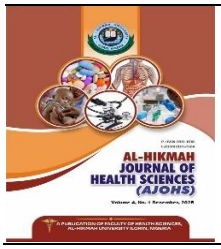
P-ISSN: 2811-1516
E-ISSN: 2811-1524



AL-HIKMAH JOURNAL OF HEALTH SCIENCES (AJOHS)

Official Publication of Faculty of Basic Medical Sciences

Al-Hikmah University Ilorin, Nigeria

https://alhikmahuniversity.edu.ng/AJOHS/index.php/journal

Original Article

Microbiological Evaluation and Phenotypic Profiling of Bacterial Isolates from Selected Water Bodies in Ilorin Metropolis, Nigeria

Omosola S.O.[1], Oladimeji L.O.[2], Omotoso I.O.[3] and Adewoye S.O.[4]

[1]Department of Community Medicine and Public Health, Faculty of Basic Medical Sciences, College of Health Sciences, Al-Hikmah University, Ilorin

[2]Department of Community Medicine and Public Health, Faculty of Basic Medical Sciences, College of Health Sciences, Al-Hikmah University, Ilorin

[3]Department of Environmental Health Science, Faculty of Allied Health Sciences, Ajayi Crowther University, Oyo

[4]Department of Pure and Applied Biology (Environmental Biology Unit), Ladoke Akintola University of Technology, Ogbomoso.

ARTICLE INFO

Article History
Received: 6th August, 2026
Accepted: 3rd October, 2026
Available online: 15th November, 2026

Keywords:
Surface water
Microbiological assessment
Phenotypic characterization
Bacterial isolates
Water bodies

Corresponding Author:

Omosola, S.O.
Department of Community Medicine and Public Health, Faculty of Basic Medical Sciences, Al-Hikmah University, Ilorin, Nigeria.

Email: omolaraomosola2340@gmail.com

ABSTRACT

Background: Surface water sources can become contaminated with microbes, potentially degrading their microbiological quality. Identifying and characterizing these bacterial contaminants is vital for assessing the microbial condition of surface waters.

Aim: This study evaluated the microbiological quality and conducted phenotypic characterization of bacterial isolates obtained from selected surface water bodies in Ilorin Metropolis, Nigeria.

Materials and Methods: Five 500 mL surface water samples were collected from each of the Asa River and the University of Ilorin River and combined separately by water body. Standard microbiological methods were employed to determine total bacterial counts and phenotypic traits of the isolated bacteria.

Result: The University of Ilorin River exhibited a higher bacterial load (1.05 × 105 CFU/mL) compared to the Asa River (6.8 × 104 CFU/mL). Based on cultural, morphological, and biochemical properties, three isolates were preliminarily identified as *Enterococcus faecium, Shigella sp*., and *Streptococcus sp*.

Conclusion: The results indicate bacterial contamination in the sampled surface water bodies, with notable differences in bacterial counts between them. Ongoing microbiological surveillance and enhanced environmental sanitation practices are advised.

Please cite this article as: Omosola, S.O., Oladimeji, L.O., Omotoso, I.O. & Adewoye, S.O. (2026). Microbiological Evaluation and Phenotypic Profiling of Bacterial Isolates from Selected Water Bodies in Ilorin Metropolis, Nigeria. *Al-Hikmah Journal of Health Sciences, 5*(3), 194-198.

Introduction

Surface water serves as a critical resource for domestic, agricultural, recreational, and industrial purposes (Priyan, 2021). Rivers, streams, and other surface water bodies sustain livelihoods, especially in areas with limited access to treated water. Nevertheless, such sources are highly susceptible to contamination from natural and human-induced activities. Urban expansion, population growth, disposal of industrial and domestic effluents, agricultural runoff, and insufficient sanitation infrastructure can introduce microorganisms and other

P-ISSN: 2811-1516
E-ISSN: 2811-1524

pollutants into surface water bodies (Debassi *et al*., 2025; Ezenwaji and Nwoye, 2025).

Microbial contamination plays a pivotal role in surface water quality evaluation, offering insights into the types and traits of bacterial pollutants present. Laboratory techniques facilitate the counting, isolation, and initial characterization of bacteria, thereby aiding in the assessment of water source microbiological safety (Cabral, 2010; Tolentino *et al*., 2021). The World Health Organization identifies microbial hazards as a key factor in water-quality management and advocates risk evaluation, preventive strategies, and monitoring as essential elements of water safety (World Health Organization [WHO], 2026). Although this study was not intended as a formal drinking-water compliance test, microbiological screening remains valuable for documenting bacterial contamination and guiding environmental monitoring efforts.

Bacteria commonly found in contaminated aquatic environments include *Enterococcus*, *Shigella*, *Escherichia coli*, *Salmonella*, *Pseudomonas*, and *Streptococcus*, several of which originate from human or animal fecal matter (Cui *et al*., 2019; Daniels and Komolafe, 2025). Their presence may indicate sewage overflow, surface runoff, improper waste disposal, or other environmental inputs. However, merely detecting bacterial isolates does not confirm human infection or directly measure health risks; rather, it signals contamination and underscores the need for additional environmental investigation.

Isolation and characterization are therefore essential for accurately describing the microbial composition of surface water bodies. Conventional methods, such as cultural traits, Gram staining, and biochemical assays, remain valuable for initial or presumptive identification, though they may face challenges in distinguishing closely related species.

Ilorin Metropolis hosts multiple surface water bodies subjected to diverse environmental influences. Prior research has highlighted environmental and microbial contamination linked to the Asa River; however, fluctuating contamination patterns necessitate localized evaluation. This study offers a comparative description against another selected water body and centers on the isolation and phenotypic profiling of distinct bacterial isolates. Specifically, it assessed the bacterial load of selected water bodies in Ilorin Metropolis and isolated and phenotypically characterized the recovered bacterial isolates. The results add to existing evidence on the microbiological profiles of surface water bodies in Ilorin Metropolis and support ongoing environmental surveillance and water resource management.

Materials and Methods

Study Area: The study was carried out in Ilorin Metropolis, Kwara State, North-Central Nigeria. Two surface water bodies, the Asa River and the University of Ilorin River, were selected for analysis. The Asa River flows through zones with varying population densities and environmental activities, whereas the University of Ilorin River passes through sparser, less populated regions. These two water bodies were chosen to enable a descriptive comparison of their microbiological profiles.

Study Design and Sample Collection: This laboratory-focused study involved collecting surface water samples from ten sites: five along the Asa River and five along the University of Ilorin River. At each site, approximately 500 mL of water was aseptically gathered into sterile sampling bottles at a depth of 15-20 cm beneath the surface. Samples were promptly transported to the Central Research Laboratory in Tanke, Ilorin, and processed within 1 to 4 hours of collection.

For laboratory testing, the five samples from the Asa River were combined to create composite Sample A, while those from the University of Ilorin River were merged to form composite Sample B. Thus, the findings reflect the microbiological profile of the composite samples and do not permit evaluation of variations among individual sampling points.

Determination of Total Bacterial Count: Nutrient agar was prepared per the manufacturer's guidelines and sterilized via autoclaving at 121°C for 15 minutes. Serial dilutions were prepared by transferring 1 mL of each pooled sample into 9 mL of sterile distilled water, yielding a 10-1 dilution, followed by further tenfold dilutions. Aliquots from suitable dilutions were plated onto nutrient agar using the pour-plate method. Plates were incubated at 37°C for 24 hours, after which colonies were counted and reported as colony-forming units per millilitre (CFU/mL).

Isolation and Phenotypic Characterization of Bacterial Isolates: Prominent bacterial colonies were selected from the culture plates and repeatedly subcultured to obtain pure isolates, which were stored on sterile agar at 4°C prior to further analysis. Initial characterization relied on colony morphology, Gram staining, and biochemical assays. Features such as colony colour, shape, and elevation were documented, and Gram staining was employed to determine Gram reaction and cellular shape.

The isolates underwent additional characterization via indole, catalase, urease, citrate utilization, and oxidase assays, alongside glucose, lactose, and sucrose fermentation analyses. Based on an integrative assessment of cultural, morphological, microscopic,

P-ISSN: 2811-1516
E-ISSN: 2811-1524

and biochemical traits, the isolates were assigned preliminary taxonomic designations. Consequently, the bacterial identifications were deemed presumptive, rooted in phenotypic profiles rather than conclusive at the taxonomic level.

Results

Total Bacterial Count Enumeration: The composite surface water sample from the University of Ilorin River (Sample B) exhibited a higher total bacterial count of 1.05×10^5 CFU/mL compared to the pooled Asa River sample (Sample A), which measured 6.8×10^4 CFU/mL (Table 1). This disparity reflects differences in bacterial load between the two composite water sources.

Table 1. Total Bacterial Count in Surface Water Samples

Sample	Total Bacterial Count (CFU/mL)
A (Asa River)	6.8×10^4
B (University of Ilorin River)	1.05×10^5

Isolation and Phenotypic Characterization of Bacterial Isolates

Three unique bacterial isolates were successfully isolated and labeled A1, B2, and B3. According to colony morphology, Gram staining, and biochemical profiling, the isolates were tentatively identified as *Enterococcus faecium*, *Shigella* sp., and *Streptococcus* sp., respectively. Isolate A1, isolated from the Asa River, displayed Gram-positive brown cocci and tested positive for indole, citrate utilization, oxidase, and fermentation of glucose and sucrose. Isolate B2, obtained from the University of Ilorin River, manifested as a Gram-negative yellow rod and yielded negative results across all tested biochemical reactions. Isolate B3, also sourced from the University of Ilorin River, appeared as a Gram-positive pink coccus and reacted positively only to the oxidase test. Collectively, these findings support a preliminary phenotypic identification based on the observed characteristics.

Table 2: Morphological and Biochemical Traits of Bacterial Isolates

Isolate	Source	Gram	Colony Colour	Shape	Biochemical Characteristics	Probable Organism
A1	Asa River	Positive	Brown	Cocci	Indole (+), Catalase (−), Urease (−), Citrate (+), Oxidase (+), Glucose (+), Lactose (−), Sucrose (+)	*Enterococcus faecium*
B2	University of Ilorin River	Negative	Yellow	Rod	Indole (−), Catalase (−), Urease (−), Citrate (−), Oxidase (−), Glucose (−), Lactose (−), Sucrose (−)	*Shigella* sp.
B3	University of Ilorin River	Positive	Pink	Cocci	Indole (−), Catalase (−), Urease (−), Citrate (−), Oxidase (+), Glucose (−), Lactose (−), Sucrose (−)	*Streptococcus* sp.

Discussion

The current study revealed bacterial contamination in the two selected surface water bodies in Ilorin Metropolis. The University of Ilorin River exhibited a higher total bacterial count (1.05×10^5 CFU/mL) compared to Asa River (6.8×10^4 CFU/mL), suggesting a disparity in bacterial abundance between the composite samples. This variation should be viewed descriptively, as the study was not intended to pinpoint the specific environmental or anthropogenic causes underlying the differences, and sample pooling prevented evaluation of variations among individual sampling sites. Comparable fluctuations in bacterial levels across surface water systems have been documented by Haldar *et al*. (2022) and Olawale *et al*. (2020), underscoring the impact of local environmental conditions and contamination sources.

Three distinct bacterial isolates were isolated and, on the basis of colony morphology, Gram staining, and biochemical tests, were tentatively identified as *Enterococcus faecium*, *Shigella* sp., and *Streptococcus* sp. Conventional phenotypic techniques remain valuable for the preliminary characterization of environmental bacterial isolates, especially in settings with limited laboratory resources. These methods yield crucial insights into the cultural, microscopic,

P-ISSN: 2811-1516
E-ISSN: 2811-1524

and biochemical traits of isolates and continue to serve as a reliable tool for initial microbiological screening. Nevertheless, they offer only presumptive, not conclusive identification and may fail to differentiate closely related taxa or clarify atypical biochemical patterns. Thus, the reported identifications in this study must be understood within the confines of the phenotypic methods applied.

The tentative isolation of *Enterococcus faecium* aligns with the known presence of enterococci in environmentally contaminated waters. Ajayi and Adejumo (2011) and Ichor *et al*. (2014) previously detected Enterococcus species in Nigerian surface waters, frequently alongside other microbes associated with environmental and faecal pollution. Likewise, the presumptive identification of *Shigella* sp. and *Streptococcus* sp. corresponds with earlier reports of these bacterial groups in contaminated aquatic environments (Ichor *et al*., 2014; Odeyemi *et al*., 2018). However, due to the absence of confirmatory identification, these findings should not be taken as definitive proof of the presence of these species in the studied water bodies. Rather, they suggest that isolates exhibiting phenotypic traits consistent with these taxa were obtained from the selected composite samples.

Nonetheless, the isolation of phenotypically diverse bacterial strains confirms the microbial heterogeneity of the sampled surface waters. Variations in colony morphology, Gram reaction, and biochemical profiles further support the presence of bacteria with differing phenotypic traits within the investigated water bodies. These observations are in agreement with prior research demonstrating that environmental waters often host diverse bacterial communities shaped by surrounding ecological and contamination dynamics (Ajayi and Adejumo, 2011; Ichor *et al*., 2014; Haldar *et al*., 2022). Consequently, the bacterial counts and tentative identifications from this study serve as descriptive indicators of the microbiological profiles of the two selected water bodies.

This study establishes baseline data on bacterial contamination and the phenotypic attributes of isolates from Asa River and the University of Ilorin River. The elevated bacterial load in the University of Ilorin River should not be misconstrued as definitive evidence of greater anthropogenic pollution, as the exact contamination sources were not identified. Additionally, the use of pooled samples limits interpretation of spatial variation within each water body. Future investigations should therefore analyze samples from individual locations, not composite pools and integrate confirmatory identification techniques to enhance taxonomic precision. Such strategies would facilitate a more nuanced evaluation of spatial heterogeneity and bacterial contaminant diversity across surface water bodies in Ilorin Metropolis.

Conclusion

This study confirmed bacterial contamination in the selected surface water bodies in Ilorin Metropolis. The University of Ilorin River displayed a higher total bacterial count than Asa River, indicating variation in Differences in bacterial abundance between the two composite samples. Three phenotypically distinct bacterial isolates were isolated and tentatively identified as *Enterococcus faecium*, *Shigella* sp., and *Streptococcus* sp. The results offer descriptive baseline insights into the bacterial profile of the selected waterbodies, contributing to the understanding of their microbiological quality in Ilorin Metropolis.

Recommendation

Routine microbiological surveillance of surface waterbodies in Ilorin Metropolis should be enhanced. Future investigations should collect and test samples from discrete sampling points and utilize confirmatory identification techniques to yield more precise data on the diversity and spatial distribution of bacterial contaminants.

Limitation

A limitation of this study was the pooling of samples from five sites within each waterbody prior to laboratory analysis. While this method offered a holistic overview of each waterbody, it prevented evaluation of spatial variability and statistical comparisons across individual sampling sites. Moreover, bacterial identification relied solely on phenotypic traits; thus, the reported identities should be regarded as presumptive, not conclusive.

Declarations

Ethical Approval: This study did not involve human participants or animal experimentation and therefore did not require formal ethical approval.

Declaration of Conflict of Interest: The authors declare that no known conflict in this paper.

Declaration of Data Availability: The data that are used in this research are available upon request from the corresponding author through (first author)

Reference

Cabral, J. P. S. (2010). Water microbiology: Bacterial pathogens and water. *International Journal of Environmental Research and Public Health, 7*(10), 3657–3703.

Cui, Q., Huang, Y., Wang, H., & Fang, T. (2019). Diversity and abundance of bacterial pathogens in urban rivers impacted by domestic sewage. *Environmental Pollution, 249*, 24–35.

P-ISSN: 2811-1516
E-ISSN: 2811-1524

Daniels, A. O., & Komolafe, T. O. (2025). Presence, distribution and antimicrobial resistance profiles of microorganisms in surface and underground water in Owo metropolis. *MSI Journal of Medicine and Medical Research, 2*(5). https://doi.org/10.5281/zenodo.15448075

Debassi, B., Allaoua, N., Ghanem, N., Hafid, H., Benacherine, M., & Chenchouni, H. (2025). Assessment of water quality of groundwater, surface water, and wastewater using physicochemical parameters and microbiological indicators. *Science Progress, 108*(2), 00368504251348544.

Ezenwaji, E. E., & Nwoye, T. N. (2025). Physical and socio-economic factors responsible for poor WASH services in Onitsha urban area, Anambra State, Nigeria. *Journal Arbitrase: Economy, Management and Accounting, 3*(2), 62–82.

Ganiyu, F. J., & Bolaji, F. S. (2025). Anthropogenic and domestic waste impacts on surface water quality of Asa River, Ilorin, Nigeria. *World News of Natural Sciences, 63*(2), 259–281.

Gerba, C. P., & Pepper, I. L. (2019). Microbial contaminants. In M. L. Brusseau, I. L. Pepper, & C. P. Gerba (Eds.), *Environmental and pollution science* (3rd ed., pp. 191–217). Academic Press. https://doi.org/10.1016/B978-0-12-814719-1.00013-6

Haldar, K., Kujawa-Roeleveld, K., Hofstra, N., Datta, D. K., & Rijnaarts, H. (2022). Microbial contamination in surface water and potential health risks for peri-urban farmers of the Bengal Delta. *International Journal of Hygiene and Environmental Health, 244*, 114002.

Ichor, T., Umeh, E. U., & Duru, E. E. (2014). Microbial contamination of surface water sources in rural areas of Guma Local Government Area of Benue State, Nigeria. *Journal of Medical Sciences and Public Health, 2*(2), 43–51.

Isukuru, E. J., Opha, J. O., Isaiah, O. W., Orovwighose, B., & Emmanuel, S. S. (2024). Nigeria's water crisis: Abundant water, polluted reality. *Cleaner Water, 2*, 100026.

Ogunsola, F. T., & Mehtar, S. (2020). Challenges regarding the control of environmental sources of contamination in healthcare settings in low- and middle-income countries: A narrative review. *Antimicrobial Resistance & Infection Control, 9*(1), 81.

Olawale, S. I., Odebisi-Omokanye, M. B., Oladunjoye, I. O., Muhammed, M., & Olanrewaju, S. O. (2020). Plasmid profiles and antibiotic susceptibility patterns of bacteria isolated from abattoir wastewater within Ilorin, Kwara, Nigeria. *Iranian Journal of Microbiology, 12*(6), 547–555.

Oliveira, T. R., Gomes, R. P., Rodrigues, A. B., Ferreira, L. M., Gama, A. R., Vieira, J. D. G., Fernandes, M. R., & Carneiro, L. C. (2021). Identification and resistance profile of Gram-positive bacteria from aquatic environment. *Research, Society and Development, 10*(13), e226101321182. https://doi.org/10.33448/rsd-v10i13.21182.

Priyan, K. (2021). Issues and challenges of groundwater and surface water management in semi-arid regions. In C. B. Pande & K. N. Moharir (Eds.), *Groundwater resources development and planning in the semi-arid region*. Springer. https://doi.org/10.1007/978-3-030-68124-1_1.

Tolentino, F. M., de Almeida, I. A. Z. C., dos Santos, C. C. M., de Carvalho Teixeira, I. S., de Lima e Silva, S. I., Nogueira, M. C. L., Arroyo, M. G., Faim, W. R., Gottardo de Almeida, M. T., & Peresi, J. T. M. (2021). Phenotypic and genotypic profile of the antimicrobial resistance of bacterial isolates and evaluation of physical and chemical potability indicators in groundwater in Brazil. *International Journal of Environmental Health Research, 31*(2), 186–201. https://doi.org/10.1080/09603123.2019.1640354.

World Health Organization. (2026). *Guidelines for drinking-water quality: Fourth edition incorporating the first, second and third addenda*. World Health Organization.