

Physiochemical and Bacteriological Analysis of Groundwater at Dutse, Bwari Area Council, FCT, Abuja.

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Abstract

This study characterizes groundwater's physicochemical parameters and bacteriological analysis in Bwari, FCT the capital city of Nigeria. Nine boreholes were randomly selected for sampling. Sample locations include Dutse Sokali, Dutse Baupma, Dutse Jabu, Kogo, Bwari, Sabon Gari Bwari, Dimas Isuwa Street, Bwari, Dutse Alhaji, Tasha Bwari and F01 Kubwa Bwari. The parameters studied were pH, Electrical Conductivity, Fluorine, Nitrate, Total Dissolved Solids, Chloride, Sulphate, Bio-carbonate and bacteriological assessment. In addition, a comparative analysis was done using the World Health Organization water quality standard (WHO). The comparative analysis shines a light on the groundwater contamination in the area.

Keywords: Abuja; Nigeria; Bacteriological analysis; Bwari; Electrical Conductivity; pH; Physicochemical analysis; Total Dissolved Solids; Underground water.

1. Introduction

The availability of clean water is one of the great issues facing humanity today; in some ways the greatest, because its problems affect the lives of millions of people (Geyh, M. A, 2000).

On 28 July 2010, through (United Nations, 2014), the United Nations General Assembly (UNGA) explicitly recognised the human right to water and sanitation. The UNGA also acknowledged that clean water and sanitation are essential to actualising all human rights.

In urban and rural areas, groundwater is the major source of drinking water (Gupta et al., 2009). It is mostly abstracted through pumps and hand wells and sometimes spring. Groundwater contamination, therefore, poses a serious threat to the health of the rural populace because they are consumed without any form of treatment

(Dahunsi, S.O. et al., 2014). Furthermore, certain activities like; Saline water intrusion, agricultural activities, urbanisation, and improper waste disposal affect groundwater quality in a locality (Akhtar, M. M. et al., 2014). Therefore, regular environmental and groundwater assessment is necessary for the protection of public health in areas with high risks of contamination. The study area is one of such areas with agricultural activities, prevalent quarrying and indiscriminate waste disposal.

The recent improvement in water supply amongst Sub-Sahara African countries is sourced from groundwater, and these private boreholes are not usually monitored (WHO/UNICEF, 2015). Nigeria being a major Sub-Saharan African country with a population of 190 million people, still has a huge challenge in providing improved drinking water to her citizens, given the near-complete absence of a pipe-borne water scheme (Dahunsi, S. O. et al., 2014). This absence has made a majority of Nigerians in both urban and rural communities depend mostly on water sourced from the ground for drinking and other domestic purposes (Owumah, I.H. et al., 2013). Also, in recent decades, Nigeria has experienced an increase in privately owned boreholes; especially in rural areas, these wells are rarely monitored for quality assurance and are not enough to satisfy the local population (Owumah, I.H. et al., 2013). This water demand has resulted in unprotected and unsafe water sources like shallow wells (Sojobi, S.O. et al., 2016).

Summarily, this research aims to investigate the quality in the Dutse community to create the necessary drinking water quality consciousness in the community and facilitate the provision of a treated pipe-borne water scheme in the study area.

2. Research Method

2.1 Study area:

Bwari is an area council in the Federal Capital Territory of Nigeria. It is the second biggest area council by population, with a population of 581,100 [0] located within latitude N 9° 16' 34.5612" and Longitude 7° 23' 8.5992" (<https://www.findlatitudeandlongitude.com/l/Bwari+abuja/1104650/>). Geologically, the area comprises mainly Granite and undifferentiated Gneiss Migmatite (Adelana, S. M. A. et al., 2008)

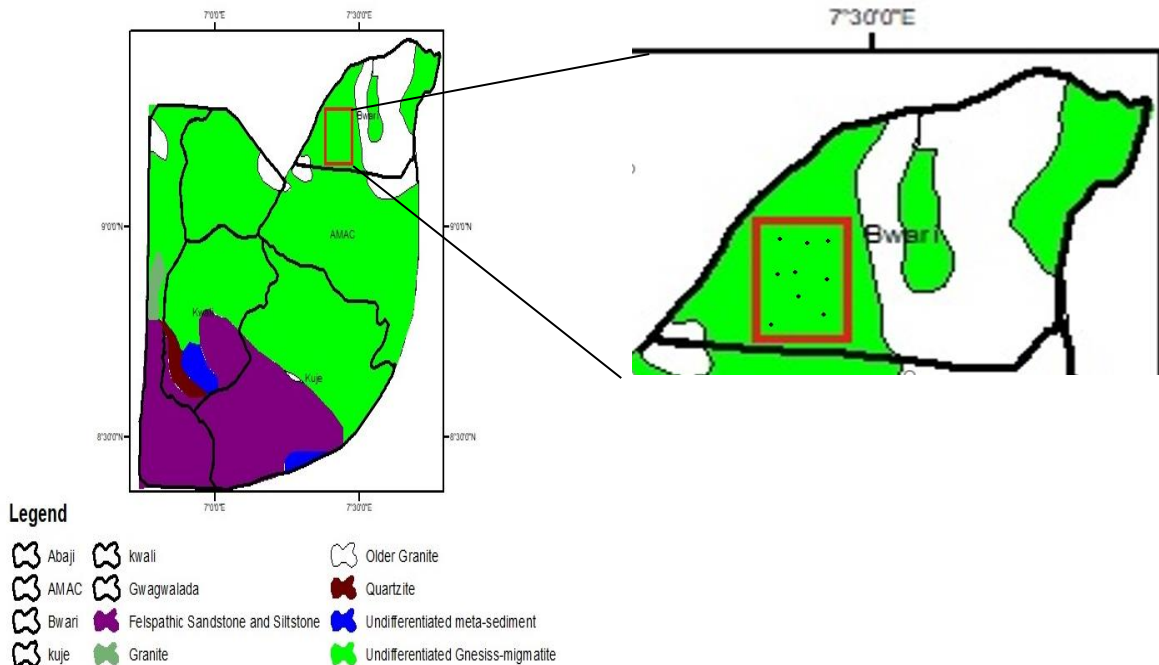


Fig 1a: Geological map of the Federal Capital Territory, Abuja showing the different rock types (Modified after NGSA, 2004). B. showing study area and sample points.

Two methods of study were adopted, namely field study and laboratory analysis. The field studies involved water borehole sampling, physical analysis, and observation of the study area's prevailing geologic and hydrogeologic settings. The laboratory analysis entailed the study of groundwater parameters using chemical reagents and laboratory apparatuses.

In the study, samples were collected from nine (9) locations (table 1) of drinking water in 2litre plastic containers. The sampling method adopted was the grab sampling method. This method involves the collection of water samples at specific boreholes locations representing conditions at only the time of sampling. The goal of sampling was to obtain a portion for analysis from the wells that are a true representation of water conditions in the area. The most necessary precautions exercised in order to achieve the set goal are;

- The point of sampling represented the general water conditions in the area.
- The sampling frequency enabled the sampling of different water aquifers if present.
- The maintenance of the sample after sampling and before analysis prevents alteration of the sample from its inherent properties.
- A total of nine (9) samples were collected from the water borehole in the study area. A litre rubber

Container was used for each water sample.

- They were carefully labelled, indicating the sample location to prevent mix-up.
- GPS coordinates and elevation of each sample point were also recorded.

Table 1: Location, coordinates and elevations of sample points.

S/N	LOCATION	LATITUDE(⁰)	LONGITUDE (⁰)	ELEVATION (m)
S-1	Dutse Sokali	9 ⁰ 09' 08.5" N	7 ⁰ 22' 28.1" E	452
S-2	Dutse Baupma	9 ⁰ 10' 18.6" N	7 ⁰ 22' 56.5" E	466
S-3	Dutse Jabu	9 ⁰ 10' 16.2" N	7 ⁰ 22' 34.7" E	446
S-4	Kogo, Bwari	9 ⁰ 15' 35.4" N	7 ⁰ 23' 00.7" E	530
S-5	Sabon Gari, Bwari	9 ⁰ 16' 30.5" N	7 ⁰ 22' 59.4" E	562
S-6	Dimas Isuwa Street, Bwari	9 ⁰ 16' 49.0" N	7 ⁰ 22' 59.8" E	522
S-7	Dutse Alhaji, Bwari	9 ⁰ 5' 30" N	7 ⁰ 22' 16" E	470
S-8	Tasha, Bwari	9 ⁰ 11' 50" N	7 ⁰ 22' 53" E	500
S-9	F01 kubwa, Bwari	9 ⁰ 9' 54" N	7 ⁰ 22' 16" E	430

2.2 Experimental procedure:

The geological analysis here involved the geochemical analysis of groundwater performed with a spectrophotometer. The physicochemical parameters analyzed are; pH value, Total dissolved solids (TDS), turbidity, Bicarbonate, Potassium (K⁺), Sulphate (SO₄²⁻) and Chloride (Cl⁻). In addition, bacteriological assessments were carried out using indicator organisms.

2.2.1 Electrical conductivity and PH value:

The conductivity of the samples was determined using a Jenway model 4010, and the pH Meter, model PBS – 51 was used to determine the PH value.

2.2.2 Determination of Chloride (CL⁻):

100ml of the sample is taken in a clean volumetric flask. The content of one carbon zone and reagent powder pillow is added, and the mixture is titrated to a high pink colour with 2.256N mercuric nitrate filtrate. The concentration of chloride in the sample in Mg/L is read from the digital titrate converters' window.

2.2.3 Calcium Hardness:

Calcium hardness was determined using the EDTA method with murexide (ammonium purpurate).

2.2.4 Determination of Total Suspended Solids (TSS):

In determining the Total Suspended solids (TSS), a measured volume of the water sample is filtered through a pre-weighted filter. After which, the filter is dried and re-weighed. This method determines the weight of suspended solids per volume of water (typically in mg/l).

2.2.5 Determination of Potassium DREL/5:

The sample is taken in a 25ml sample cell. The contents of one potassium one reagent powder pillow and one potassium two reagent solution pillows are added and mixed when the solution is cleared. The content of one potassium reagent powder pillow is added stopper and shook for some seconds. After a while, turbidity will develop if potassium is present. The instrument is standardized with the original sample with wavelength adjusted to 450Nm. The concentration of K^+ in Mg/L is read.

2.2.6 Determination of Sulphate (SO_4):

One Silver (IV) Sulphate reagent powder pillow was dissolved in a 25ml sample. White turbidity will develop if Sulphate is present. About 5 minutes is allowed for maximum turbidity to develop. Another sample cell is filled with the untreated sample used to standardize the instrument with the set at 450Nm.

2.2.7 Determination of Bicarbonate (HCO_3):

In determining the amount of Bicarbonate, a few drop of phenolphthalein is added to 100ml of the sample water. This new solution is titrated with 0.05N until the colour disappears of pink is produced with the phenolphthalein. The burette reading is multiplied by 30 to get the Mg/l HCO_3^- ion. To the colourless solution from this titration on the original solution, if no colour is produced with phenolphthalein, one drop of methyl orange is added, and titration continues until pink colour is produced. The total burette reading is multiplied by 30.5 to obtain the value of HCO_3^- in Mg/L.

2.2.8 Determination of Total Dissolved Solids (TDS):

An indirect method was used to determine the total dissolved solids in a sample. The method involved electrical conductance, which is inversely proportional to the electric resistance. Electrical conductance is the conductivity of a body or mass of fluid in a unit length and unit x- sectional area at a specified temperature.

$$TDS = AC$$

Where A = Constance ranging from 9.24 mg/l to 9.84mg/l.

C = Electrical Conductance (microseisms or micromhos).

2.2.9 Bacteriological Assessment:

In bacteriological assessment, indicator organisms rather than the pathogens that might cause concern were analysed. Indicator organisms are bacteria such as non-specific coliforms and Escherichia coli that are commonly found in the human or animal gut. If detected, it may suggest the presence of sewage. Indicator organisms are used because even when a person is infected with a more pathogenic bacterium, they will still be excreting many millions more indicator organisms than pathogens. It's therefore reasonable to surmise that if indicator organism levels are low, then the pathogen levels will be very much lower or absent.

3. Result and Discussion:

The parameters sampling sites and result obtained from calculations made:

Table 2: Physiochemical analysis of samples.

Sample site	pH	EC	TDS	TSS	Hardness
S-1	5.80	20.00	47.00	199.00	126.83
S-2	5.80	30.00	72.00	397.00	156.10
S-3	6.10	14.00	60.00	138.50	124.39
S-4	6.70	16.00	44.00	143.60	90.24
S-5	5.90	36.00	83.00	210.40	110.00
S-6	6.50	45.00	100.00	279.50	98.00
S-7	6.80	56.00	39.00	305.80	95.20
S-8	5.80	33.00	48.00	240.00	105.30
S-9	6.00	45.00	50.00	70.00	92.60
WHO	6.5-9.0	14.00	1000.00		100.00

Table 3: Chemical Analysis of Samples.

Sample Site	Cl ⁻	SO ₄	Ca ²	K ⁺
S-1	627.74	1.64	40.37	50.2
S-2	755.64	6.88	34.48	40.5
S-3	746.6	10.38	27.75	50.3
S-4	527	6.88	26.07	50.8
S-5	486.5	5.42	48.6	62.5
S-6	568.3	3.68	60.3	48.3
S-7	632.5	7.51	53.4	41.3
S-8	487.1	6.15	69.3	45.6
S-9	512.6	4.25	58.2	50.8
WHO	250	500	200	50-70

Table 4: Bacteriological Analysis of Samples.

Sample Site	Total Coliform Count, cfu/100ml	Total E.coli count cfu/100ml	Total Vibrio Bacteria Count, cfu/100ml
S-1	90.00	10.00	30.00
S-2	102.00	10.00	40.00
S-3	80.00	6.00	22.00
S-4	60.00	7.00	18.00
S-5	65.00	4.00	20.00
S-6	80.00	5.00	31.00
S-7	70.00	8.00	26.00
S-8	88.00	5.00	24.00
S-9	78.00	6.00	17.00
WHO	-	-	-

3.1 Physicochemical Analysis of Samples:

From table 2, it can be seen that in terms of EC, TDS and TSS, the samples are within the desirable range of quality drinking water (WHO, 2006). Whereas with the pH and Hardness, some samples exceed the WHO standard (WHO, 2008)

The pH ranges from 5.80 to 6.80, with a mean value of 6.16 (Table 2). 66% of the samples were lower than

the lower WHO limit. However, pH has no direct impact on human health (WHO 2008).

Also, the total hardness value ranges from 90.24 to 156.10 (Table 2), with a mean value of 110.96. a closer look shows that five (5) samples out of nine (9) fall beyond the Who standard (WHO, 2008).

3.2 Chemical Analysis of Samples:

From table 3, one can see that the measured chemical components are all within the range of desirable drinking water standards (WHO, 2008), except chloride and potassium. Chloride value ranges from 486.5 to 755.6, with a mean value of 593.78. According to WHO standards (WHO, 2006), chloride concentration above 250mg/l can give rise to a detectable taste in water, while chloride greater than 600mg/l would greatly impair the portability of the water (WHO, 2008). According to WHO (WHO, 2006), chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt and saline intrusion. Due to the prevalent population density in the study area, low industrial activities and the evident poor sewer system, one can suggest that the potential source of this high chloride could be the sewer.

3.3 Bacteriological Analysis:

Table 4 shows the result of the bacteriological analysis. Therein, a high level of indicator organisms like *E. coli*, Coliform and *Vibrio* bacteria were shown. The presence of these organisms negatively affects the portability of water.

4. Conclusion:

The study investigated groundwater's physicochemical and bacteriological parameters in Dutse, Bwari Area Council, Abuja. The analysis of these samples shows that while most of its physicochemical parameters are in line with WHO water standards, coliform, *E. coli*, and *vibrio* bacteria organisms mean the water, without treatment, is contaminated and unsafe for human consumption. These bacteria agents can be attributed to the proximity of water wells to pit latrines and poor constructed septic tanks. In addition, the majority of these boreholes are on shallow sedimentary layers due to the difficulty of drilling through igneous rocks for water. Therefore, the following recommendations should be considered:

- Treatment of groundwater in the area for bacteriological contamination.
- Frequent monitoring will help detect contaminated water, particularly during and after rainfall.
- Disposal points should always be above the maximum elevation of the water table and void of fractures, serving as an infiltration point for groundwater contaminants.

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