Kwaghe International
Journal of Sciences and Technology

ISSN : 0000-0000
Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/KIJST.v1i1.3567

Determination of Trace Metals in Borehole, Tap, and Well Water from Dawakin Kudu Local Government Area of Kano State, Nigeria

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Jul 1, 2024	Jul 20, 2024	Jul 27, 2024	Jul 31, 2024

Abstract

This study investigates the concentration of trace metals in borehole, tap, and well water samples from Dawakin Kudu Local Government Area in Kano State, Nigeria. Understanding the levels of trace metals in these water sources is crucial for assessing potential health risks and ensuring safe drinking water for the local population. The samples undergo evaporation to dryness and are then pre-concentrated with 0.5 M nitric acid. The metals were analyzed using an atomic absorption spectrophotometer *(AAS)*. The study found that all samples had iron concentrations, with the highest concentration in tap water (722.976 µg/L) and the lowest in well water (36.504 µg/L). Cadmium concentrations were highest in sample B (0.114 µg/L) and lowest in sample D (0.018 µg/L), all below WHO's permissible limit of 3 µg/L. Nickel concentrations were highest in sample C (0.336 µg/L), lowest in sample A

(0.384 μg/L), and not in samples B and D (0.384 μg/L). Lead concentrations were only detected in samples A and B (0.384 μg/L), all below WHO's permissible limit of 10 μg/L. Iron was high compared to the permissible level of trace metal in water, but only in sample C, among all the samples, sample C is the safest water for drinking.

Keywords: Borehole Water, Tap Water, Well Water, Trace Metal

INTRODUCTION

Water is crucial for all aspects of life, the defining feature of our planet. Ninety-seven and a half per cent of all water is found in the oceans; of the remaining freshwater only one per cent is accessible for extraction and use. Functioning and healthy aquatic ecosystems provide us with a dazzling array of benefits – food, medicines, recreational amenity, shoreline protection, processing our waste, and sequestering carbon. Declining water quality has become a global issue of concern as human population grow, industrial and agricultural activities expand and climate change threatens to cause major alterations to the hydrological cycle(Abubakar M.Y *et al.,* 2024). At the beginning of the 21st century, the world faces a water crisis, both of quantity and quality, caused by continuous population growth, industrialization, food production practices, increased living standards and poor water use strategies. Water is essential to life and because of its importance; the pattern of human settlement throughout history has often been determined by its availability (Dobson and Burgess 2007).

Water is exposed to innumerous natural and/or anthropogenic influence in the form of pollutants including toxic metals such as lead, cadmium and chromium. Rivers are the dominant pathway for metals transport (Mendie 2005), in all three states makes a large contribution to the planet's climate. Water vapor is a greenhouse gas that traps energy radiated from the surface of the planet and helps to keep the planet warm enough to sustain the complex life that has evolved in this environment. Water vapor is responsible for more than half the Earth's greenhouse gas warming. On the other hand, clouds and ice fields on the Surface reflects a good deal of the radiation from the sun, so this radiation does not reach the surface and warm it. The reflectivity of clouds and ice has a cooling effect on the planet. However, where the earth's surface has been heated by solar (Alabaster and Lloyd, 1982).

Due to the use of contaminated drinking water human population suffer from varied of water borne diseases it is difficult to understand the biological phenomenon fully because radiation, clouds help trap energy radiated from the heated surface and thus have a warming effect as well. Variations in the amount and form of water in the atmosphere have a complex relationship to our climate that is difficult to model and predict the chemistry of water revels much about the metabolism of the ecosystem and explain the general hydro biological relationship (Basavaraja et al.2011).

Pure water is colorless, odorless, and tasteless and so common that you probably never think about how unique it is and how essential to life. Most plants and animals contain more than 60% water by volume. Without water, life would not have evolved on Earth, and it is the presence of water on Mars and some moons of Jupiter and Saturn that causes us to speculate about past or present life there as well (Chiaudani and Premazzi1988).

Water has a number of unique chemical and physical properties that make it essential for life. One such property is familiar to everyone: solid water floats on liquid water. Almost all liquids contract when they get colder and reach a maximum density when they solidify. Water is different. As water cools, it contracts until it reaches 4 C, then it expands until it freezes at 0 C. Ice is less dense than water which allows ice cubes to float in a soft drink, icebergs to float in the ocean, and ponds and lakes to freeze from the top down so that aquatic plants and animals can survive in the unfrozen liquid below (Dick, 1975).

Heavy metals are non-biodegradable and thus persist in the environment, potentiallyinfiltrating the food chain via crop plants and accumulating in the human body through biomagnification. Due to their toxic nature, heavy metal poisoning poses a severe threat to human health and the environment (Abubakar, M. Y *et al.*, 2024),

Source of Water

Ground water has historically been considered as reliable and safe source of water protected from safe contamination by geological filters that removes pollutants from water as it is percolated through the soil (Prasad and Chandra1997)

Surface Water

This type of water may be from the rivers, streams, ponds, lakes, etc. It usually contain suspended solids of decaying organic matter, sand, clay, micro-organism and small amount of ions such as Ca^{2+}' Mg^{2+},Na^{+},SO_4^{2-},Cl^{-}etc mostly dissolved from the top soil (Vermani and Narula, 1989).

Sea water is also a type of surface water that contains dissolved minerals in high concentration of about 3.5% of which 2.6% is sodium chloride (Vermani and Narula, 1989).

Heavy Metals

The term heavy metal has been given a wide range of meaning by different authors. Many different definitions have been proposed, some based on density, atomic number or weight and chemical properties or toxicity.Heavy metals are bio concentrated or bio accumulated in one or several compartments across food webs. Metal bioaccumulation can be of importance from the public health point of view, especially for human at the end of the food chain. An important link in the transfer of heavy metals from soil/sediment to man is plants (Ostapezuk et al., 2001).

The development of humans and society since prehistoric times has been closely linked with an increasing ability to manage the soil to human benefit. This progress has been achieved by adjusting the balance between the soil and its natural environment. These adjustments have not always resulted in positive responses and bene- fits, and there are records throughout history describing soil destruction as a result of mismanagement and misuse of the soil, often as a result of the failure to understand the nature and complex of the soil environment relationships. (Shittu et al., 2024). Heavy metal pollution is a significant environmental issue that affects the health of aquaticecosystems, terrestrial ecosystems, and human populations. Heavy metals, including lead(Pb), mercury (Hg), cadmium (Cd), arsenic (As), and chromium (Cr), are persistentpollutants that can have long-lasting effects on the environment due to their toxicity,persistence, and bioaccumulation potential (Abubakar, M. Y., et al., 2024).

The presence of heavy metals in the water may have a profound effect on the microalgae which constitute the main food source for bivalve mollusks in all their growth stages, zooplankton (rotifers, copepods, and brine shrimps) and for larval stages of some crustacean and fish species. Moreover, bio concentration and magnification could lead to high toxicity of these metals in organisms, even when the exposure level is low. Under such conditions, the toxicity of a moderately toxic metal could be enhanced by synergism and fish population may decline. Apart from destabilizing the ecosystem, the accumulation of these toxic metals in aquatic food web is a threat to public health and thus their potential long-term impact on ecosystem integrity cannot be ignored [D.O.Ogoyi et al 2011].

MATERIALS AND METHODS

All the reagents used were of analytical grade. Water samples were analyzed using Atomic Absorption Spectrophotometer. The AAS was used because it has advantage over colorimetric method due to its high sensitivity, detection limit, degree of accuracy and reproducibility with the ease of sample preparation and handling. Concentrated Nitric Acid (Analargrade)

Study Area Description

Galadanchi is an area located in Dawakin Kudu Local Government Area Kano State, Kano is 481 meters (or about 1580 feet) above sea level. The city lies to the north of the Jos Plateau, in the sudanian savanna region that stretches across the south of the Sahel. The city lies near where the Kano and Challawa Rivers flowing from the southwest converge to form the Hadejia River, which eventually flows in to Lake Chad to the east. According to the 2006 census, Kano is the most populous state in Nigeria, with about 9,383,682 million people (Illife, 2007).

The region features savanna vegetation and a hot, semi-arid climate. Kano sees on average about 690mm (27.2 in) of precipitation per year, the bulk of which falls from June through September. Kano is typically very hot throughout the year; through from December through February, the city is noticeably cooler. Night time temperature is cool during the months of December, January and February, with average low temperatures of 11^0C-14^0C. Kano metropolis encountered problems of environmental sanitation due to improper refuse disposal and sitting industries in residential area. So,the level of heavy and trace metals was considerably expected to be high (observatory, 2012).

Sampling

The samples were collected randomly in various sites in Galadanchi area of Dawakin kudu LGA. The water samples were collected in clean 5 liter polythene plastic containers, the sample containers were rinsed with respective water sample before filling each with the sample, and were labeled A, B, C and D. For borehole and Sachet water, samples were collected from different direction, at an intervalthe tap was allowed to run for some minutes before filling the sample containers as to obtain a composite sample.

Methods

The samples were first allowed to settle followed by decantation. Exactly 5Litre of each sample is measured with measuring cylinder and transferred in to a pot for evaporation on sand bath. When the samples were reduced to about 1 Liter, the sample is poured in to Pyrex beaker (250cm^3) were the evaporation to dryness will be completed. The evaporated sample residue is dissolved in 30ml of 0.5M Nitric Acid in a beaker and then filtered and transferred in to 30ml sample bottle and made up to the marked with 0.5M nitric acid. And all the samples were analyzed using Atomic Absorption Spectrophotometry method (Jimoh 2011).

RESULTS

The concentration of the metals is analyzed using A.A.S machine from the experimental research that undergoes on some water samples in Galadanchi of Dawakin Kudu LGA of Kano state. Dilution equation ($c_1v_1=c_2v_2$) the actual concentration of the samples is calculated.

Table 1 concentration of metals in the samples

S/N	Sample I.D	Concentration in µg/L				
		Iron	Cadmium	Nickel	Lead	Chromium
1	Sample A	62.76	0.03	0.822	0.384	N.D
2	Sample B	135.906	0.114	0.003	0.336	N.D
3	Sample C	722.976	0.054	1.038	N.D	N.D
4	Sample D	36.504	0.018	N.D	N.D	N.D

Sample A = Borehole water 1, Sample B = Borehole water 2, Sample C = Tap water, Sample D = Well water, N.D = Not Detected, C_1=Initial concentration, C_2=Final concentration, V_1=Initial volume, V_2= Final volume

DISCUSSION

The result was been compared with drinking water standards provided by different agencies for example W.H.O, SON and others. Different water samples are analyzed in order to see how the metal varies in different area for each sample. Some of the samples analyzed were the permissible level of metal while others are above the limit provided by WHO.

IRON (Fe)

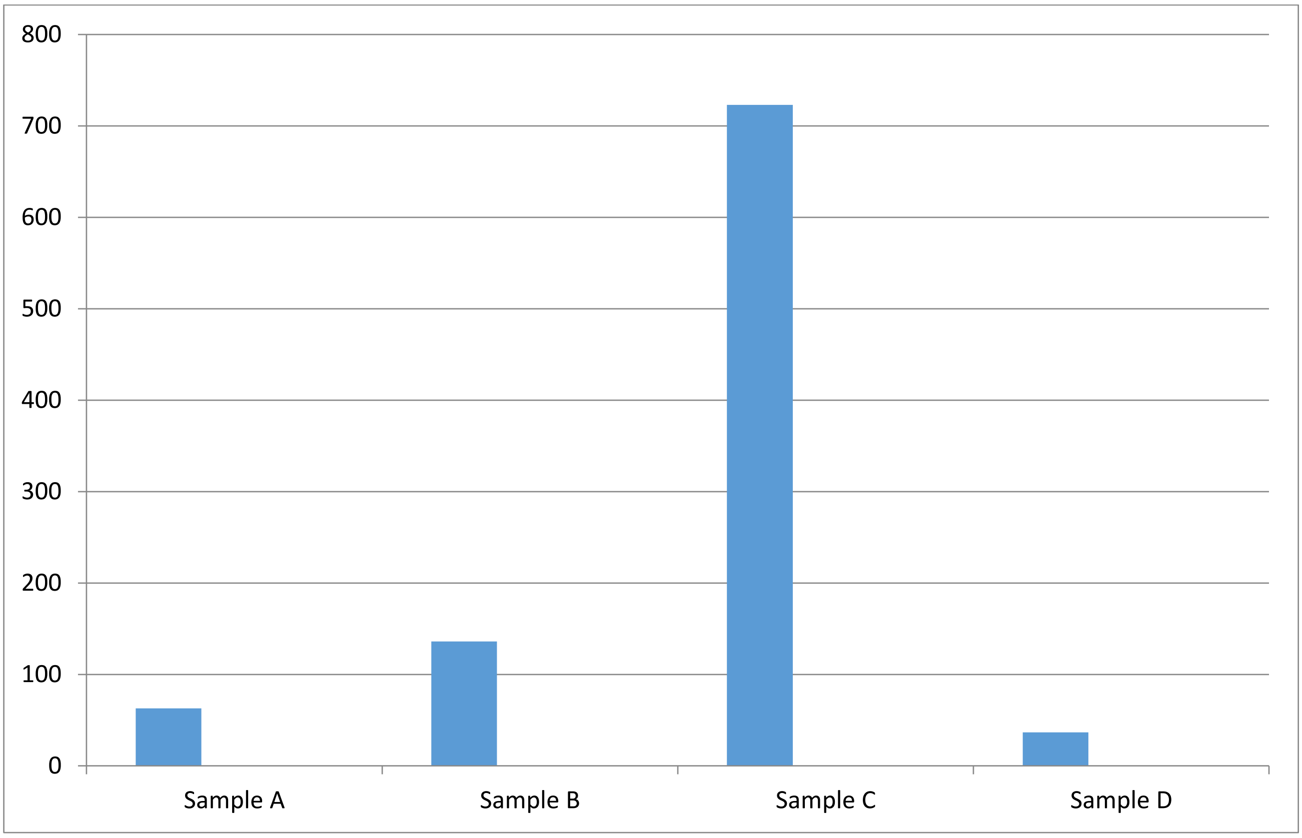

Fig 1: metal ion concentration

All the samples iron were detected but the highest concentration of iron is detected in sample C 722.976µg/L (Tap water) while sample D (Well water) shows the lowest concentration 36.504µg/L .Sample C is above the limit 200µg/L provided by (W.H.O 2011 and SON 2007).

CADMIUM (Cd)

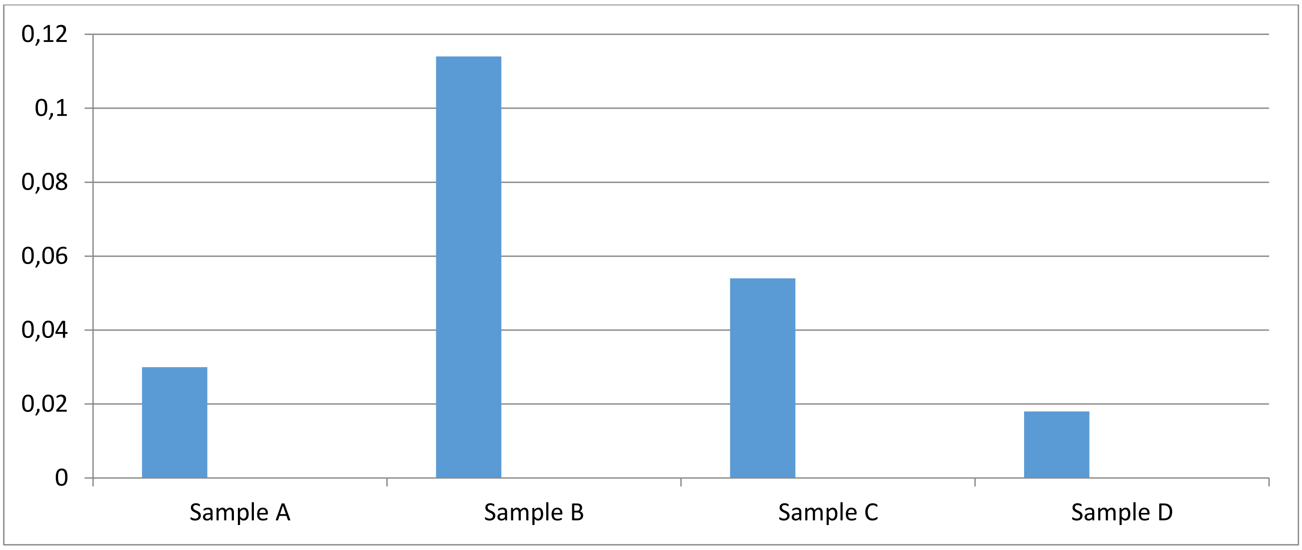

Fig 2.: cadmium concentration

The highest concentration of cadmium is detected in sample B 0.114µg/L and the lowest in sample D 0.018µg/L. All the samples are below the permissible limit provided by WHO which is3µg/L.

NICKEL (Ni)

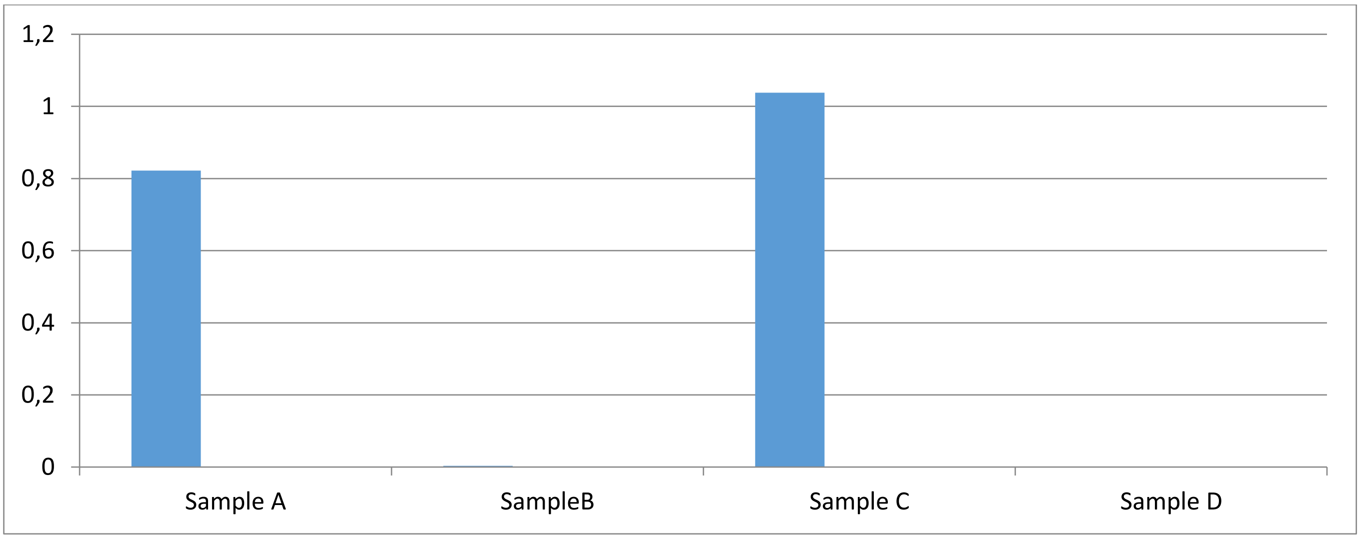

Fig 3: nickel concentration

Nickel was detected only in sample A and sample C, the highest concentration of nickel is detected in sample C 0.336µg/L the lowest concentration in sample A 0.384µg/L while sample B and D nickel was not detected. All the sample are below the limit 20µg/L provided by WHO (W.H.O 2011)

LEAD (Pb)

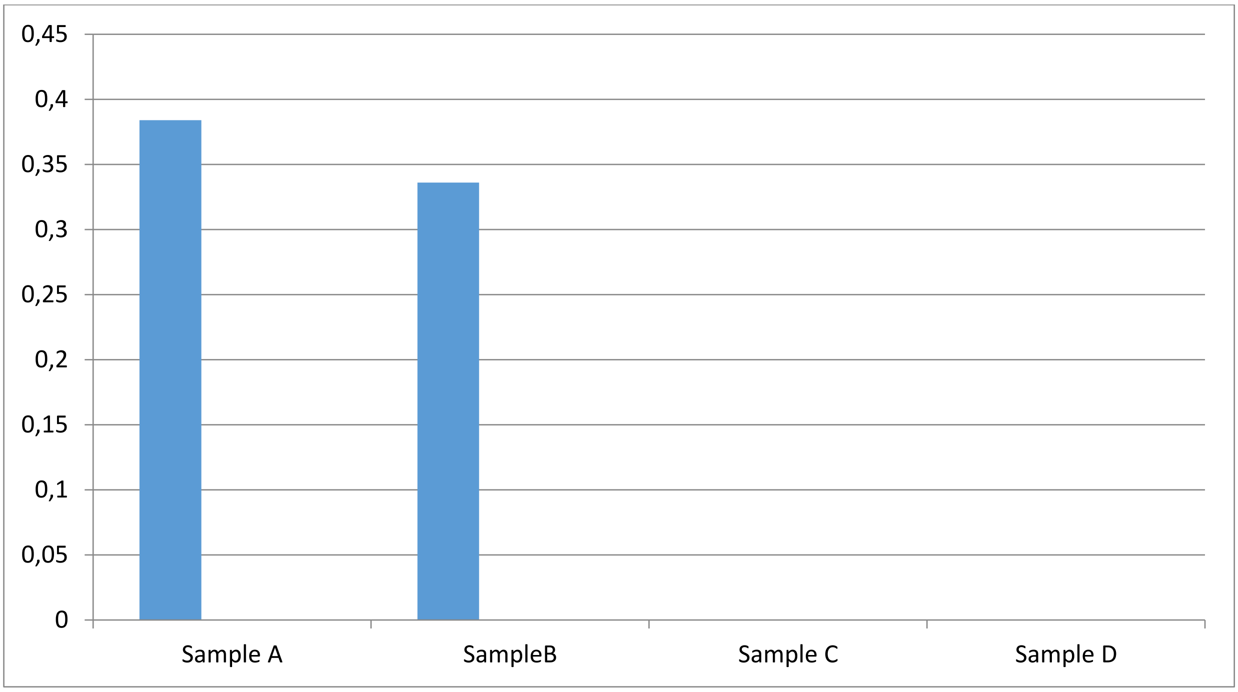

Fig 4: lead concentration

Among the entire sample, lead was detected only in Sample A 0.384µg/L and sample B 0.336µg/L. Based on permissible level of lead 10µg/L set by W.H.O the samples are all below the limit.

CONCLUSION

From trhe results ofd the findings, lead concentrations were only detected in samples A and B (0.384 µg/L), all below WHO's permissible limit of 10 µg/L. Iron was high compared to the permissible level of trace metal in water, but only in sample C, among all the samples, sample C is the safest water for drinking.

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