Biometric Assessment of Bacteriological Profile of Borehole Water in Relation to Sewage Disposal Units in Students' Hostels in Ikot Udota, Eket

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Borehole water is a major water source in some parts of the world and human health depends largely on the quality of water consumed. Hence, bacteriological assessment of borehole water in relation to distance and age of septic tanks in nine student's hostels in Ikot Udota was investigated using standard scientific methods. The organisms isolated were: Escherichia coli, Klebsiella spp, Bacillus spp, Pseudomonas spp, Streptococcus spp, Enterobacter spp, Salmonella typhi, Vibrio cholerae, and Proteus vulgaris. The result revealed that the total bacteria counts of the samples ranged from 30 cfu/ml in Ario house, 246 cfu/ml in Macdone. However, Macdone's lodge had the highest faecal coliform count with 2 (66.6%), while Anthonys' had the lowest faecal coliform count with 1 (33.3%). Correlation analysis signaled that there is a significant (p<0.05) likelihood that contaminants enrichment grossly emanated from a point source seeing that 72.2% of TBC and 73.5% of FCC were associated with short distances from septic tanks. Also, 28.5% of TBC and 15.4% of FCC were associated with borehole age. Conclusively, boreholes should be situated far from refuse/sewage disposal units and routine treatment of old borehole water sources is a necessity.

Keywords: Borehole, Bacteriological, Ikot Udoata

INTRODUCTION

Water is essential to the life of all living organisms including microorganisms. It plays an important role in the structure and function of the human body and remains a medium for biological and chemical processes in all living things. It constitutes about 70% of the body weight of every healthy adult (Sotade, 2003). To have safe drinking water is a human right and need for every man, woman and child, having good water also is essential in breaking the cycle of poverty since it improves people’s health, strength to work and ability to function, yet over 884 million people around the world live without safe drinking water (WHO, 2008).

The health of the people depends solely on the quality of water available for consumption. Water pollution as a result of microbial contaminant and pollutants has resulted in epidemics of water borne diseases such as typhoid fever, cholera, dysentery, Salmonellosis and diarrhoea (Reeves et al., 1989) these may present symptoms like nausea, stomach cramps, vomiting, low grade fevers which begin from two to ten days after drinking the contaminated water (Reeves et al., 1989). Water borne disease can be cause by protozoa, viruses, or bacteria (WHO, 2000).

Coliform bacteria are known bacteria indicator of water pollution which are present in the faeces of all warm-blooded animals and humans (Howard et al, 2002). Their presence in drinking water indicates that disease-causing organisms could be in water system and may pose an immediate health risk in the water (Teburt, 2007).

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According to World Health Organization Standards and guidelines, borehole should be sunk 150ft below the ground level, and should be situated far and opposite from refuse disposal and sewage disposal units (WHO, 1996). This is because contaminants can enter water bodies through variety of ways, these includes discharges from sewage works and industrial plants at identifiable point sources, continuous leaching from surrounding ground water entering the system, deposition from the air, deliberate oil spillage or dumping and release from dead or decaying aquatic flora or fauna. Some microorganisms which are mostly found in surface water which could cause human health problems includes; Cryptosporidium pavum, Gardia lambia, Salmonella spp., Clostridium spp., Streptococcus spp., parasitic worms (helmiths), and viruses (Olawuyi, 2006). For pathogens transmitted by the faecal-oral route, drinking water is the only one vehicle of transmission, contamination of foods, hands, utensils and clothing can play a role when domestic sanitation and hygiene are poor. Improvements in the quality and availability of water in excreta disposal in general hygiene are all important in reducing faecal oral-route disease transmission (Amyes, 2007).

Contamination of water bodies has increasingly become an issue of serious environmental concern particularly when coliform and other bacteria are found. Hence, there is need for periodic assessment of microbiological quality of water in line with World Health Organization standards (Edema and Omem, 2001). This study will create awareness within and outside the school community on the quality of borehole water available to student in hostels which may serve as a baseline data and basis for further public health recommendations.

MATERIALS AND METHODS

This study was conducted in Ikot Udota, Eket Local Government Area of Akwa Ibom State which is located between Latitude 4.6423N and 4°3832N and Longitude 7.9244 and 7° 5528E with an estimated population of 172,557. The climate falls within the tropical zone where in its dominant vegetation is the green foliage of trees and shrub as well as oil palm tree belt. Eket has two distinct seasons: The wet and dry seasons the driest months are January and the mean average rainfall is 3119mm. Their major and easily accessible source of drinking water is borehole.

Nine (9) borehole water samples were collected from student’s hotels in Ikot Udota into a sterile bottle and covered with ice packs. Then the samples were transferred with ice bags within two hours to the laboratory for analysis. However, each sample was labeled with the hostel name and was mixed thoroughly.

Inoculation and Incubation

Total viable count of Bacteria was determined by enumerating the colony forming unit (cfu/ml) by spreadplating, 15 to 20 ml of the sterilized nutrient agar media was aseptically dispensed into sterile Petri dishes and was allowed to solidify. 0.1 ml of the diluted sample was pipette from 10⁻³ test tube on to the surface of the solidified media and a sterile hockey stick was used to spread the sample evenly on the solidified agar plate and the plate was wrapped with a foil paper and incubated at 37°C for 24 hours (Chesbrough, 2006). Controls were made for each sample by pipetting 0.1 ml from each sample onto a nutrient agar plate for each sample and incubated at 37°C for 24 hours.

Purification and Maintenance of Media

At the end of the incubation period, the plate was observed for growth. The population of the bacterial isolates was estimated by counting the number of discrete colonies in the plates. Morphological and cultural characteristics was observed according to Bergey’s (2005) manual.

Total Bacteria counts

The total bacteria counts were determined by spread plate technique using Standard Methods (APHA, 1985). Nutrient agar medium was used for the enumeration of bacteria in the samples.

Faecal coliform counts

The faecal coliform counts were determined using Eosin methylene blue medium, using spread plaiting technique using Standard Methods (APHA, 1998). Organisms with greenish metallic sheen were taken for positive Escherichia coli and was confirmed by lactose fermentation after incubation at 45°C for 24-48 hours.

Statistical Analysis

The occurrence of bacteria in (TBC and TCC) in each hostel is expressed as a percentage of the total bacteria counts and faecal coliform counts. The relationship between the occurrence of bacteria and predisposing factors proximity to septic tank and borehole age are establish by multiple correlation analysis using Statistical Package for Several Sciences (SPSS:vision22).

RESULTS

The bacteriological quality of water in relation to septic tank in student’s hostels in Ikot Udota is presented in table 1. It revealed that the total bacteria counted ranged from 30 cfu/100ml in Arioup to 246 cfu/100ml in Macdone. Also, Anthony’s lodge had 1 (33.3%) cfu/100ml faecal coliform count, while Macdone had 2 (66.6%) cfu/100 ml faecal coliform counts. Similarly, the three years old Macdone lodge recorded the highest bacterial and faecal coliform counts of 246 cfu/100ml and 2 cfu/100ml respectively.
Table 1: Bacteriological Profile of Borehole Water in Relation to Septic Tank Vicinity in Student’s Hostels in Ikot Udota

<table>
<thead>
<tr>
<th>Sample source</th>
<th>Total bacteria count (cfu/100ml)</th>
<th>Faecal coliform counts (cfu/100ml)</th>
<th>distance from septic tank (m)</th>
<th>Age of borehole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adventures’ Lodge</td>
<td>168 (11.89%)</td>
<td>0 (0.0%)</td>
<td>16.90</td>
<td>7 years</td>
</tr>
<tr>
<td>All Stars Lodge</td>
<td>198 (14.01%)</td>
<td>0 (0.0%)</td>
<td>21.10</td>
<td>7 years</td>
</tr>
<tr>
<td>Anthonys’ Lodge</td>
<td>240 (16.98%)</td>
<td>1 (33.3%)</td>
<td>11.70</td>
<td>8 years</td>
</tr>
<tr>
<td>Arios’ House</td>
<td>30 (2.12%)</td>
<td>0 (0.0 %)</td>
<td>32.00</td>
<td>8 months</td>
</tr>
<tr>
<td>Beulahs’ Lodge</td>
<td>80 (5.66%)</td>
<td>0 (0.0%)</td>
<td>28.40</td>
<td>1 year</td>
</tr>
<tr>
<td>Edopets’ Lodge</td>
<td>125 (8.85%)</td>
<td>0 (0.0%)</td>
<td>22.80</td>
<td>2 years</td>
</tr>
<tr>
<td>Ekpeyongs’ Lodge</td>
<td>170 (12.03%)</td>
<td>0 (0.0%)</td>
<td>12.00</td>
<td>2 years</td>
</tr>
<tr>
<td>Grace Court</td>
<td>156 (11.04%)</td>
<td>0 (0.0%)</td>
<td>28.50</td>
<td>4 years</td>
</tr>
<tr>
<td>Macdones’ Lodge</td>
<td>246 (17.50%)</td>
<td>2 (66.6%)</td>
<td>4.90</td>
<td>3 years</td>
</tr>
<tr>
<td>WHO Standard</td>
<td>100</td>
<td>0</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

The morphology and biochemical characteristics of bacteria isolates are presented in Table 2. The isolates identified were: *Escherichia coli*, *Pseudomonas spp.*, *Bacillus spp.*, *Streptococcus spp.*, *Enterobacter spp.*, *Salmonella typhimurium*, *Vibrio cholera*, *Klebsiella*, and *Proteus vulgaris*.

Table 2: Morphology and biochemical characteristics of bacteria isolated from student’s Hostels in Ikot Udota

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Gram’s</th>
<th>Shape</th>
<th>Motility</th>
<th>Indole</th>
<th>Mr</th>
<th>VP</th>
<th>Citrate</th>
<th>Maltose</th>
<th>Lactose</th>
<th>Sucrose</th>
<th>Fructose</th>
<th>Probable organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+</td>
<td>Short rod</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>AG</td>
<td>AG</td>
<td>A</td>
<td>AG</td>
<td><em>Escherichia coli</em></td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>Rod</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td>-</td>
<td><em>Klebsiella spp.</em></td>
</tr>
<tr>
<td>3</td>
<td>+</td>
<td>Rod</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td><em>Bacillus spp.</em></td>
</tr>
<tr>
<td>4</td>
<td>+</td>
<td>Rod</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>AG</td>
<td>AG</td>
<td><em>Pseudomonas spp.</em></td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>Cocci</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td><em>Streptococcus spp.</em></td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>Rod</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td><em>Enterobacter spp.</em></td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>Rod</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>AG</td>
<td>AG</td>
<td>-</td>
<td>-</td>
<td><em>Salmonella spp.</em></td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>Rod</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>AG</td>
<td>-</td>
<td>-</td>
<td>AG</td>
<td><em>Vibrio cholera</em></td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>Rod</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>AG</td>
<td>AG</td>
<td>-</td>
<td>-</td>
<td><em>Proteus vulgaris</em></td>
</tr>
</tbody>
</table>

**Keys**

+ = Positive, - = Negative,
MR = Methyl Red,
VP = Voges Proskeur.
A = Acid Production
AG = Acid and Gas Production.

Table 3 relates the numeric distribution of bacteria (TBC and FCC) in borehole water samples to prevailing factors such as distance from septic tank (Distance) and age of boreholes. TBC correlated strongly and positively with FCC (r= 0.691*). However, both TCC and FCC correlated significantly but negatively with distance from septic tanks (r= -0.772* and -0.735* respectively).

Table 3: Relationship Between the Bacteria (TBC and FCC) and Predisposing Factors

<table>
<thead>
<tr>
<th>TBC</th>
<th>FCC</th>
<th>DISTANCE</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.691*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>-0.772*</td>
<td>-0.735*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.285</td>
<td>0.154</td>
<td>-0.387</td>
<td>1</td>
</tr>
</tbody>
</table>

*significant at p< 0.05

DISCUSSION

The use of microorganisms as water quality indicator is well established (Grabow, 1996; WHO, 1993). The total bacteria count and faecal coliform counts were above the WHO Recommended standard limits (Table 1). Their presence in water sample may be attributed to contamination due to proximity to septic tanks, age of the boreholes, wastes water seepage, etc.

Again, the microorganisms isolated in this study include: *Escherichia coli*, *Klebsiella spp.*, *Bacillus spp.*, *Pseudomonas spp.*, *Streptococcus spp.*, *Enterobacter spp.*, *Salmonella spp.*, *Vibrio cholera*, *Proteus vulgaris*. This was expected (Anyanwu and Okoli, 2013: Okonko et al., 2008). Okonko et al., 2008 isolated and identified *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas spp.*, *Enterobacter*, *Proteus vulgaris*, and *Klebsiella* in different
water samples used for domestic purposes. A similar trend was also recorded by Agwu et al., (2013). The isolation of *Pseudomonas spp.* and *Salmonella typhi* in borehole water is a major source of concern, this is because *Pseudomonas* which is a Gram-negative rod shaped bacteria, is a serious opportunist with an infectious potential on human host with compromised immunity. Similarly, *Salmonella typhi* is also a strong pathogen that causes systemic infections such as typhoid fever in humans. Its presence in borehole water may be related to the incidences of typhoid amongst other infection in the area. Klebsiella spp, Enterobacter, Escherichia coli are faecal coliform bacteria and are considered as specific indicator of the presence of faeces(Maier et al., 2000). *Escherichia coli* had been named a preferred indicator of faecal pollution (Edbery et al.,2000). Hence, the presence of enteric organisms underscores the contamination of the underground water bed with substantial amount of oxygen demand waste (WHO, 1996).

According to Ubom (2003), correlation analysis is a measure of the association between two parameters or variables. Hence its applicability in relating biotic occurrences with abiotic factors in this research is well fitted. The positive significant coefficient obtained between FCC and TBC confirms that both parameters share a similar source of enrichment and so both parameters increase together (Mbong et al., 2013: Moses, Etuk and Udosen (2015).

On the contrary, significant negative coefficient obtained between the TBC and abiotic factors distance signals that higher or rapid bacterial contamination of the borehole water samples is associated with short distances away from septic tanks. Similarly, the relationship between TBC and age of boreholes is an indication of poor treatment of the boreholes.

**CONCLUSION**

The water samples assessed were of poor bacteriological quality. Most of them were contaminated with pathogens which pose serious risk to unsuspecting consumers. The values for total bacteria count and total coliform counts were beyond the WHO permissible limit.

**RECOMMENDATIONS**

Upon the findings of this research:
1. There is an urgent need to evaluate the bacteria profile of all the boreholes in Ikot Udota.
2. Also, routine treatment of hostels’ boreholes should be made mandatory.
3. Aggressive awareness should be created by Government Agencies on the effects of sitting boreholes close to sewage disposal units.

**REFERENCES**


Accepted 19 June 2020


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