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GROUNDWATER QUALITY IN BASEMENT FORMATION OF MUSAWA LGA OF KATSINA STATE, NORTH-WESTERN NIGERIA.

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Abstract

This study was aimed at assessing the Groundwater quality in Basement complex formation in Musawa LGA of Katsina State, Nigeria. A total of Ten (10) boreholes were selected at random from various locations in Musawa LGA of the state. The water samples from these boreholes were analysed for 13 physicochemical and bacteriological parameters in order to ascertain their level and confirm wether they meet the World Health Organisation (WHO) standards for drinking water (WHO, 2014).

The Mean levels of all parameters tested were within WHO limit, except magnesium (Mg) which was above the limit. Most of the samples analysed met the requirement for drinking water, probably due to the natural filtration process the water has undergone.

Keywords:- Borehole, safe drinking water, underground water, geologic formations.

INTRODUCTION

The population of Nigeria is projected to hit the 200 million mark by the year 2020. This increasing population has put the scarce resources under stress. Water is the most important resource needed for the survival of mankind. Therefore, efficient development of groundwater resources is of particular importance in northern Nigeria where due to the low rainfall and the length of dry season, surface water sources are often inadequate (Adamu *et al*, 2013). To provide alternative to surface water which in most cases is unsafe, underground water development seems the most viable and safer option. Water quantity is important but, the quality of water is of paramount importance because of the preponderance of water–borne diseases that could lead to diseases outbreak among the populace. A number of studies have been conducted on the assessment of available groundwater resources in various parts of the country. Dupreeze and Barber (1965) wrote on the distribution and chemical quality of groundwater in Chad and Basement complex of northern Nigeria. Egboka (1983), Ogunkoye (1986) and Ako (1988) also wrote on parameters such as water quality, aquifer transitivity, age of groundwater, table depth to surface and relative location of groundwater as potential resources (Adamu *et al*, 2013).

The provision of groundwater supply in Katsina state as part of a coordinated development programme for rural development is seen as an essential service imperative to the entire state's development. The provision of groundwater for rural areas is undertaken by the Katsina State Rural Water Supply and Sanitation Agency (KTRUWASSA). The agency in conjunction with International donor agencies (UNDP, DFID, JICA etc.) carry out groundwater exploitation by sinking of boreholes in all geologic formations. The agency has put so much effort in providing the rural populace with safe drinking water by drilling an estimated 1850 boreholes from 2016 to 2017 alone. However, despite the efforts of these organizations, the main source of many villages for water supply essentially consisted of seasonal streams, rainfall pools and other such reservoirs. These sources are invariably polluted and constitute hazards to health (Imerbore et al 1987).

The long residence time of groundwater brings it into contact with the rock formations so that it tends to have higher concentration of dissolved solids than surface water and at times contains inorganic matter in higher concentration. Groundwater quality could vary by such spatially varying factors as lithology, texture and structure of the rocks (Ogunkoya 1986), and in areas with heavily polluted atmosphere, rain water quality is heavily altered (Horning et al, 1990). This study assessed the quality of groundwater from some selected locations within the basement complex formation of Musawa LGA for safe drinking, by testing for Physicochemical parameters; Iron (Fe), Calcium (Ca), Magnesium (Mg), Chloride (Cl^-), Nitrate (NO_3^{2-}), Sulphate (SO_4^{2-}), Fluoride (F^-), Temperature (Temp), Total Dissolved Solids (TDS), Total Hardness (TH), Total alkalinity (TA): and bacteriological parameters; Total coliform (TC) and Faecal coliform (FC) from selected locations in the Basement Complex formation of Musawa LGA in Katsina State.

STUDY AREA

The rocks in Katsina State comprise the following main units: migmatite - gneiss Basement Complex, younger metasediments and metavolcanics, granites, younger granite, igneous rocks and sedimentary rocks (Ibrahim, 2010a). Parts of the State are underlain by granites with lateritic capping in some of them. There are also the Daura Igneous Complex rocks and the Gundumi and Chad sedimentary formations (Kogbe, 1975).

Outcrops consist almost entirely of resistant migmatites, quartzites, conglomerates and granites, although there are small exposure of softer gneisses and semi-pelitic rocks in some stream channels. Rocks of the migmatite-gneiss Basement Complex constitute the majority in real extent (McCurry, 1970). The younger metasediments are the second most abundant rock type (occupying about 33% of the State), while most of the western part is underlain by the granites. Others include the Chad Sedimentary Formation and the Gundumi Formation which occupy about 15% of the total area of Katsina State. The least exposed rocks are the Daura Younger Granite rocks located in Zango LGA of the State. The contact relationship between most of the rocks could only be inferred, because exact contacts between the rocks have been concealed by overlying material (Rahaman, 1971).

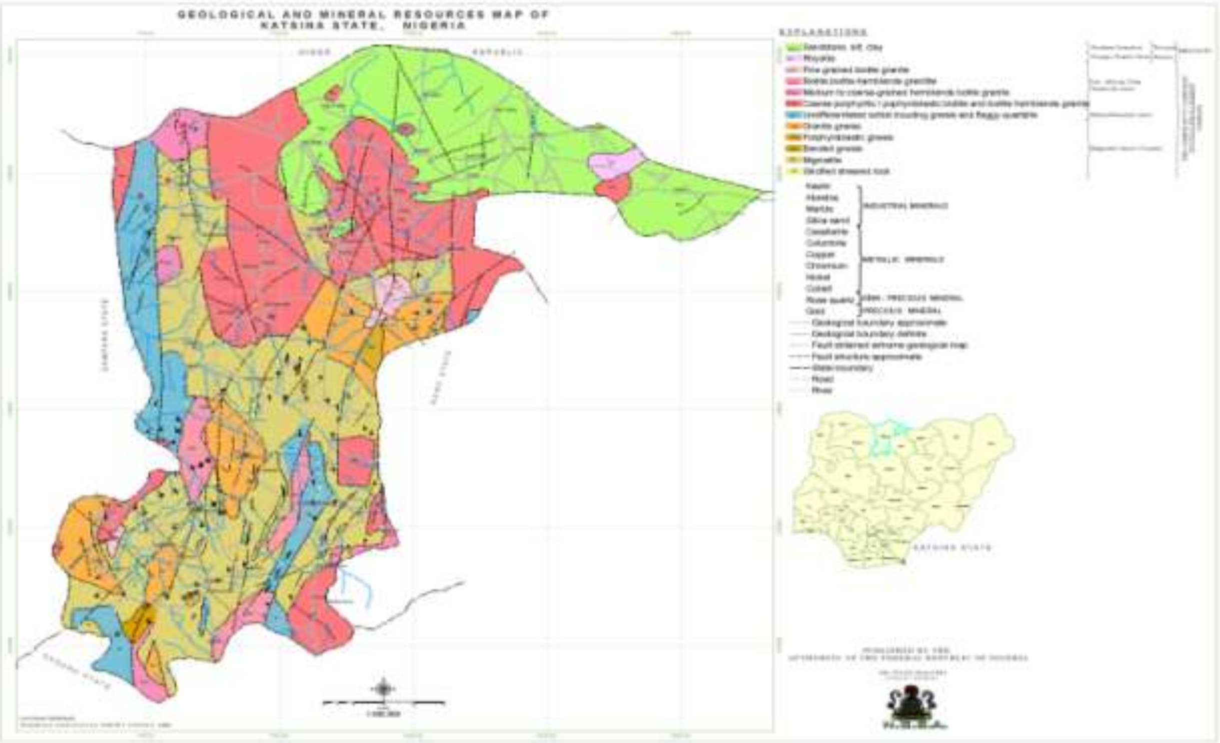

Fig 2.2. The Geology of Katsina State. N.G.S.A [2006]

METHODOLOGY

Water samples were collected in two sets of 1L polyethylene bottles (prewashed with acid, and rinsed with de-ionised water and labelled accordingly) from boreholes drilled in the Basement Complex formation of Musawa LGA in Katsina State. A total of Ten (10) boreholes were randomly selected and designated as DTS, YTS I, YTS II, BDL, BTG, KGR

A,MHB, TLG, UGL II and USB. The co-ordinates of all the selected boreholes were taken. The borehole waters were allowed to flow for about 2 minutes before the water was collected. Samples for the determination of cations were stabilized with a drop of dilute hydrochloric acid on collection. All the samples were preserved in ice on-site before being transported to the laboratory and stored in the refrigerator and were analyzed within 24 hours of collection. Samples for microbial analysis were collected in sterilized 250ml glass bottles, preserved in ice on-site before being transported to the laboratory, refrigerated and analysed within 24 hours of collection. Thirteen (13) parameters were chosen based on their importance in characterizing water quality of an area. TDS was determined in-situ using pre-calibrated TDS meter (Orion, Model 114) while the temperature was determined using pre-calibrated pH meter (Hanna, Model HI98107). The Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) concentrations was determined titrimetrically using EDTA. Iron (Fe) was determined by colorimetric method using thioglycollic acid which reduces iron (III) to iron (II) and forms a reddish purple colour. Chloride was determined by titration with a standard solution of silver nitrate with 8% potassium chromate solution added as an indicator. Sulphate (SO_4^{2-}) concentration was determined by turbidimetric method. Total hardness was determined by titration with EDTA (sodium ethylendiamine tetracetate) using Eriochrome black T as indicator. Nitrates were determined by the cadmium reduction method. All analyses were carried out using standard methods (APHA, 1998). The microbial analysis was carried out using the filter membrane method and presumptive count and each sample was incubated for at least 24 hours. The samples were analysed at Aqua Tetra Laboratory, Katsina, Katsina State.

The statistical tools employed in this study are both descriptive and inferential. Mean and Standard Deviation is also used in the analyses of the data.

RESULT AND DISCUSSION

Table1: Water Quality data from selected boreholes in Basement Formation

BH No	TA	TEM	Cl-	TH	SO_4^{2-}	Fe	NO_3^{2-}	F-	TDS	Ca	Mg	TC	FC
DTS	252.00	37.00	45.40	121.00	70.00	0.10	13.30	0.10	482.00	24.4	12.40	0.00	0.00
YTS I	114.00	38.00	60.00	60.00	90.00	0.10	8.86	0.10	263.00	12.20	6.30	0.00	0.00
YTS II	144.00	38.00	80.00	63.00	120.00	0.10	12.27	0.10	264.00	13.10	6.90	0.00	0.00
BDL	222.00	37.00	130.00	92.00	30.00	0.10	13.39	0.10	395.00	22.30	12.90	0.00	0.00
BTG	144.00	37.00	120.00	58.00	40.00	0.10	8.86	0.10	362.00	25.80	145.00	0.00	0.00
KGRA	144.00	37.00	60.00	66.00	70.00	0.08	8.86	0.20	258.00	20.20	11.10	0.00	0.00
MHB	120.00	37.00	50.00	48.00	180.00	0.10	0.00	0.10	233.00	19.10	10.80	0.00	0.00
TLG	168.00	37.00	80.00	62.00	160.00	0.11	0.00	0.20	336.00	26.20	15.50	0.00	0.00
UGL II	222.00	37.00	100.00	104.00	30.00	0.10	12.29	0.10	463.00	25.80	16.20	0.00	0.00
USB	138.00	37.00	60.00	63.00	80.00	0.10	8.86	0.10	246.00	20.30	11.10	0.00	0.00

Source; Laboratory analysis 2016

Table 2: Mean and Standard deviation (SD) of parameters in Basement formation

Parameter	Minimum	Maximum	Mean	S.D
TA	114.00	252.00	166.80	47.98
TEMP	37.00	38.00	37.20	0.42
Cl^-	45.40	130.00	78.54	29.39
TH	48.00	121.00	73.70	23.59
$S0_4^{-2}$	30.00	180.00	87.00	52.08
Fe	0.08	0.11	0.1	0.01
NO_3^-	0.00	13.39	8.67	4.95
F^-	0.10	0.20	0.12	0.04
TDS	233.00	482.00	330.20	92.24
Ca	12.20	26.20	20.94	5.07
Mg	6.30	145.00	24.82	42.35
TC	0.00	0.00	0.00	0.00
FC	0.00	0.00	0.00	0.00

Source; Data analysis 2016

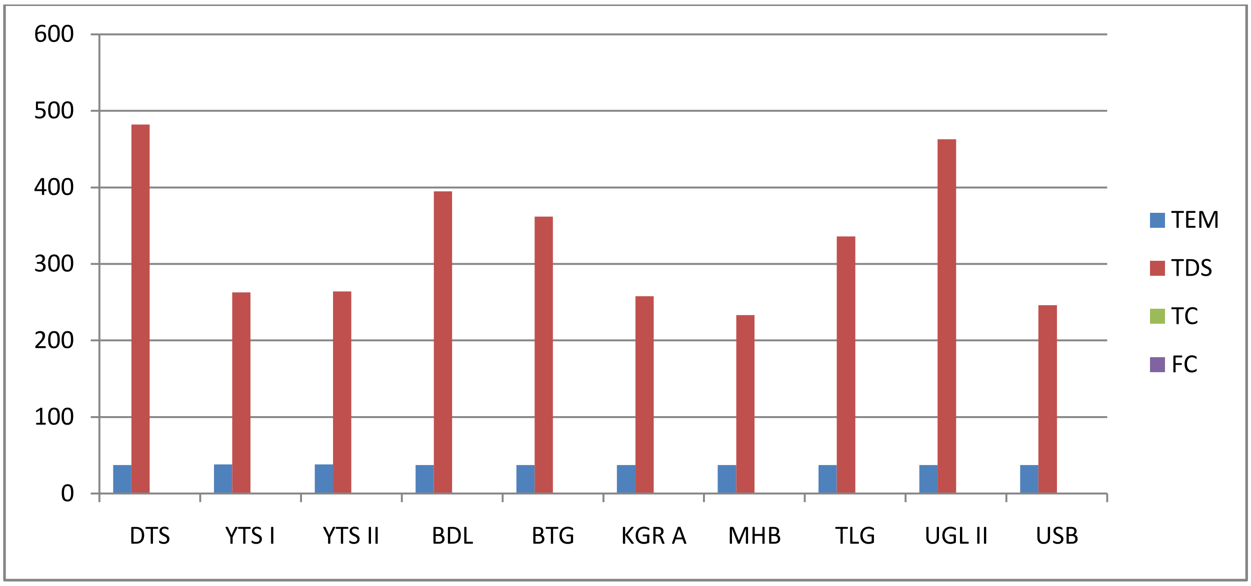

Fig 1.1: Representation of Temperature, TDS, Faecal and Total coliform in the selected locations in basement formation of Musawa LGA, Katsina State.

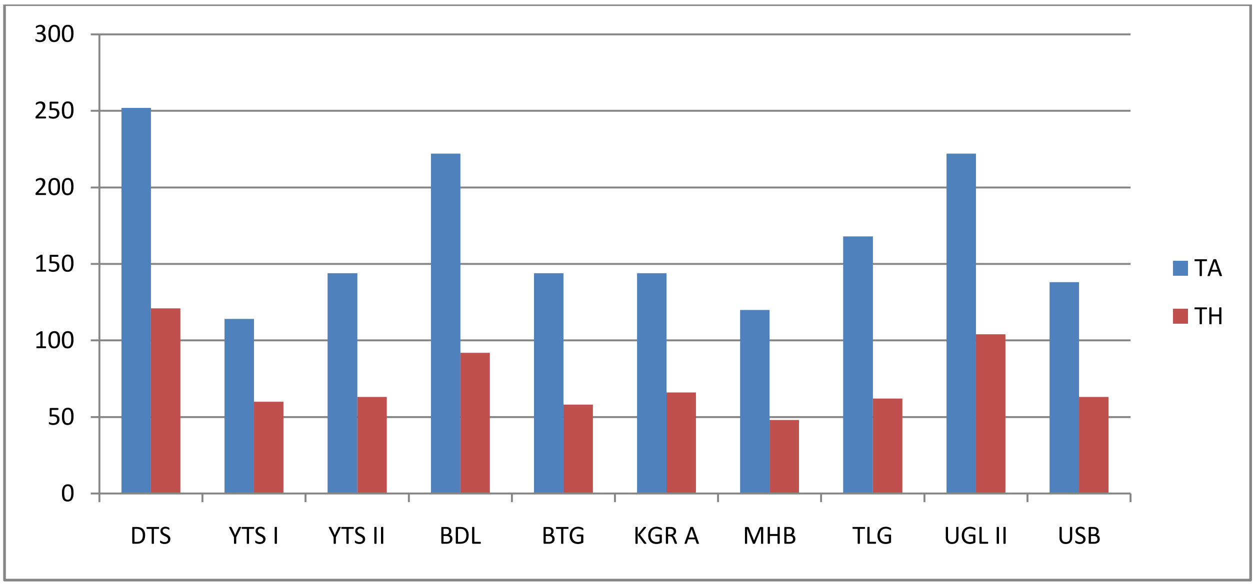

Fig 1.2: Representation of Total alkalinity (TA) and Total Hardness (TH) in the selected locations in basement formation of Musawa LGA, Katsina State.

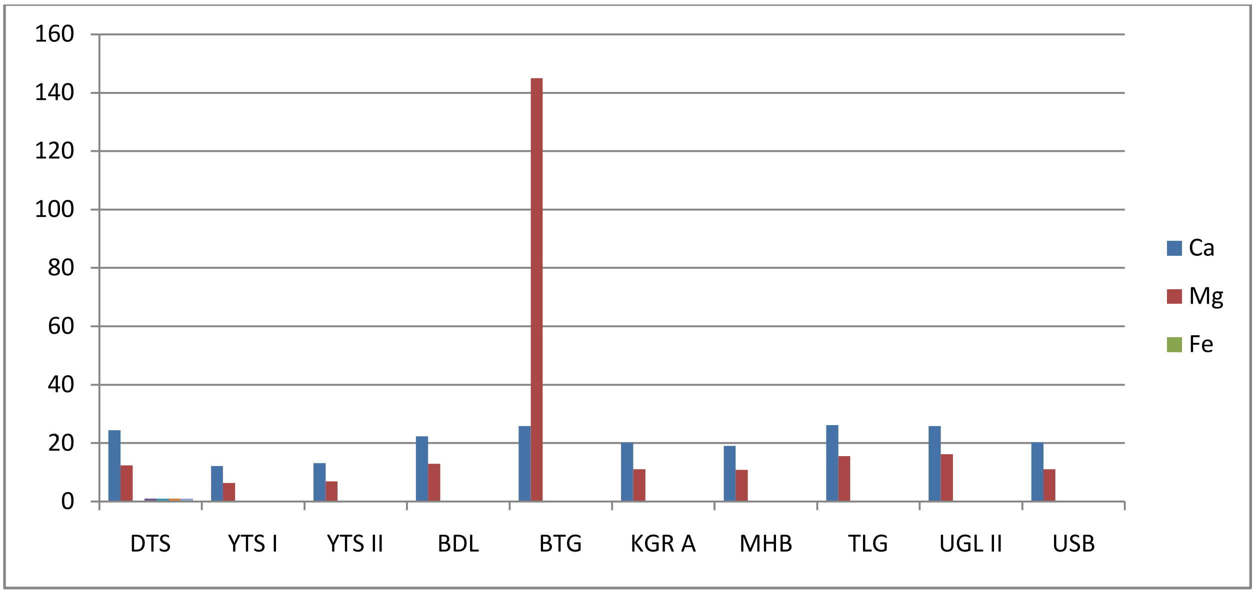

Fig 1.3: Representation of concentration of calcium (Ca), magnesium (Mg), and iron (Fe) in the selected locations in basement formation of Musawa LGA, Katsina State.

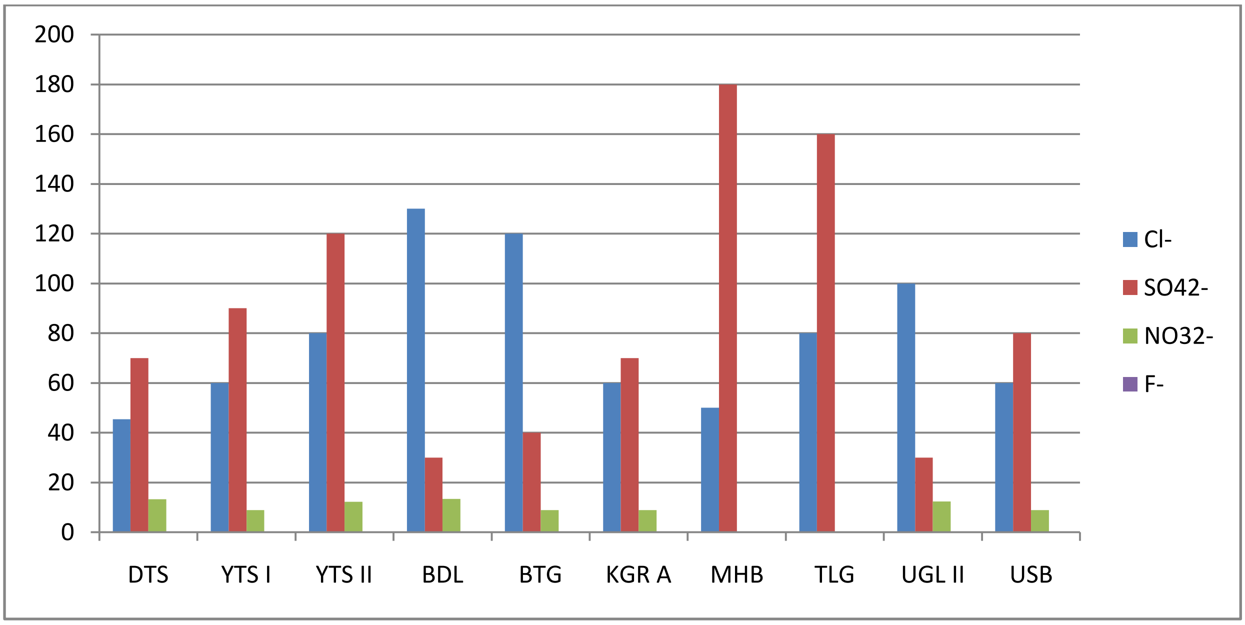

Fig 1.4: Representation of concentration of chlorides (Cl-), sulphates (SO_4^{2-}, nitrates (NO_3^-) and fluorides (F^-) in the selected locations in basement formation of Musawa LGA, Katsina State.

The result of the chemical and microbial analysis of groundwater in the basement formation is summarized in Table 1. The Total dissolved solids (TDS) ranges between 233 – 482 mg/l with a mean value of 330mg/l. The amount of TDS in water is a function of dissolved ions in water, and may be natural via bedrock dissolution or anthropogenic through industrial effluents. The temperature ranges 37.00°C - 38.00°C with mean value of 37.2°C. The values of Total hardness, sulphate (SO_4^{2-}), nitrate (NO_3^{2-}) and fluoride (F^-) fall between 40.00 – 121.00mg/l, 30.00 – 180.00mg/l, 0.00 – 13.39mg/l and 0.10 – 0.20mg/l respectively, with mean values of 73.70mg/l, 87.00mg/l, 8.67mg/l and 0.12mg/l respectively. The sulphate concentration is within the limit of 200mg/l (WHO, 2014; NSDWQ, 2007) in this formation. High sulphate enrichment in groundwater can be traced to bedrock dissolution via migration or application of sulphate rich manure/fertilizer in the soil. The low level of nitrates is an indication of absence of pollution from septic percolation. High nitrate level in drinking water causes infant methaemoglobinaemia (blue-baby syndrome), gastric cancer, metabolic disorder in children as well as livestock poisoning (Dan-Hassan *et al.*, 2012; Stadler, 2005; Tredoux *et al.*, 2005; Vogel *et al.*, 2004). Total hardness is within maximum permissible limit of 500mg/l. The fluoride concentration is also within the limit of 1.5mg/l. High concentration of fluoride in ground water causes a disease known as fluorosis which affects mainly the teeth and bones of animals/man (NSDWQ, 2007)

The values for Chloride (Cl^-) fall between 45.40 – 130.00mg/l with a mean of 78.54mg/l. These values fall within the permissible limit of 250.0 mg/l (WHO, 2014; NSDWQ, 2007). High chloride content in groundwater may indicate pollution by sewage, effluent or marine source (Amadi *et al.*, 2011; Dan-Hassan *et al.*, 2012).

The values for the cations, Calcium (Ca), Magnesium and iron (Fe), have ranges of 12.20 – 26.20mg/l, 6.30 – 145.00mg/l, and 0.08 – 0.11mg/l respectively, with means of 20.94mg/l, 24.82mg/l and 0.10mg/l respectively. The values for Calcium (Ca) are within the recommended permissible value of 75.00 mg/l (WHO, 2006). Calcium is necessary in animals for the formation of strong teeth and bones. The concentration of magnesium (Mg) is above the acceptable limit of 20mg/l. Studies by Amadi *et al.*, (2012b) have shown that magnesium in water is better and easily absorbed than dietary magnesium. Epidemiological data in man has proved that intake of water containing sufficient amount of magnesium prevents hypertension and nervous disorder (Akoto *et al.*, 2008).

The iron (Fe) concentration is within the recommended limit of 0.3 mg/l (WHO, 2014; NSDWQ, 2007). The human body needs iron (Fe) for basic metabolic activities as it is a useful ingredient of the blood. Lack of iron in the body causes goitre. Iron infiltrates into the groundwater as a result of chemical weathering of rock/lateralization. It is responsible for the reddish-brown colour in laterites (Juang et al., 2009).

The values for Total coliform (TC) range between 0.00 – 0.00 Cfu/100ml with a mean of 0.00 Cfu/100ml. The result indicates absence of faecal coliform (E. coli) bacteria. The presence of TCC and FCC in water is a clear indication of groundwater contamination by human or animal faeces. Faecal contamination of groundwater is responsible for most water borne diseases such as cholera, typhoid, meningitis and diarrhoea (Amadi, 2009; Egharevba et al., 2010). Poor sanitary situation of an area such as close proximity of unlined soak away/pit-latrine can be introduced into the shallow aquifer via infiltration. The maximum allowable limit is 10.0 cfu/100ml for TC and 0.0 cfu/ml for FC (NSDWQ, 2007; WHO, 2014).

CONCLUSION

The quality of groundwater is determined by many factors such as the chemistry of the saprolite (Ogunkoye, 1986) through which groundwater percolates, nature of chemical reactions between the water and the minerals in associated rocks, the velocity of the water body and the contact time between the host rock and percolating water. In basement complex, groundwater can move from one aquifer to another, and the quality may be modified by each in turn. The background value of the chemical elements in groundwater should have some direct bearing to the geology of the environment from which it is taken (Adamu et al, 2013). Thus, one expects to find similarity in ions concentration in samples from similar geologic formations. This study has established high concentration (above WHO limit) of magnesium. The presence of faecal contamination has also not been established by this study. Overall, the quality of water is very good.

RECOMMENDATION

Water can be polluted through natural and or anthropogenic means. All sources of contamination should be properly checked and monitored. Global best practices should be adhered to during construction and installation of boreholes. Good sanitary conditions must be maintained around groundwater sources to prevent contamination through seepage. More interventions are needed to provide adequate supply of safe drinking water in the rural areas to curtail the use of surface waters such as ponds, streams and rivers which are prone to contamination due to poor sanitary habits, and could lead to outbreaks of diseases such as diarrhea, cholera, typhoid and other water-borne diseases.

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