MICROBIOLOGICAL AND PHYSICOCHEMICAL PROPERTIES OF DRINKING WATER AT OTA, SOUTHWEST, NIGERIA

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ABSTRACT: Quality drinking water is of basic importance to human physiology and man’s continued existence depends much on its availability. Water samples from different outlets and homes in Ado Odo - Ota Local Government, Ogun state, Nigeria were analyzed for their microbiological and physicochemical properties. Total viable count was assessed by the pour plate technique, while physicochemical evaluations was carried out using Standard Chemical Methods such as pH analysis, physical appearances, Total Dissolved Solid (TDS), as well as tests for chloride, sulphate, calcium, zinc and oxidizable substances. All the water samples were found to harbor coliforms in numbers greater than the required World Health Organization (WHO) and the Food and Agricultural Organization (FAO) standards for water. The total viable counts for all the water samples were generally high, exceeding the limit of \(1.0 \times 10^2\) cfu/ml for water, while all the samples tested passed the physicochemical tests except the test for chloride.

Keywords: Water quality, physicochemical tests, fecal contamination, coliform

INTRODUCTION

Water is a valuable commodity for the survival of all life forms in the ecosystem (Alfred and Patrick, 1985). It is essential for growing crops, plants, household uses such as drinking, cooking, sanitation and in industries for various physical, chemical and biological processes (Nester et al., 2001). Quality drinking water is of basic importance to human physiology and man’s continued existence depends very much on its availability (Lamikanra, 1990; FAO, 1997). Provision of quality water to rural and urban population is necessary in order to prevent health hazards (Nikoladze and Akastal, 1989).

The combination of unsafe drinking water and inadequate sanitation facilities constitute one of the major causes of death and disability as a result of water borne diseases, which is often on epidemic scale among the poor in developing countries. Water has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking before it can be described as being of good quality (Tebutt, 1983). Quality water is defined as water that is free from disease - producing microorganisms and chemical substances deleterious to health (Ihekorozye and Ngoddy, 1985).

Despite the abundance of water, large percentage of the world population does not have enough to drink and meet their essential needs, as the provision of quality water remains a major problem. Water from most sources is therefore unfit for immediate consumption without some sort of treatment (Raymond, 1992). The original source of most drinking water is rich in aquatic microbes, some of which could be pathogenic if they enter the human body (Mellaine, 1998). Conformation with microbiological standard is therefore of special interest because of the capacity of water to spread diseases within a large population (Okonkwo et al., 2008). There is paucity of information from literature reports concerning the quality of water in Ota, Ogun state, Nigeria.

This study was therefore carried out to evaluate the microbiological and physicochemical properties of drinking water from different sources in Ota, Ado Odo – Ota Local Government Area of Ogun State, Nigeria.

MATERIALS AND METHODS

Source of samples and sample collection: Water samples were collected from different sources at different locations in Ota, Ado Odo-Ota Local Government Area of Ogun state, Nigeria.
and analyzed in triplicates. Sample names were adopted from their sources and types and they are represented in Table 1.

Table 1: Locations and labels names of water samples

<table>
<thead>
<tr>
<th>Location</th>
<th>Label name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public tap water, Ota, Ogun state, Nigeria</td>
<td>PTW</td>
</tr>
<tr>
<td>Bore hole opposite Covenant University, Ota</td>
<td>BCU</td>
</tr>
<tr>
<td>Well water from Sango, Ota</td>
<td>WSO</td>
</tr>
<tr>
<td>Bore hole from Iyana Iyesi</td>
<td>BII</td>
</tr>
<tr>
<td>Well water from Oju-Ore, Ota</td>
<td>WOO</td>
</tr>
<tr>
<td>Storage tank from Oju-Ore, Ota</td>
<td>SOO</td>
</tr>
</tbody>
</table>

Water samples were collected aseptically using sterile plastic containers and were taken to the laboratory for analyses within 6 hours of collection. The water samples were then assessed immediately for physical characteristics such as total dissolved solids, conductivity, pH, color, odor and taste.

**Enumeration of bacteria from the water samples:** The enumeration of viable bacteria was done using the plate count technique as described by Standard Method for the Examination of Water and Waste Water, America (Nikoladze and Akastal, 1989).

**Determination of coliform bacteria:** The most probable number technique as described by Nester et al. (2001) was used to isolate coliform group of organisms. This was carried out using the Presumptive, Confirmed and Completed tests as described below:

- **Presumptive test for coliform bacteria:** Three tubes of lactose broth medium were inoculated with 10 ml aliquots of water samples, another three 1.0 ml of water samples, and the last set of tubes with 0.1 ml of water samples. These were incubated for 24 hours at 37°C.
- **Confirmed test for coliform bacteria:** The tubes showing positive presumptive test were cultured on Eosin methylene blue agar and incubated for 24 hours at 37°C. The presence of greenish metallic sheen colonies of *Escherichia coli* were taken as positive result (Lamikanra, 1990).
- **Completed test for coliform bacteria:** The positive tests were then inoculated on nutrient agar slants and incubated for 24 hours at 37°C and colonies were examined under the microscope. Different biochemical tests for identification of organism were further carried out (Lamikanra, 1990).

**Physicochemical tests:** Total dissolved solids (TDS) was measured for all the samples using the Hach TDS meter, Model C020. Conductivity was measured with Suntex conductivity meter and pH values for the samples were measured using the pH tester 1TM, model Cole-Plamer. Various standard methods were used for other chemical tests (APHA, 1976).

**RESULTS AND DISCUSSION**

From the result of the microbiological analysis illustrated in table 2, the microbial load for PTW, BCU, WSO, BII, WOO and SOO were 2.0 x 10³, 1.0 x 10³, 1.0 x 10³, 1.5 x 10², 1.0 x 10³ and 1.0 x 10³ respectively. All the samples tested positive to coliform. Samples BCU, WSO and BII tested negative to fecal contamination and had zero readings for MPN coliform test, while samples PTW, WOO and SOO tested positive to fecal contamination, and had 1, 13 and 6 bacilli/100 ml reading respectively from the MPN coliform test.

Table 2: Microbiological attributes of the water samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>Microbial Cfu/ml</th>
<th>Coliform Test</th>
<th>MPN Coliform bacilli/100ml</th>
<th>Fecal contamination</th>
<th>E. coli</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTW</td>
<td>2.0 x 10³</td>
<td>+</td>
<td>1</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>BCU</td>
<td>1.0 x 10³</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>WSO</td>
<td>1.0 x 10³</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BII</td>
<td>1.5 x 10²</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>WOO</td>
<td>1.0 x 10³</td>
<td>+</td>
<td>13</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>SOO</td>
<td>1.0 x 10³</td>
<td>+</td>
<td>6</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

PTW - Public Tap water; BCU - Bore whole Opposite Covenant University; WSO - Well water, Sango, Ota; BII - Bore hole, Iyana Iyesi, Ota; WOO - Well water, Oju-Ore, Ota; SOO - Storage tank, Oju-Ore, Ota; + Present; _ Absent
The physicochemical analysis illustrated in table 3 had all the water samples within the World Health Organization (WHO) acceptable range for conductivity, total dissolved solid (TDS), sulphate, zinc, calcium and ammonium. All the water samples failed the test for chloride, while only BCU, BII and WOO failed the test for pH and acidity.

The results of this investigation show the presence of *Escherichia coli* in three out of the six samples examined indicating of fecal contamination in these samples. *E. coli* has long been used as an indicator for water pollution since it is foreign to water. The presence of *E. coli* in these samples of water therefore implies fecal contamination, which further suggests the possible presence of enteric pathogenic bacteria like *Salmonella typhi*, *S. paratyhi*, *Vibrio cholerae*, *Aeromonas hydrophilia*, *Yersinia enterocolitica*, cryptosporidium, *Listeria*, enteric viruses and protozoan (Haygarth and Jarvis, 2002). Although most strains of *E. coli* are harmless, it has been implicated in diseases (Nataro and Kaper, 1998).

### Table 3: Physicochemical properties of the water samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>pH</th>
<th>Acidity/Alkalinity</th>
<th>Conductivity (microS/cm)</th>
<th>TDS (ppm)</th>
<th>Cl (ppm)</th>
<th>SO₄²⁻</th>
<th>Zn²⁺</th>
<th>Ca²⁺</th>
<th>NH₄⁺</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTW</td>
<td>6.85</td>
<td>+</td>
<td>149.2</td>
<td>98.5</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>X</td>
</tr>
<tr>
<td>BCU</td>
<td>5.71</td>
<td>-</td>
<td>35.8</td>
<td>23.7</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>X</td>
</tr>
<tr>
<td>WSO</td>
<td>7.1</td>
<td>+</td>
<td>68.6</td>
<td>45.5</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>X</td>
</tr>
<tr>
<td>BII</td>
<td>6.05</td>
<td>-</td>
<td>57.9</td>
<td>38.5</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>X</td>
</tr>
<tr>
<td>WOO</td>
<td>5.74</td>
<td>-</td>
<td>62.1</td>
<td>40.6</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>X</td>
</tr>
<tr>
<td>SOO</td>
<td>6.93</td>
<td>+</td>
<td>165.9</td>
<td>109.2</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>X</td>
</tr>
</tbody>
</table>

- **X** A clear, colorless liquid, odorless and tasteless
- **+** Complies with WHO water standard.
- **-** Does not comply with WHO water standard

The different levels of contamination exhibited by the contaminated water samples is expected for PTW, WSO and WOO because well water is usually contaminated through handling and most well water are not adequately treated. BHCU is obviously a well-treated well. PTW and SOO were expected to be free of fecal contaminants but this is not so as shown in the tap water and the storage tank samples. The presence of *E. coli* in the two samples could be because of the distribution network.

Ungate (1996) reported another possible source of contamination of water supply, which could be linked to cross connections used in the joints, leather wash of pumps, faulty plumbing and back siphonage. The use of storage tank may allow the dissipation of chlorine. It is expected that the tap water and water in the storage tanks must have undergone adequate chlorination but Besner *et al.* (2002) reported that the presence of *E. coli* in the tap and storage tank samples could be attributed to a possible regrowth of the organisms despite chlorination.

All the water samples were clear, odorless, colorless and tasteless. The intensity of acidity or alkalinity of a sample is measured on the pH scale, which actually measures the concentration of hydrogen ions present in the sample. The pH of the samples ranged from 5.71 to 6.93. The European Economic Commission (ECC, 1976) pH guide for water requiring simple treatment is 6.5 – 8.5. PTW, WSO, STOO fell within the accepted pH range, while BHCU, BII, WOO had pH values lower than the recommended range.

Conductivity varied from 35.8 - 165.9 µS/cm. Conductivity values of all samples are within acceptable standard. The guide limit of water conductivity is 400 µS/cm (EEC, 1976). The sulphate, calcium, ammonium and zinc ion contained in the samples were in accordance with the World Health Organization (WHO, 1993) standard, while the chloride ions were not.

### CONCLUSION

All the water samples analyzed were found to harbor coliforms in numbers greater than the required World Health Organization (WHO) and the Food and Agricultural Organization (FAO) standards for potable water. It is therefore recommended that appropriate agencies should properly monitor the location and drilling of wells and boreholes by individuals and other agencies by putting in place correct measures and enforcing the right policies concerning potable water.
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REFERENCES


