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| RESEARCH ARTICLE

Microbial Air Quality Assessment of Selected Abattoirs in Rivers State, Nigeria

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| ABSTRACT

The air in an abattoir environment is massively contaminated with large quantities of dust particles from biological and non-biological agents, toxic gases, and an offensive smell, which leads to air pollution as one of the basic causes of environmental health issues. The aim of this study was to assess the microbial air quality of selected abattoirs in Rivers State, Nigeria. A total of twenty (20) air samples were aseptically assessed using the settling plate culture method with appropriate media. Microbial isolates were identified and characterized biochemically. The percentage frequency of occurrence of the bacterial genera were *Micrococcus* 6 (23.1%), *Bacillus* 10 (38.5%), *Staphylococcus* 5(19.2%), *Escherichia coli* 2 (7.7%), and *Streptococcus* 3(11.5%) The fungal genera identified and frequency of occurrence in air samples assessed were *Aspergillus* 4(20.0%), *Mucor* 6 (30.0%), *Trichophyton* 3(15.0%), *Fusarium* 5(25.0%), and *Penicilluim* 2(10.0%). The percentage of occurrence of bacteria per location were Chokocho Etche 7(26.9%), Rumuokoro 5(19.2%), Trans Amadi 6(23.1%), Mbodo Aluu 8(30.8%).while fungal per location were Chokocho Etche 4(20.0%), Rumuokoro 5(25.0%), Trans Amadi 5(25.0%), Mbodo Aluu 6(30.0%).This study has revealed that the air quality in abattoir environments has been negatively altered because of anthropogenic operations that increased the population of bioaerosol, thereby increasing the possibility of health challenges for humans who live or do business within such environments. The study also revealed that there was a higher bacterial and fungal frequency of occurrence in the Mbodo Aluu abattoir location than in others. Therefore, it is imperative for relevant authorities like the Federal Ministry of Environment, the Environmental Protection Agency, and Community Health Officers to monitor the activities of such facilities to reduce their adverse impact on the environment to the barest minimum

| KEYWORDS

Air quality, Pollution, Bioaerosol, Abattoir, Anthropogenic, Environment

| ARTICLE INFORMATION

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1. Introduction

Air quality is an important environmental factor that directly influences human health and well-being. Poor air quality resulting from human activities and inadequate waste management practices has become a major public health concern, especially in developing countries such as Nigeria. Abattoirs are recognized as significant sources of environmental pollution because of the large quantities of organic wastes generated during animal slaughtering and processing activities. These wastes include blood, faecal materials, bones, wastewater, animal tissues, and decomposing organic matter, all of which contribute to environmental contamination when improperly managed (Eze et al., 2021).

In many abattoirs, poor sanitary conditions, indiscriminate disposal of waste materials, open burning of animal remains, and roasting of animal hides with hazardous substances release offensive odours, toxic gases, smoke, and suspended particulate matter into the atmosphere. These pollutants negatively affect air quality and may pose serious health risks to workers, nearby residents, and the surrounding environment (Adelegan et al., 2020). The emission of bioaerosols containing pathogenic microorganisms from abattoir activities further increases the risk of environmental and occupational exposure to infectious diseases**.**

The quality of air inhaled within an environment largely determines the health status of individuals exposed to it. Airborne microorganisms such as bacteria and fungi can remain suspended in the atmosphere for long periods and may be transmitted through inhalation, direct contact, or indirect exposure. Consequently, abattoir environments can serve as important routes for the transmission of respiratory infections and other communicable diseases (Magaji & Hassan, 2021). Individuals who work in or live close to abattoirs are therefore more vulnerable to respiratory disorders, allergic reactions, skin infections, and other environmental health problems associated with microbial air pollution.

Globally, environmental air pollution continues to contribute significantly to morbidity and mortality. According to recent environmental health reports, exposure to polluted air has been associated with increased cases of asthma, chronic respiratory diseases, cardiovascular disorders, and weakened immune responses (World Health Organization [WHO], 2022). In urban areas, abattoirs contribute substantially to localized air pollution due to inadequate environmental planning, poor monitoring systems, and ineffective waste disposal practices. These activities increase the microbial load within the atmospheric environment and create unhealthy conditions for humans, particularly children, elderly individuals, and immunocompromised persons.

In addition, microbial contaminants present in abattoir air environments may include pathogenic bacterial species such as *Bacillus, Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella* species, as well as fungal organisms including *Aspergillus*, *Penicillium*, and *Candida* species. These microorganisms are capable of causing various infections and environmental health complications when inhaled or transmitted through contaminated surfaces (Okeke et al., 2023). The continuous release of these microbial agents into the atmosphere can alter the ecological balance of the environment and reduce overall air quality.

Despite the increasing environmental and public health concerns associated with abattoir operations, there is still limited information regarding the microbiological air quality of many abattoirs in Rivers State, Nigeria. Therefore, this study was designed to assess the microbiological air quality of selected abattoirs in Rivers State through the isolation, identification, and characterization of bacterial and fungal organisms present in the abattoir air environment. The study also seeks to create awareness among abattoir workers and residents on the dangers associated with poor waste disposal practices and air pollution, which may result in serious environmental and health consequences if not properly controlled.

2. Materials and Methods

2.1 Materials

The materials used for this study included microbiological media, laboratory equipment, staining reagents, and biochemical test reagents required for the isolation and identification of airborne microorganisms from selected abattoirs. Culture media used were Nutrient Agar (NA), Potato Dextrose Agar (PDA), Eosin Methylene Blue Agar (EMB), and MacConkey Agar. Other materials included normal saline, distilled water, peptone water, Simmons citrate agar, Christensen's urea broth, and phenol red broth. Laboratory equipment used included sterile Petri dishes, test tubes, pipettes, bijou bottles, wire loops, microscope, slides, cover slips, inoculating needles, and Bunsen burner. Gram staining reagents such as crystal violet, Lugol's iodine, acetone, and safranin were used for bacterial identification, while lactophenol cotton blue was used for fungal examination. Biochemical reagents used included hydrogen peroxide, oxidase reagent, and Kovac's reagent for microbial characterization. These materials were carefully selected to ensure accurate isolation and identification of bacterial and fungal isolates from the abattoir air environment.

2.2 Study Area

This study was conducted in selected abattoir environments located at Rumuokoro, Chokocho Etche, Mbodo Aluu, and Trans-Amadi in Rivers State, Nigeria. These abattoirs were selected due to their high level of slaughtering activities and continuous generation of organic wastes, which may contribute to microbial air pollution within the surrounding environment.

2.3 Preparation of Media for Microbial Analyses

The media that were used for the isolation of microorganisms are Nutrient agar, MacConkey agar, *Salmonella Shigella* agar (SSA), Mannitol salt agar, Potato Dextrose agar (PDA), these different media were prepared according to manufacturer's specifications.

2.4 Sampling Procedure

A total of twenty (20) air samples were collected from selected abattoir environments using the passive settle plate method described by Stanley et al. (2019) with slight modifications. Sterile Petri dishes containing prepared culture media were aseptically placed at different sampling points about one meter above the ground to represent the human breathing zone. Nutrient Agar (NA), MacConkey Agar (MAC), and Mannitol Salt Agar (MSA) were used for the isolation and identification of bacterial organisms, while Potato Dextrose Agar (PDA) supplemented with antibiotics was used for fungal isolation. The culture plates were exposed to the ambient air for 30 minutes to allow airborne microorganisms to settle on the agar surfaces by gravitational sedimentation. The plates were positioned at central locations within each sampling site to obtain representative air samples. (Okafor et al., 2021).

After exposure, the plates were immediately covered, labelled, wrapped with aluminium foil, and transported aseptically to the laboratory for incubation. Bacterial plates were incubated at 37°C for 24 hours, while fungal plates were incubated at room temperature (25°C) for 3–5 days. (Eze & Nwachukwu, 2022).

Following incubation, visible colonies were counted and examined. The isolates were identified based on their colonial characteristics, microscopic features, Gram staining reactions, and biochemical tests. The settle plate method was adopted because it is simple, reliable, cost-effective, and widely used for microbial air quality assessment studies. (Iheanacho et al., 2023).

2.5 Purification and preservation of colonies

A sterile wire loop was used to pick discrete from the nutrient agar based on shape, opacity, elevation and edge and subsequently sub-cultured into nutrient agar plate to obtain pure culture. These plates were incubated at 37^{o}C for 24hrs after which pure colonies were obtained and then sub cultured into nutrient agar slant. After 24hrs incubation the nutrient agar slants were preserved in the refrigerator at 4^{o}C (Sule et al.,2019).

2.6 Biochemical Test

Biochemical tests were used in the differentiation of isolated organisms preserved on nutrient agar slant. The slants were brought to room temperature and sub-cultured unto fresh nutrient agar to obtain fresh cultures that were used for biochemical test. The bacterial isolates were characterized using biochemical techniques such as Catalase test, Coagulase, citrate utilization test, indole test, oxidase test respectively (Anele et al., 2023).

3. Results

Figure 1a: Shows the percentage occurrence of Bacteria isolates, isolated from selected abattoir Air environment in Rivers State. The isolates were identified as Micrococcus, Bacillus, (the most occurring at 41.7%), Staphylococcus, and Streptococcus (the least occurring at 12.5%).

Figure 1b: Bacterial frequency of occurrence in abattoirs air samples based on different locations. Mbodo –Aluu had the most occurrences of 30.8% each, while Rumuokoro had the least occurrence of 19.2%.

Figure 2a: Shows percentage occurrence of the fungal isolates. Aspergillus sp and Mucor sp were the most occurring at 30% and *Penicillium* sp was the least occurring at 10%.

Figure 2b: Fungi frequency of occurrence in abattoir air samples based on different locations. Mbodo Aluu had the most occurrences of 30.0% each, while Chokocho Etche had the least occurrence of 20%.

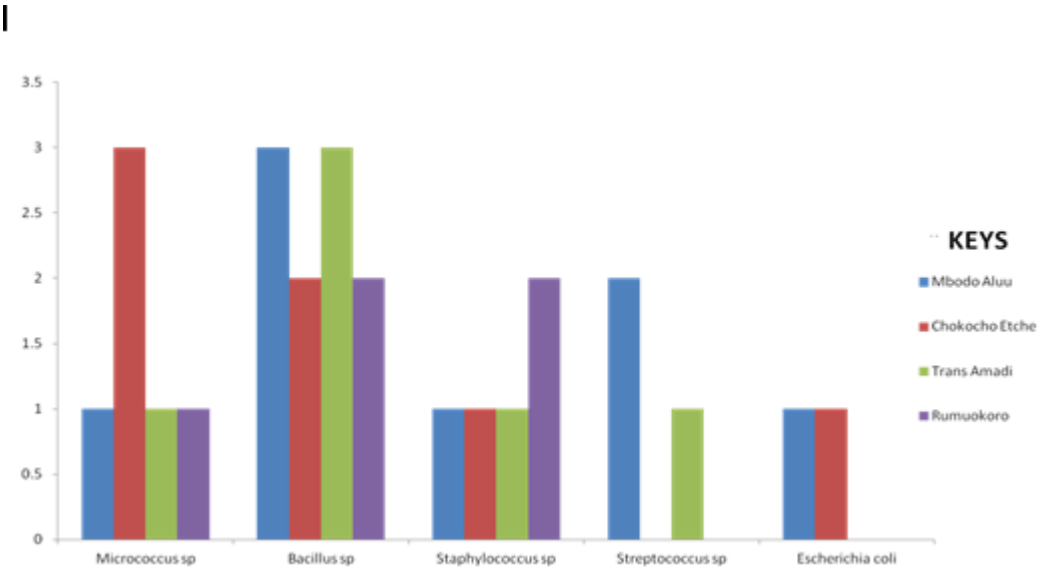

Fig. 1a: Percentage occurrence of Bacteria isolates, isolated from selected abattoir Air environment in Rivers State

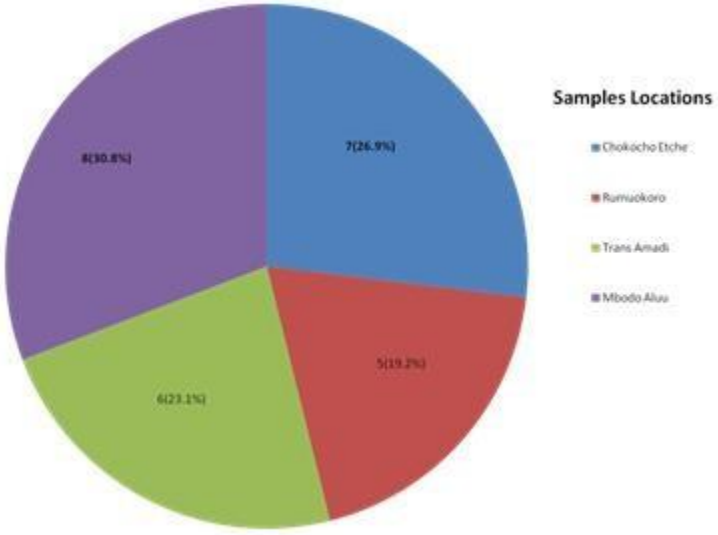

Fig. 1b: Bacteria frequency of occurrence on Air quality of Abattoir base on different locations

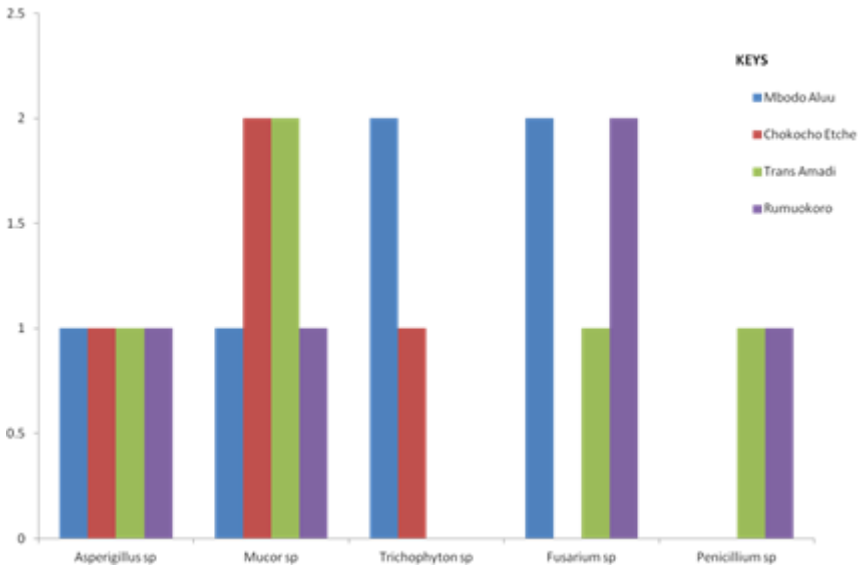

Fig. 2a: Percentage occurrence of Fungi isolates, isolated from selected abattoir Air Environment in Rivers State

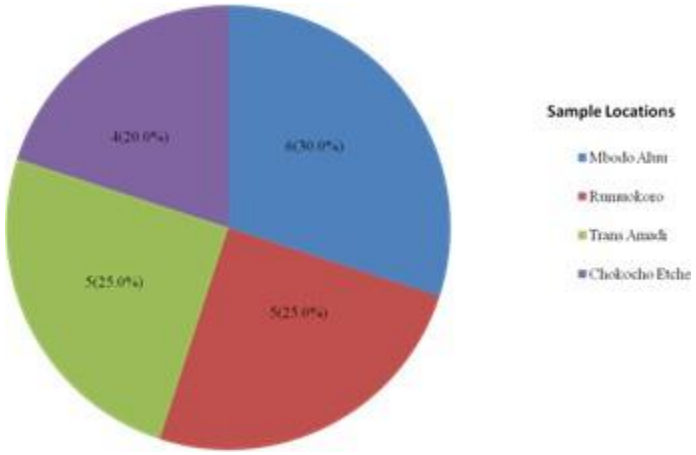

Fig. 2b: Fungal frequency of occurrence on Air quality of Abattoir base on different locations

4. Discussion

The present study revealed the occurrence of different bacterial and fungal genera in the air samples collected from the selected locations, indicating considerable microbial contamination of the environment. Among the bacterial isolates, *Bacillus* species showed the highest frequency of occurrence (38.5%), followed by *Micrococcus* species (23.1%), *Staphylococcus* species (19.2%), *Streptococcus* species (11.5%), and *Escherichia coli* (7.7%). The predominance of *Bacillus* species may be attributed to their ability to form resistant endospores that enable them to survive harsh environmental conditions, including dust, heat, and air exposure. This finding agrees with the report of World Health Organization environmental studies which identified *Bacillus* species as common airborne contaminants in polluted environments and waste disposal sites (Ameh et al., 2021). Similarly, Eze et al. (2022) reported a high prevalence of *Bacillus* species in ambient air due to their adaptability and resistance to environmental stress.

The presence of *Micrococcus* and *Staphylococcus* species further suggests contamination from human activities, dust particles, and animal sources. *Staphylococcus* species are common inhabitants of human skin and nasal cavities; therefore, their occurrence may indicate anthropogenic contamination within the study areas. This observation is consistent with the findings of Okereke

and Obi (2020), who reported that densely populated and highly trafficked environments usually harbor high levels of *Staphylococcus* species in air samples. However, the relatively lower occurrence of *Escherichia coli* in this study may indicate limited direct faecal contamination of the sampled air. Despite the low percentage, the detection of *E. coli* remains significant because it is an indicator of poor sanitary conditions and possible public health risks. This result agrees with the findings of Hassan et al. (2021), who stated that the presence of enteric bacteria in ambient air may arise from waste dumps, sewage exposure, and poor environmental hygiene.

The fungal isolates identified in this study included *Mucor* species (30.0%), *Fusarium* species (25.0%), *Aspergillus* species (20.0%), *Trichophyton* species (15.0%), and *Penicillium* species (10.0%). The predominance of *Mucor* species could be associated with the abundance of decaying organic matter and humid environmental conditions that support fungal sporulation and dispersal. This finding is similar to the report of Nwachukwu et al. (2020), who observed that *Mucor* species are common airborne fungi in waste-contaminated and poorly ventilated environments. The occurrence of *Aspergillus* species is of medical importance because some species are opportunistic pathogens capable of causing respiratory infections, especially among immunocompromised individuals. This observation corroborates the findings of Adekunle et al. (2021), who associated the presence of *Aspergillus* species in ambient air with increased risks of allergies and respiratory diseases.

The detection of *Fusarium* and *Penicillium* species further confirms environmental contamination because these fungi are commonly associated with soil, decomposing materials, and organic waste. The findings support the work of Ibrahim and Yusuf (2023), who reported that airborne fungal spores increase significantly in areas characterized by poor waste management and environmental pollution. However, the lower occurrence of *Penicillium* species in this study may suggest less favorable environmental conditions for its proliferation compared to other fungal genera identified.

The distribution of bacterial isolates across the different locations showed that Mbodo Aluu recorded the highest bacterial occurrence (30.8%), followed by Chokocho Etche (26.9%), Trans Amadi (23.1%), and Rumuokoro (19.2%). Similarly, fungal occurrence was highest in Mbodo Aluu (30.0%), while Rumuokoro and Trans Amadi each recorded 25.0%, and Chokocho Etche had 20.0%. The high microbial load observed in Mbodo Aluu may be associated with increased environmental exposure to waste materials, poor sanitation practices, overcrowding, and human activities that promote microbial aerosolization. This finding agrees with the study of Ugbogu et al. (2022), who reported that locations with poor environmental sanitation and indiscriminate waste disposal usually exhibit higher concentrations of airborne microorganisms.

The comparatively lower microbial occurrence observed in Rumuokoro may be due to better sanitation practices, reduced waste accumulation, or improved airflow within the environment. Environmental factors such as humidity, temperature, wind movement, and human activities have been reported to influence microbial distribution in air samples (Olalekan et al., 2021). Differences in microbial occurrence among the locations therefore suggest that local environmental conditions play an important role in determining airborne microbial diversity and abundance.

In general, the findings of this study demonstrate that the sampled environments harbor potentially pathogenic bacterial and fungal organisms capable of posing health risks to exposed individuals. Continuous exposure to contaminated air may contribute to respiratory infections, allergies, and other public health problems. The study therefore emphasizes the need for improved environmental sanitation, proper waste management, and regular environmental monitoring to reduce airborne microbial contamination and associated health hazards.

5. Conclusion

This study revealed the presence of diverse airborne bacterial and fungal species across the selected abattoir locations, indicating a considerable level of microbial contamination in the ambient air. The dominance of *Bacillus* species among bacterial isolates suggests their resilience and ability to survive under harsh environmental conditions, including fluctuating temperatures and nutrient-limited settings commonly found in abattoir environments. Similarly, the high prevalence of *Mucor* species among fungal isolates reflects their strong adaptability and association with decomposing organic matter and poor sanitation practices.

The detection of potentially pathogenic microorganisms such as *Staphylococcus aureus*, *Escherichia coli*, *Aspergillus*, and *Trichophyton* raises serious public health concerns. These organisms are well known for their ability to cause a range of infections, including respiratory tract infections, allergic reactions, skin diseases, and opportunistic infections, particularly among vulnerable populations such as workers and nearby residents. Their presence in the air underscores the occupational hazards associated with abattoir operations where meat processing, waste disposal, and animal handling are conducted under varying hygienic conditions.

Furthermore, the observed variation in microbial load across the sampled locations, with notably higher contamination levels recorded in Mbodo Aluu, highlights the critical role of environmental sanitation, waste management efficiency, and human activity intensity in influencing air quality. Poor drainage systems, inadequate waste disposal practices, and overcrowding of slaughtering activities likely contributed to elevated microbial dispersion in this area.

Overall, the findings of this study confirm that inadequate environmental sanitation significantly contributes to airborne microbial pollution in abattoir settings. This emphasizes the urgent need for routine environmental monitoring, enforcement of hygiene standards, proper waste management strategies, and improved occupational health practices to mitigate potential health risks and safeguard both workers and surrounding communities. Strengthening these interventions will play a vital role in reducing microbial exposure and improving overall environmental and public health outcomes in abattoir environments.

6. Recommendations

We hereby recommend the following:

1. Environmental sanitation should be significantly improved in all the studied locations through proper waste disposal, regular cleaning, and effective drainage maintenance to reduce airborne microbial contamination.
2. Government and environmental health agencies should establish routine monitoring of ambient air quality to detect and control potentially pathogenic microorganisms in the environment.
3. Public health education programs should be intensified to create awareness on the health risks associated with exposure to contaminated air and poor environmental hygiene practices.
4. Indiscriminate dumping and open burning of refuse should be strictly discouraged, as these practices promote the dispersal of microbial aerosols and increase environmental pollution.

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