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Examining the Bacteriological Quality of Sachet Water commonly Sold in Oye-Ekiti Local Government Area, Ekiti State, Nigeria.

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Abstract

Sachet water has become a popular substitute for the inadequate supply of portable water because of its availability, accessibility and affordability. In Nigeria, sales and consumption of sachet water are on the increase, and its potability is crucial for the general public's health. This study assessed the microbiological quality of sachet water sold in Oye-Ekiti Local Government Area (LGA). Sixteen (16) samples of sachet water were obtained from four different brands (A, B, C, and D) from various vendors in Oye-Ekiti LGA, while the control samples were obtained from the water production factories. The samples were subjected to microbial analysis using Nutrient agar (NA), MacConkey agar (Mac) and Eosin-methylene blue agar (EMB) as culture media. A self-administered questionnaire was used to obtain data from a total of 1,304 Federal University Oye-Ekiti students using online Google form. The bacteria isolated from the samples were characterized and identified as Staphylococcus sp, Enterobacter sp, Proteus sp, Klebsiella sp, and Escherichia coli with colony forming units (cfu) ranging from 1.6 × 10^1 to > 3.5× 10^3 cfu/ml and coliform count ranging from 0 to 9.2 × 10^2 cfu/ml. Sample D had the lowest of bacterial load, hence, safe to drink. More than 55% of the students consume sachet water and fifteen percent of them consume sample A which has the highest bacteria load, while only 9% drink sample D. The results obtained showed the importance of conducting routine monitoring and quality control procedures to ensure the microbiological safety of sachet water products.

Keywords: Bacteria load, Culture medium, Oye Ekiti, Sachet water, Students

INTRODUCTION

Water is an essential necessity for all living forms and cannot be avoided in a man's day-to-day existence. Since human bodies don't have a reserve supply, water makes up a sizable portion of our daily food intake. Its natural abundance makes it regarded as a universal solvent (Anyamene and Ojiaku, 2014). For the sake of public health and wellbeing, access to drinking water that is microbiologically safe is crucial. Waterborne illnesses, which have a substantial influence on morbidity and death rates, especially in vulnerable populations like the elderly and children, are mostly caused by contaminated drinking water (WHO, 2019). According to Oluduro and Aderiye (2007), the main causes of contaminated drinking water

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in Nigeria include industrial discharges, agricultural runoff, and fecal pollution from poor sanitation facilities.

The percentage of the population that has reasonable access to a sufficient supply of safe water for drinking, washing, and other basic household tasks is used to determine how many people have access to water. It shows the state of a nation's population's health as well as its ability to gather, purify, and supply water to citizens. In addition to treated surface water, safe water can also come from untreated but uncontaminated sources including sanitary wells, natural springs, and sealed boreholes (Ojeh and Semaka, 2021). To meet their daily needs for metabolism, cleanliness, and household purposes, an individual requires approximately 20 liters of safe water per day on average. For governments, development organizations, and water sector groups, providing sufficient and better drinking water is a major, although difficult, problem, particularly in nations with fast expanding populations like Nigeria with over 200 million people (Abubarkar, 2019).

A large number of people in both rural and urban areas get their drinking water from boreholes and/or packet water sources. Unconfirmed reports suggested that most sellers do not treat their sachet waters before selling them to the public, raising doubts about the purity of these fluids. Public health professionals and rational people alike are concerned about this, especially given that many people, including nursing mothers, purchase water from these vendors for their young children (Shear *et al*., 1995).

Water, sanitation, and hygiene (WASH) programs are funded throughout Nigeria in afflicted areas by a number of organizations, including the World Bank, African Development Bank, French Development Bank, USAID, and partners, in an effort to solve the persistent problems with WA in the country. 2.5 million impacted Nigerians are to receive sustainable water access through these WASH programs. It is significant to remember that the majority of Sub-Saharan Africa depends on groundwater supplies (Yusuf *et. al*., 2019). The availability of groundwater in Nigeria is dependent on geographic location, with some areas having a lot of it and others not, Also, pollutants and pollution pose a hazard to groundwater (Aikowe and Mazancová 2021).

Studies have linked untreated or inadequately treated water containing bacteria pathogens isolated from sachet water to multiple disease outbreaks, the bacteriological quality of drinking water is crucial, and monitoring needs to be given top priority (Oladapo *et al*., 2009). Numerous recent investigations have brought attention to the frequency of microbiological contamination in drinking water sources in Nigeria. For example, a study conducted in 2022 by Bello *et al*. discovered that fecal coliforms were present in 76% of water samples taken from boreholes and wells in rural communities, suggesting a significant risk of gastrointestinal disorders. Similarly, in river water samples used for drinking in Nigeria's largest city, Ibadan, Adekunle *et al*. (2021) reported the presence of pathogenic bacteria. These results highlight how critical it is to monitor and manage water quality effectively in order to protect public health. Therefore, the main aim of this research was to investigate the microbiological quality of the sachet water sold in *Oye Ekiti* Local Government Area, Ekiti State.

MATERIALS AND METHODS

Study Area

The *Oye* Local Government Area in Ekiti state was created in 1989 from the division of the previous *Ekiti* North Local Government. Oye Local Government's boundaries are defined by

Ilejemeje Local Government to the north, *Irepodun/Ifelodun* to the south, *Ikole* Local Government to the east, and *Ido/Osi* Local Government to the west. *Ayede Ekiti, Itaji Ekiti, Imojo Ekiti, Ilafon Ekiti, Omu Ekiti, Ijelu Ekiti, Oloje Ekiti, Ire Ekiti, Itapa Ekiti, Osin Ekiti*, etc. are among the cities and villages that make up this region. This research was carried out in towns (Oye, Aiyegbaju and Ilupeju) within Oye Local Government Area (LGA) in Ekiti State, Nigeria.

Collection of Samples

Sixteen samples of sachet water from four different brands were procured from vendors in the selected towns in Oye Local Government and labelled A-D respectively, while a sample was obtained from each sachet water producing company and used as control. The total number of samples obtained was twenty. The samples were transported to the Microbiology Departmental laboratory of the Federal University of Oye Ekiti and analyzed immediately.

Sample Analysis

The samples were physically analyzed for taste, colour and odour adapting Adekunle *et. al.* (2021) method. Each sachet water sample was diluted and appropriate dilution (10^{-1} to 10^{-3}) was then added to sterile MacConkey, Nutrient agar, and Eosin Methylene Blue agar plates. The plates were incubated for twenty-four hours at 37°C. To obtain pure culture, distinct colonies were picked from the plates after 24 hours using a sterile wire loop. They were then streaked onto freshly made agar plates and cultured for another 24 hours at 37°C. After which, each separate colony was aseptically re-cultivated on a brand-new agar slant, and then kept at 37°C for another 24-hour period. The slants were then kept in a refrigerator at -4^{o}C for further analysis.

Phenotypic Identification of isolates.

Sugar fermentation and other biochemical tests were carried out on the isolates. Based on their microscopic, cultural, physiological and biochemical characteristics, the isolates were identified using the routine laboratory method of (Umoessein *et al*., 2019). Bergey's Manual of Determinative Bacteriology was used as a benchmark for comparison when morphological characteristics of pure colonies of each isolate were examined. Following gram staining and light microscope inspection with an X100 objective lens, the morphology of the cell was ascertained. Additionally, biochemical characterizations including sugar fermentation, indole, oxidase, catalase, etc., were done. Berget's manual of determinative bacteriology was used to identify the bacteria based on the results obtained.

Questionnaire

A self-administered questionnaire was used to obtain data about sachet water sold in Oye Ekiti LGA from students of the Federal University Oye-Ekiti using online Google form

Statistical analysis: Data was analyzed using Microsoft excel.

RESULTS

The bacteria isolated from the sachet water samples were phenotypically identified as *Staphylococcus* sp, *Enterobacter* sp, *Proteus* sp, *Klebsiella* sp, and *Escherichia coli* with colony forming units (cfu) ranging from 0 to >292 cfu/ml and coliform count ranging from 0 to >448 cfu/ml. The Tables below reveal the details of the results.

Table 1: Total Number of bacterial, coliform and *E. coli* counts from sachet water sold in *Oye Ekiti* Local Government Area (CFU/ml)

Sachet water	Bacteria	Coliform	E-coli
Sample A	3.5×10^3	4.48×10^3	9.2×10^2
Sample B	4.0×10^1	4.0×10^1	2.0x102
Sample C	1.2×10^3	1.6×10^2	0
Sample D	2.0×10^1	0	0

The online survey revealed that 55% of the sample's respondents are between the ages of 19 and 22. Of the sample's respondents, 73% are female and 27% are male. Yoruba ethnicity makes up the majority of respondents (62%), with 92% being undergraduate students and only 8% being postgraduates. The most represented faculty is the Faculty of Science, with 55% of the sample being made up of members of this group as shown in the table below

Table 2: Socio-Demographic Characteristics of Respondents

VARIABLE	FREQUENCY N (%)
Age Group	
- 15 - 18	261 (20%)
- 19 - 22	715 (55%)
- 23 - 26	195 (15%)
- 27 - 30	130 (10%)
- 31 and above	0 (0%)
Gender	
- Male	352 (27%)
- Female	952 (73%)
Ethnic Group	
- Yoruba	808 (62%)
- Hausa	26 (2%)
- Igbo	131 (10%)
- Others	339 (26%)
Education Level	
- Undergraduate	1200 (92%)
- Postgraduate	104 (8%)
Faculty	
- Faculty of Science	720 (55%)
- Others	584 (45%)
Variable	Frequency (n=1304)

Table 3: Drinking Habit and storage pattern of sachet water among students of the University.

	FREQUENCY N (%)
How many sachets of water do you drink per day	
1 or 2	939 (72%)
3 or 4	285 (22%)
5 or 6	52 (4%)
More than six	24 (2%)
Do you buy in bags or sachets	
Bags	275 (21%)
Sachets	1029 (79%)
If bags, how many do you buy	
One bag	599 (43%)
Two bags	303 (22%)
Three bags	302 (22%)
Four bags and above	170 (13%)
If sachets, how many do you buy	
Between 1 and 5	988 (76%)
Between 6 and 10	316 (24%)
How long does it last	
1 - 5 day(s)	1188 (91%)
1 - 2 week(s)	92 (7%)
3-4 weeks	14 (1%)
More than 4 weeks	14 (1%)

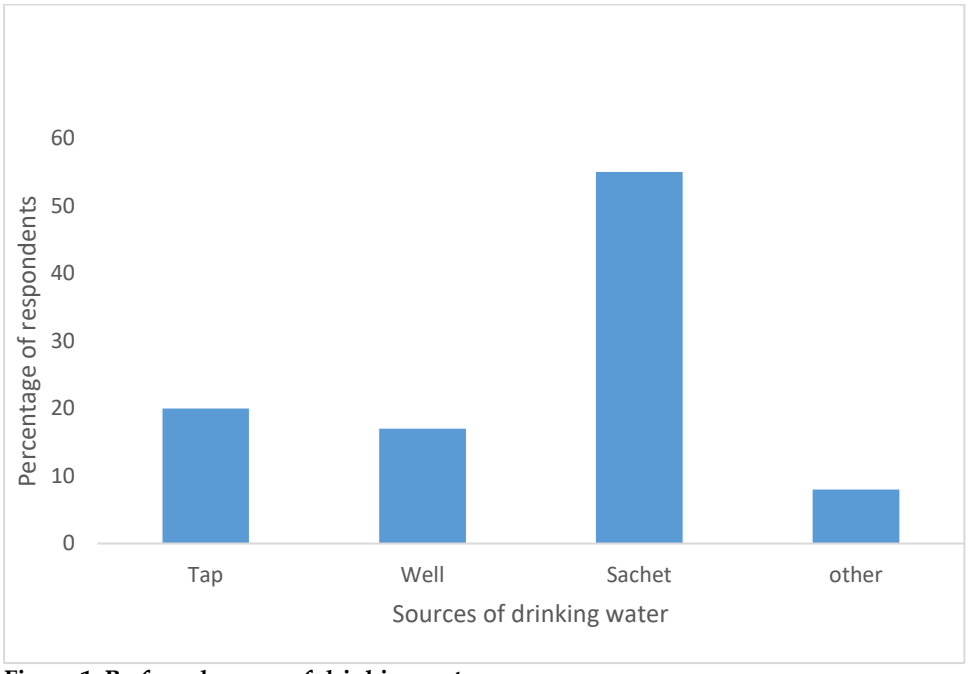

Figure 1: Preferred source of drinking water

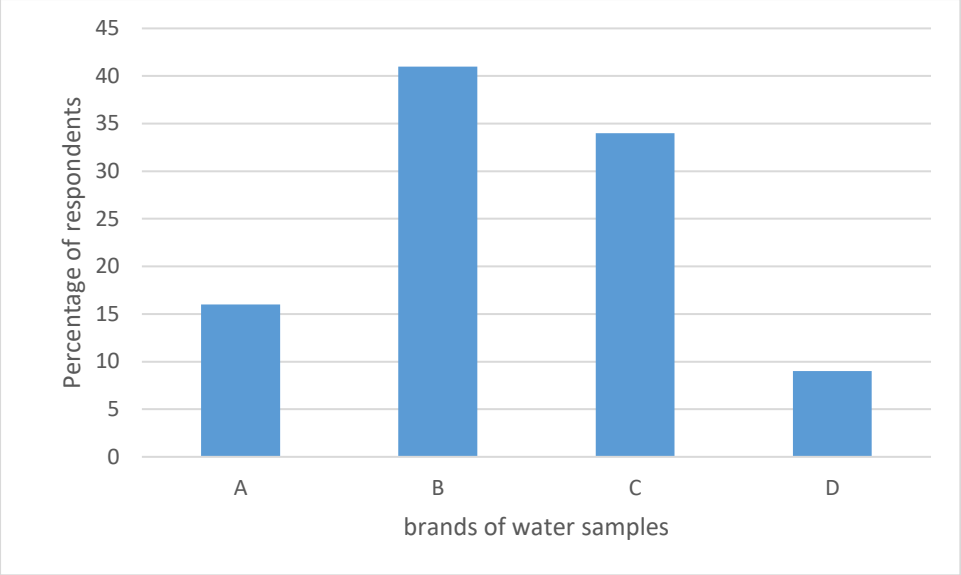

Figure 2: Preference of brands.

DISCUSSION

The bacteria isolated from the different brands of water sample were characterized and identified as *Staphylococcus* sp, *Enterobacter* sp, *Proteus* sp, *Klebsiella* sp, and *Escherichia coli.* Table 1 reveals bacterial count of the samples with colony forming units (cfu) ranging from 1.6×10^1 to $> 3.5 \times 10^3$ cfu/ml. According to Opafola *et al*. (2020), all the samples of sachet water from several brands that were taken at a university in Abeokuta, Nigeria, showed Total Bacterial Counts (TBC) ranging from 200 to 1700 cfu/mL, hence in line with this study. The WHO recommended threshold for the total heterotrophic count in drinking water, which is 100 cfu/mL. Sample B and D met with these criteria, while Sample A and C had the higher bacterial count therefore not fit for human consumption. The test group had higher measured bacterial counts than the control group in this study as shown in Table 1, which may indicate that there was microbial contamination during production or storage. This outcome is in line with recent studies that demonstrated how sachet water can become contaminated by microorganisms due to inappropriate handling and insufficient sanitation practices (Udoh *et al*., 2021).

The total coliform and *E. coli* counts ranged from 0 to 9.2×10^2 cfu/ml in the samples are shown in Table 1. The presence of coliform which includes E. coli, in some of the samples indicated a possible fecal contamination of the water before or during packaging in sachets. The WHO guideline for coliform bacteria in drinking water which is at zero total coliforms per 100 mL of water (WHO, 2014). Absence of coliform in sachet water sold in South western Nigeria was reported in other studies (Ojo 2015, Opafola. *et al*., 2020). This is contrary to the result obtained in this study as only sample D had no coliform hence fit for human consumption. This is alarming since it puts consumers' health at serious danger, especially in Nigeria with limited access to clean drinking water. Given that *E. coli* in particular is a known pathogen that causes illnesses transmitted through the water, it is imperative that sachet water production facilities use efficient sanitation methods and quality assurance protocols. (Ibeh *et al*., 2023)

The demographic profile of respondents revealed interesting patterns as shown in Table 2. The majority of respondents fell within the age group of 19-22 years, comprising 55% of the total sample, reflecting the prevalence of young adults among sachet water consumers, which aligned with findings from similar studies (Addo *et al*., 2020). Additionally, the study showed

a higher representation of females (73%) compared to males (27%), indicating potential gender-specific. Fifty-three percent of respondents reported using sachet water as their primary source of drinking water. This study emphasizes the widespread dependence on sachet water as a simple and accessible hydration option, particularly in areas where tap water quality is dubious or unavailable. However, it is vital to highlight that a considerable portion (47%) still relies on alternative sources such as tap water or well water, indicating various preferences or worries about sachet water quality. Sample B emerged as the most popular sachet water brand, with 41% of respondents preferring it. This brand domination could be due to reasons like perceived taste, cost, or brand repute in the local community. Despite its potability, Sample D had the fewest consumers.

The examination of consumption patterns uncovered some intriguing patterns. First, most participants reported consuming 1-2 sachets of water daily (72%), which indicates moderate daily consumption levels. This suggests that most consumers use sachet water as a supplemental source of hydration rather than as their primary source. Second, most participants preferred to buy sachet water in sachets as opposed to bags (79%), which is consistent with the cost and convenience of single-serving packaging options as reported by Addo *et al*., 2020.

CONCLUSION.

Sachet water marketed in Oye Ekiti Local Government Area is microbiologically unfit for human consumption, with the exception of sample D, as it contains coliforms, including *E. coli*, and a bacterial level greater than 100 cfu per 100ml. This can be the consequence of the used water treatment method being inefficient or broken. Consequently, regulatory bodies must keep an eye on the quality of sachet water that is sold to customers.

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