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Assessment Of Microbial Contaminants In Municipal Area Council Boreholes, Abuja, Nigeria.

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ABSTRACT

Introduction: This study evaluated microbial contamination in borehole water across fifteen locations within the Abuja Municipal Area Council (AMAC), FCT.

Materials and Methods: Thirty water samples were collected and analyzed for microbial parameters, including total bacterial count (TBC), Escherichia coli, Salmonella, Shigella, yeasts, molds, and parasites.

Results: Results indicated significant microbial contamination, with key locations such as Wuse and Durumi showing TBC levels exceeding 14,000 CFU/ml, far above the WHO and NIS recommended 100 CFU/ml limit. Yeast and mold contamination was also prominent, particularly in Jabi. Data analysis was performed using SPSS and Python, revealing that 80% of the sampled boreholes failed to meet microbial safety standards.

Conclusion: The findings emphasize the need for immediate interventions, including water treatment, routine microbial monitoring, improved sanitation around boreholes, and public health campaigns to raise awareness of the risks associated with untreated borehole water. These steps are crucial for mitigating contamination risks and ensuring regional water safety.

INTRODUCTION

Water is indispensable for sustaining life and plays a crucial role in public health (1). Groundwater, a significant source of drinking water globally, is increasingly relied upon in urban areas like Abuja, where water scarcity has forced many to rely on boreholes for water supply (2). However, boreholes are susceptible to contamination from various sources, including surface runoff, inadequate construction, and sewage infiltration (3).

The safety of this water is often compromised by microbial contamination, which can lead to waterborne diseases such as cholera, diarrhea and typhoid (4). The World Health Organization (WHO) estimates that waterborne diseases lead to approximately 485,000 deaths each year, mainly from diarrheal diseases. Children under five are especially at risk, with a substantial number of these deaths occurring in this age group (5). In AMAC, rapid urbanization has exacerbated the risk of microbial contamination, yet there is limited data on the extent of contamination in boreholes, posing a significant public health concern. Therefore, the primary objective of this study is to evaluate the microbial quality of borehole water in AMAC by assessing the levels of microbial contaminants and comparing them with WHO and NIS standards. This study seeks to provide insights into the safety of borehole water, focusing on fecal indicators and pathogens such as Escherichia coli, Salmonella, Shigella, yeasts, molds and parasites. By identifying and quantifying these contaminants, this research aims to offer actionable recommendations to safeguard public health.

MATERIALS AND METHODS

Study Area

This study was conducted in AMAC, FCT on borehole water samples collected from 15 locations viz: Kurudu, Utako, Jabi, Kubwa, Maitama, Gwarimpa, Asokoro, Wuse, Garki, Galadimawa, Guzampe, Gaduwa, Lugbe, Lokogoma, and Durumi. Thirty water samples were collected (2 from each location).

Sample Collection

Water samples were aseptically collected using sterile sample bottles. The taps were sterilized using ethanol, and water was allowed to run off for two minutes before collection. The samples were transported to the laboratory in ice packs for immediate microbial analysis.

Microbial Analysis

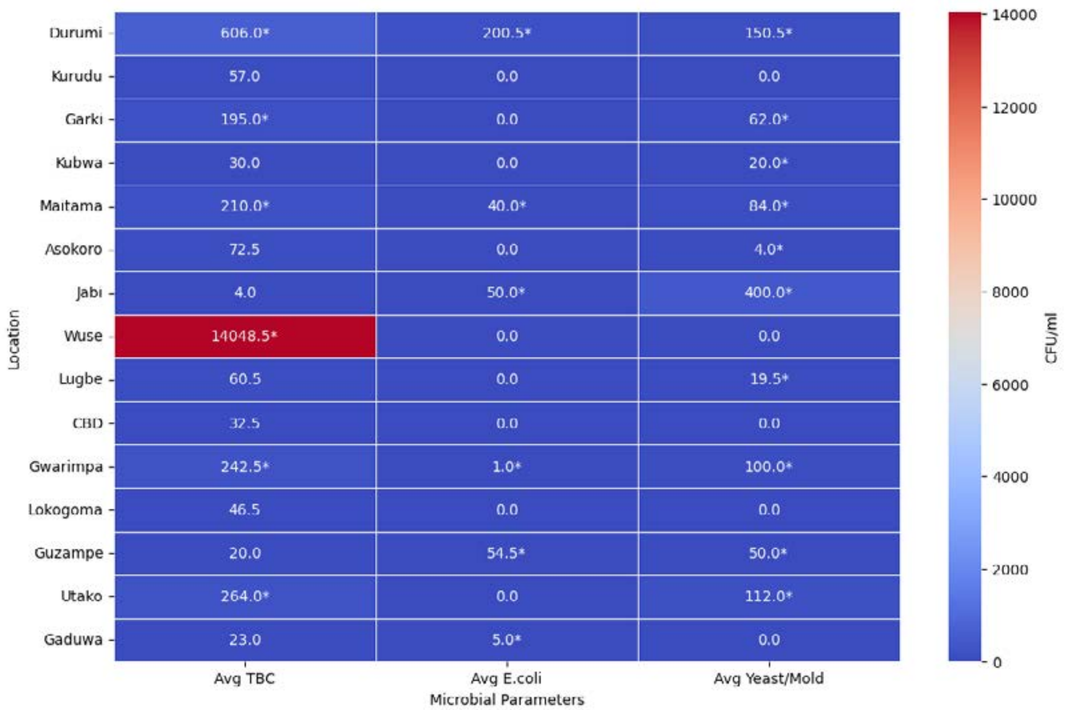
The microbial parameters evaluated included total bacterial count (TBC), Escherichia coli, Salmonella, Shigella, yeasts, molds, and parasites. Samples were cultured on Eosin Methylene Blue (EMB) agar, Salmonella Shigella Agar (SSA), Potato Dextrose Agar (PDA), and Plate Count Agar (PCA). Bacterial incubation was conducted at 37°C for 24-48 hours, while fungi and molds were incubated at 25°C for 72 hours. Biochemical tests used for the identification and characterization of isolates included Gram staining, motility, indole production, the triple sugar iron test, citrate utilization, and oxidase testing. Parasites were identified through microscopy. The detected microbial contaminants were compared with WHO and NIS standards.

RESULTS AND DISCUSSION

Microbial Contaminants in Borehole Water Samples

The microbial contamination levels in borehole water from 15 locations across AMAC, Abuja, are summarized in Figure 1, which provides a detailed heat map. This figure illustrates the variation in contamination levels for Total Bacterial Count (TBC), Escherichia coli, and Yeast/Mold, along with their compliance or non-compliance status with WHO/NIS standards.

Key locations such as Wuse and Durumi showed excessive microbial contamination, with TBC levels significantly exceeding the permissible limits of the WHO/NIS standards. In particular, Wuse recorded a TBC value of over 14,000 CFU/ml and the highest observed across all locations. Other locations, including Maitama, Gwarimpa, Garki and Utako, also reported elevated TBC values above the recommended 100 CFU/ml threshold. Meanwhile, other locations were within acceptable limits, suggesting lower contamination levels and reduced public health risks.



Heat Map of Microbial Contaminants by Location (WHO/NIS Limit Exceedance Annotated)

Compliance and Non-Compliance Analysis
Figure 2 presents the proportion of compliant and non-compliant locations in relation to microbial contamination based on WHO/NIS standards. From the chart, it is evident that a substantial portion of the boreholes, 80%, are non-compliant with the microbial safety guidelines. These boreholes show microbial parameters (such as total bacteria count, *Escherichia coli*, or yeast and mold) that exceed the permissible limits, raising serious concerns regarding water safety for consumption or domestic use. On the other hand, only 20% of the boreholes meet the WHO/NIS standards, indicating a relatively small number of locations where the water is considered microbiologically safe.

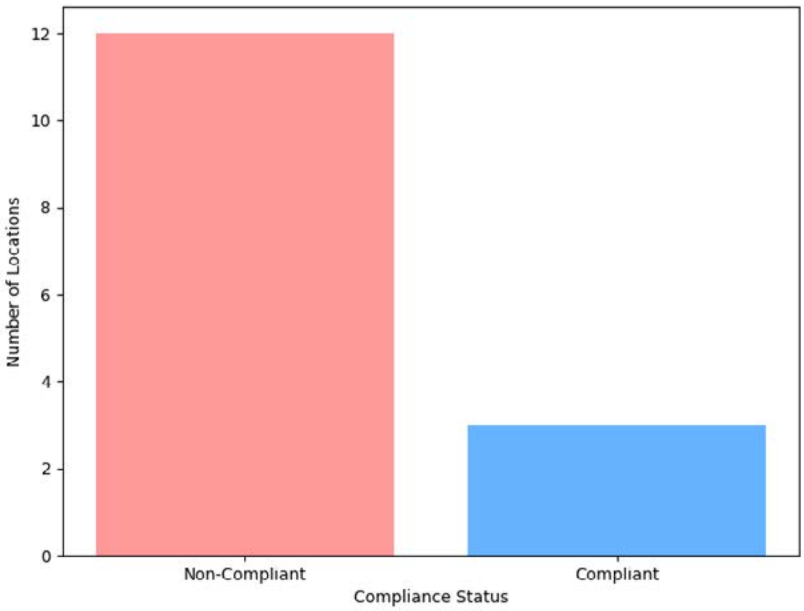


Figure 2: Proportion of Compliant and Non-Compliant Locations Based on WHO/NIS Microbial Standards

Comparison of Microbial Contaminants by Location
Figure 3 presents a bar chart showing the average concentration of TBC, E. coli, and Yeast/Mold across the 15 locations. This chart highlights significant disparities between locations, with Wuse emerging as the most contaminated in terms of TBC. It recorded a value exceeding 14,000 CFU/ml, making it the most heavily contaminated location. Durumi also displayed considerable contamination, with both TBC and E. coli levels surpassing WHO/NIS standards. Jabi exhibited a high level of yeast/mold contamination, raising concerns about fungal pollutants in that location.

In contrast, Kurudu, Kubwa, and Gaduwa had relatively low microbial concentrations, suggesting better water quality in these areas. The absence of detectable E. coli and low levels of TBC and yeast/mold in these locations are notable for ensuring safer water for consumption.

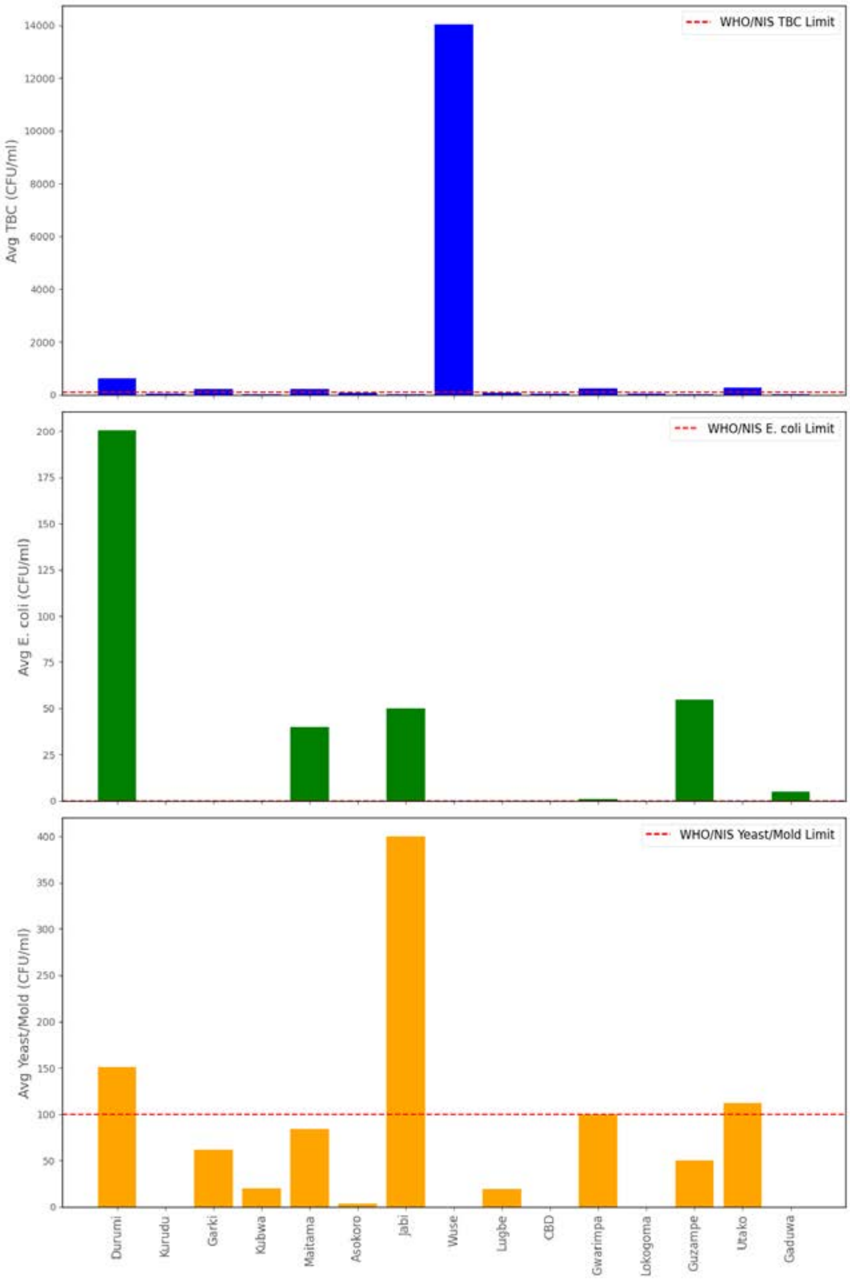


Figure 3: Average Microbial Contaminants per Location

Proportional Distribution of Contaminants

Figure 4 provides a stacked bar chart that presents the proportional contributions of TBC, E. coli, and Yeast/Mold in each location. This chart emphasizes the dominance of TBC as the primary contaminant in locations like Wuse and Durumi, where bacterial loads far exceed WHO/NIS limits. In Jabi, yeast and mold account for a substantial portion of the contamination, highlighting the need for targeted interventions to address fungal contamination in that area. The stacked chart also shows that in compliant locations such as Kurudu and Gaduwa, microbial contamination is minimal across all parameters, underscoring the relative safety of these boreholes.

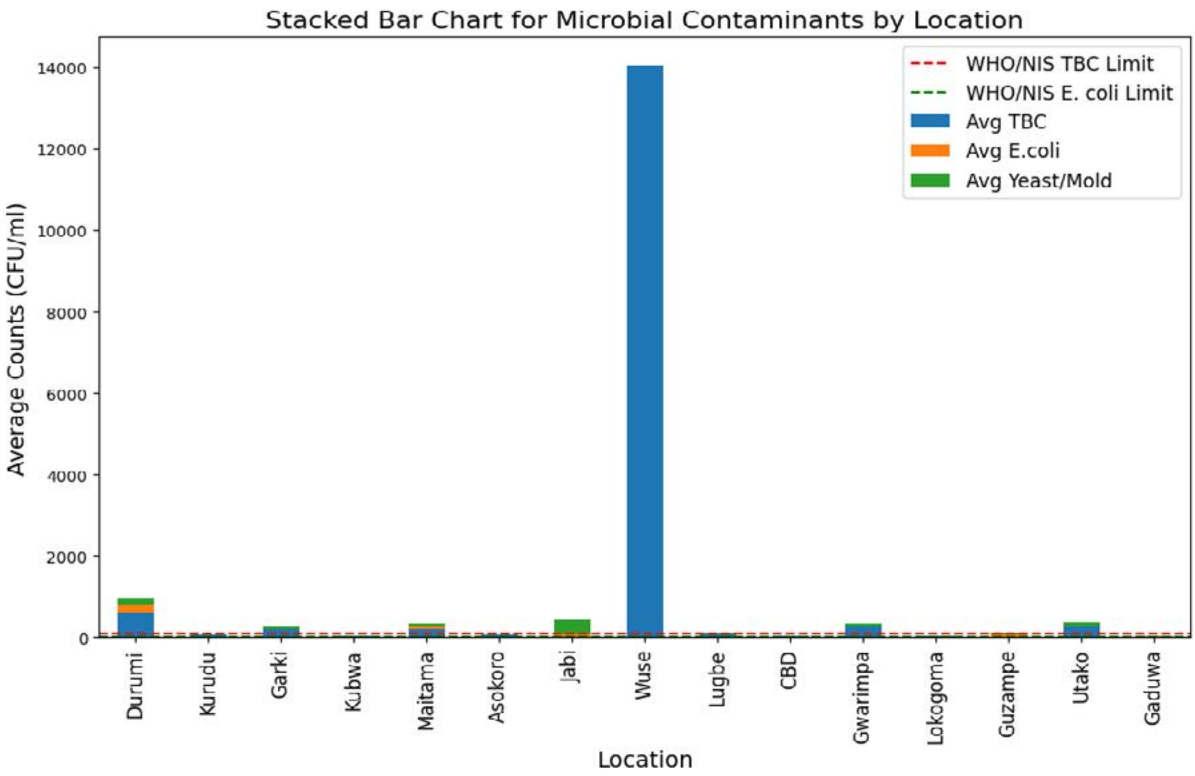


Figure 4:Comparison of Microbial Contaminants at Various Locations Against WHO/NIS Limits.

Waterborne bacterial pathogens are causative agents of many human diseases and their

presence poses a potential threat to the human health. The presence of Escherichia coli and high total bacterial counts in multiple locations points to fecal contamination, likely caused by poor sanitation and proximity to sewage systems. The findings from the current study are similar to the findings by Ezeh et al. (6) in Abuja and Ojo et al. (7) in Ondo state whom also isolated E. coli from boreholes which indicative of pollution of the water by human activities. According to WHO (8) Pathogenic E. coli O157:H7 and E. coli O111, cause diarrhea and haemorrhagic colitis which usually develop into potentially fatal haemolytic uraemic syndrome in children, and characterized by acute renal failure and haemolytic anaemia.

High level of yeast/mold contamination observed in this study is similar to the findings of Ayanbimpe et al. (9) who isolated yeast and yeast-like contaminants in boreholes in Jos.

Samuel et al. (11) also isolated various fungal species from well water in Anambra State. They attributed their findings to seasonal variations, noting that more isolates were obtained during the wet season compared to the dry season. Fungi, including yeast and mold, can thrive in water environments, forming biofilms on surfaces like pipes over time as reported by Afonso et al. (10). According to Frazer-Williams et al. (11), poor sanitation practices around boreholes can enhance the risk of fungal contamination. Exposure to these fungi may lead to skin, wound, ear, and allergic infections, especially from common species like Penicillium and Aspergillus.

Heterotrophic bacteria and fungi present in water pose no direct health risks to humans and are not subject to specific guidelines. However, a high heterotrophic bacteria count (HBC) indicates ideal conditions for bacterial growth, which can be significantly reduced through ozonation, chlorination, and ultraviolet radiation (8).

Contaminated water, particularly in locations like Maitama, Kurudu, and Garki, presents an immediate health threat, especially to vulnerable populations such as children and the elderly. The presence of yeasts and molds also poses risks for individuals with compromised immune systems.

CONCLUSION AND RECOMMENDATION

The results of this study reveal significant microbial contamination in borehole water across AMAC, with several samples falling short of WHO and NIS standards for microbial safety. Immediate measures such as water treatment, disinfection, and improved sanitation around boreholes are necessary to address these issues. Borehole water should be treated with chlorine or other disinfectants, and routine monitoring should be established to ensure ongoing safety. Additionally, improving sanitation to prevent sewage contamination and implementing public health campaigns to educate the community on the risks of consuming untreated borehole water are crucial steps in mitigating these risks and ensuring safe water practices.

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