slight variations in accumulated Pb values. Values varied within the narrow range of 0 mg/l to 0.08 mg/l. Highest value of 2.21 mg/l was in station 2 during October while the lowest was 0.003 mg/l was in station 4 in all months of the study. Mean values per station ranged from 2.15±0.03 mg/l in station 2 0.003±0 mg/l in station 4 (Table 2).

Statistical analysis showed high significant difference among the stations. DMR revealed that the difference exists in station 4.

Zinc (Zn)

The analyzed prawn tissue showed that zinc concentration varied within 0 mg/l to 0.06 mg/l. Highest observed value 2.12 mg/l was in station 1 in the month of November while the lowest value 0.01 mg/l in station 3 in December. Mean values per station ranged from 0 mg/l in station 4 to 2.11 mg/l in station 1.

Analysis showed highly significant difference within stations sampled (Table 3). DMR further showed the difference is being in station 4.

Nickel (Ni)

Nickel in prawn tissue showed data variation within 0.01 mg/l and 0.02 mg/l. the highest value of 0.24 mg/l was in station 1 in December while the minimum of 0.01 was in all months of station 2 and 4. The mean values per station varied between 0 mg/l and 0.23 mg/l.

Statistical analysis showed high significant difference between stations (Table 4). DMR further showed that the difference was due to stations 2.

Discussion

Organisms accumulate metals as they feed and interact with their environment. Most of these metals get into the environment either through natural process or anthropogenic means. Thus, food chain bears varying quantities of these metals at different trophic levels. The Niger Delta as an oil producing region is prone to incessant oil spillage that result in contaminating the environment with varying components of hydrocarbon-based chemicals and heavy metals.

Table 1: Chromium Variation among Stations during the Period of Study using Prawn's Tissue.

PERIODS	STATIONS			
	1	2	3	4
September	1.10	0.00	0.01	0.03
October	1.05	0.00	0.01	1.03
November	0.15	0.00	0.01	1.03
December	1.04	0.00	0.01	1.03
Total	3.34	0.01	0.04	3.11
Maximum	1.10	0.00	0.01	1.03
Minimum	0.15	0.00	0.01	0.03
Average	0.15	0.00	0.01	0.03
SD	0.46	0	0	0.50

Table 2: Lead Variation among Stations during the Period of Study using Prawn's Tissue.

PERIODS	STATIONS			
	1	2	3	4
September	0.09	2.14	0.06	0.003
October	0.09	2.21	0.05	0.003
November	0.09	2.14	0.05	0.003
December	0.08	2.13	0.05	0.003
Total	0.34	8.62	0.21	0.012
Maximum	0.09	2.21	0.06	0.003
Minimum	0.08	2.13	0.05	0.003
Average	0.09	2.15	0.05	0.003
SD	0.00	0.03	0.00	0

Table 3: Zinc Variation among Stations during the Period of Study using Prawn's Tissue.

PERIODS	STATIONS			
	1	2	3	4
September	2.11	2.06	0.61	0.003
October	2.11	2.07	0.61	0.003
November	2.12	2.06	0.61	0.003
December	2.11	2.06	0.01	0.003
Total	8.45	8.25	1.84	0.012
Maximum	2.12	2.07	0.61	0.003
Minimum	2.11	2.06	0.01	0.003
Average	2.11	2.06	0.46	0.00
SD	0.01	0.00	0.30	0.00

Table 4: Nickel Variation among Stations during the Period of Study using Prawn's Tissue.

PERIODS	STATIONS			
	1	2	3	4
September	0.22	0.01	0.08	0.001
October	0.24	0.01	0.09	0.001
November	0.23	0.01	0.08	0.001
December	0.24	0.01	0.08	0.001
Total	0.93	0.04	0.33	0.004
Maximum	0.24	0.01	0.09	0.001
Minimum	0.22	0.01	0.08	0.001
Average	0.23	0.01	0.08	0.00
SD	0.01	0.00	0.00	0.00

Table 5: Results Compared with WHO/FEPA Permissible Limits for Heavy Metals.

Heavy Metals	Biota		WHO(2011)	FEPA
	max	min	Approved limit	Approved limit
Zn (mg/1)	2.12	0.003	1.0	0.01
Pb (mg/1)	2.21	0.003	0.01	0.01
Ni (mg/1)	0.24	0.001	0.02	---
Cr (mg/1)	1.10	0.00	0.05	----

The fate of such spilled oil is usually the aquatic environment. Thus, often having aquatic resources contaminated with the substance.

The new Calabar River with its rich biota including the prawn (*Macrobrachium sp.) i*s not an exception. In this study, Cr in the prawn muscular tissue varied with value range of 0 mg/l to 1.10 mg/l which mean values per station were also 0 mg/l to 0.15±0.41 mg/l, depicting low accumulation levels. Analysis showed significant difference among station means. The DMR showed the difference existed in station 2.

Pb values ranged within 0.003 mg/l to 2.21 mg/l while mean values were 0.003±0 mg/l to 2.15±0.03 mg/l. there is high significant difference among the stations with DMR indicating that the means existed in station 4.

Zn also shows value variation of 0 to 2.12±0 mg/l. The mean values per station varied from 0.01±0 mg/l to 2.11±0 mg/l throughout the period studied. ANOVA showed high significant difference among stations with LSD revealing that the difference lies in station 4.

Ni varied within 0.01 mg/l and 0.24 mg/l. Similarly, the mean values per station were within 0 and 0.23±0 mg/l. DMR showed the difference lie in station 2.

CONCLUSION

Heavy metals are diverse and conservative pollutants that bioaccumulate and bio-magnify along the food chain with deleterious effects on the aquatic ecosystems. The levels of lead, zinc, nickel, and chromium observed in the prawn tissues were above the acceptable limits as recommended by the World Health Organization (WHO). The consistent high values of Pb, Ni, Zn, and Cr in the prawn tissue could be attributed to the high usage of agrochemical by farmers around the study stations and high industrial activities around the area which are the major sources of heavy metal contaminants in aquatic environment (Banjo, et al., 2010). Generally, the indicated presence of Pb, Ni, Zn, and Cr in the studied environment is largely attributable to the presence of high anthropogenic activities, most of the stations serves as a source of discharge of heavy metal containing pollutants from industrial, domestic, and agricultural and other human activities.

RECOMMENDATION

The following recommendations are made based on the findings of this study, as a means for reducing the impact of heavy metals in the New Calabar River:

1. Efforts should be made to ensure that zinc, lead, nickel, and chromium and other heavy metals do not exceed the prescribe World Health Organization (WHO) and Federal Ministry of Environment (FMENV) acceptable limits.

2. To achieve a reduction of the level of these metals in prawn; environmental policies and their implementation should be enhanced and targeted campaigns carried out to educate the public on the importance to protect and preserve aquatic systems and their resident biota by not discharging toxic containing wastes/effluents into the river.

3. Strict compliance to regulatory standards on limits of effluents by industries located along the stretch of the river should be enforced by the relevant regulatory bodies such as National

Environmental Standards regulatory Agency of Nigeria (NESREA), such as Federal Ministry of Environment (FMENV) and Nigerian Oil Spill Response and Detection Agency (NOSDRA).

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