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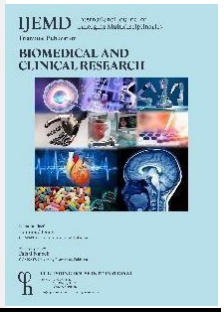

Assessment of Heavy Metal Concentrations in River Kaduna Water in Relation to Seasonal Variations

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Abstract

The concentrations of toxic metals in many ecosystems are reaching unprecedented levels. The aim of this research work was to assess heavy metals concentration in River Kaduna water in relation to seasonal variations. Twenty-four water samples were collected for the period of eight months between January and September, 2023 and were used to assessed the concentration of selected heavy metals in water samples. Samples were assessed using Atomic Absorption Spectrometer (AAS). The mean concentration of heavy metals in wet season water sample downstream are: Pb 0.0520 ± 0.0179ppm, Cd 0.0613 ± 0.0167ppm, Cr 0.8907 ± 0.1030ppm, Cu 0.7108 ± 0.2300ppm and Zn 1.5202± 0.2600ppm. The Dry season include; Pb with 0.0524 ± 0.0217ppm, Cd, 0.0703 ± 0.0042ppm, Cr, 0.9319 ± 0.1780ppm, Cu, 0.7271 ± 0.2675ppm and Zn, 17.1686 ±4.9498ppm. The result obtained shows that there was significant difference ($P<0.05$) between the mean concentration of heavy metals in wet and dry season at 5% level of significance only with Pb and Zn whilst Cd, Cr and Cu were not statistically significant. While the mean concentration of heavy metals in wet season water sampled midstream were; Pb 0.0500 ± 0.0186ppm, Cd 0.0490 ± 0.0186ppm, Cr 0.8367 ± 0.1630ppm, Cu 0.7287 ± 0.3203ppm and Zn 1.9674± 0.6148ppm. Dry season are: Pb 0.0524 ± 0.0217ppm, Cd 0.0515 ± 0.0142ppm, Cr 0.9667 ± 0.1420ppm, Cu 0.8270 ± 0.2675ppm and Zn 2.0723 ± 0.4310ppm. the result obtained shows that there was significant difference($P<0.05$) between the mean concentration of heavy metals in wet and dry seasons.

Keywords: Assessment, Heavy, Metals, Concentration, Relation, Season and Variations

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Introduction

The concentrations of toxic metals in many ecosystems are reaching unprecedented levels. The increasing use of metals in industry and mining activities have led to serious environmental pollution through effluents and emissions [11]. Under certain environmental conditions, heavy metals may accumulate and cause serious ecological damage. The aquatic ecosystem is often seen as the ultimate recipient of almost everything including heavy metals [17]. Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate. There are various sources of heavy metals; some originates from anthropogenic activities like draining of sewage, dumping of hospital wastes and recreational activities [17]. River basins in Nigeria are enhancing crop farming areas during both the dry and rainy seasons. Fertilizers, herbicides and insecticides are used on these crops and are eventually washed into the river via surface runoff [15]. Reports that petrol powered water pumps are used to irrigate the farmlands in the dry season and this enables petroleum wastes to get into the river, while [9] stated that most of the industries (tobacco, metal smelting, electricity meter manufacturing, ginnery, textile, vegetable oil mill etc.) located in Zaria discharge their wastes directly into rivers and adjacent tributaries. Trade wastes (from auto mechanics, metal fabrication/finishing, abattoirs, local tanneries etc.) are also directly or indirectly discharged into rivers [1]. Domestic sewage and refuse also find their way into the river from the many settlements along the river via leaching, direct discharge and surface runoff [7]. Thus, there is every possibility of contamination of water, sediments and fish of most rivers by heavy metals since industrial effluents and municipal wastewaters are known to contain high amounts of heavy metals [21].

The aim of this research was to assess heavy metal concentrations in River Kaduna water in relation to seasonal variations.

Materials and Methods

Study Area

The study was conducted at river Kaduna, Kaduna state. Lying between latitude 9^{O} 30N and latitude 11º45N, longitude 7º03E and longitude 8º30E. Fishing and farming are the main activities carried out at river Kaduna. The site selected was a result of anthropogenic activities carried out within the area such as; industrial activities, agricultural run-off and urban waste disposal into the water body system.

Sample Collection

Water samples were collected at three points in a plastic bottle (1: point down, point 2: mid and point 3: upstream). The water samples were put in an ice packed container, labelled, and transported to Spectral Laboratory, Kaduna for digestion.

Digestion of the Water Sample

One hundred milliliter of Surface water samples were collected using a plastic container. 20ml of Nitric acid were added and heated on a hot plate to dryness and allowed to cool, then 50ml of distilled water was added and stirred, thereafter Whatman filter paper were placed in a funnel on a

sample bottles, each of the samples were transferred into the filter paper for filtration, distilled water were added gradually to each of the sample until it reaches 80ml and the samples were ready for assessment [18].

Heavy Metal Analysis

Digested soil solutions were introduced into Atomic Absorption Spectrophotometer (AAS). The absorbance of each metal at its characteristic wavelength was recorded for each selected metal. calibration curves to determine the amount and total concentration of each metal in the samples was used. proper disposal procedures for chemical wastes and contaminated materials and quality control was implemented [2]

Data Analysis

The sample collected were subjected to statistical analysis using SPSS version 25.0. The mean, standard deviation and charts were used as descriptive statistics whilst P-value < 0.0.5 were used for test of significance at 95% confidence level.

Results

In table 1 the result shows the concentration of heavy metals in wet and dry season downstream. The result reveals that only Lead and Zinc are statistically significant that (two asterics) **= ($P<0.01$), (one asteric) *= ($P<0.05$) whilst Cadmium, Chromium and Copper were not (they are found in trace amount).In table 2 the result shows the mean concentration of heavy metals in wet and dry season midstream are statistically significant**= ($P<0.01$), *= ($P<0.05$). In table 3 the result shows the concentration of heavy metals obtained in wet and dry season upstream are statistically significance with only Pb not statistically significant**= ($P<0.01$), *= ($P<0.05$). In all the five heavy metals assessed (Pb, Cd, Cr, Cu and Zn) the concentration of Zinc was found to be the highest in both wet and dry season. The table on heavy metals concentration in water sampled from downstream shows that there is significant difference between the mean concentration of heavy metals in wet and dry season at 5% or 1% level of significance only with Pb and Zn whilst Cd, Cr and Cu were not statistically significant. There is significant difference between the mean concentration of heavy metals in wet and dry season either at 5% or at 1% level of significance. However, there is also significant difference between the mean concentration of heavy metals in wet and dry season at 5% or 1% level of significance with only Pb not statistically significant.

Table 1: Heavy Metals Concentration in Water Sampled from Downstream

Heavy Metals (ppm)	(Wet Season)	(Dry Season)
Pb	0.0520 ± 0.0179	0.0524 ± 0.0217*
Cd	0.0613 ± 0.0167	0.0703 ± 0.0042
Cr	0.8907 ± 0.1030	0.0319 ± 0.1780
Cu	0.7108 ± 0.2300	0.7271 ± 0.2675
Zn	1.5202 ± 0.2600	17.1686 ±4.9498**

The mean and Standard deviation for the concentration of Heavy Metals for both Wet and Dry season.**= (P<0.01), *= (P<0.05) Statistically significant.

Table 2: Heavy Metals Concentration in Water Sample Midstream

Heavy Metals (ppm)	(Wet Season)	(Dry Season)
Pb	0.0500 ± 0.0186	0.0524 ± 0.0217*
Cd	0.0490 ± 0.0186	0.0515 ± 0.0142**
Cr	0.8367 ± 0.1630	0.9667 ± 0.1420**
Cu	0.7287 ± 0.3203	0.8270 ± 0.2675**
Zn	1.9674± 0.6148	2.0723 ±0.4310*

The mean and Standard deviation for the concentration of Heavy Metals for both Wet and Dry season.**= (P<0.01), *= (P<0.05) Statistically significant.

Table 3: Heavy Metals Concentration in Water Sample Upstream

Heavy Metals (ppm)	(Wet Season)	(Dry Season)
Pb	0.0500 ± 0.0186	0.0513 ± 0.0110
Cd	0.0490 ± 0.0186	0.0515 ± 0.0017*
Cr	0.8341 ± 0.1630	0.8270 ± 0.1060**
Cu	0.7200 ± 0.3013	0.8270 ± 0.2675**
Zn	1.7202± 0.6100	1.9357 ±0.4204*

The mean and Standard deviation for the concentration of Heavy Metals for both Wet and Dry seasons. **= ($P<0.01$), *= ($P<0.05$) Statistically significant.

Discussion

Cadmium is a nonessential element in food and natural water, with high toxicity that accumulates principally in the kidney and liver. Similar to the result obtained by [14] who conducted a study that shows the mean concentration of heavy metals in water samples.

Zinc is an essential element in human diet and it is required to maintain the function of the immune system for normal growth and development. It enhances resistance to infections. This agrees to the findings of [16] who concluded that deficiency of zinc from insufficient dietary intake reduced absorption, excretion or inherited defects in zinc metabolism. Zinc was found to be the highest in water samples similarly [12] have reported. The result on the other hand disagrees with the finding of [13] in high concentration may result to system dysfunction. The symptoms of high zinc concentration have been reported to include vomiting, liver failure, blood urine, diarrhea and anemia [3].

Lead has been dictated for centuries as a cumulative general metabolic poison over the years. Lead metal content was dictated in all the samples thou within the permissible limit set by World Health Organization. Lead is a toxic metal that can damage nervous system especially in young children. It also causes blood and brain disorder. It is also a potent neurotoxin that gather in soft tissue and bone and a possible human carcinogenic. Similarly, [19].

Copper is an important element for human life but in excess may accumulate in some organs of body like liver and may result to gastrointestinal problem anemia and kidney damage [10].

Chromium (Cr) is an essential mineral that plays a crucial role in various bodily functions. It helps in glucose metabolism, weight management and cardiovascular health. Chromium deficiency can lead to impaired glucose metabolism, weight loss and fatigue. High level of chromium can cause kidney damage, liver damage and other health problems [6].

The findings from this research work showed the assessed heavy metals (Copper, Cadmium, Chromium, Lead and Zinc) in water sample from river Kaduna were present in all samples collected in both wet and dry season [20]. The concentration of heavy metals in water samples

varies at different time interval. Among all the heavy metals assessed in wet and dry season, the concentration of zinc was found to be the highest whilst either chromium or cadmium were the least in concentration. It was also observed that zinc was abundant almost in all the water samples analyzed.

The study revealed that the observed heavy metals concentration in water is due to effluents discharged from industries into the surrounding water body without proper treatment as reported by [8].

The concentration of heavy metals in water samples from the study area were higher in zinc, the possible sources for zinc concentration might be due industrial runoff and road runoff as the river is close to high way. Report by some researchers [5].

The differences in the heavy metals concentration may be as a result of the differences in absorption capacity. Generally, the accumulation depends on metal concentration, time of exposure, way of metal uptake, environmental condition and intrinsic factor. This agrees to the findings [4]. It is important to know the concentration of heavy metals in the study area due to anthropogenic activities carried out around the river, knowing its levels regards to the consumption of produce from the area. The location of the river may also result in the high level of the heavy metals in water samples.

Conclusions

The result obtained shows that there was significant difference ($P<0.05$) between the mean concentration of heavy metals in wet and dry season at 5% level of significance only with Pb and Zn whilst Cd, Cr and Cu were not statistically significant. While the mean concentration of heavy metals in wet season water sampled midstream were; Pb 0.0500 ± 0.0186ppm, Cd 0.0490 ± 0.0186ppm, Cr 0.8367 ± 0.1630ppm, Cu 0.7287 ± 0.3203ppm and Zn 1.9674± 0.6148ppm. Dry season are: Pb 0.0524 ± 0.0217ppm, Cd 0.0515 ± 0.0142ppm, Cr 0.9667 ± 0.1420ppm, Cu 0.8270 ± 0.2675ppm and Zn 2.0723 ± 0.4310ppm. the result obtained shows that there was significant difference($P<0.05$) between the mean concentration of heavy metals in wet and dry seasons.

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