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HEAVY METAL CONTAMINATION IN FISH, WATER AND SEDIMENT IN RIVER YUNA, NEW BUSSA, NIGER STATE

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ABSTRACT

Freshwater and sediment pollutions have not only shown serious ecological threats but also brought about environmental toxicity in many water bodies in developing countries like Nigeria. Amongst the pollutants are heavy metals whose concentrations when above the tolerance level in aquatic organisms produce serious toxic effects. This study assessed the heavy metals contamination in sediment, water and fish in Yuna Community, Niger State, Nigeria. Water and sediment samples were collected from three different stations while the fish samples (*Citharinus citharus*) were bought directly from the local fishermen. The samples were stored in an icebox after which it was transferred to the laboratory for analysis. The samples were and digested using standard methods for each heavy metal, and the analyses were done using Atomic Absorption Spectrophotometer (AAS). The results showed that, the heavy metals; Lead, Copper, Cadmium, Zinc and Chromium levels determined were above the maximum permissible limit of 0.05µg/g as recommended by World Health Organization except for Chromium which was not detectable in the liver of fish and sediment while Lead was not detectable in sediment. These metals had values that ranged from 0.25±0.02-19.45±1.22µg/g in the flesh, gills (0.43±0.07 - 42.90±0.19µg/g), liver (0.86±0.02 - 69.80±0.54µg/g) and sediment (0.26±0.00 - 6.33±0.20µg/g) but Copper and Cadmium fell below the recommended value in water while Zinc, Lead and Chromium were not detectable in the water samples. The order of the concentrations of the heavy metals in fish in this study was found to be: liver > gills > flesh. These findings showed that, there were appreciable health risks associated with consuming *Citharinus citharus* sourced from this River.

Keywords: Heavy Metal, Bioaccumulation, River Yuna.

INTRODUCTION

Freshwater and sediment pollutions have not only been shown to be serious ecological threats in many water bodies in developing countries but have also resulted in toxicity in exposed organisms. When the concentrations of heavy metals exceed the tolerance of aquatic organisms, they will produce serious toxic effects on their related indicators and even the activities of the affected organisms. According to Sani *et al.* (2019), the major sources of heavy metals pollution in Nigeria are industrial effluents discharged from various manufacturing industries. Also, in pollutants from solid waste, industrial effluents, and agricultural run-offs which are deposited into rivers. Heavy metals (that are persistence, bioconcentrate, bioaccumulate, and biomagnify) get into the aquatic environment, accumulate in the sediments due to processes such as, adsorption and precipitation; and result in the concentrations of these elements in sediments several times higher than in the water column (Zhao *et al.*, 2018; Liu *et al.*, 2021). Benthic fish species at the bottom of the aquatic food chain may amass heavy metals from the sediment thereby passing it to human through fish consumption; leading to severe health implications due to continuous consumption of such fish species from contaminated water sources over some time. Study on Yuna River by Atiribom *et al.* (2020), showed that, the metals, Lead (Pb), Copper (Cu), Cadmium (Cd), Chromium (Cr) and Arsenic (As) were determined only in the water samples. According to Vardi and Chenji (2020), supported by Authman (2008), Islam *et al.* (2015),

fish and sediments are the best bio-indicators recognized in the assessment of heavy metals in natural aquatic ecosystems. This implied that, fish associated with such benefits in the natural aquatic ecosystem, is also best used in evaluating habitat transformations. The aim of this study was to assess the heavy metals contamination in the water, sediment, and fish in River Yuna in Niger State, Nigeria.

MATERIALS AND METHOD

Study Area

Yuna is located in the southern part of Kainji Lake on Latitude 9°12'11.57"E and longitude 4°59'14.58"N. About 10,000 people are living in this community and their major occupations are farming and fishing.

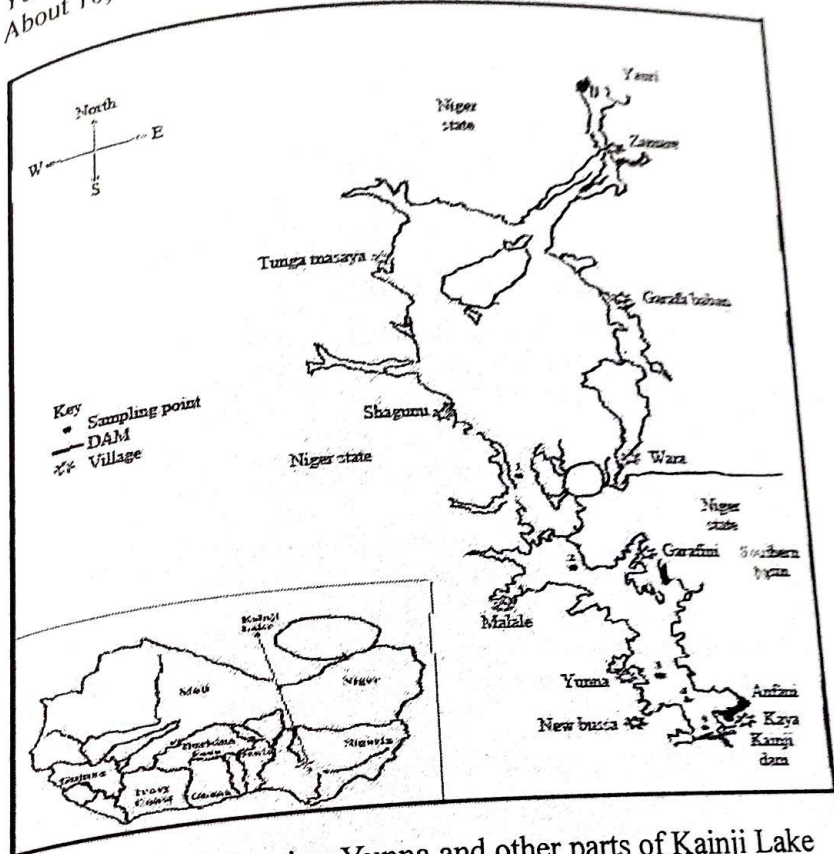


Figure 1: Map Showing Yunna and other parts of Kainji Lake

Water Sample Collection

Water samples were collected from three (3) different points along the water body with the aid of a sampler and stored inside sterile well labeled 500ml amber bottles. The samples were fixed *in-situ* concentrated Nitric acid and stored in an icebox at 4°C and transported to laboratory for analysis.

Sediment Sample Collection

Sediment samples were collected from three (3) different points using Ekman grab. The samples were in plain sterile well labeled polyethylene sacks. The sacks were sealed and transported in an ice chest to laboratory.

Fish Sample Collection

Fish samples (*Citharus citharus*) were bought directly from local fishermen and were quickly stored in an icebox and transported to laboratory for analysis.

Digestion of Water Sample

Nitric Acid digestion technique as described by APHA (1992) was used to concentrate the metals in the water samples.

Digestion of Sediment Sample

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

Digestion of Fish Sample

The scales of the fish sample were removed and the fish dissected to excise the target organs (flesh, gills and liver) using a clean sterilized stainless knife. All the excised organs from the samples were put in separate, clean, well labelled beakers and oven-dried. The dried organs were then grounded to fine powder and sieved with 0.2mm mesh size. One gram of the powder of each sample was digested according to Sreedevi *et al.* (1992). The reagent blank was prepared and standard solution were equally prepared for these metals and the concentration of the heavy metal in the fish (flesh, gill and liver), water and sediment were determined using Atomic Absorption Spectrophotometer (AAS).

Data Analysis

The data obtained were statistically analyzed using Analysis of Variance (ANOVA) and the means separated.

RESULTS AND DISCUSSION

The results (Table 1) shows that, heavy metals (Cu, Cd, Zn and Pb) had significantly higher concentrations in the liver, gills and sediment from the sampling points than the fish flesh which was in agreement with study of Ali *et al.* (2019), who suggested that, the accumulation of heavy metals in organs should be higher in the following pattern: liver, gills than in the flesh.

Table 1: The Means of the Heavy Metals in Yuna River

Metals	Water (mg/L) Flesh (µg/g) Gill (µg/g) Sediment (µg/g) Liver (µg/g)				
	Water (mg/L)	Flesh (µg/g)	Gill (µg/g)	Sediment (µg/g)	Liver (µg/g)
Copper (Cu)	0.01±0.00 ^a	0.78±0.02 ^b	2.30±0.03 ^c	6.33±0.20 ^d	33.90±0.30 ^e
Cadmium (Cd)	0.01±0.00 ^a	0.25±0.04 ^b	0.43±0.07 ^c	0.26±0.00 ^b	0.86±0.02 ^d
Zinc (Zn)	BDL	19.45±1.22 ^b	42.90±0.19 ^c	2.45±0.57 ^a	69.80±0.54 ^d
Lead (Pb)	BDL	1.17±0.04 ^a	2.33±0.21 ^b	BDL	2.97±0.07 ^c
Chromium (Cr)	BDL	1.11±0.11 ^a	1.82±0.38 ^b	BDL	BDL

BDL= Below Detectable Limit

This could be due to lipophilic nature of these metals hence, higher levels in these organs. Chromium was found to be significantly higher in the gills, which served as route for the entry of these metals into the fish but was not detectable in the water, sediment and liver. From the results, cadmium and chromium concentrations exceeded the permissible range of 0.05µg/g in Fish (gills, flesh and liver) as recommended by World Health Organization (WHO, 2011). Cu concentration was also significantly higher than the permissible limit of 0.5µg/g as recommended by WHO. In the sediment, Cd and Zn concentrations exceeded the permissible range as recommended (0.1µg/g, 1µg/g respectively). Pb and Cr exceeded the maximum permissible range as recommended (WHO, 2011) in both flesh and gills of fish. These could be due to anthropogenic activities and proximity to the Power holding company of Nigeria.

CONCLUSION

This study showed significantly high concentrations of the analyzed heavy metals in the flesh, gill and liver of *Citharus Citharus*, and in the sediment in Yema River which though had low concentrations in the water column. The pattern of distribution of these heavy metals in the fish species *Citharus Citharus* used in this study was found to be: liver > gills > flesh, these findings stressed that, there were appreciable health risks associated with consuming *Citharus citharus* from River Yema by people from the community.

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