

Water Quality Analysis of Akure Metropolis, Ondo State, Nigeria

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ABSTRACT: This study was carried out to analyze the quality of drinking water supplied to Akure metropolis by Ondo State Water Corporation, ODSWC (Ukere Tap water), TISCO Pharmaceutical Company, and Benin Owena River Basin Development Authority (BORBDA) Akure. Samples from these different sources were collected and taken to the laboratory for analysis. ODSWC (Ukere Tap water), TISCO (Bore hole) and BORBDA (Bore hole). Physical, Chemical and Bacteriological tests were carried out on each sample and the values compared with NAFDAC and World health organization (WHO) guidelines for drinking water. The physical parameters showed that the PH ranges from 4.5 to 6.3 which are slightly acidic. The highest Temperature of 30.6^oc was recorded in the month of April while the lowest temperature of 27.4^oc was recorded in the month of August, these occurred due to weather variation. The chemical parameters revealed that for all the samples from the three locations: Turbidity value ranges from (0.11NTU to 1.44NTU), Electrical conductivity (142 to 412us/cm⁻¹). Total Dissolved Solids (89 to 276mg/l), Total hardness (22-120mg/l), Nitrate (2.10to 23.5mg/l), Total alkalinity (0 to 44mg/l), Chlorides (0.0 to 0.3 mg/l), Chromium (0.01 to 0.03mg/l), Fluoride (0.06-0.23mg/l), Iron (0.00 to 0.06mg/l). The results of chemical parameters for all the samples conform to WHO standard. E-coli and Total coli form were not found in sample from TISCO, the highest recorded value of E-coli(57) and Total coli form(99) were found in sample from BORBDA which is very high and above WHO,(1993) recommended standard. This shows that there is an indication that the water is polluted with fecal or the water line has been mixed with sewage line. To improve the bacteriological Quality of water it is recommended to make the installed chlorination devices functional.

Keywords: Water, Quality, Health, Environment, Contaminants.

I. INTRODUCTION

Monitoring of drinking water is essential because water must be free from contaminants which may adversely affect the human health because the quality of drinking water is a powerful environmental determinant of health. (WHO, 2010). Water plays an indispensable role in sustenance of life and it is a key pillar of health determinant, since 80% of diseases in developing countries are due to lack of good quality water(Cheesbrough,2006). In Nigeria, urbanization, industrialization, agriculture and various activities has increase the pollution of surface water and ground water (Okonko et al., 2009). With the increasing attention on water quality of receiving water bodies, Regulatory authorities such as NAFDAC and WHO strive to mitigate the adverse impacts of urbanization and population growth on water environment by implementing water quality strategies. It is also estimated in Nigeria that Diarrhea, water borne disease is reported as the leading cause of death in infant and children while Adults suffers from illness and disease caused by polluted water. A number of studies and test conducted in different areas of Akure have shown that the population is exposed to unsaved drinking water due to varying level of biological contamination effect on the drinking water quality in Akure environment. There has been a report of borehole water contamination through domestic waste water if there is a puncture in a layer of soil (Obi and Okacha, 2007). The purpose of this research work is to present an assessment on present drinking water quality off three areas in Akure and to propose preventive measures if any lapses observed.

II. MATERIALS AND METHODS

Sampling area: Akure metropolis is the study area. Akure is the capital of Ondo State located in southwestern part of Nigeria. Alagbaka quarters, NEPA area, and Old Ado-Owo road represent the sampling sites. These areas are surrounded by Government/Corporate buildings and residential homes, and water is served through piped supply system.

Samples Collection and Analysis:

Samples from the three selected locations of the town were collected in sterilized wrapped bottles for a period of three months and brought to the laboratory for analysis. Standard methods and protocols were followed to

carry out sampling and analysis. One direct sample source was ODSWC (Ukere Tap water) from the area while the remaining samples were collected from borehole sources (BORBDA) and (TISCO).

Physical, chemical and bacteriological parameter tests were carried out on the water samples collected in the laboratory. Temperature and PH of the samples were recorded insitu at the time of samples collection by using thermometer and pocket digital PH meter. Samples Turbidity was measured using Turbidity meter H1 93703(HANNA). Other parameters such as TDS, THD, CAH, Calcium magnesium, sulphate, phosphate, ammonium, sodium, chloride, nitrate, potassium, and fluoride were estimated in the laboratory using digital titration method 8207 and spectrophotometer (Merck). Bacteriological analysis was carried out using viable counting technique (CFU).

III. RESULTS AND DISCUSSIONS

Table 1: Summary of Physical, Chemical, and Bacteriological tests result on the ODSWC (Ukere Tap water).

| S/N | PARAMETERS | NAFDAC MAXIMUM ALLOWED LIMITS | WHO STANDARD (Maximum permissible limits) | APRIL | JUNE | AUGUST |
|-----|-------------------------------------|-------------------------------------|---|--------|--------|--------|
| 1 | PH | 6.50-8.50 | 6.50-8.50 | 4.5 | 5.4 | 5.6 |
| 2 | Temperature(^o c) | | | 30.6 | 30.6 | 28.8 |
| 3 | Conductivity (us/cm ⁻¹) | 1000 | 1200 | 412 | 395 | 410 |
| 4 | Turbidity (NTU) | 5.0 | 5.0 | 1.36 | 0.53 | 0.45 |
| 5 | Total Alkalinity (mg/l) | 100 | 100 | 2.0 | 6.0 | 0 |
| 6 | Iron (mg/l) | 0.3 | 3 | 0.02 | 0.02 | 0.06 |
| 7 | Total Dissolved Solids (mg/l) | 500 | 1000 | 276.04 | 264.65 | 274.7 |
| 8 | Total Hardness (mg/l) | 100 | 500 | 92.0 | 86 | 120 |
| 9 | Calcium (mg/l) | 75 | NS | 8.82 | 9.62 | 11.22 |
| 10 | Magnesium (mg/l) | 20 | 20 | 17.08 | 15.13 | 22.45 |
| 11 | Sulphate (mg/l) | 100 | 500 | 0 | 1 | 0 |
| 12 | Chromium (mg/l) | 0.05 | 0.05 | 0.03 | 0.02 | 0.01 |
| 13 | Fluoride (mg/l) | 1.0 | 1.5 | 0.11 | 0.18 | 0.11 |
| 14 | Chloride (mg/l) | 100 | 250 | 50.99 | 46.0 | 52.98 |
| 15 | Nitrate (mg/l) | 10 | 50 | 5.5 | 23.5 | 16.1 |
| 16 | Potassium (mg/l) | 10 | NS | 16.7 | 15.8 | 12.0 |
| 17 | E.Coli | | | 2 | 0 | 0 |
| 18 | Total Coli form | | Must not be detected in any 100ml sample. | 24 | 0 | 1 |
| 19 | Faecal Streptococci | | | 0 | 0 | 0 |

Table2: Summary of Physical, Chemical, and Bacteriological tests result on the borehole water (TISCO)

| S/N | PARAMETERS | NAFDAC MAXIMUM ALLOWED LIMITS | WHO STANDARD (Maximum permissible limits) | APRIL | JUNE | AUGUST |
|-----|-------------------------------------|-------------------------------------|---|--------|--------|--------|
| 1 | PH | 6.50-8.50 | 6.50-8.50 | 5.8 | 6.1 | 6.2 |
| 2 | Temperature(^o c) | | | 29.8 | 28.5 | 29.5 |
| 3 | Conductivity (us/cm ⁻¹) | 1000 | 1200 | 179 | 173 | 175 |
| 4 | Turbidity (NTU) | 5.0 | 5.0 | 1.44 | 0.31 | 0.17 |
| 5 | Total Alkalinity (mg/l) | 100 | 100 | 2.0 | 44.0 | 8.0 |
| 6 | Iron (mg/l) | 0.3 | 3 | 0.02 | 0.00 | 0.02 |
| 7 | Total Dissolved Solids (mg/l) | 500 | 1000 | 119.93 | 115.91 | 117.25 |
| 8 | Total Hardness (mg/l) | 100 | 500 | 60.0 | 66 | 98.0 |
| 9 | Calcium (mg/l) | 75 | NS | 12.83 | 11.22 | 30.46 |
| 10 | Magnesium (mg/l) | 20 | 20 | 6.8 | 9.27 | 5.37 |
| 11 | Sulphate (mg/l) | 100 | 500 | 2 | 0 | 3 |
| 12 | Chromium (mg/l) | 0.05 | 0.05 | 0.03 | 0.01 | 0.02 |
| 13 | Fluoride (mg/l) | 1.0 | 1.5 | 0.17 | 0.23 | 0.06 |
| 14 | Chloride (mg/l) | 100 | 250 | 7.99 | 15 | 17.99 |
| 15 | Nitrate (mg/l) | 10 | 50 | 2.3 | 2.7 | 3.8 |
| 16 | Potassium (mg/l) | 10 | NS | 3.00 | 1.6 | 2.0 |
| 17 | E.Coli | | | 0 | 0 | 0 |
| 18 | Total Coli form | | Must not be detected in any 100ml sample. | 0 | 0 | 0 |
| 19 | Faecal Streptococci | | | 0.17 | 0 | 0 |

Table2: Summary of Physical, Chemical, and Bacteriological tests result on the borehole water (BORBDA)

| S/N | PARAMETERS | NAFDAC MAXIMUM ALLOWED LIMITS | WHO STANDARD (Maximum permissible limits) | APRIL | JUNE | AUGUST |
|-----|-------------------------------------|-------------------------------|---|--------|-------|--------|
| 1 | PH | 6.50-8.50 | 6.50-8.50 | 5.9 | 6.0 | 6.3 |
| 2 | Temperature(^o c) | | | 30.9 | 26.0 | 27.4 |
| 3 | Conductivity (us/cm ⁻¹) | 1000 | 1200 | 155 | 142 | 133 |
| 4 | Turbidity (NTU) | 5.0 | 5.0 | 0.39 | 0.11 | 0.85 |
| 5 | Total Alkalinity (mg/l) | 100 | 100 | 4.0 | 8.0 | 8 |
| 6 | Iron (mg/l) | 0.3 | 3 | 0.01 | 0.02 | 0.01 |
| 7 | Total Dissolved Solids (mg/l) | 500 | 1000 | 103.85 | 95.14 | 89.11 |
| 8 | Total Hardness (mg/l) | 100 | 500 | 62.0 | 32 | 22 |
| 9 | Calcium (mg/l) | 75 | NS | 10.42 | 2.44 | 8.16 |
| 10 | Magnesium (mg/l) | 20 | 20 | 8.78 | 8.82 | 0.49 |
| 11 | Sulphate (mg/l) | 100 | 500 | 2 | 2 | 1 |
| 12 | Chromium (mg/l) | 0.05 | 0.05 | 0.02 | 0.01 | 0.01 |
| 13 | Fluoride (mg/l) | 1.0 | 1.5 | 0.07 | 0.10 | 0.06 |
| 14 | Chloride (mg/l) | 100 | 250 | 0.00 | 6.0 | 0.8 |
| 15 | Nitrate (mg/l) | 10 | 50 | 2.7 | 2.10 | 3.6 |
| 16 | Potassium (mg/l) | 10 | NS | 21.0 | 30 | 18.5 |
| 17 | E.Coli | | | 7 | 9 | 57 |
| 18 | Total Coli form | | Must not be detected in any 100ml sample. | 10 | 22 | 99 |
| 19 | Faecal Streptococci | | | 1 | 8 | 37 |

PH, Total Alkalinity and Temperature

The samples collected from the three locations were analyzed against selected Parameters. According to WHO Standard, PH of drinking water should be between 6.5 to 8.5. PH values of all the tested water for the three months were below 6.5. That means, not within WHO desirable limit. This can enhance corrosion of water mains and house hold plumbing system. Total alkalinity values of all the three samples for the three months ranges from 0mg/l to 44mg/l. WHO standard have specified 100mg/l for maximum permissible limit for Alkalinity. TISCO (Bore hole) recorded the highest value of 44mg/l in the month of June, while 0mg/l was recorded for ODSWC (Ukere Tap water) in the month of August, all these values are within the permissible limit. The temperature of ODSWC (Ukere Tap water) varies between 28.5 and 30.6, TISCO (Bore hole) 28.5 and 29.8 and BORBDA (Bore hole) between 30.9 and 26.0.

Conductivity

WHO standard maximum permissible limit for conductivity is 1200us/cm⁻¹. All the values of the three samples from the three locations have their conductivity ranges between 142 and 412us/cm⁻¹. That is, the highest conductivity value is 412us/cm⁻¹ and the lowest 142us/cm⁻¹. It is a direct reflection of the salinity, which is also a function of the salt content of the samples. The electrical conductivity of all the samples were within the permissible limits of (NAFDAC, WHO, 2003). This is due to the lower concentrations of cat ions and anions in the water samples analyzed. Since electrical conductivity is an indicator of how salt- free, ion-free, impurity free a water sample is (Aktar et al., 2010).

Turbidity, Total Dissolved Solids and Total Hardness

The turbidity level of all the three samples for the period of three month were also within WHO permissible limits with lowest value of 0.11NTU and highest value of 1.44NTU. WHO maximum standard permissible limit is 5.0NTU. The highest TDS (Total Dissolved Solids) recorded for all the sample is 276mg/l and the lowest is 89mg/l. The TDS is the term used to describe the inorganic salt and small amount of organic matter present in water solution. The principal constituents are usually calcium, magnesium, sodium and potassium cat ion, carbonate, hydrogen carbonate, chloride, sulphate and nitrate anion (WHO, 1996). Since no health based guideline is proposed by WHO for TDS, and TDS higher than 1000mg/l impact taste to the water, therefore, a desirable value of 1000mg/l is proposed by WHO so all the samples TDS are within the specified WHO standard permissible limit. The value of Total hardness of all the samples varies within the maximum value of 120mg/l for ODSWC (Ukere Tap water) and minimum value of 22mg/l for BORBDA (Borehole), all value below WHO maximum permissible limits.

Nitrates and Chloride

For all the three samples, the values of nitrates ranges from 2.10mg/l to 23.5mg/l. Ukere Tap water has maximum Nitrate value of 23.5mg/l in the month of June while BORBDA(Bore hole) has minimum value of 0.11mg/l in the same month. WHO standard have specified the guidelines value for Nitrate to be 50mg/l, so all the samples value are below WHO maximum standard value. The WHO standard maximum permissible limit of

chloride for drinkable water is 250mg/l. the values of chloride of all the samples from the three location ranges from 0.8mg/l to 52.98mg/l. The maximum value was recorded in the month of August for ODSWC (Ukere Tap water) while the minimum value was recorded for BORBDA (Bore hole) also in the month of August. All the values were within WHO maximum specified limit.

Chromium, Fluoride, and Iron.

WHO Specified 0.05mg/l as maximum permissible value for chromium. All the values of the three samples from three locations were below the specified maximum value. The maximum value recorded is 0.03mg/l while the lowest value is 0.01mg/l. The minimum value of Fluoride recorded for the samples is 0.06mg/l while the maximum value is 0.23mg/l. All the values are below WHO maximum permissible standard limit which is 1.5mg/l. All the values of Iron recorded for all the samples ranges from 0.00mg/l to 0.06mg/l all are below maximum value specified by WHO which is 3mg/l.

Bacteriological

The World Health Organization, (1993) recommended that the number of bacteria and coli form count should be zero per colony. Also according to WHO guideline 2008, there must be no total coli forms per 100ml of sample. The total coli form results of TISCO (Bore hole) water is zero and it is safe for drinking, other samples from ODSWC (Ukere Tap water) and BORBDA(Bore hole) water had total coli form contamination. If the total Coli forms is found in drinking water then there is indication that the water is polluted with fecal or the water line has been mixed with sewerage line. The results of TISCO (Bore hole) shows that the water is free from fecal contaminants, ODSWC (Ukere Tap water) also had lower numbers of fecal contaminants while BORBDA(Bore hole) had highest number of Fecal contaminants. Contaminations also show that water has come in contact with human faeces.

IV. CONCLUSIONS AND RECOMMENDATIONS

From the study, it is concluded that the selected physical and chemical parameters, with exception of PH were acceptable within acceptable limits set by WHO standards and hence suitable for drinking and other domestic purposes. However, bacteriological results such as E.coli, Total coli form and fecal streptococci of BORBDA (borehole) water were alarming and exceeded the water quality standards and pose a threat to humans' health. The total coli form seen in BORBDA samples show the indication that the water line may be mixed with sewerage line .In order to prevent increase level of contamination there is a need of proper analysis and prior treatment.

To improve the bacteriological quality of water, it is recommended to make the installed chlorination devices functional. Borehole operators must be trained to use these devices properly and to administer proper dose of chlorine. Treatment of polluted water should be carried out by installing separate monitoring plants in the housing societies. The leakage problems in the pumping assembly should be rectified by replacing old and rusted parts and using chemical sealants at the earliest.

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