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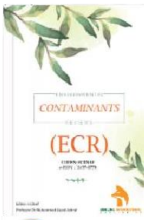

RESEARCH ARTICLE

ASSESMENT OF SOME HEAVY METALS CONTENT IN BOREHOLE WATER SAMPLES DRILLED NEAR PUBLIC CONVENIENCES IN KANO METROPOLIS, NIGERIA

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ABSTRACT

Boreholes have traditionally been one of the sustainable water sources for domestic use. However, in Kano state, Nigeria, some of these boreholes have been drilled close to soak ways or pit latrines without considering the possibility of water contamination. This research was carried out to assess some heavy metals in borehole water samples drilled near public conveniences in Kano, Nigeria. To achieve this, 31 samples were randomly collected from different sampling sites and analyzed for heavy metal content. Heavy metals were analyzed using an Atomic Absorption Spectrophotometer (Agilent 200 series Model No. 240 FS) and their concentrations were found to be in the range; For Fe (0.028±0.004-2.001±0.001 mg/L), Zn (0.019±0.002-0.138±0.015 mg/L), Pb (0.004± 0.000-0.057±0.002 mg/L), Cd (0.001±0.000-0.013±0.001 mg/L), while, most of the sampling sites had Fe levels to be within the WHO permissible limit with the exception of two sampling sites that exceed the WHO permissible limit, Zn was found to be within the maximum Permissible limit set by WHO (2020). Similarly, Cd and Pb were found to exceed the maximum permissible limit set by the WHO (2020) at most of the sampling sites analyzed. Analysis of variance showed a significant difference ($P < 0.05$) for all of the metals analyzed. It can be concluded that most of the analyzed borehole water is not safe for drinking and other purposes because its metal concentration exceeded the maximum permissible limit set by WHO. As a result, people should be aware of the dangers associated with the presence of these heavy metals in borehole water.

KEYWORDS

Boreholes, Kano, Cadmium, Lead, Zinc and Iron

1. INTRODUCTION

Water is regarded as one of the most fundamental components of existence, influencing practically every area of life. In numerous developing nations, water quality and the danger of waterborne infections are major public health problems. Today, billions of people in the developing countries lack access to safe and sufficient water (UNICEF/WHO, 2012). The World Health Organization (WHO) estimates that unsafe drinking water, inadequate sanitation, and poor hygiene practices cause around 94% of the worldwide diarrheal burden and 10% of the total disease burden (Fewtrell et al., 2007).

Pollution of groundwater occurs from a variety of sources, including an unsanitary working environment during borehole construction, splashing of run-off into wells if left uncovered, flooding at the borehole site, leachate from an old buried waste pit or latrine into the hole through cracks in the aquifer and annular of the hole, and borehole proximity to septic tanks, particularly where space is limited; boreholes are sometimes drilled in old garbage landfill site formations

Toilets, for example, enable individuals to satisfy their hygienic needs in public settings such as marketplaces and transportation hubs (Kolsky, 2006). Water could contain harmful inorganic compounds that can have either immediate or long-term health consequences. Nausea, lung irritation, skin rash, vomiting, disorientation, and, in rare cases, death is among the acute adverse effects. Cancer, birth abnormalities, organ damage, neurological system diseases, and immune system damage are often more prevalent (Erah et al., 2002). Inorganic substances, such as lead, can harm your health by interfering with red blood cell chemistry, delaying normal physical and mental development in infants and young children, shortening attention span, hearing, and learning abilities in children, and causing a slight increase in blood pressure in some adults. Furthermore, the presence of Cr in drinking water has been demonstrated in animals and people to induce long-term harmful consequences (including liver and kidney damage, internal bleeding, and respiratory issues). Although the sources of metal contamination in subterranean water are unknown, they might be caused by both natural and human processes (Erah et al., 2002).

There is a consensus that metals may react directly with DNA. Cross-linking between DNA strands is most likely the most detrimental metal-DNA interaction (Hussain, 2016). These metals are taken up by humans, animals, and plants from the environment, and long-term deposition causes harmful effects. Heavy metals, such as lead, iron, and zinc, have severe environmental and health consequences. Heavy metals cannot be biodegraded and hence persist in the environment for a long time. Previous research on borehole water in Kano investigated various physicochemical characteristics and heavy metal content in Kano municipal drinking water sources and revealed elevated heavy metal concentrations (Dabo and Saleh, 2017). The current study aimed to evaluate boreholes dug near public conveniences at various Kano City local governments.

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2.MATERIALS AND METHOD

Chromic acid was used to clean all glassware, which were then washed with deionized water. The standards for analysis were prepared using analytical-grade chemicals.

2.1 Field of Study

Kano is Northern Nigeria's largest and most populated metropolis. It's in latitude 12°02'n and longitude 08°30'E. There are a lot of public facilities found across the state, particularly in urban areas. To collect coordinates, GPS (EFREX 10 of Garmin Product) was utilized. Borehole water samples were taken from 31 distinct locations, and their proximity to public convenience is depicted in Figure 1.

2.2 Collection of Samples

Water samples were collected in 10 L clean and dry plastic containers. The sample bottles were filled after being washed three times with water. For each of the 31 sampling locations, a discrete sampling approach was used. Samples were collected in triplicate and mixed to obtain representative samples (USEPA, 2016).

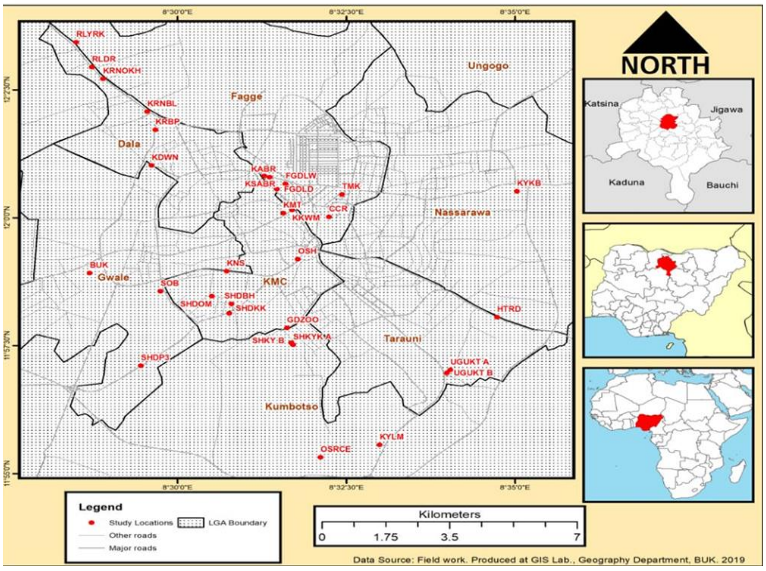

Figure 1: Map Showing Location Area

Table 1: Distance Between Soakaways and Boreholes

S/NO.	Sampling Sites	Distance (Metre)
1.	SHKYK A	13
2.	SHKYK B	13.8
3.	GDZOO	4.5
4.	OSH	18.3
5.	KNS	15.5
6.	SHDOM	9.5
7.	SHDBH	15.7
8.	SHDKK	15.3
9.	SHDP3	22.5
10.	SOB	4
11.	KYLM	12.3
12.	OSRCE	14.8
13.	UGUKT A	10.8
14.	UGUKT B	14.7
15.	HTRD	15.5
16.	KKWM	18.8
17.	KMT	34
18.	FGDLD	31.4
19.	FGDLW	14.3
20.	KABR	21.3
21.	KSABR	32.5
22.	KRNBL	18
23.	RLDR	18
24.	RLYRK	12.3
25.	KRNOKH	16.1
26.	KRBP	19.9
27.	KDWN	33.3
28.	KYKB	29.5
29.	CCR	6
30.	TMK	18.5
31.	BUK	22.6
	(WHO, 2006)	**≥ 15**

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2.3 Sample Evaporation and Digestion

5 L of each sample was collected in triplicate and evaporated to 100 ml on a hot plate before being dissolved in 25 ml of 0.025 M nitric acid. The digests were then filtered via a filter into a 100 ml volumetric flask with deionized water. The sample solutions were then put into 100-ml plastic bottles and AAS (Agilent 200 series Model No. 240 FS) was used to determine the concentrations of Cd, Pb, Zn, and Fe (Sachchida, 2011).

2.4 AAS Principle

The samples were atomized after being aspirated into the flame. The light beam goes through the flame, into a monochromator, and then into a detector, which detects the quantity of light absorbed by the atomized atom.

Over a narrow concentration range, the quantity of energy absorbed by the flame at a characteristic wavelength is proportional to the concentration of the element in the sample (FSSAI, 2015).

2.5 Determination of Heavy Metals

After tuning the lamps for 15 minutes, we read the iron working standard, followed by the samples at 248.3 nm. We used the equipment to record the absorbance of the working standard and the concentrations of the samples based on the calibration curve. The wavelength was then adjusted to 213.9 nm for zinc determination.

The equipment recorded the absorbance of the working standards and the concentrations of the samples from the calibration curve. The wavelength was changed to 217 nm for the analysis of Pb by using a new bulb in the lamp compartment. Using the instruments, the absorbance of the working standards and sample concentrations were recorded from the calibration curve. After that, the wavelength was changed to 228 nm for Cd analysis utilizing separate lamps in the lamp compartment. The equipment recorded the absorbance of the working standards as well as the concentrations of the samples from the calibration curve.

To minimize cross-contamination, the nebulizer was cleaned with deionized water after each sample was examined (FSSAI, 2015).

2.6 Data Analysis

JMP® 15 edition was used for descriptive statistics and one-way analysis of variance (ANOVA).

3. RESULTS AND DISCUSSION

3.1 Iron

The mean concentration of iron in the evaluated samples ranged from 0.028 to 0.004-2.001± 0.011 mg/L, as shown in Figure 2. The KNS sample location has the highest amount of Fe (2.001± 0.011 mg/l). Cast iron, steel, or galvanized iron pipes may be responsible for its high composition (National Research Council, 1997). This might also be linked to the high color and turbidity values obtained, which could stimulate bacterial development and contribute to water-borne illnesses (Ottawa, 1990). The lowest value (0.028± 0.004 mg/l) was recorded for KMT and KKWM. Abdul and Thabit (2016) obtained similar result; from the analysis of variance (ANOVA; F pr. p 0.001), there was a significant variation in iron levels among the borehole water samples. Approximately 95% of the samples evaluated fell under the World Health Organization's recommended level (0.3 mg/l) (WHO, 2020). The control sample had a concentration of (0.092± 0.007 mg/l).

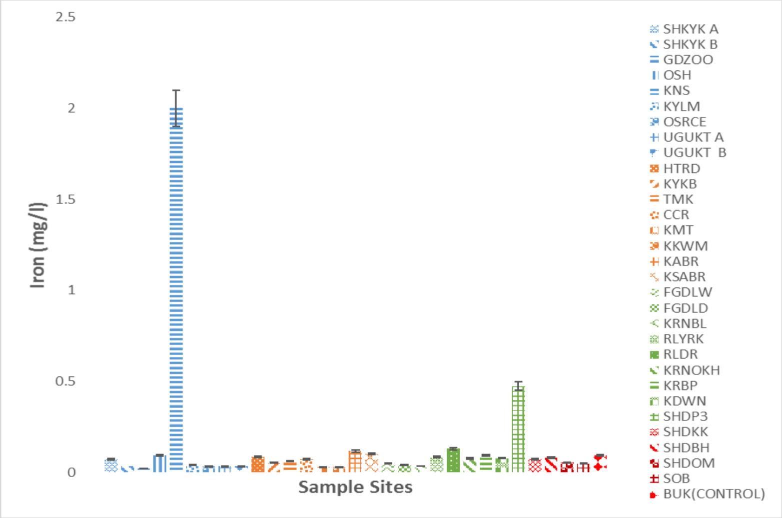

Figure 2: Mean Concentration of Iron

3.2 Zinc

The zinc content in the samples ranged from 0.019 ±0.002 to 0.138 ±0.015 mg/l (Fig. 3). The SHDKK sample site had the greatest Zn level (0.138±0.015 mg/l), whereas the OSH sampling site had the lowest Zn value (0.19±0.002 mg/l). Ebri (2016) achieved similar results. ANOVA, (F pr. p 0.001), suggesting a significant difference in zinc concentrations across borehole water samples. All of the examined samples were under the permissible limit (-<3 mg/l) defined by (2020), as well as the control samples' mean concentration (0.103 0.003 mg/l). The discovered low content is consistent with the findings of (Swaminathan et al., 2011).

3.3 Lead

As indicated in Figure. 4, the mean Lead Concentration for the samples tested varied from (0.004±0.000-0.057±0.002 mg/l). The maximum lead concentration was found at SHKYK B (0.057±0.002 mg/l). This high concentration may be linked to neighboring mechanics' activity, which may result in the leaching of harmful substances into boreholes, as indicated by (Ediin et al., 2000). Lead was known to cause long-term harm to both children and adults. Pb stunts physical and mental development in youngsters (Simeonov et al., 2010). The lowest value (0.004±0.000 mg/l) was observed at the KNS sample location had a similar result (Obiri-Danso et al., 2008). The analysis of variance (ANOVA) results show a significant difference in Pb levels across the water samples from the boreholes (F pr. < 0.001). Approximately 45% of the examined samples, along with the control sample with a mean concentration of (0.017±0.001 mg/l), are within the WHO's tolerable level (≤ 0.015 mg/l) as of 2020.

3.4 Cadmium

As seen in Fig. 5, the mean Cadmium Concentration for the samples that were analyzed ranged from (0.001±0.000-0.013±0.001 mg/l). The KDWN sampling site showed the highest cadmium concentration, at 0.013±0.001 mg/l. According to the elevated levels could be caused by the vulcanization process causing the lubricating oil residues in automobile tires to leach the contaminants(Jaradat and Momani, 1999). Given that the metal is frequently utilized in the production of batteries, plastics, stabilizers, electroplating, and pigments, industrial activities may also be to blame for the high level (Mehbrahtu and Zerabruk, 2011). The HTRD sample site yielded the lowest value, at 0.001±0.000 mg/l. Someone else achieved a comparable outcome (Erah et al., 2002). Analysis of variance (ANOVA), (F pr. < 0.001), shows that P <0.05, this means that there is a significant difference in Cd values among the Boreholes water samples. About 39 % of the samples analysed fall within the acceptable limit (≤ 0.003 mg/l) set by WHO (2020). Cd is highly toxic metal and responsible for several cases of poisoning through food. Small quantities of Cd can cause adverse changes in the arteries of human kidney. It replaces zinc biochemically and causes high blood pressures and kidney damage (Mehbrahtu and Zerabruk, 2011).

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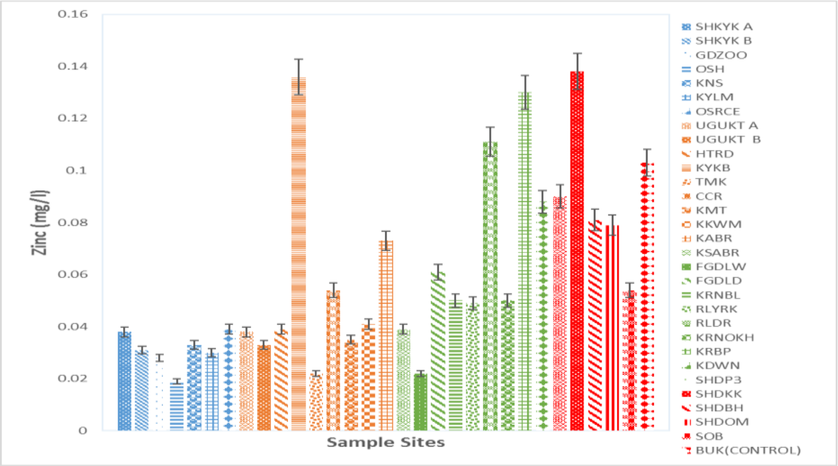

Figure 3: Mean Concentration of Zinc

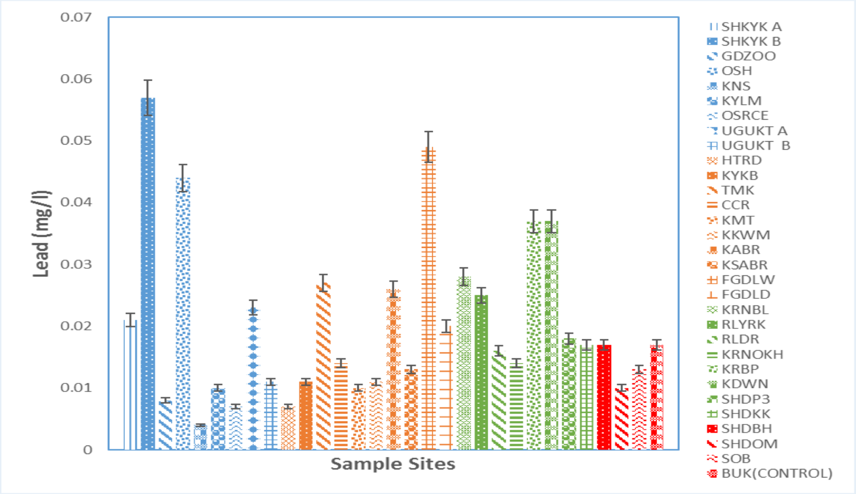

Figure 4: Mean Concentration of Lead

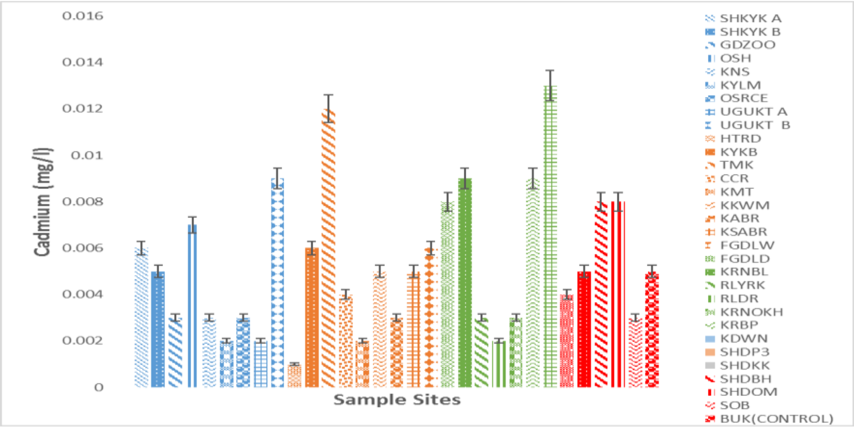

Figure 5: Mean Concentration of Cadmium

4. CONCLUSION

It was found that lead and cadmium levels exceeded the WHO's maximum acceptable limit (2020). Acceptable standard limits for the content of heavy metals in drinking water. In every sample examined, iron and zinc levels were found to be within the maximum allowable limit. The public should be made aware of the potential risk that these heavy metals present in the water from boreholes can pose (WHO's, 2020).

RECOMMENDATION

- As a number heavy metals, particularly those found in test locations near industries and mechanical workshops, exceeded the WHO's maximum acceptable limit, phytoremediation must be used to lower the levels of heavy metal contamination.
- In order to ensure that cleanliness and sanitation are maintained around the borehole water supplies, local communities and health professionals should keep an eye on anthropogenic activity near the boreholes and conduct frequent sanitary inspections.
- It is important to take into account the safe distance between the borehole and any possible sources of groundwater pollution.

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