International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 10, Issue 3, pp 118-123, March-2026
https://doi.org/10.47001/IRJIET/2026.103015

Bacteriological Analysis of Sachet Water Sold at Adamawa State University, Mubi Commercial

[1]*Hadiza Mahmud Usman, [2]Mohammed Umar Faruk, [3]Mariya Yahaya

[1,2,3]Department of Microbiology, Adamawa State University, Mubi, P M B 25, MUBI, Adamawa State, Nigeria
*Corresponding Author's E-mail: hadizamahmud19@gmail.com

***Abstract* - Access to safe drinking water remains a persistent public health challenge across Nigeria. For many, especially in urban and academic communities, sachet water has become the primary source of drinking water. Yet, questions about its quality and adherence to safety standards linger. This study assessed the bacteriological quality and safety of sachet water sold at Adamawa State University, Mubi Commercial. We specifically looked for faecal contamination, identified the bacteria present, and determined their resistance to common antibiotics. Twelve sachet water samples from two brands were collected. The Most Probable Number (MPN) technique was used to estimate faecal coliform levels. Bacteria were isolated using standard culture methods on Nutrient Agar and identified through a combination of cultural, morphological, and biochemical characteristics. Antimicrobial susceptibility of the isolates against 14 antibiotics was then tested using the Kirby-Bauer disk diffusion method. The results were striking. Physically, all samples (100%) failed to meet essential NAFDAC labeling requirements. Bacteriologically, 10 out of 12 samples (83.33%) were contaminated with faecal coliforms specifically Escherichia coli with MPN values ranging from 7 to 20 per 100ml. From these, we isolated 28 bacterial isolates: *E. coli* was most common (71.43%), followed by Staphylococcus aureus (21.43%) and Pseudomonas aeruginosa (7.14%). Perhaps more worrying was the antimicrobial resistance profile. The *E. coli* isolates, for instance, were uniformly resistant to Augmentin, while all *S. aureus* isolates showed resistance to Erythromycin. These findings suggest that much of the sachet water sold here is contaminated with faecal matter and other bacteria, making it unfit for drinking. The added dimension of multidrug-resistant bacteria only compounds the public health risk.**

Keywords: Sachet water, Bacteriological quality, Escherichia coli, Faecal coliforms, Antimicrobial resistance, Public health, Adamawa State University Mubi.

I. INTRODUCTION

Water is fundamental, we all know this. The human body needs it to function, and access to a safe, affordable supply is a prerequisite for health and life itself [1]. It covers over two-thirds of the planet, yet the water that's fit for us to drink, what we call potable water, is far scarcer than one might think. Exactly how much we need varies from person to person's age, activity level, even the climate you live in, all play a role [2]. Globally, the numbers are sobering. An estimated two billion people still lack access to safely managed drinking water services [1]. This isn't just a statistic from a far-off place; it's a daily reality in many developing nations, where the consequences of contaminated water are measured in human lives. Nigeria's situation is particularly acute, with thousands of children under five dying each year from diarrheal diseases linked to poor sanitation and unsafe water [3]. The link between water quality and these illnesses is well established [4]. As a result, many communities have turned to sachet water; those small, sealed plastic bags of water, as their primary source. It's affordable and widely available. But its quality is a persistent question mark, with studies often finding it falls short of international standards [5, 6]. The reasons are complex: population growth, urbanization, and inadequate industrial oversight all play a part. This study grew out of a simple, local concern: what is the actual quality of the sachet water being sold right here, at Adamawa State University, Mubi Commercial? Our aim was to move beyond assumption and provide clear, evidence- based answers. By assessing the bacteriological quality, we hope to give consumers, university authorities, and public health officials a clearer picture of the potential risks. Ultimately, this kind of data can be a catalyst for better monitoring and, hopefully, safer water for the university community.

Research objectives

1. To examine sachet water packages for compliance with basic regulatory labeling requirements.
2. To isolate and identify the bacteria present in the sachet water samples.
3. To determine the occurrence of faecal coliforms in the water.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 3, pp 118-123, March-2026

https://doi.org/10.47001/IRJIET/2026.103015

4. To determine the antimicrobial susceptibility profile of the bacterial isolates.

II. MATERIALS AND METHODS

2.1 Study area

This work focused on the sachet water vendors operating at Adamawa State University's Boni Haruna Campus in Mubi, a major urban center in northeastern Adamawa State, Nigeria. The wider Mubi metropolis is geographically extensive, covering both Mubi North and Mubi South local government areas, and its location near the Cameroon border makes it a key commercial hub [13, 14]. Situated between latitudes 9°26′ and 10°10′ North and longitudes 13°01′ and 13°44′ East, the area sits at a considerable elevation between 1,200 and 1,500 meters above sea level, which tempers its local climate [13, 14, 15]. The metropolis, home to a diverse mix of ethnic groups including Fali, Gude, Fulani, and Hausa, covers over 500 km² and has a population exceeding 750,000, making it a densely populated regional center [13, 16]. The climate is tropical wet and dry, with a pronounced dry season from November to March and a wet season from April to October [13, 17].

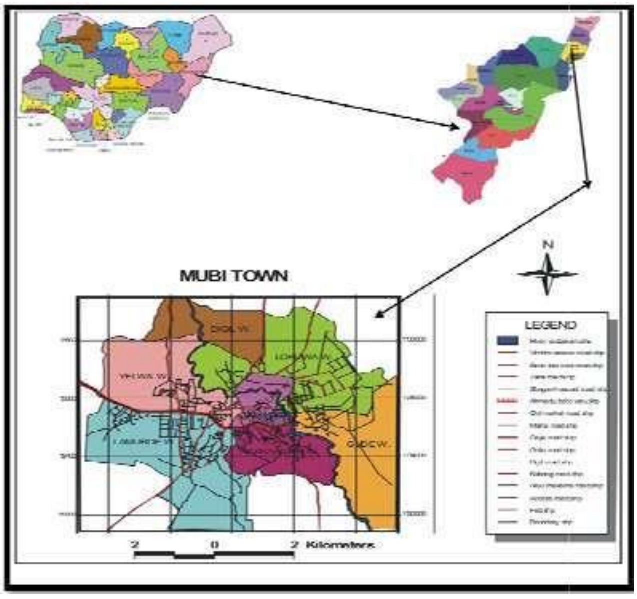

Figure 1: Map of Mubi Metropolis, Adamawa State

Source: Researcher Extracts (2021)

2.2 Study design

This was a microbiological evaluation of two different brands of sachet water. A total of 12 samples were randomly collected from various vendors within the university's commercial area. Over four weeks, each of the two brands was sampled twice, with three sachets collected per brand per sampling event.

2.3 Sample collection

A total of 12 sachet water samples all bearing a NAFDAC registration number were purchased from different vendors at Adamawa State University, Mubi Commercial. They were transported immediately to the university's Microbiology Laboratory for analysis.

2.4 Microbiological analysis

We used the pour plate method for initial bacterial isolation and the standard Most Probable Number (MPN) three-by-three dilution to estimate faecal coliform counts. All culture, isolation, and biochemical identification steps followed established procedures from standard microbiological manuals [7, 8, 9]. For antimicrobial susceptibility, we employed the Kirby-Bauer disk diffusion method, interpreting the results using the then-current EUCAST clinical breakpoints (version 15.0) [10].

2.5 Isolation and identification of bacteria

Each water sample was first serially diluted from 10^{-1} to 10^{-6}. From each dilution, 1ml was pipetted into sterile Petri dishes, onto which molten nutrient agar was poured. After solidification, the plates were incubated at 37°C for 24 hours. Colonies that grew were then sub-cultured onto fresh media to obtain pure isolates for identification. These pure isolates were identified using a combination of Gram staining and biochemical tests. Gram staining, that classic method from 1884 by Hans Christian Gram [11], was performed to determine cell wall structure and morphology. Briefly, a smear of the isolate was heat-fixed, then flooded with crystal violet, followed by Lugol's iodine. After a quick decolorization with ethanol, the smear was counterstained with safranin. Gram-positive bacteria retained the crystal violet-iodine complex and appeared purple or blue, while Gram-negative cells, having lost the complex, took up the safranin and appeared pink or red. Cellular shape (cocci or rods) was noted under oil immersion at 100x.

2.6 Determination of faecal coliform

The three-tube MPN test was used to estimate the number of faecal coliforms [12]. This involved three phases. For the presumptive test, three sets of lactose broth tubes were inoculated with different volumes of water sample: 10ml into double-strength broth (Set A), 1ml into single-strength broth (Set B), and 0.1ml into single-strength broth (Set C). All tubes were incubated at 44.5°C for 24 hours. Gas production in the Durham tubes indicated a positive presumptive result.

For the confirmed test, a loopful from each gas-positive tube was streaked onto Eosin Methylene Blue (EMB) agar and

ISSN (online): 2581-3048
Volume 10, Issue 3, pp 118-123, March-2026
https://doi.org/10.47001/IRJIET/2026.103015

incubated. Growth of colonies with a green metallic sheen was considered presumptive for *E. coli*. The completed test involved inoculating a colony from the EMB plate into fresh lactose broth; acid and gas production here confirmed the presence of faecal coliforms.

2.7 Statistical analysis

We used descriptive statistics (percentages and means) to summarize bacterial occurrence and antibiotic resistance. A Chi-square test, run on SPSS (version 26), was used to compare faecal coliform occurrence between the two brands.

III. RESULTS AND DISCUSSIONS

3.1 Physical Examination of Sachet Water Packages

A quick look at the sachets revealed some immediate red flags. While all 12 did show the producer's name, address, and a NAFDAC number, this was where compliance ended. Not a single sample had a batch number, a production date, or an expiry date printed on the package (Table 1). This kind of omission is hard to explain away as a minor oversight. It's a basic disregard for NAFDAC's labeling regulations, which exist specifically to ensure traceability and allow consumers to know if a product is still within its shelf life [18]. Without a date, you're buying water with no guarantee of its age, and without a batch number, tracing the source during a disease outbreak becomes nearly impossible. This mirrors findings from other parts of Nigeria, suggesting this isn't an isolated incident [19].

Table 1: Results of Physical Examination of Sachet Water Packages

Brand	NAFDA C No.	Production date	Expiry date	Batch No.	Net volume (CL)	Producer's name & address
A	+	-	-	-	50	+
B	+	-	-	-	50	+

Key: +: present -: absent

3.1.1 Isolation and Identification of Bacteria

Based on their morphology and biochemical profiles, the bacteria we isolated fell into three species: *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* (Table 2). The presence of *S. aureus* and *P. aeruginosa* hints at contamination sources beyond just faecal matter. *S. aureus*, for instance, is often associated with human skin and handling, while *P. aeruginosa* can thrive in moist environments, potentially pointing to issues in the production line or packaging process [20].

Table 2: Morphological and Biochemical Characteristics of Isolates

MC	GR	Shape	CAT	OXI	CIT	UR	Inference isolate
GLC	+	cocci	+	-	-	+	*S. aureus*
SSB	-	rod	+	-	-	-	*E. coli*
SSB	-	rod	+	+	-	-	*P. aeruginosa*

Key: MC: Morphological characteristics, GR: Gram reaction, CAT: catalase, OXI: oxidase, CIT: citrate, UR: urease, GLC: grape-like cluster, SSB: single straight bacilli

3.1.2 Percentage occurrence of isolates

Across all samples, *E. coli* was by far the most common, accounting for 20 of the 28 isolates, or just over 71%. *S. aureus* was next with 6 isolates (21.43%), and *P. aeruginosa* was the least frequent, with only 2 isolates (7.14%) (Table 3). The fact that over 83% of the samples, 10 out of 12 contained faecal coliforms at levels reaching 20 MPN/100ml is, alarming. This isn't a matter of slight contamination; it's a direct violation of the WHO standard, which mandates 0 CFU/100ml for any water meant for drinking [24]. To put it plainly, this water is unfit for human consumption. It poses a clear and present risk for transmitting diseases like cholera, typhoid, and chronic diarrhea [23]. This aligns with earlier work in the Mubi area that also flagged sachet water as a potential health hazard [21].

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 10, Issue 3, pp 118-123, March-2026

https://doi.org/10.47001/IRJIET/2026.103015

Table 3: Occurrence of bacterial isolates from the various sachet water samples investigated

Isolates	*E. coli*	*S. aureus*	*P. aeruginosa*
Sample A	4 (14.29%)	3 (10.71%)	-
Sample B	16 (57.14%)	3 (10.71%)	2 (7.14%)
Total (A+B)	20 (71.43%)	6 (21.43%)	2 (7.14%)

Key: - = No P, aeruginosa grown

3.2 Presumptive Faecal Coliform Count

Figure 2 details the MPN counts. Samples B1 and B4 showed the highest contamination, with counts of 20 MPN/100ml. B2 followed at 15 MPN/100ml, while several others (I3, I4, I6, B3, B5) registered 7 MPN/100ml. All of these exceed the permissible limit of 0 [24, 18]. A Chi-square test suggested that the difference in contamination levels between Brand A and Brand B wasn't statistically significant (p = 0.121335). In other words, neither brand appeared safer than the other.

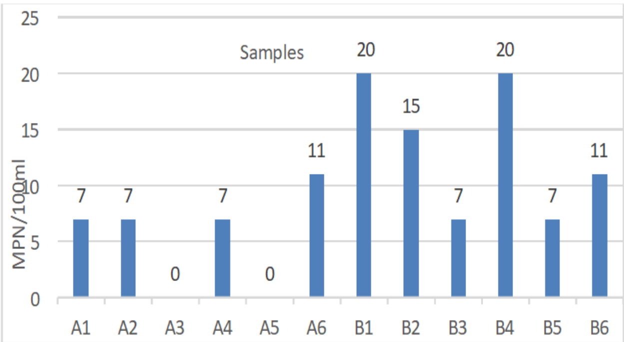

Figure 2: Presumptive faecal coliform count of sachet water samples investigated

3.3 The antibiotic susceptibility profile of bacterial isolates

The antibiotic susceptibility results, interpreted using the 2025 EUCAST breakpoints, showed a mixed but concerning picture. All isolates were fully susceptible to Gentamicin, Ofloxacin, and Levofloxacin. *S. aureus* and *P. aeruginosa* were susceptible to Augmentin. However, every single *E. coli* isolate was completely resistant to it (Fig. 3). Similarly, the *S. aureus* isolates showed blanket resistance to Erythromycin.

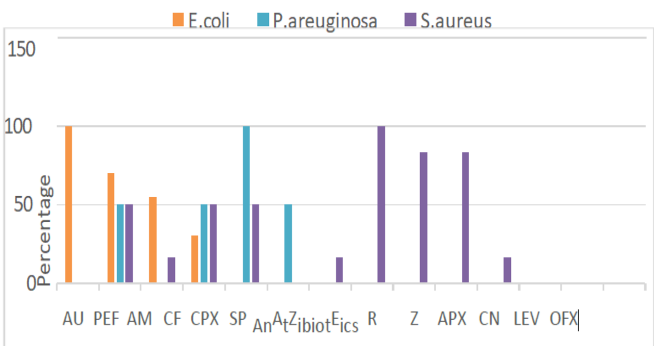

Figure 3: The antibiotic susceptibility profile of bacterial isolates

This is perhaps the most worrying finding. Finding multidrug-resistant bacteria in drinking water isn't just an environmental issue; it's a direct public health threat. It creates a potential pathway for resistance genes to travel from the environment into the human gut, potentially turning common, easily treatable infections into complicated clinical problems. This really underscores the "One Health" nature of antimicrobial resistance, linking what we see in the environment to challenges we face in the clinic.

IV. CONCLUSION AND RECOMMENDATIONS

This study looked at a small slice of the sachet water market serving Adamawa State University, Mubi. And what it found is troubling. The physical packages were universally non- compliant with basic NAFDAC labeling rules. More critically, over 80% of the samples were contaminated with faecal matter, making them unsafe by any global standard for drinking water. The bacteria we isolated also showed worrying levels of resistance to common, important antibiotics like Augmentin and Erythromycin. This isn't just about the immediate risk of a stomach bug; it's about the longer-term threat of spreading antibiotic resistance.

Based on these findings, a few steps seem necessary:

Regulators like NAFDAC and the Adamawa State Ministry of Health could consider increasing their surveillance and enforcing existing quality standards more strictly. Sanctions against vendors selling non-compliant products might help.

- For sachet water manufacturers, the path forward likely involves better training in Good Manufacturing Practices (GMP) and a real effort to identify and fix the points in their production lines where contamination is happening. An outright ban might seem like a solution, but it could simply cut off access to water for many.
- The university authorities are in a position to inform their community. A simple awareness campaign for staff and students—explaining the risks and showing them how to

ISSN (online): 2581-3048
Volume 10, Issue 3, pp 118-123, March-2026
https://doi.org/10.47001/IRJIET/2026.103015

spot a properly labeled product—could make a real difference.

- The antimicrobial resistance we found suggests a need for a broader, routine surveillance system to track resistance patterns in environmental samples. This data would be invaluable for public health policy and for guiding treatment decisions.
- Finally, this study only looked at bacteria. A more comprehensive study, one that also looked at chemical and viral contaminants, would give us a much more complete picture of what's really in this water.

REFERENCES

[1] World Health Organization. (2023). Progress on household drinking water, sanitation and hygiene 2000-2022: special focus on gender. WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene. https://www.who.int/publications/i/item/9789240088813

[2] Bennett, G., Bhave, P., & Cheuvront, S. N. (2024). Water intake: validity of population assessment and recommendations. European Journal of Nutrition, 63(2), 339–350.

[3] UNICEF. (2023). Water, Sanitation and Hygiene: Annual Results Report 2023. UNICEF. https://www.unicef.org/reports/annual-results-report-2023/wash

[4] Oloruntoba, E. O., & Kumar, N. (2024). A review of the public health impacts of consuming sachet water in low- and middle-income countries. Toxicology Reports, 12, 50-57.

[5] Odonkor, S. T., & Addo, K. K. (2023). Microbial Contamination of Packaged Water and the Implications for Food Safety and Public Health in Ghana. Journal of Food Quality and Hazards Control, 10(4), 189–200.

[6] Eze,C. N., Onwurah, I. N. E., & Okeke, C. U. (2024). Microbiological and physicochemical assessment of sachet water marketed in Awka Metropolis, Nigeria: A call for stricter regulatory oversight. Scientific African, 23, e02031.

[7] American Public Health Association (APHA), American Water Works Association (AWWA) & Water Environment Federation (WEF). (2023). Standard Methods for the Examination of Water and Wastewater (23rd ed.). APHA Press.

[8] Lennette, E. H., Balows, A., Hausler, W. J., & Shadomy, H. J. (Eds.). (1985). Manual of Clinical Microbiology (4th ed.). American Society for Microbiology.

[9] Barrow, G. I., & Feltham, R. K. A. (Eds.). (1993). Cowan and Steel's Manual for the Identification of Medical Bacteria (3rd ed.). Cambridge University Press.

[10] European Committee on Antimicrobial Susceptibility Testing (EUCAST). (2025). Breakpoint tables for interpretation of MICs and zone diameters. Version 15.0. https://www.eucast.org/clinical_breakpoints/

[11] Gram, H. C. J. (1884). Über die isolierte Färbung der Schizomyceten in Schnitt- und Trockenpräparaten. Fortschritte der Medizin, 2, 185–189. https://archive.org/details/fortschritteder02unkngoog/page/185/mode/1up

[12] Baird, R. B., & Smith, E. P. (2024). Standard Methods for the Examination of Water and Wastewater, 24th Edition. American Public Health Association, American Water Works Association, Water Environment Federation. Washington, DC: APHA Press.

[13] Adebayo, A. A. (2004). Mubi Region: A Geographical Synthesis. Paraclete Publishers, Yola, Nigeria. (Page numbers would be added here if available).

[14] Yonnana, E., Adebayo, A. A., & Mahmud, K. A. (2008). An Assessment of the Impact of Gully Erosion in Mubi Metropolis, Adamawa State, Nigeria. Journal of Environmental Sciences and Resource Management, 1(1), 1-9.

[15] Vawale, M. M., & Musa, S. D. (2017). Analysis of land use/land cover change in Mubi metropolis, Adamawa State, Nigeria. Global Journal of Pure and Applied Sciences, 23(2), 303-310. DOI: 10.4314/gjpas.v23i2.15

[16] Mele, F. G., & Waziri, M. (2015). An Assessment of Ethnic Integration in Mubi North Local Government Area, Adamawa State, Nigeria. Journal of Humanities and Social Science (IOSR-JHSS), 20(6), 43-49.

[17] Markus, N. D., & Mensah, A. C. (2015). Analysis of Rainfall Trends and its Implications on Food Security in Mubi Region, Adamawa State, Nigeria. International Journal of Climate Research, 1(1), 1-11.

[18] National Agency for Food and Drug Administration and Control (NAFDAC). (2023). Guidelines for the Production, Importation, Distribution and Sale of Packaged Water. NAFDAC Regulatory Directive No. 0004.

[19] Nnaji, C. C., Oyeyi, T. I., & Eze, C. C. (2023). Compliance with regulatory labelling requirements and its impact on the perceived quality of sachet water in a Nigerian urban city. Journal of Water and Health, 21(7), 1001-1013.

[20] Adeolu, A. T., Ojo, O. O., & Akinyemi, O. O. (2024). Vendor practices and environmental determinants of sachet water quality in Southwestern Nigeria: A public health risk assessment. Environmental Health Insights, 18.

ISSN (online): 2581-3048
Volume 10, Issue 3, pp 118-123, March-2026
https://doi.org/10.47001/IRJIET/2026.103015

[21] Kadmiel, A. D., Bawa, M. A., & Ishaq, M. (2021). Bacteriological quality assessment of sachet water marketed in Mubi Metropolis, Adamawa State, Nigeria. Nigerian Journal of Microbiology, 35(2), 5671-5680.

[22] Liguori, K., Keenum, I., Calarco, J., Davis, B. C., Milligan, E., Harwood, V. J., & Pruden, A. (2024). A critical review of waterborne pathogen outbreaks and their investigation methods. Clean Water, 7(1), 13.

[23] Centers for Disease Control and Prevention (CDC). (2023). Waterborne Diseases. Centers for Disease Control and Prevention. https://www.Center for Disease Control and Prevention.gov/healthywater/disease/index.html

[24] World Health Organization. (2023). Burden of disease attributable to unsafe drinking-water, sanitation and hygiene. https://www.who.int/publications/i/item/978924007561

Citation of this Article:

Hadiza Mahmud Usman, Mohammed Umar Faruk, & Mariya Yahaya. (2026). Bacteriological Analysis of Sachet Water Sold at Adamawa State University, Mubi Commercial. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 10(3), 118-123. Article DOI https://doi.org/10.47001/IRJIET/2026.103015

****

