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ABSTRACT

Freshwater and sediment pollution have not only shown serious ecological threats but also bring about environmental toxicity in many water bodies in developing countries. With the concentration and toxicity levels of heavy metals exceed the tolerance of aquatic organisms, they will produce serious toxic effects on their related indicators and even their life activities. The aim of this study was to assess the level of pollution in Musawa area of Southern Kainji lake. The water and sediment samples were collected from three (3) different locations while the fish (*Citharinus citharus*) were bought from local fishermen at the same locations, the muscles of the *Citharinus citharus* were then transported to the laboratory and stored in an ice box for further analysis. The sediment samples were first digested using Aqua Regia method, the muscle of the fish were digested according Sreedevi Method, while the water samples were digested using Nitric Acid digestion. The digested samples were then analyzed using Atomic Absorption Spectrophotometer (AAS). The results showed that concentration of Cadmium (0.70 ± 0.05) and Copper (4.78 ± 0.34) were significantly higher ($P < 0.05$) in sediment than in muscles of *Citharinus citharus* (0.14 ± 0.04), (1.45 ± 0.13) and Lead (0.01 ± 0.01), (0.02 ± 0.01) respectively. Lead was not detected in water and sediment ($P > 0.05$) in water (0.01 ± 0.01) and sediment (0.01 ± 0.01) concentration of Mercury was not detected in *Citharinus citharus*. The geoaccumulation index (Igeo) showed that sediment was polluted only with Cadmium while it was not polluted with Copper, and Lead. The Heavy metal pollution index (HPI) revealed that the water sample was polluted with any of the heavy metal studied. Finally, the sample samples were not polluted with any of the Heavy Metal studied but the sediment was polluted with Cadmium.

Keywords: Water, Sediment, Fish, Heavy Metal, Pollution

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INTRODUCTION

Heavy metals though they occur naturally, are increasing in the environment as a result of anthropogenic activities such as burning of fossils fuels, agricultural practices, mining and various other industries (Dickinson, 2019). According to

Sani *et al.* (2019), the major source of heavy metals pollution in Nigeria is industrial effluents discharged from various manufacturing industries. Heavy metals are well-known toxins that can cause organ damage and are also teratogenic and carcinogenic.

Presently, about 2.4 billion people lack adequate sanitation and 3.4 million die each year in the Whole World from water related diseases World Health Organisation (2015). Environmental risk factors account for a quarter of the total burden of disease and 2.97 million human deaths every year in Africa (WHO, 2016). In most developing countries like Nigeria, most industries dispose their effluents without treatment. These industrial effluents have hazard effects on water quality, habitat quality, and complex effects on flowing waters (Ethan, *et al.*, 2003). Study on Musawa area of Southern Kainji lake by Atiribom *et al* (2020) showed that the heavy metals were determined in the water sample only without the sediment and fish. However, Vardi and Chenji (2020) and Islam *et al.*, (2015) reported that fish and sediments were the best bio-indicators recognized for the assessment of heavy metals in the natural aquatic ecosystem. The aim of this work is to assess the level of heavy metal pollution in water, fish (*Citharinus citharus*) in Musawa area of South Kainji lake, New Bussa, Niger State, Nigeria.

MATERIALS AND METHODS

Study Area

Southern Kainji lake lies between 9°30'N and 10°35'N latitudes and 4°25'E and 4°45'E longitudes. About 10,000 people are living in this community and their major occupation are farming and fishing. The lake is their major source of water for domestic used and the fish harvested from the river serve as their main source of protein.



Fig 1: Map of Southern Kainji Lake

Sample Collection

Water and Sediment samples were collected at three (3) different point from the sampling stations (Musawa). Water samples were collected using 500 ml amber bottles for heavy metals analysis. The samples were fixed *in-situ* with Concentrated Nitric Acid and were analysed according to method prescribed by APHA, (1992).

The sediments were collected using Ekman grab. The samples were stored in plain sterile polyethylene packs employing a plastic pipe to scoop sediment, with the sacks sealed. Fish sample (*Citharinus citharus*) was bought from local fishermen around the studied area for heavy metal analysis. All the samples (water, fish and sediment) were stored in an icebox at 4 °C and transported to laboratory for analysis.

Digestion of Sediment Sample

The digestion of sediment sample was done by Aqua-regia digestion method as described by Bamgbose *et al.*, (2000). The sample was air-dried by spreading it on a cleaned plain plywood surface at room temperature (25°C) before digestion.

Digestion of Fish Sample

The scales of the fish sample were removed and the flesh was dissected to separate it from other part of the fish with

the help of clean sterilized stainless knife. The flesh sample was put in separate cleaned, labelled beaker and oven-dried. The dried flesh was then grounded to fine powder and sieved with 0.2 mm mesh size. One gram of the powder sample was digested according to Sreedevi *et al.*, (1992).

Digestion of Water Samples

The water sample was digested by Nitric Acid digestion technique as described by APHA 1992 was used to concentrate the metal in water sample.

The reagent blank was prepared and standard solution were equally prepared for these metals and the concentration of the heavy in fish (flesh), water and sediment were determined using Atomic Absorption Spectrophotometer (AAS).

Data Analysis

The data obtained from this study were statistically analysed using Analysis of Variance (ANOVA).

Geoaccumulation Index (Igeo)

Table 1: Heavy metal concentrations in water, sediments and fish (*Citharinus citharus*) from Musawa South Kainji lake, New Bussa

Heavy Metal	Water	Sediment	Fish
Cadmium (Cd)	0.02±0.01 ^a	0.70±0.05 ^c	0.14±0.04 ^b
Copper (Cu)	0.02±0.01 ^a	4.78±0.34 ^c	1.45±0.13 ^b
Mercury (Hg)	0.01±0.01 ^a	0.02±0.01 ^a	BDL
Lead (Pb)	BDL	BDL	2.82±0.20

BDL- Below detectable limit

The table below showed that the sediment (Igeo) was polluted with only Cadmium (Cd) while the water (HPI) was not

The Igeo was first defined and used by Müller (1969). It will be used to calculate the level of pollution in sediment, it can be expressed as follows:

$$Igeo = \log_2 \left[\frac{Cn}{1.5 \times Bn} \right]$$

Where Cn is the heavy metal concentration in sediment
 Bn is the Taylor's referenced heavy metal background value

Heavy metal pollution index (HPI)

This is the used to determine the level or degree of heavy metal pollution. It will be calculated using the formula below:

where Wi is the Unit weight of the parameter

Qi is the ideal value of the parameter

RESULTS

Table 1 showed that Cadmium (Cd) and Copper (Cu) were significantly higher (P < 0.05) in Sediment than in fish and water. Mercury was not detected in fish but was detected in water and sediment with no significant difference between (P > 0.05) them. Lead (Pb) was not detected in water and sediment but was detected in fish.

polluted with any of the heavy metals studied because they are all less than 100.

Table 2: Heavy metal pollution in Sediment and Water from Musawa South Kainji lake, New Bussa

Heavy Metal	Igeo	HPI
Cadmium (Cd)	0.65	64.5
Copper (Cu)	-1.51	0.00072
Mercury (Hg)	-0.85	0.04
Lead (Pb)	-	-

DISCUSSION

The result revealed that Cadmium (Cd) and Copper (Cu) were significantly higher in the sediment than in fish and water. This could be due to bioaccumulation and biomagnification of the heavy metals in the sediment (El-Moselhy, *et al.*, 2014). These metals are partially soluble in water and at such tend to settle down in the sediment due to their poor solubility in water could also be the reason for low concentration of these metals in water but significantly higher in fish than water (Mariusz, k., & Joanna, J. 2023). The level of Mercury (Hg) in sediment and water was not too significant to be detected in the fish. The high level of Lead (Pb) in fish could be due to bioaccumulation of Lead in the muscle of fish.

The heavy metals studied in water all fell within the recommended range value of 0.05 µg/l as suggested by World Health Organisation (WHO). Only Copper (Cu) and Lead (Pb) fell above the permissible value as recommended by WHO of 0.6 and 2.0 mg/kg. Pb is well-known toxicant and has several harmful effects on human health even at low concentrations. Bioaccumulation of Pb may be due to long-term exposure and sometimes cause death or permanent damage to the central nervous system, the brain, kidneys, and liver (Olatunji-Ojo *et al.*, 2020). In children, Pb is considered a serious health threat as its poisoning effect can last a lifetime.

Cadmium and Copper fell were above the permissible range as recommended by WHO (0.1 and 0.05-0.15µg/g) in the sediment sample and this suggests that the sediment was polluted with Cd and Cu. Cu is essential to fish and human, but at high concentration, it will be dangerous to both. Bioaccumulation of Cu may lead to vomiting, haematemesis (vomiting of blood), low blood pressure, coma, jaundice, and gastrointestinal distress (Igharo *et al.*, 2014).

The geographical index (Igeo) showed that Cadmium (Cd) was moderately polluted while other heavy metals studied were not polluted. The heavy metal pollution index (HPI) showed that the water was not polluted with any of the heavy metal studied.

CONCLUSION

Water sample from Musawa area of South Kainji lake was not polluted with all the heavy metals studied and supported HPI method. Cd and Cu were found to be above the recommended range value in sediment, but Igeo showed that the sediment was polluted with only Cd. The concentration of Cu and Pb were found to be above the permissible range in *(Citharinus citharus)*.

REFERENCES

American Public Health Association (APHA 1992). Standard method for examination of water and waste water.

18th Edition. American Public Health Association, Washinton D.C. ISBN.

Atiribom, R.Y., Abioye, O., Peter, Safiya, Y., Daniyan, Ojutiku, O., Rashed, & Yem, I.Y (2020).

Limnological qualities and heavy metals status of water from Southern Basin of Kainji Lake,

Nigeria. *Journal of Fisheries and Aquatic Science* 15(2), 51-58.

Badeenezhad, A. (2023). Comprehensive health risk analysis of heavy metal pollution using water quality indices and Monte Carlo simulation in R software. *Scientific Report* 13, 158-167.

Bamgbose, O., Odukoye, O., and Arowolo, T.O.A (2000). Earthworm as bio indicator of metal

pollution in dump sites of Abeokuta city, Nigeria. *Revistrade Biological Tropical* 48, 221-226.

Chowdhary, P., Bharagava, R. N., Mishra, S. & Khan, N. (2020). Role of Industries in Water

Scarcity and Its Adverse Effects on Environment and Human Health. In *Environmental Concerns*

and Sustainable Development (eds. Shukla, V. & Kumar, N.) 235-256 (Springer Singapore, 2020).

https://doi.org/10.1007/978-981-13-5889-0_12.

Dickinson, A.W. (2019). Heavy metal pollution and co-selection for antibiotic resistance: A

microbial paleontology approach. *Environmental International Journal* 132, 105-117.

El-Moselhy, K. M., Othman, A. I., El-Azem, H. A., & El-Metwally, M. E. A. (2014).

Bioaccumulation of heavy metals in the tissues of fish in the Red Sea, *Egyptian Journal of Basic and Applied Sciences* 1(2), 97-105.

Ethan, J. N., Richard, W. M. & Michael, G. (2003). The effect of an industrial effluent on an urban stream benthic community: water quality vs. habitat quality. *Environment Pollution* 123 (1), 1-13.

Igharo, G. O., Anetor, J. I., Osibanjo, O. C. Osadolor, H. B., & Dike, K. C. (2014). Toxic metal levels in Nigerian electronic waste workers indicate occupational waste management practices. *Biochemistry* 26(4), 107-113.

Islam, M. S., Ahmad, M. k., & Habibullah Mamun, M. (2015). Determination of heavy metals in fish and vegetables in Bangladesh and health implication. Human and Ecological Risk Assessment: *An International Journal* 21(4), 986-1006.

Mariusz, K., & Joanna, J. (2023). Variability and Heavy metal pollution levels in water and bottom sediments of Liwiec and Muchawka Rivers (Poland). *Journal of water*, 15(15), 1-15.

Muller, G. (1969). Index of geoaccumulation in sediments of the Rhine River. *Geographical journal* 2, 108-118.

Sani, A., Darma, A.I., Rukkaya, A.A., & Namadina, M.M. (2019). A study of physicochemical