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Evaluating the health implication of different packaged water produced in Aviele, Nigeria

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ABSTRACT

The scientific research technique was used in this project's research design. This study looked at the physical, chemical, and microbiological aspects of sachet water produced by multiple companies in Aviele, Edo State, Nigeria. The results were compared to the WHO water quality guideline to see if they were portable and safe to consume. As a result, three distinct types of sachet water samples, marked A, B, and C were collected and analyzed for physical, chemical, and microbiological parameters. pH, conductivity, Total Dissolved Solids, BOD, Chemical Oxygen Demand (C.O.D), Sulfate, chloride, and Iron were among the characteristics investigated. The results revealed that the pH values for samples A-C were in the range of 7.87-7.40. Total dissolved solids ranged at 42mg/l, 48mg/l and 32 mg/l in samples A-C, conductivity was between 0.47 uS/cm to 1.49uS/cm, and chloride levels were between 10 mg/l to 12mg/l. Hardness levels ranged from 60 to 124 mg/l, whereas biological oxygen demand (BOD) levels ranged from 0.98 to 2.46 mg/l. Chemical oxygen demand (COD) was measured between 13 to 27 mg/l, while dissolved oxygen (DO) was measured between 7.45 to 10.23 mg/l. No coliforms were linked in any of the samples. The samples were sufficient overall, although they fell short in some areas, like magnesium, according to the data. Nevertheless, they still met the necessary W.H.O criteria.

Keywords: Packaged water, Aviele, Quality of water, Physical analysis, Chemical analysis

1. INTRODUCTION

Water is among the most important resources that plants and animals need to sustain their existence and well-being, as is widely recognized. It is necessary for all living things to survive and maintain life.

Packaged water is pre-packaged and machine-sealed water that is ready to drink. Many people in Nigeria and other African surrounding nations such as Ghana refer to this water as "clean water." Hand-filled, hand-tied plastic bags, sachets, and bottled water are also available for packaged water. This is known as "ice water" in the area [1]. Factory-produced sachet water is made by mechanically filling plastic bags with water, whereas "hand-tied" sachet water is made by manually filling plastic bags with water and knotting the water-filled bags. The borehole water is the primary source of packaged water. Aeration and double or single filtration with porcelain are used to treat packaged water produced by small-scale companies. Molecular candle filters or membrane filters are used, and disinfection is used in rare cases. The level of treatment is usually determined by the water source. Water that is intended for human consumption must meet specific standards. It must be free of disease-causing germs and low in substances that are acutely hazardous or have a long-term negative impact on health. Drinking water should be pure, odorless, and free of compounds that can cause illness. Boreholes and shallow wells are drilled through the current water table to establish a good point, which provides drinking water. As water percolates through the soil in certain parts of Africa, undesirable physical, biological, and chemical elements (such as fine suspended matter, fecal coliform, and fluoride) accumulate, rendering the water unfit for human use.

Because of the potential public health implications, the quality of drinking water has gotten a lot of attention around the world. In Nigeria, packaged drinking water is fairly widespread. It's a common source of water in food canteens and is sold by a variety of food vendors across the country. Because the bulk of the populace consumes it, it is necessary to determine the borehole quality. In underdeveloped countries, several widespread health problems have been linked to drinking water, the majority of which are biological in origin. In underdeveloped nations such as Nigeria, unsafe water, poor sanitation, and poor hygiene have been reported to rank third among the 20 top risk factors for health burden [2]. The quality drinking water recommendations are designed to serve as a foundation for developing national standards that, if correctly applied, will assure the safety of drinking water [3].

Because it is inexpensive, ready to drink and always available, packaged water has grown in appeal and acceptance. But, more importantly, how clean, portable, and safe is it to consume? As a result, the goal of this study is to examine some samples of packaged water to see if it is portable, safe to drink, and free of disease-causing bacteria.

2. MATERIALS AND METHODS

2.1. Sample collection

The water samples were collected from stores and street vendors of the Aviele's neighborhood City called Benin city, Edo State, Nigeria. Additionally, it was stored at ambient temperature in a dry, cool setting.

Three samples were chosen since they had notes on them and because the community relies on them the most for drinking water. There were 60 ml samples in each case.

2.2. Physical Analysis

2.2.1. Temperature

The temperature of the sample was measured by filling a beaker with 75 ml of water sample (after being rinsed with distilled water). To acquire a stable value, a digital thermometer was put into the water table and left for two minutes. The procedure was performed thrice, with the average result for each sample taken and recorded [4].

2.2.2. Taste analysis

The taste of the sample was tested by measuring 75 ml of water sample in measuring cylinder. It was then poured into a porcelain cover and placed on an electric heater. The sample was allowed to boil for four minutes before cooling and tasting with the tongue to determine the outcome [4].

2.2.3. Color

The color of the sample was determined with nesler glass which was rinsed twice with distilled water before being rinsed once more with the water sample. In the color testing machine, the filled nesler glass and Hazen disc were placed in their respective compartments. The machine was switched on after being connected. The Hazen disc was rotated and watched indefinitely until a color match was found. The obtained values were read and recorded [4].

2.2.4. Turbidity

The turbidity of the water sample was measured by using A Hanna H198703 Turbidimeter. The samples were poured into the measuring bottle, which was then wiped clean using silicon oil. After that, the bottle was placed into the turbidimeter and a reading was taken [5].

2.2.5. Total Dissolved Solids (T.D.S)

The porcelain clad was weighed, balanced, and observed. About 100 ml of water sample was poured into the porcelain-coated, which was then heated until dry. The weight of the porcelain clad to the dryness of the water sample was acquired by weighing the porcelain clad to the dryness of the water sample on a digital weighing balance [4].

2.3. Chemical Analysis

2.3.1. Determination of pH

About 75ml of water sample was measured and poured into a beaker, with the temperature control set to the temperature of the water sample.

The buffer solution was prepared with 6ml of acetic acid was mixed with the water sample. Readings were performed after inserting the PH electrode into the buffer solution [4].

2.3.2. Determination of chloride

About 100ml of water was measured and poured into the conical flask. The water sample was treated with a 0.5 potassium chemistry solution, and the burette was clamped to the clamp stand. After that, silver nitrate N 35.5 was dissolved in distilled water and stirred constantly for 5 minutes. Silver nitrate N 35.5 was used to titrate the solution in the conical flask. The solution was then recorded together with the accompanying readings. The procedure was repeated for a total of 100ml of water [4].

2.3.3. Total hardness

With the measuring cylinder, 100ml of the water sample was measured and poured into the conical flask. To obtain a wine red color, the sample was treated with 1.0 mL ammonium solution and 3 drops of Eriochrome Black T indicator. The EDTA solution was made by dissolving 0.5g of EDTA SaH in 65 ml of distilled water and then using it to titrate the already prepared solution. The procedure was then performed with a boiling EDTA solution, with the results reported [4].

2.3.4. Iron

A measuring cylinder was used to measure 20ml of water into a Becker. Hydrochloric acid (HCl) 2.5ml was added to the water sample. To the aforementioned solution, 3 drops of potassium permanganate and 2.5 ml potassium thiocyanate sodium were added. The color of the solution was observed for any change [4].

2.3.5. Magnesium

To obtain a homogeneous solution, 6 mL concentrated ammonia was added to the water sample, followed by 30 ml distilled water. The water sample was titrated using an EDTA salt solution and put to a 50ml level in the burette. The color change (from purple to blue) was witnessed and recorded [4].

2.3.6. Sulfate

A measuring cylinder was used to measure 2.5 ml of the water sample. The measured water sample was placed into a beaker, and 0.5g of barium chloride was dissolved in distilled water and well mixed with a stirring rod, before adding 25ml of the dissolved barium chloride solution to the water sample. The color change was detected after the solution had been left for 25 minutes using a spectrophotometer [6].

2.3.7. Conductivity

A 100 ml sample of water was taken and poured into a beaker. The electric socket had the Jenway conductivity meter connected in. After rinsing the electrode in distilled water, it was put into the water sample. After five minutes in the water sample, the electrode was removed and a reading was taken [4].

2.4. Bacteriological Analysis

2.4.1. Total coliform (fecal pollution)

Hands were thoroughly cleansed before handling the kits. The aqua chek/Coliform bottle was promptly filled with 20ml of water. The lid was quickly placed on the bottle and snugly closed. To keep the bottle warm, it was left out at room temperature (approximately 25-35°C) and wrapped in a cloth.

To keep the temperature stable, the bottle was kept out of direct sunlight. The material in the coliform bottle was stored at a temperature of 25 °C-35 °C for around 24 hours to 48 hours. The sample in the bottle was monitored and the result was recorded after 24 hours [7].

2.4.2. Determination of Dissolved Oxygen (DO)

The following reagents were added to 1L of distilled water to make 2ml of distilled water: phosphate buffer, Magnesium sulfate, Calcium chloride, and Iron (III) Chloride solution, which were then aerated with clean compressed air. 1ml of alkali-iodide-azide and $MnS0_4$ reagent were added to the produced sample in a DO bottle to exclude air bubbles and stirred until clear super stand water was formed. After that, it was given 4 minutes to settle. 2 mL distilled water before decanting the required amount for titration, and a 1-2 ml starch solution was added to achieve a homogeneous solution. After titrating the solution with Na2S2O3, the color of the sample changed from blue to the original color [7].

2.4.3. Determination of chemical oxygen demand (COD)

A pipette was used to take 20 ml of water, and a measuring cylinder was used to take 10 ml of 0.025 m potassium dichromate. A 70 ml solution was made by diluting 15 ml of concentrated sulphuric acid with 40 ml of distilled water. The phenanthroline ferrous sulfate indicator was applied in seven drops. Allow time for this to cool. Titration was performed on the blank sample after the color shifted from greenish blue to orange. The blank sample's titrated value exceeds the sample's titrated value [7].

2.4.4. Determination of Biological Oxygen Demand (BOD)

The starting 5-day DO values were used to calculate the five-day BOD. A duplicate sample of DO5 was prepared and incubated in the dark at 20°C for 5 days [7]. The 1 L stock solution of BBM media, standard procedure was followed. The following solutions were prepared and finally diluted to 1 L volume with the help of distilled water (table 1).

3. RESULTS AND DISCUSSION

The maximum allowed limits (MPLs) recommended for drinking water quality were observed and stated in table 1-4 and 7 [3, 8-9]. In terms of product names, manufacturer's addresses, manufacturing and expiration dates, and NAFDAC registration number, all packaged water samples were found to be compliant. This information is critical since it tells the consumer whether or not the water sample is still good.

The average thermal energy of a substance is measured by temperature [10]. Temperature, color, conductivity, total suspended particles, turbidity, and total dissolved solids were all measured in Table 2.

The temperature in sample C is higher than in samples A and B, as shown in the table above.

The conductivity levels found in the packaged water tested were within the WHO/NIS standard conductivity range (0-1000 s/cm) for clean water. The ability of water to carry an electric current is measured by conductivity. The higher the ion concentration, the higher the conductivity of water. Similarly, the fewer ions in the water, the less conductive it is.

Metallic elements such as copper, zinc, and iron in water give it a metallic taste. There are also dissolved leaf fragments present. The samples were found to be tasteless, as evidenced by the results. The three samples tested tasteless, indicating that they both met the WHO and SON drinking water standards.

The term "apparent color" refers to the appearance of water that has been contaminated with organic matter such as leaves or wood in various stages of decomposition. Surface water can appear highly colored due to suspended matter. It is distinguished from the color by colloidal vegetable and organic additions. The findings of this investigation revealed that there was no color in the packaging water tested (Table 2). This means there were no dissolved humic acids in any of the water brands [11].

The packaged water's turbidity was within WHO/NIS's recommended level (0-5 NTU). Sample A had a TDS level of 42 mg/l, while sample B's was 48 mg/l, and sample C's TDS value was 32 mg/l, as shown in table 2. The rise in TDS in a water sample indicates that there were more dissolved solids present, whereas a reduction indicates that the sample water contained fewer dissolved solids.

Taste and odor in water are inextricably linked. Metallic substances, as well as dissolved materials, induce it. One of the most common reasons for odor is the presence of

Table 1. Physical study of produced packaged water in Aviele

Sample names	NAFDAC Number	Manufacturer Address	Manufacturing Date	Batch Number	Expiry Date	Product name
WHO/NIS	+	+	+	+	+	+
MAC-ES table water	+	+	+	-	+	+
BALADI table water	+	+	+	-	+	+
ESTANAM table water	+	+	+	-	+	+

Table 2. Physical analysis of packaged water production in Aviele

Water Samples	Temperature(°C)	Taste	Odor	Color (HU)	Turbidity (NTU)	T.D.S(mg/L)	Conductivity (µs/cm)
WHO/NIS	25	-	-	0-15	0-5	1000	0-1000
A	30	Nil	Nil	Nil	Nil	42	0.47
B	31.2	Nil	Nil	Nil	Nil	48	1.49
C	31.4	Nil	Nil	Nil	Nil	32	1.44

Table 3. Chemical analysis of packaged water produced in Aviele

Water Sample	PH	Chloride(Cl) (mg/L)	Total Hardness	Iron(Fe) (mg/L)	Magnesium(Mg) (mg/L)	Sulfate(SO_4) (mg/L)
WHO/NIS	6.5-8.5	250	50-350	0.3	0.2	0-100
A	7.87	11	124	Nil	6.5	0.32
B	7.23	10	60	Nil	6.3	0.48
C	7.40	12	90	Nil	4.4	0.00

Table 4. Dissolved Oxygen of packaged water produced in Aviele

Water Samples	DO (mg/L)
WHO/NIS	---
A	10.23
B	9.18
C	7.45

Table 5. Biological Oxygen Demand of packaged water produced in Aviele

Water Samples	BOD (mg/L)
WHO/NIS	---
A	1.76
B	0.98
C	2.46

Table 6. Chemical Oxygen Demand of packaged water produced in aviele

Water Samples	COD (mg/L)
WHO/NIS	---
A	13
B	25
C	27

chemicals in drinking water that emit an unpleasant odor. The samples of drinking water were found to be odorless.

The pH level of water is a useful predictor of its hardness or softness. Pure water has a pH of seven. Water with a pH less than 7 is acidic, and water with a pH greater than 7 is basic. Alkalinity is a measurement of water's ability to withstand a pH change that would cause it to become more acidic [12]. The positively modified hydrogen (H+) ion is responsible for acidity, while the negatively charged hydroxide (OH+) ion is responsible for alkalinity. From the chemical analysis carried out, the results show that sample A had 7.87, sample B had 7.23, and sample C had 7.40, implying that the water is safe to drink.

Metal pipelines and structures, as well as growing plants, are harmed by high chloride concentrations. The concentration of chloride ions was found to vary in this investigation. The result is well under the WHO's recommended maximum allowable limit for drinking water of 250 mg/L.

The presence of calcium and magnesium compounds in the water causes hardness in water. Temporary and permanent hardness are the two categories. Hardness and water were found to be absent in the samples analyzed. Sample A has a total hardness of 124 mg/1, Sample B has 60 mg/l, and Sample C has 90 mg/l, according to the results of the test.

Magnesium in water contributes a tiny amount of hardness to the water, produces vomiting or diarrhea, and gives clothes a brownish color.

Sample A has a value of zero (0.32 mg/l) in the sulfate test, Sample B has a value range of 0.48 mg/l, and Sample C has zero amount of sulfate. Water contains sulfate as a result of flowing over gypsum-containing soil.

Iron-in-water determinant is critical for monitoring natural and drinking water corrosion control in industry. When water has enough oxygen, dissolved iron precipitates as low as ferric hydroxide. Iron can be found in water in the form of bicarbonate or sulfate.

The amount of oxygen contained in the water is called dissolved oxygen (DO). Because of different impurities in

Table 7. Bacteriological Analysis of packaged water produced in aviele

Sample Names	Total Coliform/Fecal Pollution	Bacteria (*Klebsiella Pneumonia, Enterobacter)*	Species, *Aerobater arogenese, Escherichia Coli*	*Salmonella, (E.Coli) Proteus And Citrobacter*
WHO/NIS	---	---	---	---
A	Nil	Nil	Nil	Nil
B	Nil	Nil	Nil	Nil
C	Nil	Nil	Nil	Nil

the water and waste products created by organisms that live in such low oxygen environments, water with little dissolved oxygen can have a foul odor. As a result, dissolved oxygen is one of the finest markers of the health of a specific water environment, as well as a critical indicator of a water body's ability to support aquatic life and determine whether it is safe to drink.

Chemical oxygen demand (COD) is the total amount of oxygen required to chemically oxidize both biodegradable and non-biodegradable organic matter, whereas biological oxygen demand (BOD) is the amount of oxygen consumed during aerobic processes of decomposition of organic materials caused by microorganisms. BOD measures how organic matter influences water's dissolved oxygen (DO) concentration.

A high BOD and COD in general implies a high quantity of easily degradable and non-degradable organic matter in the water sample, which results in a decrease in DO due to the high demand for oxygen by bacteria feeding on the organic material [13].

The desire to have portable water that is free of pathogenic microorganisms that cause water-borne disease necessitates bacteriological analysis of water. These diseases are transmitted to the human body through contamination of the water by human or animal excrement, either directly through drinking or indirectly through food preparation. Microorganisms or coliforms should not be discovered in drinking water, according to WHO/NIS guidelines. The result clearly shows that aviele-produced packaged water has no microbiological quality.

4. CONCLUSION

The findings of this investigation suggest that all three packaged water samples are safe for human consumption. Although the packaged water samples' temperatures were much higher than the WHO/NIS norm, this had no impact on their microbiological quality characteristics. It is also suggested that the water produced from the borehole be treated for magnesium because the magnesium level in the water surpassed the acceptable amount of 0.20 mg/l. People should be more concerned about the safety of their drinking water. Water supplies that were once thought to be pure are now proven to have contaminants due to advances in analytical procedures that allow for the detection of impurities in water at very low amounts.

The pursuit of quick cash has led to the "clean water" business, as well as the inability to adhere to the prescribed treatment method. Despite being sealed, packaged water has been found to pose a health concern to customers due to the presence of bacteria commonly linked to food poisoning and intoxication in the water. As a result, one can advocate for the National Agency for Food and Drug Administration Control to implement the water quality rule (NAFDAC). Regular monitoring is required to maintain compliance with World Health Organization guidelines and to inform the people that their water is portable.

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NA

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