AN ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF DRINKING WATER SOURCES IN KASHERE, GOMBE STATE

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ABSTRACT

The aim of this study is to examine the quality of drinking water sources available to residential households and the university community in the rapidly growing new federal university town, Kashere. Data was obtained from water samples collected from 11 (eleven) hand-dug wells and boreholes within the vicinity of the university campus and residential dwellings. The samples were analyzed for Temperature, pH, Electrical Conductivity (EC), Turbidity, Colour, Total Dissolved Solids (TDS), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Magnesium (Mg^{2+}), Chloride (Cl^-) and Total Hardness. The results were compared with the standards prescribed by World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ). With regards to the physicochemical parameters, the results obtained shows that the drinking water sources had a reasonably good chemical quality with the exception of EC, TDS and Mg^{2+} that were above the WHO and NSDWQ recommended value for drinking water. To improve the taste and aesthetic properties of the water supply, pre-treatment in the forms of boiling, filtration, sedimentation and aeration for up to 1-2 days by households are recommended. Also, good sanitary conditions around the water sources should be encouraged.

Keywords: Contamination, Water, Hand-dug wells, boreholes and Physico-chemical

INTRODUCTION

Increasing international discourse on safe water supply, sanitation and hygiene for health and development has been continuously emphasized in series of international conferences (UNEP, 1996; WaterAid, 2011 and Yohanna et al, 2016). The United Nations General Assembly declared the period of 2005 to 2015 as the International decade for Action on “Water forLife”. Most recently, the UN General Assembly declared safe and clean drinking water and sanitation a human right essential to the full enjoyment of life and all other human rights (WHO, 2011). However, despite the numerous calls by the international community on the importance of water to life, it still remains a scarce commodity in the developing world. Over one billion people today lack access to clean water and over 1.2 billion people lack access to basic sanitation (Gadgil and Derby, 2003). It is estimated that about 2.7 billion people will face water shortage by 2025 (Obrecht, 2003). Development indices attributes crisis in the water sector to profound failures in water governance (UNDP, 2010). Safe and good quality drinking water is essential for the well-being of all people. In Nigeria, most drinking water sources have been contaminated through uncontrolled sewage disposal into water bodies, increased use of chemical fertilizer in agricultural practices resulted in higher concentration of metal pollutant in fresh water reservoir due to water run-off, untreated effluent discharge from industrial activities and open dumping of refuse into water courses has impacted on the health and economic status of the people (Abii and Nwabienvanne, 2007). Furthermore, Akhtar, et al (2005) reported that the rate of water pollution of all types has increased much more as compared to other fields of pollution due to discharge of all sorts of obnoxious matter into it. Also, Adakole and Abolude (2012) observe that global concern about heavy metals in the environment stems from their persistence, toxicity and bioaccumulation in the trophic chain. Metal contaminants also pose serious threat to humans through ingestion of metal enriched aquatic organisms. Amman, et al (2002) are of the view that anthropogenic activities like mining, final disposal of treated and untreated waste effluents containing toxic metals as well as metal chelates from different industries, such as tannery, steel plants, battery, industries, thermal power plants and also the indiscriminate use of heavy metal containing fertilizers and pesticides in agriculture are some of the main causes of metal pollution in the aquatic ecosystem. Drinking water from sources such as well, borehole, streams and rivers provide a significant potential exposure to environmental contaminants. It has been estimated that up to 20% of human exposures can come from these routes and it is certainly higher for infants whose formula is prepared with water (Shyamala *et al*, 2008).

The study of Yakubu (2013) in Zaria on the quality of drinking water from hand-dug wells reported a high variation in the physicochemical parameters in comparison with the WHO acceptable limit for drinking water. Moreover, the results of the study of Isa et al, (2013) on physiochemical and bacteriological quality of drinking water sources in Maiduguri shows that the parameters studied were above the WHO standards. Since these studies were carried out in the same ecological zone with the present study, it is suspected that drinking water sources may be experiencing the same level of contamination and degradation given the similar nature of human activities around the water sources. Therefore the objective of this study is to assess the physicochemical properties of drinking water sources in Kashere and to compare the parameters with that of World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) for drinking water. The study will also provide baseline information on water quality in the area.

MATERIALS AND METHODS

Study area

Kashere is located on latitude $9^{0}54'20''$ N - $9^{0}54'50''$N and longitudes$11^{0}0'10''$ E - $11^{0}1'10''$E. It is located at an elevation of 431 meters above sea level with a land mass of approximately 2,627 km². About 80 percent of the population is engaged in livestock rearing and crop production of groundnut, maize, Guinea corn, beans, benniseed, Sorghum, Millet and rice. (Fig. 2.1). The climate over Kashere is described as tropical continental climate. Temperature is high all year round with a mean annual air temperature of 30^{0}C. The highest temperatures are recorded during the dry heat wave months of between March and May with maximum air temperature of above 37^{0}C. During the rainy season, there is a drop temperature due to dense cloud cover between July and August as well as during the harmattan period of November to February. Rainfall is highly seasonal due to the oscillation of the inter-tropical convergence zone (ITCZ) which controls the Tropical Maritime and the Tropical Continental air masses of contrasting air moisture and relative humidity over the study area. The mean annual precipitation is 835 mm (Balzerek et al, 2003).

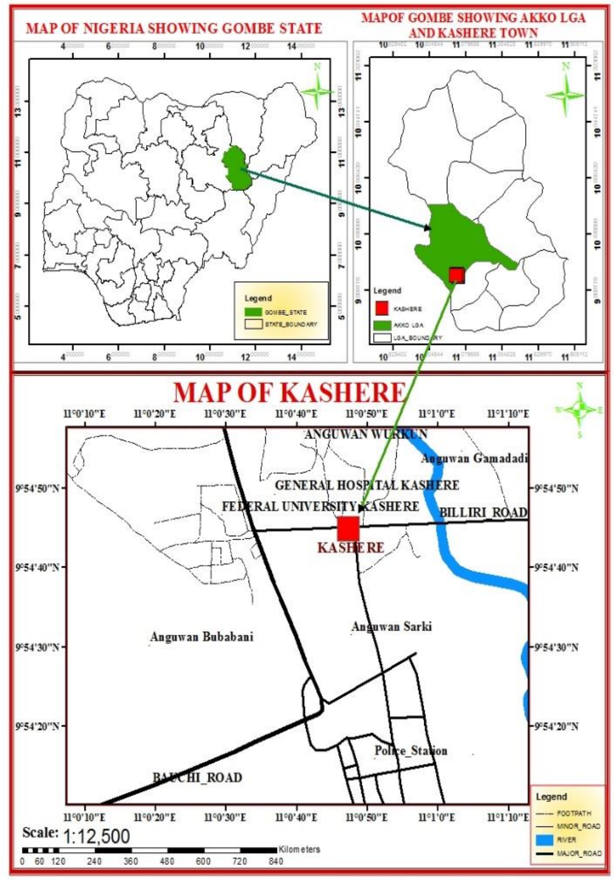

Figure 2: Map of the study area

Collection of water sample and determination of physicochemical properties

The study was conducted during the warm wet season of July, August and September, 2016. Water samples were collected in triplicates from hand-dug wells and boreholes for each of the study months in other to improve the reliability of the data collected. Samples were labeled K_{W1-6} for hand-dug wells and K_{B7-11} for boreholes. A total of eleven (11) water sources comprising six hand-dug wells and five boreholes were used for the study. Table 1 shows the location and distribution of the sample points.

Table 1: Location of sample points

Sample Points	Location
K_{W1}	Anguwan Wurkun
K_{W2}	Anguwan Tumburu
K_{W3}	Anguwan TudunWada
K_{W4}	Anguwan Wambai
K_{W5}	Anguwan Yuguda
K_{W6}	Anguwan Sarki
K_{B7}	Anguwan Gama-Dadi
K_{B8}	Anguwan Bubabani
K_{B9}	FUK Campus
K_{B10}	Anguwan Pawari
K_{B11}	Anguwan Ubandoma

Samples were collected using washed one-litre plastic bottles soaked in 10% nitric acid and rinsed with distilled water. Water samples collected from each of the sources were taken to the laboratory for analysis within the same day of collection. Standard procedures of water and wastewater sample analysis by the American Public Health Association (APHA, 1998) were adopted in this study for determination of physicochemical parameters. The mean monthly value of the various physicochemical parameters was used to represent their levels of concentration.

RESULTS

The physicochemical parameters of drinking water from Kashere village

The mean monthly value of the various physicochemical analyses of the water samples are presented in table 2 and shows a mean temperature value of 29.2°C for well water samples and 29.1°C for boreholes. These values are within the mean annual air temperature value for the study area.

Table 2: Mean values water physico-chemical parameters

Unit/ Parameter	Temp. 0°C	pH (mg/l)	EC (µs/cm)	TDS (mg/l)	BOD (mg/l)	DO (mg/l)	Mg^{2+} (mg/l)	Chloride (mg/l)	Hardness (mg/l)	Colour (TCU)	Turbidity (NTU)
K_{W1}	27	7.43	5220	2610	4.98	1.5	0.17	38.36	36	-	2.0
K_{W2}	30	6.95	7680	3840	1.34	2.0	0.34	48.00	336	-	4.0
K_{W3}	30	7.10	4480	2240	9.55	1.3	0.39	18.36	480	-	3.0
K_{W4}	28	6.19	2330	1160	8.40	1.5	0.41	09.57	304	-	6.0
K_{W5}	30	7.08	7450	3720	3.60	1.8	0.25	16.15	133	-	3.0
K_{W6}	30	6.94	3290	1645	4.90	2.5	0.24	19.10	270	-	3.0
Mean	29.2	6.95	5075	2536	5.46	1.77	0.3	24.92	260	-	3.5
K_{B7}	26	7.08	2700	1414	4.22	1.5	0.27	17.14	158.4	-	2.0
K_{B8}	30	7.30	9400	4710	6.30	3.0	0.44	18.19	126	-	3.0
K_{B9}	30.5	6.53	887	444	7.01	2.2	0.18	17.22	168	-	4.0
K_{B10}	30	7.55	1943	972	8.02	2.6	0.36	57.28	90	-	4.0
K_{B11}	29	7.62	3530	1770	4.60	3.5	0.29	27.87	120	-	5.0
Mean	29.1	7.22	3692	1862	6.03	2.56	0.3	27.54	133	-	3.6
WHO Rec. Limit	N/A	6.5-8.5	1400	500	6-9	7.5	N/A	250	500	15	5.0
NSDWQ Rec. Limit	Ambient	6.5-8.5	1000	500	N/A	N/A	0.20	250	150	15	5.0

N/A: Not Available; WHO (2011), NSDWQ (2007)

DISCUSSION

pH is an important indicator of water quality and the extent of its pollution. All the water sources had a pH level within the regulated guideline of WHO and NSDWQ. The mean value for wells and boreholes recorded 6.95 and 7.22 respectively. Although there is no health impact indicated for low or high pH values by the regulated standards, low pH indicates acidity and can become corrosive and cause damage to metal-based storage containers which eventually lead to metal leaching. As a consequence, low pH values indirectly affect human health, since heavy metals released into the water containers can have adverse consequences on people (WHO, 2011). This implies that the water sourced from well K_{W4} will require some degree of treatment to improve its level of potability.

The electrical conductivity (EC) for all samples was significantly higher than the WHO and NSDWQ acceptable limit of 1400 µS/cm 1000 µS/cm respectively. The mean value recorded for wells was 5075 µS/cm and boreholes recorded 3692 µS/cm. Higher values of EC over time indicate that the water has become increasingly salty and may have been contaminated by saline medium, some soluble minerals from weathered bedrocks, faecal pollution and leachate that percolate into the ground water sources. The results also showed that the sampled hand-dug wells had higher mean values than the samples from boreholes. The results also confirm the observation made during sample collection that most of the hand-dug wells were shallow and were adjoined by the pit latrine system used by most of the residential households in the study area. The results from related studies on the water quality of shallow hand-dug wells conducted by Akungbo (1990), Ariziki (1991), Gideon (1999), (Folorunsho, 2010) and Yakubu (2013) also recorded higher values above the WHO acceptable limits for electrical conductivity (EC) and the high levels of (EC) observed in the selected wells were attributed to the indiscriminate dumping of refuse from which leachate percolate to pollute the ground water. Other sources were attributed to the nature of the geologic material developed on the poorly weathered crystalline basement complex rocks, poor drainage and sewage systems, effluent discharge from industries and application of fertilizers could also be responsible for the level of pollution in the well water.

The concentration of Total Dissolved Solid (TDS) in water sources is an indication of the level of contamination. The TDS values for the sampled wells and boreholes were generally higher than 500mg/l recommended by WHO and NSDWQ acceptable limit for potable water. A mean value of 2536 mg/L was recorded for hand-dug wells while the mean value for the sampled boreholes was 1862mg/L. The presence of total dissolved solids (TDS) in the water samples as observed in table 2 indicates the presence of solutes such as the bicarbonates, sulphates, and chlorides, calcium, magnesium, sodium, phosphates, nitrates and other earth minerals in water. Some level of water treatment may be required to increase the potability of the water.

The mean Biochemical Oxygen Demand (BOD) value was 5.46 mg/L for well water sources while the mean value of BOD concentration for boreholes was 6.03 mg/l. All the water sources were within the acceptable limit of the WHO guideline which ranges 6-9 mg/L except for well K_{W3} that was above the regulated limit with a value of 9.55mg/L. The high level of BOD recorded for well K_{W3} indicates that the well is contaminated and the sources of the contamination may have been derived from the decomposition of organic waste from neighborhood refuse dumps and the storm runoff from the Maiganga coal mine located within 11km radius of the settlement Anguwan TudunWada. The mean value of the Dissolved Oxygen (DO) was 1.77 mg/L and 2.56 mg/L for wells and boreholes respectively. DO is the measure of the degree of pollution by organic matter and in comparison, with the WHO acceptable limits of 7.5 mg/L, it suggests that the water sources is less polluted by organic matter.

The mean value of Magnesium (Mg^{2+}) was 0.3mg/L respectively for the well and borehole water sources. The value is slightly above the NSDWQ of 0.20 mg/L. Magnesium is one of the commonest elements in the earth's crust and it is present in all-natural waters. The undesirable effect of higher value of Mg^{2+} in drinking water is its ability to render the water hard. There is no evidence of adverse health effects attributed to magnesium in drinking water.

The mean turbidity and chloride value for the water sources studied were below the acceptable limit of both WHO and NSDWQ. The mean recorded value for turbidity was 3.5 NTU and 3.6 NTU for well and borehole water respectively. Chloride recorded a mean value of 24.94 and 27.54 for well and borehole water respectively while the colour of the water was clean and clear indicating low level of impurities.

The mean total hardness value for hand-dug well water was 260 mg/L which is above NSDWQ limit of 150 mg/L while water from borehole with a mean concentration of 133 mg/L were within the acceptable limit. The World Health Organization (WHO) standard for drinking water (2011) classified water with a total hardness of $CaCO_3$ <50 mg/L as soft water, 50 to 150 mg/L as moderately hard water and water hardness above 150 mg/L as hard, therefore it can be concluded that the Studied water sources ranges from moderately to very hard water and thus are not suitable for domestic use in terms of its hardness and requires some level of treatment in order to attain the required standards.

CONCLUSION

The study revealed that the physicochemical parameter of water quality studied in Kashere particularly Temperature, Turbidity, pH, Biochemical Oxygen Demand, Dissolved Oxygen, Chloride and Colour were found mostly within the regulated limits of WHO and NSDWQ for drinking water quality except for Hardness, Electrical Conductivity, Total Dissolved Solids and Magnesium that were found to be relatively above the set standards. There is need to apply some level of treatment so as to increase the quality of drinking water sources.

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