Bacteriological and physicochemical assessment of Ochaja natural spring water

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Abstract

This study investigated the bacteriological and physicochemical quality of Ochaja natural spring water. The total viable organisms and fecal coliform ranged from 2.3 \times 10^3 cfu/ml to 4.0 \times 10^3 cfu/ml and 1.25 \times 10^3 cfu/ml to 2.3 \times 10^3 cfu/ml. There were no significant differences (p<0.05) in the total viable and fecal coliform counts. The pH tends toward neutrality; the turbidity and nitrate levels were low while higher values of phosphate were observed in the course of the study. There were no significant differences (p<0.05) in the physicochemical qualities of the spring water analyzed. The elevated value of fecal coliform in the spring water is an indication of bacterial contamination. The concentration of the physicochemical parameters was within the acceptable limits of World Health Organization. Therefore, it is imperative that the water should be treated before consumption.

Keywords: bacteria, Ochaja, coliform, contamination, turbidity

1. Introduction

Accessibility and availability of fresh clean water is a key to sustainable development and an essential element in health (Adekunle et al., 2004) [1]. Unfortunately, almost half of the world population is without access to improved sanitation facilities and almost one billion people still lack access to improved drinking-water supplies (Oladipo et al., 2009) [13]. World Health Organization, WHO (1992) reported an estimated four billion cases of diarrhea resulting in about 2.2 million deaths annually. The consumption of unsafe water has been implicated as one of the major causes of this disease. Gradual deterioration of water quality results from increase in human population and urbanization (Ho and Hui, 2001) [4]. Apparently, clear water without taste and odor may be a potential carrier of pathogenic organisms and can endanger health and life of human beings. Water receives microorganisms from air, soil, sewage, organic wastes, dead plants and animals. It is now evident that most of the enteric diseases of human and animals are transmitted through contaminated food and water (Johnson et al., 2003) [6]. The transmission of waterborne diseases is still a matter of major concern, despite worldwide efforts and modern technologies which are employed for the production of safe drinking water (Venter, 2000) [16]. This problem is not only confined to the developing world where water treatment may not exist or is inadequate, but also in some developed countries.

WHO (2000) [19] reported that nearly one-fourth of all hospital beds in the world are occupied by patients with complications arising from infections by waterborne organisms and it also states that nearly 6000 people, mostly children die every day due to waterborne diseases. Though water is abundant, suitable drinking water is limited by geography, demography and affordability (WHO, 2000) [19].

Surface water accumulates mainly as a result of direct runoff from precipitation (National Water Research Institute, 1997). The amount of available surface water depends largely upon rainfall. When rainfall is limited, the supply of surface water will vary considerably between wet and dry season. Surface water is susceptible to algal blooms especially after the “turn overs” (National Water Research Institute, 1997). Surface water supplies may be further divided into rivers, streams, reservoir supplies, lakes and ponds (National Water Research Institute, 1997).
The main problems associated with surface water are solid suspensions, turbidity, iron, and excess of carbon dioxides, deficit of oxygen, organic biomass and high organoleptic parameters (color tastes / odors). Natural pollution of surface water as a result of runoff with agricultural pollutants, fertilizers, pesticides, detergents and pollution with wastes water of animal or human origin is frequent and increasing in Nigeria (National Water Research Institute, 1997). It affects the quality of well, springs and consequently streams, lakes, and reservoirs (Dam). There is no information on the quality of the Ochaja natural spring water. The community including the schools (Ochaja Boys and Girls College) depends on it for their source of water.

This study was undertaken to provide information concerning the bacteria and physicochemical quality of the water which they community has been using for a very long time. This study will also assist the decision-making of the health-workers in the town as well as Dekina Local government Area of Kogi State, Nigeria, to act on any problem that may arise as a result of pollution and provide a partial insight of the microorganisms that might be present in the Ochaja natural spring water which may be pathogenic or not.

Materials and Method

Sampling procedure

Water samples were collected from two different locations from the spring using 250 ml sterile sized-bottles that were properly labeled. Samples were taken once a week for a period of one month (every Monday before 12 noon) and transported to the laboratory in an ice box containing ice packs. The water samples were analyzed within 24 hours.

Determinations of bacterial load in water samples

The total viable count of bacteria were determined by serial dilution and plating on Nutrient agar (NA). The plates were inoculated with 1ml of water and cultured at 37 °C for 24 to 48 hours. The isolates that grew were sub-cultured on Nutrient agar. Characteristic colonies grown on the NA were identified by comparing with known taxa using the schemes of Buchanan and Gibbons (1974). The bacterial isolates were identified on the basis of colonial morphology following Gram’s staining and biochemical tests.

Determination of total / fecal coliform

The pour plate method and spread plate was used to carry out this analysis. 1ml of the water from the serial dilution of 10^3 was inoculated into the sterilized Petri dishes and the prepared Eosin methylene blue agar was poured into the plate containing the inoculum and was gently rocked on the bench to allow for proper mixing and then allowed to gel. The plates for total coliform were cultured at 37 °C for 24 to 48 hours while plates for fecal coliform were incubated in the water bath for 24-48 hours at 44 °C.

Laboratory/ statistical methods

pH of the water was determined using glass electrode pH and conductivity meter (Hannia, Italy). Turbidity was determined using Turbidity meter (WGZ-IB, Shanghai, China). Nitrogen was determined by the micro Kjedahl method as described by Ibitoye (2006). Phosphorus was determined by the Murphy and Riley (1962) method. Descriptive statistics and paired T-test was performed using procedure of SPSS version 16 (2007). Experimental precision achieved was reported at p≤0.05 level.

Result

Table 1 shows the bacterial quality of the Ochaja natural spring water. The total viable count ranged from 1.0 x 10^3 cfu/ml to 6.0 x 10^3 cfu/ml for site A while that of site B ranged from 2.0 x 10^2 - 7.0 x 10^2 cfu/ml. There was no significant difference in the TVC between the two sites. Ordinary coliform were not detected in the course of the study. However, the fecal coliform count ranged from 2.0 x 10^2 - 3.0 x 10^2 cfu/ml in site A and 1.0 x 10^3 - 4.0 x 10^3 cfu/ml in site B. There was no significant difference in the fecal coliform counts at 5% probability level between sites A and B.

Table 2 shows the physicochemical qualities of Ochaja natural spring water. The pH of the water was weakly acidic. The pH ranged from 5.6 to 6.3 in site A. The highest pH value was observed at the fourth week in site A and third week in site B. There was no significant difference in the pH at 5% probability level between sites A and B. The turbidity of the spring water was low. It ranged from 1.02 NTU to 1.06 NTU for site A and 1.02 – 1.24 NTU for site B. There was no significant difference in the turbidity at 5% probability level between the two sites.

The nitrate content was low throughout the period of sampling. It ranged between 0.01%-0.02%. There was no significant difference in the nitrate concentration at 5% probability level between the two sites.

The phosphorus content of the Ochaja spring was high but however within the acceptable limits prescribed by WHO. The highest phosphorus value was observed at week three in site.

Table 1: Bacteriological counts (Mean ± Standard error of mean)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Site A (x 10^3) (Weeks)</th>
<th>Site B (x 10^3) (weeks)</th>
<th>M ± S.D</th>
<th>M±S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVC</td>
<td>6.0</td>
<td>7.0</td>
<td>3.25 ± 2.22a</td>
<td>4.0± 2.45a</td>
</tr>
<tr>
<td>TCC</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>FCC (%)</td>
<td>3.0</td>
<td>2.0</td>
<td>2.25 ± 0.05a</td>
<td>4.0 ± 1.26a</td>
</tr>
</tbody>
</table>

a: means denoted by same alphabet along the same column are not significantly (p<0.05) different.

TVC: Total viable counts of bacteria, TCC: Total coliform counts, FCC: Fecal coliform counts.
Table 2: Physicochemical characteristics of soil analysed (Mean ± Standard error of mean)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Site A (Weeks)</th>
<th>Site B (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>pH</td>
<td>5.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Turbidity</td>
<td>1.02</td>
<td>1.06</td>
</tr>
<tr>
<td>Nitrogen (%)</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Phosphorus (ppm)</td>
<td>15.1</td>
<td>18.1</td>
</tr>
</tbody>
</table>

a: means denoted by same alphabet along the same column are not significantly (p<0.05) different.

Discussion

The total viable bacteria count low. This suggests low level contamination of the spring water (Stephen and Ijah, 2006). This may be as a result of restriction placed by the community on the conduct of the villagers using the spring. The presence of fecal coliform is an indication of contamination by human and animal wastes (Stephen and Ijah, 2006). This may be due to surface runoff from the bank of the spring. The fecal population observed in this study is higher than the recommended value of fecal coliform per 100 ml in drinking water by WHO (1984). This bacteriological quality poses an increased risk of infectious disease transmission to the Ochaja community that depends on the spring for drinking and household chores.

The range of pH of the water was all within the acceptable limit and agrees with that reported by Obire and Amusan (2003). This implies that the pH of the water is acceptable for drinking.

The ranges of values for turbidity in this study were lower than the 5 NTU stipulated by WHO (1984). This may be due to low levels of suspended particulate matter carried by the flowing spring (Stephen and Ijah, 2006).

The nitrate and phosphate values were within the WHO guidelines for potable water. However, the bacteriological quality poses an increased risk of infectious disease transmission to the Ochaja community that depends on the spring for drinking and household chores.

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The nitrate and phosphate values were within the WHO limits for potable water. Their presence in water may be due to the components of domestic wastes entering the spring and surface runoff from farm lands previously enriched with artificial fertilizers such as NPK, urea and superphosphate (Obire et al., 2003; Stephen and Ijah, 2006).

Conclusion

This study has shown that the physicochemical quality of Ochaja natural spring water were within the limits of WHO guidelines for potable water. However, the bacteriological quality of the spring fell short of the requirement by WHO. Fecal coliform observed throughout the period of sampling is a cause for concern as this may become a source of water borne disease. Therefore, it is advisable the spring water is treated before consumption in order to avoid outbreak of water borne disease.

References