Physical And Chemical Assessment Of Some Selected Borehole Water In Gwagwalada, Abuja

N.C. Igwemmar, S.A.Kolawole, L.K. Okunoye

ABSTRACT: Drinking water or potable water is water safe enough to be consumed by humans or used with low risk of immediate or long term harm. Water samples collected from six different boreholes were subjected to physico-chemical analysis using titrimetric and spectrophotometeric method to evaluate the quality. The results showed that pH, temperature, turbidity, alkalinity, nitrate, chloride, iron and total hardness of all the borehole water samples were below the WHO limits while phosphate and magnesium gave values well above the WHO limits for all the samples except borehole B1 which gave a magnesium concentration lower than the WHO limit. Also conductivity result showed boreholes B1, B2, B5 and B6 gave values below WHO limit while B3 and B4 gave higher values. Generally, the results exhibited significant variation in the parameters studied on the samples; this could be attributed to the geographical positions and depth of the boreholes.

Key words: Borehole, Conductivity, Gwagwalada, Human body, Physico-chemical analysis, Portable water, Titrimetric method.

INTRODUCTION

Water has always been an important and life-sustaining drink to humans and is essential for the survival of all known organisms [1]. It accounts for about 70% of the weight of a human body. About 80% of the earth surface is covered by water out of which only a small fraction is available for consumption. The rest is locked up in oceans as salt water, polar ice caps, glaciers and underground [2]. Groundwater is already used throughout the world through wells and boreholes. Unfortunately, underground reservoirs are renewed only slowly by natural seepage. Groundwater is a reliable source of water supply, because it is often unpolluted due to restricted movement of pollutants in the soil profile [3]. However, when water travels through the ground, it dissolves parts of the soil components and so it is usually hard, it may even contain objectionable concentration of salts, such as those of iron and manganese [4]. Human activities and settlement hinge on the availability of water. Owing to increasing industrialization and exploding population, the demand of water supply have been increasing tremendously. In most developed countries, the water supplied to households, commerce and industry meets drinking water standards, even though only a very small proportion is actually consumed or used in food preparation. More than 3.4 million people die each year from water, sanitation, and hygiene-related causes. Nearly all deaths, 99 percent, occur in the developing world [5]. UNDP [6] also reported that the water and sanitation crisis claims more lives through disease than any war claims through guns. Thus the quality as well as quantity of clean water supply is of vital significance for the welfare of mankind.

- *N. C. Igwemmar, S.A. Kolawole and L. K. Okunoye*
- *Faculty of Science, Department of Chemistry, University of Abuja, P.M.B.117, Abuja, Nigeria*

Public (tap) water consumed in Gwagwalada environs is supplied from the Lower Usman Dam, Buhari, Abuja but the taps are most times without water. Hence, borehole water are presumed to be the major source of good water and have been increasingly commercialized for the water-starved populace of Gwagwalada, Abuja. The qualities of this water are generally not guaranteed and could cause health problems as a result of consumers drinking from such sources. This research investigated some physico-chemical parameters on six boreholes constantly in usage by the water vendors (Meruwas).

MATERIALS AND METHODS

Study area:

Gwagwalada is one of the five Local Government area councils in the Federal Capital Territory, Abuja with an area of 1,043 km² and a population of 157,770 at the 2006 census. Its geographical coordinates are 8^0 56' 29" North, 7^0 5' 31" East in DMS (Degree Minutes Seconds).

Sample collection:

Water samples used for study were collected from six different boreholes located in Gwagwalada. These samples were collected using pre-cleaned polyethylene bottle (1 liter capacity) for each and labeled accordingly as thus - Paiko borehole (B1); Passo borehole (B2); Old Kutunku borehole (B3); New Kutunku borehole (B4); Dagiri borehole (B5) and Phase one borehole (B6). This study did not put the depth and site of the boreholes into consideration.

Sample preservation and treatment:

Some physical parameters were analyzed on the borehole water samples at the site of collection. The temperature of each sample was measured and recorded using a thermometer calibrated in degree Celsius. Also the odour and taste were noted. The samples were then transferred to the laboratory in an improvised ice box where they were kept in the refrigerator to preserve the quality of the sample prior to analysis. All the apparatus used for analysis were properly washed and rinsed and the reagents are all of analytical grade. Standard method of analyses was employed in the various physico-chemical parameters determined. Electrical conductivity meter (Perkin-Elmer Model) was used to measure the conductivity of the water samples. The chemical parameters: calcium, magnesium, alkalinity, chloride and total hardness were determined by titrimetric method. Nitrates and phosphate were obtained using a JENWAY visible spectrophotometer (model 720). For pH determination of the water samples, a digital pH meter standardized with buffer solutions pH 4 and 9 was employed. All measurements were completed in triplicate and the mean values recorded on the table.

RESULTS AND DISCUSSION

The results of the physico-chemical parameters obtained in the six borehole water samples are presented on the Table 1.

Temperature: The water sample temperatures ranged between (31.2 – 32.0^{o} C) with borehole B1 having the highest temperature while boreholes B2 and B3 have the lowest. Temperature values are known to be dependent on the climatic condition at a particular geographical area and period.

pH: The pH values recorded in this work is between (6.5 – 7.1). The values fall within the (6.5 to 8.5) WHO [7] permissible limit for portable water. It was also observed that boreholes B1 = 6.5; B2 = B6 = 6.8 and B3 = B4 = B5 = 7.0. The pH value is an important index of acidity or alkalinity and the concentration of hydrogen ion in ground water [8].

Table 1: Physico-chemical parameters of the six borehole water samples

S/N	Parameters	B1	B2	B3	B4	B5	B6	Range
1	Temperature (^{o}C)	32.0	31.2	31.2	31.5	31.5	31.3	31.2 - 32.0
2	pH Value	6.5	6.8	7.0	7.0	7.0	6.8	6.5 - 7.0
3	Turbidity (NTU)	0.75	1.05	1.88	0.42	0.48	0.78	0.42 - 1.88
4	Colour (Pt-Co)	4	2	3	1	1	0	0 - 4
5	Alkalinity (mg/l)	6.90	7.20	5.80	3.60	6.00	9.30	3.60 - 9.30
6	Nitrate (mg/l)	4.60	1.00	0.40	0.90	0.50	0.30	0.30 - 4.60
7	Chlorides (mg/l)	21.30	21.30	61.60	14.20	25.56	21.30	14.20 - 61.60
8	Conductivity (µs/cm)	206	295	613	484	252	260	206 - 613
9	Hardness (mg/l)	116	118	162	386	106	228	106 - 386
10	Magnesium (mg/l)	41	70	142	246	88	168	41 - 246
11	Iron (mg/l)	0.06	0.06	0.05	0.03	0.08	0.18	0.03 - 0.18
12	Calcium (mg/l)	75	48	20	140	18	60	18 - 140
13	Phosphate (mg/l)	6.40	7.60	1.80	2.50	0.70	2.70	0.70-7.60

Turbidity: The turbidity value of the borehole samples was found to be in the range of 0.42 NTU to 1.88 NTU in the order B4 < B5 < B1 < B6< B2< B3. The values compared well with the (5.0 NTU) WHO [7] permissible limit for portable water. Turbidity is due to the presence of colloidal particles arising from clay and silt during rainfall, or from discharges of sewage and industrial waste.

Conductivity: Conductivity measures the ionic content of the water and it is linked directly to total dissolved solids. The conductivity of the samples ranged between (206 – 613µs/cm). This is due to high dissolved inorganic minerals. Boreholes B1, B2, B5 and B6 reported values below the WHO [7] permissible limit of 300µs/cm while boreholes B4 (484mg/l) and B3 (613µs/cm) were higher. However, the values obtained were within the range of literature values of (170 - 650µs/cm) for some selected hand dug wells and a borehole in Bauchi [9].

Calcium: The value of calcium was found in the range of 18 mg/l to 140 mg/l. The maximum value (140mg/l) was found in the borehole sample B4 and minimum value (18mg/l) found in B3. The values are below the 200 mg/l recommended by WHO [7]. Excess calcium contributes to formation of kidney and bladder stones. Aremu et al. [10] reported that calcium and magnesium are predominant minerals in surface and ground water. Calcium plays a significant role in blood clotting, muscular contraction and in some enzymes assisting in metabolic processes. It functions as a coordinator among inorganic elements, such that when K, Mg or Na are present in quantities beyond a particular limit in the body, Calcium assumes a corrective role [11]. Calcium also contributes to the hardness of water and may cause problems with laundering, washing and bathing.

Iron: The concentration of iron in the borehole samples did not vary widely. In all the borehole samples, iron content lower than (0.3mg/l) recommended by WHO [7] was reported, with B4 having the lowest value of 0.03mg/l and B6 the highest of 0.18mg/l. Dependence on these boreholes as a source of iron can result in anemia. Iron in ground water is normally present in the ferrous or bivalent form (Fe^{++}). It is a rare element required by both plants and animal. Iron in water may be present in varying qualities depending upon the geological area and other chemical component of the water way. Iron is an essential element in human nutrition. The minimum daily requirement of iron is ranged from about 10 to 50 mg/day [12]. It is vital in oxygen transport in the blood of all vertebrate and some invertebrate animals.

Magnesium: The values obtained ranged between (41 – 246 mg/l). When compared with the WHO [7] maximum permissible level of 50mg/l for magnesium, borehole B1 was lower while boreholes B2, B5, B3, B6 and B4 were all higher than the WHO [7] allowable limit. However, the NIS [13] limit of 150mg/l for magnesium accommodates the lower values of boreholes B1, B2, B3 and B5 but B4 and B6 are higher with values 246.03mg/l and 168.20mg/l respectively. Magnesium is a salt that contributes to the hardness and taste of water. Excessive magnesium may give water a bitter taste, but is normally not a health hazard.

Hardness: The total hardness of the water samples were observed to be in the range (106 - 386mg/l). The concentration of each of the borehole is below the 500mg/l WHO [7] maximum permissible limit for drinking water. Hardness is the property that makes water form an insoluble curd with soap and primarily it is due to the presence of calcium and magnesium. Based on the hardness value ground water may be classified as soft (<75 mg/l), moderately soft (75-150 mg/l), hard (150-300 mg/l) and very hard (>300 mg/l).Very hard waters have no known adverse health effects and may be more palatable than soft waters. Total hardness less than 80 mg/l may result in corrosive water, while hardness above 100 mg/l may result in the need for more soap during bathing and laundering; forms scum and curd; causes yellowing of fabrics; toughens vegetables cooked in the water; excessive hardness may also lead to scale deposits in pipes, heaters, and boilers.

Alkalinity: Alkalinity is primarily due to carbonate, bicarbonate and hydroxide contents. The maximum and minimum alkalinity concentrations were found to be 3.60mg/l and 9.30mg/l. These values are below the WHO [7] acceptable limit of 250 mg/l. Excessive alkalinity may cause stomach upset and encrustation of utensils, pipes, and water heaters. High levels can also give a 'flat' taste to the water and cause "itchy" skin when bathing.

Nitrate: The concentration of nitrate in water samples depends on the nitrification activities of micro-organisms. The results of nitrate varied from 0.30mg/l to 4.60mg/l. The values are well below (45mg/l) FEPA [14] as well as (50mg/l) WHO [7] permissible limits of nitrate in drinking water. In general, vegetables are the main source of nitrate intake when level in drinking water is below 10 mg/l. When nitrate level in drinking water exceeds 50 mg/l, drinking water becomes the main source of total nitrate intake. Makhijani and Manoharan [15] reported high level of nitrate in drinking water due to excessive use of agriculture fertilizers, decayed vegetable water, domestic effluent, sewage disposal industrial discharges, leachable from refuse dumps, and atmospheric precipitation has become a serious problem. Water that is contaminated with nitrate proves harmful especially to infants causing methaemoglobinaemia otherwise called infantile cyanosis or blue baby syndrome if consumed [16].

Phosphate: The result of phosphate analysis in the samples ranged from 0.70mg/l to 7.60mg/l. All the boreholes gave values higher than (0.5mg/l) WHO [7] permissible limit. Also boreholes B3, B4, B5 and B6 show values lower than (5mg/l) FEPA [14] set limit while boreholesB1(6.40mg/l) and B2 (7.60mg/l) values are higher. Phosphate stimulates the growth of plankton and aquatic plants which provide food for fish, this increased growth may cause an increase in the fish population and improve the overall water quality. However, if an excess of phosphate enters the water way, algal and aquatic plants will grow wildly, choke up the water way, and use up large amounts of oxygen. This condition is known as eutrophication or over-fertilization of receiving waters.

Chlorides: The concentration of the chloride was lowest in borehole B4 (14.20mg/l) and highest in borehole B3 (61.60mg/l). The values were within the WHO (200mg/l) limit for chloride but higher than the FEPA (2.5mg/l) set limit. Chlorides occur in natural water at varying concentrations depending on the geographical condition. It may also get into surface water from several sources including: rocks containing chlorides, agricultural run-off, waste water from industries, oil well wastes, and effluent waste water from waste water treatment plants. Small amounts of chlorides are required for normal cell functions in plant and animal life.

Table 2: Permissible Water Quality Criteria for Drinking Water

S/N	Parameters	WHO	FEPA	NIS
1	pH (mg/l)	6.5 - 8.5	6.5 – 9.2	6.5 – 8.5
2	Colour (mg/l Pt-Co)	15	-	15
3	Turbidity(NTU)	5	-	5
4	Temperature (^{0} C)	-	-	Ambient
5	Odour/ Taste	-	Virtually absent	-
6	Conductivity(µs/cm)	300	-	-
7	Alkalinity (mg/l)	250	500	-
8	Total Hardness (mg/l)	500	500	150
9	Iron (mg/l)	0.3	< 0.3	0.3
10	Chloride (mg/l)	200	-	-
11	Nitrate (mg/l)	50	45	50
12	Calcium (mg/l)	200	-	-
13	Magnesium (mg/l)	50	150	0.2
14	Phosphate (mg/l)	0.5	< 5	-

Sources: "Report on the Committee on Protection of Water Quality Criteria" Federal Environmental Protection Agency, Nigeria (FEPA, 1998) World Health Organization (WHO, 2006), Guidelines for Drinking Water Quality Nigerian Industrial Standard (NIS, 2007), Nigerian Standard for Drinking Water Quality

CONCLUSION

Physico-chemical analysis was carried out on six borehole water samples in Gwagwalada, Abuja. The results revealed that all the samples – B1, B2, B3, B4, B5 and B6 gave concentration values below the WHO maximum permissible limit in drinking water for pH, temperature, turbidity, alkalinity, chloride, hardness, nitrate, and iron whereas, phosphate and magnesium showed values above the WHO limit but borehole B1was an exception for magnesium. Also for conductivity, boreholes B1, B2, B5 and B6 reported values below the WHO permissible limit while boreholes B4 and B3 showed higher values. The results suggest a need to consider soil structure, position as well as depth boreholes while siting. A regular monitor of the water quality parameters is also recommended. It was observed that the permissible limits of all parameters of drinking water were not set for all by different agencies i.e. FEPA [14], WHO [7] and NIS [13]. Also the different parameters set by different agencies do not show uniformity. This research paper relied on WHO permissible limit as reference.

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