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Comparative Analysis of Some Selected Deep and Shallow Wells in Niykangbe Community, Niger State

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ABSTRACT

Rural dwellers depend basically on hand-dig wells or boreholes for potable water supply as the streams usually dry up in summer season. This useful resource is under threat of pollution from human life style manifested by the low level of hygiene practiced in the developing nations. Water samples were collected from shallow wells and deep wells. A total of 10 samples were collected, five each from boreholes and wells in the community over a period of three months. The samples were collected in a 1liter sterilized bottle and the physiochemical properties were carried out in the laboratory. The results showed that the minimum and maximum values recorded colour from borehole analysis was 0.00pt.Co respectively while that of well ranges between 0.00 and 416 pt.Co. The turbidity values for borehole samples showed no result while that of the well samples ranged between 3 NTU and 75 NTU. The total dissolved solid content for borehole ranged between 100 mg/L and 160 mg/L while that of well samples ranged between 90 mg/L and 200mg/L. The maximum nitrite content in drinking water should not exceed 0.2 mg/l. Nitrite values in the borehole water samples ranged between 0.03 mg/L and 0.08 mg/L, while that of the well water samples ranged between 0.00 mg/L and 0.10 mg/L. The sulphate values for boreholes ranged between 1.2 mg/L and 4.2 mg/L while that of wells ranged between 2.3 mg/L and 9.4 mg/L. It was concluded that the values obtained from the well and borehole were within the recommended values of NSDWQ (2007).

Keywords: *Agrarian, borehole, community, water, well*

1. INTRODUCTION

The pollution of groundwater has been attributed to industrialization and urbanization that has gradually developed over time not minding its impact on the environment. The quality of groundwater is generally based on the various physical and chemical parameters linked to weathering activities from surrounding rocks and anthropogenic activities [1]. Groundwater is an important water resource in both the urban and rural areas of most developing countries like Nigeria. In some of the major cities in theses developing countries, pipe borne water is also available which runs sporadically. In areas were rivers and stream are far from rural settlement and some cases dry up during the dry season, they depend mainly on hand-dig wells or boreholes for potable water supply. “This useful resource is under threat of pollution from human life style manifested by the low level of hygiene practiced in the developing nations. Protection of groundwater is a major environmental issue since the importance of water quality on human health has attracted a great deal of interest lately. Several researchers have concluded that it is the high rate of exploitation of groundwater than its recharging, inappropriate dumping of solid and liquid wastes are the main causes of deterioration of ground water quality. Thus, there is needed to look for some useful indicators, both chemical and physical, which can be used to monitor both drinking water operation and performance” [2]. “Importance of groundwater resources for human consumption, agricultural and industrial uses as well as its quality has been widely researched. Increased knowledge of processes that controls chemical compositions of groundwater can improve the understanding of their usability status” [3].

Emphasis that communities and individuals can exist without many things if the need arises; they can be deprived of comfort, shelter or food for a period, but they cannot be deprived of water and survive for more than a few weeks [4]. It has being emphasized by Health officials that drinking at least eight glasses of clean water every day to maintain good health. Adequate water supply to any community is, therefore, crucial and a determining factor in dictating the healthy condition of such a community.

Groundwater pollution has generally being on the increase especially in developing countries were lots of industrial activities, population growth, poor sanitation, land use for commercial agriculture and other factors occur for environmental degradation. “The concentration of contaminants in the groundwater also depends on the level and type of elements naturally or by human activities distribute through the geological stratification of the area. The presence of such contaminants in the groundwater, above the recommended standard set by water quality regulating bodies like EPA, FEPA and WHO may result in serious health hazards. This perceived consequence of consumption of unregulated waters (used as potable water) has triggered various studies on water aquifer and aquatic ecosystem” [5]. Contaminated sites are a significant threat to deep well resources worldwide. [6] estimates that there may be as many as 3 million contaminated sites across the European Union (EU), of which about 250 000 sites require clean up. The costs for investigation and clean-up of these sites are excessive and compared to the scope of the problem, the available resources for investigating and cleaning up contaminated sites are very limited. Thus, though considerable efforts have already been made, it will still take decades to clean

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up the legacy of contamination [6]. It is therefore important that the resources are allocated to the contaminated sites posing the greatest risk. In order to decide which sites should be given the highest priority and to streamline future activities, risk assessment is a very important and useful tool [7].

The objectives of this study was to comparatively analyze the physicochemical parameters of some selected deep and shallow wells in Niykangbe community of Niger state and to establish a baseline information on physicochemical properties for groundwater in the area.

2. MATERIALS AND METHODOLOGY

2.1 Study Site

Nyikangbe town is one of the twenty-five (25) neighborhoods of Minna, Niger State. Niger state is located in the North Central area of Nigeria with an estimated population over one million [8]. Minna having an average temperature of 31^0C and wind speed at 10km/h lies on the geographical coordinates of latitude $9^{\circ}36^{'}50^{''}$ north and longitude $6^{\circ}33^{'}24^{''}$ east. The average elevation of Minna is 272m and altitude 1007 feet above the sea level.

2.2 Sample Collection

A total of 10 samples were collected, five each from boreholes and wells in the community over a period of three months. The wells and boreholes were randomly selected with the coordinates of where the samples taken noted. Samples from these sources of underground water were collected during pick period of the dry season (February). The samples were collected in a 1liter sterilized bottle with each carefully labelled and kept in an iced box. This procedure was carried out based on the recommendations from [9, 10 and 11].

The physiochemical properties for the various samples collected were carried out in the laboratory. The temperature was measured *in-situ* in the field with a capillary filled thermometer which was first suspended in the air to know the temperature of the environment before it was inserted in all the samples to know their various temperatures. Total dissolved solids, pH and conductivity were analyzed immediately using electrodes including pH probe and electrical conductivity meter.

3. RESULTS

The results from the water sample analysis for the physical and chemical parameters for five boreholes are presented in Table 1 while Table 2 shows the results of some selected wells all in Nyikangbe agrarian community.

Table1: Average Physico-Chemical Analysis of Water Samples for a period of three months

N/S	PARAMETER	BH1	BH2	BH3	BH4	BH5	NSDWQ
1	Colour (pt. Co)	0	0	0	0	0	15
2	Turbidity (NTU)	0	0	0	0	0	5
3	Suspended Solid (mg/L)	0	0	0	0	0	N.S
4	Electrical Conductivity (μS/cm)	200	310	310	310	250	1000
5	Total Dissolved Solid (mg/L)	100	160	160	160	130	500
6	Temperature (^oC)	28.9	28.8	28.7	28.7	28.1	Ambient
7	PH	7.2	6.9	6.9	7.1	6.7	6.5-8.5
8	Nitrate (mg/L)	0.89	0.53	0.80	1.11	1.33	50
9	Aluminum (mg/L)	0.00	0.00	0.00	0.00	0.00	0.2
10	Nitrite (mg/L)	0.05	0.03	0.05	0.08	0.06	0.2
11	Chromium (mg/L)	0.00	0.00	0.00	0.00	0.00	0.05
12	Copper (mg/L)	0.03	0.05	0.01	0.01	0.00	1.0
13	Iron (mg/L)	0.12	0.19	0.17	0.19	0.10	0.3
14	Cyanide (mg/L)	0.00	0.00	0.00	0.00	0.00	0.01
15	Fluoride (mg/L)	0.02	0.09	0.06	0.04	0.01	1.5
16	Sulphate (mg/L)	1.5	4.2	3.1	2.9	1.2	100
17	Magnesium (mg/L)	0	0	0	0	0	0.20
18	Calcium (mg/L)	0.3	1.1	0.8	0.5	0.1	N.S
19	Total Hardness (mg/L)	70	146	132	138	112	150
20	Total Alkalinity (mg/L)	22	73	68	65	31	N.S
21	Phosphate (mg/L)	0.02	0.8	0.5	0.5	0.1	N.S
22	Manganese (mg/L)	0	0	0	0	0	0.2
23	Ammonia (mg/L)	0.12	0.23	0.15	0.10	0.08	N.S
24	Sodium (mg/L)	3.2	7.1	2.4	2.7	1.5	200

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Table 2: Average Physico-Chemical Analysis of Water Samples for a period of three months for Well water samples

N/S	PARAMETER	W1	W2	W3	W4	W5	NSDWQ
1	Colour (pt. Co)	11	0	461	78	58	15
2	Turbidity (NTU)	3	0	75	14	11	5
3	Suspended Solid (mg/L)	2	0	86	18	8	N.S
4	Electrical Conductivity (µS/cm)	220	260	300	190	410	1000
5	Total Dissolved Solid (mg/L)	110	130	150	90	200	500
6	Temperature (^oC)	29.9	29.9	29.8	29.8	29.9	Ambient
7	PH	6.8	7.3	6.5	7.2	6.4	6.5-8.5
8	Nitrate (mg/L)	4.5	0	24.7	3.6	33.4	50
9	Aluminum (mg/L)	0.00	0.00	0.00	0.00	0.00	0.2
10	Nitrite (mg/L)	0.10	0.0	0.04	0.01	0.08	0.2
11	Chromium (mg/L)	0.00	0.00	0.00	0.00	0.00	0.05
12	Copper (mg/L)	0.2	0.05	0.6	0.5	0.9	1.0
13	Iron (mg/L)	0.06	0.0	0.20	0.04	0.30	0.3
14	Cyanide (mg/L)	0.00	0.00	0.00	0.00	0.00	0.01
15	Fluoride (mg/L)	0.02	0.00	0.09	0.05	0.20	1.5
16	Sulphate (mg/L)	5.0	2.3	7.2	9.4	3.5	100
17	Magnesium (mg/L)	0.04	0.01	0.07	0.03	0.09	0.20
18	Calcium (mg/L)	0.9	0.2	2.3	1.2	0.7	N.S
19	Total Hardness (mg/L)	92	43	62	102	206	150
20	Total Alkalinity (mg/L)	48	22	26	58	164	N.S
21	Phosphate (mg/L)	0.09	0.03	0.12	0.10	1.2	N.S
22	Manganese mg/L)	0	0	0	0	0	0.2
23	Ammonia (mg/L)	0.24	0.12	0.71	0.42	0.83	N.S
24	Sodium (mg/L)	4.1	2.6	6.3	5.2	5.8	200

4. DISCUSSION OF RESULTS

Dissolved organic matter from decaying vegetation or some inorganic materials, such as coloured soils, etc., may impart colour to the water. The excessive growth of algae and aquatic micro-organisms may also sometimes impart colour to the water. The presence of colour in water is not objectionable from health point of view, but may spoil the colour of the clothes being washed in such water, and is also objectionable from aesthetic and physiological point of view, as people may not like to drink coloured water. The colour in water can be easily detected by the naked eyes. The maximum permissible colour for domestic water is 15 pt.Co as stated by [12]. The minimum and maximum values recorded from borehole analysis was 0.00pt.Co respectively while that of well ranges between 0.00 and 416 pt.Co. The observed data from the well analysis were found to be higher for all the wells except for W1 and W2 which were below the recommended values by [12]. These results were further compared to the works of [13] and [14] which showed some of the samples were excessively coloured.

The maximum turbidity value as recommended by [12] is 5 NTU. From the analyzed water samples, the borehole samples showed no result while that of the well samples ranged between 3 NTU and 75 NTU. This shows that the well water samples were highly turbid when compared with that of the borehole. Except for three well locations W3, W4 and W5 observed to have higher values than the recommended [12] values. The results obtained were compared to previous works of [16) and [17] which were found to be similar.

Though no specific value was stated by [12] as a standard, but the maximum and minimum values obtained during the analysis for borehole was zero, meaning that no suspended solids was observed from the water samples. The total suspended solids for well water samples ranged between 2.0 mg/L and 86 mg/L. This is a clear indication that the deeper the wells the lower the suspended solids that will be observed in the water. The wells where the samples were collected from were below 10m deep. Another major contributing factor could be the geological formation of the area. It is important to know that [15, 16, and 17] results were compared to the results obtained from the analysis which show distinct similarity.

Temperature of water usually has no practical significance in water quality parameter but only to the organisms living in the water body. The ideal temperature for drinking water ranges between 10°C and 25°C. From our study the temperature for borehole ranges between 28.1°C and 28.9°C while that of the well ranges between 29.8°C and 29.9°C. The recommended temperature by [12] is that of the ambient temperature. The observed values were compared to works of [15, 16 and 17] and were found to be similar.

The maximum permissible limit according to [12] for electrical conductivity in drinking water is 1000 µs/cm. The minimum and maximum values borehole water samples are 200 µ/cm and 310 µ/cm respectively while that of the well is between 190 µ/cm and 410 µ/cm. All the samples fall below the maximum permissible limit. The values obtained for electrical conductivity were compared to previous works of [18, 19] which were observed to be lower when compared with the NSDWQ permissible level.

The recommended standard by [12] is 500 mg/L. The total dissolved solid content for borehole ranged between 100 mg/L and 160 mg/L while that of well samples ranged between 90 mg/L and 200mg/L. Comparing these values with standard, it can be seen that the values are within the permissible limits. The values obtained were observed to be similar to the results from previous works of [16, 17]. The effects of total dissolved solids on drinking water depend on the level of individual elements, compounds, and components. Common properties of such water include taste, colour, and turbidity and so on. High concentration may affect taste adversely and deteriorate plumbing appliances. Treatment for household use is reverse osmosis.

[12] stated that the maximum nitrite content in drinking water should not exceed 0.2 mg/l. Nitrite values in the borehole water samples ranged between 0.03 mg/L and 0.08 mg/L, while that of the well water samples ranged between 0.00 mg/L and 0.10 mg/L. It was observed that the values were all within the range with the values from the well water relatively higher than those of the borehole water samples. These results are in conformity with the works of [11, 20, 15, 13 and 14] which show distinct similarity to the results obtained from the analysis.

The standard stated by [12] for nitrate (NO_3) is 500 mg/l. The minimum and maximum values obtained for borehole were 0.53 mg/L and 1.33 mg/L while that of well ranged between 0.00 mg/L and 0.10 mg/L. This shows that all the samples are within the permitted level. The results obtained were compared with previous results obtained by [15, 21] which show similar correspondence. However, the presence of excess nitrate in water may adversely affect the health of infants, causing a disease may be vomiting; their skin colour may become dark, and may lead to death in extreme cases.

The recommended standard as provided for by [12] for pH is given as 6.5 – 8.5. The samples for both boreholes and wells were observed to be within the recommended Nigerian standard. The maximum and minimum values that were recorded for borehole ranged between 6.7 and 7.2 while that of wells ranged between 6.4 and 7.3. pH is a measure of the acidity or alkalinity of water when the pH 6.5 could be acidic, soft, and corrosive while, while water with a pH > 8.5 could indicate that the water is hard. The results obtained were found to be within the recommended range when compared with the works of [20, 15, 13, 14].

The maximum permissible limit for iron set by the [12] is 0.30mg/l. The analyzed values of iron content in borehole ranged between 0.1 and 0.19 mg/L while that of well water sample ranged between 0.00 and 0.3mg/L respectively. The obtained results fell below the maximum permissible limit of NSDWQ. The result of [18, 13] when compared with this study, they were found to be similar. Most iron is absorbed in the duodenum and upper jejunum. Absorption depends on the individual's iron status and is regulated so that excessive amounts of iron are not stored in the body. Total body iron in adult males and females is usually about 50 and 34-42 mg/kg of body weight respectively. The largest fraction is present as hemoglobin, myoglobin, and haem – containing enzymes. Other major fractions are stored in the body as ferritin and haemosiderin, mainly in the spleen, liver, bone marrow, and striate muscle.

No cyanide was identified even in trace amounts. This may be due to the absence of major cyanide based chemical industries in our focus area. Cyanide values for all the water samples did not show any remarkable deviation and were very much within the tolerance limit, 0.01mg/l as stated by [12]. The results correlated with the works of [21, 16].

The recommended maximum permissible limit by [22] for fluoride in drinking water is 1.5 mg/l. Groundwater containing values higher than 1.5 mg/L are found in area or terrains of metamorphic rocks and granite and occasionally in sedimentary basins. They are also more likely to be found in arid regions than regions with high rates of groundwater recharge. Granitic rocks and sedimentary basins in the arid northern parts of the country are therefore potentially most vulnerable to development of high groundwater-fluoride concentrations. Fluoride is beneficial when present in small concentrations (0.8 mg/L to 1.0 mg/L) in drinking water for calcification of dental enamel. However, it causes dental and skeletal fluorosis if high. The fluoride concentration in the study area is found to be negligible. The minimum and maximum values recorded for borehole water samples ranged between 0.01mg/l and 0.9mg/l while that of well water sample ranges between 0.00 and 0.20mg/L respectively. The results obtained were compared with the maximum permissible limit of [12]. When these values were compared with the works of [21, 23] they showed high level of similarity.

The standard stated by the [12] for sulphate (SO_4) is 100 mg/L. The sulphate values for boreholes in Nyikangbe agrarian community ranged between 1.2 mg/L and 4.2 mg/L while that of wells ranged between 2.3 mg/L and 9.4 mg/L. This shows that shallow wells have a higher concentration of sulphate content than the boreholes whose depth were greater than 30 m. Another major factor may be the geological formations of the various locations of both the wells and boreholes. The results obtained were comparable with the works of [11]. The result was compared with the [12], it was observed that both the wells and the boreholes values were far below the recommended standard.

The desirable limit of magnesium in drinking water is 50 mg/L as recommended by [12]. From our study the maximum and minimum values obtained from borehole water was 0.00 mg/L respectively while that of well water ranges between 0.01 mg/L and 0.09 mg/L. These results were compared with the results of [21, 19] and were found similar. When the results were also compared with the recommended maximum and minimum permissible limit of [12], they were found to be lower. The high concentration of magnesium adversely affects domestic use of water. Most especially, it constitutes to water hardness which in turn increase soap consumption in laundry and even present a scaly appearance on human skin. Therefore, magnesium content in water has to be reduced to the desirable limit.

[12] did not state any value either at the minimum or maximum level for calcium. The values obtained from the analysis for the borehole water ranged between 0.3 mg/L and 1.1 mg/L while that of the well water ranged between 0.2 mg/L and 2.3 mg/L. Adverse effects of calcium can be observed only if there is a high intake of it into the human or animal system. Calcium ions, if consumed in moderate quantities are beneficial to human and animal system. The analyzed value for the total dissolved solids for the borehole water ranged between 100 and 160mg/L, while that of wells ranged between 90 and 200 mg/L. These values were compared with [12], and were found to be within the maximum permissible limit of 500 mg/L. This shows that there is a low concentration of dissolved solid in the various water samples, thus making it very safe for domestic use. The values obtained were in line with works of [11, 23, 24].

The recommended standard by [12] for total hardness of water is 150 mg/L. The values obtained from the borehole sample ranged between 70 mg/L and 146 mg/L, while that of well ranged between 43 mg/L and 206 mg/L. When compared with the recommended values of [12], all the values for the borehole water samples were found to be below 150 mg/L. While W5 for the well water samples was found to be above the recommended value though the other values were within the range. When these results were further compared with the works of [11, 23, 24], they confirmed with the results obtained from the Nyikangbe agrarian community in Niger State, Nigeria.

From [12], there is no recommended standard stated for total alkalinity. The borehole values ranged between 22 mg/L and 73 mg/L while that of wells ranged between 22mg/L and 164 mg/L. It can therefore be observed that total alkalinity for the wells were higher when compared to that of the boreholes. This further shows that the deeper the depth of the borehole and wells the lower the total alkalinity. These results were compared to the works of [20, 15, 13, 14] and were observed that the values obtained were range within.

Sodium occurs as a major cation in water samples. The concentration of sodium in the various boreholes for the study area ranged between 1.5 to 7.1 mg/L while that of well samples ranged between 2.6 and 6.3 mg/L. It was observed that sodium content of the well water samples were higher compared to those of the borehole water samples. This may be as a result of the geological formation of the area and the filtration processes through the medium that the water passes through to get the storage point before being pumped out.

The recommended standard by [12] is 200 mg/L and when the values were compared with those from the study area, they were observed that they were far below the recommended value. These values were also similar to the work of [18, 15].

5. CONCLUSION

It can therefore be concluded that the values obtained from the well and borehole were within the recommended values of [12]. Since the community does not have any baseline information regarding the various physical and chemical properties for the underground water source in the community, this present result can therefore serve as one upon which further studies can be compared with.

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