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# BACTERIOLOGICAL ASSESSMENT OF BOREHOLES AND WELLS WATER IN AKUNGBA-AKOKO, NIGERIA

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## ABSTRACT

Groundwater is generally considered a "safe source" of drinking water because it is abstracted with low microbial load with little need for treatment before drinking. Bacteriological assessment of boreholes and well waters in some selected locations within Akungba-Akoko, Ondo state, Nigeria were studied to determine the level of contamination of drinking water which might be responsible for the occurrence of water borne diseases. The study used standard laboratory techniques for the water quality analysis and the results were evaluated based on the benchmark standards of the World Health Organization and Nigerian Standard of Drinking Water Quality. According to the borehole water analysis, the total bacterial count (TBC) was extremely high in Akunmi 1, Ilale 1 and Okele boreholes and quite moderate in the other locations but was lowest in Etioro. The variation showed that the bacteria counts in the wet season where really high than those in the dry season. The total coliform count (TCC) and feacal coliform counts (FCC) were constant in both seasons. The TCC and FCC of both seasons were not more than the WHO and NSDWQ standards which is not above 10 cfu/ml. Therefore, groundwater obtained from both boreholes and wells in Akungba-Akoko metropolis were suitable for drinking and human consumption.

**Keywords:** Bacterial, Microbial Analysis, Hand Dug well, Boreholes, Drinking water quality.

## 1. INTRODUCTION

Water is a transparent and nearly colorless chemical substance that is the main constituent of Earth's streams, lakes and oceans, and the fluids of most living organisms. Its chemical formula is $H_2$ O, meaning that its molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds (Bhat, 2014). Water strictly refers to the liquid state of that substance that prevails at standard ambient temperature and pressure but it often refers also to its solid state (ice) or its gaseous state (steam or water vapor). It also occurs in nature as snow, glaciers, ice packs and icebergs, clouds, fog, dew, aquifers and atmospheric humidity. Water plays an important role in the world economy (Bhat, 2014). Approximately 70% of the freshwater used by humans goes to agriculture. Fishing in salt and fresh water bodies is a major source of food for many parts of the world. Much of long-distance trade of commodities (such as

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oil and natural gas) and manufactured products is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industry and homes. Water is an excellent solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing and diving. Groundwater is the water present beneath earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water tabl***e***. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps and can form oases or wetlands.Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikarran, 1999). In Nigeria, majority of the rural populace do not have access to potable water and therefore, depend on well, stream and river water for domestic use. The bacterial qualities of groundwater, pipe borne water and other natural water supplies in Nigeria, have been reported to be unsatisfactory, with coliform counts far exceeding the level recommendation by WHO (2017).The bacteriological quality of most drinking water in many rural areas in Sub-Sahara Africa is worrisome. Interestingly, water borne illnesses like typhoid fever, amoebic and bacillary dysentery, cholera, meningitis and diarrheaas well as food and equipment damages are caused by bacteria (Cowan, 1974; Amadi, *et al*., 2012). Lack of bacteriological analysis of drinking water may be attributed of prevalence of water borne diseases in rural area where basic amenities such as good road network, electricity, good pipe borne water and adequate health care are lacking. Studies have shown that the act of disposing feacal wastes and untreated effluents on rivers and streams are still commonin rural areas in the country (Amadi *et al*., 2011; Amadi *et al*., 2013).

The objectives of the research project is to determine the bacteriological qualities of both borehole and well water, ascertain the pollution of groundwater, compare the values obtained from analysis with that of national and international standards with a view to improve the quality of potable water and also sensitise the public on the dangers and consequences of consuming polluted water.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Akungba-Akoko is a town in Ondo state South-western Nigeria. It has a population of 170,123,740 with a land area of 923,768 $km^2$. Its geographical coordinates are 7°28'0" North and 5°44' 0" East as shown in Figure 1. It is bordered to the North by Ikare-Akoko, South by Oba-Akoko. East by Odowara and West by Supare-Akoko. The climate of Akungba-Akoko falls within the tropical region with rainfall which varies from 1100 - 2000 mm per annum. The temperature is between 26 and 28°C. There are alternate wet and dry seasons (Ehinmowo and

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Eludoyin, 2010; Ale *et al*., 2017). It is located on an undulating and rocky terrain. The rocks in the study area are migmatitic with the most predominant components being the granite-gneiss and grey gneiss. These rocks are covered by regoliths with thickness variation across the town. The wells in many parts of Akungba are shallow reflecting the extent of the weathered profile in the study area. Structural features in the rocks are those typically found in metamorphic rocks. Faults and fractures are also present in the rocks (Taiwo *et al*., 2015).

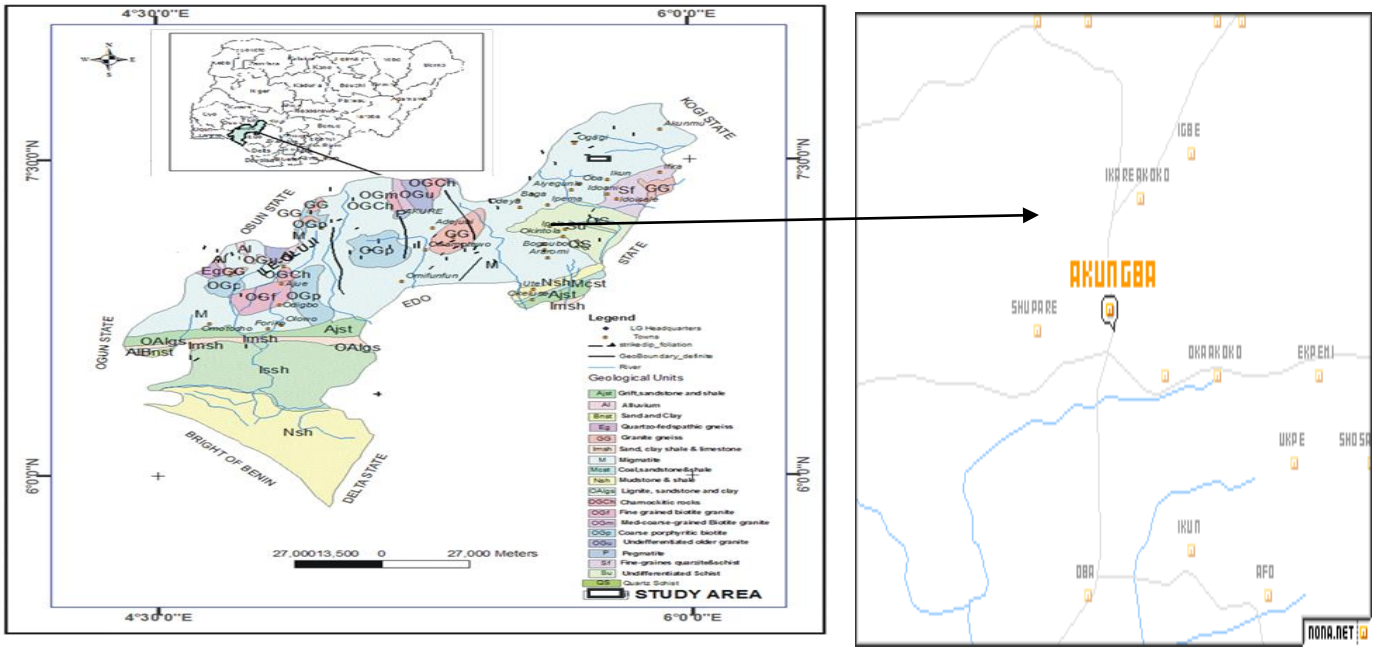


**Figure 1:** Map of Nigeria showing Ondo state and Akungba-Akoko
Source : (https://www.google.com.ng/search?q=map+of+Nigeria+show+ondo+state&client=ms-opera mini)

## 2.2 Samples and Sampling

The sample was collected from 13 different boreholes within Akungba metropolis using sterile sampling bottles. Also, the well water samples was collected from 11 different wells in the same geographical location with the use of sterile sampling bottles. The samples were then transported in ice bath to the laboratory for immediate analysis.The points at which the borehole water samples were collected in Akungba metropolis are Ilale 1and 2, Abi 1and 2, Alale palace, Okele, Igbelu, Ibaka, Akunmi 1 and 2, Okusa 1and 2 and Etioro while well water samples location were Igbelu, Araromi 1, Emmanuel Street, Alafiatayo, Otalokija, Okele, Akunnu, Supure, Alale, Araromi 2 and Etioro.

## 2.3 Bacteriological Quality Determination

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### 2.3.1 Total bacterial count (TBC)

It was determined by pour plate technique using standard methods. Nutrient agar medium was used for the enumeration of bacteria in the samples. Mannitol salt was used for the isolation of *Staphylococcus aurens* while *salmonella spp*. was isolated on salmonella shigella agar (Adogo *et al*., 2016).

### 2.3.2 Total coliform count (TCC)

It was determined by Most Probable Number (MPN) index method using 3-3-3 regimen. MacConkey bath was used and positive result was indicated by acid and gas production on incubation at 37$^{o}$C for 98 hours (Dada *et al*, 1999a; Edema, *et al*., 2001; Adogo *et al*., 2016).

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### 2.3.3 Feacal Coliform Count (FCC)

It was determined using Eosin methylene blue medium employing the pour plate techniques. On Eosin Methylene Blue (EMB) agar, *E. coli* strains appeared as greenish metallic sheen colonies and this was further confirmed by the ability of the organism to ferment lactose at 44.5$^{o}$C while *Aerobacter aerogenes* appeared as large pinkish mucoid colonies (Dada *et al*, 1999a; Edema, *et al*., 2001; Adogo *et al*., 2016).

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## 3. RESULT AND DISCUSSION

### 3.1 Bacteriological analysis for borehole water for dry and wet season
### 3.2 Total bacterial count (TBC)

Tables 1 and 2 showed the total bacterial counts (TBC), total coliform counts (TCC) and Faecal coliform count (FCC) from borehole water samples in both dry and wet season. There was variation in total bacterial counts (TBC) analysed for borehole water in both seasons from all location sample. The total bacterial counts (TBC) for all the water samples were generally high exceeding the limit of $1.0 \bullet 10^{2}$cfu/ml which is the standard limit for drinking water (EPA, 2009). The high total count is indicative of the presence of high organic and dissolved salts in the water. According to the analysis, the TBC was extremely high in Akunmi 1, Ilale 1 and Okele borehole and quite moderate in the other locations but was lowest in Etioro. The result from this study agrees with the separate findings of Erah, *et al*., (2002); Uzoigwe and Agwa, (2012) and Adogo *et al*., (2016). The high values obtained could be due to poor environmental conditions and the presence of stagnant water around the borehole which provide an excellent breeding ground for bacteria.

The total coliform counts (TCC) and faecal coliform count (FCC) of both seasons were not detected. This agreed with recommendation of WHO standard for potable water which states that no coliform should be present in any drinking water.The presence of TCC and FCC in water is a clear indication of groundwater contamination by human or animal faeces. The presence of these

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bacteria organisms (*Salmonella*, *Staphylococcus*, *Escherichia*, *Pseudomonas*, *Proteus* and *Klebsiella*) suggests fecal contamination. It could probably be that the pipes used for water distribution were rusty thus allowing seepages of microbial contaminants into the borehole (Uzoigwe and Agwa, 2012; Adogo *et al*., 2016).

**Table1: Bacteriological analysis for borehole water for dry season**

| SAMPLE CODE | MICROBIOLOGICAL CHARACTERISTICS | | |
|---|---|---|---|
| | TOTAL BACTERIAL COUNT (TBC) (cfu/mL) | TOTAL COLIFORM COUNT (TCC) (MPN/100mL) | FAECAL COLIFORM COUNT (FCC) MPN/100mL |
| Okusa 1 | 80 | N.D | N.D |
| Okusa 2 | 80 | N.D | N.D |
| Ilale 1 | 110 | N.D | N.D |
| Ilale 2 | 90 | N.D | N.D |
| Abi 1 | 80 | N.D | N.D |
| Abi 2 | 80 | N.D | N.D |
| Akunmi 1 | 120 | N.D | N.D |
| Akunmi 2 | 80 | N.D | N.D |
| Ibaka | 80 | N.D | N.D |
| Alale palace | 80 | N.D | N.D |
| Okele borehole | 100 | N.D | N.D |
| Igbelu borehole | 80 | N.D | N.D |
| Etioro | 60 | N.D | N.D |

**Table2: Bacteriological analysis for borehole water for wet season**

| SAMPLE CODE | MICROBIOLOGICAL CHARACTERISTICS | | |
|---|---|---|---|
| | TOTAL BACTERIAL COUNT (TBC) (cfu/100mL) | TOTAL COLIFORM COUNT (TCC) (MPN/100mL) | FAECAL COLIFORM COUNT (FCC) MPN/100mL |
| Okusa 1 | 60 | N.D | N.D |
| Okusa 2 | 60 | N.D | N.D |
| Ilale 1 | 90 | N.D | N.D |
| Ilale 2 | 70 | N.D | N.D |
| Abi 1 | 50 | N.D | N.D |
| Abi 2 | 60 | N.D | N.D |
| Akunmi 1 | 100 | N.D | N.D |
| Akunmi 2 | 70 | N.D | N.D |

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| | | | |
|---|---|---|---|
| Ibaka | 60 | N.D | N.D |
| Alale palace | 50 | N.D | N.D |
| Okele borehole | 80 | N.D | N.D |
| Igbelu borehole | 60 | N.D | N.D |
| Etioro | 50 | N.D | N.D |

NOTE: cfu= colony forming unit; MPN= Most Probable Number; N.D= Not Detected

### 3.2 Bacteriological analysis for well water for dry and wet season

The results in Table **Error! No text of specified style in document.** and 4 showed that there was variation in the total bacteria counts (TBC) of well water in both dry and wet seasons. The variation showed that the total bacteria counts (TBC) in the wet season where really high than those in the dry season and the total coliform count (TCC) and feacal coliform counts (FCC) were constant in both seasons. The total coliform counts of both seasons were not more than the WHO and NSDWQ standards which is not above 10 cfu/ml (NSDWQ, 2007; WHO, 2017). The TBC were extremely high in the following locations: Akunnu, Supure, Alale, Araromi 2 and TBC was lowest at Etioro in both seasons. The presence of these bacteria organisms (*Salmonella, Staphylococcus, Escherichia, Pseudomonas, Proteus* and *Klebsiella*) suggests fecal contamination (EPA, 2009; Uzoigwe and Agwa, 2012).

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**Table 3: Bacteriological analysis of well water for dry season**

| SAMPLE CODE | MICROBIOLOGICAL CHARACTERISTICS | | |
|---|---|---|---|
| | TOTAL BACTERIAL COUNT (TBC) (cfu/Ml) | TOTAL COLIFORM COUNT (TCC) (MPN/100Ml) | FAECAL COLIFORM COUNT (FCC) MPN/100Ml |
| Igbelu | 120 | N.D | N.D |
| Araromi 1 | 100 | N.D | N.D |
| Emmanuel street | 150 | N.D | N.D |
| Alafiatayo | 180 | N.D | N.D |
| Otalokija | 100 | N.D | N.D |
| Okele | 180 | N.D | N.D |
| Akunnu | 360 | N.D | N.D |
| Supure | 250 | N.D | N.D |
| Alale | 270 | N.D | N.D |
| Araromi 2 | 250 | N.D | N.D |
| Etioro | 70 | N.D | N.D |

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**Table 4: Bacteriological analysis for well water for wet season**

| CODE | MICROBIOLOGICAL CHARACTERISTICS | | |
|---|---|---|---|
| | TOTAL BACTERIAL COUNT (TBC) (cfu/100mL) | TOTAL COLIFORM COUNT (TCC) (MPN/100mL) | FAECAL COLIFORM COUNT (FCC) MPN/100mL |
| Igbelu | 100 | N.D | N.D |
| Araromi 1 | 80 | N.D | N.D |
| Emmanuel street | 130 | N.D | N.D |
| Alafiatayo | 140 | N.D | N.D |
| Otalokija | 70 | N.D | N.D |
| Okele | 120 | N.D | N.D |
| Akunnu | 240 | N.D | N.D |
| Supure | 180 | N.D | N.D |
| Alale | 200 | N.D | N.D |
| Araromi 2 | 190 | N.D | N.D |
| Etioro | 60 | N.D | N.D |

NOTE: cfu= colony forming unit; MPN= Most Probable Number; N.D= Not Detected

## 4. CONCLUSIONS

It is evident that water borne diseases are due to improper disposal of refuse contamination of water by sewage and surface runoff. From the results of this research, it can be concluded that groundwater obtained from both boreholes and wells in Akungba-Akoko metropolis were suitable for drinking and human consumption because the total coliform count and feacal coliform count were 0.0 and 0.0 MPN-index/100 ml respectively and this may be attributed to the location of these wells and boreholes which are away from animal wastes, proximity to toilet facilities, sewage, refuse dump sites, seepage or discharge from septic tanks, sewage treatment facilities and the nature of the soil which does not allow the transfer of some chemicals and bacteria to the groundwater. To maintain these good qualities of boreholes and wells water in Akungba-Akoko, there should be periodic enlightenment for the inhabitants to keep to good hygiene within their environment.

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