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Assessment of Borehole Water Quality in OredoMunicipality

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Abstract: *In Oredo municipality, households basically rely on groundwater sources as their only source of water to meet their ever-growing water demands and as such the need to study the quality of these sources of water arises. Water samples were collected from 15 boreholes located within the study area and their physico-chemical and microbial parameters assessed. The laboratory results obtained were compared with standards limits specified by World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality (NSDWQ).Results of the pyhsico-chemical tests conducted on the water samples indicated that all the parameters except pH and nitrate were within the permissible limits given by the WHO and the NSDWQ. pH values ranged from 4.0 -6.5, withonly BS12 having a pH of 6.5. Also, nitrate values were above both standards in water samples fromBS4, BS5, BS6, BS9 and BS14 (68-81.5mg/l), whilewater samples fromBS1, BS2, BS3,BS7,BS8,BS11 and BS15 (15.2-43.9 mg/l) were above the set standard by WHO but below that of NSDWQ. Coliform was present in samples BS4, BS5, BS6,BS7, BS8, BS14 and BS15 in amounts that are above the permissible limits. This signifies about 50% of water samples tested. The presence of coliform bacteria in borehole water source has been attributed to the unhygienic environment around the water source. It is recommended that water from borehole sources in the locality should be treated to minimize water related diseases.*

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I. Introduction

In Nigeria, the rate of urbanization is characterized by high population concentration, increasing industrial and agricultural activities coupled with environmental pollution/degradation and indiscriminate disposal of all kinds of wastes, which pose serious pollution threats on quality ground water(Kehinde, 1998, Adelana et al, 2003, Adelana et al, 2004, Adelana et al, 2005, Ajala, 2005, Ocheri, 2006, Adelana et al, 2008; Eni et al,2011). This concern has attracted overwhelming attention of researchers in different parts of Nigeria urban areas. (Okonko, et al., 2008; Edema et al., 2001; Agwu et al., 2013).This borders on the fact that the public or municipal water supply is inaccessible to a large proportion of urban dwellers, and even where it is available, the supply is highly inadequate, unreliable and irregular. Consequently, there is high dependency on untreated groundwater abstracted through hand dug wells and borehole systems (Ocheri, 2006; Ocheri, 2010). According to Forster et al (1998) urbanization affects the quality and quantity of underlying sub-surface water by radically changing the pattern and rate of recharge, initiating new abstraction regimes and adversely affecting the quality. This can happen through waste deposited in landfills or in refuse dumps immediately becomes a part of the prevailing hydrological system as a result of biodegradation. Fluids derived from rainfall, snowmelt and groundwater, along with liquids generated by the waste itself through processes of hydrolysis and solubilization, caused by an entire series of complex biochemical reactions during degradation of organic wastes, percolate through the deposit and mobilize different components within the waste. The liquid drains from the dump, chiefly organic carbon largely in the form of fulvic acids migrate downward and contaminate the groundwater. Another source of contamination is the run off of sewageknown as municipal waste water. It consists mostly of greywater (from sinks, tubs, showers, dishwashers, and clothes washers), blackwater (the water used to flush toilets, combined with the human waste that it flushes away), soaps and detergents; and toilet paper. It has been reported that nearly 90% of diarrhea related cases and deaths have been attributed to unsafe water supply and sanitation conditions (WHO, 2006). In Oredo municipality, the populace depends on untreated borehole water as the source of safe drinking water, enhance this work to assess the physico-chemical and microbiological qualities of these water sources and compare to regulatory standards for safe drinking water by WHO (2006) and NSDWQ (2007).

II. Materials and Methods

2.1 Study Area

Oredo Local Government Area of Edo state is situated in the south-south geopolitical zone of Nigeria, bounded by latitudes 6^0 06' N, 6^0 30' N and longitudes 5^0 30' E, 5^0 45' E. It has an area of 249 km² and a population of 374,671 at the 2006 census.The location map of Oredo Local Government Area and the boreholes are shown inFigures 1 and 2 respectively.

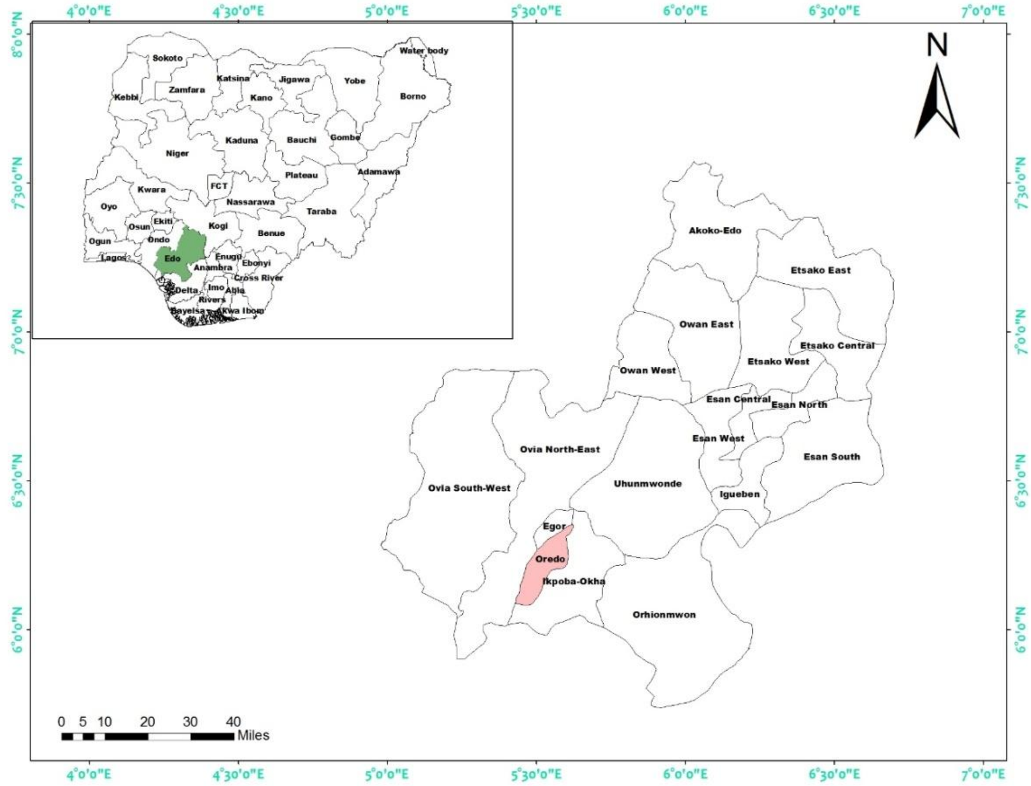

Fig 1:Location map of Oredo local government area

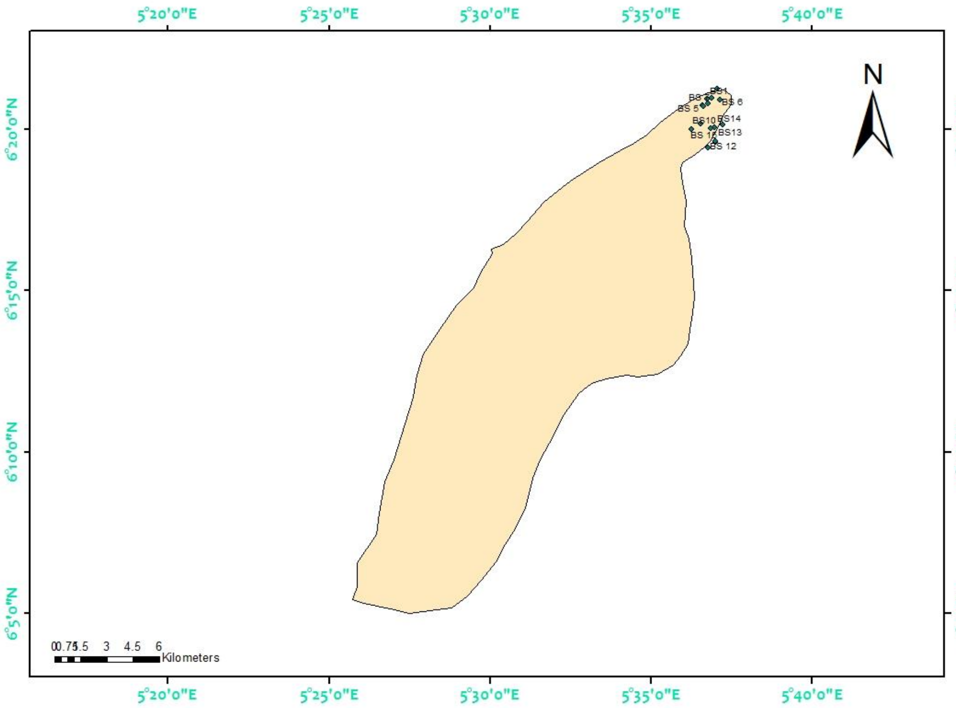

Fig 2:Location of Borehole Stations

2.2 Sample Collection and Laboratory Tests

Water samples were collected from fifteen (15) different boreholes in 75cl containers, sterilized containers. These containers were rinsed with the sample water, corked air tight, labeled and immediately taken to the Benin -Owena River Basin/ University of Benin joint analytical research laboratory for analysis to determine the physico-chemical and microbiological parameters.

III. Results and Discussions

3.1 Physicochemical parameters

The mean concentration of some physico-chemical properties of groundwater obtained from several boreholes in Oredo municipality is presented in Table 1. The mean values of the pH value from all the locations except BS12falls below the minimum recommended values stated by WHO and NSDWQ. The range of pH values for this work lies between 4.0-6.5. These values indicate acidic groundwater and is similar to the work of Agwu et al., (2013) for borehole water in an urban metropolis. It has been suggested that low pH may be due to the geology of the catchment area and also high level of free Co_2(Edema et al., 2011; Agwu et al., 2013). The range of pH values specified by WHO and NSDWQ lies between 6.5 and 8.5 which means that variations from this rangecan have undesirable health impacts. It may affect toxicity of poisons in the water, survival of pathogenic organisms and metals solubility (Agwu et al., 2013; Ho, Chow, and Yau 2003; Khan et al. 2013).The mean values of the colour of water samples from the boreholes ranges between 0-5TCU. This is within the permissible limits of 15TCU recommended by WHO and NSDWQ.Also, the mean range of values for conductivity (20-270mg/l) for the water samples from the various boreholes is below the recommended valueof 400mg/l and 1000mgl by WHO and NSDWQ respectively. But the presence of electrical conductivity in all the samples (though in acceptable limits) indicates the presence of salts in the borehole water meaning there might be some level of unfavourable taste in the water.The electrical conductivity is dependent on the dissolved mineral matter and thus has a direct correlation to total dissolved solids (Ademoroti 1996; Agwu et al., 2013). The dissolved solids in the water samples from the boreholes in this work ranged from 2.6-5.2mg/l. These limits are below the permissible limit of 7.5 specified byWHO and NSDWQ.

Table 1.Mean concentration of some physicochemical properties of groundwater samples (N=15)

Borehole Station	pH	Colour (TCU)	Turbidity (NTU)	Conductivity Mg/l	Total dissolved Solids Mg/l	Hardness Mg/l	Dissolved oxygen Mg/l
BS1	4.2	3	0	180	95.4	26	5.1
BS2	4.6	0	2	70	37.1	16	3.4
BS3	4.7	5	3	140	74.2	40	3.4
BS4	4.3	0	3	270	143.1	46	4.1

BS5	4.0	0	0	240	127.2	36	2.7
BS6	4.2	0	0	220	116.6	36	3.3
BS7	5.2	0	0	20	10.6	18	4.6
BS8	4.3	0	0	180	95.4	38	3.3
BS9	4.2	0	0	220	116.6	32	1.3
BS10	4.1	4	0	70	123	16	5.2
BS11	6.4	0	0	40	37.1	6	3.4
BS12	6.5	0	0	80	74.2	35	4.1
BS13	6.2	0	0	180	95.4	20	3.3
BS14	4.0	2	5	140	150	16	3.4
BS15	4.7	0	5	240	115.5	35	2.6
WHO	**6.5-8.5**	**15**	**5**	**400**	**500**	**500**	**7.5**
NSDWQ	**6.5-8.5**	**15**	**5**	**1000**	**500**	**150**	**7.5**

The mean values of hardness for the borehole water samples range from 6 to 46mg/l. The hardness of all the borehole water samples were below limits of 150mg/l and 500mg/l by NSDWQ and WHO respectively.The borehole water samples are all soft water since their hardness values fall within the stipulated range of 0-75 mg/l for soft water (Agwu et al., 2013)

3.2 Anions and Metals

Anions have influences on safe water drinking quality with negative impacts on human health. Table 2, shows the mean values of concentration of anions obtained from this work.The values of 1.80 – 81.5mg/l were recorded for nitrate in the borehole water sources.The concentration of nitrate in this work for water samples BS10 and BS13 have values that are below the standards specified by WHO and NSDWQ. This represent 13% of water samples tested. While 47% water samples are above the maximum permissible standard set by the W.H.O but falls below the standard set by the NSDWQ. The boreholes are BS1, BS2, BS3, BS7, BS8, BS11 and BS15. Also, 33% of water samples shows a high concentration of nitrate above the stipulated standards set by WHO and NSDWQ. The boreholes are BS4, BS5, BS6, BS9 and BS14. It means that NO_3^- has huge impact on the groundwater of this locality. Nitrate is the obtained from aerobic decomposition of organic nitrogenous matter (Shinde et al., 2011), and sources of nitrate include industrial and domestic effluents, decayed vegetation, animal matter.The concentration of chloride in this work ranges between 14.1 and 42.4mg/l for the borehole water samples. These values are below the standard value of 250mg/l set by WHO and NSDWQ. It has been reported that high quantity of chloride (> 20mg/l) may be an indication of groundwater pollution from domestic waste and sewage (Shyamala et al., 2008).

Table 2. Mean values(mg/l) of some anions and metals of groundwater samples (N=15)

BoreholeStation	No_3^-	Cl^-	Ca	Mg
BS1	42.4	28.2	6.4	2.9
BS2	26.6	14.1	3.2	1.9
BS3	40.2	35.3	7.2	5.4
BS4	77.2	42.4	10.4	4.9
BS5	68.0	42.4	8.0	3.9
BS6	81.5	42.4	9.6	2.9
BS7	15.4	14.1	1.6	1.5
BS8	43.9	28.2	8.0	4.4
BS9	68.5	35.3	8.8	2.4
BS10	1.8	21.2	5.6	0.5
BS11	40	15.1	1.6	1.5
BS12	3.6	24.4	19.2	2.0
BS13	1.8	25.7	4.8	2.0
BS14	80.5	42.4	9.6	5.3
BS15	15.2	14.1	6.4	2.9
WHO	**10**	**250**	**75**	**150**
NSDWQ	**50**	**250**	**-**	**0.2**

Note: A dash (-) means that no information is available regarding possible limits.

Magnesium and Calcium were detected in the water samples. The range of valuesfor Magnesium and Calcium obtained in this work were 0.5-5.4mg/l and 1.6-10.4mg/l respectively. These values met the WHO guidelines but not the requirements stipulatedby NSDWQ for magnesium.

3.3 Bacterial contamination

The values of E-coli and coliform bacteria from the various borehole water samples is shown in Table 3. There was no presence of E-coli in all the borehole water samples, indicating the absence of faecal contamination. The test for coliform showed that there was contamination in water samples from BS4, BS5, BS6, BS7, BS8, BS14 and BS15. The total coliform count per 100mL ranged from 1x 10^2 to 6 x 10^4. Based on the zero count per 100mL from WHO and NSDWQ specifications, these water from the boreholes are contaminated with coliform bacteria. Coliform in water is an indication of pollution (Agwu et al., 2013). There is a huge possibility for the existence of pathogenic organisms in the drinking water due to the presence of coliform bacteria. It has been reported that the pathogenic organisms are responsible for diseases as hepatitis, intestinal disorders, etc. (Khan et al. 2013).The presence of coliform in the present study may be due to the unhygienic environment of the boreholes. As a result of lack of space in residential buildings, most boreholes are usually situated close to septic tanks, and the points of collection of the water are usually dirty.

Table 3. Number of coliform bacteria (MPN 100 m/l) in groundwater samples (N=15)

Borehole Station	E-Coli	Coliform
BS1	0	0
BS2	0	0
BS3	0	0
BS4	0	$6x10^4$
BS5	0	$6x10^2$
BS6	0	$6x10^3$
BS7	0	$6x10^2$
BS8	0	$6x10^2$
BS9	0	0
BS10	0	0
BS11	0	0
BS12	0	0
BS13	0	0
BS14	0	$6x10^2$
BS15	0	$6x10^3$
WHO	**0**	**0**
NSDWQ	**0**	**0**

IV. Conclusion

Water qualities in Oredo municipality of Edo State met the WHO and NSDWQ physicochemical permissible limits except pH and nitrate parameters. The presence of coliform in about 50% of the water samples analyzed is an indication of pollution. It is imperative to advocate that drinking water sources should not be sited in unhygienic environment and places close to waste disposal system.It is recommended that water from borehole sources in the locality should be treated to minimize water related diseases.

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