Physico-Chemical Quality Assessment of Various Bottled Commercial Water Brands in Okada Town, Edo State, Nigeria

F. W. Ngubi¹ and I. Eiroboyi¹*  
¹Department of Chemical/Petroleum Engineering Igbinedion University, Okada, Nigeria.

Authors’ contributions  
This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information  
DOI: 10.9734/CJAST/2021/v40i1531407  
(1) Dr. Teresa De Pilli, University of Foggia, Italy.  
(1) Zwahruddeen Muhammad SALISU, National Research Institute for Chemical Technology (NARICT), Nigeria.  
(2) Ngiongboung Nguiamba, University of Ngaoundere, Cameroon.  
Complete Peer review History: http://www.sciarticle4.com/review-history/70398

ABSTRACT  
In this study, Physico-chemical assessment of some commercial drinking water sold in bottles in Okada Town was evaluated to ascertain their compliance with World Health Organization (WHO) and Nigerian Industrial Standard (NIS): Nigerian Standard for Drinking Water Quality threshold limits using standard analytical methods. Seven different bottled water samples obtained from different manufacturers labelled BWA to BWG were analyzed physically and chemically. Physical examination of the samples showed that they were odourless, colourless, and tasteless. Chemical quality parameters examined were pH, Chloride (Cl⁻), total hardness (TS), Phosphate (PO₄³⁻), Nitrate (NO₃⁻), Sulphate (SO₄²⁻), Iron (Fe), Potassium (K), Sodium (Na), Manganese (Mn), Zinc (Zn), total dissolved solids (TDS), conductivity, turbidity, and total suspended solids (TSS). The pH values of 57.1% of the water samples (BWA, BWB, BWC, BWE & BWF) were within the standards. The remaining chemical quality parameters (Cl⁻, TS, PO₄³⁻, NO₃⁻, Sulphate SO₄²⁻, Iron Fe, K, NA, Mn, Zn, TDS, Conductivity, turbidity, and TSS) of the branded bottled water samples were within the standards for clean and safe drinking. Therefore, they were considered safe and fit for human consumption.

*Corresponding author: E-mail: ebitoh@yahoo.com;
Keywords: Water brands; drinking water; physicochemical quality; borehole.

1. INTRODUCTION

Water is a vitally necessary component of all flora and fauna [1]. All life-sustaining biochemical processes occur in a water medium [2]. It is an indispensable natural resource without which life will cease to be, both in animals and plants [3]. Water is plenty in nature, making up 71% of the earth's surface [4], and yet just a meager 1% is accessible for human consumption [5].

Potable water is water that could be consumed without the risk of acute or chronic harm or injury. [6] assert that various physicochemical and biological agents pollute water sources. Previous research has shown that man is suffering from the scarcity of good quality drinking water despite its relative abundance in nature [7]. Good quality drinking water is devoid of harmful chemical substances and disease producing microbes [7]. Furthermore, [8, 9] agree that potable water should possess neither taste, colour nor odour and should be devoid of faecal waste. Human health depends to a large extent on quality, safe, and clean water available in adequate quantities [10]. Previous studies have shown that lack of access to safe and adequate water supply is partly responsible for illness and death mostly in children [11]. Public health protection and maintenance vitally depends on water quality control [11].

The physicochemical quality of drinking water is of paramount importance and monitoring. Therefore, it must be given the highest priority. According [12], “Several studies on the quality of sachet water have reported violations of international quality standards”. According to the Institute of Public Analysts of Nigeria (IPAN), 50% of the sachet water sold in the streets of Lagos may not be fit for consumption [13]. The possibility that the same situation may be applicable to bottled water sold in Okada prompted this study. The objective of this study was to investigate some physico-chemical qualities of seven widely consumed bottled water brands sold in Okada Town and to recommend plausible solutions.

2. MATERIALS AND METHOD

2.1 Study Area

Okada is a rural area community; it is the headquarters of Ovia North East Local Government Area of Edo State, which was created on 27th August 1991. It has an area of 2,301km² and a population of 153,849 at the 2006 census. Okada lies on the geographical coordinates of 6°44'0"N, 5°23'0"E, Okada is a warm weather region; therefore, there is a high rate of consumption of drinking water.

2.2 Sample Collection

A preliminary survey identified 10 brands of bottled water sold in Okada and the most readily available and popular to consumers were chosen for the study. Seven (7) brands of bottled water were randomly purchased in plastic bottles from provision stores situated at different locations in Okada town. Plastic bottle sizes ranged from 0.75 to 1.5 liters in volume. To keep the brand names anonymous, the samples were coded BWA, BWB, BWC, BWD, BWE, BWF, and BWG.

2.3 Sample Preservation and Treatment

The samples were then taken to the laboratory and refrigerated at standard conditions (at 4 °C). The apparatus used for the analyses were properly washed and rinsed and all reagents used were of analytical grade. Standard methods of analyses were employed in the various physico-chemical parameter determination.

2.4 Physical Analysis

Appearance and taste of the samples were evaluated subjectively using 5-member laboratory, specialized technician alongside the researchers. The standard operating procedure for water analysis as specified by NIS (2017). Objective physical analysis was done using instrumental methods. Conductivity was determined with a conductivity meter as described by [14]. The total suspended solids (TSS) content and turbidity of each water sample were determined with the HACH portable colorimeter (Model DR/350) as described by [14].

2.5 Chemical Analysis

pH of each water sample was determined with a pH meter (pH-550 Precision pH/mV meter, Lohand Biological) after standardization with buffer solution. Chloride was determined by the silver nitrate titrimetric method as described by [14]. Total hardness was determined by the
Ethylene Diamine Tetra Acetic acid (EDTA) titrimetric method as described by [14]. Phosphate was determined by the molybdate spectrophotometric method, Nitrate was determined by the spectrophotometric sodium salicylate method, while Sulphate was determined by a titrimetric method described by [14].

2.6 Determination of other Metals
Calcium, sodium, and potassium were determined by standard methods using the flame photometer [15]. Iron was determined by a colorimetric method and ferrover iron powder pillow reagent was used as described by the HACH colorimeter manual.

3. RESULTS

3.1 Selected Physical and Aggregate Parameters

Results of selected physical and aggregate parameters obtained in the seven bottled water samples are presented in Table 1.

Table 1. Selected physical properties of the investigated bottled water brands from Okada Town

| Parameter          | Appearance | Taste | TDS (mg/L) | EC(μS/cm at 25°C) | Turbidity (NTU) | Total suspended solids (mg/L) |
|--------------------|------------|-------|------------|-------------------|-----------------|------------------------------|
| Brand code         |            |       |            |                   |                 |                               |
| BWA                | CCL        | UTS   | 18         | 20                | 0               | 0                             |
| BWB                | CCL        | UTS   | 35         | 26                | 0               | 0                             |
| BWC                | CCL        | UTS   | 31         | 60                | 0               | 0                             |
| BWD                | CCL        | UTS   | 40         | 80                | 0               | 0                             |
| BWE                | CCL        | UTS   | 20         | 19                | 0               | 0                             |
| BWF                | CCL        | UTS   | 46         | 90                | 0               | 0                             |
| BWG                | CCL        | UTS   | 30         | 60                | 0               | 0                             |
| Range              | -          | -     | 18.46-35   | 19-90             | -               | -                             |
| Mean               | -          | -     | 31.42      | 50.71             | -               | -                             |
| NIS                | UTS        | UTS   | 500        | 1000              | 5               | N/A                           |
| WHO 2017           |            |       | 500        | 1000              | 5               | 500                           |

CCL=Clear colourless; UTS= Unobjectionable taste.

3.2 Results of Chemical Analysis

Table 2. Selected chemical properties of the investigated bottled water brands from Okada Town

| Parameter          | pH | Cl⁻ (mg/L) | TH (mg/L CaCO₃) | PO₄³⁻ (mg/L) | NO₃⁻ (mg/L) | SO₄²⁻ (mg/L) | Iron (mg/L) | K⁺ (mg/L) | Na⁺ (mg/L) | Ca²⁺ (mg/L) | Mn²⁺ (mg/L) | Zn²⁺ (mg/L) |
|--------------------|----|------------|-----------------|--------------|-------------|--------------|--------------|-----------|------------|------------|------------|------------|
| Brand code         |    |            |                 |              |             |              |              |           |            |            |            |            |
| BWA                | 6.7| 2.73       | 0.8             | 0.0          | 0.0         | 0.07         | 0.06         | 0.56      | 0.64       | ND         | ND         |
| BWB                | 6.9| 3.8        | 1.21            | 0.16         | 0.50        | 0.08         | 0.09         | 0.52      | 1.00       | 0.017      | 0.05       |
| BWC                | 5.9| 5.5        | 1.09            | 0.22         | 0.38        | 0.22         | 0.15         | 0.49      | 0.84       | 0.017      | 0.07       |
| BWD                | 6.4| 5.1        | 1.32            | 0.11         | 0.27        | 0.11         | 0.22         | 0.18      | 0.34       | 1.14       | 0.013      | 0.05       |
| BWE                | 6.6| 3.0        | 0.8             | 0.0          | 0.0         | 0.07         | 0.04         | 0.48      | 0.70       | ND         | ND         |
| BWF                | 6.6| 4.8        | 1.41            | 0.19         | 0.49        | 0.19         | 0.09         | 0.28      | 1.17       | 0.010      | 0.02       |
| BWG                | 6.0| 3.4        | 1.19            | 0.08         | 0.59        | 0.18         | 0.18         | 0.07      | 0.59       | 0.98       | 0.008      | 0.10       |
| Range              | 5.9-6.9| 2.73-5.5 | 0.8-1.41       | 0.0-0.22     | 0-0.59      | 0-0.07       | 0-0.04       | 0-0.28     | 0-0.64     | 0-0.1      | 0-0.01     | 0-0.16     |
| Mean               | 6.45| 4.05      | 1.12            | 0.11         | 0.32        | 0.12         | 0.09         | 0.47      | 0.92       | 0.01       | 0.04       | 0.07       |
3.3 Classification of Bottled water Brands

Table 3. Classification of drinking water based on TDS and TH in mg/L (Present study)

| S/n | Brand code | TDS (mg/L) | EU Class | TH (mg/L) | Water class |
|-----|------------|------------|----------|-----------|-------------|
| 1   | BWA        | 18         | very low mineral concentration | 0.8       | Soft        |
| 2   | BWB        | 35         | very low mineral concentration | 1.21      | Soft        |
| 3   | BWC        | 31         | very low mineral concentration | 1.09      | Soft        |
| 4   | BWD        | 40         | very low mineral concentration | 1.32      | Soft        |
| 5   | BWE        | 20         | very low mineral concentration | 0.8       | Soft        |
| 6   | BWF        | 46         | very low mineral concentration | 1.41      | Soft        |
| 7   | BWG        | 30         | very low mineral concentration | 1.19      | Soft        |

4. DISCUSSIONS

4.1 Selected Physical and Aggregate Parameters

4.1.1 Appearance, taste, colour, and turbidity

Result of the physical analyses (Table 1) showed that the bottled samples were colourless, odourless, tasteless. Turbidity, which was within the acceptable value of WHO/NIS of less than 5NTU was not detected in any of the samples. This is an indication that the bottled water sold in Okada Town is well filtered and good for human consumption. The presence of particles such as silt, clay, and other forms of living microorganisms and non-living materials found in water results in degradation in clarity [16].

pH is a measure of hydrogen ion concentration in water. Its values recorded in this work were between 5.9 – 6.9 as shown in Table 1, this means that the samples were acidic. 75% of the samples (BWA, BWB, BWE, and BWF) fall within the [17] permissible limit for portable water. Samples BWC, BWD, and BWG were slightly more acidic, having pH values less than 6.5., and hence falling short of the standard. The pH value is an important index of acidity or alkalinity and the concentration of hydrogen ions in water.

4.1.2 EC and TDS

Table 1 shows that the electrical conductivity (EC) of the samples ranged between (19 – 90 μS/cm), having an average value of 50.7 μS/cm. Sample BWG had the highest electrical conductivity of 90 μS/cm, which is 11.1 times less than the WHO standard. EC is important because it is a measure of cations that affect taste in no small way, and thus has a significant impact on the user acceptance of water as potable [18]. It was observed that the TDS values, on the other hand, appeared in the range of 18-46 mg/L with the mean of 31.42 mg/L. It is also observed that 57.14% of the branded bottled water samples (BWC, BWD, BWF & BWG) had TDS values which were approximately half the magnitude of their corresponding EC values. These kind of coincidences between the EC and TDS values may point to a direct relationship between the two parameters.

4.1.3 TH

The results shown in Table 1 indicate that the total hardness of branded bottled water samples ranges from 0.8 – 1.41 mg/L with a mean value of 1.12mg/L. The TH values for the water samples in question were far below the national and international standards of NIS (150 mg/L) and WHO (500 mg/L), respectively. It was observed that BWA & BWE branded bottled water samples contained the lowest amount of TH and the highest amount was found in BWF. Water can be classified as soft (<75 mg/L), moderately hard (75-150 mg/L), hard (150-300 mg/L), and very hard (>300 mg/L) according to the concentration of calcium and magnesium. It is an important criterion for determining the usability of water for domestic, drinking, and many industrial applications [19]. Water having hardness below 300 mg/L is considered portable, but beyond this limit, causes gastrointestinal irritation. On this premise, the water samples can safely be classified as “soft” water suitable for human consumption. Hardness in water is caused by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations. It is usually expressed as milligrams of calcium carbonate per litre.

4.1.4 TSS

The value for total suspended solids was 0 as shown in Table 1. This suggests that the filtration of the water was very effective.
4.2 Chemical Analysis

4.2.1 Chlorine, phosphate, nitrate and sulphate

From Table 2, Chlorine concentrations were found to be in the range 2.73 mg/l (Brand BWA) to 5.5 mg/l (Brand BWC). The average concentration were 4.05 mg/l. The brands had values far lower than 600 mg/l [17] permissible limit. Small amounts of chlorides are required for normal cell function in plant and animal life [20]. Phosphate concentrations were found to range from 0.00 mg/l (Brand BWA & Brand BWE) to 0.22 mg/l (Brand BWC). The average concentration is 0.11mg/l. The brands had values far lower than 50 mg/l [17] permissible limit. The concentration of nitrates in the bottled water samples varies from a minimum of 0.00 mg/l (Brand BWA & brand BWE) to a maximum of 0.59 mg/l (Brand BWG) with an average concentration of 0.32 mg/L. All of which are far below the WHO standard of 50 mg/l. In general, vegetables are the main source of nitrate intake when the level in drinking water is below 10 mg/l. When the nitrate level in drinking water exceeds 50 mg/l, drinking water becomes the main source of total nitrate intake. Water that is contaminated with nitrate proves harmful especially to infants causing methemoglobininaemia, otherwise called infantile cyanosis or blue baby syndrome if consumed [21]. The average Phosphate concentration in the water samples was 0.11mg/l and the lowest was 0.00 mg/l (Brand BWA) with the highest being 0.22 mg/l (Brand BWC). The brands had values far lower than 5 mg/l [17], the lowest permissible limit for drinking water.

4.2.2 Iron, potassium, sodium, calcium, zinc, manganese

A look at Table 2 shows that the concentration of iron in the bottled water samples varied from a minimum of 0.07 mg/L (Brand A & Brand E) to a maximum of 0.22 mg/l (Brand A). It was also observed that iron concentration for Brand BWA=Brand BWE and Brand BWB = Brand BWF. The Iron concentration in the brand samples is below the NIS/WHO standard (Appendix A2). The minimum daily requirement of iron is ranged from about 10 to 50 mg/day [22]. It is vital in oxygen transport in the blood of all vertebrates and some invertebrate animals.

Potassium concentrations were found to the range of 0.04 mg/l (Brand BWE) to 0.18 mg/l (Brand BWD). The average concentration were 0.09 mg/l. The brands had values far lower than 12 mg/l [17] permissible limit. The average Phosphate concentration in the water samples was 0.15mg/l and the lowest was 0.28 mg/l (Brand BWF) with the highest being 0.59 mg/l (Brand BWG). The brands had values far lower than 5 mg/l [17], the lowest permissible limit for drinking water. The value of calcium was found in the range of 0.64 mg/l to 1.17 mg/l. The maximum value (1.17 mg/l) was found in the bottled water sample Brand F and the minimum value (0.64 mg/l) was found in Brand A. The average is 0.92 mg/l. The values are below the 200 mg/l recommended by [17]. Excess calcium contributes to the formation of kidney and bladder stones. Calcium plays a significant role in blood clotting, muscular contraction, and some enzymes assisting in metabolic processes. It functions as a coordinator among inorganic elements, such that when K, Mg, or Na are present in quantities beyond a particular limit in the body, calcium assumes a corrective role [23]. Calcium also contributes to the hardness of water and may cause problems with laundering, washing, and bathing. The concentration of manganese in the battling water samples varied from 0.008 mg/l (Brand B) to a maximum of 0.017 mg/l (Brand BWB & Brand BWC). It was not detected in brands BWA & BWE. With an average concentration of 0.01. All of which are far below the WHO standard of 0.05 mg/l. The concentration of Zinc in the bottled water samples varied from 0.02 mg/l (Brand BWF) to a maximum of 0.10 mg/l (Brand BWG). It was not detected in brands BWA & BWE. All of which are far below the WHO/NAFDAC standard of 5.0 mg/l.

4.3 Classification of Bottled Water Brands

Water types can be classified according to various hydro-chemical classification systems. In this study, the system used to classify the investigated branded bottled water samples by evaluating the obtained TDS and TH values was the European Union (EU) mineral Water directive [24]. Chemical differences or similarities among the branded bottled water samples can be spotted by using classification systems. The classification of water based on the EU mineral water directive for the criteria of chemical composition is shown in Appendix A1, whereas the classification of branded bottled water samples investigated in this study in line with the EU mineral water directive is shown in Table 3. A cursory look at Appendix A1 and Table 3 reveals
that the brands belong to the “very low mineral concentration” class since the mineral content of the brands (BWA-BWG) is less than 50 mg/l. Meanwhile, the brands can be described as soft water, given the fact that the observed concentrations of TH were between 0-50mg/L.

5. CONCLUSION

Assessment of bottled water quality sold in Okada Town, via physicochemical analysis indicated that physical parameters such as appearance, colour, taste, and pH conformed to the acceptable standards. Chemical properties such as conductivity, total hardness, nitrate, total dissolved solids, and heavy metals such as Manganese (Mn), Zinc (Zn), and Lead (Pb) conformed to the requirements of WHO and NIS standards. It can be concluded from the results of this study that the physicochemical parameters tested in the bottled water samples were within the permissible limits stipulated by the drinking water standards, hence to this basis, the water is considered fit for drinking. Although most of the brands are regarded as safe, some samples have slightly high values of pH. To safeguard consumers’ health, it is recommended that all marketed branded bottled waters be monitored twice a year for quality and identity, and their licenses, renewed yearly after scrupulous scrutiny by the concerned authorities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Uwah E, Busari R, Sayi A. Physicochemical and bacteriological analyses of sachets water samples in Kano Metropolis, Nigeria. IOSR Journal of Applied Chemistry(iosr-jac). Jan. 2014; 6(6):52-56. Available: www.iosrjournals.org

2. Chidinma L, Emmanuel CN, Nennaya R. Physicochemical and bacteriological assessment of some borehole waters in the Federal Capital Territory, Nigeria. International Research Journal of Public and Environmental Health. 2016; 3(6):3(6):140-145. DOI:http://dx.doi.org/10.15739/irpeh.16.018;

3. Akpen G, Kpoghol I, Oparaku L. Quality assessment of sachet and bottled water sold in Gboko, Nigeria. Nigerian Journal of Technology (NIJOTECH). 2018;37(1):241-248.

4. Gleick P. The world’s water. The Biennial Report on Fresh water Resources. Washington. Washington: Island Press; 2006.

5. Lefort R. Down to the last drop. UNESCO Sources. 2006;84:7.

6. Onweluzo J, Akuagbazie C. Assessment of the quality of bottled and sachet water sold inNsukka Town. Assessment Of The Quality Of Bottled And SacAgro-Science Journal of Tropical Agriculture, Food, Environment and Extension. 2010;9(2):104-110.

7. Lamikaran A. Essential Microbiology for students and Practitioners of Pharmacy, Medicine and Microbiology (2nd ed.). Amkra Books; 1999.

8. Omalu I, Eze GC, Olayemi IK, Gbesi S, Adeniran LA, Ayanwale AV, Chukwuemeka V. contamination of sachet water in Nigeria: Assessment and Health Impact. Online Journal of Health and Allied Sciences. 2010;9(4). Available: http://www.ojhas.org/issue36/2010-4-15.htm

9. Omalu IJ, Mohammed AZ, Olamide PI. Bacteriological and physico-chemical analysis of sachet water in North Central Nigeria. Journal of Pharmaceutical and Biomedical Sciences; 2012. Available: www.ipbms.info

10. Peh Z, Sorsa A, Halamic J. Composition and variation of major and trace elements in Croatian bottled waters. Journal of Geochemical Exploration. 2010;107(3):227-237.

11. Ishaku H, Rafee M, Ajayi A, Haruna A. Water supply dilemma in Nigerian rural communities: Looking towards the sky for an answer. Journal of Water Resource and Protection. 2011:589-606. DOI:10.4236/jwarp.2011.38069APHA.

12. American Public Health Association.Standard Methods for the Examination of Water and Waste Water. (20th Ed.) Washington, D.C.; 1998.

13. Sheshe M, Magashi A. Assessment of physicochemical quality of sachet water produced in selected Local Government Areas of Kano Metropolis, Kano State – Nigeria. Bayero Journal of Pure and Applied Sciences. 2014;7(2):31-35.
13. Oshibanjo O, Ajayi S, Adebiy F, Akinyanju P. Public analysis reporting system as applied to environmental issues. IPMAN News. 2000;1(3):10.

14. APHA. American Public Health Association. Standard Methods for the Examination of Water and Waste Water. (20th, Ed.) Washington, D.C.; 1998.

15. Association of Official Analytical Chemists. Official Methods of Analysis. (14th, Ed.) Washington, D.C.; 1984.

16. Rputheti R, Okigbo M, Advanapu R. Ground water pollution due to aquaculture in east coast region of Nellore District, Andhra Pradesh, India. ADJEST. 2008;2(3):046--050.

17. WHO. Guidelines for drinking water quality. World Health Organisation, Geneva, Switzerland; 1983.

18. Rozoska J. Euphrates and Tigris Mesopotamian Ecology and Destiny. (E. Dr Junk, Ed.) Monographiae Biologicae; 1980.

19. Mitharwal S, Yadav RD, Angasaria RC, Rasa J. J. Chem. 2009;920-923.

20. Igwenmar NC, Kolawole SA, Okumoye LK. Physical and chemical assessment of some selected borehole water in Gwagwalada, Abuja. International Journal of Scientific & Technology Research. 2013;2(11).

21. WHO. Guidelines for Drinking-Water Quality Fourth Edition Incorporating the First Addendum; 2017.

22. FAO/WHO. Requirement of vitamin A, Iron, Folate and Vitamin B12. Report of a joint FAO/WHO Expend Consultation Rome, Food and Agricultural Organization of the United Nations (FAO Food and Nutrition series No. 23); 1988.

23. Fleck H. Introduction to Nutrition. (3 ed.). New York, U.S.A: Macmillan; 1976.

24. Vander Aa N. Environ. Geol. 2003;44:554-563.
## APPENDIX

### Appendix A1: Classification of water based on EU mineral water directive

| S/n | Water type                        | Criterion                        |
|-----|-----------------------------------|----------------------------------|
| 1   | Very low mineral concentration    | Mineral content (TDS) < 50 mg/l  |
| 2   | Intermediate mineral concentration| TDS 500-1500 mg/l                |
| 3   | High mineral concentration        | TDS > 1500 mg/l                  |
| 4   | Containing sulphate               | Sulphate > 200 mg/l              |
| 5   | Containing chloride               | Chloride > 200 mg/l              |
| 6   | Containing calcium                | Calcium > 150 mg/l               |
| 7   | Containing iron                   | Bivalent iron > 1 mg/l           |
| 8   | Containing chloride               | Chloride > 200 mg/l              |

### Appendix A2: Physico-chemical parameters of drinking water according to the NIS and WHO

| S/n | Parameter | Unit | Nigerian Industrial Standard (NIS) | WHO |
|-----|-----------|------|-----------------------------------|-----|
| 1   | Appearance| -    | CCL                               | 6.6-8.5 |
| 2   | Taste     | -    | UTS                               | UTS  |
| 3   | TDS       | mg/L | 500                               | 500  |
| 4   | EC        | μS/cm| 1000                              | 1000 |
| 5   | Turbidity | NTU  | 5                                 | 5    |
| 6   | TSS       | mg/L | N/A                               | 500  |
| 7   | TH        | mg/L | 150                               | 500  |
| 8   | pH        | -    | 6.6-8.5                           | 6.6-8.5 |
| 9   | Cl        | mg/L | 250                               | 600  |
| 10  | Nitrate   | mg/L | 50                                | 45   |
| 11  | Sulphate  | mg/L | 100                               | 5-250 |
| 12  | Iron      | mg/L | 0.3                               | N/A  |
| 13  | Potassium | mg/L | N/A                               | <12  |
| 14  | Sodium    | mg/L | 200                               | <20  |
| 15  | Calcium   | mg/L | N/A                               | 10-200 |
| 16  | Manganese | mg/L | 0.2                               | 0.05 |
| 17  | Zinc      | mg/L | 3                                 | 5    |

CCL=Clear colourless; UTS= Unobjectionable taste; N/A=Not available

© 2021 Ngubi and Eiroboyi; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/70398