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BACTERIOLOGICAL ASSESSMENT OF SELECTED HAND DUG WELLS IN STUDENTS' RESIDENTIAL AREA: A CASE STUDY OF OSUN STATE COLLEGE OF HEALTH TECHNOLOGY, ILESA, NIGERIA

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ABSTRACT

An investigative study was carried out to determine the microbial qualities of drinking water within student's residential community around Osun State College of Health Technology, Ilesa, Nigeria (OSCHT). Ten water samples of hand dug well water sources were collected within the geographical location (OSCHT). Seven (7) genera of bacteria which include Staphylococcus aereus, Streptococcus Spp, Bacillus Spp, Shigella spp, Salmonella spp, Shigella spp, Pseudomonas spp,Enterobacter spp, and Escherichia coli were isolated from the water samples. The objectives of this study is to identify the sources of water and the safety of their location in the study area by comparing the results with WHO standard; to examine the bacteriological quality and its diversity of water produced by these hand dug well and to identify the possible health impact of water from hand dug well in the study area. The total viable count was determined and it ranges from the minimum value of 200 viable cells to the maximum value of 3000 viable cells. The coliform count also ranges from 0 -3 cfu/ml. The sample "8" had zero coliform count which could be as a result of its hygienic source. It was also identified that proximity of well water to pollution source and unhygienic handling makes them more prone to contamination though well could also be contaminated by leaching from runoff, animal manure or improperly treated septic sewage discharge especially when wells are not properly protected.

1.0 INTRODUCTION

Promoting education is essential for development globally as its one of the basic for any nation to implement including Nigeria. [1] A basic requirement in achieving this sustainable goal is access to potable water (an essential ingredient for good health) to everyone involved. In Nigeria, the major source of drinking water is the groundwater most especially from hand dug wells, only a few can access and afford boreholes and other potable water sources for consumption as these has become an essential ingredient for good health. [2][3][4] Owners of hand dug well capitalize on this opportunity to commercialize their hand dug well which many resort to buying the hand dug well water for drinking, since it is cheaper for them to afford. [5] In Nigeria, groundwater contamination is one of the least recognized environmental problems, this may be due to lack of awareness because groundwater problems are not readily detected and pathways for contamination are not as noticeable as those affecting surface water. [6] Urbanization and industrialization also contribute greatly to the pollution of water sources. The geochemical composition of water and sediment is largely governed by the bacteriological characteristics of the depositional environment. Water-related diseases continue to be one of the major health problems globally. [2][7][8] Larry [9] opined that, there is an estimated, 4 billion cases of diarrhea annually represented 5.7% of the global disease burden in the year 2000. Open dumping of municipal solid wastes, is mainly the existing method of waste disposal used even in capital cities except perhaps among few and affluent institutions in Nigeria. Water contamination by leachate can transmit bacteria and disease, typhoid fever is a common problem for the people of developing nations, many of them cannot afford to dig wells deep enough to reach fresh aquifers. Microorganisms play a major role in water quality and the microorganisms that are concerned with water borne diseases are *Salmonella sp., Shigella sp., Escherichia coli* and *Vibrio cholera*. All these cause typhoid fever, diarrhoea, dysentery, gastroenteritis, cholera. The most dangerous form of water pollution occurs when faeces enter the water supply. Many diseases are perpetuated by the faecal-oral route of transmission in which the pathogens are shed only in human faeces. Presence of faecal *coliforms* of *E. coli* is used as an indicator for the presence of any of these water borne pathogens.[9] Various investigations have been carried out on the bacteriological quality of water as a result of increase in demand of hand dug well as a water source.[10][11] However, there is paucity of information on the quality of hand dug well being the major source for drinking and other domestic uses for students and other residents of Osun State College of Health Technology Ilesa, Nigeria environs. This study however aimed at assessing the bacteriological water quality of well water within student residential community around Osun State College of Health Technology, Ilesa, Osun State Nigeria.

2.0 MATERIALS AND METHOD STUDY AREA

The study was carried out in Ilesa, Nigeria. Geographically, Ilesa is located within Latitude 7°37'N and Longitude 4°43'E. Ilesa is a city located in the Osun State, South West Nigeria. The area is characterized by high temperatures of about 29º-32ºC and by two distinct seasons namely: the wet and dry seasons. The dry season extends from late October to May, while the wet season lasts for the remaining part of the year (June-September). The annual rainfall regime is characterized by two modes occurring in March - June, and September - November. There are also two peaks, which may vary from year to year, but usually the minor one occurs in June - July and the major one occurs either in September or October. In-between the two modes, there is a short dry spell called 'the little drought' or 'depression' or 'little dry season' or 'August break'. During this period rain hardly falls. During the period of study, the august break was not long, characterized by relatively cold weather

2.1 Sample collection treatment and preservation

The study was carried out on water sources in student residential area of Osun State College of Health Technology (Imelu, Ultimate, Olomilagbala, Hope, Gbamila, Guru and Oke-Anu area) in Ilesa, Ilesa East Local Government Area of Osun State. Ten water bodies were identified for sampling in the area. The choice of the sampling sites was based on the accessibility by the students; and the rate at which people depend and utilize water resources from the hand dug well. A handheld Global Positioning System (GPS) device was used to obtain the coordinates of the sampled wells (Table 1). Samplings were carried out for a period covering both the dry and wet seasons. The dry season samplings were conducted in month of March, April and May, while the wet season samplings were conducted in August, September and October same year. At each sampling site, water samples were collected using clean, properly washed and rinsed 50 centilitre plastic bottle containers for biological parameters study.

Table 1: The Geographical Locations of Water Sampling Stations

Location	Latitude	Longitude
Sample 1	7.591927	4.735867
Sample 2	7.60206	4.736107
Sample 3	7.597705	4.744683
Sample 4	7.596235	4.744683
Sample 5	7.596595	4.74197
Sample 6	7.598663	4.741162
Sample 7	7.595715	4.736134
Sample 8	7.59306	4.73824
Sample 9	7.600543	4.738222
Sample 10	7.592928	4.738222

A basemap showing the spatial location of the sampled wells in Nigeria, Osun State and Ilesha East Local Government was developed from the coordinate obtained using the Arc-GIS 10.3 software for map development (Figure 1).

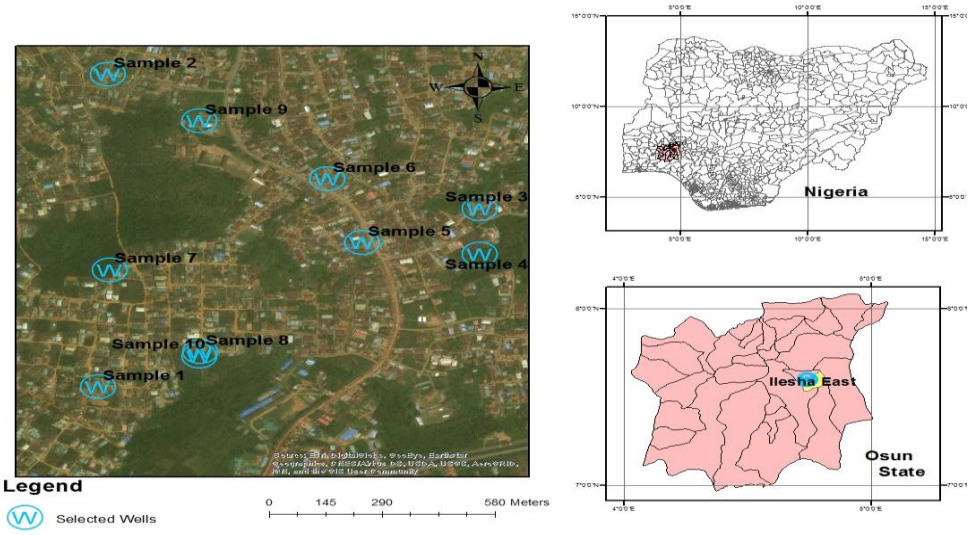

Figure 1: Map of Study Area showing Sampling Points

Figure 1 showed the description of the sampling areas. Sampling protocols described by APHA [12] were strictly adhered to during sample collection. Care was taken not to allow air bubbles into the bottles during collection, kept in an ice chest, and transported immediately to the laboratory for analysis. The biological tests were carried out on fresh samples since samples for bacteriological should not be stored longer than six hours.

2.2 Laboratory analysis

Microbial analyses as indicated in various literatures such as [12][13][14][15][16] were referred to guide during analysis.

Media used: Media for both the multiple tube fermentation and plate counts were prepared according to the manufacturer's instructions. The media used were MacConkey broth, Nutrient Agar (NA), Brilliant Green Lactose Bile (BGLB) broth (double strength and single strength), and Eosin Methylene Blue (EMB) agar.

Enumeration of total heterotrophic bacteria or total viable count: Total heterotrophic bacteria in the water samples were obtained using the pour plate method. Isolation of bacteria was completed within 24 hours of samples collection. This was carried out by mixing 1g of the water samples with 9mL of sterile distilled water and diluted serially up to 10-10. This was repeated for all the water samples. 0.2mL (aliquot) of the suspension was plated out of Nutrition Agar. Distinct colonies growing on each plate were counted selected, subcultured and stored on slants. Pure cultures of all the isolates were subjected to biochemical test.

Enumeration of total and faecal coliform Bacteria:

Presumptive test: Total and Total and faecal coliform were enumerated by multiple tube fermentation tests. Coliform count was obtained using the three tube assay of the Most Probable Number (MPN) technique. Presumptive coliform test was carried out using MacConkey broth (oxoid). The first set of the three tubes had sterile 10ml double strength broth lactose broth (DSLB) and the second and third sets had 10ml single strength lactose broth (SSLB). All the tubes contained Durham tube before sterilization. The three sets of the tubes received 10, 1 and 0.1 ml of water samples using sterile pipettes. The tubes were incubated at 37ºC for 24-48 hours for estimation of total coliforms and at 44.5ºC for faecal coliforms for 24-48 hours and examined for acid and gas production. Acid production was determined by colour change of the broth from reddish purple to yellow and gas production was checked for by entrapment of gas in the Durham tube. The MPN was then determined from the MPN table for the three set of tube

Confirmed test: Confirmed test was carried out by transferring a loopful of culture from a positive tube from presumptive test into a tube of Brilliant Green Lactose Bile (BGLB) broth (oxoid) with Durham tubes. The tubes were incubated at 37ºC for 24-48 hours for total coliform and 44.5ºC for faecal coliforms and observed for gas production.

Completed test: Completed test was carried out by streaking a loopful of broth from a positive tube onto Eosine Methylene Blue (EMB) agar plate for pure colonies. The plates were incubated at 37ºC for 24-48 hours. Colonies developing on EMB agar were further identified as faecal coliforms (*Escherichia coli*). Colonies with green metallic sheen were confirmed to be faecal coliform bacteria with rods shape.

2.3 Characterization of isolates

The macroscopic examination for physical morphology (colour, texture, odour, etc) and microscopic examination through Gram staining and biochemical tests (coagulase, oxidase, indole, urease, methyl red, citrate utilization and sugar fermentation tests) as reported by previous researchers, were used in identifying all isolates and results were matched with the Bergy's manual of determi-

native bacteriology for confirmation.

3.0 RESULTS AND DISCUSSION

Table 2: Bacteriological Counts of the Hand dug well Water Samples

Sample Number	Total viable counts (cfu/ml) x10^2	Total coliform counts (MPN/100ml)
1	3.0	2
2	3.7	2
3	3.9	2
4	4.0	2
5	4.1	2
6	2.9	1
7	4.2	3
8	3.0	0
9	3.3	2
10	3.2	2
Mean	4412.5	2.25
Range	2.9-4.2	0-3

Table 2 showed the range and mean values of total bacterial counts, total coliform and faecal coliform counts of water samples collected. Total viable bacterial counts of the samples were relatively high. The lowest counts of total bacterial were recorded in sample 6 with 2900cfu/ml, while the highest counts of total bacterial were recorded in sample 4 with 4100cfu/ml with their mean value of 4412.5cfu/ml.

All the hand dug well water samples were not devoid of faecal coliform, they were however not free of total coliforms which are probably from the environmental sources and are non-faecal in origin unlike results compared from Ahmed et al., [17] work conducted on the quality of WASH borehole water in Gombe Metropolis, Gombe State, Nigeria. In a similar work by Adetunde and Glover [10] done in selected secondary schools within Navrongo, Kassena-Nankana District in Upper-east Region of Ghana there were higher value of total heterotrophic bacteria counts in all the samples analyzed.

The Nigerian Standard for Drinking Water Quality [18] recommends that drinking water may contain up to 10CFU/100ml total Coliform CFU/100ml, but WHO [19] recommended 0CFU/100ml. Similarly, both WHO [18] and NSDWQ [19] recommend no faecal coliform should be found in any water meant for drinking. The total coliform contents of the samples ranged from 0 to 3MPN of coliform/100ml of the sample. Total coliform counts for the samples were highest in sample 7 with a mean value of 2.25MPN/100ml while the lowest total coliform counts were recorded in sample 8.

Table 3: Genera of micro organisms isolated from the hand dug well water samples

Isolate Occurrence	n= 46	Frequency of occurrence %
Staphyloocus Aereus	*10*	100%
Streptococcus Spp	*10*	100%
Bacillus Spp	9	90%
EnterobacterSpp	7	70%
Shigella Spp	7	70%
Pseudomonas	6	60%
E.coli	*4*	40%

Seven genera of micro organisms (or bacteria) were identified (Table 3) from a total of 46 isolates. These genera include: *Staphylococcu Aereus, Streptococcus Spp, Bacillus Spp, Shigella Spp, Pseudomonas Spp, Enterobacter Spp* and *Eschericha coli*. Out of the seven genera, *Staphyloocus Aereus* (100%)*, Streptococcus Spp* (100%)*,* had the highest percentage frequency of occurrence, followed by *EnterobacterSpp* (70%), Bacillus (90%), *Shigella Spp* (70%), Pseudomonas (60%) *E.coli* (40%). respectively. These Isolates with high frequency of occurrence are important human pathogens associated with a variety of infectious diseases such as gastroenteritis, typhoid fever, dysentery, cholera, urinary tract infection, etc. The high number of these pathogens in the water samples from study areas needs public health attention. The high prevalence pathogens in this study are in agreement with the findings of Obi and Okocha [20], in selected hand dug well waters in World Bank Housing Estate, Umuahia and of Amajor *et al.,* [21] on enumeration and identification of pathogenic pollution indicators in different water sources used in processing root and tuber crops in Umudike, Umuahia, Abia State, Nigeria. The presence of *Esherichia*, *Staphylococus* and *Enterobacter spp* in some of the hand dug well water samples are unacceptable from the public health point of view. These organisms could be pathogenic. Therefore, there is need for caution when using these contaminated hand dug well water sources for any purposes. Agbabiaka and Sule [22], obtained some members of coli-

form in Ilorin (Nigeria) metropolis hand dug well water samples. Most of the samples were contaminated with both nonfaecal and faecal coliform bacteria. The sample (sample 8) with low bacteria counts and total coliform counts could be considered to be of better quality for domestic use than the ones with the highest counts of both bacteria counts and total coliform counts. WHO [23] specified that potable drinking water should be devoid of total coliform in any given sample. Water samples in which coliforms are detected should be considered unacceptable for drinking water as they are regarded as the principal indicators of water pollution.

The hand dug well water with the highest bacterial count also had the highest total coliform count. Water Sample from sample 8 source is fit for drinking and domestic purposes because they had total coliform counts of 0.0MPN/100ml which conformed to the set standard of WHO [19], which says that no water sample should contain faecal coliform in any 100ml of water sample, while other Samples analysed were not fit for consumption without purification.

4.0 CONCLUSION AND RECOMMENDATION

This investigation suggests that not all hand dug well waters in student's residential community of Osun State College of Health Technology Ilesa Nigeria are fit for human consumption. The sites of hand dug well are very important as clean and hygienic environment promote safety of water.

The level of contamination of some of the samples with higher number of total viable counts may be due to the location of the hand dug well and environmental factors whereby some domestic animals visit the site to drink water. When drinking, they lick the water fetching container used for the hand dug well and defecate around the borehole. These activities could enhance bacterial contamination to the groundwater. Also unhygienic handling nature of the taps by some people may contribute to the contamination level of the water. Pit latrines may be possible sources of contamination of the samples. For example, at the location where sample 4 was collected**,** the distances between the hand dug well and public pit latrines were found to be 40, 46, 70, and 80m, which were below the allowable distance of 100m in the sandy soil area.

People digging boreholes have to be educated on the importance of ensuring that dump sites are not good for drilling boreholes. Moreover, the populace need to be educated on the importance of maintaining clean and hygienic environment around the hand dug well to ensure the safety of water from such boreholes. It is also recommended that, water resources from these wells should be boiled and filtered for clarity before drinking.

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