Bacteriological Quality of Borehole Water Used by Students' of University for Development Studies, Navrongo Campus in Upper-East Region of Ghana

L.A. Adetunde and R.L.K. Glover
Department of Applied Biology, Faculty of Applied Sciences, University for Development Studies, Navrongo Campus, Navrongo, Ghana

Abstract: The aim of this study was to assess the bacteriological quality of borehole water used by the students’ of University for Development Studies, Navrongo Campus, Upper East Region of Ghana. Borehole water samples from different locations within the University for Development Studies, Navrongo campus of Upper East Region of Ghana were collected for four consecutive weeks for bacteriological analysis to assess the wholesomeness. Pour plate method and multiple tube fermentation methods were used to determine heterotrophic bacterial viable counts and coliform bacterial counts respectively. For total viable bacterial counts of the samples the range of the mean was from 1.50x10⁴ to 5.90x10⁴ cfu/mL, 0 to 17 MPN/100 mL for total coliform bacteria and 0 to 4.07 MPN/100 mL. The highest counts were consistently found in the sample BW where the borehole was located in an unsanitary environment near septic tank. The findings show that the water samples except those from SSNIT hall did not meet the WHO for drinking and domestic water and should be treated or boiled and filtered before drinking.

Key words: Borehole water, faecal coliforms, Ghana, Kassena-Nankan District, Navrongo, total coliforms, upper east region

INTRODUCTION

Water is indispensably and intricately connected to life without which there is no life. This is the reason for which water must be given the necessary attention at all times. Good drinking water is not a luxury; it is one of the most essential amenities of life itself. The supply of safe drinking water to all has therefore engaged the attention of many individual, groups, governmental organisation and private. Safe drinking water is the priority of all people.

Micro-organisms play a major role in water quality and the micro-organisms that concern with water borne diseases are Salmonella sp., Shigella sp., Escherichia coli and Vibrio cholera (Birmingham et al., 1997). All these cause typhoid fever, diarrhoea, dysentery, gastroenteritis, cholera. Other agents of water borne diseases are protozoan of diarrhoea- Entamoeba histolytica, Giardia lamblia, Balantidium coli (Jawetz et al., 1991) and Cryptococcus pervum (Kelly et al., 1997) Enteroviruses of various clinical ailment- Polivirus, Rotavirus, Hepatitis A virus (Hejkal et al., 1982) and Hepatitis E virus (Benjelloun et al., 1997). 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 (Tortora et al., 1998). Presence of faecal coliforms of E. coli is used as an indicator for the presence of any of these water borne pathogens Chukwural, 2001; Okpokwasili and Akujobi, 1996; Okafor, 1985). To maintain good health (Cheesbrough, 2000) stated that water should be of good quality and quantity meeting local and WHO recommended standards of taste, odour and appearance.

The people of the Upper-East Region of Ghana depend on the groundwater through borehole and hand-dung wells or processed water from Ghana Water Company Limited. The people of Kassena-Nankan District is no exception because 70.8% of them depend on groundwater. The students of University for Development Studies located in the Navrongo of the District also depend on groundwater through borehole and treated water from Ghana Water Company Limited. The borehole water is the mainly used by the students. Although a student of this university have accessed the borehole water quality and tap water some years ago and it was proven that borehole water had a high coliform loads with a statistical proven that about 39% of the students were affected with water related diseases precisely typhoid fever within the month of October 2005. This implies that the Institution’s borehole is contaminated with high level of bacteria for a couple of years now. This comprehensively boils down to say that the water sources on the university campus may be potables, it may not

Corresponding Author: L.A. Adetunde, Department of Applied Biology, Faculty of Applied Sciences, University for Development Studies, Navrongo Campus, Navrongo, Ghana
yield the expected health benefit but causes the university authorities to continue wasting resources in the treatment of water related diseases, which is easily preventable. The study is to review the bacteriological quality of institutions’ borehole water in order to see whether there is change in coliform level after some years. To also predict the hygienic status of the institution borehole water by comparing the data with WHO standard and to prone into what actually caused the high level of coliform in the institutions’ borehole water and to recommend solution to mitigate such situation in the university campus.

MATERIALS AND METHODS

Study area: The study took place at the Navrongo campus of the University for Development Studies (UDS). The University campus is located 3 km off the central business district of Navrongo, the district capital of Kassena-Nankana District Assembly of the Upper East Region of Ghana. The study took place around April to May, 2009 at Danida laboratory of Microbiology Department, University for Development Studies. Navrongo. Upper East Region, Ghana.

Student’s population: The University campus had a total student population of about 2880 during the time this study was carried out.

There three major sources of water made available to the students. These are hand dug well water, Ghana Water Company Limited through stand pipe (distribution system) and borehole water channelled into reservoir tanks.

Sample collection: Water samples were collected from borehole water source (both mechanized and manual), UDS reservoirs and distribution points into various hall such as Savana, Ecowas, SSNIT, Navron, chemistry/biology Department and Spanish block used as source of domestic water by students and other members of the Navrongo campus of University for Development Studies. The samples were collected at weekly interval for four weeks from the student’s halls.

A total of 26 water samples were collected. Two borehole water samples from source, one sample from UDS reservoir and one sample from bore hole manual were collected within the campus. Other samples were collected at various halls within the campus. Samples were collected between the hours of 9am and 10am when the sampling points were freed of students. Sampling protocols described by Claassen (1982), Barcelona et al. (1985) and APHA (2005) were strictly adhered to during sample collection. The nozzles of the boreholes were swabbed with cotton wool soaked in 70% (v/v) ethanol and flamed for 2 to 3 min. Samples were collected using washed and sterilized plastic containers after pumping water sample to waste for 4 to 5 min. Duplicate samples were taken from each sampling point aseptically into plastic container and kept in an ice chest and transported immediately to the laboratory for analysis. The samples were collected at weekly interval for 4 weeks within the campus.

Sampling code:
BM = Bore hole mechanized
HW = Bore hole manual
RT = UDS Reservoir Borehole Staff area
SM = Savana main stand pipe
SA = Savana Annex stand pipe
EL = Ecowas Left stand pipe
ER = Ecowas Right stand pipe
SB = SSNIT Borehole
SL = SSNIT Left stand pipe
SR = SSNIT Right stand pipe
NH = Navron hall stand pipe
CB = Chemistry/Biology Depatments
SB = Spanish Block

Laboratory 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 broths, Brilliant Green Lactose Bile (BGLB) broth, Eosin Methylene Blue (EMB) agar and Plate Count Agar (PCA).

Enumeration of total heterotrophic bacteria or total viable count: Total heterotrophic bacteria in the water samples were obtained using the pour plate method. Dilutions of $10^{-1}$ to $10^{-6}$ of the samples were prepared in 0.1% buffered peptone water (oxoid) and duplicate 1ml aliquots of each dilution was inoculated into 10ml each of molten Plate Count Agar (PCA) in universal bottles. These were then thoroughly mixed poured into sterile Petri-dishes and incubated at 37°C for 24 h enumerated. Petri-dishes from dilutions containing between 30 and 300 discrete colonies were counted and the result expressed as the numbers of bacteria per millilitre. Anonymous (1994) and APHA (2005).

Enumeration of total and fecal coliform:
Presumptive test: Total coliform and faecal coliform were enumerated by multiple tube fermentation tests as described by APHA (2005) 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 five tubes had sterile 10ml double strength broth and the second and third sets had 10ml single strength broth. All the tubes contained Durham tube before sterilization. The
Table 1: The range and mean values of bacteriological quality of water samples used by the students

<table>
<thead>
<tr>
<th>Water sources</th>
<th>Total bacteria counts (cfu/mL) x 10^{9}</th>
<th>Total coliform counts (MPN/mL)</th>
<th>Faecal coliform counts (MPN/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Means</td>
<td>Range</td>
</tr>
<tr>
<td>Bore hole mechanized-BM</td>
<td>1.2-2.2 x10^4</td>
<td>1.65 x10^4</td>
<td>4-6</td>
</tr>
<tr>
<td>Bore hole manual - HW</td>
<td>3.4-7.8 x10^4</td>
<td>5.90 x10^4</td>
<td>14-20</td>
</tr>
<tr>
<td>UDS Reserve Borehole Staff - RT</td>
<td>30.7-90 x10^4</td>
<td>5.05 x10^4</td>
<td>6</td>
</tr>
<tr>
<td>Savannah main stand pipe - SM</td>
<td>3.6-5.8 x10^4</td>
<td>4.76 x10^4</td>
<td>11-13</td>
</tr>
<tr>
<td>Savannah Annex stand pipe - SA</td>
<td>2.2-4.7 x10^4</td>
<td>3.05 x10^4</td>
<td>8.2-10</td>
</tr>
<tr>
<td>Ecovas Left stand pipe - EL</td>
<td>3.6-5.4 x10^4</td>
<td>4.88 x10^4</td>
<td>9.2</td>
</tr>
<tr>
<td>Ecovas Right stand pipe - ER</td>
<td>3.4-5.8 x10^4</td>
<td>4.49 x10^4</td>
<td>11</td>
</tr>
<tr>
<td>SSNIT- Borehole- SB</td>
<td>1.0-2.2 x10^4</td>
<td>1.50 x10^4</td>
<td>1.8-3.6</td>
</tr>
<tr>
<td>SSNIT Left stand pipe - SL</td>
<td>1.4-3.2 x10^4</td>
<td>1.95 x10^4</td>
<td>2-6</td>
</tr>
<tr>
<td>SSNIT Right stand pipe - SR</td>
<td>1.4-2.6 x10^4</td>
<td>1.80 x10^4</td>
<td>1.8-3.6</td>
</tr>
<tr>
<td>Navron hall stand pipe - NH</td>
<td>3.0-5.4 x10^4</td>
<td>4.22 x10^4</td>
<td>7.8-11</td>
</tr>
<tr>
<td>Chemistry/Biology Departments- CB</td>
<td>3.2-5.8 x10^4</td>
<td>4.65 x10^4</td>
<td>11-13</td>
</tr>
<tr>
<td>Spanish Block- SB</td>
<td>3.2-5.8 x10^4</td>
<td>4.60 x10^4</td>
<td>10</td>
</tr>
</tbody>
</table>

**RESULTS**

Table 1 showed the range and mean values of total bacterial counts, total coliform and faecal coliform counts of water samples collected at weekly interval over a period of four weeks. Total viable bacterial counts of the samples were relatively low except for sample HW, the Hand dug well. The lowest counts of total bacterial were recorded in sample SB, SSNIT borehole which ranged from 1.0-2.2 x10^4 cfu/mL with mean value of 1.50 x10^4 while the highest counts of total bacterial were recorded in sample HW, Hand dug well which ranged from 3.4-7.8 x10^4 cfu/mL with a mean value of 5.90 x10^4.

Total coliform counts for the samples were highest in sample HW with a mean value of 17 MPN/100 mL while the lowest total coliform counts was recorded in sample SB with a mean value of 2MPN/100 mL. Faecal coliform counts was highest for sample HW with a mean value of 12 MPN/100 mL while sample BM, SB, SL and SR had mean values of 0MPN/100 mL.

**DISCUSSION**

Most of the samples were contaminated with both non-faecal and faecal coliform bacteria. The samples with low bacterial 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 bacterial counts and total coliform counts. Water samples from SSNIT HALL and from the BM source are fit for drinking and domestic purposes because they had faecal coliform counts of zeroMPN/100 mL which is conformed to the set standard of WHO (1993) which says no water sample should contain faecal coliform in any 100 mL of water sample, while other samples analysed were not fit for consumption without processing. Therefore these samples should be boiled and filtered for clarity before drinking.

The level of contamination of some of the samples with higher number of total viable bacterial counts may be due to the location of the borehole and environmental factors whereby some domestic animals visit the site to drinking water. When drinking, they lick the mouth of the borehole taps and defecate around the borehole. These activities could enhance bacterial spore to contaminate the water through the opening side of the borehole. The high contamination in the UDS reservoir could be attributed to the lack of routine measure of UDS personnel. The small increase in the means values of the water samples at various halls and blocks may be due to the contamination level from the UDS reservoir as well as the old pipelines that channel the water to the halls and departments. Also unhygienic handling nature of the taps by some students may contribute to the contamination level of the water.

**CONCLUSION AND RECOMMENDATION**

There was a significant difference in the level of contamination between the main source and the point of use. The factors that predispose the water source to
contamination in the case of the UDS reservoir was the non existence of routine measure of the treatment as well as disinfection of the water in the reservoir. In the case of the manual bore hole one of the hall septic tank is directly located on the water table. Unhygienic handling of water by the students and the old nature of the distribution network of the pipelines to the students’ hall may contribute to level of the contamination. Continuous consumption of this water by students could lead to an increase risk level of outbreak of water borne diseases on the university campus. The University authorities should map out more refined public health measure to mitigate or minimize the occurrence of major water borne disease outbreak on the campus.

Collaboration of Applied Biology and Chemistry/Biochemistry Department of the University could help to establish a clear framework for the maintenance of the quality of water used by the students through regular water quality testing. Furthermore routine measure to disinfect the water storage reservoir supplying the campus should be implemented. The septic tank found directly located on the water table should be relocated and the tap nozzles of all the borehole should be covered when not in use to prevent contamination from the domestic animals if the school authorities could not get rid of domestic animals within the campus.

ACKNOWLEDGMENT

The authors are thankful to Prof. Adetunde, I.A Dean of Faculty of Engineering, University of Mines and Technology, Tarkwa, Ghana for his advice, valuable comments and suggestions.

REFERENCES


