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Analysis of Physicochemical and Bacteriological Quality of Surface and Groundwater Samples in Offa, Kwara State, Nigeria

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ABSTRACT: The water quality assessment in First Baptist Church, Offa, Kwara State Nigeria was carried out by examining nine samples in and around the church premises. One surface water sample, five borehole water samples and three well water samples were examined. The result obtained from the physicochemical analysis showed a turbidity range of (2-6NTU), electrical conductivity EC (693-893 µs/cm), total dissolved solids TDS (346-542mg/L), pH (6.83-7.62), magnesium Mg (17-53mg/L), manganese Mn (0.02-0.1), aluminium Al (0.02-0.13mg/L), iron Fe (0.10-0.44mg/L), zinc Zn (0.8-3.60mg/L), chromium Cr (0.02-0.13mg/L), lead Pb (0.01-0.04), Sulphate SO_4 (3-20mg/L), Nitrate NO_3 (3-18mg/L), phosphate PO_4 (1.5-14mg/L), chlorine Cl (14-42mg/L), copper Cu (0.04-0.7mg/L), chemical oxygen demand COD (62-120mg/L), total hardness TH (80-160mg/L) and total alkalinity TA (80-136mg/L). These results, together with that of the microbial analysis were compared with the standard provided by the World Health Organization WHO. Hence, it is crucial that the water supplies are regularly assessed and properly treated to provide the consumers with safe and healthy water.

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All life on earth depends on the availability of water for their survival, growth and development (Simpi *et al*., 2011). The three primary sources of water are surface water, groundwater and rainwater. Groundwater has been considered as one of the purest forms of water in nature that meets the overall demand of rural and semi-urban people. The high rate at which cities are growing across the world is frightening; this implies that the human population with its associated sanitation problems are growing faster than the supply of qualitative water (Jackson *et al*., 2001). This situation has led to a reduction in the per capita availability of quality water (Ajayi and Adejumo, 2011). Today surface and groundwater reservoirs are constantly being polluted at a high rate through the addition of industrial, domestic and agricultural wastes (Aremu *et al*., 2011). Consequently, developing countries are particularly plagued with water-borne diseases because many communities suffer scarcity of qualitative water. Only little percentage of total urban population has direct access to treated pipe-borne water, and the more significant percentage has other water sources of questionable quality to contain with (Aderibigbe *et al*., 2008).

In Nigeria, many rural dwellers rely on well, stream and river water for their domestic use due to lack of access to potable water (Shittu *et al*., 2008). Taking this paper's case study into consideration, almost all groundwater sources (wells) in Offa which are not used during the rainy season when there are alternative sources of water, are major sources of water in homes during the dry season when the resource is scarce. These water sources are contaminated by multiple pathogenic microorganisms – bacteria, fungi, and viruses. These pathogenic agents have caused various diseases that affect human health. Almost every community in Offa has several wells (open and closed) which serve as water sources for the inhabitants. Within these communities there are various improperly managed sanitation systems; wastes are disposed indiscriminately on major roads, market

places, inadequate toilet facilities and in water bodies, these practices potentially pollute the groundwater. Therefore, it is essential to routinely examine the sources and quality of drinking water to safeguard public health. The analyses of some water sources have revealed a considerable degree of water contamination by total and fecal coliforms (Miller *et al*., 2012).

That is why this study is aimed at accurately assessing the quality of water from both surface and groundwater for drinking and other municipal uses within First Baptist Church in Offa metropolis of Kwara State, using some selected physicochemical and bacteriological properties.

MATERIALS AND METHODS

Description of study area: Offa is an ancient town and the Headquarters of Offa local government area of Kwara State, Nigeria. It is the second largest town in the state, located in central Nigeria with geographic coordinates of 8'9N and 4'43E. One of the sources of water supply to Offa township is Oyun Reservoir, which is located on longitude 08°30'N and latitude 08°15'E in Offa, Kwara State, Nigeria. First Baptist Church, Offa is a religious center for Christian within the community. The water samples used for this research was gotten from five different boreholes (inside and outside First Baptist Church premises), three different well-water locations (inside and outside First Baptist Church premises) and river Orita which was the only river within the area of consideration (First Baptist Church, Offa).

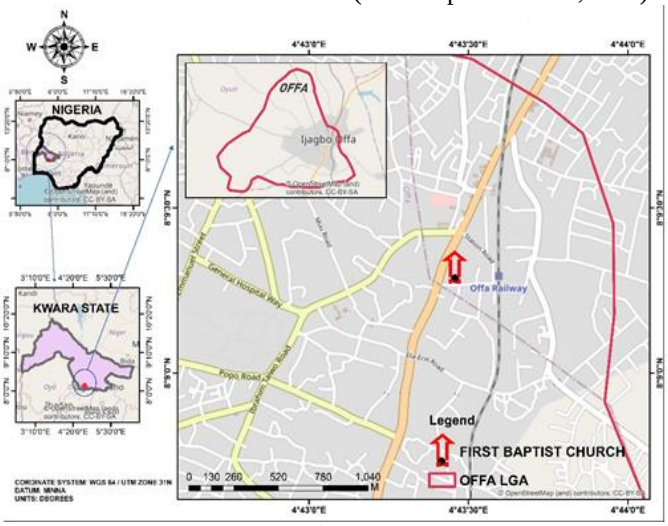

Fig 1: Map of the Study Area

Sample collection: Water samples were collected using clean 2.5-liters plastic polyethene bottles. There were 9 sample locations which includes; five different boreholes, three different well-water locations and river Orita. Surface water samples were collected at 100mm depth at the river axis where many human activities such as washing, bathing, and fish farming take place and at the mid-section of the reservoir which represents the area of lentic water. Sampling, preservation and transportation of water samples were carried out according to the American Public Health Association (APHA, 2002). Samples were collected during the rainy season. These samples were taken to the laboratory for relevant physio-chemical and microbial analysis. The longitude, latitude and elevation of all the sampling locations were recorded using a Global Positioning System (GPS).

Physicochemical Analysis: The physicochemical analysis of the water samples was carried out using standard methods as stated by APHA (2002). The temperature of the water samples is determined using a thermometer, the pH was measured using a digital electrode pH meter, the electrical conductivities and turbidity of the water samples were determined using a standard conductivity kit. Chemical Oxygen Demand (COD) was determined using the Winkler's titration method. Total hardness and sulfate concentrations were determined by the titrimetric method, while total solids, total dissolved solids, and total suspended solids were determined by the gravimetric method). Nitrate, phosphate, sulphate and silica were measured using Hach spectrophotometer as described by APHA (2002). Also, the heavy metals were determined using the Atomic Absorption (AAS).

Microbial Analysis: The total bacterial count was determined by standard pour plate methods using Nutrient Agar (oxoid) (Fawole & Osho 2001). The number of total coliforms was determined with

membrane filtration techniques using Eosin Methylene Blue Agar (oxoid) as described by APHA (2002). For the determination of total bacterial counts and total coliform count, the water samples were incubated at 37^0C. Generally, bacteria including coliforms grow optimally at 37^0C while fecal coliforms thrive at a higher temperature of 44^0C.

RESULTS AND DISCUSSION

Physicochemical Analysis: Table 1 shows the result of the physicochemical analysis carried out on the samples collected from nine different locations in and around First Baptist Church, Offa. The surface water sample had a turbidity of 6NTU, while the turbidity of the groundwater samples had a constant value of 2NTU for all the water samples gotten from the borehole points and a range of 3 to 4NTU for the well water samples. Although these values were slightly above (for the surface water sample) and slightly below (for the groundwater samples) the recommended standard by the WHO which is 5NTU. The Electrical Conductivity (EC) of both the surface and groundwater samples was higher than the required standard which is 400µs/cm. It can be inferred that the water samples are of high conductivity, which could be as a result of the presence of dissolved salts and chemicals that carry electric charges in the water samples. Therefore, there is need for the water from each location to be treated.

Table 1: Physicochemical properties of the raw water samples compared with WHO standard

S/N	Parameters	A	B	C	D	E	F	G	H	I	WHO
1.	Turbidity	2	6	3	2	4	2	2	2	3	5
2.	EC	875	711	893	719	709	779	693	834	904	400
3.	TDS	439	355	446	360	354	389	346	418	542	300-600
4.	pH	6.83	7.38	7.28	6.93	7.22	7.32	7.62	6.85	7.60	6.50-8.50
5.	Mg	17	53	36	19	32	22	20	19	34	50
6.	Mn	0.02	0.1	0.05	0.03	0.04	0.03	0.03	0.02	0.06	0.1-0.5
7.	Al	0.02	0.13	0.03	0.03	0.04	0.05	0.03	0.02	0.03	0.2
8.	Fe	0.13	0.44	0.23	0.11	0.20	0.13	0.15	0.10	0.21	0.3
9.	Zn	2.60	0.80	3.10	2.50	3.60	2.30	2.60	2.20	3.30	0.01-3.00
10.	Cr	0.09	0.02	0.13	0.11	0.13	0.07	0.08	0.10	0.12	0.05
11.	Pb	0.01	0.04	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01
12.	SO_4	3	20	9	5	12	4	3	6	8	250
13.	NO_3	5	18	11	7	10	3	5	8	12	50
14.	PO_4	1.60	14.00	2.80	14.00	3.00	13.0	1.50	2.10	2.90	0.10
15.	Cl	30	42	14	22	17	27	29	25	19	5
16.	Cu	0.04	0.70	0.07	0.05	0.06	0.04	0.08	0.10	0.08	1
17.	Ca	32	62	46	46	38	42	35	32	40	60
18.	COD	80	120	62	84	65	78	82	86	72	<120
19.	TH	120	160	145	105	130	100	80	65	115	500
20.	TA	90	136	114	80	104	98	108	90	110	20-200

NOTE: Location A = 1st Baptist bore-hole 1; B = River Orita; C = Well water 1; D = Back of 1st Baptist bore-hole 2; E = Well water 2; F = Bore-hole point 3; G = Bore-hole point 4; H = Bore-hole point 5; I = Well water (Ile Olu-oro). EC = Electrical Conductivity (µs/cm); Turbidity (NTU); others (mg/L); TDS = Total Dissolved Solid; TH = Total Hardness; TA = Total Alkalinity; WHO = World Health Organization

Table 2: Bacteriological properties of the raw water samples compared with WHO standard

Parameters	A	B	C	D	E	F	G	H	I	WHO
E-coli	16	320	32	21	28	20	18	23	30	0
TVC	95	TNC	290	102	284	112	98	110	295	-
TCC	30	TNC	180	54	168	46	32	36	175	-
MPN	70	1800	520	82	480	94	75	86	464	-

NOTE: Location A = 1st Baptist bore-hole 1; B = River Orita; C = Well water 1; D = Back of 1st Baptist bore-hole 2; E = Well water 2; F = Bore-hole point 3; G = Bore-hole point 4; H = Bore-hole point 5; I = Well water (Ile Olu-oro); MPN = Most Probable Number (CFU/ml); Others (mg/L); TVC = Total Viable Count; TCC = Total Coliform Count; TNC = Too Numerous to Count; WHO = World Health Organization

The Total dissolved solids (TDS) and pH of all the water samples fell within the required limit by the WHO (300 to 600mg/L) and (6.5 to 8.5) respectively. This can be regarded as a water parameter that is within safe limits for human consumption. Calcium had the highest concentration of all the elements examined with a concentration of 62mg/L for the surface water sample which met the standard. The groundwater samples gotten from the borehole points varied between 32 and 46mg/L and the well samples varied between 38 to 46mg/L, all of which were below the standard which is 60mg/L. The groundwater samples had a range of SO_4 value from 3 to 12mg/L, with the well water samples having the highest values from the range and the surface water sample had a value of 20mg/l. The same trend was recorded for the NO_3 with a value range from 3 to 12mg/L for the groundwater samples and 18mg/L for the surface

water sample. The results, especially that of SO_4 were far below the recommended values; also, the PO_4 and Cl concentrations of all the water were above the recommended limits for drinking water by WHO. This means that appropriate treatment is required for domestic use. From Table 1, Metals such as Magnesium (Mg), Manganese (Mn), Aluminium (Al) and Iron (Fe) were found to behave the same way. The ground water samples had lesser values than the standard, while the surface water sample was close to the standard. The Lead (Pb) concentration was 0.01mg/L for all the borehole sample, which of the well water sample was 0.02mg/L, while the river sample was 0.04mg/L. The bore-hole samples met up to the required standard (0.01mg/L), while the other water sources would need to be treated.

Bacteriological Analysis: Table 2 shows the bacteriological analysis carried out on samples collected from nine different locations in and around First Baptist Church, Offa. The bacteriological properties were highest in the water sample from the river, followed by the well water samples and then the bore-hole samples. The results revealed the presence of bacteria in all the sources of water in and around First Baptist Church, Offa.

Conclusion: Although some of the physicochemical properties such as the TDS and pH of the water samples were within the WHO acceptable limits, the bacteriological analysis indicated bacterial contamination. Since some of the physicochemical and bacteriological parameters did not conform to WHO standard for potable water, it is of uttermost importance that routine assessment and adequate water treatment be carried out regularly so that safe and healthy water can be made available to the consumers.

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