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Investigations on Bacteriological Quality of Tap Water Sources within the University of Port Harcourt

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Authors' contributions

This work was carried out in collaboration among all authors. Author HOS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CJU and PCU managed the analyses of the study. Author PCU managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

In this study, the sanitary quality of tap water sources within the University of Port Harcourt was investigated in order to determine its suitability for drinking and other domestic applications. Eight composite samples of tap water were collected from Eight different locations within the three campuses of the University of Port Harcourt using 300 ml-capacity sterile containers. These locations included NDDC Hostel, Sports Hostel, Medical Hostel, NUH Hostel, Dan Etete Hostel, Delta A Hostel, Delta B Hostel and Choba Campus. After collection, water samples were taken to the laboratory for enumeration and identification of Total heterotrophic bacteria (THB), Total coliform (TC) and Faecal coliform (FC) using the membrane filtration method. Result showed that the average THB, TC and FC counts recorded in the tap water samples across the eight locations ranged from 12.4 CFU to 36.7 CFU, 4.3 CFU to 10.1 CFU and 2.8 CFU to 5.2 CFU per 100ml respectively. Bacterial isolates were identified as probably belonging to genera such as *Bacillus* spp., *Klebsiella* spp., *Enterobacter* spp., *Staphylococcus* spp., *Proteus* spp., *Citrobacter* spp., Serratia spp. and *Escherichia* spp., respectively. Samples from Delta B hostel and Choba campus

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recorded the lowest and highest THB, TC and FC counts respectively. According to WHO standard, the result of THB, TC and FC counts indicated that the tap water in all eight locations were above the limit acceptable for drinking but within acceptable limit for other domestic use such as bathing and washing.

Keywords: Tap water sources; University of Port Harcourt; coli form bacteria.

1. INTRODUCTION

Water is an important commodity for man and his environment. It has so many applications such as in drinking, industrial, livestock, irrigation, aesthetics, boating, swimming, fishing etc. However, it is being threatened by various forms of pollution. Water from different sources, i.e., rivers, lakes, reservoirs and groundwater aquifers are subjected to varying degrees of faecal pollution [1]. The number of different types of pathogens that can be present in water as a result of pollution with human or animal faeces is very large and it is not possible to test water samples for all of the pathogens [2]. Therefore, a measure which will alert water managers to their presence is required. Despite world-wide efforts and modern technologies utilized for the production of safe water, the transmission of waterborne diseases is still a matter of major concern [1]. In fact, the detection of microbial contaminants of faecal origin is a major priority in the control of drinking water quality [3]. The presence of faecal contamination is most often evaluated using members of the coli form group [2]. Many studies have been carried out to identify contaminants of drinking water in order to prevent water borne diseases throughout the world [4-6].

Total coliforms include faecal coliform bacteria such as *Escherichia coli* (*E. coli*), as well as other types of coliform bacteria that are naturally found in the soil [7,8]. Faecal coliform bacteria are found in the intestines of warm blooded animals and humans as well as in bodily waste, animal droppings and naturally in soil [9,10]. Total coliform do not necessarily indicate recent water contamination by faecal waste, however, the presence or absence of these bacteria in treated water is often used to determine whether water disinfection is working properly [2]. The presence of faecal coliform in well water may indicate recent contamination of the groundwater by human sewage or animal droppings which could contain other bacteria, viruses, or disease causing organisms [11-13]. This is why coliform bacteria are considered “indicator organisms” because their presence warns of the potential presence of disease causing organisms and should alert the person responsible for the water to take precautionary action [14]. Monitoring the faecal and total coliform is an essential component of any water quality study [15]. The aim of this study was to evaluate the sanitary quality of tap water within University of Port Harcourt in order to determine its suitability for drinking and other domestic applications.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in the university of Port Harcourt located at East/West Road Choba, Port Harcourt, Rivers State, Nigeria. Founded in 1975, the University of Port Harcourt is a second generation University with over 40,000 students and three major campuses namely, Abuja, Delta and Choba Campuses.

2.2 Collection of Samples

To obtain tap water samples, the nozzle of the tap was sterilized with cotton wool soaked in 96% ethanol. The tap was left to run for two minutes to avoid water left in the pipe from being used as samples. Eight composite samples were collected from eight different locations within the three campuses of the University of Port Harcourt using 300 ml-capacity sterile containers. These locations included NDDC Hostel, Sports Hostel, Medical Hostel, NUH Hostel, Dan Etete Hostel, Delta A Hostel, Delta B Hostel and Choba Campus.

2.3 Enumeration and Isolation of Total Heterotrophic Bacteria

The method used in enumerating total heterotrophic bacteria in the tap water samples was the membrane filter technique [16]. One hundred (100) ml of water samples were filtered into a membrane filter using a sterile filtration unit. After filtration, forceps were used to place

the membrane filter on Nutrient Broth in invert plate. The plate was then incubated in an incubator at a temperature of 37°C for 24 h. The plates were then checked for bacteria growth [2]. Results were recorded as colony forming units (CFU) per 100 ml of sample. Afterwards, the colonies that grew on the membrane filter were later sub-cultured in agar slants and incubated at 30°C between 24 to 48 h for short term preservation at 4°C.

2.4 Identification of Heterotrophic Bacterial Isolates

Bacterial isolates were identified according to Bergey's Manual of Determinative Bacteriology [17] using morphological and metabolic/ biochemical tests. These bacteriological characterization tests included Gram staining test, oxidase test, catalase test, coagulase test, citrate test, indole test, urease test, hydrogen sulphide production, Methyl red test, Voges Proskauer test, fermentation tests involving glucose, mannitol and lactose respectively.

2.5 Enumeration of Total and Faecal Coliforms

The method used in enumerating total coliform and faecal coliforms in the tap water samples was the membrane filter technique [16]. One hundred (100) ml of water samples were filtered into a membrane filter using a sterile filtration unit. After filtration, forceps were used to place the membrane filter on Membrane Lauryl Sulphate (MLS) Broth in invert plate. The plate was then incubated in an incubator at a temperature of 37°C (for total coliforms) and 45^{o}C (for faecal coliforms) for 24 h. After 24 h, colonies with yellow colouration were counted. Results were recorded as colony forming units (CFU) per 100 ml of sample.

2.6 Statistical Analysis

Statistical comparisons of the results were performed by one-way ANOVA using SPSS ver.20, to ascertain significant differences at $p<0.05$.

3. RESULTS AND DISCUSSION

The results of bacteriological examination of tap water samples collected from various locations within the University of Port Harcourt are shown in Table 1. Average total heterotrophic bacteria (THB) count found in the tap water samples across the locations ranged from 12.4 CFU to 36.7 CFU per 100 ml of the respective water samples. Tap water samples collected from Delta B hostel recorded the lowest average THB count (12.4 CFU/100 ml) while the composite sample collected from Choba Campus recorded the highest average THB count (36.7 CFU/100 ml). Total coliform (TC) count found in the tap water samples across the locations ranged from 4.3 CFU to 10.1 CFU per 100ml of the respective samples. Again, samples from Delta B hostel and Choba Campus recorded the lowest (4.3 CFU/100 ml) and highest (10.1 CFU/100 ml) average total coliform counts. Faecal coliform (FC) count found in the tap water samples across the locations ranged from 2.8 CFU to 5.2 CFU per 100ml of the respective samples. Likewise, samples from Delta B hostel and Choba campus recorded the lowest (2.8 CFU/100 ml) and the highest (5.2 CFU/100 ml) average faecal coliform counts.

Generally, tap water samples collected from these locations showed THB counts less than 100 CFU/100 ml but greater than 10 CFU/100 ml of the respective water samples.According to WHO (2006) standard, drinking water should have a THB count of < 10 CFU/100

Table 1. THB, TC and FC counts of tap water samples

Sample location	THB count (CFU/100 ml)	TC count (CFU/100 ml)	FC count (CFU/100 ml)
NDDC Hostel	31.9^{a}	6.3^{a}	3.4^{a}
Dan Etete Hostel	33.8^{a}	9.4^{b}	4.9^{b}
NUH Hostel	14.6^{b}	5.2a	2.5^{a}
Sports Hostel	28.6^{a}	8.5^{b}	4.2^{ab}
Medical Hostel	16.3^{b}	6.4^{a}	3.1^{a}
Delta A Hostel	18.5^{b}	7.5^{b}	3.7^{a}
Delta B Hostel	12.4^{b}	4.3^{a}	2.8^{a}
Choba Campus	36.7^{a}	10.1^{b}	5.2^{b}

Means followed by the same letter(s) are not significantly different at $p<0.05$

ml and < 100 CFU/100 ml for domestic purposes such as bathing, washing, recreation, etc. Result of THB count showed that tap water samples across all the locations were above the WHO permissible limit acceptable for drinking but below the limit for other domestic use (Table 1). According to the WHO (2006) standard, the permissible limit for both total coliform (TC) and faecal coliform (FC) is 0 CFU/100 ml for drinking water and 10 CFU/100 ml for other applications such as bathing, washing, recreation, etc. the result of TC and FC counts showed that the tap water samples across the respective locations were above the limit acceptable for drinking but within acceptable limit for other domestic use such as bathing and washing.

In the present study, the bacteriological quality of tap water sources from Eight (8) locations within the University of Port Harcourt was investigated and the result showed that eight (8) genera of microorganisms were identified from a total of Eight (8) composite samples according to Bergey's Manual of determinative bacteriology [17]. These genera included *Bacillus* spp., *Klebsiella* spp., *Enterobacter* spp., *Staphylococcus* spp., *Proteus* spp., *Citrobacter* spp., *Serratia* spp. and *Escherichia* spp., respectively. Coliforms are Gram-negative rods that ferment lactose with the production of gas are used as indicators for the suitability of water for domestic and other purposes [1,2,18]. Coliform bacteria are represented by four genera of the family *Enterobacteriaceae* are; *Citrobacter*, *Enterobacter*, *Escherichia* and *Klebsiella*. *Escherichia coli* which was identified as one of the contaminants in this study is the most preferred microbial indicator of faecal pollution, [2,18]. *E. coli* which is found in the faeces of warm-blooded animals including humans was isolated in one sample from Choba campus. Some of these organisms as seen in this study can leads to water borne diseases [2,15]. However, the presence of these organisms in water bodies does not always represent direct sewage or faecal contamination [2]. Their presence in water could be due to some natural phenomenon and other anthropogenic activities which includes but not limited to the following; inappropriate sittings of boreholes close to dump sites, extraction of ground water from very shallow aquifers, discharges from septic tanks close to the sources of the taps, storage system and piping units [2].

4. CONCLUSION

The study revealed that some of them tap water supplies within the three campuses of the University of Port Harcourt may not be safe for drinking because of their microbiological quality. However, they may be fit for use in other non-drink applications such as bathing, washing and even cooking if properly treated. The reliance of students of the University of Port Harcourt on tap water sources within the University without proper treatment facilities and poor basic hygiene practices may therefore pose a public health risk especially to those may not have the means of accessing other alternative water sources.

COMPETING INTERESTS

Authors have declared that no competing interests exist

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