

Occurrence of antibiotic-resistant *Staphylococcus aureus* in chicken meat sampled in Maiduguri metropolis, Borno State, Nigeria

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Abstract

The occurrence of antibiotic-resistant *Staphylococcus aureus* (*S. aureus*) poses significant public health risks. This study investigated the occurrence and antibiotic resistance patterns of *S. aureus* isolated from chicken meat sampled in Maiduguri metropolis, Borno State, Nigeria. A total of 150 chicken meat samples were collected purposively from different locations in the metropolis, to ensure that various locations were adequately represented. Bacterial organisms in the meat samples were isolated and identified. Out of the 150 chicken meat samples, 113 (75.3%) tested positive for bacterial contamination. *Staphylococcus aureus* was identified in 54% of the 150 chicken carcasses sampled, followed by *Klebsiella spp* (8.7%), *Enterobacter spp* (6.7%), and *Proteus spp* (6.0%). Antibiotic susceptibility testing showed high susceptibility to Amoxicillin, Streptomycin, Erythromycin and Chloramphenicol (100%), with resistance observed against Rifampine (20.0%), Norfloxacin (13.3%) and Gentamicin (13.3%). These results highlight the high occurrence of *S. aureus* in chicken meat in Maiduguri metropolis and the potential health hazards associated with the antibiotic-resistant *S. aureus*. Enhanced surveillance, strict antibiotic stewardship and improved food safety practices were recommended to reduce chicken meat contamination and the risk of transmission of antibiotic-resistant bacteria to humans.

Keywords: Bacterial contamination; Chicken meat; *Staphylococcus aureus*; Antibiotic susceptibility; Maiduguri, Nigeria.

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Introduction

Staphylococcus aureus is a Gram-positive facultative anaerobic bacterium commonly found on the skin and mucous membranes of humans and animals (Phan *et al.*, 2025). As a versatile pathogen, *S. aureus* can cause a wide range of infections and diseases in humans and animals, ranging from mild skin infections to more severe diseases, including pneumonia, sepsis and endocarditis (Gouba *et al.*, 2020). The presence of *Staphylococcus aureus* in food products, particularly in chicken carcass, poses significant public health risks due to its potential to cause diseases. When it contaminates food products, particularly under unsanitary conditions, *S. aureus* can cause gastroenteritis and other health issues, leading to nausea, vomiting, abdominal cramps and diarrhoea (Abubakar *et al.*, 2023).

The growing concern over *S. aureus* resistance to antibiotic treatment has become a global health issue, especially in food products such as chicken carcass, which is widely consumed. Resistance to commonly used antibiotics, including methicillin, tetracycline, and penicillin has been reported in *S. aureus* strains isolated from poultry and other food animals (Fadaei *et al.*, 2022). The indiscriminate use of antibiotics in poultry farming contributes to the development of resistant strains, which can be transmitted through consumption of contaminated carcass (Hassan *et al.*, 2021). Antibiotic-resistant *S. aureus* strains in chicken carcass pose a direct threat to consumers, as resistance to commonly prescribed antibiotics can result in treatment failures and prolonged infections (Khaliq *et al.*, 2023). The global spread of resistant *S. aureus* underscores the need for integrated approaches to managing AMR that involve both human health and animal health sectors. Effective surveillance, monitoring, and regulation of antibiotic use in poultry farming are critical to preventing the further spread of resistant strains. Additionally, public health campaigns aimed at educating consumers and

food handlers about proper carcass handling, cooking practices and hygiene can help mitigate the risks of foodborne transmission of resistant *S. aureus* (Miller *et al.*, 2020).

The consumption of poultry meat serves as a primary source of animal protein, yet the risk of bacterial contamination of poultry products has not been thoroughly investigated and reported on. The prevalence of *S. aureus* in chicken carcass, particularly antibiotic-resistant strains, has not been well-studied in the Northeastern region of Nigeria (Adeleke *et al.*, 2020). The present study evaluated the occurrence of *Staphylococcus aureus* in chicken meat sampled in Maiduguri metropolis, Borno State, Nigeria, and further investigated the antibiotic resistance patterns of the *S. aureus* isolates obtained.

Materials and Methods

Study Area: The study was conducted in Maiduguri metropolis, Borno State, Nigeria. Located approximately between latitudes 11°46'N to 11°53'N and longitudes 13°2'E to 13°13'E, Maiduguri is a major urban centre in northeastern Nigeria with a population exceeding one million. The city serves as a regional hub for commerce, agriculture and trade, with poultry farming being a key economic activity that significantly contributes to the protein intake of the local population. Maiduguri exhibits a blend of urban and rural characteristics, hosting numerous poultry farms and vibrant markets such as the Maiduguri Central Market and the Old Maiduguri Market, which are critical in the retail distribution of poultry products, especially fresh chicken carcass. These markets are essential components of the poultry supply chain, attracting a high volume of consumers and vendors (Ezema *et al.*, 2021).

Ethical Considerations: Ethical approval for the study was obtained from the University of Maiduguri Ethical Review Committee.

Permission was sought from the vendors, market authorities and slaughterhouse management before sample collection. All samples were collected with strict adherence to hygiene and safety standards to minimize risks to the researchers and the public. Additionally, data confidentiality was maintained, and findings were reported without revealing the identities of specific vendors or farms involved in the study.

Study Design: This study adopted a descriptive cross-sectional study design.

Sample Collection: A total of 150 chicken carcass samples were collected following random sampling procedure, from poultry vendors and slaughterhouses in Maiduguri metropolis and transported to the laboratory as soon as possible after collection. The samples were obtained from both retail markets (such as the Maiduguri Central Market) and slaughterhouses that supply poultry carcass to these markets. The spread of the collection points ensured adequate representation of various locations across the metropolis.

Isolation and Identification of *Staphylococcus aureus*: Chicken carcass samples were processed immediately upon arrival at the lab to prevent contamination. A 25 g portion of each sample was homogenized in 225 mL of sterile saline (0.85% NaCl) to form a 1:10 dilution, and then incubated at 37°C for 24 hours. After enrichment, serial dilutions were plated on Mannitol salt agar (MSA), a selective

medium that supports *Staphylococcus* growth and differentiates *S. aureus* by its yellow colonies. Suspected *S. aureus* colonies were sub-cultured on nutrient agar and confirmed through biochemical tests. Additional tests such as glucose fermentation and haemolysin production tests on blood agar were also used for confirmation.

Antibiotic Susceptibility Testing: Antibiotic susceptibility of the *Staphylococcus aureus* isolates was determined using the disk diffusion method, also known as the Kirby-Bauer method, which is a standard and widely accepted technique for assessing bacterial resistance. This method involved placing antibiotic-impregnated paper discs onto an agar plate inoculated with the bacterial isolate and measuring the zones of inhibition around the discs after incubation as described by Clinical and Laboratory Standards Institute (CLSI, 2021).

Data Analysis: Data collected from the study were subjected to descriptive statistics. Summary of the results were presented in table format.

Result

Out of 150 chicken carcass samples tested, 113 were positive for bacterial organisms (Table 1). *Staphylococcus aureus* spp was the most prevalent (54% out of the 150 samples), followed by *Klebsiella* spp (8.7%), *Enterobacter* spp (6.7%), and *Proteus* spp (6.0%) Table 1].

Table 1. Bacterial organisms isolated from chicken meat (n = 150) sampled in Maiduguri metropolis, Borno State, Nigeria.

| Organisms isolated | Occurrence of isolate | Percentage |
|------------------------------|-----------------------|--------------|
| <i>Enterobacter</i> spp | 10 | 6.7% |
| <i>Klebsiella</i> spp | 13 | 8.7% |
| <i>Proteus</i> spp | 9 | 6.0% |
| <i>Staphylococcus aureus</i> | 81 | 54.0% |
| Total | 113 | 75.3% |

Table 2. Antibiotic susceptibility test results for *Staphylococcus aureus* isolated from chicken meat sampled in Maiduguri metropolis, Borno State, Nigeria.

| Antibiotics | Number of isolates tested | Number susceptible, with % in bracket | Number intermediate, with % in bracket | Number resistant, with % in bracket |
|-------------------------|---------------------------|---------------------------------------|--|-------------------------------------|
| Ciprofloxacin (10mcg) | 15 | 13 (86.7%) | 2 (13.3%) | 0 (0%) |
| Norfloxacin (10mcg) | 15 | 12 (80.0%) | 1 (6.7%) | 2 (13.3%) |
| Gentamicin (10mcg) | 15 | 12 (80.0%) | 1 (6.7%) | 2 (13.3%) |
| Amoxicillin (20mcg) | 15 | 15 (100%) | 0 (0%) | 0 (0%) |
| Streptomycin (30mcg) | 15 | 15 (100%) | 0 (0%) | 0 (0%) |
| Rifampin (20mcg) | 15 | 10 (66.8%) | 2 (13.3%) | 3 (20.0%) |
| Erythromycin (30mcg) | 15 | 15 (100%) | 0 (0%) | 0 (0%) |
| Chloramphenicol (30mcg) | 15 | 15 (100%) | 0 (0%) | 0 (0%) |
| Ampiclox (20mcg) | 15 | 13 (86.6%) | 1 (6.7%) | 1 (6.7%) |
| Levofloxacin (20mcg) | 15 | 15 (100%) | 0 (0%) | 0 (0%) |

Results of the antibiotics susceptibility test on the *Staphylococcus aureus* isolates obtained from the chicken carcasses showed that antibiotics like amoxicillin (AML), streptomycin (S), erythromycin (E), chloramphenicol (CH), and levofloxacin (LEV) exhibited 100% susceptibility (Table 2). Ciprofloxacin (CPX) and ampicillin (APX) showed relatively high efficacy with 86.7% and 86.6% susceptibility, respectively, but also exhibited small proportions of intermediate responses (Table 2). On the other hand, some antibiotics, including norfloxacin (NB), gentamicin (CN), and rifampin (RD), demonstrated resistance (Table 2). Norfloxacin and gentamicin exhibited 80% susceptibility, but resistance was observed in 13.3% of isolates (Table 2). Rifampin showed the lowest susceptibility at 66.8%, with 20% resistance (Table 2).

Discussion

The results of the present study show that *Staphylococcus aureus* was the most frequently isolated bacterial pathogen from chicken meat sampled in Maiduguri, Nigeria, with an overall occurrence of 54.0%, which is 71.8% of total isolates. This is in agreement with reports of earlier studies that identified *S. aureus* as a dominant foodborne pathogen in poultry, globally (Odetokun *et al.*, 2023; Michalik, *et al.*, 2025; Ugbo *et al.*, 2024; Elshebraway *et al.*, 2025; Elsalkh *et al.*, 2025; Faraj *et al.*, 2025). Its high prevalence presents significant public health risks, including foodborne illnesses ranging from mild gastrointestinal infections to severe systemic conditions (Song *et al.*, 2024).

The antibiotic susceptibility testing in the present study that revealed notable resistance to Rifampicin (20%) is consistent with previous findings (Michalik, *et al.*, 2025). Moderate resistance was also observed to Ciprofloxacin,

Norfloxacin, and Gentamicin (13.3% – 20%), raising concerns due to their widespread use in both human and veterinary medicine (Song *et al.*, 2024). Similar earlier studies have reported resistance to Ciprofloxacin, Norfloxacin and Gentamicin (Lekko *et al.*, 2025; Fox *et al.*, 2016; Nworie *et al.*, 2016; Kwoji *et al.*, 2019; Back *et al.*, 2020; Gaddafi *et al.*, 2022). Conversely, no resistance was recorded for Amoxicillin, Streptomycin, Erythromycin, and Chloramphenicol, suggesting these drugs may still be effective, though their continued use should be monitored (Song *et al.*, 2024). The above information on the antimicrobial resistance profile of isolates can serve as a useful guide in the choice of appropriate therapy for the clinical treatment of infection caused by this microorganism.

Earlier reports have shown that the development of antibiotic resistance by *S. aureus* is related to acquisition of determinants by horizontal gene transfer of mobile genetic elements and can also develop by mutations resulting in alteration of the drug-binding sites on molecular targets and by the expression of endogenous efflux pumps (Foster, 2017).

The multi-drug resistance recorded in the present study underscores the risk of antibiotic misuse in poultry farming and highlights the need for stricter regulation of the use of antibiotics (Odetokun *et al.*, 2023). The findings also stress the importance of improved hygiene during slaughtering, storage and handling of poultry to prevent *S. aureus* contamination (Michalik, *et al.*, 2025). Ultimately, the results of the study calls for surveillance programmes to monitor antimicrobial resistance in the food chain and enforce better food safety measures, particularly in high-consumption areas like Maiduguri metropolis, to minimize public health risks.

Conclusion: *Staphylococcus aureus* is the predominant bacterial organism isolated from chicken meat sampled in Maiduguri metropolis, Nigeria: other organisms of relatively lower occurrence (< 10%) include *Klebsiella spp*, *Enterobacter spp* and *Proteus spp*. The results of the antibiotics susceptibility test on the *Staphylococcus aureus* isolates from chicken meat revealed varying degrees of susceptibility: antibiotics like amoxicillin (AML), streptomycin (S), erythromycin (E), chloramphenicol (CH), and levofloxacin (LEV) displayed 100% susceptibility, while norfloxacin (NB), gentamicin (CN) and rifampin (RD), demonstrated resistance.

Conflict of Interest

The authors declare no conflict of interests.

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