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Seasonal Influence on the Bacteriological Quality of Well-Water in Rumuekini Community in Rivers State, Nigeria.

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Abstract:*This study examines the bacteriological quality of well water in Rumuekini community in Obio/Akpor Local Government Area of Rivers State, Nigeria. A total of ten wells were sampled in the months of September and February representing both wet and dry seasons respectively. Samples were subjected to some physicochemical and bacteriological analysis using standard methods. Results of Physicochemistry showed that seasons influenced pH, electrical conductivity, total dissolved solids, alkalinity and total hardness of the well water. Temperature was not affected. Total aerobic bacterial counts ranged between 15.47±0.23 and 80.53±1.37 x 10^3cfu/ml and between 7.67±0.57 and 36.00±0.10 x 10^3cfu/ml in the wet and dry seasons respectively. Coliform counts ranged between 92.67±2.52 and 296.33±5.13/100ml and between 41.33±1.53 and 152.33±2.08 coliform/100ml in the wet and dry seasons respectively. There were differences ($p \leq 0.05$) in the parameters at the different wells due to the seasons. A total of 19 coliforms were isolated during the wet season and 18 during the dry season. These emerging coliforms after characterization were found to be either of these genera: Escherichia coli, Citrobacter spp., Enterobacterspp. and Klebsiellaspp.Citrobacterspp. was observed to have the highest frequency of occurrence with 47.36%, followed by Escherichia coli and Enterobacterspp. with a frequency of 21.05% and Klebsiellaspp. with 10.53%. These organisms can elicit clinical conditions in humans; hence treatment of water for domestic purposes is advocated to avoid health problems.*

Keywords: *seasonal influence, physicochemistry, bacteriology, well water,*

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I. Introduction

Water is very important to all life forms. This fact is evidenced by the high percentage occurrence of water in the life support system as well as in organisms. There is about 71% water on the earth surface[1] and about 60% of adult humans consist of water[2]. This water need of man is met by drinking. Hence, the need for safe drinking water for all. TWAS[3]posits that safe drinking water is the birthright of every human. This is against the background that scarcity of safe, potable drinking water is responsible for many diseases that threaten public health[4, 5, 3].

The availability of fresh, safe and potable drinking water is threatened by several natural and anthropogenic processes[6, 7]. Further, the failure of authorities to supply potable, pipe borne water in Nigeria and other developing countries is on the increase[4]. Thus, higher demand from underground water sources. Ground water has been assumed safe and free of any form of contamination[8]. This has led to use of the underground water harnessed variously, including wells. However, studies have shown evidence of contamination in underground water[8, 9,4]. Contamination of underground water sources depends mainly on leaching and seepage into the underground water table[9, 4]. Contamination in wells also depend on the class and existing structure of the well. Wells are classified by the method of construction[10, 4]. Open dug wells are worst based on chances of contamination[10, 5].

Water supply on earth is maintained by the hydrologic cycle[1], recharging both underground and surface water bodies. The hydrologic cycle depends largely on seasons. The increase and decrease in the volume of rain between the wet and dry season respectively account for a lot of processes on the underground water table. During this recharge, water that seep into the water table and other surface water bodies carry microbial as well as other contaminants along[8]. Moreso, contamination of well water depends largely of siting. Previous studies[4,] suggest thatsiting wells close to septic tanks and other contaminants is a major source of contamination. This increases the incidence of microorganisms in well water, including pathogens. Similarly, Ibe and Agbamu[12]have demonstrated that underground seepage contribute significantly to well contamination. Seepage carrying industrial wastes as well as agrochemicals have also contributed to underground water contamination. WHO report[13] indicate that structural defects in wells are also responsible for contamination of well water.

Drinking water must be potable[14]. The microbiological quality of water is key to its potability. Previous studies have successfully isolated microorganisms from well water samples. Diseases, like cholera, typhoid fever and hepatitis have been associated to drinking contaminated water [8]. Water borne diseases account for more than 70% of all public health issues globally[8]. Most water borne diseases have been linked to untreated underground water sources, like well[4]. Several studies have reported microbial contamination of ground water in Nigeria[15, 12, 16].

The dependence on undergrond water sources for the water needs should be matched with adequate monitoring. However, Adebolaet al[17]observed that there is no integrated check in place for confirming underground water potable and safe for use. There are several treatment methods to make the water potable. However, effective treatment is dependent on ascertaining the quality of the water. The aim of this study was to establish the bacteriological quality of well water in Rumuekini, Port Harcourt, Rivers State. Specifically, this research sought to understand the effect of the two main seasons on the bacteriology of well water in Rumuekini community, Port Harcourt.

II. Materials and Methods

Study Site

This study was conducted in Rumuekini community in ObioAkpo Local Government Area of Rivers State of, Nigeria. The chosen wells lie within 6º56’0”E, 6º57’0”E and 4º53’0”N, 4º53’30”N.

Sample Collection

Ten (10) water wells were sampled in Rumuekini community in February and September, representing the dry and wet seasons respectively. Samples collected were labelled accordingly to show the season of collection, using W for wet season and D for dry season. Sampling for analysis were done aseptically according to WHO[13].

Physicochemical Analysis

Physicochemical parameters studied include temperature, pH, electrical conductivity, hardness, alkalinity, and total dissolved solids[18, 19, 20].

Microbiological Analysis

Physiological saline prepared as in Cheeseborough[21]was used as diluent. Peptone water was used as the enrichment medium. While Nutrient Agar was used as the general purpose media, Lactose Broth and Eusine Methylene Blue were used as selective and indicative media. Further, Triple Sugar Iron Agar, Methyl Red-Voges-Proskauer and Simmons Citrate Agar were used for isolation and enumeration of bacteria. All media were obtained commercially (Oxoid) and were prepared following manufacturer’s instruction.

For analysis, samples were diluted serially to 10^{-5} and 10^{-3} to 10^{-5} for analysis. Total Heterotrophic Bacteria Count was studied by the spread plate method[22, 20]. Most Probable Number (MPN) was used to study the incidence of Coliform[23]. Analysis for THBC and Coliform (Total and Fecal) was done as described by Cruickshank et al.[24]. Coliform count was extensively done to include presumptive, confirmatory and completed tests.

Bacterial identification was done using plate appearance as well as biochemical tests including gram staining, catalase, oxidase, motility, coagulase, hydrogen sulphide production (H_2S), indole, Voges-Proskauer (VP), Methyl red (MR), citrate, and sugar fermentation (lactose, glucose, sucrose, fructose, galactose).

Data Analysis

Analysis of variance (ANOVA) was used to check the difference in parameters measure in the two season studied using Statistical Software for Social Sciences, SPSS.

III. Results

This study measured the physicochemistry of the wells. Physicochemical parameters were measured based on their influence on the bacteriology of the wells. All measured physicochemical parameters appeared uniform across the ten wells studied apart from hardness. Hardness was highest in well 8 (86 ppm) and least in well 2 (5 ppm).

From the results, there was no significant difference in the temperature of most wells studied between the two seasons (Figure 1).

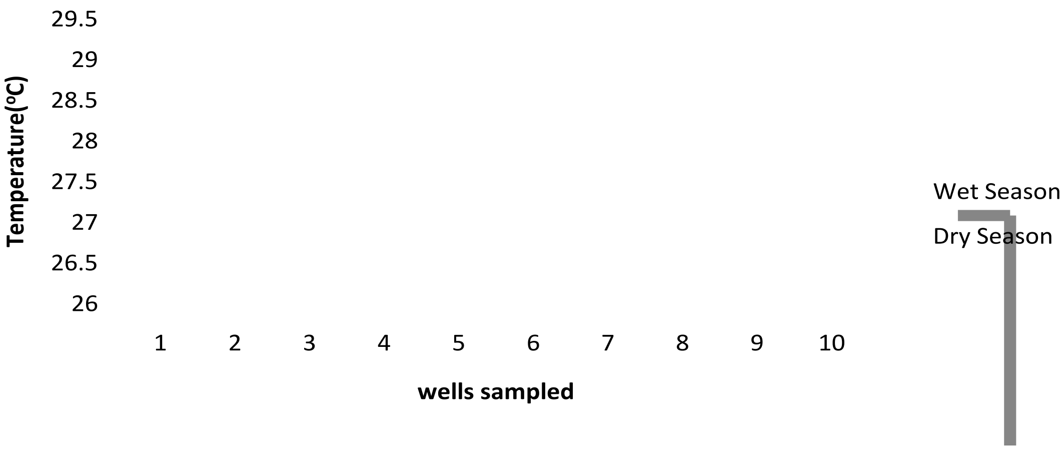

Figure 1: Effect of Seasons on the Temperature of well water samples in Rumuekini Community

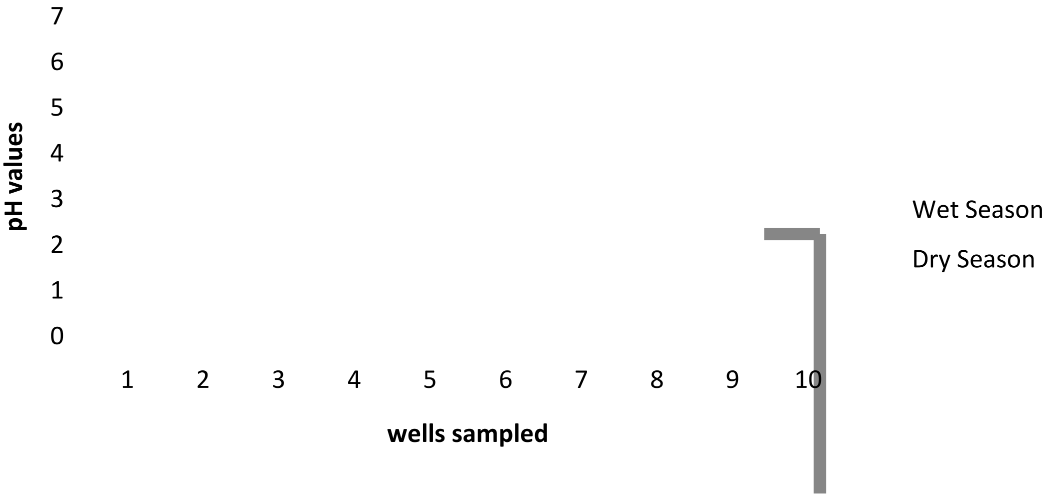

Figure 2: Effect of Seasons on the pH of well water samples in Rumuekini Community

Conversely, the pH varied between the seasons (Fig. 2). This was for all the wells studied, explainable by the fact that they were all in the same location.

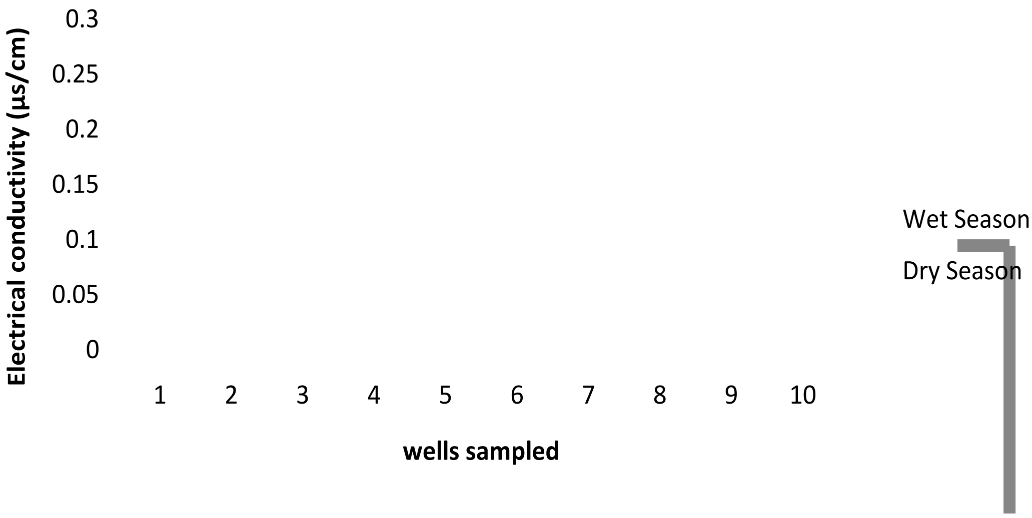

Figure 3: Effect of Seasons on the Electrical conductivity of well water samples in Rumuekini Community

The electrical conductivity of the well water was measured (Fig 3). This is the degree to which a substance can transfer electrical charges and is usually low in pure water. This study recorded low conductivity for all wells with values less than 0.5 (µs/cm) in the two seasons.

The dissolved solute results of this study agrees with the conductivity (Fig. 4). All wells were measured both in the wet and dry seasons. The results show a consistent difference in the conductivity of the water sample between the seasons. Significant increase in conductivity was recorded in wet compared to the dry season.

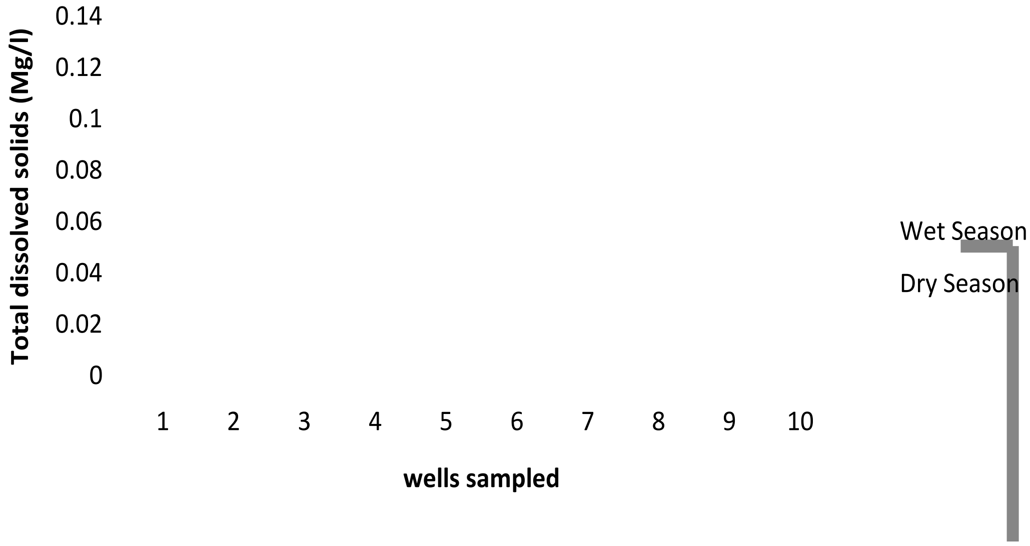

Figure 4: Effect of Seasons on the Total dissolved solids of well water samples in Rumuekini Community

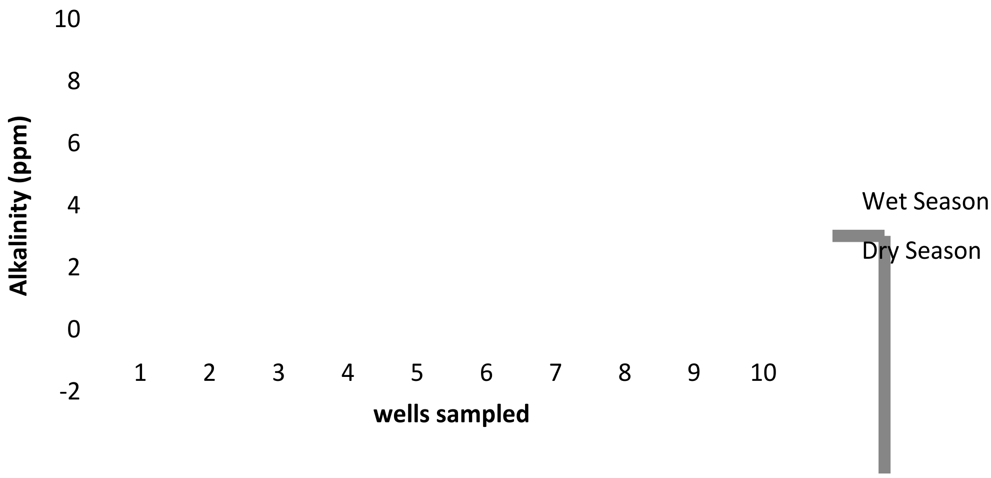

Figure 5: Effect of Seasons on the Alkalinity of well water samples in Rumuekini Community

The alkalinity in the wells studied followed no defined pattern (Fig 5). Conversely, the total hardness varied significantly between the two seasons in this study (Fig 6). Hardness of water is a function of the calcium and magnesium concentration. There was marked difference in the wet season compared to the dry.

Figure 6: Effect of Seasons on the Total hardness of well water samples in Rumuekini Community

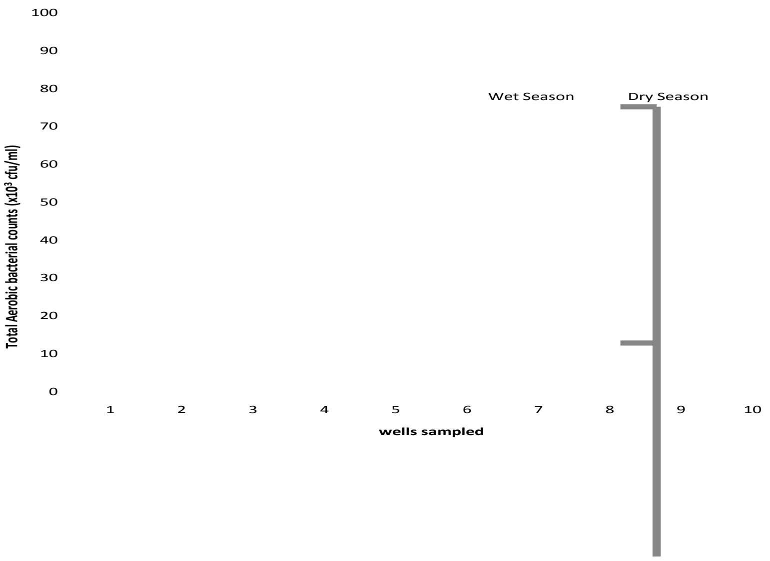

Figure 7: Variation of Total Aerobic Bacterial Counts in the dry and wet seasons

The Total Aerobic Bacterial Count also varied in consonance with most physicochemical parameters (Fig 7). The bacterial load of most wells studied increased significantly in the rainy season. Similarly, the coliform count followed the same trend with the total bacterial count (Fig 8).

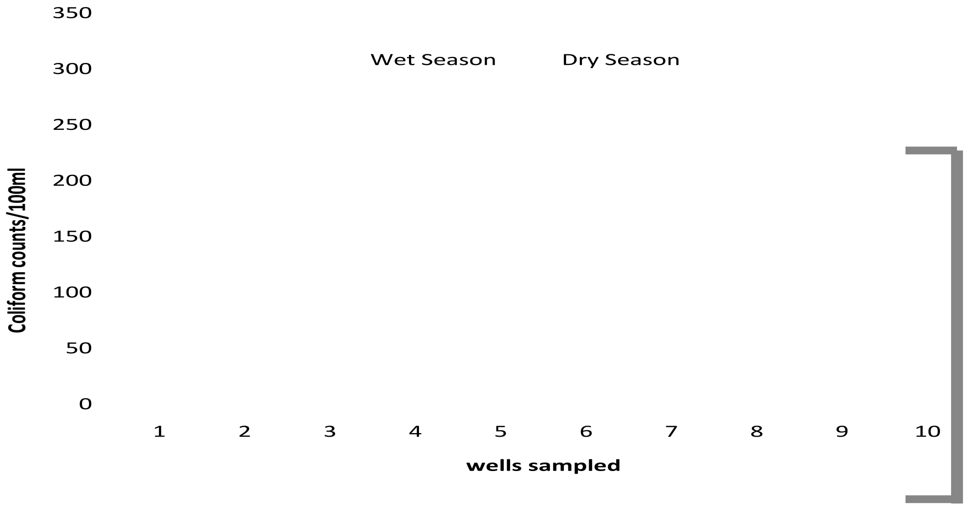

Figure 8: Variation of Coliform counts in the different wells in the wet and dry season

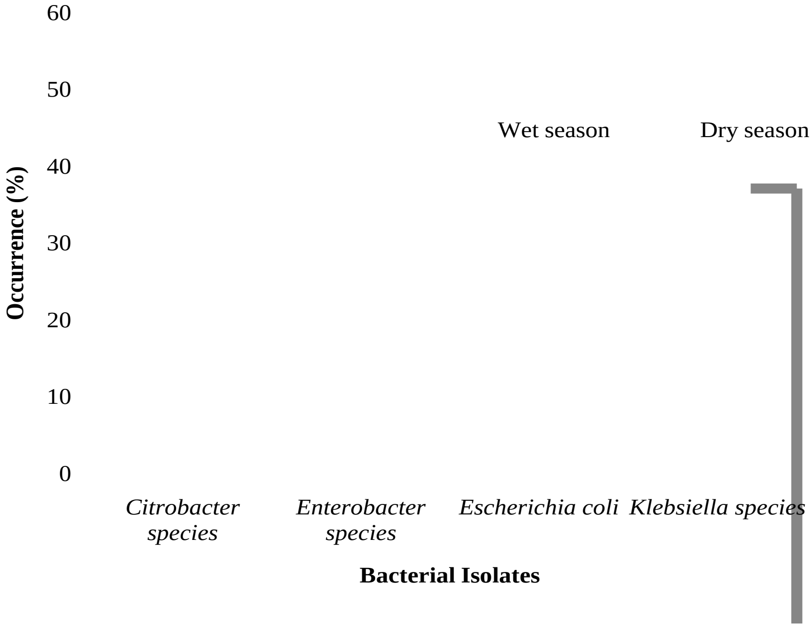

Fig. 9: Occurrence of Bacterial Isolates in the wells in the wet and dry seasons

Table 1: Bacterial Occurrence in the wells studied for Wet Season

wells	**Bacterial Isolates**			
	Escherichia coli	Citrobacter spp.	Enterobacter spp.	Klebsiella spp.
1	+	-	-	-
2	+	+	-	-
3	+	+	+	-
4	-	+	-	-
5	-	+	-	-
6	-	+	+	-
7	+	+	+	-
8	-	+	-	+
9	-	+	-	+
10	-	+	+	-

wells	Bacterial Isolates			
	Escherichia coli	Citrobacter spp.	Enterobacter spp.	Klebsiella spp.
1	+	-	-	-
2	+	+	-	-
3	+	+	+	-

4	-	+	-	-
5	-	+	+	+
6	-	+	+	-
7	+	-	-	-
8	-	-	-	+
9	-	+	-	+
10	-	-	+	+

Table 2: Bacterial Occurrence in the wells studied for Dry Season

Four bacterial species were isolated consistently in the two seasons. These were *E. coli*, *Klebsiella*spp., *Citrobacter*spp. and Enterobacter sp. Of the four species in the both seasons, *Citrobacter*spp. occurred in more wells.

IV. Discussion

Well is an underground water source. Underground water sources have been shown to maintain a constant temperature irrespective of the season[8]. The consistent temperature over the seasons could be attributed to the depth of groundwater away from the sun as the heat source. Previous studies agree with the findings of this study in terms of temperature[8,25, 26]. The temperature values in the current study meets the potable water quality set by regulators[18, 19].

The pH was more basic during the wet season (5.133 - 6.300) than the dry season (3.005 – 5.310). This could be due to the relative decrease in the buffering capacity of the water. The buffering capacity of water is correlated with the relative volume of water[27]. This follows that it increased with increase in the volume of water during the wet season and vice versa for dry season. However, this pH values are within the allowed safe water drinking limit for Nigeria of 6.5-8.5[18, 19].

There was a remarkable difference in the conductivity between the seasons. It reduced significantly in the dry season compared to the wet season. This may be explained by increase in precipitation leading to increase in dissolved particles in the wells in the wet as compared to dry season. Adekunle[4]has attributed increased conductivity to higher dissolved solids in the wet as compared to dry season. This is explained by solute to solvent dynamics[27].

Again, the dissolved solids were significantly higher in wet as compared to dry season. The solute to solvent equilibrium which is higher in the wet season explains this result.

No defined pattern was observed in the alkalinity of the wells between the two seasons. The alkalinity of the wells in the both seasons are within the allowed limit for drinking water[18, 19].The alkalinity values also agree with the pH measure as seen in figure 2 above. The alkalinity is however slightly higher in the wet season. This could be attributed to increased flow explained by leaching[8].Increased leaching entails more contaminants and these affect the alkalinity ultimately.

Hardness of water is a function of the calcium and magnesium concentration[28]. There may also be other trace metals explaining hardness. Total hardness in the present study was consistently higher in the wet season compared to dry season. This could be explained by increase in floatation with resultant increase in the concentration of the ions responsible for hardness. This is in consonance with the findings of previous studies[28, 4]. However, the total hardness in the present study is below the acceptable limit[18].

There was clear seasonal effect on the total aerobic bacterial count. Bacterial contamination of well water has been reported variously[6, 8, 9, 4]. Contamination of well water has been blamed on a number of factors. While some factors are structural on the well, others are environmental[8, 9]. The total aerobic bacteria was significantly higher in the wet season as compared to dry season. This is aided by similar factors as for other physicochemical parameters measured in this study. Further, the parameters already measured encourage the proliferation of bacteria on water [28, 4, 23]. The bacterial level in the present study surpasses the allowed limit for safe drinking water[18, 19].

Fecal contamination of well water studied is confirmed by the results of the microbiological analysis. The safety standard for coliform is zero for drinking water[4, 18, 19]. Coliforms are used as indicators of fecal contamination[23].Fecal contamination of well water has been blamed on siting. Introduction of human waste have been traced to latrines and septic tanks sited close to wells[8, 9, 4]. Accordingly, this study recorded higher contamination in the wet as compared to dry season. This is rationalized by the increased floatation in the rainy season. There is increased transport of fecal matter from the point sources into the groundwater table. Also, the ground water table is increased remarkably in the wet season due to increased precipitation.

The occurrence of bacteria in the seasons showed that *Citrobacter* spp., *Enterobacter* spp., E. coli and *Klebsiella*spp. were consistent in the two seasons. All organisms apart from *Citrobacter* spp. were higher in the dry season. This may be explained by water to organism concentration which is expected to be higher in the dry season.*Citrobacter* is found mainly in water soil and intestine, but may be opportunistic pathogens. They are anaerobic organism hence their presence in this underground water source. Previous studies[29, 9] have isolated this organisms from water.

V. Conclusion

The study revealed that there is a significant influence of the seasons on the bacteriological quality of well water in Rumuekini community, Port Harcourt, Rivers State. Marked increase in the microbial load of the wells studies was recorded. All other physicochemical parameters measured also changed significantly between the seasons. These factors also encourage the proliferation of bacteria in well water. Most physicochemical parameters measured fell within the recommended safe limits. Treating the well water is essential to make it fit for human use.

Considering the fact that most microbial contamination of wells is based on siting close to contamination sources, it is important that wells are sited within the recommended distance from this contamination sources. Further, there is the need for integrated monitoring to continuously study and ascertain the potability of this important drinking water source.

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