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# Bacteriological quality of municipal borehole waters in Imo State, Nigeria

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**Abstract**

Bacteriological quality of municipal borehole samples in Imo State, Nigeria was carried out over a period of 4 months using standard bacteriological methods. The result revealed the total heterotrophic and coliform counts ranges of 3.0 x $10^1$ - 9.6 x $10^3$cfu/ml and 0 - 5.0 x $10^3$ cfu/ml, respectively. The highest total heterotrophic and coliform counts of 9.6 x $10^3$cfu/ml and 5.0 x $10^3$ cfu/ml were obtained from Vitaco and Akunna boreholes while Obibiezena borehole haboured the least. Identification tests revealed the presence of *Pseudomonas*, *E. coli*, *Bacillus*, *Micrococcus*, *Salmonella*, *Staphylococcus* and *Proteus* spps. Isolates occurred as follow: *Pseudomonas* (80%), *Bacillus* (70%), *Micrococcus* (50%), *Staphylococcus* (40%), *E. coli* (40%), *Proteus* (20%) and *Salmonella* (10%). The occurrence of bacterial isolates from each sample showed that Akunna, Pego, Iheoma and Menaccord boreholes recorded 4(57.14%), Vitaco, Genesis and Akpunku 3(42.86%) while the rest haboured 2(28.57%).

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## Introduction

Water has remained one of the prized natural resources of any nation and it occupies a permanent position among rural and urban dwellers. Ground water is formed by rainfall which permeates into the ground through the pores of rocks (Agunwamba, 2000). During this percolation, the water carries along with it, dissolved organic and inorganic materials. Additionally, water from streams, lakes and reservoirs percolate through the soil to the underground water table (Ojiako, 1985). Ground water varies in purity depending on the geological conditions of the soil through which it flows (Ajiwe *et a*l. 1999). As it flows, it absorbs from the soil some of the soluble gasses and salts. Ground water is less subject to contamination than surface water. However, it is still polluted by domestic, agricultural and industrial effluents as well as nutrient leaching. Such organic and inorganic impurities that predominantly come from man's socio – economic and technological activities are harmful or toxic to humans especially when tolerable limits are exceeded. It is therefore important that drinking water and water for other uses be monitored to ascertain the level and nature of pollution. Any information derived will subsequently guide in determining the type and degree of treatment required to make the water portable and to guarantee health and safety. The contamination and importance of ground water in Nigeria have been reported (Ajiwe *et al*; 1999; Egereonu *et al*; 2000; and Iwugo, 2000).

The inefficient supply of tap water, remote nature of surface water and pollution of surface water with urban wastes has made water from borehole systems, the main source of water for domestic, agricultural and industrial purposes (Agunwamba, 2000). However, the direct bottling and packaging of borehole water for human consumption in Nigeria has raised many public health questions so as to warrant the evaluation of its bacteriological quality. With this aim the present study was carried out in three municipalities in Imo State, Nigeria.

## Materials and methods

*Sources of sample*

A total of 320 water samples were collected from ten (10) borehole systems of three municipalities (Owerri, Okigwe and Orlu) located in Imo State, Nigeria. Thirty two (32) samples each from borehole systems of Akpunku, Iheoma, Kedeni, Obibiezena, Akunna, Vitaco, Pego, Genesis, Menaccord and Chicago were collected as shown in Table 1.

**Table 1.** Sources of borehole water samples.

| Names of borehole | Sample collection (dry season) | Number of Months | Total number of samples |
|---|---|---|---|
| Akpunku | Biweekly | 4 months (Oct - Jan) | 32 samples |
| Iheoma | Biweekly | " | " |
| Kedeni | Biweekly | " | " |
| Obibiezena | Biweekly | " | " |
| Akunna | Biweekly | " | " |
| Vitaco | Biweekly | " | " |
| Pego | Biweekly | " | " |
| Genesis | Biweekly | " | " |
| Menaccord | Biweekly | " | " |
| Chicago | Biweekly | " | " |
| | **Total** | | **=sum (above) 320 samples** |

*Sample Collection*

Samples for bacteriological analysis were collected biweekly for a period of four months (October 2007 – January 2008) during the dry season as described by Hach (1980). Each water outlet was swabbed with cotton wool soaked in 95% ethanol. This procedure ensured that each water outlet nozzle was sterile. Finally, the water outlet was turned on to flush the system and allowed to run for 10 minutes before being collected.

*Bacteriological analysis*

Water samples were analyzed bacteriologically as described by Cruickshank et al, (1982) and APHA (1985). Total heterotrophic bacterial and coliform counts were determined by plating 0.1ml of appropriate dilution of the sample using spread plate technique on Oxoid Nutrient and MacConkey agar,

respectively. Inoculated samples were incubated at 37°C for 18-30h. Acceptable plate counts were those that harboured between 30-300cfu/ml. Bacterial isolates generated were subjected to cultural and biochemical tests as described by Cruickshank et al (1982) and identified as in Holt et al (1994).

**Table 2.** Prevalence of bacterial isolates from various borehole water samples.

| Isolate | Vitaco | Kedeni | Akunna | Genesis | Pego | Akpunku | Chikago | Iheoma | Menaccord | Obibiezina | % Occurrence[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Peusdomonas* | + | - | + | + | + | + | + | + | + | - | 80 |
| *Bacillus* | + | - | + | + | - | + | + | + | - | + | 70 |
| *Micrococcus* | + | - | - | + | - | + | - | - | + | + | 50 |
| *Salmonella* | - | + | - | - | - | - | - | - | - | - | 10 |
| *Staphylococcus* | - | + | - | - | + | - | - | + | + | - | 40 |
| *Escherichia* | - | - | + | - | + | - | - | + | + | - | 40 |
| *Proteus* | - | - | + | - | + | - | - | - | - | - | 20 |
| %Occurrence [a] | 42.86 | 28.57 | 57.14 | 42.86 | 57.14 | 42.86 | 28.57 | 57.14 | 57.14 | 28.57 | |

a = %Occurrence of total isolates from each sample

b = %Occurrence of individual isolates across the sample

+ = Positive and - = Absent

**Results**

The bacteriological analysis of the 320 water samples studied revealed the isolation of thirty one distinct isolates from the ten borehole water samples. The cultural, morphological and biochemical properties of these isolates revealed them to belong to the genera *Pseudomonas*, *Bacillus*, *Micrococcus*, *Salmonella*, *Staphylococcus*, *Escherichia* and *Proteus*. The analysis also revealed that the total heterotrophic and coliform counts were between 3.0 x $10^1$ to 9.6 x $10^3$ cfu/ml and 0 to 5.0 x $10^3$cfu/ml, respectively. The highest total heterotrophic and coliform counts of 9.6 x $10^3$ and 5.0 x $10^3$ cfu/ml were obtained from Vitaco and Akunna borehole water systems while Obibiezena harboured the least total heterotrophic and coliform counts in the borehole water systems are as shown in Figure 1**.** The prevalence of bacteria in various borehole water samples studied is as shown in Table 2.

Amongst the seven bacterial genera isolated, *Pseudomonas* occurred in 80% of the samples, *Bacillus* occurred in 70% while *Micrococcus* and *Staphylococcus* occurred in 50% and 40% of the samples, respectively. *Escherichia*, *Proteus* and *Salmonella* occurred in 40%, 20% and 10% of the samples, respectively. The percentage occurrence of bacterial isolates in the borehole water samples studied as shown in Figure 2, revealed that of the seven bacterial genera isolated, 4(57.14%) occurred in Akunna, Pego, Iheoma and Menaccord borehole waters. Vitaco, Genesis and Akpunku borehole harboured 3(42.86%) of the bacterial genera while Kedeni, Chicago and Obibiezena harboured only 2(28.57%) of the isolates.

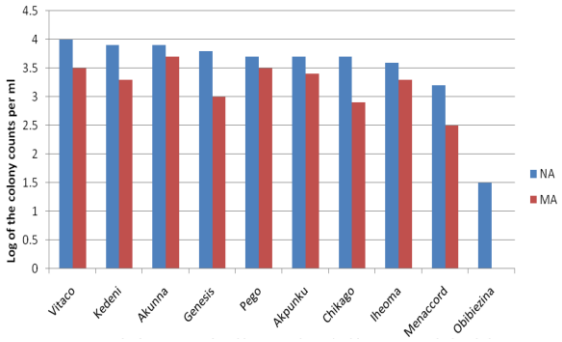


**Fig. 1.** Levels of occurrence of total heterotrophic and coliform counts in the borehole water systems.

**Discussion**

The present study revealed the level of contamination of the various borehole water samples. The presence of *Escherichia*, *Bacillus*, *Micrococcus*, *Salmonella*, *Staphylococcus*, *Pseudomonas* and *Proteus* species in some of the borehole water samples analyzed is indicative of the poor microbiological quality of the borehole water samples. The World Health Organization (WHO, 2006), recommended one *E. coli* colony per 100ml of water sample to be normal. However, this indicator organism was found in large numbers in four borehole water samples with a prevalence of 40% (Table 2). The high total coliform count present in some of the borehole water samples is indicative of pollution with human excreta. The presence of this indicator organism may suggest the possible presence of pathogens causing cholera, typhoid, gastroenteritis, etc. this calls for an initial treatment before such borehole waters are consumed. Seventy percent of the borehole samples contained *Bacillus* spp. Most *Bacillus* spp. are non-pathogenic, however, some strains are pathogenic as they have been implicated in endotoxin production (Cruickshank *et al.*, 1982). The isolation of *Micrococcus*, *Bacillus* and *Proteus*, a powerful proteolytic agent is not surprising in view of the fact that these organisms show a widespread distribution in soil and water (Rogers *et al.*, 1977). Although, *Micrococcus* and *Proteus* are non-pathogenic organisms, however, they can bring about changes in water quality (Wan, 1997). The isolation of *Salmonella* spp from Kedeni borehole water sample indicates that the direct consumption of such water without treatment may be very dangerous. This genus is known to cause Salmonellosis. The typhi and paratyphi species cause typhoid fever which can be spread through contaminated water. However, there was no further study to prove the pathogenicity of these isolates.

Four of the borehole water samples contains *Staphylococcus epidermidis*, an organism which is a normal flora of the skin, and its presence in water suggest poor human handling. Very high level of occurrence (80%) was recorded for *Pseudomonas* which can be justified by their widespread distribution in aquatic and soil ecosystems as reported by Rogers *et al.*, (1977). Some species of *Pseudomonas* belong to the category of opportunistic pathogens which do not normally exist in animal hosts, but which can establish infections in individuals whose natural resistance has been reduced (Rogers *et al.*, 1977). This organism is remarkably resistant to many of the more commonly used antibiotics, a fact that makes infection by this organism even more serious. However, water samples were collected only during the dry season and the effect of seasonal variation on its microbial loads was not considered. Thus, further studies are recommended in this direction.

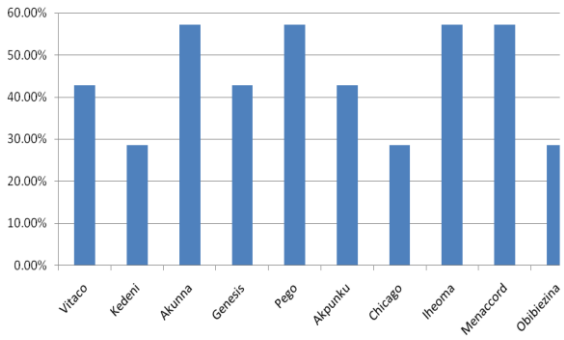


**Fig. 2.** Percentage occurrence of bacterial isolates in borehole water samples.

The isolation of these organisms some of which are pathogenic from borehole water sample may be associated predominantly with the microbial pollution of aquifers by human and domestic pollutants. Such pollutants that predominantly come from man's socio-economic and technological activities may be harmful, pathogenic or toxic with deleterious health consequence to humans when tolerable limits are exceeded. It is therefore important that drinking water and water for other uses be monitored to ascertain the level and nature of pollution just as has been recommended (Vrba, 1989). In addition, thorough public health survey must be carried out before constructing a borehole. This is because, some of the boreholes are within residential and industrial environments, and as such,

the probability of domestic, sewage and industrial waste contamination cannot be ruled out and studies are recommended in this direction.

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