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Assessment of Heavy Metal Contamination and Related Risks in well water Sources from Angwa Ashanu Gwagwalada

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ABSTRACT: Consumption of water with heavy metals can accumulate in the body and heighten the likelihood of cancer and other health risk diseases. This study assessed four specific heavy metals, namely lead, cadmium, mercury, and arsenic, in well water samples collected from AngwaAshanuGwagwalada. The analysis was carried out using an atomic absorption spectrophotometer (AAS) and ultraviolet-visible spectrophotometer (UVS) adhering to standardized protocols. The results show that the heavy metals present in AngwaAshanuGwagwaladawell water is as followed: for lead (0.002 mg/L), cadmium (0.020 mg/L), and mercury (0.000 mg/L), and the results were compares with the WHO standards, it was observed that lead and arsenic were above the maximum permissible limit which signifies a potential health risk if used without appropriate treatment. The high level of arsenic 0.059 mg/L may likely be linked to human activities in the area. However, according to regulatory standards, the well water examination revealed that the quantities of mercury, and cadmium were all within permissible ranges.

KEYWORDS: Heavy metal, Absorption spectrophotometer, Ultraviolet-visible spectrophotometer, Well water, Concentration

I. INTRODUCTION

Freshwater is considered a renewable resource; the availability of clean and fresh water worldwide is diminishing gradually due to water-related diseases that are responsible for about 80 % of human illness as a result of unhygienic activities and practices that contaminate the water [1]. Contaminants with water comefrom various sources, either through anthropogenic sources or natural sources which reduce the amount of water to the populace, and consequently pose health risks that are directly linked with water[2]; [3].

In the past two decades, extensive research has focused on understanding the relationship between drinking water and chronic diseases [4]; [5]; [6]; [7]. The chemical composition of drinking water has emerged as a significant factor contributing to various ailments. Contaminated drinking water containing heavy metals such as lead, cadmium, arsenic, and mercury has been linked to chronic conditions like renal failure, kidney stones, liver cirrhosis, hair loss, and chronic anemia [8]; [2]; [9]. This has posed a continuing threat to the population of AgwanAshanuGwagwalada area council in Abuja due to the lack of comprehensive data on heavy metal concentrations which hinders our understanding of the extent and severity of contamination, as well as the potential health risks posed to the area population.

Additionally, the absence of robust data limits the development of effective regulatory frameworks to protect public health and ensure the long-term sustainability of groundwater resources in this area. To address these issues, we conducted a comprehensive assessment that provided crucial insights into the extent of contamination by determining the levels of lead, cadmium, mercury, and arsenic in well water sources in AgwanShanu, assessed the compliance of measured heavy metal concentrations with relevant national and international regulatory standards,and identify potential sources and pathways of heavy metal contamination in the well water sources. The results of the findings support sustainable water resource management, guiding decisions to ensure the availability and quality of groundwater for future generations. Additionally, the studyalso facilitates the establishment of guidelines and

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standards for safe drinking water supplies, benefitting various stakeholders, including communities, government agencies, water resource managers, and researchers in the field.

II MATERIALS AND METHOD

Study Area

AngwaShanu is situated within the geographical area of Gwagwalada Area Council in Abuja, Nigeria. The community falls under the Gwagwalada area council and covers an area of 206 square kilometers. According to the 2006 census, the population of AngwaShanu was recorded as 1,014 individuals. AngwaShanu is a residential area. The climate of AngwaShanu is defined by high temperatures and low annual rainfall, particularly in the northern region. Rainfall ranges between 400 mm and 800 mm annually, with an average of 750 mm per year. The mean annual temperature is approximately 39°C, with monthly values ranging from 27°C in the coolest month of December to January, to 32°C in the hottest month of April to May. Figure 1 depicted the geographical map of the study area.

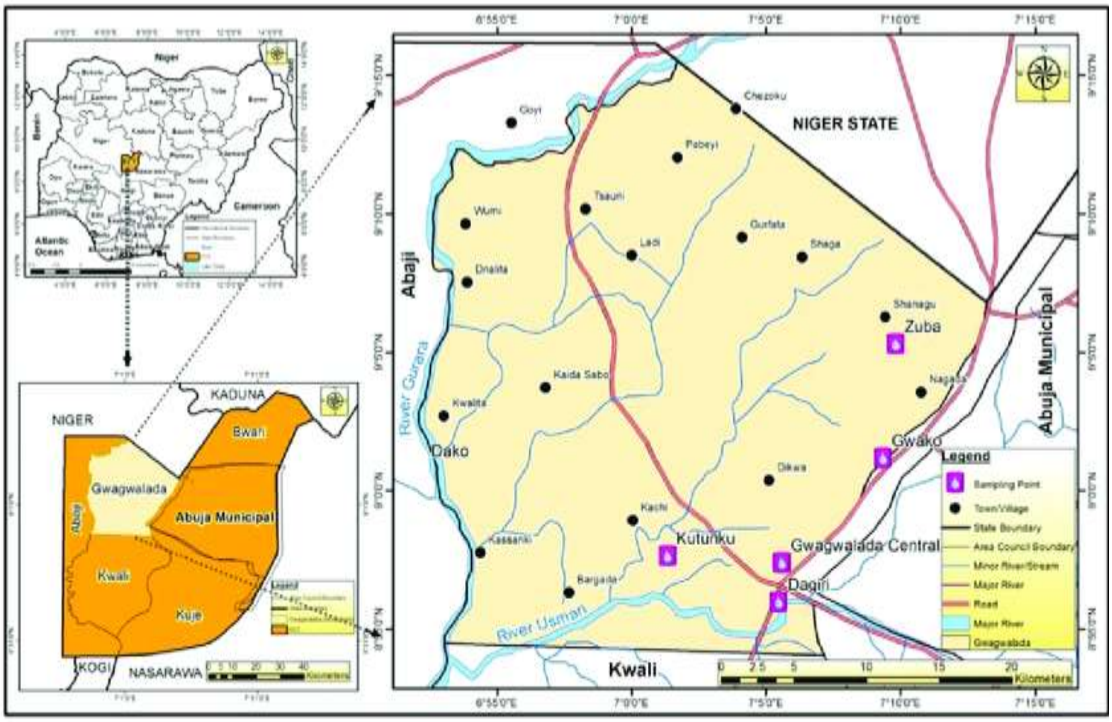

Figure 1: Map of the Study Area

Sample Collection

Water samples were collected from the study area. The water samples were stored in pre-cleaned 75cl plastic bottles, which were washed and rinsed with the same well water. Each sample was properly labeled and transported to Sheda, for analysis using standard laboratory techniques. Figure 2 depicts the example of the well water where the sample was collected in AngwanShanu.

Figure 2: Well in AngwanShanu

Sterilization of Glass Wares

To eliminate any potential presence of impurities, a thorough cleaning of all glassware employed in this study was conducted. The glassware underwent a meticulous cleansing process, involving the use of soap and distilled water, after being immersed in a chronic acid solution for a duration of 12 hours. Following this cleaning procedure, the glassware was carefully washed and subsequently stored in a temperature-controlled oven at 110°C until the time of analysis. This rigorous cleaning and storage protocol ensured the integrity and purity of the glassware, thereby minimizing the risk of contamination during the analysis phase.

Comparison with Control

To ensure the accuracy and precision of the measurements, quality control methods were implemented. In the case of atomic absorption spectrophotometer (AAS), calibration and quality control were performed using a blank sample as well as standard reference materials with known concentrations of Cadmium, Lead, Mercury, and Arsenic. The blank sample was utilized for calibration purposes, while the standard reference materials were employed for quality control. Similarly, for the Ultra-visible spectrophotometer (UVS), calibration and quality control procedures involved the utilization of a blank sample, accepted reference materials, and reagent blanks, respectively. These rigorous quality control techniques played a crucial role in verifying the correctnessand reliability of the measurements obtained using both AAS and UVS methods.

Laboratory Analysis Techniques for Heavy Metal Determination

The sample of wellwater obtained from AngwanShanu in Gwagwalada was assessed to determine the contaminated level of lead, mercury, cadmium, and arsenic byemploying two distinct analytical techniques which are Atomic Absorption Spectroscopy (AAS) and Ultraviolet Spectrometer (UVS).

AAS played a pivotal role in determining the concentration of metals present in the samples. This technique harnessed the power of a laser beam that traversed through the sample containing the metal of interest. As the laser beam interacted with the sample, the atoms of the metal selectively absorbed specific wavelengths of light, enabling precise measurement of the metal concentration. By leveraging this property, AAS provided valuable insights into the amounts of lead, mercury, cadmium, and arsenic within the well water samples.

Complementary to AAS, UVS offered a powerful approach to evaluate the concentration of organic chemicals in the samples. By employing a laser beam, UVS probed the targeted organic compound within the sample. As the laser beam penetrated the sample, the organic chemical selectively absorbed certain wavelengths of light, thereby allowing for the determination of its concentration. This application of UVS facilitated the assessment of organic contaminants within the well water samples, enhancing the understanding of the overall water quality.

To ensure accuracy and reliability, before the analysis, the equipment used for AAS and UVS underwent calibration. This involved the utilization

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of reference solutions with known concentrations of specific analytes, such as lead, cadmium, mercury, and arsenic. By calibrating the equipment using these established standards, precise measurements and comparisons were made, enabling accurate assessments of metal and organic chemical concentrations within the well water samples.

III RESULTS AND DISCUSSION

The water samples were collected and analyzed in line with established methods and protocols to guarantee the correctness and dependability of the data obtained.

The findings of the study of the well water in AngwaShanuGwagwalada for lead, cadmium, mercury, and arsenic were presented. The analytical techniques of AAS and UVS were used to calculate the measured concentrations of each heavy metal and the results is displayed in Figure 3. The concentrationsresult for each of lead, cadmium, mercury, and arsenic using AAS and UVS was averaged and compared with the World Health Organization's (WHO, 2010) as in Table 1.

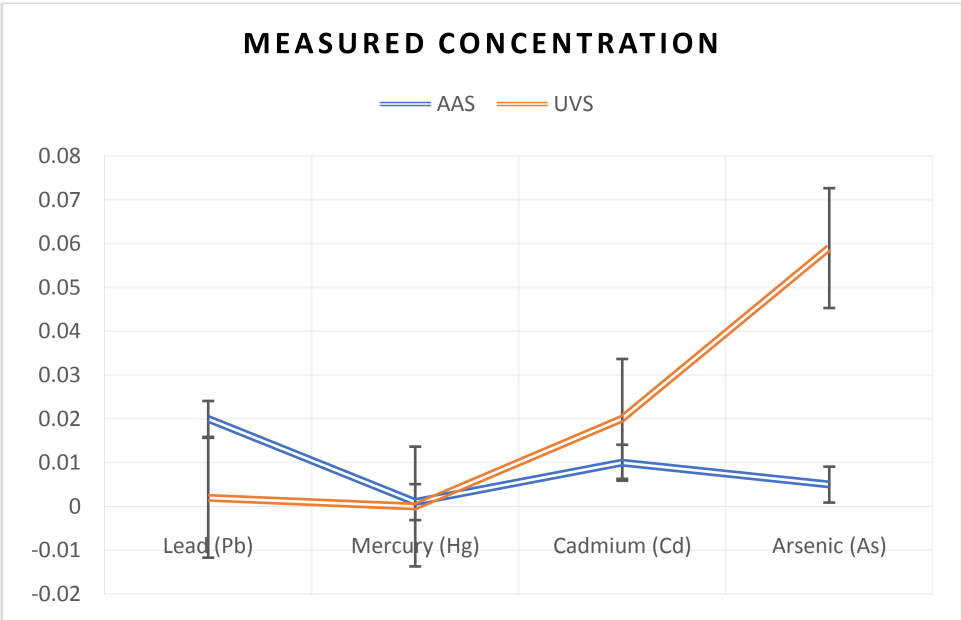

Figure 3: Measured Concentration of Heavy metals using AAS and UVS

TABLE 1: THE HEAVY METAL COMPOSITION OF GWAGWALADA WELL WATER

PARAMETER	METHOD	MEASURED CONCENTRATION (MG/L)	MEAN VALUE CONCENTRATION (MG/L)	W.H.O MAXIMUM CONTAMINATION LEVEL (MG/L)
Lead (Pb)	AAS UVS	0.020 0.002	0.011	0.010
Mercury (Hg)	AAS UVS	0.001 0.000	0.0005	0.030
Cadmium (Cd)	AAS UVS	0.010 0.020	0.015	0.040
Arsenic (As)	AAS UVS	0.005 0.059	0.032	0.010

Figure 3 presents the results of measured concentration of lead (Pb), mercury (Hg), cadmium (Cd) and arsenic (AS) in well water using AAS in comparison with the results using UVS for measurement. Both instrument show different value for each of heavy metal measured. For clarification, numerical values were presented in Table 1. It was noted that concentration of lead (Pb) in well water using AAS was 0.020 mg/L while that of UVS was 0.002 mg/L the means value of AAS and UVS was

0.011 mg/L when compared with regulatory guidelines, we found that lead concentration in Gwagwalada well water is slightly higher than maximum contaminant level (MCL) with a difference of 0.001 mg/L.Analysis of mercury (Hg) using AAS was 0.001 UVS read 0.000 mg/L. the mean value of were compared with regulatory guidelines or standards.This falls below the maximum contaminant level (MCL) of 0.030 mg/L set by the World Health Organization (W.H.O).

Concentration of cadmium (Cd) in Gwagwalada well water by using AAS method of analysis reads 0.010 mg/Lwhile UVS reads 0.020 mg/L with the mean of 0.015 mg/L which fall below the maximum contaminant level (MCL), which is established at 0.040 mg/L.Concentration of arsenic presents in Gwagwalada well water when use AAS for analysis was 0.005 mg/L and that of UVS was 0.059 mg/L with the mean value of 0.032 mg/L which ii above the maximum contaminant level (MCL) of 0.010 mg/L set by the World Health Organization (W.H.O) Regulatory Guidelines.

IV CONCLUSION

This study of assessed the heavy metal contamination and related risks in groundwater sources from AngwaAshanuGwagwalada, FCT, Abuja. AAS and UVS were used to measure the levels of lead, cadmium, mercury, arsenic and mercury. The mean concentration of Lead and arsenicin well water sourceare 0.011 mg/L and 0.032 mg/L respectivelywhich were both above the maximum contaminant levels (MCL) of 0.010 mg/Lestablished by the World Health Organization (WHO). Mean concentration of mercury is 0.005 mg/L and cadmium is 0.015 mg/L. both mercury and cadmium concentrations are below the MCLs established by the WHO which are 0.030 mg/L and 0.040 mg/L respectively.Although, the detected quantities presented in these studies were within permissible ranges except lead and arsenic.It must be noted that short-term exposure to low concentrations of these metals can significantly be harmful to human health. In other to guarantee the safety range of the concentrations of these metals, it is advisable to routinely monitor this well water. Furthermore, the analysis was constrained by the sample size and detection limits of the analytical techniques employed. To fully determine the well water's quality, more tests could be required.

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