PHYSICO-CHEMICAL PROPERTIES OF GROUNDWATER SAMPLES FROM ISOLU AREA OF ODEDA LGA, OGUN STATE, NIGERIA

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Abstract: The study was carried out to assess the suitability of potable water used for domestic activities in ten selected locations at Isolu area of Odeda Local Government, Abeokuta. This is done to ascertain the qualities of the ground water being consumed in the locality. Several water quality parameters such as temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), among others were measured using Atomic Absorption Spectrophotometer (AAS), Combined pH/EC/TDS meter and other standard procedures. The results of the physical parameters considered revealed the following ranges of values for minimum and maximum respectively; temperature (27.0 – 29.5°C), pH (4.65 - 5.06), conductivity (180 - 800 mg/L), and total dissolved solids (90 - 400 mg/L). In addition, the results of chemical properties examined yields the following minimum and maximum values; Potassium (27.00 - 30.00 mg/L), Sodium (8.00 - 20.00 mg/L), Nitrate (24.00 - 48.00 mg/L), Chloride (21.00 - 189.00 mg/L), Calcium (50.00 - 100.00 mg/L), Magnesium (20.00 - 54.00 mg/L) and Bicarbonate (60.00 - 244.00 mg/L), respectively. Potassium, sodium and chloride recorded concentrations below the WHO and NAFDAC standard of 200 and 100 mg/L, respectively. However calcium, magnesium and bicarbonate recorded concentrations higher than WHO and NAFDAC limits of 75, 20 and 100, respectively.

Keywords: Bicarbonate, physicochemical, Isolu, electrical conductivity, groundwater, domestic

Introduction

Groundwater is considered among the healthiest source of drinking water, but domestic, agricultural and industrial activities have led to the degradation of groundwater quality in different parts of the world (Gimba *et al.,* 2015). The quality of groundwater is of great importance in determining the suitability of a particular groundwater for a certain use (public water supply, irrigation, industrial, industrial application, cooling, heating, power generation etc). It is the result of all processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by either a well or spring. The time span involved may range from less than a day to more than 50,000 years. The chemical composition of groundwater can also be indicative of its origin and history, of the underground materials that the water has been in contact with, and of deep-seated temperatures (Patil *et al.,* 2012).

Naturally, groundwater contains ions slowly dissolved from minerals in the soils, rocks, and sediments as the water travels along its flow path of precipitation water or river water that recharges the aquifer. The ions most commonly found in groundwater quality analysis include: Na^+, Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^-, SO_2^-, while minor ions include NO_3^-, NO_3^-, F^-, CO_3^-, K^+, Mn^{2+}, and Fe^{2+}. The concentration of these ions gives groundwater their hydro-chemical characteristics, and often reflects the geological origin and groundwater flow regime (Rawat & Arora, 1986; Aladejana & Talabi, 2013). Groundwater is uniformly cool and usually has a temperature near the long-term average air temperature for the region. It is common for deeper groundwater to show increasing temperature with increasing depth. Groundwater generally contains higher dissolved solids concentration than surface waters of the same locality (Canter *et al.,* 1987). Most of the minerals present in greater amounts are those which contribute to hardness (Ca and Mg) and alkalinity (HCO_3^-, CO_3^- and hydroxide). This is due largely to the increased amounts of CO_2 in the groundwater (Robertson, 1968).

Water can also be a source of serious environmental and health problems if the design and development of such water supply system is not coupled and tied with appropriate sanitation measures. According to Oloke (1997), drinking water can act as a passive means of transporting into the body system. However, the objectives or primary concern in providing potable water are freedom from harmful micro-organisms and freedom from undesirable or harmful chemicals. Therefore, both the physicochemical and bacteriological assessment of potable water is of paramount importance and monitoring must be given the highest priority. Groundwater pollution is mainly due to the process of industrialization and urbanization that has progressively developed over time without any regard for environmental consequences (Davies *et al.,* 2008).

Generally, groundwater has been alternative option that people rely on for the provision of water for adequate use among most inhabitants of Africa. Importance of groundwater for human consumption, agricultural and industrial uses as well as its quality has been widely researched (Sayyed and Wagh, 2011; Adekunle *et al.,* 2004). Increased knowledge of processes that controls chemical compositions of groundwater can improve the understanding of their usability status. The main objective of this survey is to assess the availability of quality underground water for Domestic and Irrigation uses in Isolu Area of Odeda local Government of Ogun state.

Materials and Methods

Study area

The study area is located within Odeda local government, Abeokuta within coordinates latitude 7°7'49.1'' – 7°10'32.3''N; longitude 3°18'43.2'' – 3°19'58.8''E. The altitude is about 170 m above sea level on basement complex of igneous and metamorphic origin (Jones & Hockey, 1964). Geologically, the study area is said to be part of transition zones of the southwestern Nigeria. It is underlain in the north by basement rock (Fig. 1) while in the south by the sedimentary rocks of the eastern Dahomey basin.

Sampling materials

The materials used for sampling from the study area were Storage bottles (2-litres each), glass funnels, Sterilized glass bottles, conical flask. Plastic bottle were rinsed with distilled water and used to collect water samples from the selected boreholes and wells in the study area and were taken to the water treatment laboratory for both physical and chemical analyses the same day for accurate results. The results obtained were compared with WHO publication for drinking water standard to ascertain conformity with the national and international guidelines.

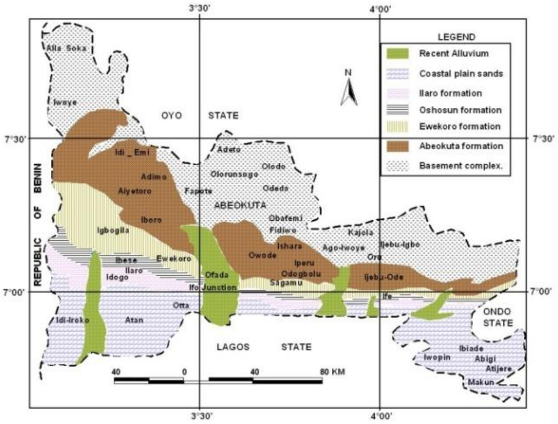

Fig. 1: Geological map of the study area (adapted from Nigeria Geological Survey Agency, 2009)

Sampling procedure

Ten (10) samples each were collected from shallow and deep wells. Upon collection of the samples, parameters such as pH, Temperature, Colour, Turbidity, Total dissolved solid (TDS), Electrical Conductivity (EC), among others were measured in situ using appropriate instruments. Prior to sample collection, all the plastic bottles were thoroughly washed and sun-dried; and the plastic battles were rinsed twice with the same water collected samples. The water samples were subjected to various laboratory analyses using standard procedures which include Thermometer, Conductivity meter, Atom Absorption Spectrophotometer (AAS), Combined pH/EC/TDS meter (combo HI 98130, Hanna USA) among others. The analyses were carried out at the Water Laboratory, department of Water Resources Management, College of Environmental Management, (COLERM), Federal University of Agriculture (FUNAAB).

Results and Discussion

Physical parameters

pH

The result of physicochemical analysis of water shows that the pH of the water samples from Isolu area of Odeda Local Government do not comply with standard requirements. Their values ranges from 4.75 – 5.06 which are less than the lower limits of the pH (6.5) recommended by WHO (2011), and NAFDAC (2001) as shown in Table 1 and Fig. 2, respectively.

Total dissolved solids (TDS)

Total dissolved solids (TDS) are the concentration of all dissolved minerals in water which indicates the general nature of salinity of water. The values of total dissolved solids (TDS) determined for these samples are within 90 mg/L – 400 mg/L as contained both in Table 1 and Fig. 2 found below the minimum tolerance limits of 500 mg/l of WHO (2011). The higher value of total dissolved solids is attributed to application of agricultural fertilizer contributing the higher concentration in the ground water. High values of TDS in ground water are not harmful to human beings but high concentration of these may affect persons, who are suffering from kidney and heart diseases.

Electrical conductivity (EC)

Conductivity is a measure of capacity of substance to conduct the electric current. Most of the salts in water are present in their ionic forms and capable of conducting current. Electrical conductivity is an indication of the concentration of total dissolved solids and major ions in a given water body. Electrical conductivity in a ground water of the location varied from 180 to 800 mg/L (Table 1), where permissible limit is 1000 mg/L for domestic use. In agreement with Ojekunle, 2017, all the samples are within the tolerance limit of specified standard WHO (2011) as indicated by Table 1 and Fig. 2, respectively.

Table 1: Results of physical parameters of samples

Samples	Temp. (°C)	pH	E.C (mg/L)	TDS (mg/L)
SW1	29.00	4.75	270.00	130.00
SW2	27.00	4.89	270.00	130.00
SW3	29.50	4.77	180.00	90.00
SW4	28.00	4.80	189.00	120.00
SW5	28.5	4.70	185.00	100.00
BH6	27.50	4.85	260.00	130.00
BH7	27.00	4.89	330.00	160.00
BH8	28.50	5.06	500.00	240.00
BH9	28.50	4.65	800.00	400.00
BH10	28.50	4.90	400.00	300.00
WHO	**27**	**7.0-8.9**	**900**	**500**
NAFDAC	**27**	**6.5-9.5**	**1000**	**500**

SW = Shallow Well; **BH** = Bore Hole

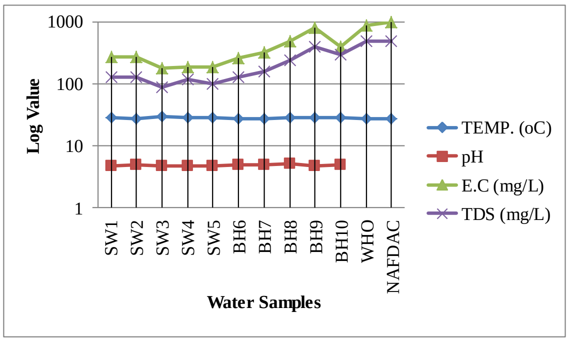

Fig. 2: Comparison of the log value of physical parameters of water samples with WHO and NAFDAC

Temperature

Temperature is one of the most important ecological and physical factor which has a profound influence on both the living and non-living components of the environment, thereby affecting organisms and the functioning of an ecosystem. Although temperature generally influences the overall quality of water (physico-chemical and biological characteristics), there are no guideline values recommended for drinking water. Therefore, having analysed temperature for the collected water samples the values are between 27.0 and 29.5°C (Table 1 and Fig. 2). These may have been influenced by the intensity of the sunlight as temperature rose from 26 to 32°C on relatively hot days (Mulusky, 1974). This was also reported by Banwo, (2006) for Ogunpa River in Ibadan. A temperature range of 26 and 30°C was attributed to the insulating effect of increased nutrient load resulting from industrial discharge.

Chemical parameters

Chloride

Chloride is one of the major inorganic anion in water. In potable water, the salty taste is produced by the chloride concentrations. There is no known evidence that chlorides constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/L in supplies intended for public use (WHO). In Table 2 and Fig. 3a, the chloride levels measured in the water samples ranged between 21.00 mg/L (shallow well 3) and 189 mg/L (Bore Hole 9). All of the samples analysed however, measured chloride levels below the WHO (2011) limit, however 30% of the samples were above NAFDAC (2001) limits.

Bicarbonate

HCO_3^- is the dominant anion in all the water samples. However, 90% of the water samples measured HCO_3^- the dominance. The HCO_3^- concentrations ranged from 60.00 to 244.00 mg/L as shown in Table 2 and Fig. 3b, respectively.

Calcium

In Table 2 and Fig. 3b, the Ca^{2+} concentrations were between 50.00 and 100.00 mg/L. Calcium is a major constituent of various types of rock. It is one of the most common constituents present in natural waters ranging from zero to several hundred milligrams per litre depending on the source and treatment of the water. Calcium is a cause for hardness in water and incrustation in boilers.

Table 2: Concentration of chemical parameters of samples expressed in mg/L

Samples	K^+ (mg/L)	Na^+ (mg/L)	NO_3^- (mg/L)	Cl^- (mg/L)	Ca^{2+} (mg/L)	Mg^+ (mg/L)	HCO_3^- (mg/L)
SW1	29.00	10.00	28.00	37.00	82.00	20.00	244.00
SW2	29.00	15.00	24.00	45.00	86.00	34.00	120.00
SW3	29.50	08.00	31.00	21.00	80.00	23.00	60.00
SW4	27.00	15.00	26.50	30.00	90.00	30.00	160.00
SW5	28.50	15.00	25.50	35.00	85.00	27.00	200.00
BH6	29.50	15.00	42.00	72.00	50.00	35.00	112.00
BH7	30.00	20.00	43.00	50.00	84.00	54.00	244.00
BH8	28.50	17.50	48.00	134.00	64.00	44.00	244.00
BH9	29.50	18.50	47.00	189.00	100.00	22.00	244.00
BH10	27.50	19.50	46.50	150.00	90.00	25.00	200.00
WHO	**200**	**200**	**10**	**200**	**75**	**20**	**100**
NAFDAC	**200**	**200**	**10**	**100**	**75**	**20**	**100**

SW = Shallow Well; **BH** = Bore Hole

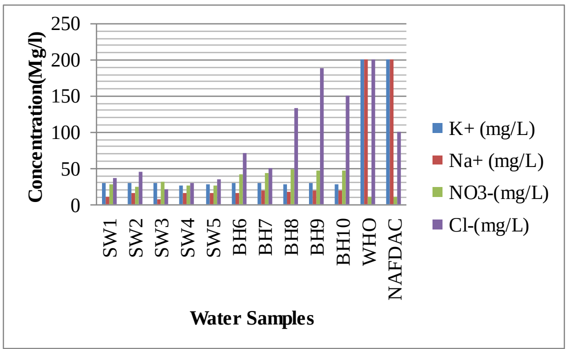

Fig. 3a: Comparison of concentration of chemical parameters of water samples with WHO and NAFDAC

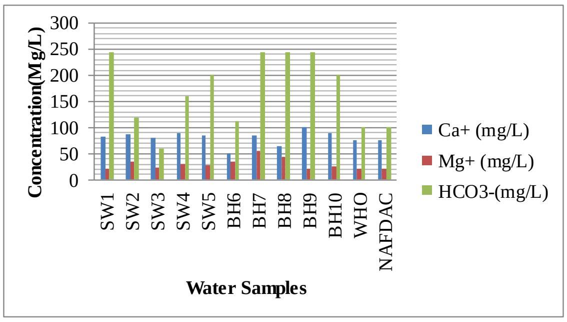

Fig. 3b: Comparison of concentration of chemical parameters of water samples with WHO and NAFDAC

Magnesium

The solution resists the pH variations during titration. Magnesium in all sampled well water ranges between 20.00 and 54.00 mg/L (Table 2 and Fig. 3b). Magnesium detected in all sampled water is higher than the WHO (2006) and the NAFDAC regulatory limit of 20 mg/L.

Sodium

In Table 2 and Fig. 3a, sodium detected in the water sampled ranges between 8.00 and 20.00 mg/L. The findings reveal that sodium contents in all sampled sources are generally low when compared to the WHO (2006) and NAFDAC regulatory limit of 200.00 mg/L.

Potassium

Potassium is an essential element in plant, animal and human nutrition (Lewis, 1997). In humans, potassium ions play a critical role in many vital cell functions, such as metabolism, growth, repair and volume regulation, as well as in the electric properties of the cell (Adriogue and Wesson, 1994). Potassium concentrations range between 27 and 30.00 mg/L as shown in Table 2 and Fig.re 3a, respectively.

Nitrate

Nitrate is the dominant anion in all the water samples. However, all the water samples from the study area measured NO_3^- dominance. The NO_3^- concentrations ranged from mg/L to 48.00 mg/L (Table 2 and Fig. 3a). The nitrate (NO_3^-) content was higher than permissible limit (10 mg/L) in all the water samples. Higher concentration of NO_3^- in water causes a disease called "Methaemoglobinaemia" or known as "Blue-baby Syndrome". It is particularly Infant disease up to 6 months of child (Kumar and Singh, 2010).

Conclusion

This work has presented the physicochemical parameters such as temperature, pH, conductivity, magnesium, chloride, nitrate, potassium and total dissolved solid contents in the water samples collected from Isolu area. The results showed that most of the parameters determined did not exceed the safe limit of WHO/NAFDAC. However calcium, nitrate and bicarbonate were found to exceed the maximum permissible limit as recommended by WHO/NAFDAC.

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