



Evaluation of Heavy Metals Concentrations in Borehole Water from Talata Mafara Metropolis, Zamfara State, Nigeria

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Abstract

The levels of heavy metal concentrations and some physico-chemical parameters in two samples of borehole water from Talata Mafara metropolis in Talata Mafara Local Government of Zamfara State, Nigeria were determined. The physico-chemical parameters were evaluated using standard procedures while elemental analysis was conducted using atomic absorption spectroscopy (AAS). The samples have a relatively neutral pH (6.54, 6.83) while electrical conductivity (3.30 ± 0.03 and 3.23 ± 0.03 $\mu\text{S/cm}$), turbidity (9.99 ± 0.34 and 9.22 ± 0.31 NTU), phosphorus (0.11, 0.12), DO (8.52 ± 0.32 and 8.06 ± 0.18 mg/L), COD (1.99 ± 0.02 and 1.58 ± 0.01 mg/L) and BOD (2.25 ± 1.21 and 1.85 ± 0.81 mg/L) were all below the maximum allowable limits approved by the World Health Organization resulting in a high quality index for the studied samples. However, lead (0.345 ± 0.04 and 0.332 ± 0.04 mg/L for AGP and LCH respectively) was found to be higher than the levels recommended by WHO. On the other hand, iron, nickel and zinc were not detected in both samples whereas cadmium (0.039 ± 0.023 and 0.435 ± 0.075 mg/L), chromium (0.027 ± 0.030 and 0.177 ± 0.003 mg/L) and copper (0.047 ± 0.007 and 0.031 ± 0.021 mg/L) were all below the WHO permissible limit. Manganese is, however, higher (0.032 ± 0.002 mg/L) than the recommended levels in LCH. This led to the conclusion that while the community is not in any immediate danger, prolonged usage could result in exposure.

Key words: Talata Mafara; heavy metals; concentrations; determination; Abdu Gusau/Low cost

1.0 INTRODUCTION

In developing countries such as Nigeria, where drinking water has always been a major issue and where the majority of people live in rural areas; rivers, streams, wells and more recently boreholes, serve as the main sources of water for drinking and domestic use (Raji *et al.*, 2010). The underground water supplies are usually considered safe provided they are properly located, constructed and operated according to the World Health Organization Guidelines for drinking water (WHO, 2011).

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability (Idowu 2012). Water plays an indispensable role in sustenance of life and it is a key pillar of health determinant, since 80% of diseases in developing countries are due to lack of good quality water (Asaolu *et al.*, 1997). Drinking water quality management has been a key pillar of primary prevention for over one and half centuries and it continues to be the foundation for the prevention and control of water borne diseases (Audu, 2015). The quality of drinking water is, according to WHO (2011), a powerful environmental determinant of health (Bakirdere and Yaman, 2008).

It is believed that greater percentage of man and animal are exposed to Heavy metal through environment. Due to their non-biodegradability; they accumulate in living organisms, thus causing various diseases and disorders even in relatively lower concentrations. Cadmium accumulates in the kidney of mammals and cause kidney dysfunctions. The most severe form of cadmium toxicity in humans is called "Itai-Itai" a disease condition which causes pain in the bones (Jamal, 2012).

Lead (Pb) is a relatively stable nevertheless, when released in the air, it stays airborne for a short period, then falls to the soil and enters the food chain. It (Pb) can affect many biological

systems, especially nervous system (Jamal, 2012).

Chromium (Cr) is use in melts alloys and pigments for paints, paper, rubber, tanning and other materials. Low-level exposure can irritate the skin and cause ulceration. Long-term exposure can cause kidney and liver damage and damage to the circulatory and nerve tissue. It often accumulates in aquatic life adding to the danger of eating fish that might had been exposed to highest levels of chromium. It may also cause congestion and inflammation of organs (Raji *et al.*, 2010; Audu, 2015).

Copper is an essential elements to human life but in high doses it can cause anemia, liver and kidney damages, stomach and intestinal irritation (Audu, 2015). Zinc is also an essential element for the growth of much kind of organs in both plants and animals. Zinc and its compounds taken orally are relatively non-toxic, although its soluble salts in a very large doses can produced an acute gastroenteritis characterized by nausea, vomiting and diarrhea (Raji *et al.*, 2010).

While some are essential in small quantities for growth and development, micronutrients like copper (Cu), manganese (Mn), molybdenum (Mo), iron (Fe) and zinc (Zn) can be toxic at high concentrations. Others not known to be essential for growth, such as arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), nickel (Ni), and selenium (Se), also are toxic at high concentrations or under certain environmental conditions in the soil (Asaolu *et al.*, 1997; Oluduro and Adewoye, 2007). The extent of soil pollution by heavy metals and base metal ions some of which are soil micronutrients is very alarming. It has been observed that the larger the urban area, the lower the quality of the environment (Reddy *et al.*, 2012).

Borehole water is one of the main sources of water supply in Talata Mafara which is used for both domestic and industrial purposes. This

work was, therefore, aimed at studying the physico-chemical properties and heavy metal concentrations in in borehole water within the

main campus of Abdu Gusau Polytechnic and Low Cost Housing Estate in Talata Mafara metropolis.

2.0 MATERIALS AND METHOD

The assessments of the physico-chemical properties of the water samples followed standard analytical procedures. Heavy metal levels were determined using Atomic Absorption Spectroscopy using Perkin Elmer model 306 Atomic Absorption spectrophotometer.

2.1 Sample Collection and Treatment

The samples were collected from the students' hostels in Abdu Gusau Polytechnic main campus and Low Cost housing estate in Talata Mafara. The sample containers were washed with 10% HNO₃ for 48 hrs and rinsed with the sample before collection and were labelled AGP (for AGP main campus) and LCH (for Low Cost housing estate).

2.2 Sample Preparation

50 ml of each sample was transferred into an evaporating dish, to which 10 ml of concentrated nitric acid (HNO₃) was added and then placed in a steam bath to evaporate to 25 ml. Each sample was then transferred to a bottle to which deionized water was added up to 50ml mark before being taken for analysis (Reddy *et al.*, 2012). Heavy metals were determined using a

Perkin Elmer model 306 Atomic Absorption spectrophotometer.

2.3 Physico-chemical Analysis

The pH and electrical conductivity were measured immediately after sample collection. Analysis for total dissolved solids (TDS) and turbidity measurement were conducted using model 1000m TDS scanner and model 2100p HACH, respectively (ALPHA, 2005).

The phosphorus was determined after the prepared samples were poured into a cuvette and inserted the spectrophotometer and absorbance was taken at 660 wavelengths. The percentage of phosphorus was calculated using equation reported by AOAC (2005) in Reddy *et al.*, (2012).

Chemical oxygen demand (COD) was determined using appropriate procedure reported by and calculated using an equation also reported in Reddy *et al.*, (2012).

Initial and final (after a 5-day incubation at 25^oC) dissolved oxygen was determined using the winklers method via model 2002 filter. The BOD was calculated from the dissolved oxygen using the relation (AOAC, 2005).

3.0 RESULTS AND DISCUSSION

3.1 Results

Table 1: Results of physico-chemical assessment of the samples

PARAMETERS	AGP	LCH	WHO STD (2011)
B.O.D (mg/L)	2.25±1.21	1.85±0.81	<5
C.O.D (mg/L)	1.99±0.02	1.58±0.01	
E.C (µS/cm)	3.30±0.03	3.23±0.03	1400
D.O (mg/L)	8.52±0.32	8.06±0.18	
TDS (ppt)	143.20±2.13	122.51±2.08	500
Turbidity (NTU)	9.99±0.34	9.22±0.31	
pH	6.58	6.83	6.5-9.5

*Results are means of three replicate analyses

Table 2: Concentrations of the heavy metals analyzed (mg/L)

ELEMENT	AGP	LCH	WHO STD (2011)
Cd	0.039±0.023	0.435±0.075	0.05
Cu	0.047±0.007	0.031±0.021	0.05
Cr	0.027±0.030	0.177±0.003	0.05
Fe	ND	ND	0.3
Mn	0.102±0.005	0.032±0.002	0.1
Ni	ND	ND	0.07
Pb	0.345±0.04	0.332±0.04	0.01
Zn	ND	ND	5.00

* Results are means of three replicate analyses

ND: Not detected

3.2 Discussion

The results of the physico-chemical parameters determined, shown in Table 1, indicated that there is an overall high quality index in the samples. AGP has a slightly lower pH (6.58) than LCH (6.83) but both were within the acceptable range of 6.58-6.83 approved by WHO (2011). Similarly, BOD (2.25±1.21 and 1.85±0.89 mg/L for AGP and LCH, respectively) is within the range classified as good for drinking water by WHO (2011). Electrical conductivity (3.30±0.03 and 3.23±0.03 µS/cm), COD (1.99±0.02 and 1.58±0.01 mg/L), DO (8.52±0.32 and 8.06±0.18

mg/L), turbidity (9.99±0.34 and 9.22±0.31 NTU) (Table 1) were all found to be lower than recommended standards (EPA, 2002; WHO, 2011) for both samples. The total dissolve solids in all the samples were also within the recommended given by EPA (2002) standard limit for drinking water.

The heavy metals analyzed (Table 2) showed slight differences in the sampling areas. Cadmium concentrations ranged from 0.039±0.023 and 0.435±0.075mg/L for AGP and LCH, respectively, and are found to be within

the WHO (2011) approved limit of 0.05 mg/L. Iron, nickel and zinc were not detected in both samples, AGP showed higher concentrations of manganese (0.102 ± 0.005 and 0.032 ± 0.002 mg/L), copper (0.047 ± 0.007 and 0.031 ± 0.021 mg/L) and lead (0.345 ± 0.04 and 0.332 ± 0.04 mg/L) than LCH. Chromium (0.027 ± 0.030 and 0.177 ± 0.003 mg/L) followed an opposite trend and is higher in LCH than AGP. With the exception of lead, which is higher than the recommended values of 0.1 mg/L (EPA, 2002; WHO, 2011), all other elements analyzed were below the level recommended by the global

4.0 CONCLUSION

The study established the high quality index for the water samples analyzed due to suitable physico-chemical parameters. However, there is a likelihood of long term exposure to heavy

bodies. This agreed with the findings of Raji et al (2010) who studied the physico-chemical and heavy metal characteristics in Sokoto metropolis and Idowu (2012) who carried out similar studies in Kano metropolis.

The presence of heavy metals in the samples is not unusual as earlier studies (Udeh, 1997 in: Raji *et al.*, 2010) have reported similar findings in the geographical zone. Also, the slight acidity found in the samples may be responsible for the presence of the heavy metals since acidity favors the concentration of heavy metals as reported by Adefemi *et al* (2007) and Idowu (2012).

metals, especially lead and manganese from the samples. It is therefore recommended that urgent action has to be taken to mitigate the effect

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