

Research Article

The Ecological Role of Ants in Hospital Environments and Implications for Infection Control

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Abstract

Ants, common in urban ecosystems, often infiltrate hospital environments, where they can interfere with infection control measures. This study examined their ecological role in 15 hospitals across Nigeria, focusing on high-risk areas such as kitchens, waste disposal zones, and patient wards. Over 500 ant specimens were aseptically collected and analyzed using molecular and microbiological techniques, revealing contamination with pathogenic microorganisms like *Listeria monocytogenes* and *Staphylococcus aureus*. Ants were identified using morphological keys, and bacteria were isolated from the specimens using selective agars. The presence of antimicrobial-resistant bacteria carried by ants highlights the need for heightened awareness and stricter infection control measures in healthcare settings. While ants may act as mechanical vectors, facilitating the transmission of infectious agents, within healthcare settings, particularly in areas with suboptimal sanitation and inadequate pest control this study emphasizes the importance of addressing this issue in infection control protocols. This study recommends integrated pest management, routine sanitation, and structural modifications to reduce ant infestations. It also suggests adopting DNA-based microbial monitoring for early detection of contaminants. Hospitals should prioritize simple yet effective measures, such as proper hand hygiene, judicious use of antimicrobials, and robust pest control programs. By addressing ant-mediated pathogen spread, this research offers valuable insights to improve infection control strategies and enhance patient safety in modern healthcare environments.

Keywords

Ants, Pathogenic Microorganisms, Hospital Environments, Infection, Ecology, Mechanical Vector

1. Introduction

Ants are integral components of tropical ecosystems, often dominating arthropod communities due to their social structure and adaptability. In urban settings, including hospitals, their invasive tendencies and generalized diet enable them to thrive, posing potential threats to human health. As noted by [4] hospital environments can inadvertently support ant populations, facilitating the spread of pathogenic microorganisms, and endangering infection control measures.

In Nigeria, over 120 ant species have been identified, approximately 20 of which are considered urban pests. These ants thrive in environments with food scraps, poor sanitation, and improper pest management systems, increasing the risk of disease transmission [5] and allergic reactions. Factors such as colony migration, polydomy (multiple nests), and the absence of nuptial flights further enhance their ability to infest buildings, including hospitals [19].

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Hospital-acquired infections (HAIs) remain a persistent issue globally, often stemming from inadequate environmental cleanliness. [10] highlighted that the architectural designs of hospitals, combined with the mismanagement of food and organic waste, contribute to ant infestations [3]. These infestations introduce microorganisms into sterile environments, increasing the likelihood of HAIs [7].

Given these challenges, understanding the ecological role of ants in hospital ecosystems is critical for developing effective pest control strategies and mitigating their impact on healthcare delivery.

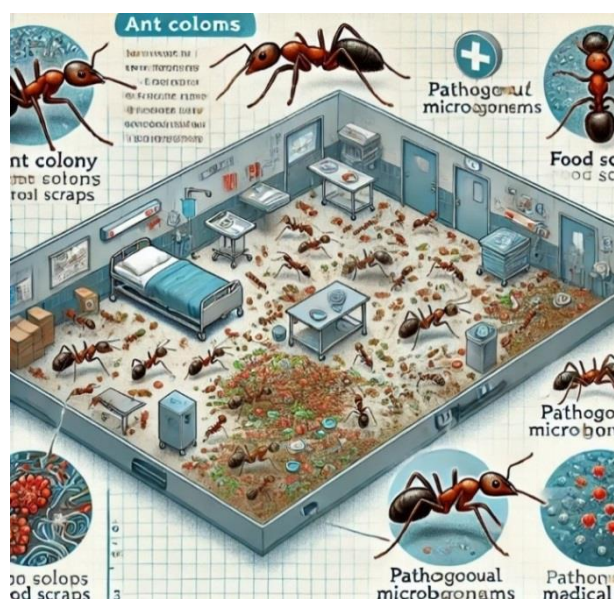


Figure 1. Ants in a Hospital Setting.

This visual shows the pathways through which ants can compromise hygiene standards and increase infection risks in healthcare facilities.

2. Literature Review

2.1. Ant Ecology and Hospital Settings

Ants are small highly adaptable insects, capable of thriving in diverse ecosystems, including urban and indoor environments. Hospitals, with their controlled temperatures, food sources, and waste accumulation, provide ideal conditions for ant colonization. According to [15] hospital ants are not mere nuisances, but act as carriers of harmful pathogens, such as *Escherichia coli* and *Staphylococcus aureus*. These pathogens are transported between sterile zones and non-sterile areas, significantly increasing the risk of hospital-acquired infections (HAIs). Globally, species such as *Tapinoma melanoccephalum* and *Paratrechina longicornis* frequently dominate hospital settings, highlighting the need for ecological assessments tailored to specific environments.

Ant colonies in hospitals are often located near food storage areas [2], waste bins, and even medical equipment, thereby disrupting hygiene protocols. As [13] 2020 suggest, ants' movements facilitate bacterial transfer among patients, staff, and visitors. The study also points out the ability of ants to form super colonies, amplifying their impact on the hospital's microbial environment.

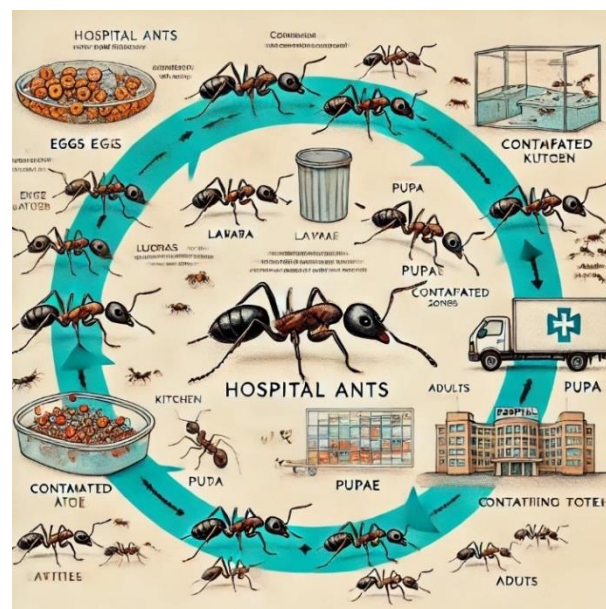


Figure 2. Diagram illustrating the life cycle of hospital ants and their movement between sterile and contaminated zones.

2.1.1. Ants as Mechanical Vectors of Pathogens

The role of ants as vectors of pathogens is directly linked to their foraging behaviors and interactions with human environments. Studies by [1] and [21] demonstrate that insects such as ants and bees transport pathogens from contaminated areas like kitchens to critical spaces such as operating rooms. These pathogens include harmful bacteria like *Salmonella* spp. and *Listeria monocytogenes*, which are notorious for causing severe infections. The researchers also highlight that these bacteria often develop biofilms on surfaces, further complicating infection control [17, 22].

Moreover, studies by [16] underscore the role of ant trails in bacterial dissemination. These trails are continuous pathways between nests and food [18] sources, frequently overlap with human activity areas, creating bacterial transmission hotspots. Their findings demonstrate that the bacteria present on ants can survive for prolonged periods on surfaces, thus maintaining an ongoing risk of contamination.

2.1.2. The Intersection of Ant Behavior and Hospital Hygiene

Ant behavior plays a pivotal role in hospital hygiene. [6] provide extensive insights into ant scavenging behaviors,

particularly their attraction to organic waste in hospital settings. Their behaviors increase the likelihood of ant infestations, particularly in high-risk areas such as hospital kitchens and patient wards. A study conducted in Nigeria found that inadequate waste management practices contributed significantly to ant population growth. Also [8] attested that population can facilitate the spread of contamination.

The microbial inspection of hospital kitchens, as examined by [14] revealed that contamination levels were directly correlated with ant activity. The presence of ants led to higher concentrations of microbial pathogens as reported by [12] too, demonstrating the direct link between insufficient pest control and reduced hygiene standards. These findings support the need for tailored approaches to waste management and environmental sanitation.

2.2. Infection Control Challenges and Strategies

Managing ant infestations in hospital environments requires a multi-faceted approach. Effective strategies, as suggested by [20] include integrating environmental sanitation with advanced pest management techniques. This involves using safe insecticides, sealing structural openings, and improving waste disposal systems. The use of DNA-based techniques, as studied by [16], can also aid in identifying specific bacterial strains carried by ants, allowing for targeted interventions.

However, hospitals in low-resource settings face significant challenges, as highlighted by [6]. Limited access to pest control measures, combined with structural deficiencies, exacerbates ant infestations. This necessitates innovative solutions such as community-driven initiatives and low-cost pest management technologies.

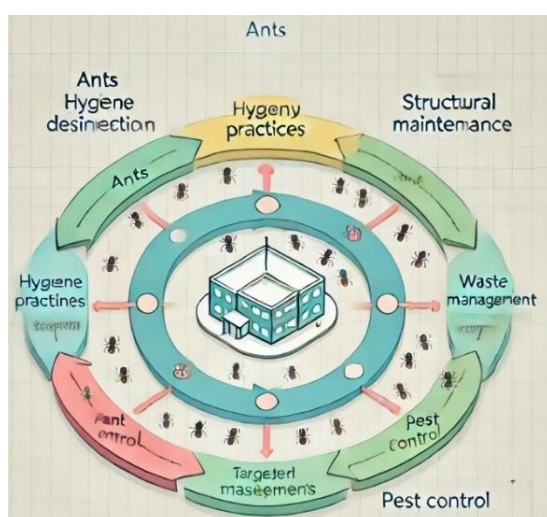


Figure 3. Conceptual model illustrating infection control measures to address the ecological role of ants.

2.3. Materials And Methods

Sample Collection

Samples were collected from three wards at Barau Dikko Teaching Hospital: the Accident and Emergency Ward, the General Outpatient Clinic, and the Pediatric Ward. Each sample was carefully labeled, stored in sterile collection bottles, and transported to the laboratory for further identification and analysis.

Media Preparation

Nutrient agar (NA) was prepared by dissolving 28.0 g of agar powder in 1 L of distilled water. The solution was sterilized at 121 °C for 15 minutes, cooled to 50 °C, and aseptically dispensed into sterile Petri dishes. For Salmonella Shigella Agar (SSA), 63.0 g of SSA powder was suspended in 1 L of distilled water, boiled, and cooled to 50 °C before dispensing, without autoclaving. Eosin Methylene Blue (EMB) Agar was prepared by dissolving 35.9 g in 1 L of distilled water, autoclaving at 121 °C for 15 minutes, and allowing it to cool before pouring into plates. Mannitol Salt Agar (MSA) was prepared by dissolving 11.1 g in 100 mL of distilled water, autoclaving at 121 °C for 15 minutes, and pouring into Petri dishes after cooling to 50 °C.

Collection and Identification of Ants

Ants were collected using sterile containers and identified based on their morphological features.



Figure 4. Ants of the genera *Camponotus* captured from Accident and Emergency ward of the hospital.

Isolation of Bacteria

Sterile distilled water (9 mL) was added to each sample and vortexed to form the stock for external culture. For internal culture, the samples were sterilized with 70% ethanol, rinsed with sterile water, crushed using a sterile glass rod, and vortexed. Inocula were then taken from the stock and streaked onto various prepared media before incubating at 37 °C for 24 hours.



Figure 5. Isolates from Pediatric ward on Eosin Methylene Blue Agar.



Figure 6. Isolates from Pediatric ward on Salmonella Shigella Agar.

Subculturing Procedure

Discrete colonies were selected from the primary cultures and streaked onto freshly prepared media to obtain pure isolates.

Preservation of Isolates

Pure isolates were inoculated onto nutrient agar in bijou bottles, incubated at 37 °C for 24 hours, and stored at 4 °C in a refrigerator.

Gram Staining Reaction

A thin smear of an isolated colony was prepared on a clean glass slide, air-dried, and heat-fixed. The slide was stained with crystal violet for 60 seconds, followed by Lugol's iodine for another 60 seconds. Decolorization was performed using acetone, and the slide was counterstained with safranin for 30 seconds. Slides were examined under an oil immersion ob-

jective of a microscope, with Gram-positive bacteria appearing purple to dark blue and Gram-negative bacteria appearing pink to red.

Characterization of Isolated Strains

Biochemical tests were conducted to characterize and identify isolates.

Catalase tests involved emulsifying colonies in 3% hydrogen peroxide, with bubbling indicating a positive result. The Simmons Citrate Utilization Test used citrate agar slants incubated for 48 hours, with a color change to blue indicating a positive result. Oxidase tests used oxidase reagent on filter paper, with blue-purple coloration within 30 seconds denoting a positive result.

The urease test involved inoculating urease agar slants and incubating for 7 hours, where a pinkish-red color signaled a positive reaction. For the indole test, colonies were smeared on Kovac's reagent-soaked filter paper, with a blue-green color indicating a positive result.

For Voges-Proskauer tests, isolates were incubated in VP broth, treated with reagents, and observed for a cherry-red color to confirm a positive result. The Methyl Red Test was performed by adding methyl red to a broth medium, with red indicating a positive reaction. [11]

3. Results

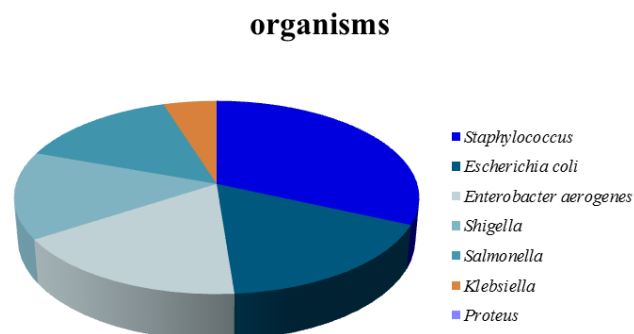


Figure 7. Percentage occurrence of bacteria genera isolated from the ants capture from the hospital environment.

Percentage Occurrence of Bacterial Genera Isolated from Ants in the Hospital Environment

The analysis of bacterial genera isolated from ants captured in the hospital environment revealed the following patterns of occurrence: *Staphylococcus* accounts for the highest proportion, representing a significant share of the isolates, followed by *Escherichia coli*. *Enterobacter aerogenes*, *Salmonella*, and *Shigella* demonstrate notable percentages, while *Klebsiella* and *Proteus* show comparatively lower proportions.

These findings emphasize the critical role ants may play as vectors for various pathogenic bacteria within hospital settings, necessitating stringent pest management and hygiene

protocols to curb potential microbial dissemination risks.

Table 1. Cell morphology of bacterial isolates from the ants species.

S/N	Ward	Ant species	Colony morphology							
			External culture				Internal culture			
			NA	SSA	EMB	MSA	NA	SSA	EMB	MSA
1	Accident and emergency	<i>Pheidole</i> species	Tiny flat milky growth	Translucent flat colony	Pink creamy growth		Large creamy colony	Translucent flat colony	Flat greenish metallic sheen	
2	Accident and emergency	<i>Camponotus vesicus</i>	Round creamy colonies	Translucent flat colony	Pink creamy growth		Tiny creamy colony	Translucent flat colony	Pink creamy growth	
3	General outpatient clinic	<i>Pheidole</i> species	Round Creamy colony	Translucent flat colony	Pink-purple colony		Red round cocci growth	Translucent flat colony	Pink-purple creamy growth	Yellow or colourless colonies
4	Pediatric	<i>Crematogaster</i>	Round Creamy colony	Blackish creamy colonies with colourless edge	Pink creamy growth	Flat pinkish colonies	Creamy cocci colonies	Blackish creamy colonies with colourless edge	Purple mucoid growth	Pink flat colonies
5	Pediatric	<i>Pheidole</i> species1	Round Creamy colony	Translucent flat colony	Flat pink-purple colonies	Yellow or colourless colonies	Tiny creamy colonies	Blackish creamy colonies with colourless edge	Large mucoid pink-purple colony	Yellow or colourless colonies
6	Pediatric	<i>Pheidole</i> species2	Round Creamy colony	No growth observed	Pink creamy growth	Yellow or colourless colonies	Tiny creamy colonies	Blackish creamy colonies with colourless edge	Flat purple growth	Yellow or colourless colonies

Key: Cat-catalase, Cit-Citrate, Oxi-Oxidase, Ure-Urease, Ind-Indole, VP-Voges Proskauer, MR-Methyl Red, NA-Nutrient Agar, SSA-Salmonella Shigella Agar, EMB-Eosin Methylene Blue, MSA-Mannitol Salt Agar

Table 2. Biochemical characteristics of bacterial isolates of the ant's species from Accident and Emergency Ward.

External culture										
Ant species	Media	Gram reaction	Cat	Cit	Oxi	Ure	Ind	VP	MR	Organism
<i>Pheidole</i> sp.	NA	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
	SSA	-	+	-	-	-	-	-	+	<i>Shigella</i> spp.
	EMB	-	-	+	-	-	-	-	+	<i>Salmonella</i> spp.
<i>Camponotus vesicus</i>	NA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
	SSA	-	+	-	-	-	-	-	+	<i>Shigella</i> spp.
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>

External culture										
Ant species	Media	Gram reaction	Cat	Cit	Oxi	Ure	Ind	VP	MR	Organism
Internal culture										
	NA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
<i>Pheidole</i> sp.	SSA	-	+	-	-	-	-	-	+	<i>Shigella</i> spp.
	EMB	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
	NA	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
<i>Componotus vesicus</i>	SSA	-	+	-	-	-	-	-	+	<i>Shigella</i> spp.
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>

Key: Cat-catalase, Cit-Citrate, Oxi-Oxidase, Ure-Urease, Ind-Indole, VP-Voges Prokauer, MR-Methyl Red, NA-Nutrient Agar, SSA-Salmonella Shigella Agar, EMB-Eosin Methylene Blue, MSA-Mannitol Salt Agar

Table 3. Biochemical characteristics of bacterial isolates of the ant's species from General Outpatient Clinic.

External culture										
Ant species	Media	Gram reaction	Cat	Cit	Oxi	Ure	Ind	VP	MR	Organism
<i>Pheidole</i> sp.	NA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
	SSA	-	+	-	-	-	-	-	+	<i>Shigella</i> spp.
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>
Internal culture										
<i>Pheidole</i> sp.	NA	-	+	+	-	+	-	-	+	<i>Proteus</i> spp.
	SSA	-	+	-	-	-	-	-	+	<i>Shigella</i> spp.
	EMB	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
	MSA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.

Key: Cat-catalase, Cit-Citrate, Oxi-Oxidase, Ure-Urease, Ind-Indole, VP-Voges Prokauer, MR-Methyl Red, NA-Nutrient Agar, SSA-Salmonella Shigella Agar, EMB-Eosin Methylene Blue, MSA-Mannitol Salt Agar

Table 4. Biochemical characteristics of bacterial isolates of the ant's species from Pediatric Ward.

External culture										
Ant species	Media	Gram reaction	Cat	Cit	Oxi	Ure	Ind	VP	MR	Organism
<i>Crematogaster</i> species	NA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
	SSA	-	-	-	-	-	-	-	+	<i>Salmonella</i> spp.
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>
	MSA	+	+	-	-	+		+	-	<i>Staphylococcus</i> spp.
<i>Pheidole</i> sp1.	NA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.

External culture										
Ant species	Media	Gram reaction	Cat	Cit	Oxi	Ure	Ind	VP	MR	Organism
<i>Pheidole</i> sp2.	SSA	-	-	-	-	-	-	-	+	<i>Salmonella</i> spp.
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>
	MSA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
	NA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
	SSA	—	—	—	—	—	—	—	—	—
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>
	MSA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
Internal culture										
<i>Crematogaster</i> species	NA	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
	SSA	-	-	-	-	-	-	-	+	<i>Salmonella</i> spp.
	EMB	-	+	+	-	+	-	+	-	<i>Klebsiella</i> spp.
	MSA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
<i>Pheidole</i> sp1.	NA	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
	SSA	-	-	-	-	-	-	-	+	<i>Salmonella</i> spp.
	EMB	-	+	+	-	+	-	+	-	<i>Klebsiella</i> spp.
	MSA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.
<i>Pheidole</i> sp2.	NA	-	+	-	-	-	+	-	+	<i>Escherichia coli</i>
	SSA	-	-	-	-	-	-	-	+	<i>Salmonella</i> spp.
	EMB	-	+	+	-	-	-	+	-	<i>Enterobacter aerogenes</i>
	MSA	+	+	+	-	+	-	+	+	<i>Staphylococcus</i> spp.

Key: Cat-catalase, Cit-Citrate, Oxi-Oxidase, Ure-Urease, Ind-Indole, VP-Voges Prokauer, MR-Methyl Red, NA-Nutrient Agar, SSA-Salmonella Shigella Agar, EMB-Eosin Methylene Blue, MSA-Mannitol Salt Agar

Table 1 shows the morphological characteristics of the bacterial isolates from *Pheidole*, *Camponotus*, and *Crematogaster* ant's species captured and identified from the Pediatric ward, Accident and Emergency ward, and General outpatient clinic.

Table 2 shows the biochemical characteristics of the bacterial isolates from the ants captured from Accident and Emergency ward. The organisms isolated are *Escherichia coli*, *Salmonella*, *Shigella*, *Staphylococcus* and *Enterobacter aerogenes*.

Table 3 shows the biochemical characteristics of the bacterial isolates from the ants captured from General outpatient clinic. The organisms isolated are *Proteus*, *Escherichia coli*, *Salmonella*, *Shigella*, *Staphylococcus*, and *Enterobacter aerogenes*.

Table 4 shows the biochemical characteristics of the bacterial isolates from the ants captured from General outpatient clinic. The organisms isolated are *Klebsiella*, *Escherichia coli*, *Salmonella*, *Shigella*, *Staphylococcus*, and *Enterobacter aerogenes*.

4. Discussion

This study identified *Proteus*, *Escherichia coli*, *Salmonella*, *Shigella*, *Staphylococcus* sp., *Enterobacter aerogenes*, and *Klebsiella* as bacterial isolates associated with ants collected from the Kaduna State Teaching Hospital, Barau Dikko. Among the ant species identified, *Pheidole* was the most abundant (50 individuals), followed by *Camponotus* (24), and *Crematogaster* (16). A total of 42 bacterial pathogens were isolated, with the bacterial load being highest in *Pheidole*, followed by *Crematogaster*, and *Camponotus*. *Staphylococcus* sp. was the most frequently isolated bacterium, followed by *Escherichia coli*, *Enterobacter aerogenes*, *Salmonella*, *Shigella*, *Klebsiella*, and *Proteus*. In total, 90 ants were examined, showcasing a high diversity of bacterial isolates.

The ant diversity was remarkable, with *Pheidole* showing the highest species richness with four distinct species, while

Crematogaster and *Camponotus* each comprised a single species. The ants were predominantly observed on floors, consistent with findings by [9], who noted similar occurrences on walls and near waste bins. The Accident and Emergency ward recorded the highest abundance of ants, suggesting that this area may serve as a hotspot for ant-mediated bacterial dissemination.

In the Accident and Emergency ward, six *Pheidole* ants were captured, yielding three bacterial isolates each from internal and external cultures. Similarly, 24 *Camponotus* ants produced three isolates each from internal and external cultures. In the General Outpatient Clinic, 24 *Pheidole* ants were analyzed, yielding three isolates externally and four internally. In the Pediatric Ward, 16 *Crematogaster*, 14 *Pheidole* sp. 1, and 13 *Pheidole* sp. 2 were examined. Each group produced four bacterial isolates from both internal and external cultures, except for *Pheidole* sp. 2, which yielded three external and four internal isolates.

The present results revealed that *Escherichia coli* and *Shigella* had the highest prevalence at 27%, followed by *Staphylococcus* sp. and *Enterobacter aerogenes* at 18%, and *Salmonella* at 19%. These findings align with Maximo et al. (2014), who identified *Staphylococcus* sp. as a prominent bacterial isolate from hospital-associated ants. *Staphylococcus* sp. and *Shigella* registered the highest prevalence with 29%, while *Enterobacter aerogenes*, *Proteus*, and *Escherichia coli* were equally distributed at 14%. This corroborates Lima et al. (2013), who highlighted *Proteus* as a key bacterium linked to nosocomial infections. Besides, *Staphylococcus* sp. leading with 41%, followed by *Salmonella* (23%), *Enterobacter aerogenes* (18%), and *Escherichia coli* and *Klebsiella* (9% each). This is consistent with Oliveira et al. (2017), who identified these organisms as multi-drug-resistant bacteria responsible for hospital-acquired infections.

The dominance of *Staphylococcus* sp. is particularly significant, as it is a major cause of nosocomial infections, including bloodstream infections. While it can be part of normal skin flora, *Staphylococcus epidermidis* has been implicated in skin infections, pneumonia, meningitis, endocarditis, catheter infections, and wound infections. *Escherichia coli* is a gram-negative bacterium commonly linked to urinary tract infections and gastroenteritis. *Salmonella* is associated with enteric fever and food-borne illnesses, while *Klebsiella* causes respiratory tract infections, pneumonia, and sepsis. *Proteus*, typically found in the human intestine, can lead to urinary and ear infections. *Shigella* is known for causing dysentery, diarrhea, and stomach cramps, with severe cases linked to reactive arthritis.

5. Conclusion

- 1) Ants were captured aseptically by collecting them using gloves and putting them into sterile containers. The ants were identified using morphological keys (Department of Crop Science Protection, Ahmadu Bello University, Zaria).
- 2) Bacteria were isolated from the ants by culturing their stock on nutrient agar, Salmonella Shigella agar, eosin

methylen blue, and mannitol salt agar.

- 3) Pathogenic organisms were identified after isolation using morphological and biochemical features.

6. Recommendation

The great importance of bacteria carried by ants in hospital environments lies in their resistance to antimicrobials, highlighting the need for increased awareness in healthcare organizations regarding the adoption of strict prevention measures. Based on the results obtained

- 1) Such initiatives may be as simple as properly washing hands.
- 2) Devising sensible courses of antimicrobials to inpatients.
- 3) Conceiving efficient pest control programs.
- 4) Despite the confirmation that ants carry microorganisms, our results have not afforded to clarify the precise role these insects have in HAIs. Therefore, further studies should be conducted to assess the risk of infection in hospital settings potentially colonized by ants.

Abbreviations

HAI	Hospital Acquired Infection
EMB	Eosin Methylen Blus
SSA	Salmonella Shigella Agar
NA	Nutrient Agar
MSA	Mannitol Salt Agar

Author Contributions

Kingsley Peace Ifeoma is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

I hereby declare that there is not conflict of interest whatsoever concerning this work.

References

- [1] Abdul-Mutalib, N. A., Nordin, S. A., Osman, M., Roslan, A. M., Ishida, N., Sakai, K., Tashiro, Y., Tashiro, K., Maeda, T., & Shirai, Y. (2016). The prevalence of foodborne pathogenic bacteria on cutting boards and their ecological correlation with background biota. *AIMS Microbiology*, 2(2), 138-151. <https://doi.org/10.3934/microbiol.2016.2.138>
- [2] Adamu, A. I., Pam, V. A., Ashigar, M. A., Ombugadu, A., Maikenti, J. I., Ahmed, H. O., Sangari, J. S., Osehgele, P. A., Karenegebe, P., & Haruna, S. (2024). Nest biota and composition of household ants in Lafia Local Government Area, Nasarawa State. *Asian Journal of Biological and Medical Research*, 7(1), 21. <https://doi.org/10.52589/AJBMR-1YFYAUVG>

- [3] Akinwande, K. L., Atunwa, O. B., & Adewale, P. O. (2024). Anthropization drives indoor establishment, dispersal, and foodborne pathogens' carrying capacity of ants (Hymenoptera: Formicidae). *Tropical Zoology*. <https://doi.org/10.1007/s43538-024-00274-1>
- [4] Alruwaili, R. F., Alsadaan, N., Alruwaili, A. N., & Alrumayh, A. G. (2024). Unveiling the symbiosis of environmental sustainability and infection control in health care settings: A systematic review. *Sustainability*. <https://doi.org/10.3390/su152215728>
- [5] Anicetus, A., Nguvumali, D. T., & Mbise, G. W. (2022). Assessment of environmental cleaning practices and their impacts on infection prevention and control in selected hospitals in Tanzania. *Journal of Hospital Infection*. <https://doi.org/10.1016/j.jhin.2022.03.001>
- [6] Ashigar, M. A., & Majid, A. H. A. (2021). 16S rDNA metabarcoding of the bacterial community associated with workers of *Pheidole rugaticeps* Emery (Hymenoptera: Formicidae). *Asian Pacific Journal of Tropical Biomedicine*, 24(1), 176. <https://doi.org/10.1016/j.aspen.2020.12.003>
- [7] Chi, N. T. Q., Lan, N. T. H., Toyama, K., & Mukai, Y. (2020). Microbial inspection of a Vietnamese hospital kitchen with reference to a Japanese hospital kitchen. *Journal of Food Safety*, 40(5), e12827. <https://doi.org/10.1111/jfs.12827>
- [8] Gaucher, M. L., Thibodeau, A., Fravallo, P., Archambault, M., Arsenault, J., Fournaise, S., Letellier, A., & Quessy, S. (2018). Broiler chicken carcasses and their associated abattoirs as a source of enterotoxigenic *Clostridium perfringens*: Prevalence and critical steps for contamination. *AIMS Microbiology*, 4(3), 439-454. <https://doi.org/10.3934/microbiol.2018.3.439>
- [9] Lima, W. R. dos S., Marques, S. G., Rodrigues, F. S., & Rebêlo, J. M. M. (2013). Ants in a hospital environment and their potential as mechanical bacterial vectors. *Revista da Sociedade Brasileira de Medicina Tropical*, 46(6), 637-640. <https://doi.org/10.1590/0037-8682-1607-2013>
- [10] Leistner, R., et al. (2023). Environmental cleaning to prevent hospital-acquired infections on non-intensive care units: A pragmatic, single-center, cluster-randomized controlled, crossover trial comparing soap-based, disinfection, and probiotic cleaning. *Infection Control & Hospital Epidemiology*. <https://doi.org/10.1017/ice.2023.123>
- [11] MacFaddin, J. F. (1980). *Biochemical tests for identification of medical bacteria*. Williams & Wilkins Co.
- [12] Muratore, M., Prather, C., Sun, Y., & Ishaq, S. L. (2020). The gut bacterial communities across six grasshopper species from a coastal tallgrass prairie. *PLOS ONE*, 15(1), e0228406. <https://doi.org/10.1371/journal.pone.0228406>
- [13] Nascimento, L. E., Amaral, R. R., Ferreira, R. M. A., Trindade, D. V. S., Nascimento, R. E., Costa, T. S., Souto, R. N. P., & Rust, M. (2020). Ants (Hymenoptera: Formicidae) as potential mechanical vectors of pathogenic bacteria in a public hospital in the Eastern Amazon, Brazil. *Journal of Medical Entomology*, 57(5), 1619. <https://doi.org/10.1093/jme/tjaa062>
- [14] Nguyen, V. T., Bian, L., Tamaoki, J., Otsubo, S., Muratani, M., Kawahara, A., & Kobayashi, M. (2020). Generation and characterization of keap1a- and keap1b-knockout zebrafish. *Redox Biology*, 36, 101667. <https://doi.org/10.1016/j.redox.2020.101667>
- [15] Oliveira, B. R. M., Sousa, L. F., Soares, R. C., Nascimento, T. C., Madureira, M. S., & Fortuna, J. L. (2017). Ants as vectors of bacteria in hospital environments. *Journal of Microbiology Research*, 7(1), 1-7. <https://doi.org/10.5923/j.microbiology.20170701.01>
- [16] Papatheodorou, S. A., Halvatsiotis, P., & Houhoula, D. (2021). A comparison of different DNA extraction methods and molecular techniques for the detection and identification of foodborne pathogens. *AIMS Microbiology*, 7(3), 304-319. <https://doi.org/10.3934/microbiol.2021019>
- [17] Pramitasuri, T. I., Susilawathi, N. M., Tarini, N. M. A., Sudewi, A. A. R., & Evans, M. C. (2023). Cholesterol-dependent cytolysins and the brain: Revealing a potential therapeutic avenue for bacterial meningitis. *AIMS Microbiology*, 9(4), 647-667. <https://doi.org/10.3934/microbiol.2023033>
- [18] Raheem, D. (2016). Outbreaks of listeriosis associated with deli meats and cheese: An overview. *AIMS Microbiology*, 2(3), 230-250. <https://doi.org/10.3934/microbiol.2016.3.230>
- [19] Saadeh, D., et al. (2022). Water, sanitation, and hygiene and infection prevention and control in Jordanian hospitals in the context of COVID-19: A national assessment. *BMC Health Services Research*. <https://doi.org/10.1186/s12913-022-08191-8>
- [20] Schroeder, A. R., Dahlen, A., Purington, N., Alvarez, F., Brooks, R., Destino, L., Madduri, G., Wang, M., & Coon, E. R. (2022). Healthcare utilization in children across the care continuum during the COVID-19 pandemic. *PLOS ONE*, 17(10), e0276461. <https://doi.org/10.1371/journal.pone.0276461>
- [21] Tiritelli, R., Giannetti, D., Schifani, E., Grasso, D. A., & Cilia, G. (2024). Neighbors sharing pathogens: The intricate relationship between *Apis mellifera* and ants (Hymenoptera: Formicidae) nesting in hives. *Journal of Applied Entomology*. <https://doi.org/10.1111/1744-7917.13433>
- [22] Xu, Y., Nagy, A., Bauman, G. R., Xia, X., & Nou, X. (2017). Enhanced biofilm formation in dual-species culture of *Listeria monocytogenes* and *Ralstonia insidiosa*. *AIMS Microbiology*, 3(4), 774-783. <https://doi.org/10.3934/microbiol.2017.4.774>