Bacteriological Analysis of River Water in Oriade/Obokun Local Government, Osun-State, Nigeria

Abstract

This research investigates the bacteriological composition of the Oriade/Obokun stream water, specifically focusing on IwoyeIjesa and Ijebu Jesa. The study encompasses an analysis of water sources, usage patterns, pollution sources, and the identification of waterborne bacterial pathogens. Water samples were collected and subjected to laboratory examination for the identification of opportunistic pathogenic bacteria using a microscope.The results revealed the presence of various pathogenic bacteria, including *E. coli*, *Salmonella*, *V. cholerae*,*Shigella spp*, and Campylobacter. Notably, E. coli emerged as the predominant coliform, typically associated with fecal contamination. The detection of *Vibrio cholerae* signals inadequate sanitation practices, while the presence of other pathogenic bacteria raises concerns about public health implications such as gastro-intestinal infections, diarrhea, dysentery, and typhoid.The findings suggest a correlation between the identified waterborne pathogens and improper waste disposal, water source contamination through sewage and surface run-off. The study underscores the potential threat and risk of waterborne epidemics posed by bacterial contamination in the Oriade/Obokun stream water. Consequently, water supply authorities are urged to acknowledge this situation and implement measures to ensure the provision of contamination-free drinking water, thereby mitigating the risk of waterborne disease outbreaks in the IwoyeIjesa and Ijebu Jesa communities.

Key words: Contamination, Fecal Coliform, Pollution, Diseases, *Salmonella*

1.0 INTRODUCTION

Water, acknowledged as a universal solvent, plays a pivotal role in various physiological and ecological processes, serving as an essential component of all cells. Its accessibility is a key developmental issue, and the demand and supply dynamics within the water use-cycle pose challenges such as population displacements, loss of wildlife, and alterations in river ecology (Armstrong et al., 2019). Water contamination, defined as the degradation of water quality from public health or ecological perspectives, results from the presence of pollutants in identifiable excess. These pollutants include heavy metals, sediments, radioactive isotopes, phosphorus, nitrogen, sodium, arsenic, heat, fecal coliform bacteria, and pathogens (Botkin et al., 2022). In regions with inadequate waste management practices, direct discharge of domestic and agricultural wastes is a significant source of waterborne diseases.

Municipal water pollution from human and animal sources poses a major threat to public health, particularly in economically challenged countries. Contaminated water serves as a vector for infectious diseases, transmitting ailments ranging from mild gastroenteritis to severe dysentery, cholera, typhoid, hepatitis, and giardiasis (Wanda, 2021). Drinking water safety is paramount, routinely tested for coliform bacteria—a key indicator of waste contamination. Coliform bacteria, including Escherichia coli and Streptococcus faecalis, are naturally present but their presence in water supplies is unacceptable (Kathleen, 2020; FEPA, 2021).

Bacterial contamination, imperceptible by appearance, taste, or smell, requires testing for indicator organisms, specifically Escherichia coli and total coliform bacteria (Gomes and Martinis, 2019). Water samples with coliform bacteria are further analyzed through fecal coliform or Escherichia coli tests. The presence of these fecal bacteria in any concentration in water supplies is deemed unacceptable (Kathleen, 2020).

Water pollution manifests in two primary forms: point source pollution, resulting from the direct release of harmful substances into bodies of water, and non-point source pollution, arising from the indirect introduction of pollutants from the environment into water bodies/sources (Kerker, 2019). In Nigeria, water pollution is pervasive, affecting both rural and urban areas. An estimated 1.5 million people lack access to safe drinking water, with sources of contamination including raw sewage, garbage, and oil spills (Ladeji, 2023). Over 80% of diseases in developing countries stem from contaminated water, inadequate sanitation, and poor hygiene practices (WHO, 2020). Addressing these challenges is essential for ensuring the well-being of communities and fostering sustainable development.

2.STUDY LOCATION

Oriade and Obokun are two local government areas situated in Osun State, Nigeria, with rich historical backgrounds that span centuries and reflect the diverse cultural tapestry of the region. This historical overview aims to provide a concise narrative of the significant milestones and cultural evolution of Oriade and Obokun.

The history of Oriade Local Government is deeply rooted in the traditions of the Yoruba people, one of the major ethnic groups in Nigeria. The town of Ipetu-Ijesa, a prominent settlement within Oriade, has played a pivotal role in the region's cultural and economic development. Historically, the Yoruba people established powerful kingdoms, and the impact of these kingdoms is evident in Oriade's historical narrative. The town is known for its adherence to Yoruba traditions and customs, contributing to the preservation of the cultural heritage of the people.

Similarly, Obokun Local Government has a storied past closely intertwined with the Yoruba civilization. The town of Ibokun, a key community within Obokun, has been a center of cultural activities and historical significance. The Yoruba people, known for their vibrant art, rich mythology, and advanced political structures, have left an indelible mark on the history of Obokun. The town has witnessed the rise and fall of kingdoms and has been a hub for trade and commerce, reflecting the economic dynamism of the region.

Both Oriade and Obokun have been influenced by the presence of powerful Yoruba kingdoms, such as the Oyo Empire, which played a crucial role in shaping the political landscape of the area. The Oyo Empire, with its complex system of governance and military prowess, significantly impacted the social and political organization of Oriade and Obokun.

The advent of colonialism in Nigeria marked a transformative period in the history of Oriade and Obokun. The British colonial administration, seeking economic opportunities and strategic control, left an imprint on the socio-political structure of the region. The effects of colonial rule, including changes in land tenure systems and administrative structures, have had lasting consequences on the development of Oriade and Obokun.

Post-independence, Oriade and Obokun have continued to evolve as integral parts of Osun State. The local governments have embraced modernity while preserving their cultural heritage.

Urbanization, improved infrastructure, and educational developments have shaped the contemporary landscape of Oriade and Obokun.

Culturally, the people of Oriade and Obokun celebrate various festivals and ceremonies that highlight their traditions, music, dance, and art. These cultural practices serve as a testament to the resilience of the Yoruba heritage in the face of changing times.

2.1 Materials

The materials, equipment, and reagents employed in this study encompassed Nutrient Agar, Eosin Methylene Blue (EMB) Agar, Petri dishes, conical flasks, beakers, test tubes, inoculating loops, sterile swab sticks, cotton wool, spirit lamps, distilled water, hand gloves, nose masks, sterile plastic containers, aluminum foil, masking tape, sterile EDTA bottles, needles and syringes, measuring cylinders, micro pipettes, autoclave, incubator, microscope, microscope slides, weighing balance, immersion oil, ethanol, hydrogen peroxide, Gram's staining reagents, detergent, and disinfectant, among others.

2.2 Sterilization of Materials

To ensure the sterility of all materials, thorough procedures were followed before and after each use. Glassware was meticulously washed with detergent, rinsed, and drained before being wrapped in aluminum foil and sterilized in an oven (hot air) at 70°C for 1 hour. The working bench and surrounding area were disinfected using cotton wool soaked in 70% alcohol. The inoculating loop was flame-sterilized to red hot and allowed to cool before use. Culture media and distilled water were sterilized in an autoclave at 121°C for 15 minutes. Microbial analyses were conducted near a Bunsen flame.

2.3 Sample Collection

Water samples from the Oriade Local Government Area, specifically Iwoye and Iloko divisions in Osun State, Nigeria, were collected from labeled sites A and B (upstream and downstream). Collected in sterile plastic containers, these samples were promptly transported to the laboratory and analyzed within three hours of collection.

2.4 Preparation of Culture Media

Culture media, including Nutrient Agar and Eosin Methylene Blue (EMB) Agar, were prepared following the manufacturer's instructions. For Nutrient Agar, 14 grams were dissolved in 500ml of distilled water, heated, and swirled for a homogeneous mixture. The resulting solution was sterilized in an autoclave at 121°C for 15 minutes. Similarly, Eosin Methylene Blue (EMB) Agar was prepared by dissolving 17.9 grams in 500ml of distilled water, heating, swirling, and sterilizing under the same conditions.

2.5 Sample Inoculation

A serial dilution followed by the Pour-plate technique was employed for total viable count and presumptive coliform testing. Using sterile pipettes, 1 ml of each diluent was transferred to labeled petri dishes, mixed with sterile Nutrient Agar, allowed to set, and then incubated at 37°C for 24 hours. The resulting colonies were subcultured onto freshly prepared Eosin Methylene Blue Agar for further biochemical and morphological characterization.

2.6 Cultural Characterization

Morphological and cultural characteristics such as shapes, elevation, and edges were considered for the identification of isolates.

2.7 Catalase Test

The presence of catalase enzyme was detected by smearing a small portion of the culture on a clean, grease-free glass slide, adding one to two drops of 3% hydrogen peroxide, and observing for the release of free oxygen gas.

2.8 Gram's Staining

Gram's staining was conducted to differentiate bacterial types. Smears were made on glass slides, air-dried, heat-fixed, stained with crystal violet, rinsed, flooded with Lugol's iodine, decolorized with alcohol, stained with safranin, and then air-dried. Microscopic examination under oil immersion revealed Gram-positive (purple) and Gram-negative (red to pink) organisms.

2.9 Coagulase Test

A smear of the developed colony was made on a clean, grease-free glass slide, and blood serum was added, checked for agglutination, and interpreted for coagulase activity.

3.0 RESULT AND DISCUSSION

3.1 RESULTS

Table 1: Morphological and Cultural Characteristics of Bacteria Isolated from Water Samples

Samples	Isolated Microorganisms	Gram's Reaction	Shapes	Motility	Edge	Elevation
1	*Escherichia coli*	-ve	Rod	Motile	Rough	Undulate
2	*Vibrio cholerae*	+ve	Spiral	Non	Rough	Undulate
3	*Bacillus spp.*	+ve	Rod	Non	Rough	Undulate
4	*Serratia spp.*	-ve	Rod	Non	Smooth	Flat
5	*Streptococcus spp.*	+ve	Cocci	Non	Rough	Undulate
6	*Streptobacillus spp.*	+ve	Rod	Non	Rough	Undulate

Key: (1) Iwoye downstream A, (2) Iloko downstream B, (3) Iwoye up stream A, (4) Iloko upstream stream B, (5) Okeeruru up stream, (6) Okeeruru downstream.

Table 2: Biochemical Reactions

Samples	Isolated Microorganisms	Catalase Test	Coagulase Test
1	*Escherichia coli*	+ve	+ve
2	*Vibrio cholerae*	+ve	+ve
3	*Bacillus spp.*	+ve	-ve
4	*Serratia spp.*	+ve	-ve
5	*Streptococcus spp.*	+ve	-ve
6	*Streptobacillus spp.*	+ve	-ve

Key: (1) Iwoye downstream A, (2) Iloko downstream B, (3) Iwoye up stream A, (4) Iloko upstream stream B, (5) Okeeruru up stream, (6) Okeeruru downstream.

Discussion

The findings of this study emphasize the critical need for robust water treatment measures to ensure the safety of water intended for human consumption. The prevalence of various microorganisms, particularly enteropathogens like Escherichia coli and Serratia spp., highlights the potential health risks associated with contaminated surface water. It is essential to acknowledge that the point prevalence of these pathogens can vary based on factors such as sampling time and site, offering important insights for risk assessment (Kukkula et al., 2019).

The high presence of Escherichia coli in the water samples aligns with the results of previous studies conducted by Niemi et al. (2017) and Leclerc et al. (2022). This consistency in findings emphasizes the persistent challenge of fecal contamination in surface water sources. Escherichia coli, a well-established indicator of fecal contamination, points to potential sources of contamination, implicating inadequate sanitation and unhygienic practices as significant contributors to microbial pollution in water (Sahota, 2015). The coexistence of other pathogenic organisms like Vibrio cholerae, Streptococcus spp., and Streptobacillus spp. raises additional health concerns due to their associated risks.

The correlation between the current research and the studies conducted by Howard et al. (2019), Oyedeji et al. (2021), Adekunle et al. (2014), Onifade et al. (2018), and Dada (2019) underscores the persistent challenges posed by waterborne diseases, particularly in developing nations. The prevalence of diseases such as diarrhea, typhoid fever, cholera, and bacillary dysentery is closely linked to the consumption of unsafe water and unhygienic drinking water production practices (Mead et al., 2019). Fecal contaminants, including E. coli, Vibrio cholerae, and Salmonella typhi, pose a significant threat to public health when they enter water bodies or the water supply.

Mitigating the impact of waterborne diseases necessitates multifaceted efforts, including improvements in water treatment infrastructure, promotion of proper sanitation practices, and enhanced public awareness. Strategies focused on reducing fecal contamination and ensuring the safety of water sources are crucial for safeguarding the health of communities relying on these water bodies. This research contributes essential insights into the microbial composition of water samples, laying the groundwork for future initiatives in water quality management and disease prevention. The need for continued research and comprehensive interventions is evident, especially in the context of evolving environmental and public health challenges.

Limitations

It is crucial to acknowledge the limitations of this study, particularly in the areas of sampling and laboratory diagnosis. The representativeness of the water samples may be influenced by factors such as sampling time and site, introducing potential variability in the observed prevalence of microorganisms. Additionally, the methods used for laboratory diagnosis, while providing valuable qualitative data, may have inherent limitations in detecting low levels of contamination or specific pathogens. Future studies could benefit from more extensive and systematic sampling, considering different seasons and locations, and employing advanced diagnostic techniques for a more comprehensive understanding of water quality.

Moreover, the study faced challenges in obtaining a truly representative sample due to constraints such as time, budget, and geographical factors. These limitations may impact the generalizability of the findings to a broader population.

Future Directions

Expanding on this research, future studies could delve into more advanced molecular techniques for microbial identification and quantification. This would provide a deeper understanding of the specific strains present, their virulence factors, and potential antibiotic resistance profiles. Additionally, investigating the impact of climate change on water quality and the proliferation of waterborne pathogens could be a crucial area of research, considering the dynamic environmental conditions.

4.0 Conclusion

The conclusion highlights the critical importance of preventing bacterial contamination in drinking water through strategic well location and construction, alongside effective control of human activities to curtail sewage entry into water bodies. The observed correlation between waterborne diseases and improper waste disposal, sewage contamination, and surface runoff accentuates the necessity for comprehensive public education programs. These initiatives should focus on waste disposal best practices, sewage treatment, and the imperative of water purification to ensure its suitability for consumption. The identified microorganisms carry substantial public health implications, contributing to a spectrum of infections.

In regions without access to piped water, particularly in rural areas, there is a pressing need for researchers and governmental bodies to coordinate informative campaigns. These initiatives aim to enlighten residents on the proper utilization of surface water, advocating for safe practices to minimize health risks associated with waterborne pathogens. By fostering awareness and promoting responsible water-related behaviors, these programs can significantly contribute to improving the overall water quality and, subsequently, public health in these communities.

Recommendations

In light of the water quality findings in the study area, several crucial recommendations are proposed to ensure the safety of drinking water:

Boiling of Drinking Water: To proactively eliminate potential bacterial contaminants, it is strongly advised to boil drinking water before consumption. This simple and effective measure can significantly reduce the risk of waterborne infections.

Government Intervention: The alarming cases of waterborne bacterial pathogens underscore the need for immediate government intervention. Government agencies should prioritize and fulfill their responsibility of providing safe drinking water to the community. This may involve infrastructure improvements, water treatment facilities, and regular monitoring.

Chlorine Disinfection: Implementing regular chlorine disinfection treatment for drinking water is vital. Chlorine has proven effectiveness in neutralizing harmful bacteria and ensuring the microbial safety of the water supply. Regular treatment should be maintained to prevent the proliferation of waterborne pathogens.

Quality Check: Regular monitoring and assessment of the quality of drinking water are imperative. Adhering to the drinking water guidelines established by reputable organizations such as the World Health Organization (WHO) ensures that the water meets the necessary safety standards. Routine quality checks should be conducted to identify and address any deviations promptly.

Source Protection: Measures should be implemented to protect the sources of drinking water from unnecessary human and animal access. This involves the establishment of physical barriers and controlled access points to minimize the risk of contamination. Source protection is a fundamental step in ensuring the ongoing safety of the water supply.

Maintaining Reservoir Hygiene: The general cleanliness and hygiene of water main storage reservoirs play a crucial role in preventing the growth and spread of waterborne pathogens. Regular cleaning, maintenance, and inspection of reservoirs should be conducted to uphold proper hygiene standards.

Sewage Treatment: Proper treatment and disinfection of sewage water are paramount. Before disposal, sewage water should undergo thorough treatment processes to eliminate harmful contaminants. This step is critical in preventing the contamination of water sources and, consequently, safeguarding public health.

By implementing these recommendations, there is a substantial opportunity to enhance the overall quality and safety of drinking water in the study area. It requires collaborative efforts from individuals, communities, and government bodies to ensure the effective implementation of these measures and guarantee the well-being of the population.

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