WET SEASON EVALUATION OF BIOCONCENTRATION OF HEAVY METALS IN SEDIMENTS OF RIVER BENUE, BAGANA, KOGI SATE

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ABSTRACT
This study investigated the bioconcentration of heavy metals in the sediments of River Benue at Bagana, Kogi State, Nigeria, during the wet season. The heavy metals analyzed include cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), iron (Fe), and mercury (Hg). Sediment samples were collected at three points along the river and analyzed using Atomic Absorption Spectrophotometry (AAS). The results revealed fluctuations in heavy metal concentrations, with Cd, Cu, Pb, and Fe highest in July and lowest in September. The levels of these metals were within permissible limits set by FAO, indicating no immediate threat to fish health and safety for human consumption, except for chromium, which showed a significant increase in concentration by September. The study concludes that while the sediment quality remains largely safe, continuous monitoring is crucial to prevent potential ecological risks posed by industrial activities and agricultural runoff in the metropolis.
Keywords: Metals, Concentration, Sediments, Season, Kogi State

INTRODUCTION

The growing concern about environmental pollution, particularly in aquatic ecosystems, has led to an increased focus on the bioconcentration of heavy metals, which are among the most toxic contaminants found in nature. Heavy metals, such as lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu), and mercury (Hg), have been identified as significant pollutants due to their persistence in the environment and ability to accumulate in living organisms. River systems, which are vital for supporting ecological balance and human activities like agriculture, fishing, and transportation, are especially vulnerable to contamination from both natural and anthropogenic sources, including industrial effluents, agricultural runoff, and urbanization (Ravera *et al.,* 2013). The contamination of riverine environments poses severe threats to both aquatic life and human health, necessitating a deeper investigation into these pollutants. (Smith *et al.*, 2020).

Sediments play a crucial role in aquatic ecosystems, serving as both reservoirs and sources of heavy metals. Evaluating the concentration of these metals in sediments provides essential insights into the pollution status of rivers and the associated ecological risks. The Benue River, one of Nigeria's largest rivers, is instrumental in supporting socio-economic activities in regions like Bagana in Kogi State. However, the river is increasingly at risk from contamination caused by mining, farming, and urban expansion. Such pollution is exacerbated during the wet season, which, with its higher rainfall and increased runoff, accelerates the transport and redistribution of heavy metals in river systems (Malakootian *et al.,* 2016). Understanding the dynamics of heavy metal accumulation during this season is critical for managing the river's ecological health and ensuring the safety of its resources.

This study sought to evaluate the bioconcentration of heavy metals in the sediments of the River Benue during the wet season, focusing specifically on the Bagana region of Kogi State. The investigation will not only help determine the pollution levels but also provide valuable data for environmental monitoring and pollution control efforts. It will also highlight the risks to aquatic life, particularly fish, which are often bio-accumulators of these metals. The study also, is an attempt to evaluate the anthropogenic activities in Bagana metropolis and several settlements upstream that affect fish survival. Such contamination can affect the health of the local population, who rely on these fish for essential nutrients. Ultimately, this research will contribute to the development of policies and strategies aimed at protecting both the aquatic ecosystem and the human population from the adverse effects of heavy metal contamination.

MATERIALS AND METHODS

Study Location

The study was carried out in River Benue at Bagana which lies within latitude 8º02N and longitude 7º59E, a tropical climate area characterized with agricultural activities and proximity to small-scale industrial operations, which contribute to potential heavy metal contamination. Bagana community is about 15km from the Makurdi River, Benue state and has about 50,000 people in local government area called Omala, Kogi state, flowing through several states in Nigeria. The wet season in this region typically spans from May to October, characterized by high rainfall and increased river discharge.

Sample Collection

Samples were collected between the month of July to September at three sampling points at 100m apart from each other designated as upper A, middle B, and lower C. The sediment samples were collected from three different points of the river bank, about two meters into the water, using a nylon (polyethene) bag which has already been labeled and tied tightly after collecting the samples.

Sediment sample

Total concentration of heavy metals was analyzed using atomic absorption spectrometer (Schimadzu Corp, Japan, AA-6200) with a system double beam, equipped with hollow cathode lamps. The spectral range extends at least from 180 to 900. Around 2gm of sample was taken in 100ml beaker and placed on hot plate. 15ml concentrated HNO_3 was added and the samples heated at 1200ºC for 1 hour. 5ml of HCL was added and heated at 1200ºC for 1 hour. Then 5ml of $HCLO_4$ was added and heated until 1-2ml remains. Further dilution was made as per required. Finally, the samples were examined with AAS for metal estimation. The determination of the heavy metals was carried out by atomic absorption spectrometer using an air-acetylene flame.

Statistical Analysis Result

The statistical result analysis is presented as means ± SEMfor all samples. Result from all samples were analyzed using ANOVA of GenStat discovery software and $P<0.05$ was considered to indicate statistically significant difference. Means of significant differences were separated using Duncan's Multiple Range Test.

Quality Assurance/Quality Control

All instruments were calibrated prior to use, and standard reference materials were analyzed alongside the samples to ensure accuracy. Additionally, all chemicals used were of analytical grade, and laboratory equipment was regularly cleaned and calibrated to minimize contamination.

RESULTS

Table. Heavy Metal Concentration in Sediments

The monthly mean concentrations of heavy metals (mg/kg) in sediments samples is presented in table 1. From the table presentation, the mean concentration of heavy metals in sediment decreased from 0.60mg/kg in July to 0.26mg/kg in September for cadmium, however, there was significant difference ($p<0.05$) between July, August and September.

The mean concentration of Cr ranged from 1.05mg/kg in July to 2.85mg/kg in September, however, there was significant difference ($p<0.05$) between July to August.

The mean concentration of Cu ranged from 4.03mg/kg in July to 4.14mg/kg in August, however, there was no significant difference ($p>0.05$)) between July, August and September.

The mean concentration of pb decreased from 2.96mg/kg in July to 2.60mg/kg in September with a significant difference ($p<0.05$) between July, August and September.

The mean concentration of iron reduced from 4.89mg/kg in August to 4.50mg/kg in September with a significant difference ($p<0.05$) between July.

The mean concentration of Hg ranged from 0.01mg/kg in July to 0.01mg/kg in September, remained the same and there was no significant difference ($p>0.05$) between July, August and September.

Table. Monthly Mean Concentration of Heavy Metals in Sediment Samples of River Benue at Bagana

Month	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Iron (Fe)	Mercury (Hg)
July	0.60[a]	1.05[b]	4.03	2.96[a]	4.65[b]	0.01[a]
August	0.42[b]	2.65[a]	4.14	2.79[b]	4.89[a]	0.01[a]
September	0.26[c]	2.85[a]	3.98	2.60[c]	4.50[c]	0.01[a]
L.S. D	0.03	2.25	NS	0.07	0.10	0.00
Grand mean	0.43	2.18	4.05	2.78	4.75	0.01

Mean with the same letter superscript along the column are not significantly different ($p>0.05$)

DISCUSSION

The table from this study shows the concentration of cadmium (Cd), copper (Cu), iron (Fe) and lead (Pb) heavy metals to be highest in the sediment as in the month of July (0.60mg/kg, 4.03mg/kg, 4.65mg/kg, and 2.96mg/kg) and lowest in September (0.26mg/kg, 2.85mg/kg, 3.98mg/kg, 4.50mg/kg and 3.98mg/kg) which is below the permissible limit of FAO, however they are in a trace amount and therefore safe for fish species in the river. The fluctuations in the month of July maybe due to the runoffs from agricultural farms containing high manure and pesticides into the water body, heavy metal like lead maybe due to high oil spillage industrial waste while the low percentage in September maybe due to dilution by rainfall over time in wet season. However, the mean value observed in the present study is less than the values reported by Usero *et al.,* (2013). The concentration of chromium is high in September ($p<0.05$), hence, there was a significant difference. The increase from 1.05mg/kg in July to 2.85mg/kg in September agrees with the report by Mohiuddin *et al.,* (2012) and Islam *et al.,* (2015) that, the consequence of high chromium maybe due to untreated industrial waste and effluent. However, mercury (Hg) maintains a permissible natural state in the sediment. (Kumar *et al*., 2020)

CONCLUSION

The concentration of the heavy metals in wet season of River Benue sediment at Bagana remain within safe levels for aquatic life and fish consumption in this study, except for chromium in trace amount.

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