



Quality Assessment of Domestic Water Sources in Two Communities of Kanke Local Government Area of Plateau State, North Central Nigeria

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ABSTRACT

Domestic water sources in two communities of Kanke Local Government Area of Plateau State have been assessed for their portability. Most of the physicochemical parameters determined were within the recommended standards except for the Total Dissolved Solids, Total Hardness and Total Alkalinity. For example, TDS in Kaler Well was 1080mg/L, T. Hardness in Kaler Well was 534mg/L, T. Alkalinity in Kaler Well was 200mg/L while that of Kaler Stream and Borehole were 350mg/L, and 313.30mg/L respectively. Similarly, metals assessed conformed to the required standards except for Pb, Cd and Ni, which had values above the recommended limits in all the six samples. The results of the microbial assessment indicated pollution in all the water samples. This is an indication that the water sources were contaminated and unfit for human consumption. Appropriate recommendations have been proffered to avoid water-borne diseases and long term accumulative health problems associated with the pollutants identified.

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INTRODUCTION

Having access to safe drinking water and sanitation is a human right. However, many developing countries lack access to safe drinking water from improved sources and adequate sanitation services. (Maseret, 2012). As a result, many people are still dependent on unprotected water sources such as rivers, streams, springs, and hand-dug Wells. Since these sources are open, they are highly susceptible to human and animal contamination.

It is currently estimated that about 1.1 billion people in the world lack access to improved water supplies and 2.6 million lack access to adequate sanitation (Christine et al., 2006). Many of these people are among those hardest to reach, those living in remote rural areas and urban slums

and people displaced by war and famine (Christine et al., 2006). Also, diarrhoea kills more children than malaria, measles and HIV/AIDS combined as it accounts for 1 in every 9 child deaths worldwide (CDC, 2012).

While the Nigerian Government has publicly committed to prioritizing water and sanitation services, it faces massive problems in achieving the Millennium Development Goals (MDGs) of reducing by half the proportion of people without access to safe water and sanitation between 1990-2015 (Lohdip, 2011).

Acceptable quality shows the safety of drinking water in terms of the physical, chemical and bacteriological parameters (WHO, 2004). Consumer perceptions and aesthetic criteria need to be considered when accessing drinking water sources even though



they may not adversely affect human health (WHO, 2013). From 1990-2004, more than 1.2 billion people gained access to improved water sources, but not all of these new sources are necessarily safe (UNICEF, 008). The chemical contamination of water sources- both naturally and from pollution is a serious problem. It is imperative to ensure that the water supply and sanitation services are adequate, affordable and reliable (Meseret, 2012).

The significance of this research lies in the fact that no baseline study on the physicochemical and microbiological quality of water in these two communities have been carried out or conducted.

METHODOLOGY

The container (plastic and glass) for collecting samples for analyses were first leached with 20% nitric acid and washed thoroughly with detergent, rinsed severally with distilled-deionized water. The containers for microbial analyses were glass containers and were sterilized in an autoclave at a temperature of 121°C for 15 minutes.

A grab sample was taken and transferred into a one-litre plastic

container (with a screw cap) that has been specifically prepared for that given parameter. How the water samples are collected for analyses has an important bearing on the results of the analyses.

The temperature of the water samples was determined with a mercury-in-glass thermometer by dipping it in the sample until a steady reading was obtained while pH was determined using a duly calibrated 215 model pH meter. Conductivity was determined using model 1152 conductivity meter while Total Alkalinity, Total Hardness, Acidity and Chloride were determined using titrimetric methods described by Salami et al., (2011) Gravimetric, Colourmetric, Spectrometric and Nephelometric methods described by Ameh et al., (2012) were used for the determination of (TDS, TSS, TS and sulphate), phosphate and nitrate, heavy metals and Turbidity respectively. The microbial quality of the water samples was determined using the methods described by Ochei et al., (2010) and Egbere (2008).

RESULTS

The results of the physicochemical and microbial studies of the various samples of water from Kaler and Goktok villages are given in Tables 1-4.



Table 1: Physicochemical Characteristics of Kaler Borehole, Well and Stream

Parameter	Borehole	Well	Stream	WHO guideline Value (2012)	USEPA guideline Value
pH	7.08	7.46	6.96	6.50-8.50	6.50-8.50
Turbidity (NTU)	0.16	0.42	0.66	5.00	5.00
TDS (mg/L)	240.00	1080.00	200.00	1000.00	500.00
TSS (mg/L)	360.00	320.00	260.00	NS	NS
TS (mg/L)	600.00	1400.00	460.00	NS	NS
Conductivity	730.00	910.00	690.00	1000.00	300.00
Temperature (°C)	20.00	22.00	21.00	30.00	28.00
Colour	8.00	8.00	10.00	15.00	15.00
Taste	Unobj	Unobj	Unobj	NS	NS
Odour	Unobj	Unobj	Unobj	NS	NS
T. Hardness (mg/L)	444.00	534.00	440.00	500.00	500.00
T. Alkalinity (mg/L)	313.30	200.00	350.00	150.00	150.00
Chloride (mg/L)	50.62	70.48	45.66	250.00	250.00
Sulphate (mg/L)	15.00	20.00	15.00	400.00	500.00
Phosphate (mg/L)	0.90	0.70	1.00	6.50	6.50
Nitrate (mg/L)	5.60	7.60	7.00	50.00	50.00
Acidity (mg/L)	135.00	171.00	144.00	NS	NS
Fluoride (mg/L)	0.61	0.06	0.76	1.50	2.00
Pb (mg/L)	0.08	0.03	0.09	0.01	0.01
Cd (mg/L)	0.03	0.01	0.02	0.003	0.003
Ni (mg/L)	0.57	0.46	0.41	0.07	0.07
Mn (mg/L)	0.04	0.05	0.06	0.40	0.40
Fe (mg/L)	0.01	0.02	0.04	NS	0.30
Co (mg/L)	0.37	0.38	0.33	1.00	1.0
Cu (mg/L)	0.06	0.03	0.07	0.05	0.08
Zn (mg/L)	ND	ND	ND	2.00	2.00

Table 2: Physicochemical Characteristics of Goktok Borehole, Well and Stream

Parameter	Borehole	Well	Stream	WHO guideline Value (2012)	USEPA guideline Value
pH	7.13	7.69	8.04	6.50-8.50	6.50-8.50
Turbidity (NTU)	0.13	0.43	5.35	5.00	5.00
TDS	260.00	500.00	180.00	1000.00	500.00
TSS	80.00	60.00	120.00	NS	NS
TS	340.00	560.00	300.00	NS	NS
Conductivity	460.00	660.00	90.00	1000.00	300.00
Temperature (°C)	22.00	20.00	21.00	30.00	28.00
Colour	7.00	8.00	11.00	15.00	15.00
Taste	Unobj	Unobj	Unobj	NS	NS
Odour	Unobj	Unobj	Unobj	NS	NS
T. Hardness	200.00	360.00	58.00	500.00	500.00
T. Alkalinity	82.70	121.00	63.25	150.00	150.00
Chloride	15.58	36.03	3.97	250.00	250.00
Sulphate	20.00	18.00	15.00	400.00	500.00
Phosphate	0.80	1.30	1.00	6.50	6.50
Nitrate	6.00	8.00	6.00	50.00	50.00
Acidity	92.70	125.30	50.30	NS	NS
Fluoride	0.07	0.34	0.34	1.50	2.00
Pb (mg/L)	0.18	0.13	0.06	0.01	0.01
Cd	0.01	0.01	0.02	0.003	0.003
Ni	0.54	0.59	0.50	0.07	0.07



Mn	0.06	0.07	0.05	0.4	0.4
Fe	0.03	0.11	0.03	NS	0.3
Co	0.37	0.35	0.42	1.00	1.00
Cu	0.06	0.02	0.05	0.05	0.08
Zn	ND	ND	ND	2.00	2.00

Key: ND= Not Detected, NS= Not Stated

Table 3: Total Viable Count of the Bacteria after 24 Hours (Cfu/MI)

S/N	Sample	Nutrient agar viable	MacConkey agar coliform	Salmonella Shigella
1	Kaler Borehole	2.4x10 ⁶	3.0x10 ⁶	2.2x10 ⁶
2	Kaler Well	8.0x10 ⁵	10.0x10 ⁶	2.0x10 ⁶
3	Kaler Stream	2.9x10 ⁶	2.0x10 ⁶	4.0x10 ⁵
4	Goktok Borehole	9.6x10 ⁶	3.2x10 ⁶	1.07x10 ⁷
5	Goktok Well	6.0x10 ⁶	1.6x10 ⁶	5.9x10 ⁶
6	Goktok Stream	1.9x10 ⁷	4.6x10 ⁶	9.6x10 ⁶

Table 4: Micro-Organisms Present

S/N	Sample	Micro-organisms
1	Kaler Borehole	Proteus Spp, Enterobacteriae
2	Kaler Well	Staphylococcus aureus, E.Coli, Proteus Spp, Enterbacteriae
3	Kaler Stream	Staphylococcus aureus, Proteus Spp, Enterobacterine,
4	Goktok Borehole	Proteus Spp, Enterobacteriae, Pseudomona aeruginosa
5	Goktok Well	Staphylococcus aureus, E. Coli, Proteus Spp, Enterobacteriae, Salmonella Spp
6	Goktok Stream	Proteus Spp, Enterbacteriae

DISCUSSION

The temperature of the water at the time of the analysis ranged from 20-22°C. All the water samples had temperatures less than the World Health Organization standard value of 30°C (WHO, 2012). The water sample from Goktok Stream had the highest turbidity level, (5.35-NTU) slightly above the WHO guideline value of 5NTU (WHO, 2012). High turbidity indicates the presence of micro-organism in water (CAWST, 2009). The greater the turbidity, the higher the risk of gastrointestinal diseases (Ezeribe et al., 2012). None of the water samples had objectionable Odour, Colour or Taste. The pH of the water sample ranged from 6.96-8.04. These values are within the recommended value of the WHO of 6.5-8.5. Water with a low pH is not fit for drinking (WHO, 2012). The lower the pH, the higher the level of corrosion and exposure to

extreme pH values result in eye and skin irritations (WHO, 2012).

The Total Dissolved Solids ranged from 180-1080mg/L.TDS affects the taste of water (CAWST, 2009). The value recommended by the WHO stands at 1000mg/l (WHO, 2012). The high value of TDS recorded in Kaler Well may be due to the presence of dissolved minerals from the surrounding rocks. As TDS increases, the corrosive nature of the water increases (CAWST, 2009).

Conductivity ranged from 90-910µs/cm. The highest value was obtained in Kaler Well. High conductivity also indicates a high concentration of dissolved minerals. The WHO recommended a conductivity value of 1000µs/cm (WHO, 2012) and the value obtained from Tables 1 and 2 are within the WHO guideline value for conductivity. The high conductivity of Kaler Well (Table1) may be due to the geology of the area (WHO, 2009). A failing sewage may



also increase the conductivity of water due to the presence of chlorides, phosphates and nitrates (Meseret, 2012).

The study revealed that fluoride in the water samples ranged from 0.07-0.76mg/L. These values were within recommended values by the WHO for drinking water of 1.5mg/L. Dental fluorosis is associated with high fluoride concentration.

The nitrate concentration ranged from 6.00-7.60mg/L these values are within the standard value of the World Health Organization of <50mg/L (WHO, 2012). Nitrate indicates the presence of a fully oxidized organic matter (Ezeribe et al., 2012). High nitrate concentration of >50mg/L can cause adverse health effects on infants under 3 months of age. The high concentration of nitrate is associated with the higher microbiological activity. The low concentration of nitrate could be as a result of the minimal agricultural activities in the sampling area or the low use of inorganic fertilizers in the area (WHO, 2011).

Phosphate and sulphate ranged between 0.70-1.00mg/L and 15-20mg/L respectively (Tables 1 and 2). These values are within the WHO and EPA value of 6.5mg/L for phosphate and 400mg/L for sulphate. High phosphate level encourages the growth of algae. The reason why the concentration of phosphate is low may not be far from the fact that the people in the area may prefer to use soap rather than detergents. The low use of inorganic fertilizers may affect the concentration of phosphate (WHO, 2011).

The study also revealed that chloride level in the water ranged between 3.97-70.48mg/L which is within standard values (WHO, 2012). Chlorides in natural waters result from the leaching of chloride-containing rocks and soil with which the water comes in contact with (Ezeribe et al., 2012). Also, Total Alkalinity ranged from 63.25-350mg/L. The highest value was recorded in Kaler stream while the lowest value was

recorded in Goktok stream. The value obtained for Alkalinity in Kaler Borehole (313.30mg/L), Kaler Well (200mg/L) and Kaler Stream (350mg/L) fall outside the value of 150mg/L recommended by the World Health Organization. This may be due to the nature of the rocks in the area i.e., there could be carbonate rocks composed of CaCO_3 . The presence of CO_3^{2-} will increase alkalinity by 2 units (Lenore, 2004).

Hardness in the sample of water analyzed range from 58-534mg/L. The values were within the standard except for the value in Kaler Well (534mg/L) against 500mg/L recommended by the WHO. The values are high enough to cause hardness in water. Excessive hard water has been suggested to be a risk factor that could cause eczema. Too soft water may also result in dissolving of metals such as lead, cadmium etc. The high value recorded in Kaler Well of 534mg/L may be as a result of the presence of calcium and magnesium ions in the rocks located in the area (WHO, 2011). Excessively hard water also has corrosion tendencies (WHO, 2011). In like manner, too soft water can dissolve metals like lead, resulting in the presence of certain heavy metals in water.

Also, the metals in the samples analyzed revealed that the samples had lead levels (Tables 1 and 2) greater than the value recommended by the World Health Organization of 0.01mg/L (WHO 2012). The value ranged from 0.03-0.18mg/L. High level of lead in the body has health effects of kidney damage, learning impairment, reduced sperm production, behavioural problem and memory difficulties (APEC, 2013). Lead accounts for most pediatric heavy metal poisoning (Pure water services). These values may be due to the presence of deposits of the metal in the area. Cadmium level was also high and the same thing applies to the level of nickel in the water sample (Tables 1 and 2). Cadmium is found in almost all soils and rocks (Salbine et al., 2009). Cadmium has been



implicated in learning disabilities and stress agent (CDC, 2012). Nickel has been implicated to cause allergic reactions such as skin rashes, interestingly, nickel does not bio-accumulate (CDC, 2012).

Manganese, cobalt, copper and iron had values that were within the recommended concentration of these metals in drinking water. Zinc was not detected in the water samples from the 2 villages. It could be that there are no deposits of these metals (Mn, Co, Cu and Fe) in the area of their concentration was too low to be detected. Although, some of these metals, at appropriate concentrations, have health benefits and so, monitoring the concentration of metals in water is very important.

From Table 3 one can see that all the water samples have some level of faecal contamination. Table 4 confirms the presence and type of micro-organisms present. The presence of these organisms has an immediate health implication on the consumers of this water.

The World Health Organization recommends a zero tolerant for microbiological quality of water (WHO, 2006). This implies that the water is unfit for consumption until adequate treatments have been carried out to kill these micro-organisms. The microbial pollution of the water sources could be due to the open nature of the sources and unclean dippers (Egesie et al., 2005).

CONCLUSION

The result of the present study (August 2014) revealed that quite a number of the water quality parameters investigated fell within the acceptable limits set by the World Health Organization (WHO), the United States Environmental protection Agency (USEPA) and the Nigerian Standard for Drinking Water Quality (NSDWQ). However, the water sources, if used for drinking purpose could bring about some health problems. This is because the water from all the six sources in Kaler

and Goktok villages contains high levels of lead, cadmium and nickel above the limits recommended by the Nigerian Regulatory Authority (NSDWQ), the World Health Organization (WHO) and the United States Environmental Protection Agency (USEPA). Chronic exposure of these metals in drinking water may affect cognitive development, cognitive impairment in children, behavioural changes and Kidney damage (UNICEF, 2008). In terms of microbial quality, the water samples in Kaler and Goktok villages are unsafe for human consumption without treatment (Tables 3&4). The presence of significant amounts of coliform bacteria is indicative of pollution by human or animal's faeces or a breach of sanitary integrity of the water sources (Akaaham et al., 2010).

It has been established that pollution of domestic water is an ongoing problem in most Nigerian communities, especially the government-ignored villages. The tragedy is seriously crippling human development. Proper identification of preventive and control measures would be very useful. The way forward in this respect is by educating the people on the importance of water sanitation and waste disposal methods and educating the local communities on some local ways of treating water, for example, the use of moringa seeds as a coagulant, adsorbent and disinfectant.

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