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Bacteriological assessment of borehole water in some communities in Owerri West, Southeastern Nigeria

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Abstract

The proliferation of boreholes dug by individuals, public and private entities in a bid to overcome the problem of water shortage has caused various communities in Owerri West, southeastern Nigeria to depend on borehole water as readily available water for drinking and domestic purposes. Unfortunately, the water is not treated before it is used for drinking and there is no surveillance of bacteria in the water to ascertain its safety. In consideration of this fact, a study was conducted to assess the bacteriological quality of borehole water in some communities in the area. Borehole water samples were aseptically collected from four communities. The bacteriological assessment was carried out using standard microbiological methods involving determination of total coliform count, total faecal coliform count and total heterotrophic bacterial count. The total coliform counts of the water samples ranged from $1.3x10^2$ to $1.3x10^4$ $CFUmL^{-1}$ while the total faecal coliform and total heterotrophic bacterial counts ranged from $1.3x10^2$ to $5.8x10^4$ $CFUmL^{-1}$ and $1.1x10^2$ to $8.7x10^4$ $CFUmL^{-1}$ respectively. The organisms isolated from the borehole water samples included *Shigella* sp, *Enterococcus faecalis, Staphylococcus* sp, *Klebsiella* sp and *Escherichia coli.* The total bacteria counts exceed the limit set by the World Health Organization for drinking and domestic purposes. Moreover, the pathogenic organisms isolated from the water samples could cause serious health problems in humans. Hence, the borehole water should be treated properly before use and other preventive approaches should be adopted to minimize possible health risks associated with the use of the borehole water.

Keywords: Bacteriological assessment; Borehole water; Bacterial count; Rural communities; Owerri West

1. Introduction

The usefulness of water to human life cannot be over emphasized. This natural substance has been described as the most important nutrient for the survival of man on earth because of its involvement in the various functions of human body [1-3]. One of the complex challenges facing rural communities in Africa is the provision of safe drinking water. This problem has resulted in several deaths of both children and adults [4]. Consequently, various countries have adopted programs aimed at improving the quality of water and strong emphasis has been placed on the need for reliance on other water sources such as ground water and rain water apart from surface water [5].

In Nigeria, boreholes are dug by individuals, public and private entities in a bid to overcome the problem of water shortage. This has resulted in dependence on boreholes as readily available source of water for drinking and domestic purposes. In some places, boreholes are dug close to septic tanks and pit latrines which may result in underground contamination with faecal matter. The communities in Owerri West Local Government Area in the Southeastern Nigeria mostly depend on borehole water for drinking and domestic activities. Regrettably, the underground water is not

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treated before use and there is no effort to ascertain its safety. Microbiological assessment of water is considered very important because of acute risk to human health posed by microorganisms in drinking water. It is, therefore, a health-based activity which emphasizes the protection of public health through ensuring that the available source of water is of a good quality [6].

In view of the above fact, this study was conducted to assess the bacteriological quality of borehole water in some communities in Owerri West, Southeastern Nigeria. The information generated from this study will be useful in addressing possible health problems associated with the use of borehole water in the area.

2. Material and methods

2.1. Collection of sample

A total of 12 samples of borehole water were aseptically collected from four communities in Owerri West Local Government Area of Imo State in the southeastern part of Nigeria. Three borehole water samples were collected from each community and labelled BWA_{123} to BWD_{123} respectively. The water samples were transported to laboratory for bacteriological analysis within 3 hours of collection.

2.2. Bacteriological analysis of the borehole water samples

Bacteriological analysis of the water samples involved standard microbiological methods for determination of total heterotrophic bacterial count, total coliform count and total faecal coliform count. One milliliter (1 mL) each of the borehole water samples was pipette into 9 mL of sterile physiological saline and thoroughly mixed by swirling. The mixtures were diluted decimally until appropriate dilution was obtained. The spread plate method was used in inoculating aliquot portion (0.1 mL) of appropriate dilution into a sterilized nutrient agar medium. Plates were incubated at 37 °C for 24 to 48 hours for heterotrophic bacteria and the colonies obtained after incubation were counted and expressed as colony forming units per milliliter of water ($CFUmL^{-1}$). The physiological characteristics of the colonies and their number on the culture plates were used as the basis for the counting, taking into consideration their dilution number. Counts were made from the plates containing 30-300 colonies. The isolates were ascetically sub-cultured into fresh nutrient agar after counting and incubated at a temperature of 37 °C for 24 hours to obtain pure cultures of the isolates.

2.3. Identification of the isolates

The isolates were identified based on their microscopic characteristics, motility, colony morphology, gram staining reactions and biochemical characteristics. Biochemical tests were carried out on the isolates. These included sugar fermentation, catalase activity, urease test, oxidase test, triple sugar ion agar test and indole test.

3. Results and discussion

3.1. Heterotrophic bacterial counts, coliform counts and faecal coliform counts of the borehole water samples

Table 1 shows the total heterotrophic bacterial counts, total coliform counts and faecal coliform counts of the borehole water samples. The total heterotrophic bacterial counts of the water samples ranged from $1.1x10^2$ to $8.7x10^4$ $CFUmL^{-1}$ while the total faecal coliform and total coliform counts ranged from $1.3x10^2$ to 5.8×10^4 $CFUmL^{-1}$ and 1.3×10^2 to $1.3x10^4$ $CFUmL^{-1}$ respectively. The counts obtained from all the water samples exceed the World Health Organization permissive limit of 0 $CFUmL^{-1}$ [7], indicating that the borehole water is not safe for drinking.

The presence of faecal coliforms in the borehole water samples indicates that the water is polluted with faecal substances. This could be attributed to the proximity of most of the boreholes to septic tanks. Previous researchers have reported high faecal coliform counts in water samples from boreholes located close to pit latrines and septic tanks at a distance less than the 30 m recommended by the World Health Organization [8]. Reports of groundwater contamination by pathogenic microorganisms from pit latrines and septic tanks are documented in scientific literature [9]. Unhygienic and poor sanitary environment surrounding some of the boreholes also could be responsible for the contamination [10]. Apart from the faecal coliforms present in the water samples, the high coliform count recorded in this study also has been attributed to septic tank pollution in previous studies [11] and the danger in the construction of septic tank near boreholes and other water sources has been considered to be of public health importance [12].

Table 1 Total heterotrophic bacteria, coliform and faecal coliform counts of borehole water from some communities in Owerri West, Southeastern Nigeria

Samples	Count ($CFUmL^{-1}$)		
	Total heterotrophic bacteria	**Total coliform**	**Total faecal coliform**
BWA_1	8.4×10^2	2.2×10^2	4.8×10^2
BWA_2	1.1×10^2	1.3×10^2	6.0×10^2
BWA_3	4.0×10^2	3.0×10^2	1.6×10^2
BWB_1	8.7×10^4	8.0×10^3	4.7×10^4
BWB_2	3.0×10^4	2.1×10^3	1.5×10^4
BWB_3	3.1×10^4	9.0×10^2	2.0×10^4
BWC_1	6.2×10^2	6.0×10^2	3.9×10^2
BWC_2	1.9×10^2	9.2×10^2	2.0×10^2
BWC_3	1.1×10^2	6.8×10^2	1.3×10^2
BWD_1	3.6×10^4	1.3×10^4	1.4×10^4
BWD_2	1.2×10^5	8.0×10^3	5.8 x 104
BWD_3	4.5×10^4	4.6×10^3	1.4×10^4

BWA_1 – BWA_3: Borehole water samples from Eziobodo, BWB_1 – BWB_3: borehole water samples from Ihiagwa, BWC_1 – BWC_3: borehole water samples from Obinze BWD_1 – BWD_3: borehole water samples from Umuchima.

3.2. Microbial Isolates from the borehole water

Table 2 Morphological and biochemical characterization of bacteria isolates from borehole water samples from some communities in Owerri West, Southeastern Nigeria

Isolate code	Colony morphology on nutrient agar	Microscopic characteristics	Sugar fermentation		Triple sugar iron agar					Gram staining	Motility	Urease	Oxidase	Citrate	Methyl red	Indole	Catalase	Most probable organism
			Acid	Gas	H_2S	Gas	Glucose	Sucrose	Lactose									
M	White, raised, shinny	Long rod	+	+	-	-	+	-	-	-	-	-	-	-	+	-	+	*Shigella* sp
N	Creamy	Clustered Cocci	+	+	-	-	+	+	+	+	-	-	-	+	-	-	+	*Staphylococcus* sp
O	Entire, creamy, raised	Cocci	+	+	-	+	+	+	+	+	-	-	-	-	-	-	-	*Enterococcus faecalis*
P	Creamy, round, shinny	Rods	+	+	-	+	+	+	+	-	-	-	+	+	+	+	+	*Klebsiella* sp
Q	White, circular, shinny	Rods	+	+	+	+	+	+	+	-	-	-	-	-	+	+	-	*Escherichia coli*

-; negative, +; positive, H_2S; Hydrogen sulphide test

Results of the morphological and biochemical characterization of bacteria isolates from the borehole water samples are shown in table 2. The biochemical tests for identification of the isolates showed that the organisms were *Shigella* sp, *Enterococcus faecalis, Staphylococcus* sp, *Klebsiella* sp *and Escherichia coli.*

The presence of these organisms in the borehole water samples is of great concern because they are mostly pathogenic and could cause serious health problems [13-15]. The report of this present study is similar to the previous studies carried out by Iroha *et al.,* Agwu *et al.,* and Adekoyeni and Salako who showed the presence of these bacteria in borehole water samples in Abakaliki, Aba and Ogun state of Nigeria respectively [16-18].

4. Conclusion

Bacteriological assessment of borehole water samples from some communities in Owerri West, Southeastern Nigeria revealed that the borehole water do not meet the standard criteria for drinking and domestic purposes. The presence of pathogenic microorganisms in the water samples poses serious health risk to the communities. Hence, adequate measures should be taken to save the communities from dangers associated with the use of the contaminated water.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that no competing interest exists.

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