



Selected Trace Heavy Metals Concentrations in Well and Borehole Water in Aliero Metropolis

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Authors' contributions

This work was carried out in collaboration between all authors. Author ISS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SAK, SU and MHA managed the analyses of the study. Authors ISS and SAK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Human activities had been the major causes of water pollution, and the presence of heavy metals could be an indicator that water bodies are polluted. This research examined the concentration of heavy metals in well and bore hole water from three different areas (Bodiga, Labana farm and Kalli) in Aliero town. The analysis was conducted using Atomic Absorption Spectroscopy. The concentrations of the metals in sample A (Bodiga area) are in the order Fe 1.638 ± 0.0011 > Mn 0.172 ± 0.0002 ppm > Pb 0.113 ± 0.0001 ppm > Cu 0.081 ± 0.0006 ppm > Ni 0.001 ± 0.0002 ppm, and the concentration in sample B (Labana farm bore hole water) is in order of Fe 1.260 ± 0.0016 ppm > Pb 0.234 ± 0.0002 ppm > Mn 0.100 ± 0.0001 ppm > Cu 0.060 ± 0.0002 ppm. And in sample C (Kalli well water) the concentration of metals is in order Fe 1.973 ± 0.0011 > Pb 0.323 ± 0.0002 > Mn 0.186 ± 0.0003 ppm > Cu 0.101 ± 0.0003 ppm > Ni 0.012 ± 0.0003 ppm. The concentrations of Fe and Pb in all the three sources of water was found to be above the WHO standards while copper, nickel, and manganese were found to be below the maximum limit of WHO standards. The inhabitants who used the water for both consumption and domestic purposes should be enlightened on the toxicological effects of these heavy metals to human health, plants and animals. There is therefore the need for proper monitoring of the water by the agency's concern.

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1. INTRODUCTION

Water is an indispensable substance for the sustenance of plants and animals including man. Water is obtainable to man as a ground and surface water in lakes and rivers [1]. Water contains impurities as they flow through streams, gather at the lakes and filter through layers of soil and rock in the ground, they dissolve or absorb substances they come in contact with, which may be harmful [2]. The acceptability of water is evaluated in terms of quality requirements for a specific use. All water made for human consumption should be potable, free from disease-causing organisms, mineral and other organic substance that could impair human health [3,4,5].

Pure water is hardly found naturally due to impurities found everywhere; these impurities may include suspending colloidal or dissolved substances. These impurities are removed to an accepted limit using different method of removal or reduction. There are acceptable guidelines laid down by world health organization (WHO) for the acceptable quality of potable supplies of water.

Water is one of the most essential elements of life on Earth. In its purest form, it's odorless, colorless and tasteless, but due to human and animal activities, it is usually contaminated with solid and human waste, effluents from chemical industries and dissolved gases [6,7]. The acid rain is another major water contaminant in addition; water contains some amount of mineral constituents such as iron. (Fe) magnesium (Mg), lithium (Li), zinc (Zn), copper (Cu), chromium (Cr), nickel (Ni), cobalt (Co), vanadium (V), arsenic (As), molybdenum.(Mo), selenium (Se), lead (Pb) and so many others [8]. The presence of these toxic metals in excess concentration in the environment has been a source of worry to the environmentalists, government agencies and health practitioners [9]. This is mainly due to their health implications when in higher concentrations, and some of them are non-essential metals of little or no benefit to humans [10].

Many of these minerals are required micronutrients such as copper and selenium. Concentrations of trace elements in water vary because of physiological, environmental and other factors [11]. Some trace elements have several roles in living organism. Some are essential components of enzymes where they attract substrate molecules and facilitate their conversion to specific end products [12]. In excessive concentrations, however, trace elements such as Fe, Cd, Ni, Cu, Hg, Mn and Cr, can negatively affect growth and reproduction. A safe and portable drinking water should conform to certain standards set by World Health Organization [13] (i,e Cu is 2.0mg/l, Pb 0.01mg/l, Ni 0.02mg/l, Hg 0.001mg/l, Cr 0.05mg/l) [14,15].

Boreholes and wells are groundwater types that form an integral part of water supply system in urban and rural communities of Nigeria, and so can be described as indispensable because of inadequate public water supply systems in most communities in Nigeria [16]. According to Egwari and Aboaba [17], natural processes and anthropogenic activities of man can contaminate groundwater, and such activities could be domestic, agricultural or industrial in nature. Uncontrolled discharge of toxic effluents to the soil, stream and rivers by industries and indiscriminate dumping of garbage and faeces have been reported to heavily contaminate groundwater in Nigeria [18]. Anaele, [19] reported that residential wells and boreholes water are contaminated by sewage from the numerous septic tanks, latrines, and soak away pits often sited near them. The majority of peoples drink water from these

groundwater sources without any form of treatment. Indiscriminate dumping of materials laden with lead and other toxic metals on land and use of leaded gasoline had been shown to contribute to the lead load of underground water sources of many Nigerian cities [18,20]. The aim of this study was to investigate the concentrations of heavy metals from the different sources of water (labana borehole, kalli and bodiga wells) in Aliero.

1.1 Justification for the Study

This study hopes to provide detailed information on the various heavy metals and their degree of concentration from wells and borehole water. The outcome is likely to help in reducing the effect of these substances on human health.

2. MATERIALS AND METHODS

2.1 Sampling Location

Bodiga, Kalli and Labana were located in Aliero local Government area of Kebbi State (Figs. 1 and 2). It is at latitude 12°16' 42"N and 12.27833°N and longitude 4°27'6"E and 4.45167°E.



Fig. 1. Map of Kebbi State

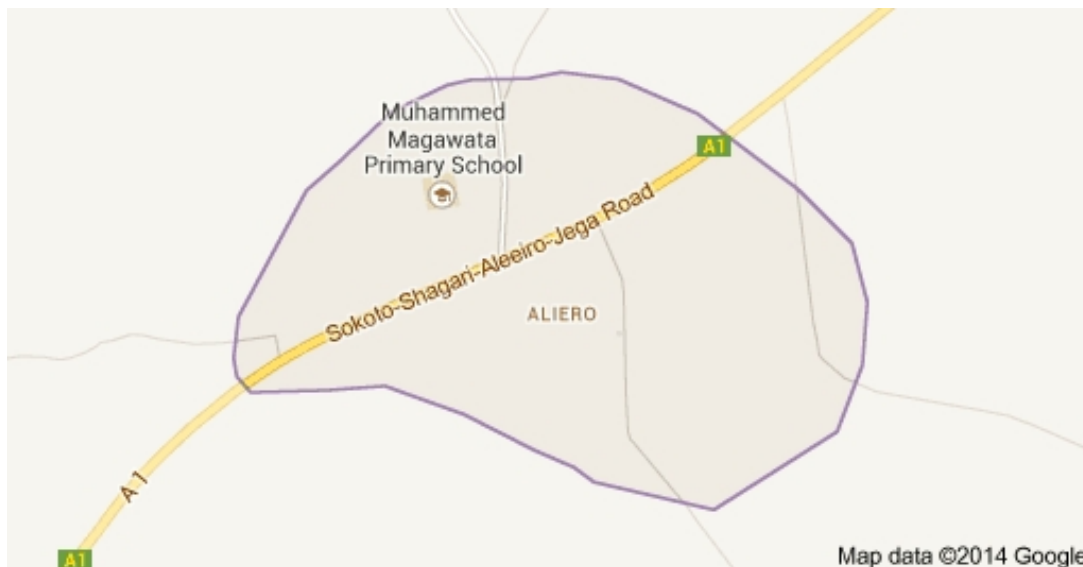


Fig. 2. Map of Aliero metropolis

2.2 Sample Collection and Preparation

Samples of water were collected from the three different sampling sites (two wells Bodiga and Kalli and one borehole labana), the well waters were collected using a plastic drawer tied to a rope and were transferred to 10litres plastic kegs after rinsing them with the well water, while that of the borehole was collected directly into the 10litres keg after rinsing with the sample water. The containers were tightly covered and stored in refrigerator 4°C in the laboratory until digestion.

2.3 Sample Digestion Procedure

The sample water was filtered, after the filtration 50cm³ of sample water were measured into beakers. 5cm³ of concentrated HNO₃ were added to the measured samples. The samples were heated on a hot plate in a fume cupboard to nearly dryness with characteristic color indicating complete digestion. After which the samples were allowed to cool, then transfer to a 50cm³ acid washed volumetric flasks and volume filled to 50 marks with deionised water. The samples were filtered and kept in sample bottles ready for atomic absorption spectrophotometer [21].

2.4 Statistical Analysis

Data obtained were analyzed using descriptive statistics for the mean and standard deviation, one way ANOVA was used to test the significant differences in the concentrations of heavy metals in wells and borehole water.

3. RESULTS AND DISCUSSION

Water being an important solvent needed for the sustenance of life is threatened by heavy metal contaminants, thus this has become a main concern to the scientist because of their

serious health effects on man. Enlightenment on the concentrations of these metals is vital because it helps in its management.

In this study, it was observed that the highest concentration of Lead (0.323ppm) was found in Kalli well and the lowest (0.113ppm) was found from Bodiga well Table 1. All the values were found to be far above WHO permissible limits for drinking water (0.01ppm) Table 3. The highest concentration in Kalli could be as a result of the use of leaded petrol in cars, generators and water pumps because the well is located by the road side and around irrigation farms. It could also be because of the mechanic workshop which is very close to the well [22].

The highest concentration of Lead in all the three samples could pose a threat to human health that depends on the water for drinking and domestic purposes. Iron concentration in all the samples revealed by the analysis was found to be higher than the WHO permissible limits for drinking water Table 3 (0.30ppm) with the highest concentration (1.973ppm) in Kalli well Table 1 and the lowest (1.260ppm) in Labana borehole water Table 2. The high concentration of Iron could be as a result of clay deposits in those areas [23]. Despite the highest concentration of Manganese (0.186ppm) from Kalli well Table 1 and the lowest from Labana borehole (0.100ppm) Table 2 all were below the WHO permissible limits (0.50ppm) Table 3. The result showed that Nickel could not be detected in Labana bore hole, and in both Bodiga and Kalli (0.001 and 0.012ppm) respectively Nickel concentration was found to be lower than the WHO permissible limits for drinking water (0.02ppm). The lower level of Nickel could be as a result of absence of igneous rock in the study area.

In this study it was observed that Copper concentrations in all the three sites were lower than the WHO permissible limits (2.00ppm) Table 3. However, except of Copper the concentrations of all the metals were higher in the wells and low in the borehole. This could be because the wells are open and not deep, while the borehole is very deep and always closed.

Table 1. Mean concentrations of Heavy metals (ppm) in well samples from Aliero metropolis

Toxic metals	Bodiga well	Kalli well
Lead	0.113±0.0001 ^c	0.323±0.0002 ^a
Iron	1.638±0.0011 ^b	1.973±0.0011 ^a
Manganese	0.172±0.0002 ^b	0.186±0.0003 ^a
Copper	0.081±0.0006 ^a	0.101±0.0003 ^a
Nickel	0.001±0.0002 ^b	0.012±0.0003 ^a

The data are mean values ± standard deviation (SD) of three replicates. In all metals and locations P<0.05 showing significant difference, except in Cu where P>0.05 showing no significant difference

Table 2. Mean concentration of Heavy metals (ppm) in Labana borehole

Toxic metals	Lead	Iron	Manganese	Copper	Nickel
Mean concentration borehole water	0.234±0.0002 ^b	1.260±0.0016 ^c	0.100±0.0001 ^c	0.060±0.0002 ^a	ND

ND not detected, the data are mean values ± standard deviation (SD) of three replicates

Table 3. WHO permissible limits

Toxic metals	Lead	Iron	Manganese	Copper	Nickel
WHO limits	0.01	0.30	0.50	2.00	0.02

WHO world health organization

4. CONCLUSION/RECOMMENDATION

Although heavy metals such as Fe, Mn and Cu play biochemical roles in the process of life and are required in traces, at high concentrations, these heavy metals are toxic to human life and animals by affecting their reproduction and other physiological function. Constant monitoring of water in Aliero is therefore recommended so as to reduce the long term effect of these toxic metals in humans. Wells should therefore be dug deeper and be properly covered to help reduce the contamination of drinking water by these heavy metals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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