ISOLATION AND IDENTIFICATION OF BACTERIA ASSOCIATED WITH HAWKED SUYA MEAT SOLD IN KAURA NAMODA METROPOLIS, ZAMFARA STATE, NIGERIA

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Abstract
Street-hawked roasted meat (suya) is generally consumed in Northern Nigeria due to its affordability, nutritious and readily available. Conversely, poor hygiene during preparation, handling and vending can expose consumers to foodborne pathogens and antibiotic-resistant bacteria. This study examined the bacterial contamination and antibiotic susceptibility patterns of bacteria isolated from hawked roasted meat sold in Kaura Namoda Metropolis, Zamfara State, Nigeria. A total of twenty-five roasted meat samples were randomly obtained from 5 major hawking locations. Microbiological techniques were used for isolation and identification of bacterial using colony morphology, Gram staining techniques, and biochemical tests, whereas antibiotic susceptibility testing was evaluated using Kirby–Bauer disk diffusion method. The results indicated that Escherichia coli, Klebsiella spp., Proteus vulgaris, and Staphylococcus aureus were identified. Staphylococcus aureus has the highest frequency of occurrence while Klebsiella spp. showed the lowest of frequency of occurrence. However, the result showed that antibiotic susceptibility testing showed varying resistance pattern, E. coli was resistant to all the tested antibiotics, whereas S. aureus was susceptible to all the antibiotics tested. It also indicated the percentages distribution shown that 50% resistance, 25% intermediate and 25% susceptibility across all the antibiotics tested. The occurrence of pathogenic and antibiotic-resistant bacteria in roasted meat proposes contamination caused by inadequate hygiene practices and inappropriate handling after roasting. These findings underline the need for better-quality food safety measures, constant bacteriological monitoring and education of food vendors to reduce contamination and decrease the public health concern connected with the consumption of street-hawked roasted meat in the study area.

Keywords: Isolation, Identification, Bacteria, Antibiotic susceptibility, Hawked meat and Kaura Namoda

Introduction

Street-vended foods play an important role in ensuring food security and meeting the nutritional requirements of urban populations in many developing countries. These foods are extensively consumed because they offer affordable, convenient and traditionally acceptable meals for low-income individuals and consumers (Moloi *et al*., 2021; WHO, 2018). Studies have linked street foods to outbreaks of foodborne illness comprising diarrhea, typhoid fever, cholera, and food poisoning, especially where sanitation and food safety practices are inadequate (Rane, 2011). Though global data on street food safety are inadequate, documented outbreaks highlight a substantial public health concern in urban areas. Meat products, such as roasted or grilled meat are predominantly susceptible to microbial contamination because they provide high levels of protein, moisture and nutrients ideal for microbial growth. Bacteria contaminate meat at various stages of processing during slaughter, transportation, preparation, handling and exposure to dust by the roadside (Adeleye *et al*., 2022; Rane, 2011). Street hawkers frequently lack access to potable water, suitable storage facilities and sanitation all of which increase the rate of contamination (Ebrahim & Wondimagegn, 2025; Werkneh *et al*., 2023). In northern Nigeria, roasted meat popularly

known as suya is among the most widely consumed street-vended foods and represents an important source of animal protein for many communities. Roasted meat is usually prepared by slicing raw meat, marinating it with spices and roasting it over an open flame. However, roasting can considerably decrease bacterial load, post-processing contamination frequently occurs through slicing, handling, display, and storage, especially under environmental conditions (Adoh & Ngozi, 2025; Adeleye *et al*., 2022). Conversely, numerous studies have indicated that meat contains a wide range of bacteria which comprises *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella spp.* and other foodborne pathogenic bacteria (Adoh & Ngozi, 2025; Adeleye *et al*., 2022; Datok *et al*., 2021). The existence of these pathogenic bacteria in street-hawked food poses a major concern. Earlier studies validated that bacteria isolated from street foods indicated resistance to regularly used antibiotics, obfuscating treatment and increasing the diseases burden (Datok *et al*., 2021). This pattern highlights the need for constant observation and enhanced food safety practices in the street food vendors. In spite of the high intake of roasted meat at Kaura Namoda metropolis, there is no recorded document on the microbiological quality and antibiotic resistance pattern in the study area.

Statement of the Problem

Street-hawked roasted meat is extensively consumed in northern Nigeria since it is affordable, readily available, and offer a significant source of animal protein. Moreover, the bacteriological safety of the meat and meat products can be compromised by poor sanitation, inappropriate handling, contaminated equipment, exposure to dust, water and other environmental contaminants, poor hygienic condition during hawking. Though roasting can lessen the bacterial load in meat, contamination may occur again during slicing, handling, display and storage. The occurrence of bacterial pathogens in ready-to-eat roasted meat is an essential public health concern because consumers may be exposed to foodborne diseases. Of particular concern is the occurrence of bacteria comprising

Escherichia coli and *Staphylococcus aureus*, which is an indication of poor hygienic practices and contamination from meat handlers. Additionally, the occurrence of antibiotic-resistant bacteria in food signifies an additional health threat because infections caused by resistant bacteria may be more challenging to treat. Regardless of the consumption of roasted meat in Kaura Namoda Metropolis, there is lack of documented information on its bacteriological quality and antibiotic resistant patterns in the study area. Therefore, there is need to investigate the bacterial contamination of hawked roasted meat sold in Kaura Namoda Metropolis, identify the bacterial species present, and evaluate their susceptibility to commonly used antibiotics.

Objectives of the Study

The following are the objectives for the study:

a. isolate and identify bacterial species associated with hawked roasted meat sold in some selected areas within Kaura Namoda.
b. determine the frequency of occurrence of the bacterial isolate identified from the roasted meat samples.
c. characterize the isolated bacteria using colony morphology, Gram-staining and biochemical test.
d. determine the antibiotic susceptibility patterns of the bacterial isolates.

Research Questions

1. What are the bacterial species associated with street hawked roasted meat sold in Kaura Namoda Metropolis?
2. What are the frequency of occurrences of the bacterial Isolates identified from the roasted meat samples?
3. What are the antibiotic susceptibility patterns of the bacterial isolates obtained from the roasted meat samples?

Methodology

The study was conducted in Kaura Namoda which is located in the Sudan savanna region of Zamfara State. The region experiences a warm dry season with moderate rainfall that promotes widespread

livestock production and street meat hawking activities. Following the procedure of ISO (2013) and Falegan *et al*., (2017) five (100g) roasted meat samples each were randomly purchased from five different areas namely General Hospital, Bakin Kasuwa, Sabuwar Tasha, Low-Cost and Tsohuwar Tasha. Samples were carefully packaged in sterile polythene bags and conveyed to the microbiology laboratory, Federal Polytechnic Kaura Namoda for analysis. Using streak plate technique, samples were homogenized, diluted serially, and inoculated. Plates were incubated at 37°C for 24 hours. Bacterial counts were expressed as colony-forming units/gram (CFU/g). Discrete colonies were subculture to obtain pure isolates and stored at 4°C (Cheesbrough, 2010; APHA, 2015). Bacterial isolates were identified on the basis of Gram staining, colony morphology and biochemical tests comprising Catalase, Indole, Motility and Coagulase tests (Cheesbrough, 2010; Cappuccino and Welsh, 2017).In accordance with the procedure of National Committee for Clinical Laboratory Standard Guidelines (NCCLS, 2018) and Clinical and Laboratory Standard Institute (CLSI. 2020) antibiotic susceptibility was evaluated using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar. After incubation at 37°C for 24 hours, zones of inhibition were measured.

Results

Occurrence of bacterial isolates

Table 1 indicated that four bacterial species were isolated from roasted meat samples which comprises *E*. coli, *Klebsiella spp., Proteus vulgaris,* and *Staphylococcus aureus*. *Staphylococcus aureus* had the highest frequency of occurrence (37) while *Klebsiella spp*.had the lowest frequency of occurrence 14.

Table 1:
Distribution of bacterial isolates in street hawked roasted meat samples obtained from Kaura Namoda metropolis

Organism	Colony morphology	Catalase	Oxidase	Citrate	Indole	Motility	Coagulase
E. coli	Dark-centered colonies with clear margins	+	–	–	+	+	–
Klebsiella spp.	Large, mucoid, pink-red colonies	+	N/A	–	–	–	–
Proteus vulgaris	Swarming confluent colonies	+	–	+	+	+	–
Staphylococcus aureus	Flat, circular, milky colonies	+	–	–	+	+	–

Note: + = Positive, – = Negative, N/A = Not applicable

Pattern of antibiotic susceptibility

Antibiotic susceptibility testing showed variable resistance patterns between the isolates as shown in Table 2. *E. coli* was resistant to all the antibiotics tested, whereas *S. aureus* was susceptible to all the tested antibiotics. Figure 1 showed the percentages distribution indicated that 50% resistance, 25% intermediate and 25% susceptibility across all the tested antibiotics

Table 2:
Antibiotic susceptibility profile of bacterial isolates from street hawked roasted meat

Bacterial species	PEF	CN	APX	SXT	CH	SP
Escherichia coli	R	R	R	R	R	R
***Klebsiella* spp.**		S	S	I	I	
R I						
Proteus vulgaris	R	R	S	I	R	R

Key: S = Susceptible, I = Intermediate, R = Resistance, PEF = Pefloxacin, CN = Gentamicin, APX = Ampiclox, SXT = Septrin, CH = Chloramphenicol, SP = Sparfloxacin.

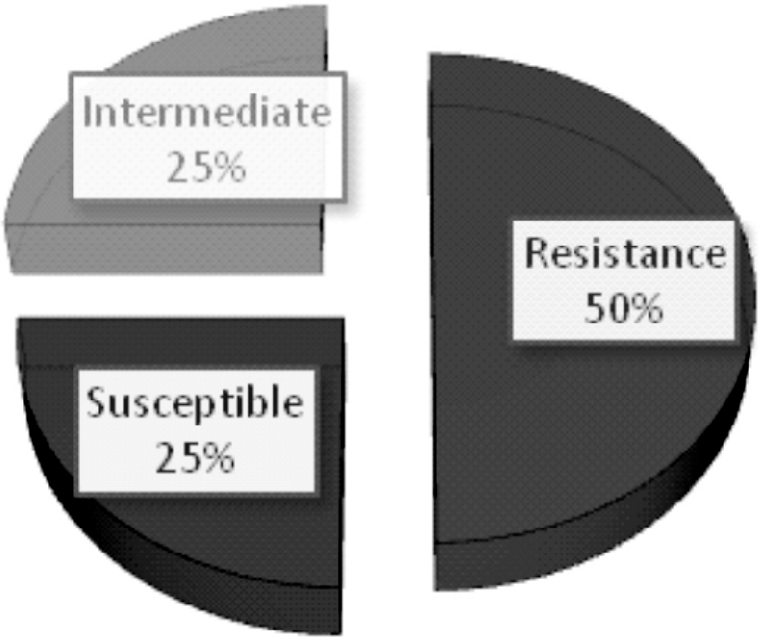

Figure 1: Accumulative percentage distribution of antibiotic susceptibility patterns of bacterial isolates from street roasted meat.

Discussion of Findings

The present study investigated isolation and identification of bacteria associated with street hawked roasted meat were studied. Isolation of diseases-causing bacteria from roasted hawked meat indicated considerable post-preparation contamination, regardless of exposure to high temperature during roasting. Though heat treatment is expected to decrease bacterial load, it does not guarantee complete sterility, especially when meat is subsequently exposed to unhygienic handling and continued exposure to the environment. Post-roasting practices, which comprise slicing with contaminated knives, handling with bare hands, and display under environmental conditions create opportunities for recontamination and bacterial proliferation. Comparable observation has been stated in numerous studies on street-vended meats, which identified post-cooking

handling as a critical point for contamination (Adeleye *et al*., 2022; Rane, 2011). Identification of *E. coli* in the roasted meats samples is an indication of fecal contamination, these could probably be the result of poor sanitary conditions during meat preparation and hawking. This contamination may originate from the use of unclean water for washing meat and utensils, inadequate hygiene or cross-contamination from raw meat and surrounding environments. The presence of *E. coli* in street-hawked food is widely identified as a significant indicator of poor hygiene and poses an important public health concern due to its association with gastrointestinal infections (Alonge *et al*., 2017; WHO, 2018). The prevalence of *S. aureus* among the isolates further highlights the role of human handlers as a most important cause of contamination. *S. aureus* is a common constituent of the skin and nasal flora and is certainly transferred to food through direct contact, coughing, sneezing or poor personal hygiene. Its recurrent occurrence in street-hawked foods has been consistently connected to inadequate hand washing practices and lack of protective barriers during food handling (Nwakanma *et al*., 2015; Bello & Bello, 2020). The occurrence of these bacteria is principally concerning due to its ability to produce heat-stable enterotoxins that can cause food intoxication even when the bacteria are no longer viable. Differences in bacterial load identified between various hawking areas may reflect variances in hygiene standards, environmental exposure, and hawk training and handling attitudes. High-traffic areas are often connected with increase dust, emissions from vehicles and flies activity which can contribute to elevated microbial contamination. However, inconsistent adherence to proper sanitation practices across areas could further elucidate the observed spatial variations in bacterial distribution (Osunde *et al*., 2024; Werkneh *et al*., 2023).

In this study the identification of multidrug resistance of *E. coli* is of particular public health concern and highlights the growing challenges of antimicrobial resistance in meats. Resistance may arise from the indiscriminate and unregulated use of antibiotics in both human medicine and livestock production leading to the collection

and distribution of resistant strains through meat consumption. The occurrence of such resistance bacteria in street hawked roasted meat indicates a serious public health concern as it may limit management selections and enable the spread of resistance genes within the community (Beric *et al*., 2018; von Wintersdorff *et al*., 2016). These findings are in agreement with previous studies documenting antibiotic-resistance bacteria in street hawked roasted meats in Nigeria and other developing nations (Datok *et al*., 2021; Hammuel *et al*., 2022).

Conclusion

It is therefore concluded that street hawked roasted meats sold at Kaura Namoda metropolis is contaminated with possibly pathogenic and antibiotic-resistant bacteria, largely due to poor personal hygiene and handling practices.

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Acknowledgement

This is to acknowledge the management of the Federal Polytechnic, Kaura Namoda, Zamfara State, for sponsoring Authors through TETFUND, the Institution Based Research (IBR)