A Preliminary Quality Assessment of Water from Vulnerable Wells in Ago-Iwoye, Part of South-Western Nigeria

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Abstract: The Ago-Iwoye community is dominated by shallow wells that are prone to the various sources of pollution. This calls for the need to evaluate the groundwater quality using its integrated basic physicochemical feature and the microbial content. Twenty-five (25) samples were collected in a week from different wells at various locations in the studied rural community. This was done in accordance with the recommended procedures for raw water samples collection. On the site, the hydrogen ion concentration (pH), temperature, Total Dissolved Samples (TDS) and the specific Electrical Conductance (EC) were measured using a standardized digital electronic multi-meter, while the Total Bacterial Count (TBC) the Total Coliform Count (TCC) were analyzed and the Isolated organisms were identified, all in the laboratory using the conventional recommended microbial methods. The water samples were generally clean, tasteless and odourless. The pH (4.0 - 6.6) revealed slightly acidic to partially neutral groundwater. The temperature was normal, and varied between 29.6 and 31$^{\circ C}$. The TDS and the EC of the water samples ranges were 101 - 1022mg/l and 203 - 2045µS/cm respectively. High TBC (1.3×10^5 to 3.4×10^5 Cfu/ml) and TCC (1.2×10^5 and 2.5×10^5 Cfu/ml) values were recorded in the samples. The isolated organisms that dominated the samples include *Staphylococcus aureus, Salmonella* spp., *Escherichia coli, Pseudomonas aeruginosa, Enterobacter aerogenes, Bacillus* spp.*, and Klebsiella* spp. Although the physicochemical properties of the groundwater samples were slightly acceptable however, the samples were laden with coliforms greater than the recommended WHO standards. Water treatment should be advocated in this community to prevent water borne diseases.

Key word: Bacteria, Coliform, Groundwater, Waterborne Diseases

INTRODUCTION

According to Owamah (2020), clean water is an essential requirement for life and human health, but it is significantly lacking in several rural communities of Nigeria. Despite the effort of the Nigerian government to reach the Sustainable Development Goals (SDG) through the Presidential Water Initiative programs, access to hygienic water still remains a significant problem (Idike *et al.*, 2021). Groundwater is believed to be free from microbial contamination compared to surface water. This is because of its long travel-time in the oxygen-deficient subsurface environment. However, water in a well is automatically in contact with the atmosphere, and so can be contaminated by the materials in the air. Domestic sewage, feedlots, surface runoff, and other pollution are not equally left out. In this case, large diameter, hand-dug shallow wells or drilled deep-tube wells whose casings are not properly grouted may be susceptible to microbial contamination (Sasakova *et al.* 2018). Previous studies by Owamah (2020), Douti *et al.*, (2021) Egberongbe *et al.*, (2021) and Obasi *et al.*, (2022) on the investigation of the quality of drinking water sources revealed very high levels of both chemical and microbial content. The implications of the role played by pathogenic microorganisms and the associated diseases cannot be overelaborated. Microbial contamination in groundwater has been reported to result from pathogenic bacteria such as *Salmonella typhi, Shigella dysenteriae,* and *Escherichia coli.* According to Spano *et al*., (2022), these are known to cause diseases such as typhoid fever, dysentery, and diarrhea. Microbial contamination could also occur during periods of high-water table, such as after prolonged rainfall, when groundwater has greater contact with soil organisms and nutrients. Sub-surface-dwelling organisms are usually attached to rock particles in soils and consequently lead to an increase in the microbial population of the groundwater (Islam *et al*., 2018). This study aims to provide information on the microbial pathogens in the usual groundwater sources in Ago-Iwoye. It further explains the physico-chemical characteristics of the groundwater.

MATERIALS AND METHODS

Description of Study Area: The Ago Iwoye community in Southwest Nigeria, is on the global positioning of latitudes $6^0$56'N and $7^0$00'N and longitudes $3^0$54'E and $4^0$00'E. The area is underlain by the Precambrian rocks of the Basement Complex of Southwestern Nigeria. Adabanija *et al.*, (2020) reported these rocks to comprise the Migmatites and the Porphyroblastic gneiss. These rocks lies a laterized profiles of weathered materials, which have been penetrated by wells for groundwater exploitation whose depths range between 18.0 and 32.0m. Water from wells is the major source for domestic and agricultural uses in Ago-Iwoye (Owagboriaye *et al*., 2022).

Sample Collection: The raw water samples were initially disturbed to attain homogeneity. The samples were collected aseptically from twenty-five (25) large-diameter hand-dug wells in Ago Iwoye. Each of these were obtained with a sterile 200 ml sample bottle, and immediately transported to the laboratory for microbial analysis.

Physicochemical Analysis: The water samples were assessed for physicochemical parameters. This was done immediately after collection with the use of a standardized digital electronic multi-meter, to measure their temperature, hydrogen ion concentration (pH), total dissolved solids (TDS), specific electrical conductance (EC) and colour. Other properties such as taste and odor were also determined with the aid of tongue and nose.

Bacteriological Analysis: The water samples were further subjected to ten times serial dilutions after by transferring 1ml of each diluent up to four ((10^{-1} to 10^{-4}) dilutions. The bottles were labelled with their full information to avoid misidentification. One milliliter of each water sample from the 10^{-3} and 10^{-4} dilutions was cultured on nutrient agar, eosin methylene blue, and MacConkey agar using the pour plate technique. After aerobic incubation at 37°C for 24-48 24 hours, the resultant bacterial colonies were counted and sub-cultured for further identification and characterization using cultural and biochemical characteristics. The biochemical tests carried out are catalase test, indole test, oxidase test, citrate utilization test and urease test.

RESULTS AND DISCUSSION

The physicochemical data for the groundwater samples are shown in Tables 1. The water samples to a considerable extent were clear, tasteless, and odourless. The temperature of all samples ranged from 29.6 to 31.0℃ within the WHO's recommended limit. This is consistent with the findings of Egberongbe *et al*. (2021). The similarity in the study area could be significant because of the possibility that the same climatic and environmental factors affect groundwater sources (WHO, 2017; Egberongbe *et al*., 2021). The pH values observed in the samples ranged from 2.8 to 6.6, which is much lower than the WHO water guidelines (WHO, 2017). Although this does not agree with the findings of Essumang *et al.* (2020), Owamah (2021) recorded pH range of 4.82 – 6.50 in this study, this is slightly similar to the findings in this study. The presence of mineral elements can influence the pH of groundwater in the area (Essumang *et al*., 2020; Owamah, 2020). The electrical Conductivity and Total Dissolved Solids were also reported to be within the ranges 207 – 2045 µS/cm and 101 – 1022 ppm, respectively. This finding is not in agreement with Basak (2021), who sampled groundwater from both rural and urban areas (Basak, 2021). The majority of the groundwater samples were below the WHO standards and were unfit for drinking and domestic purposes. Based on the bacteriological analysis, none of the water samples were devoid of coliforms. Coliforms are indicators of pathogenic microorganisms in water. Total Viable Count (TVC) values higher than the recommended standard of the World Health Organization (WHO) were observed in the water samples. The TVC in the water ranges from 1.3×10^5 to 3.4×10^5 cfu/ml. This is considerably higher than the WHO's recommended value of 1.0×10^3 for a safe drinking water (Table 2). The excessively high TVC of microorganisms in the water and the presence of coliforms in the water further supports its unsuitability for drinking purpose. The findings are consistent with those of Prosun *et al*. (2018) for most inhabitants of rural Noakhali area in Bangladesh who consumed well water without treatment, reflecting diseases caused by these bacteria. A total of 41 isolates belonging to seven bacteria genera were recovered from the groundwater samples. The genera include *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Salmonella* spp., *Bacillus* spp., *Enterobacter* aerogenes, and *Staphylococcus aureus*. *Escherichia coli* had the highest percentage of occurrence (24.39%). This is followed by Salmonella spp. *(*19.51%), and in the order of decreasing percentage, *Pseudomonas aeruginosa and Klebsiella pneumoniae (*17.07%), and *Bacillus* spp. (9.96%), *Enterobacter aerogenes* (7.32%), and *Staphylococcus aureus* (4.88%) (Table 3).The presence and high percentage of *Escherichia coli* were indications of direct or indirect contamination with fecal matter. Foster *et al*. (2019) and Owamah *et al*. (2020) detected *Escherichia coli* in groundwater samples from certain rural areas. Surface runoff from rainwater, floods containing human and animal wastes were attributed to the fecal contamination in groundwater in those areas. *Salmonella* spp. have been reported to be the second most prevalent bacteria in this study. This finding is consistent with those of Li *et al*. (2018) and Wada *et al*. (2021) in rural certain areas. Consumption of *Salmonella-contaminated* water is associated with increased health risks and can cause major outbreaks in these communities. It is required that proper water treatment procedures need be performed prior to consumption.

Table 1: Physicochemical properties of the water samples

Sample	Appearance	Taste	Color	Temp (^OC)	pH	EC (μScm^{-1})	TDS (mgl^{-1})
S1	Clear	Tasteless	Colourless	30.7	5.1	207	103
S2	Clear	Tasteless	Colourless	30	5.3	246	123
S3	Clear	Tasteless	Colourless	30.4	4.7	1034	517
S4	Clear	Tasteless	Colourless	30.2	4.9	712	356
S5	Clear	Tasteless	Colourless	30	5.0	625	312
S6	Clear	Tasteless	Colourless	29.9	4.8	1314	657
S7	Clear	Tasteless	Colourless	29.9	4.8	543	271
S8	Clear	Tasteless	Colourless	31	4.4	471	235
S9	Clear	Tasteless	Colourless	30.9	4.4	203	101
S10	Clear	Tasteless	Colourless	30.8	4.0	328.	164
S11	Clear	Tasteless	Colourless	30.7	4.5	437.	218
S12	Clear	Tasteless	Colourless	30.2	4.4	604.	302
S13	Clear	Tasteless	Colourless	30.1	5.3	887.	443
S14	Clear	Tasteless	Colourless	30	5.2	2045.	1022
S15	Clear	Tasteless	Colourless	29.9	5.3	1339.	669
S16	Clear	Tasteless	Colourless	30	2.8	1218.	609
S17	Clear	Tasteless	Colourless	30	4.6	1367.	683
S18	Clear	Tasteless	Colourless	29.9	4.6	1476.	738
S19	Clear	Tasteless	Colourless	29.7	4.6	1076.	538
S20	Clear	Tasteless	Colourless	29.7	4.5	518.	259
S21	Clear	Tasteless	Colourless	29.7	4.6	848.	424
S22	Clear	Tasteless	Colourless	29.6	6.6	456.	228
S23	Clear	Tasteless	Colourless	30.2	5.5	217.	108
S24	Clear	Tasteless	Colourless	30.1	6.4	1063.	531
S25	Clear	Tasteless	Colourless	30.1	6.0	668.	334

Key: Total Dissolved Solids – TDS, Temperature – Temp, Specific Electrical Conductance - EC

Table 2: Total bacterial and coliform count in the water samples

Sample Code	Total Viable Bacterial Count (TVC) cfu/ml x10^5	Total Coliform Count (TCC) cfu/ml x10^5
S1	3.4	2.4
S2	2.7	1.6
S3	1.6	1.2
S4	1.4	1.9
S5	2	1.4
S6	2.2	1.7
S7	2.9	2.1
S8	2.5	2
S9	1.3	1.8
S10	1.9	1.5
S11	1.8	2.3
S12	3	1.7
S13	2.6	1.3
S14	2.4	2.2
S15	3.2	2
S16	2.2	2.1
S17	2.8	1.5
S18	1.5	1.7
S19	1.7	1.9
S20	2.1	1.5
S21	3.3	2.3
S22	2.3	2.4
S23	1.4	2.5
S24	1.5	1.6
S25	1.4	1.5

Table 3: Total bacterial and coliform count in the water samples

Isolate	Occurrence	Percentage (%)
Escherichia coli	10	24.39
Salmonella spp	8	19.51
Klebsiella pneumonia	7	17.07
Pseudomonas aeruginosa	7	17.07
Bacillus spp	4	9.76
Enterobacter spp	3	7.32
Staphylococcus aureus	2	4.88
Total	41	100

CONCLUSION

In this preliminary assessment of groundwater quality in rural communities in Ago Iwoye, the results were at variance with World Health Organization (WHO) standards. The physicochemical parameters were in agreement with the WHO limits set for portable water. However, the microbial characteristics of the water is indicative of its unsafe for use without proper treatment procedures. Considering the dependence of the majority of the inhabitants of Ago-Iwoye on groundwater sources, proper steps are recommended to be taken to provide safe and adequate drinking water. The anthropogenic sources of groundwater contamination in the area are needed to be continuously monitored. This should be done on a large scale to minimize or eradicate health threats in the community.

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