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Bacteriological Analysis of Water Tanks in Halls of Residence at Achievers University, Owo, Ondo State, Nigeria.

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Abstract

This study was carried out to determine the quality of water supply to the hall of residence of Achievers University Owo, Ondo State. The water samples were obtained from three different storage tanks in the institution hostel. The water sources were assessed for microbiological quality. The total coliform counts were determined by standard plate count method, multiple fermentation and the use of different media. The viable bacteria count ranges from 0 to 381 x 10^4 cfu/ml and total coliform ranges from 0 to 81 x 10^4 mpn/ml. Total number of eight bacteria were isolated from the three water tanks. These bacteria isolates were *Escherichia spp*, *Salmonella spp*, *Shigella spp*, *Proteus spp*, *Pseudomonas spp*, *Staphylococcus spp*, *Streptococcus spp* and *Bacillus spp*. The detection of *Escherichia coli*, *Salmonella*, *Klebsiella* and *Pseudomonas* species in borehole water that was intended for human consumption suggests that water from these sources may pose severe health risks to consumers and is unsuitable for direct human consumption without treatment. This study recommends treatment of water prior to use in order to protect the consumers from further possible consequences of using the water.

Keywords: Water, Quality Assessment, Hall of Residence, Direct Human Consumption, Borehole Water

1.0 Introduction

Water is indispensable as its importance to human existence and ecological sustainability cannot be underestimated as it is essential for life. This is the reason for which water must be given the necessary attention at all times, as it is intricately connected to life, without which there is no life. Human beings can do without food for up to twenty eight days, but man cannot go without water for three days (Ukpong *et al.*, 2013; Akin-Osanaiye *et al.*, 2018). Water plays a vital role in the proper functioning of the earth's ecosystem. Water serves various purposes which include drinking, transportation, industrial and domestic use, irrigation in agriculture recreation, fisheries, and waste disposal among others (Ajayi and Akonai, 2005; Shittu *et al.*, 2008).

It is estimated that over one billion people in the world lack access to safe drinking water and about 2.5 billion people do not have access to

adequate sanitation services at all (Tar *et al.*, 2009). Water free of pathogenic organisms is fundamental to breaking one of the principal routes of infectious diseases. In Nigeria, where governments are unable to meet the ever increasing water demand, people resort to ground water sources such as shallow wells and boreholes as alternative water resources (LAWMA, 2000). Natural groundwater has been said to be of good quality but can deteriorate due to inadequate source of protection and poor resource management (Sadiya *et al.*, 2018).

Ground water forms the ultimate source of boreholes. In the local population of Nigeria, borehole water serves as the major source of drinking water (Akpoveta *et al.*, 2011). Unfortunately, borehole water is not entirely pure and its purity depends on the geological conditions of the soil. Contamination of water sources arise from human activities, such as disposal or dissemination of chemicals and microbial matter on the land surface and into soils, or through injection of wastes directly into groundwater. Industrial discharges (Govindarajan and Senthilnathan, 2014) urban activities, agriculture (Moyo, 2013), can alter or affect groundwater quality. Pesticides and fertilizers applied to lawns and crops can accumulate and migrate to the water tables thus affecting both the physical, chemical and microbial quality of water. Close proximity of septic to groundwater supply and leachate from landfills and dumpsites, unhealthy means of dispensing water from storage containers, including faecally contaminated dippers, hands, tools, lack of protection against vectors (flies, cockroaches, rodents, etc.) and inadequate cleaning of storage container to prevent biofilm formation and accumulation of sediments and pathogens, all are factors contributing to this problem (Steiner *et al*., 2006; Onwughara *et al*., 2010; Akpoveta *et al.*, 2011).

Microorganisms play an important role in water quality and the microorganisms that are concerned with water borne diseases are *Escherichia coli, Salmonella species, Shigella species*, and *Vibrio cholera*. The presence of faecal coliforms of *Escherichia coli* and those listed earlier are indicators of contaminated water (Adetunde and Glover, 2010).

This research was conducted to assess the quality of water used by the students of Achievers University from the three main halls of residence present in the institution through bacteriological analysis in order to affirm that the water is free from diseases causing organisms in which, their presence may cause harm to the students consuming it and for other purpose like bathing.

2.0 Methods and Procedures

2.1 Study area

Achievers University is a research university located in Owo, Ondo State, Nigeria. It is among the universities owned by an individual in Nigeria and was founded in 2007. This study covered the three halls of residence in Achievers University, Owo, Ondo State. The halls consist of Male hostel (Mh), Female hostel 1(Fh1) and Female hostel 2 (Fh2). These halls are being supplied with borehole water stored in overhead tanks. The water from the tanks are used for various domestic purposes which include: drinking, bathing, washing etc.

2.2 Sample collection

Water samples for analysis were collected from the three halls of residence respectively using sterile containers; special care was taken while collecting samples, to obtain fair samples. Samples from the tanks were taken after allowing the tap to run for about one minute after cleaning the tap mouth with cotton wool soaked with alcohol. The samples were majorly analyzed for microbial colony count. All samples were transported to the microbiology laboratory for processing.

2.3 Media used

Media used for analyses were prepared according to the manufacturer's instructions; all were sterilized in an autoclave at 121°C for 15 min. These include: Nutrient agar (NA), Eosin Methylene Blue (EMB), MaCconkey agar and MacConkey broth which was used to screen for

lactose fermentation. Sugars used for fermentation tests were Fructose, Mannitol, Lactose Glucose and Galactose. Motility indole ornithine fluid media was used for motility and indole test.

2.4 Bacteriological analysis of water

Heterotrophic plate count (HPC)/ total count was carried out to provide an estimate of the total number of bacteria in each of the samples that would develop into colonies during the period of incubation on Nutrient Agar (NA) and MaCconkey agar using pour plate method (Dhawale and LaMaster, 2003). Aliquot of 1 ml of the 10^{-4} dilutions of the samples was used to incubate the plate in triplicates; the plates were incubated at 37°C for 24 hrs. Thereafter the mean counts of the bacteria colonies were taken and was made in cfu/mL (colony forming unit) (APHA, 2017). The bacteria isolates were further experimented in order to attain pure cultures. The pure culture, then characterized and identified to determine the bacteria species using the standard microbial method.

2.5 Enumeration of total coliform bacteria

Total and faecal coliform were enumerated by multiple tube fermentation tests. The most probable number tube fermentation technique was performed in three stages: Presumptive test, confirmatory test and completed test (APHA, 2017).

2.6 Biochemical tests and identification of microbial isolates

Biochemical tests were carried out according to Baron *et al.* (1990). Gram stain, Catalase test, oxidase, Coagulase test, Urease test, Motility-Indole test, Citrate test and Sugar fermentation were carried out. The Bergey's Manual of determinative bacteriology by Buchanan and Gibbons (1974) was used to compare the characteristics with the results obtained.

3.0 Results and Discussion

Table 1 shows the total count of bacteria colonies in CFU/ml and also the total coliform bacteria count in mpn/ml, that were isolated from the three water samples, with male hostel (Mh) having the highest with a total count of 183 x 10^4 CFU/ml and also a total of 30 x 10^4 mpn/ml respectively. For the female hostel, 85 x 10^4 CFU/ml bacteria colonies were isolated from female hostel 1 (fh1) and a total count of 113 x 10^4 CFU/ml bacteria colonies were isolated from female hostel 2 (fh2), while for the total coliform bacteria count the female hostel 1 (fh1) had a total of 22 x 10^4 mpn/ml and female hostel 2 (fh2) had a total number of 29 x 10^4 mpn/ml of isolates.

Table 2 represents the frequency of occurrence of the bacterial isolates in all the water tanks sampled. *Escherichia spp, Salmonella spp, Shigella spp, Bacillus subtilis, Staphylococcus spp,* and *Streptococcus spp* were all isolated from all the three halls of residence. *Pseudomonas spp.,* was present in female hostel 1 (fh1), but absent in male hostel (Mh) and female hostel 2 (fh2). *Proteus spp.* was present in male hostel (Mh), but absent female hostel 1 (fh1) and female hostel 2 (fh2).

Table 3 shows the morphological and biochemical characteristics of the isolates. The following organisms were negative for Gram stain, *Escherichia coli, Proteus spp, Shigella spp* and *Salmonella spp,* while the rest were positive for Gram staining, these include *Pseudomonas spp, Staphylococcus spp, Streptococcus spp* and *Bacillus subtilis.* For the biochemical tests; *Escherichia coli, Proteus spp, Shigella spp* and *B.subtilis* were all negative for the oxidase test. *Proteus spp* and *Staphylococcus spp* were the only isolates positive for urease test while other isolates tested negative. *Proteus spp, Pseudomonas spp and Bacillus subtilis* were the only isolates positive for citrate test, while other isolates were negative. *Salmonella spp, Bacillus subtilis* were the only isolate positive for coagulase test while other isolates tested negative. *Escherichia coli, Proteus spp, Shigella spp, Salmonella spp, Staphylococcus spp,* and *Bacillus subtilis* were positive for catalase test while other isolates tested negative. *Esherichia coli and Staphylococcus* were the only isolates

positive for indole test while all other isolates tested negative. For motility test, *Escherichia coli, Proteus spp, Salmonella spp, Pseudomonas spp and Bacillus subtilis* were positive while *Shigella spp, Staphylococcus spp* and *Streptococcus spp.* were negative.

Results of sugar fermentation test carried out on the isolates shows that *Eshierichia coli was* the only isolate negative for fructose sugar, while all other isolates tested positive. *Salmonella spp, Staphylococcus spp, Streptococcus spp, and B.subtilis* tested positive maltose sugar, while *Esherichia spp, Shigella spp, proteus spp, and Pseudomonas spp* tested negative. *Esherichia spp, Staphylococcus spp, Staphylococcus spp, B.subtilis* tested positive for lactose while *Shigella spp Salmonella spp, proteus spp, and Pseudomonas spp* tested negative. All isolates tested positive for glucose. All isolates also tested positive for galactose.

Table 1: Results of heterophilic count and coliform count

Water Source	Total bacteria count Cfu/ml	Total coliform count (Mpn/ml)
Mh	183×10^4	30×10^4
Fh1	85×10^4	22×10^4
Fh2	113×10^4	29×10^4

Key: Mh - Male Hostel; Fh - Female Hostel

Table 2: Morphological and biochemical characteristics of isolates

S/N	Gram staining	Cell morphology	Oxidase	Urease	Citrate	Coagulase	Catalase	Motility	Indole	Fructose	Maltose	Lactose	Glucose	Galactose	*Organisms*
1	*-ve*	*Short rod*	*-ve*	*-ve*	*-ve*	*-ve*	*+ve*	*+ve*	*+ve*	*-ve*	*-ve*	*+ve*	*+ve*	*+ve*	*Esherichia coli*
2	*-ve*	*Motile rod*	*-ve*	*+ve*	*+ve*	*-ve*	*+ve*	*+ve*	*-ve*	*+ve*	*-ve*	*-ve*	*+ve*	*+ve*	*Proteus spp*
3	*-ve*	*Short rod*	*-ve*	*-ve*	*-ve*	*-ve*	*+ve*	*-ve*	*-ve*	*+ve*	*-ve*	*-ve*	*+ve*	*+ve*	*Shigella spp*
4	*-ve*	*Rod*	*+ve*	*-ve*	*-ve*	*+ve*	*+ve*	*+ve*	*-ve*	*+ve*	*+ve*	*-ve*	*+ve*	*+ve*	*Salmonella spp*
5	*-ve*	*Motile rod*	*+ve*	*-ve*	*+ve*	*-ve*	*-ve*	*+ve*	*-ve*	*+ve*	*-ve*	*-ve*	*+ve*	*-ve*	*Pseudomonas spp*
6	*+ve*	*Cocci clusters*	*-ve*	*+ve*	*-ve*	*-ve*	*+ve*	*-ve*	*+ve*	*+ve*	*+ve*	*+ve*	*+ve*	*+ve*	*Staphylococcus spp*
7	*+ve*	*Cocci chains*	*+ve*	*-ve*	*-ve*	*+ve*	*-ve*	*-ve*	*-ve*	*+ve*	*+ve*	*+ve*	*+ve*	*+ve*	*Streptococcus spp*
8	*+ve*	*Rod*	*-ve*	*-ve*	*+ve*	*+ve*	*+ve*	*+ve*	*-ve*	*+ve*	*+ve*	*+ve*	*+ve*	*+ve*	*Bacillus subtilis*

Key: -ve = negative for reaction
+ve = positive for reaction

Table 3: Frequency of bacteria in different water sources

	Isolates	*Mh*	*fh1*	*fh2*
1	*Escherichia coli*	+	+	+
2	*Salmonella spp*	+	+	+
3	*Shigella spp*	+	+	+
4	*Pseudomonas spp*	_	+	_
5	*Staphylococcus spp*	+	+	+
6	*Proteus spp*	+	_	_
7	*Streptococcus spp*	+	+	+
8	*Bacillus subtilis*	+	+	+

Key: -ve = not present in the water sample
+ve = present in the water sample
Mh = Male Hostel;
Fh = Female Hostel

4.0 Discussion

A total count of 381 x 10^4 cfu/ml bacteria colonies were isolated from the three water sources, indicating high level of pollution in the water tanks which may be due to human and animal activities. The total heterotrophic bacteria count from the three hostels indicated that none of the water samples fell within the zero total coliform colonies per 100 milliliters of water limit allowed by WHO (2006) for potable water. The high viable bacteria count of the stored water can be attributed to lack of water treatment and hygienic care (for example, washing) of the storage tanks. These sources of bacteria contaminants may include surface runoff and animal waste. Other activities like waste disposal, domestic activities and feacal discharge, prolonging and non-washing of tanks for a long period of time, opening of tanks are also ways of introducing foreign microorganism into water tanks.

Sample of waters recorded total coliform counts exceeding the WHO recommended standards which stipulate that total coliform counts should not exceed 1-3/100 ml of potable water and 0/100 ml of thermotolerant coliforms (WHO, 2006) and SON standards that recommend 0/100 ml of coliforms in potable water. The presence of coliforms in water indicates the presence of diseases causing organisms (Bello *et al.*, 2013). This contamination could be from groundwater contamination, piping leakages within the water system network or unsanitary conditions.

Four members of the coliform bacteria group were isolated in this study (*Escherichia coli, Shigella, Salmonella and Pseudomonas spp*).

Coliforms are important markers for bacteriological water quality as they are established causes of human gastroenteritis and their presence in water makes it unsafe for consumption. The *Escherichia coli* isolated from the water samples may be a pathogenic strain. Two pathogenic strains, *E. coli 0157:H7* and *E. coli 0104:H4* are known causes of diseases in humans (Ateba and Bezuidenhout, 2008).

The result of this research also shows that four bacteria isolates were also isolated from the water samples, these include: *Staphylococcus spp, Streptococcus spp, Proteus spp, and B. subtilis spp.* These findings prove that all the water samples tested were not within permissible limits and failed to meet up with approved SON and WHO standards for potable water. Consumption of water from these supplies without treatment may pose serious health risks to the consumers

5.0 Conclusion

This research confirmed that the water samples are contaminated and contain coliforms which indicate the presence of diseases causing organisms, hence unsafe for drinking or cooking. Further investigation of the waste disposal system of hostels where coliforms were isolated from samples is necessary, together with proper monitoring of environmental conditions of the water systems in all hostels. Adequate water disinfection and treatment of all storage water tanks is needed to prevent any adverse effect to end users of the water supplies.

References

Adetunde, L. A., Glover, R. L . K. (2010). Bacteriological quality of borehole water used by students' of University for Development Studies, Navrongo Campus in Upper-East Region of Ghana. *Current Research Journal of Biological Sciences* 2(6):361-364.

Ajayi, A. O., Akonai K. A. (2005). Distribution pattern of enteric organisms in the Lagos Lagoon. *Afr. J. Biomed. Res*., 8(3): 163-168.

Akin-Osanaiye, B. C., Mohammed, S. E., Echoki, J. (2018). Comparative analysis of pipe borne water and other sources of water in Gwagwalada Area Council, Federal Capital Territory, Abuja, Nigeria. *Journal of Biology and Genetic Research* 4(1):2545-5710

Akpoveta, O. V., Okoh, B. E, Osakwe, S. A. (2011). Quality assessment of borehole water used in the vicinities of Benin, Edo State and Agbor, Delta State of Nigeria. *Current Research in Chemistry*, 3(1):62-67.

American Public Health Association (APHA) (2017). Standard Methods for the Examination of Water and Wastewater, 21st Edn., APHA, Washington DC. https://www.awwa.org/Store/Standard-Methods-for-the-Examination-of-Water-and-Wastewater-23rd-Edition/ProductDetail/65266295

Ateba, C.N., Bezuidenhout, C.C. (2008). Characterization of *Escherichia coli* O157 strains from humans, cattle and pigs in the North-West Province, South Africa. *International Journal of Food Microbiology*, 128(2):181-8.

Baron, E. J., Sydney, M. F. (1990). Bailey and Scott's Diagnostic Microbiology. The C.V. Mosby Co., St. Louis, p. 861.

Bello, O.O., Osho, A., Bankole, S.A., Bello, T.K. (2013). Bacteriological and physicochemical analyses of borehole and well water sources in Ijebu-Ode, Southwestern Nigeria. *International Journal of Pharmacy and Biological Sciences* 8:18-25.

Buchanan, R.E. and Gibbons, N.E. (1974) Bergey's Manual of Determinative Bacteriology. 8th Edition, Williams and Wilkins, Baltimore, 1268 p.

Dhawale S, LaMaster A (2003). Microbiology Laboratory manual. The mcHill Company. Inc. USA. p. 226

Govindarajan, M., Senthilnathan, T. (2014). Groundwater quality and its health impact analysis in an industrial area. *Int. J. Curr. Microbiol. App. Sci.*, 3, 1028–1034.

Lagos State Waste Management Authority (LAWMA) (2000). Management of landfill wastes: The Journey So Far. L.E.P.A. Handbook.

Moyo, N.A.G. (2013). An analysis of the chemical and microbiological quality of ground water from boreholes and shallow wells in Zimbabwe. *Phys. Chem. Earth.* 66, 27–32

Sadiya, A., Chukwuma C. O., Olatunbosun O. A., Onyinye F. N. (2018). Comparative study of the physicochemical and bacteriological qualities of some drinking water sources in Abuja, Nigeria. *Global Journal of Pure and Applied Sciences,* 24: 91-98.

Shittu, O.B., Olaotan, J.O., Amusa, T. S. (2008). Physicochemical and Bacteriological Analysis of water used for Drinking and Swimming Purposes in Abeokuta, Nigeria. *Afr. J. Biomed. Res.*, 2: 285-290.

Steiner, T. S., Samie, A., Guerrant, R. L. (2006). Infectious diarrhea: new pathogens and new challenges in developed and developing areas. *Clinical Infectious Diseases* 43:408-410.

Tar, A., Eneji, I., Ande, S., Oketunde F., Ande, S., Shaaton, R. (2009). An assessment of heavy metals loading in River Benue in the Makurdi Metropolitan Area in Central Nigeria. *Nigerian Journal of Chemical Society of Nigeria,* 34:56-62.

Ukpong, E.C., Ogarekpe, N.M., Bejor, E.S. (2013). Comparative analysis of water quality in hand dug well and borehole in Calabar South Local Government Area in Nigeria. *The International Journal of Engineering and Science,* 2(8):95-101.

World Health Organization (2006). Guidelines for Drinking Water Quality. Geneva. Addendum to the 3rd Vol. 1 Recommendations. *World Health Organization,* 1:23-48.