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Assessment of Seasonal Variation on Heavy Metal Content of Ikorodu Groundwater in Lagos State of Nigeria

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ABSTRACT
This study assessed the quarterly concentration of heavy metals in Ikorodu, southwest Nigeria. Water samples were collected from 29 different locations in Ikorodu and assessed for the presence and concentrations of heavy metals. The results obtained indicated negligible amounts of Aluminum, Arsenic, Mercury, Cadmium and Cobalt in the water samples. Concentrations observed for Calcium, Magnesium, Chromium, Copper, Lead, Magnesium, and Potassium were relatively higher for early dry, late dry, and early wet seasons but declined in the late wet season. However, there was no statistically significant difference in the average concentration of the metals in the different seasons ($p > 0.05$). The study showed no significant changes in the average concentration of heavy metals assessed through the different seasons. The average concentration of Lead for Ikorodu groundwater was found to be higher than the recommended WHO standards indicating a potential health risk for the residents of the area. It is recommended that residents treat the water for Lead removal prior to consumption.
KEYWORDS: Groundwater, Heavy metals, Physicochemical properties, Ikorodu, Assessment

I. INTRODUCTION

Groundwater refers to water found beneath the surface of the earth which is collected via drainage galleries, tunnels, or wells, and any water that flows naturally to earth's surface through springs or seeps. The availability of groundwater in an area depends on the hydrogeological feature of the underlying formation in that area(Jijingi et al., 2019). Groundwater is the cheapest, renewable, available, and important drinking water source for many people around the globe, particularly rural habitants. Groundwater quality depends on several factors which include individual hydrological, biological, chemical, and physical factors, and it varies with time and space(Jijingi et al., 2019; Sudarshan et al., 2016).

Groundwater contamination can be classified as either natural or anthropogenic sources. Natural groundwater contamination is mainly due to geological formation with shallow groundwater mass (water-rock interaction in cold waters), infiltration from low-quality surface water bodies (streams, rivers, lakes), seawater intrusion, or due to the effect of geothermal fluids (water-rock interaction in hot waters)(Chinenye, 2017). There are also natural causes like the dissolution of natural substances found in soils and rocks into water bodies. Examples of such natural substances include Radionuclides, Sulphates, Manganese, Iron, Arsenic, Boron, Synthetic organic chemicals, Pathogens, and Chlorides. Groundwater contamination can also occur as a result of human activities called anthropogenic sources(Adeola et al., 2015; Ali et al., 2018; Attahiru et al., 2016).

An earlier assessment of Majidun area in Ikorodu Local Government Area from previous studies show high heavy metals (Pb, Ni & Mg) presence in groundwater exceeding WHO drinking water limit (Awoyemi, 2014). The quality of groundwater is an important factor of consideration when used as drinking water source, support farming, and industrial uses. For instance, the alkalinity of groundwater as a result of seawater intrusion or dissolution of minerals, or the presence of salts in water can impede vegetation growth and corrosion in pipes, and scale formation when used for industrial purposes. Other heavy metals like Manganese and Iron if in higher concentration can affect plant quality(Chinenye, 2017; Ordinioha, 2011). This study assessed the concentration of heavy metals in groundwater for the entire Ikorodu Local Government Area, Lagos State.

II. MATERIALS AND METHODS

2.1Study area

This study was carried out in Ikorodu Local Government Area of Lagos State, Nigeria (Figure 1). It has a population of about 836,5100 as of the year 2017 when the last Lagos
State census was conducted. Ikorodu is about 26km from Ikeja and 36km from Lagos Island (Eko). Ikorodu is largely bounded at the south by Lagos Lagoon. Its geographical location lies between latitudes 6º 41'51.13" N and 6º 31' 20.95" N also on longitudes 3ºC 26'31.82" E and 3º 43'5.13" E.

2.2 Sample collection

Stratified sampling was used to divide the study area into different strata, with one sampling unit located in each of the 29 administrative wards that make up the Local Government Area. One litre each of groundwater samples were collected from twenty-nine different sampling points as shown in Figure 1. This task was repeated in four different quarters (seasons) within a period of one year. The water samples were collected using aseptic techniques with sterile containers and transported to the laboratory for analysis.

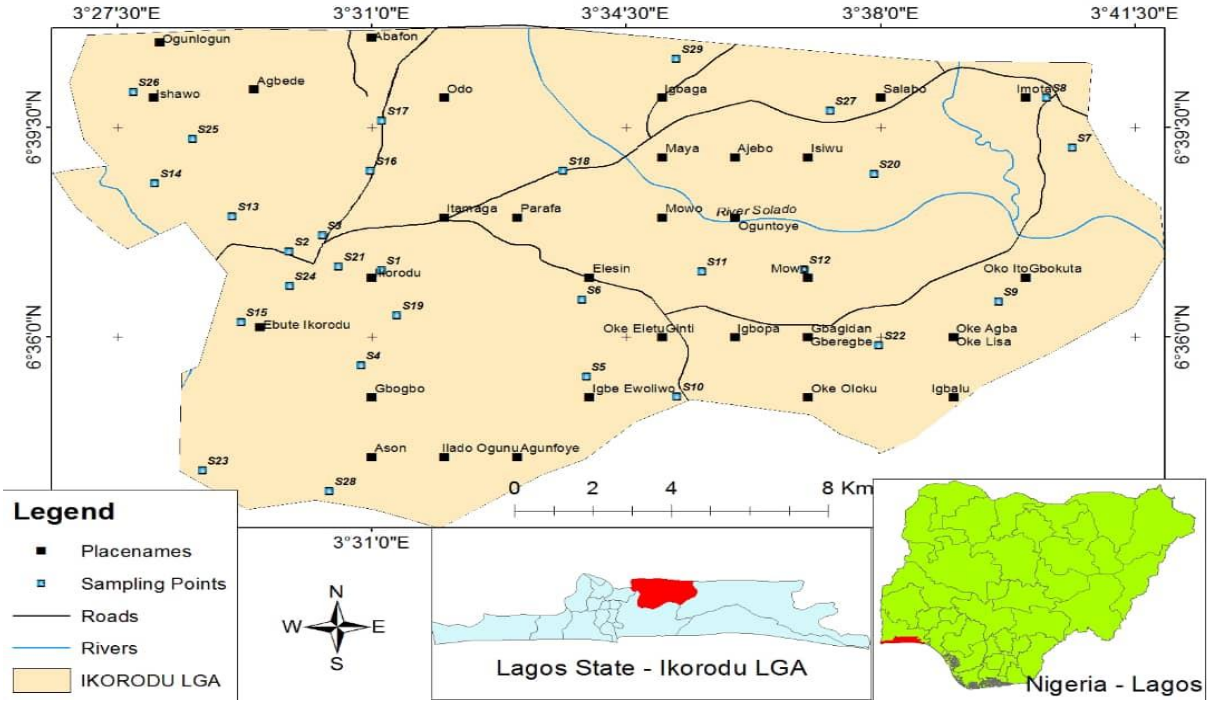

Figure 1: Map of Ikorodu showing sampling points

2.3 Sample processing

Concentration of heavy metals extracted were determined in each of the samples using Inductive couple plasma-optical emission spectrometry (ICP-OES). The samples were first digested in the lab before they were introduced into the ICP-OES machine. The ICP-OES 710 machine was powered on using high purity Argon as fuel. The machine software initialized for 10mins. A blank analysis was done by aspirating 1% Nitric acid into the machine to guide against any interference and carry over. The concentrations of various standards prepared were ran to calibrate the equipment. Then the samples were ran based on the established calibrated standard on the system to detect and determine the concentration of the heavy metals present in the samples and the results were recorded.

2.4 Data analysis

The concentration of the heavy metals assessed were presented in mean and standard deviation. The average concentrations of the heavy metals in the different quarter were compared using the analysis of variance (ANOVA). All analysis was done with the SPSS version 25 software at a 95% confidence level and a p-value less than 0.05 was considered significant.

III. RESULTS

Table 1 show comparison of the average concentration of the different heavy metals across the four quarters of the year. Analysis of variance revealed there was no significant difference in the average concentration of each heavy metal measured in the different quarters. There were negligible amounts of Aluminum, Arsenic, Mercury, Cadmium, and Cobalt in the water samples.

Table 1: Comparison of average concentration of heavy metals in different quarters

Heavy metals	1st quarter (December 2019)	2nd quarter (March 2020)	3rd quarter (June 2020)	4th quarter (September 2020)	ANOVA (p-value)
Calcium	2.85 ±1.49	2.85 ±1.49	2.85 ±1.49	2.62 ±1.22	0.8345
Aluminum	0 ±0	0 ±0	0 ±0	0 ±0	1.0000
Arsenic	0 ±0	0 ±0	0 ±0	0 ±0	1.0000
Magnesium	2.25 ±1.85	2.25 ±1.85	2.25 ±1.85	1.85 ±1.58	0.7881
Sodium	10.24 ±9.32	10.24 ±9.32	10.24 ±9.32	10.2 ±9.06	0.9833
Cadmium	0 ±0	0 ±0	0 ±0	0 ±0	0.9999
Chromium	0.02 ±0.01	0.02 ±0.01	0.02 ±0.01	0.01 ±0.01	0.9999
Copper	0.06 ±0.07	0.06 ±0.07	0.06 ±0.07	0.03 ±0.03	0.9999
Cobalt	0.01 ±0	0.01 ±0	0.01 ±0	0 ±0	0.9999
Irion	0.01 ±0.01	0.01 ±0.01	0.01 ±0.01	0.01 ±0	0.9232
Lead	0.07 ±0.04	0.07 ±0.04	0.07 ±0.04	0.03 ±0.04	0.9999
Magnesium	2.25 ±1.85	2.25 ±1.85	2.25 ±1.85	1.85 ±1.58	0.7881
Mercury	0 ±0	0 ±0	0 ±0	0 ±0	0.9999
Nickel	0.02 ±0.01	0.02 ±0.01	0.02 ±0.01	0.01 ±0.01	0.9999
Potassium	4.47 ±5.3	4.47 ±5.3	4.47 ±5.3	3.99 ±5	0.8772
Zinc	0.28 ±0.4	0.28 ±0.4	0.28 ±0.4	0.2 ±0.32	0.9999

Table 2 show the comparison of the average concentration of heavy metals measured with the WHO standard of acceptable limits.

Table 2: Comparison of average concentration of metals to WHO standard.

Heavy metals	1st quarter (December 2019)	2nd quarter (March 2020)	3rd quarter (June 2020)	4th quarter (September 2020)	WHO standard
Calcium	2.85 ±1.49	2.85 ±1.49	2.85 ±1.49	2.62 ±1.22	NA
Aluminum	0 ±0	0 ±0	0 ±0	0 ±0	0.2
Arsenic	0 ±0	0 ±0	0 ±0	0 ±0	0.01
Magnesium	2.25 ±1.85	2.25 ±1.85	2.25 ±1.85	1.85 ±1.58	20
Sodium	10.24 ±9.32	10.24 ±9.32	10.24 ±9.32	10.2 ±9.06	200
Cadmium	0 ±0	0 ±0	0 ±0	0 ±0	0.003
Chromium	0.02 ±0.01	0.02 ±0.01	0.02 ±0.01	0.01 ±0.01	0.05
Copper	0.06 ±0.07	0.06 ±0.07	0.06 ±0.07	0.03 ±0.03	2
Cobalt	0.01 ±0	0.01 ±0	0.01 ±0	0 ±0	NA
Iron	0.01 ±0.01	0.01 ±0.01	0.01 ±0.01	0.01 ±0	NA
Lead	0.07 ±0.04	0.07 ±0.04	0.07 ±0.04	0.03 ±0.04	0.01
Magnesium	2.25 ±1.85	2.25 ±1.85	2.25 ±1.85	1.85 ±1.58	20
Mercury	0 ±0	0 ±0	0 ±0	0 ±0	0.001
Nickel	0.02 ±0.01	0.02 ±0.01	0.02 ±0.01	0.01 ±0.01	0.02
Potassium	4.47 ±5.3	4.47 ±5.3	4.47 ±5.3	3.99 ±5	NA
Zinc	0.28 ±0.4	0.28 ±0.4	0.28 ±0.4	0.2 ±0.32	3

NA: Not available

IV. DISCUSSION

Comparison of the average concentration of the different heavy metals across the four quarters. Analysis of Variance revealed there was no significant difference in the average concentration of each heavy metal measured across the different quarters despite the slightly reduced average concentration observed in Calcium, Magnesium, Chromium, Copper, Lead, Magnesium, and Potassium in the fourth quarter of the year. This is in contrast with the reports of some other studies in southwest of Nigeria, where there was no variation in the heavy metal concentration throughout the year (Chinenye, 2017; Ocheri et al., 2014; Oyelakin et al., 2020). However, negligible amounts of Aluminum, Arsenic, Mercury, Cadmium and Cobalt were found in Ikorodu water samples. The various concentrations of heavy metals assessed were similar to other study reports in the region with only slight variations of ±0.2 by the different authors(Abiola, 2010; Jaji et al., 2007; Oyelakin et al., 2020).

The results showed a significantly higher concentration of lead in the water samples in all the seasons when compared to WHO permissible limit of ≤0.01mg/l. This could be attributed to contamination of groundwater sources from anthropogenic activities such as extreme use of pesticides, fertilizers, mining wastes, disposal of industrial wastes, waste disposal sites, and imperfect water-well construction commonly reported in the south western part of Nigeria(Abiola, 2010;Agwu et al., 2013; Akoteyon et al., 2018; Attahiru et al., 2016). The contamination of groundwater can lead to poor drinking water quality, health, and environmental problems, increased treatment and cleanup costs, loss of water supply, and increased cost for developing alternative water supplies (Nas and Berktay, 2010). The quality of groundwater determines its suitability for any use. Consequently, for sustainable and safe use of water there is a need for groundwater quality assessment.

V. CONCLUSION

The study showed no significant changes in the average concentration of the heavy metals assessed through the different seasons. The concentration of Lead for the different quarters were found to be higher than the recommended WHO and NIS standards for drinking water; Ikorodu groundwater poses a potential health risk for her residents. It is recommended that residents treat the water to remove Lead before to consumption.

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