Physicochemical changes and bacteriological contamination of drinking water from wash bores in Jere, Borno State, Nigeria

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ABSTRACT

Physicochemical changes and bacteriological contamination of water samples from four different wash boreholes located at various places within Jere local government area of Borno state were carried out, and the results obtained were compared with World Health Organization (WHO), National Agency for Food and Drug Administration and Control (NAFDAC) and Nigeria Standard of Drinking Water Quality (NSDWQ) standard for drinking water. Physicochemical analysis was performed for the analysis of the samples pH, Dissolved carbon (IV) oxide, Chloride, Total hardness, Sulphate, Fluoride, Nitrate, Copper, Lead, Zinc, Iron and Chromium while bacteriological examination was used for the determination of total coliform count and fecal coliform count. However, the boreholes contained abnormal level of total coliform count and inorganic metal such as lead which constitutes a major health problem. Therefore, treatment of water from these washes boreholes before consumption was highly recommended in this study and also people were advised to stop using water from the borehole contaminated with lead content.

Key words: WHO, NAFDAC, NSDWQ, Water and Wash boreholes

INTRODUCTION

Water is present in almost all part of the earth, it constitute up to three quarter (3/4) of the whole earth surface and occurs in three states; solid, liquid and gas, it is mostly require by all forms of life, Man, Animals and plants [1-3]. Water plays indispensible role for sustenance of life, without which no life could survive on earth [4-7]. Maintaining the standard of water is very important for human being since it is directly linked with his daily life [8]. Water is one of the essentials that support all forms of plant and animal life [9-10], and it is generally acquire from two major natural sources; Surface water such as fresh water lakes, rivers, streams, etc. and Ground water such as borehole water and well water [11-12]. The importance of water quality to the health of people cannot be over emphasized. Healthy people and good environment flourish where water is available in adequate quantity and acceptable quality. Adequate provision of water is directly correlated with life expectancy [13]. Many illnesses occurred due to usage of poor quality water. There were estimated 4 billion cases of diarrhoea and 2.2 million deaths annually. The Federal Ministry of Health and various State Ministries of Health in Nigeria are reporting increased number of cases of gastroenteritis, diarrhea, typhoid and cholera which are indicative of poor drinking water quality. The gradual deterioration of water quality is a result of the increase in human populations and urbanization [14-15]. It therefore becomes necessary to monitor at different intervals the quality of water from various sources in a community as to appraise and respond to any health related problem associated with drinking water [16].

Over the years, there has been a considerable growth in the awareness of environmental pollution problems and it has become a major national and international political issues. One of these major pollution problems is water...
pollution. Poor drinking water quality has been identified as one of the major causes of health problems in developing countries. The basic physiological requirements for drinking water as stipulated by World Health Organization (WHO) is about two litres of water per head per day, and a daily supply of one hundred and fifty to two hundred litres cannot be met by majority of developing countries like Nigeria [17]. However, access to safe drinking water and sanitation is critical in terms of health especially for children. For instances, unsafe drinking water contributed to numerous health problems in developing countries such as the one billion or more incidents of diarrhea that occur annually [18-19]. Every year, thousands of cholera cases causing many human fatalities are said to occur in Nigeria. In addition, it has been confirmed in the country that water-related diarrhea is the most prevalent disease among the population after malaria, prompting the need for safe drinking [20-21].Consequent to the realization of the potential health hazards that may result from contaminated drinking water, contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases [19, 22-23].

Heavy metal can also cause serious health effects with varied symptoms depending on the nature and quantity of the metal ingested [24]. The most common heavy metals that humans are exposed to are Aluminum, Arsenic, Cadmium, Lead and Mercury. Aluminum has been associated with Alzheimer’s and Parkinson’s disease, senility and presenile dementia. Arsenic exposure can cause among other illness or symptoms cancer, abdominal pain and skin lesions. Cadmium exposure produces kidney damage and hypertension. Lead is a commutative poison and a possible human carcinogen [25] while for Mercury, toxicity results in mental disturbance and impairment of speech, hearing, vision and movement [26]. In addition, Lead and Mercury may cause the development of autoimmunity in which a person’s immune system attacks its own cells. This can lead to joint diseases and ailment of the kidneys, circulatory system and neurons. At higher concentrations, Lead and Mercury can cause irreversible brain damage [10].

Ground water is a major source of water supply throughout Nigeria. In northern Nigeria especially in Borno State (Jere L. G. A), surface water is very scarce as a result of the very low and erratic rainfall in the region. Hence, throughout Nigeria, individuals, communities, Local, States and Federal government have been sinking wells and boreholes to tap the rich ground water resources for human use and irrigation purposes [13, 16].

The failure in government responsibility to provide potable water has made the people of Borno State (especially Jere local government and Maiduguri metropolis) to source for water from other available sources, such as to drill their boreholes at a depth less than 30.48m which are often called Wash boreholes. These boreholes are widely recognized within the State and it becomes an important source of drinking water in the area. Although, the population congestion and consequent indiscriminate dumping of polluted water may enhance the infiltration of harmful compound into the ground water. Thus the possibility of these contaminations may justify the purpose of this research. Therefore, the objectives of this study is to determine the physicochemical changes and bacteriological contamination of drinking water from Wash bores in Jere Local government area and compare with the standard guideline of drinking provided by NAFDAC NSDWQ and WHO

MATERIALS AND METHODS

SAMPLE SITE
This study was conducted in Jere local government area of Borno state, Nigeria. The study area has a population of 211, 204 [27]. Jere is known for its dryness, with semi-arid climate, savannah or tropical grasslands vegetation, light annual rainfall of about 300-500mm and the average daily temperature ranging from 22 – 35°C, with mean of the daily maximum temperature exceeding 40°C between March and June before the onset of the rains in July to September. Four geographical zones were randomly selected; these include Gomari (A), Maiduri (B), Mairi (C) and London ciki (D). Sampling sites were selected based on their closeness to refuse and waste disposal site. Water samples were collected from four different wash boreholes for the analyses of both physicochemical and bacteriological contamination.

COLLECTION OF SAMPLES
Water samples were aseptically collected from different Wash boreholes located from different geographical zones within the Jere local area of Borno state using sterile plastic bottle. The opening of the tap was sterilized gently and the water was allowed to flow for 2-3 minutes in other to avoid contamination. Then, the bottle was filled with water and allowed some space making shaking possible before the analysis.
PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER

The collected samples were analyzed for different physico-chemical parameters such as pH, Dissolve carbon (IV) oxide, Chloride, Total hardness, Sulphate, Fluoride, Nitrate, Copper, Lead, Zinc, Iron and Chromium [28], and the results were compared with the Nigeria Standard of Drinking Water Quality (NSDWQ), National Food and Drug Administration Agency (NAFDAC) and World Health Organization (WHO).

BACTERIOLOGICAL ANALYSIS

Bacteriological analyses of the water samples were determined using multiple tube fermentation method (most probable number) for enumeration of both total coliform count and fecal coliform count. Lauryl Tryptose Broth (LTB) along with fermentation tubes (Durham tubes) was used. A serial dilution of the water sample to be tested was made and inoculated into LTB growth media. Samples were then incubated at 35°C for 48 h for the presumptive test for total coliform count. After the positive tubes were transferred to Brilliant green lactose bile broth (confirmation test) and incubated for 48 h at 35°C, the growth or gas production confirmed the presence of coliform [29].

RESULTS AND DISCUSSION

Table 1: Results of Physicochemical parameters of Water samples from Wash borehole in Jere L.G.A. Borno State

<table>
<thead>
<tr>
<th>Parameters</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>NSDWQ</th>
<th>NAFDAC</th>
<th>WHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>7.63</td>
<td>7.76</td>
<td>8.13</td>
<td>7.93</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Dissolve Carbon (IV) oxide</td>
<td>15.0</td>
<td>10.0</td>
<td>8.13</td>
<td>7.93</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>79.0</td>
<td>92.0</td>
<td>110.0</td>
<td>104.0</td>
<td>100</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Chloride (mg/l)</td>
<td>12.0</td>
<td>15.0</td>
<td>19.0</td>
<td>11.0</td>
<td>250</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Total Hardness (mg/l)</td>
<td>80.0</td>
<td>40.0</td>
<td>88.0</td>
<td>100.0</td>
<td>150</td>
<td>-</td>
<td>500</td>
</tr>
<tr>
<td>Sulphate (mg/l)</td>
<td>21.0</td>
<td>15.0</td>
<td>11.0</td>
<td>8.0</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Fluoride (mg/l)</td>
<td>0.16</td>
<td>0.14</td>
<td>0.19</td>
<td>0.21</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td>0.038</td>
<td>0.045</td>
<td>0.024</td>
<td>0.032</td>
<td>50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Copper (mg/l)</td>
<td>0.21</td>
<td>0.01</td>
<td>0.26</td>
<td>0.32</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lead (mg/l)</td>
<td>ND</td>
<td>ND</td>
<td>0.12</td>
<td>ND</td>
<td>0.01</td>
<td>0.01</td>
<td>-</td>
</tr>
<tr>
<td>Zinc (mg/l)</td>
<td>0.18</td>
<td>0.32</td>
<td>0.12</td>
<td>0.11</td>
<td>3.0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Iron (mg/l)</td>
<td>0.21</td>
<td>0.30</td>
<td>0.25</td>
<td>0.10</td>
<td>0.3</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Chromium (mg/l)</td>
<td>ND</td>
<td>0.12</td>
<td>0.10</td>
<td>0.08</td>
<td>0.05</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

[30-32] The data presented, is a result of triplicate

Table 2: Bacteriological analysis of water

<table>
<thead>
<tr>
<th>Sample Site</th>
<th>Total coliform count/ ml</th>
<th>Fecal coliform count</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80.0</td>
<td>1.0</td>
</tr>
<tr>
<td>B</td>
<td>60.0</td>
<td>0.0</td>
</tr>
<tr>
<td>C</td>
<td>90.0</td>
<td>0.0</td>
</tr>
<tr>
<td>D</td>
<td>96.0</td>
<td>0.0</td>
</tr>
<tr>
<td>WHO</td>
<td>0 per 100ml</td>
<td>0 per 100ml</td>
</tr>
<tr>
<td>NSDWQ</td>
<td>10 per 100ml</td>
<td>0 per 100ml</td>
</tr>
</tbody>
</table>

The results of the physicochemical analysis unravel that the pH of the water samples from four different locations A, B, C and D were adhere to the standard limit of pH recommended by both NSDWQ and NAFDAC, with a water samples from C having the highest pH of 8.3 while A has the lowest pH of 7.63, even though pH do no have negative impact on human health, its indirect action on physiological process cannot be over emphasized [7, 31 and 33]. Also, a little bit rises in pH level may depress the effectiveness of the disinfectants like chlorination thereby requiring the additional chloramines [34]. The total alkalinity of all the water samples comply with the standard or acceptable level of 100 by NAFDAC and 80 by WHO, with the exception of water samples from C whose having 110 and D having 104. Total Alkalinity is a measure of the amount of buffering capacity in the water. It acts as a shock absorber for the pH. If Total Alkalinity is too low, the water is acidic and can corrode equipment and pool surfaces. It also causes pH bounce. The pH will drift down and any adjustments made to it will bounce and be difficult to control. If Total Alkalinity is too high as in water samples from C and D, the water is alkaline and scale buildup and cloudy water can result. The chloride content of all the water samples fall within the standard range recommended by NAFDAC, WHO and NSDWQ with a water samples from C have the greater chloride content of 19mg/l while samples from D had the lowest concentration of 11mg/l. Also, the total hardness of all the water samples were within the standard range of 150 acceptable limit recommended by NSDWQ and 500 recommended by WHO, with a water sample from D having the highest total hardness of 100 while B had the lowest total hardness.
of 40. However, presence of total hardness above the standard indicates that the water sample contains viable amount of Calcium and Magnesium ions.

The sulphate content of all the water samples range between 8-21mg/l which fall within the standard limit of 100mg/l by NSDWQ, 200mg/l by both NAFDAC and WHO, even though presence of sulphate above standard was not incriminated with any negative impact [31]. The nitrate content of all the water samples comply with the standard of 50mg/l recommended by NSDWQ, with water sample from B had the highest content of 0.048mg/l while C having the lowest content of 0.024mg/l. Also both the copper and fluoride content from all the water samples conformed to standard of 1mg/l and 1.5mg/l by NSDWQ respectively. However, presence of copper above the standard set by NSDWQ may cause gastrointestinal distress with a shorter term exposure while a long term exposure may experience liver or kidney damage [35]. Also, fluoride has been fairly conclusively demonstrated to be an essential element to animal including man’s teeth and bone. Although, there is good evidence to show that the presence of fluoride in water result in a substantial reduction of dental carriers in both children and adults, mottling may sometime occur even to an objectionable degree, when the level rise above 1.5mg/l [33]. Also, water samples from C found to have greater lead content of 0.12mg/l above the standard limit of 0.01mg/l recommended by NSDWQ. Presence of lead above recommended standard may produce adverse health effect which include interference with red blood cell chemistry, delay in normal physical and mental development in babies and young children, slit deficit in attention span, hearing and learning abilities of children and slight increase in blood pressure in some adults. Also presence of lead in drinking water had been shown to result in chronic toxic effect (Including liver and kidney damage, internal haemorrhage and respiratory disorders) in animal and human by ingestion, although the other samples were within the standard range.

The zinc content of all the water samples conforms to the standard of 3.0mg/l acceptable level recommended by NSDWQ and 5.0mg/l by both NAFDAC and WHO. Similarly, the iron content of the samples falls within the ranges of 0.3mg/l acceptable level by both NSDWQ and WHO. However, the chromium content of the water samples from D exceeded the acceptable level of 0.05mg/l approved by NSDWQ. Presence of this compound above the standard have adverse effect, it may even lead to cancer, although the remaining samples conform to the standard or acceptable level recommended by NSDWQ. This result of this study is not surprising considering close proximity of the wash borehole used in this study, to pit latrines. Probable, the sewage could seep slowly into boreholes, thereby polluting it. Also, long term usage of these boreholes may lead to deterioration of the water quality, because the pipeline may become corroded which may allow the seepage of inorganic metal, leading contamination of the water. Table 2 shows the results of bacteriological examination of drinking water from different wash boreholes in Jere local government area of Borno state. The total coliform count from this study range between 60 and 96.0cfu/ml, with water from point D has the highest coliform count while water from point B has the lowest coliform count, although all the water samples exceeded the standard limit of 0cfu/100ml established by WHO and 10cfu/100ml by NSDWQ. The implication of this finding is that water from these wash boreholes may look clean to naked eye and have no unwanted odour or taste but contains pathogenic bacteria that can cause significant illness such as gastrointestinal tract infection which may even become fatal in severe condition. The results of this study correlate with the report of Isa et al. [13] who showed that the water samples from wash boreholes was highly contaminated with coliform bacteria. However, with the exception of water sample from point A which has the facal coliform count of 1cfu/ml, all the remaining samples have zero fecal coliform count, which indicate that the water samples are free from recent faecal contamination. The ability to detect faecal contamination in drinking water is of paramount importance, since pathogenic microorganisms from human and animal faeces in drinking water pose the greatest danger to human health.

CONCLUSION

The usefulness of water in sustenance of life fascinating the attention of both governmental and non-governmental organization such as NAFDAC, NSDWQ and WHO to establish the standard of the drinking water quality. Important of good quality water cannot be overemphasizes, failure in government responsibility to provide potable water has made the people of Borno State (especially Jere local government and Maiduguri metropolis) to source water from other available sources, such as to drill their boreholes at a depth less than 30.48m which are often called Wash boreholes. In this study water samples from wash borehole at different location within the local government were collected and analyzed for both physicochemical and bacteriological parameters, although the boreholes contained abnormal level of total coliform count and inorganic metal such as lead which constitutes a major health
problem. Therefore, treatment of water from these washes boreholes before consumption was highly recommended in this study and also people were advice to stop using water from the borehole contaminated with lead content.

REFERENCES


