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Assessment of Heavy Metals in Water, Fish (*Clarias Gariepinus*) and Sediments of Kiri Reservoir, Adamawa State, Nigeria

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Abstract
The Assessment of Heavy Metals in Water, Fish (*Clarias gariepinus*) and Sediments of Kiri Reservoir, Adamawa State, Nigeria was conducted for the period of eight months from January to August, 2024. Data were collected from three different Sites monthly in triplicate. Heavy metals were determined using Atomic Absorption Spectrophotometer (AAS). Not all the heavy metals investigated were in measurable amount in water, Chromium and Cadmium were below detection levels. Copper, Nickel and Lead were slightly above the recommended permissible limits. All heavy metals investigated were in measurable amount in sediments. Cadmium, Chromium and Lead in Sediments were beyond permissible level. Heavy metals in fish investigated revealed that copper, nickel and lead were present in fish. The maximum value of Copper in fish did not exceed the allowable limit of 3.0 mg/kg. The maximum values of nickel were within the recommended limits of 0.5-0.9 mg/kg. The maximum values of Lead exceeded the maximum limit of 0.2 mg/kg. Therefore, Kiri Reservoir can be suitable for the survival and growth of fish. Also then Assessment of heavy metals level in Water, Sediments and Fishes should be done regularly to ascertain the healthy state of Kiri reservoir.

Keywords: Heavy metals, Sediments, Reservoir, Water, Fish. *Clarias gariepinus*

Introduction

Heavy metal contamination in aquatic environments has continued to attract global attention, this is due to their abundance, wide range of sources and bioaccumulation Edward *et al* (2016), it has been found to react with some organic substances under certain conditions to convert them into even more toxic metal-organic complex pollutants. Water is a critical factor in the life of all aquatic species. In aquaculture, any characteristic of water that affects the survival, reproduction, growth, or management of fish or other aquatic creatures in any way is a Water quality variable. One of the major environmental issues of our time is the growing demand of water quality conditions suitable for aquatic organisms like fish Edward, (2020). The suitability of water for the survival and growth of fish is governed by many variables and is also directly related to its production and therefore water is of greatest concern to fish farming and are important to consider in fish culture (WHO, 2022). According to Ayeku *et al (*2015), heavy metals cannot be degraded, they are deposited, assimilated or incorporated in water Sediment and aquatic animals especially fish. Fish are often at the top of aquatic food chain and studies have shown that they assimilate these heavy metals through ingestion of suspended particulates, food materials and/or by constant ion exchange process of dissolved metals across some membranes like the gills or adsorption of dissolve metals on tissues and membrane surfaces (Wasiu et al 2016). Uptake of heavy metals by fish from the environment primarily occurs through gills, food, and skin and through water taken with food. Sediments are important sink for various pollutants such as heavy metals and also play a useful role in the contamination of Aquatic system. Sediments particularly the surface ones may serve as a metal pool that can release back metal to the overlying

water via natural and anthropogenic process, causing potential adverse health effect to the ecosystem because of their serious toxicity and persistence (Wang 2017). Kiri reservoir is the main source of water for irrigation, fishing, domestic and industrial purposes in that area, Agricultural activity like farming takes place in5 Kiri and environ in which Fertilizers, Pesticides and herbicides are extensively used to increase yield and also to control pests, diseases, weeds and other plant pathogens, also other domestic wastes can generated flows into the reservoir and may contaminate the water with a variety of contaminants especially heavy metals. With changing environmental conditions under increasing anthropogenic activities which might affect the nature of Kiri Reservoir and might also leads to drastic changes in it biological productivity, hence the need for this research.

Materials and Methods

Study Area

The research was carried out in Kiri reservoir. Kiri reservoir is located on floodplain of lower Gongola River basin, about 25km upstream of its confluence with River Benue at Numan Zemba, (2016). The research was conducted in triplicate from three sites (A, B, C) for the period of eight months, January to August, 2024 (Figure 1).

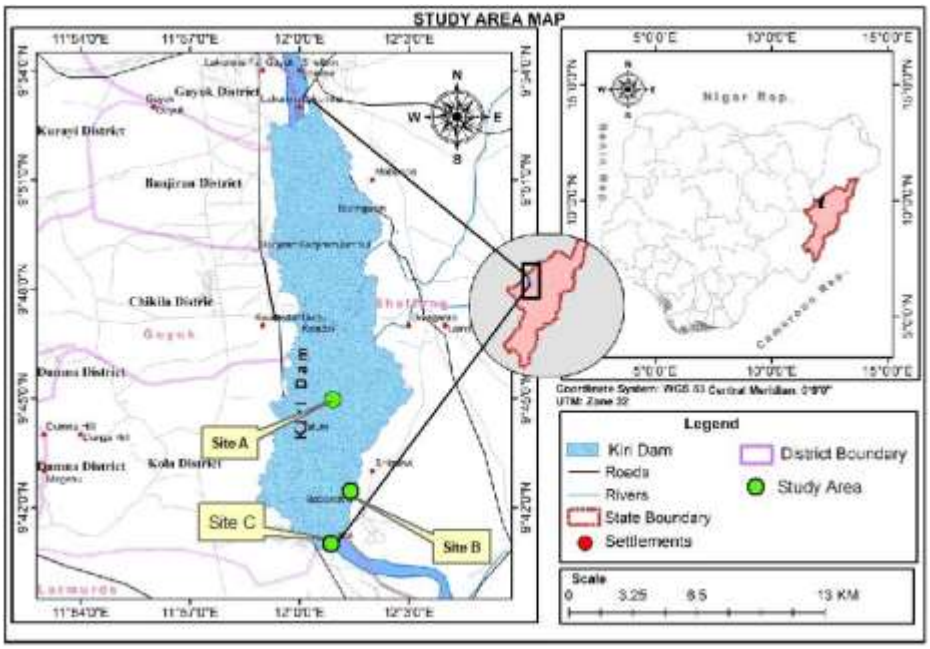

Figure 1: Study Area

Digestion of water, Fish and Sediment

Water sample was digested following standard methods for examination of water and waste water (APHA, 2015). Each of the unfiltered water sample (100ml) was digested with 5ml HCL (37%) at 90°C until the volume was reduced to 20ml. The digest was cooled, filtered and make up to the mark in 100ml standard flask. The sample solution was kept in a well cleaned analytical bottle with a label until metal analysis (Pandiyan *et al*., 2020).

Fish *Clarias gariepinus* was purchased from the study area from January to August, 2024 forth monthly in triplicate. The entire fish sample were dissected with sterile sharp knife and flesh/ muscles sample was cut out and was dried at 105°C for 48hours and grounded to a fine powder using an agate mortar and pestle. Acid digestion of fish samples followed standard methods (APHA, 2015). 2.0g of ground fish was placed into a borosilicate beaker and 12ml of Aqua regia (3:1 HCL/NH03 was added to each. The beaker was covered with watch glass and left for 16 hours at room temperature, the

samples were heated for 2 hours on a hot plate at about 80°C, after the first 15 hours, of heating, the watch glass was removed and small amount of 1% v/v HN03 was periodically added to avoid drying of the sample. The sample was allowed to cool and then filtered through whatman 41 filter papers. The sample was made up to the 100ml (Pandiyan *et al*., 2020).

Sediments were sampled from waterbed using a homemade Auger sampling device as described by U.S EPA (2020). The sample was packed in plastic bag that have been previously soaked in 10%HNO3 (Nitric acid) and 1:1 HCL (hydrochloric acid) for 24hrs followed by rinsing with distilled water and then allowed to drain to dryness in order to sterilized the plastic bags. 2.0g of grounded was placed into a borosilicate beaker and 12ml of Aqua regia (3:1 HCL/NH03 was added to each. The beaker was covered with watch glass and left for 16 hours at room temperature, the samples were heated for 2 hours on a hot plate at about 80°C, after the first 15 hours, of heating, the watch glass was removed and small amount of 1% v/v HN03 was periodically added to avoid drying of the sample. The sample was allowed to cool and then filtered through whatman 41 filter papers. The sample was made up to the 100ml (Pandiyan *et al*., 2020).

Heavy metal determination

Determination of Heavy metals Cadmium, Copper, Nickel, Lead and Zinc were made directly on each final solution of water, fish and Sediment using a Buck Scientific 200A model, Atomic Absorption Spectrophotometer (AAS) and the values obtained were expressed in milligram per kilogram (mg/kg) (APHA 2015). Data obtained in this study was analyzed using one way Analysis of Variance (ANOVA). LSD± was used to separate means at P>0.05 level of confidence.

Results and Discussion

The result of the heavy metals in water, fish and Sediment is presented on Table 1. The results of the analysis of heavy metals in water showed some variations in this study. Cadmium and chromium were beyond detection level in water samples. The non-detection of these heavy metals may be due to the inability of the metals to dissolve in water and got deposited to the bottom in the sediments as observed in this study and this is because water sediment are metal reservoirs trapping all the heavy metals that escape detection in water (Ekpechi, and Okori, 2022). The mean value of all the metal present varied among the months investigated, which indicated uneven distribution of the heavy metals along the stretch of the reservoir during the study period. This could be attributed to the variations in natural and anthropogenic activities during this study. This is in line with the study of Chukwu and Nwankwo, (2003) who reported that the high variability of heavy metals may be attributed to impact of many factors such as rainfall, surface run-off from farms, tributaries and catchments activities during the wet and dry season periods.

The result of heavy metal in fish showed a significant variability in the accumulation from the sampling months which principally depended on the bioavailable of metal concentration in their aquatic habitats (Edokpayi *et al*, 2016). The accumulation of heavy metals in fish species were found to be influenced by several factors like temperature, pH of water, conductivity, rainfall, hardness, salinity and also by biotic community interaction. The variation in metal concentration in the fish might be due to different sources of metal pollution, intensive human activities and discharge of municipal waste. Generally, heavy metal concentrations in the tissue of freshwater fish vary considerably among different studies Nkinda *et al*, 2021), possibly due to differences in metal concentrations and chemical characteristics of water. Cadmium and Chromium were below detection level in fish organs.

Table 1: Mean Heavy Metals in water, Fish and Sediment of Kiri Reservoir

	Water			Fish (*Clarias gariepinus*)					Sediment		
Month	Pb	Cu	Ni	Pb	Cu	Ni	Cr	Cd	Pb	Cu	Ni
JAN	0.02±0.71	0.27±0.66	0.04±0.05	0.04±0.10	0.44±0.13	0.04±0.02	0.56±2.82	0.86±0.29	0.62±0.28	18.45±0.51	9.80±0.63
FEB	0.03±0.21	0.33±0.06	0.04±0.09	0.41±0.10	0.62±0.13	0.07±0.02	0.56±2.78	0.81±0.24	0.93±0.24	17.87±0.36	9.71±0.65
MAR	0.03±0.11	0.12±0.07	0.03±0.01	0.22±0.10	0.67±0.13	0.07±0.02	0.50±2.98	1.03±0.26	0.58±0.22	17.50±0.54	9.94±0.68
APR	0.02±0.61	0.11±0.06	0.04±0.29	0.25±0.10	0.58±0.13	0.08±0.02	0.49±2.76	0.78±0.23	0.51±0.24	17.91±0.51	10.31±0.65
MAY	0.04±0.11	0.27±0.09	0.04±0.07	0.05±0.10	0.61±0.13	0.09±0.02	0.06±2.70	2.96±0.94	0.62±0.28	19.05±0.58	9.51±0.65
JUN	0.03±0.31	0.26±0.06	0.05±0.09	0.24±0.10	0.55±0.13	0.08±0.02	0.07±2.77	1.11±0.24	0.93±0.24	18.01±0.16	10.27±0.63
JUL	0.04±0.11	0.20±0.05	0.06±0.79	0.09±0.10	0.73±0.13	0.08±0.02	0.59±2.74	0.93±0.27	0.58±0.22	19.74±0.56	7.90±0.64
AUG	0.05±0.19	0.19±0.16	0.03±0.09	0.07±0.10	0.46±0.13	0.07±0.02	0.87±2.71	0.71±0.24	0.51±0.24	19.43±0.56	8.35±0.61
MEAN	0.03±0.19	0.22±0.16	0.04±0.09	0.17±0.10	0.58±0.13	0.07±0.02	0.46±2.71	1.15±0.24	0.66±0.24	130.96±0.56	9.47±0.61

Pb-Lead, Cu-Copper, Cd- Cadmium, Ni-Nickel, Cr-Chromium.

All the heavy metals investigated were present in sediments unlike in water and fish. The reason why all these heavy metals were found in sediments may be due to the inability of these metals to dissolve in water and got deposited to the bottom in the sediments. Sediments are metal reservoirs trapping all the heavy metals that escaped detection in water. Research has revealed that nearly all metals content in aquatic environment resides in water sediments (Ekpechi, and Okori, 2022). The result of the heavy metal in sediments in this study showed some variability of metal levels. This variation could be attributed to variation in environmental content of different sampling months as well as the diversity of the different activities taking place around the study area.

Conclusion

In conclusion therefore, a slight variation in heavy metals between sampling months was observed and not all the heavy metals investigated were in measurable amount in water, Chromium and Cadmium were below detection levels. Copper, Nickel and Lead were slightly above the recommended permissible limits. All heavy metals investigated were in measurable amount in Sediments. Cadmium, Chromium and Lead in Sediments were beyond permissible level. Heavy metals in Fish investigated revealed that Copper, Nickel and Lead were present in Fish. The maximum value of Copper in Fish did not exceed the allowable limit. Therefore, Therefore, Kiri Reservoir can be suitable for the survival and growth of fish.

Recommendation

We therefore recommend that intensive human activities and discharge of municipal waste should be monitored. Also Assessment of water quality parameters and heavy metals in water, Sediments and fish should be done regularly to ascertain the healthy state of Kiri reservoir.

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