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Organoleptic, Physico-chemical and Microbial Quality of Drinking Water in Orumba South Local Government Area, Anambara State, Nigeria.

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ABSTRACT

Organoleptic, physico-chemical and microbial parameters of groundwater sources in Orumba South L.G.A. of Anambra State, Southeast Nigeria, were analyzed to evaluate the quality of rural water supplies and provide baseline data for future pollution studies. Water samples were collected at ten different locations namely; Umunze (B_1), Ihite (B_2), Ogbunka (B_3), Owerre-Ezukalla (B_4), Akpu (B_5), Nkerehi (B_6), Isulo (W_1), Ezira (W_2), Eziagu (W_3), and Nawfija (W_4) with the letter B denoting borehole samples and W, well water samples giving a total of six borehole water samples and four well water samples. Water quality parameters were determined using standard analytical procedures. The results of organoleptic tests shows that water from all sources had unobjectionable colour, odour and taste. The mean values for the physico-chemical analysis were had the following ranges; pH 4.91 -8.5, temperature 23 – 27 $^{\circ}$C, conductivity 28 – 361 µS/cm, chloride 1.38 - 1.92 mg/L, total alkalinity 2.50 - 4.72 mg/L, sulphate 1.34 -2.19 mg/L, nitrate 0.80-1.24 mg/L, phosphate 0.006 - 0.032 mg/L, total hardness 76 - 296 mg/L and dissolved Oxygen 3.17 - 5.30 mg/L. Total dissolved solids had a range of 0.45 - 5.30 mg/L. Mean standard plate count had a range of 22.10 – 53.44 cfu/ml), mean faecal coliform count was 0.00 cfu/100ml in all samples except W_1 and W_3 which had values of 3.50 and 2.00 cfu/100ml, respectively. Mean faecal streptococcal count was also 0.00 cfu/100ml in all samples except in B_4, W_2 and W_4 which had values of 2.00, 2.33 and 2.50 cfu/100ml, respectively. The results obtained were compared with the World Health Organization (WHO) standards and Standards Organization of Nigeria (SON) standards for drinking water. The results of the comparison shows that the pH (for all borehole samples) and microbial parameters (for B_4 and W_1 – W_4 samples) were outside recommended limits.

Keywords: Organoleptic, physico-chemical, microbial, parameters, standards

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INTRODUCTION

Drinking water pollution is a problem in many countries around the world and this has impacted on the health and economic status of populations [1]. It is a fact that polluted water is responsible for thousands of deaths daily in the world's poorest countries [2]. Drinking water pollution has unpleasant consequences for Nigeria and other developing countries since the availability of good quality drinking water is essential for the wellbeing of all people and the socio-economic development of a nation [3][4]. Pollution of drinking water sources results from indiscriminate waste disposal; use of fertilizers and pesticides; industrial effluent discharges; surface run-off, lack of regulatory and remediation frameworks etc. Monitoring the pollution level of drinking water sources in the developed world has been a continuous process but the pollution level of Nigeria's water resources not been adequately monitored [5]. According to WHO, ingestion of water by human beings is through the following pathways; drinking water, water in other beverages and water from metabolism of food. Since about a third of daily average fluid intake is derived from food, the water requirement balance is met by the consumption of fluids. Water contains both potentially harmful contaminants and beneficial minerals and the goal of every consumer is to ingest water with minimum health risks. Due to the inability of governments to meet the ever-increasing water demand through the public water works, people resort to various alternative sources such as shallow wells, boreholes, streams, rivers etc. The presence of contaminants that deviate from World Health Organisation (WHO) guideline values has been associated with the occurence of different kinds of disease such as typhoid fever, dysentery, gastro intestinal and infectious hepatitis. Access to adequate urban water supply in Orumba South Local Government Area of Anambra State Water Corporation is a serious problem facing the inhabitants. Dumping of solid waste, siting of pit latrines close to boreholes, automobile repair shops layout, disposal of untreated sewage are common practices in the Orumba metropolis which may indirectly affect groundwater quality. This study investigated the organeleptic, physico-chemical and bacteriological status of drinking water sources in Orumba South Local Government Area of Anambra State and results were compared to National and International water quality standards and appropriate recommendations were made.

MATERIALS AND METHODS

Study Area

The study area covers Orumba South Local Government Area (OSLGA) which is one of the administrative units in Anambra State, Nigeria. It lies between latitude 5 ^{o} 67$^{'}$ N and longitude 7 ^{o} 14$^{'}$ E in the Southeast of Nigeria. It is a rural area with a population of 184,548. The LGA is made up of about 20 towns with headquarters at Umunze. The 10 towns (sampling sites) chosen for this study were Umunze, Isulo, Ezira, Eziagu, Ihite, Ogbunka, Owerre-Ezukalla, Akpu, Nkerehi and Nawfia (Fig 1). The dominant water sources include wells, boreholes and rainwater. There is no pipe borne water supply and although there are streams and a river, most of the populace rely on wells, boreholes and rainwater. The main occupation in the area is farming and trading.

Sample Collection

Water samples were collected monthly from different sources (boreholes and well) in ten different sites. The samples were taken from six boreholes and four wells located in various towns in OSLGA**.** The nozzles of the boreholes were sterilized with cotton wool soaked in 70% ethanol and the service line (taps) were flushed for 2 min before samples were collected with sterile 1 L plastic bottles with screw caps. Well water samples were collected by lowering the sterilized 1 L plastic bottles into the well, filling and corking them. The samples were immersed in ice contained in a cooler. Temperature, pH, and conductivity were immediately determined on-site using test meters. Samples for dissolved oxygen (DO) analysis were collected and fixed on site. Appropriate precautions were taken to prevent contamination and the samples transported to the laboratory. Samples were collected monthly for a period of three months.

Analysis of Water Samples

Standard methods for the examination of water and wastewater were used to determine the organoleptic, physico-chemical and microbial parameters of water [6]. Organoleptic parameters analyzed were odour, taste and color. Physico-chemical parameters determined were pH, conductivity, temperature, total

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dissolved solids, hardness, alkalinity, chloride, nitrate and sulphate. Microbial parameters analyzed were standard plate count, faecal coliform and faecal s*treptococci*. Odour was determined by smelling the water sample, taste was determined by tasting the water sample, color was determined by observation. A panel of 10 persons was used for organoleptic tests. Temperature, pH and conductivity were determined with a pre-calibrated Hanna pH/temperature/conductivity meter (model H1991000). pH of each water sample was measured by inserting the probe into the water immediately after collection. It was rinsed and left standing in distilled water before being used for further pH measurement. Temperature and conductivity readings were also taken at the same time. Total Dissolved Solids was determined by evaporation to dryness of water sample filtered through Whatman grade 934AH glass fibre filter and washed with with three 10 ml volumes of distilled water. Total hardness was determined with the Ethylene diamine tetra acetic acid (EDTA) titrimetric method. Dissolved Oxygen (DO) was analyzed with the Winkler's Method while total alkalinity was determined with the titrimetric method using 0.02 N H_2SO_4 and methyl orange indicator. Chloride was measured by silver nitrate method while the colorimetric method using a spectrophotometer was used for nitrate, sulphate and phosphate determinations [6]. Microbial analysis was also carried out using the standard methods for the examination of water and wastewater during which faecal coliform, standard plate count and faecal streptococci count were determined using a microscope [6].

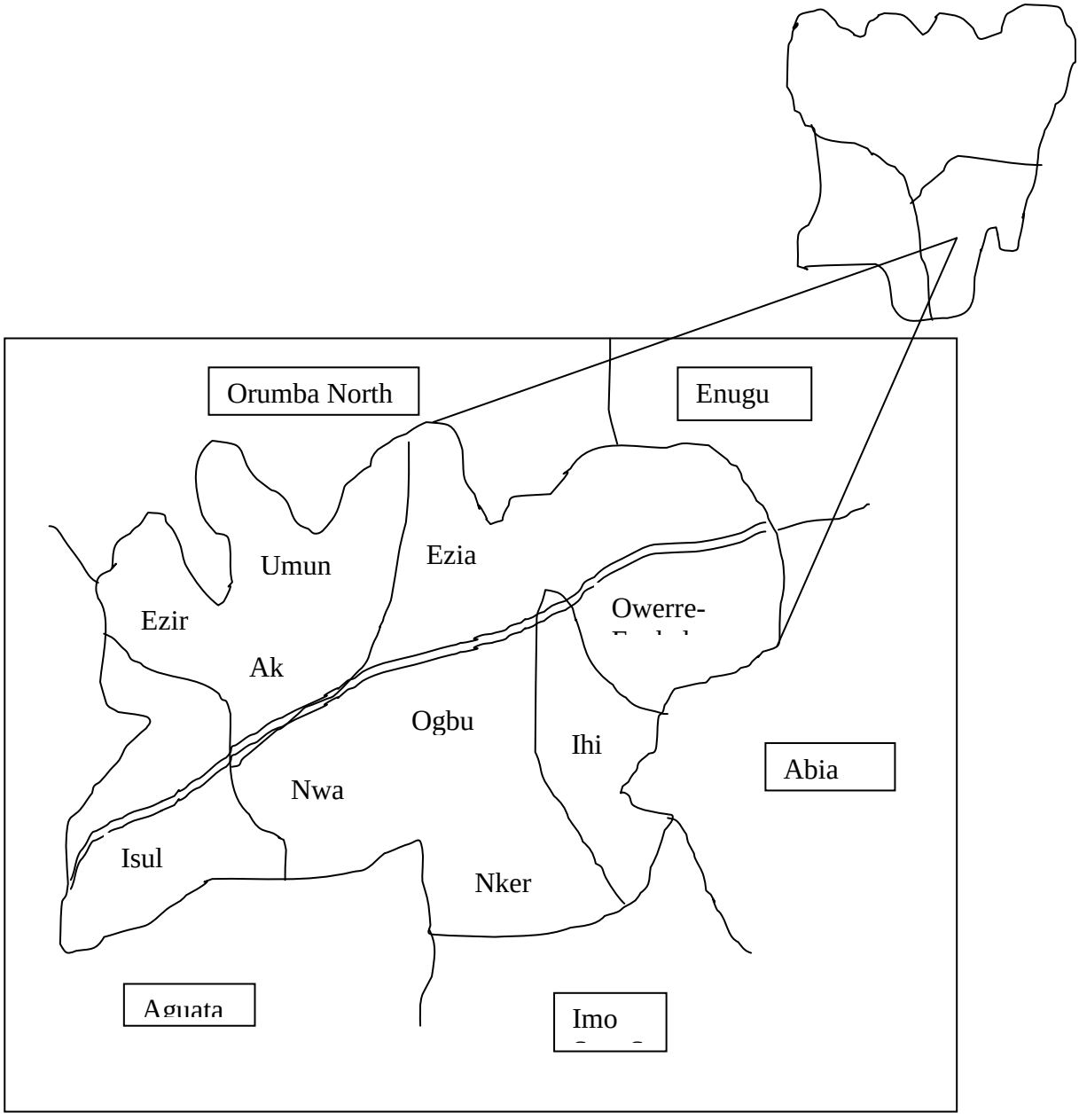

Figure 1: The Map of Orumba South LGA showing the Sampling Site

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RESULTS AND DISCUSSION

Table 1 summarizes the results of organoleptic analysis of water samples from Orumba South LGA. B_1 to B_6 denote the six borehole water samples and while W_1 to W_4 denote the four well water samples. The results show that the colour, odour and taste of the ten different samples were unobjectionable.

Table 1: Results of Organoleptic Analysis of Water Samples

Sampling sites	Sampling Tags	Colour	Taste	Odour
Umunze	B_1	Clear	Tasteless	Odourless
Ihite	B_2	Clear	Tasteless	Odourless
Ogbunka	B_3	Clear	Tasteless	Odourless
Owerre-Ezukalla	B_4	Clear	Tasteless	Odourless
Akpu	B_5	Clear	Tasteless	Odourless
Umuchukwu	B_6	Clear	Tasteless	Odourless
Isulo	W_1	Clear	Tasteless	Odourless
Ezira	W_2	Clear	Tasteless	Odourless
Eziagu	W_3	Clear	Tasteless	Odourless
Nawfija	W_4	Clear	Tasteless	Odourless
WHO standards	–	Colourless	Tasteless	Odourless
SON standards	–	–	Unobjectionable	Unobjectionable

Table 2 shows the results of Physico-chemical analysis of borehole and well water samples from towns in OSLGA. Temperature measurements are very useful in understanding the trend of physical, chemical and biological activities which are enhanced/ retarded by the variation of temperature. In the present study the mean water temperature range of all the samples in the 3-month experimental period were between 23.06 and 27.87 ºC. These values obtained are similar to those reported by [2].

Mean conductivity values of all the samples ranged between 28.55 – 361.72 µS/cm and are below the maximum permitted level accepted by World Health Organization and SON which is 1000 µS/cm. These values obtained are similar to those reported by [7].

The permissible range for pH values is 6.5-8.5 [8][9]. This occurs only in well water samples, while borehole water samples in this study had a lower mean pH range of 4.91- 6.39. The values obtained here are similar to those reported in an earlier work during which eight water samples collected from four different water sources which included stream, well, rain and borehole water in Umunze, Orumba South L.G.A were analyzed and the acceptable pH values of 6.5-8.5 occurred only in stream water while borehole, well water and rain water had low pH value which were not within the permissible range [7].

Hardness is imparted to the water mainly by calcium and magnesium ions. Calcium is essential element for human beings (nearly 2 g per day) and plant growth. However, hard water is generally undesirable because it forms precipitate with soap, produces scales in boilers on heating and has high boiling point due making it unsuitable for cooking. In the present study, the mean total hardness ranged from 76.55 to 296.40 mg/l which were lower than maximum permissible limit of 500 mg/L [8][9].

Mean total dissolved solids had a range of 0.45 to 5.30 mg/L. The values were below the SON and WHO limit of 1500 mg/L for TDS.

Alkalinity of water is a measure of its capacity to neutralize acids. In the present study, mean total alkalinity ranged from 2.50 mg/L to 4.72 mg/L. These value are lower than 160 mg/L to 748 mg/L reported by [10]. In the present study the total alkalinity values was found to be well below the maximum permissible limit of 500mg/L set by WHO and SON.

Mean phosphate concentration had a range of 0.006-0.032 mg/L which is within the WHO and SON range of 0-5 mg/L. If phosphate level in water becomes too high, plant growth can accelerate resulting in the dense growth of algae and plants.

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Table 2: Results of Physico-chemical Analysis of Water Samples (Mean ±SD)

Sampling sites	Sample Tags	Temp (ºC)	Conductivity (µS/cm)	pH	TDS (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	PO_4^{3-} (mg/L)	Cl^- (mg/L)	SO_4^{2-} (mg/L)	NO_3^- (mg/L)
Umunze	B_1	27.40 ±1.15a	28.55 ±1.20a	6.12 ±0.44a	0.45 ±0.04a	3.17 ±0.26a	2.76 ±0.84a	296.40 ±5.15a	0.018 ±0.003a	1.52 ±0.08a	1.76 ±0.02a	0.83 ±0.01a
Ihite	B_2	27.87 ±2.46a	219.74 ±2.85b	5.22 ±0.17a	3.52 ±0.15b	3.84 ±0.80a	3.45 ±1.02a	104.39 ±1.90b	0.013 ±0.007a	1.47 ±0.16a	1.84 ±0.21a	0.79 ±0.05a
Ogbunka	B_3	27.05 ±1.70a	169.40 ±1.92c	5.90 ±0.36a	2.72 ±0.36b	4.16 ±0.55a	3.60 ±0.79a	226.70 ±7.10c	0.018 ±0.004a	1.53 ±0.29a	1.65 ±0.07a	0.80 ±0.10a
Owerre-Ezukalla	B_4	25.33 ±0.82b	242.48 ±3.44b	4.91 ±0.10a	3.70 ±0.22b	3.45 ±0.31a	3.80 ±0.90b	152.13 ±3.66c	0.017 ±0.006a	1.60 ±0.05a	1.32 ±0.14b	0.83 ±0.05a
Akpu	B_5	26.75 ±0.51a	144.93 ±3.06c	5.86 ±0.25a	2.26 ±0.17b	3.52 ±0.11a	3.45 ±0.44a	190.81 ±4.71c	0.032 ±0.019b	1.54 ±0.11a	1.49 ±0.08b	0.85 ±0.12a
Umuchukwu	B_6	24.11 ±0.29b	50.84 ±2.17a	6.39 ±0.11a	0.74 ±0.09a	3.90 ±0.30a	2.50 ±0.27a	174.20 ±5.33c	0.016 ±0.007a	1.38 ±0.09a	1.54 ±0.14b	0.78 ±0.06a
Isulo	W_1	23.71 ±0.58c	326.51 ±4.86d	8.29 ±0.30b	4.76 ±0.70c	4.90 ±0.19b	3.90 ±0.70b	90.70 ±2.16b	1.009 ±0.051c	1.64 ±0.17a	1.80 ±0.23a	1.05 ±0.03b
Ezira	W_2	23.06 ±0.37c	310.40 ±3.22d	8.65 ±1.01b	4.52 ±0.41c	5.16 ±0.82b	4.61 ±1.33b	76.55 ±3.35b	0.018 ±0.004	1.86 ±0.04b	1.82 ±0.07a	1.16 ±0.09b
Eziagu	W_3	23.92 ±0.20c	267.11 ±2.60d	7.72 ±0.59b	3.90 ±0.13c	5.30 ±0.17b	2.62 ±0.45a	166.20 ±6.08c	0.016 ±0.003a	1.92 ±0.11b	2.14 ±0.59a	1.09 ±0.02b
Nawfija	W_4	23.65 ±1.04c	361.72 ±1.89d	7.75 ±0.88b	5.30 ±0.80c	5.25 ±1.21b	4.72 ±0.80b	154.73 ±2.71c	0.006 ±0.001d	1.85 ±0.03b	1.93 ±0.07a	1.20 ±0.33b
WHO standards	WHO	Ambient	1000	6.5- 8.5	1500	–	500	500	0-5	250	100	50
SON standards	SON	Ambient	1000	6.5-8.5	1500	–	500	500	0-5	250	100	50

Values are means and standard deviation of 3 samples collected over 3 months. Means on the same column with different letters are significantly different (P<0.05)

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High concentration of chloride may indicate pollution of organic origin which results in corrosiveness and impaired taste. The permissible limit of chloride according to WHO and SON is 250 mg/L. Drinking water is often chlorinated for disinfection. Mean concentration of chloride ranged from 1.38 mg/l to 1.92 mg/l which is lower than recommended limits.

Sulphate values for all the samples were below the maximum permitted level accepted by World Health Organization and SON which is 100 mg/L. The mean values in this study had a range of 1.30 mg/L – 2.19 mg/L. These values are lower than 46.12 mg/L to 443.26 mg/L reported by [10].

Nitrates are present in trace amounts in surface water but in some ground water, nitrates may be high. In the present investigation, mean nitrate values ranged between 0.80 mg/L and 1.20 mg/L. WHO and SON has fixed the maximum value of nitrate in drinking water at 50 mg/L. In the present study, nitrate values of all the sample water were found to be less than the maximum permissible limit by the two organizations.

Dissolved oxygen is an index of physical and biological processes going on in water and is important in water pollution control. The dissolved oxygen content of any water serves as an indicator to the water's hospitality to aquatic life. Mean DO in this study ranged between 3.17 and 5.30 mg/L.

Table 3 shows the occurrence rate of bacterial organisms. The results reveal the presence of some bacteria organism including *Micrococcus, Staplylococcus aureus, Streptococcus, E. coli* and *Kblessila*. The consistent presence of *E. coli* in samples from B_4 (Owerre-Ezukalla), W_1 (Isulo) and W_3 (Eziagu) is a serious public health issue.

Table 3: Occurrence Rate of Bacterial Organisms in the Water Samples.

Sampling sites	Sampling Tags	*Micrococcus*	*Staplylococcus aureus*	*Klebsiela*	*E. Coli*	*Streptococcus*
Umunze	B_1	+ – +	+ – ++	+ + +	– – –	– – –
Ihite	B_2	+ – +	+ + +	– – –	– – –	– – –
Ogbunka	B_3	– – –	– – –	– – –	– – –	– – –
Owerre-Ezukalla	B_4	+ + +	+ + +	+ + +	– – –	+ + +
Akpu	B_5	– – –	– – –	+ + +	– – –	– – –
Umuchukwu	B_6	+ + +	– – –	– – –		– – –
Isulo	W_1	+ + +	+ + +	+ + +	+ + +	– – –
Ezira	W_2	+ + +	+ + +	+ + +	– – –	+ + +
Eziagu	W_3	– – –	– – –	– – –	+ + +	– – –
Nawfija	W_4	+ – +	+ – +	+ + +	– – –	+ + +

Each cluster of 3 signs (+ and/or –) represents 3 determinations

Table 4 shows the results of standard plate, faecal coliform and faecal streptococal counts. Mean Standard Plate Count ranged from 22.10 x 10^3 to 53.44 x 10^3. These values obtained are similar to those reported by Mamoun and Arafat (2013). During the study, the mean faecal coliform count for W_1 and W_3 were 3.50 and 2.00 Cfu/100ml respectively, while values for other sites were 0.00 Cfu/100ml which were within the permissible limit prescribed by WHO and SON. Thus, while other water samples are microbiologically suitable for drinking purposes, those of W_1 and W_3 were above recommended limits and not suitable for drinking. These values obtained are similar to those reported by Mamoun and Arafat (2013). The mean faecal streptococcal count for B4 was 2.00, W_2 is 2.33 and W_4 is 2.50 Cfu/100ml while the rest were 0.00 Cfu/100ml which is the standard prescribed by WHO and SON. Thus, while water samples from other sites are microbiologically suitable for drinking purposes, samples from W_2 (Ezira) and W_4 (Nawfija) were microbiologically contaminated. A study was carried out on the quality of drinking water of Kathmandu and samples were taken from various sources like well, stream and treatment plants, all of which showed contamination. Hence, it was concluded that most drinking water supplies in Kathmandu were microbiologically contaminated [11].

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Table 4: Results of Standard Plate, Faecal Coliform and Faecal Streptococcal Counts

Sampling sites	Sampling Tags	Standard Plate Count ($x10^3$)	Faecal Coliform (cfu/100ml)	Faecal Streptococal count (cfu/100ml)
Umunze	B_1	31.47 ±2.50	0.00 ±0.00	0.00 ±0.00
Ihite	B_2	25.61 ±1.44	0.00 ±0.00	0.00 ±0.00
Ogbunka	B_3	27.82 ±3.01	0.00 ±0.00	0.00 ±0.00
Owerre-Ezukalla	B_4	30.75 ±2.99	0.00 ±0.00	2.00 ±0.00
Akpu	B_5	22.10 ±1.83	0.00 ±0.00	0.00 ±0.00
Umuchukwu	B_6	26.55 ±4.00	0.00 ±0.00	0.00 ±0.00
Isulo	W_1	52.03 ±3.34	3.50 ±0.58	0.00 ±0.00
Ezira	W_2	48.77 ±5.80	0.00 ±0.00	2.33 ±0.58
Eziagu	W_3	41.16 ±1.72	2.00 ±0.00	0.00 ±0.00
Nawfija	W_4	53.44 ±3.96	0.00 ±0.00	2.50 ±0.58
WHO standards	–	–	0	0
SON standards	–	–	0	0

CONCLUSION AND RECOMMENDATIONS

In conclusion, apart from pH values of the various borehole water samples and microbial concentration in W_1, W_2, W_3, W_4 and B_4 samples, all other parameters were within permissible level set by WHO and SON for drinking water quality. From these results, it is concluded that the borehole water in Orumba South LGA are acidic while well water samples are microbiologically contaminated. It is recommended that borehole and well water samples should be treated before use as drinking water. Also constant monitoring of drinking water in the area is important to reduce the risk of disease outbreak.

REFERENCES

[1] WHO. Guidelines for Drinking-Water Quality (Electronic Resource), 3rd edition Incorporating 1st and 2nd agenda, Volume 1, Recommendations. World Health Organization Geneva, 2008.

[2] Pund DA, Ganorkar RP. International Research Journal of Environment Sciences 2013; 2(10): 93-95.

[3] Nnaji JC, Omotugba S. International Research Journal of Pure and Applied Chemistry 2014; 4(4): 437-446.

[4] Ibrahim SI, Ajibade LT. Transnational Journal of Science and Technology 2012; 2(5):63-75.

[5] Obiekezie SO, Okereke JN, Anyalogbu E, Okorondu S I, Ezejiofor TIN. Estud Biol 2006; 28(63): 61-71.

[6] APHA. Standard methods for the examination of water and waste water. 20th edition, American Public Health Association, Washington D.C., 1998, pp 1-47.

[7] Chikwelu EE, Okpala PK, Nwokoye JN, Okolo VO, Unigwe LO. International Journal of Innovative and Applied Research 2014; 2 (3): 1 – 6.

[8] SON. Nigerian standard for drinking water quality. Standard Organization of Nigeria. Wuse, Abuja, 2007, pp 1-14.

[9] WHO. Guidelines for Drinking Water Quality. World Health Organization, Geneva Vol.1: 4 ed. ISBN 978924 1548151, 2011.

[10] Makwana SA, Patel CG, Patel TJ. Archives of Applied Science Research 2012; 4 (5): 2094-2097