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Full Length Research

Antimicrobial resistance profile of bacteria isolated from *suya* meat sold in Jos South Local Government Area of Plateau State, Nigeria

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ABSTRACT: Suya meat is a traditional meat product gotten from boneless meat hung on a stick and spiced with peanut cake, salt, vegetable oil and other flavours, followed by toasting around a glowing charcoal fire. Therefore, this study investigated the antibiotic resistance profile of bacteria isolated from suya meat, a widely consumed street-vended meat. A total of 40 suya samples were used for this study. The samples, five (5) each, were collected from eight (8) different suya meat vendors and analysed microbiologically. Results from the viable cell counts revealed significant bacterial contamination, with total bacterial counts ranging from 1.1×10^5 to 6.4×10^5 CFU/g, indicating poor hygiene practices during preparation. While many samples showed zero total coliform counts, some indicated detectable levels, suggesting potential faecal contamination risks. The bacteria isolates encountered are *Staphylococcus aureus, Klebsiella aerogenes, Bacillus species, Escherichia coli, Pseudomonas aeruginosa* and *Proteus* species. *Staphylococcus aureus* was the most frequently isolated organism (38.24%), followed by *Bacillus* species. (20.59%) and *Klebsiella aerogenes* (14.71%). Antibiotic susceptibility testing demonstrated alarming resistance, particularly in *Escherichia. coli* and *Proteus* species, with high resistance rates to Amoxicillin, Streptomycin, Chloramphenicol and Ampiclox. These findings underscore a growing public health concern regarding antibiotic-resistant foodborne pathogens, particularly for vulnerable populations. The study highlights the urgent need for improved hygiene practices in food preparation and emphasises the importance of public health initiatives aimed at educating food vendors. Future research should focus on intervention strategies to reduce microbial contamination and monitor antibiotic resistance trends in street foods.

Keywords: Antibiotic resistance, bacterial contamination, public health risk, street-vended foods, *suya* meat.

Abbreviations: TBC: Total bacteria count; TCC: Total coliform count; CFU/g: Colony forming unit per gram; AM: Amoxicillin; CN: Gentamicin; S: Streptomycin; PEF: Pefloxacin; OFX: Ofloxacin; LEV: Levofloxacin; CH: Chloramphenicol; AZ: Azithromycin; APX: Ampiclox; CPX: Ciprofloxacin.

INTRODUCTION

Suya is a widely consumed Nigerian delicacy prepared from thinly sliced cuts of meat, typically beef, chicken, or goat, marinated in a blend of spices and peanut sauce, then grilled over an open flame (Ahmed *et al.,* 2021). Vendors sell suya in public settings, including markets, restaurants, and roadside stalls, where it serves as a popular ready-to-eat street food (Adeleye *et al.,* 2022). The Suya trade significantly contributes to the Nigerian economy, supporting thousands of vendors nationwide (Amala and Onwuli, 2017).

Despite its popularity and economic value, improper handling and preparation of Suya pose serious public health risks. Poor hygiene practices, inadequate cooking, unsanitary storage conditions, and frequent cross-contamination foster the growth and transmission of pathogenic bacteria such as *Salmonella*, *Escherichia coli*, *Staphylococcus aureus*, and *Campylobacter* species (Amadi *et al.,* 2016; Ogbunugafor *et al.,* 2017; Khan *et al.,* 2017). Consumption of contaminated suya remains a potential source of foodborne diseases.

Antibiotic resistance exacerbates this concern. The misuse and overuse of antibiotics on animals accelerate the emergence and spread of resistant bacterial strains globally (Niwa *et al.,* 2016). Livestock producers often administer antibiotics to promote growth, prevent disease, and treat infections. Such practices, especially when unregulated, select for resistant bacteria that may transfer to humans through the food chain (Peirano *et al.,* 2018).

In Nigeria, weak regulatory oversight permits indiscriminate antibiotic use on livestock prior to slaughter, including those in the suya trade (Odu *et al.,* 2016). Consequently, consumers face heightened risks of infections that are increasingly difficult to treat. Moreover, rising consumer demand has spurred the rapid expansion of suya vending. Many vendors lack sufficient training in food safety and proper handling techniques (Bello and Bello*,* 2020). This situation further elevates the risk of contamination and facilitates the spread of antibiotic-resistant pathogens through street-vended meat, as antibiotic use often originates at the livestock production stage, where antibiotics are administered for growth promotion and disease prevention (Okinedo *et al.,* 2024). Residual antibiotic exposure and inadequate cooking or handling during suya processing can then select for and disseminate resistant bacteria in the final product (Orogu and Oshilim, 2017; Hassan *et al.,* 2021).

Given these public health implications, this study aimed to investigate the antibiotic resistance profile of bacterial isolates from Suya meat sold within Jos South Local Government Area, Plateau State, Nigeria. Findings from this work aim to inform food safety policies and interventions that protect consumers and curb the spread of resistant bacteria through street foods.

MATERIALS AND METHODS

Study area

The study area lies between latitudes 8°45′00″ and 9°50′00″ North of the Equator and longitudes 8°41′00″ and 8°58′00″ East of the Greenwich Meridian (Figure 1). Jos South Local Government Area covers approximately 510 km², making it the second-largest LGA in Plateau State, with a population of about 306,716 people based on the 2006 census (Ikegwuonu *et al.,* 2021). Industrial, commercial, and mining activities have attracted a high population density to this region. Notably, major industries in Plateau State, including Grand Cereals, NASCO, and Jos International Breweries, operate within Jos South LGA. The area's residents primarily comprise civil servants, entrepreneurs, traders, students, and farmers.

Sample collection

A total of forty (40) Suya meat samples were collected for this study to ensure a representative assessment of microbiological quality across the Jos South Local Government Area. The samples comprised exclusively of beef suya, as beef remains the most commonly vended meat type in the study area (Hassan *et al.,* 2021). Five (5) samples were obtained from each of eight (8) distinct suya vendors, yielding forty (40) samples in total. The vendors were purposively selected to capture diverse vending practices and hygiene conditions. Selection criteria included vendor popularity, daily customer traffic, and geographical spread to ensure coverage of urban, peri-urban, and rural settings within Jos South LGA. All samples were aseptically collected in sterile polythene bags using sterile forceps and gloves to prevent external contamination. Samples were immediately transported in insulated containers to the Microbiology Laboratory at the National Veterinary Research Institute (NVRI), Vom, Plateau State, and were analysed within one (1) hour following standard microbiological protocols (Boom, 2020).

Enumeration, isolation and identification of bacteria

Each Suya meat sample was aseptically homogenised using a sterile laboratory-grade mortar and pestle. One gram (1 g) of each homogenised sample was measured with an electronic weighing balance and suspended in 9 ml of phosphate-buffered saline (pH 8.9) (Adeleye *et al.,* 2022). A 5-fold serial dilution of each sample was prepared using the same phosphate-buffered saline (pH 8.9). From each dilution, 1 ml was aseptically inoculated by the pour plate method onto Nutrient Agar (NA) and MacConkey Agar (MAC) for general bacterial isolation, Plate Count Agar (PCA) for total bacterial count, and Violet Red Bile Agar (VRBA) for total coliform count. All inoculated plates were incubated at 37°C for 24 hours.

Colony counts were determined using the conventional plate count method described by Heuser *et al.* (2023). Suspected bacterial colonies were sub-cultured on nutrient agar to obtain pure isolates for precise identification and differentiation (Clinical Laboratory Standards Institute [CLSI], 2016). For species confirmation, isolates were further sub-cultured on selective media: Eosin Methylene Blue (EMB) Agar for detection of *Escherichia coli*, Mannitol Salt Agar (MSA) for isolation of *Staphylococcus aureus*, and Salmonella-Shigella Agar (SSA) for isolation of *Salmonella* spp. Following incubation, Gram staining was performed on representative colonies. For confirmatory identification, standard biochemical tests, including indole, citrate, oxidase, urease, methyl red, coagulase, catalase, and triple sugar iron (TSI) tests, were carried out according

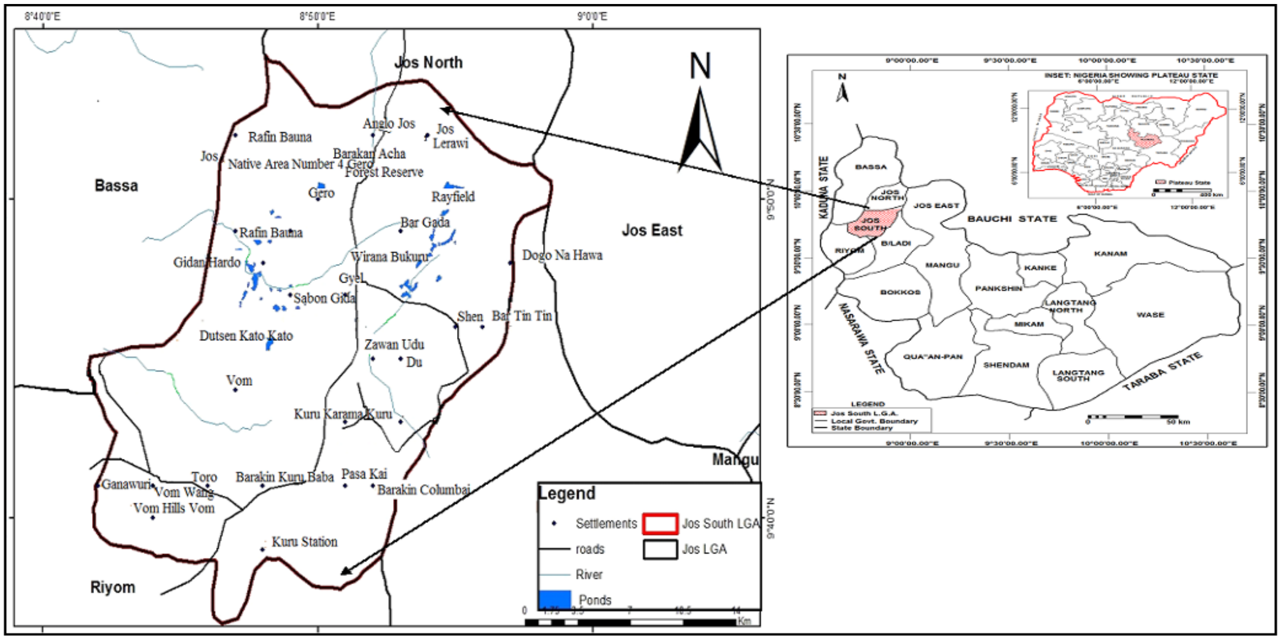

Figure 1. Jos South LGA of Plateau State, Nigeria (Source: Ikegwuonu *et al.,* 2021).

to standard laboratory procedures (CLSI, 2016). No molecular methods or use of reference strains were employed for additional confirmation of the bacterial species.

Antibiotic susceptibility test

The antibiotic susceptibility test of the bacterial isolates was carried out using the Kirby-Bauer disk diffusion method. The antibiotic disks were firmly placed on the sterile Mueller Hinton Agar (MHA) plates, seeded with test organisms standardised to 0.5 McFarland´s turbidity and incubated at 37°C for 24 hours. Diameter of zones of inhibition was then measured to the nearest millimetre and reported in accordance with the antimicrobial susceptibility breakpoint of CLSI (2016).

Data analysis

Data analysis was conducted using R Console Version 4.4.1. Data were presented in tabular form for clarity and ease of interpretation. To determine the occurrences of bacterial species isolated from suya meat, the Chi-square test was employed. Differences were considered statistically significant at $p<0.05$.

RESULTS

Viable cell count of bacterial isolates in suya meat samples

A total of 68 bacteria species were isolated from 40 suya meat samples sold within the Jos South Local Government Area of Plateau State, Nigeria. Table 1 shows the viable cell count of bacteria isolates from suya meat. The total bacterial count ranged from 5×10^4 to 3.4×10^6 (CFU/g), and the total coliform count ranged from 2×10^4 to 3.9×10^5(CFU/g).

Prevalence of bacterial isolates from suya samples

The number of occurrences and frequency distribution of the bacterial species in *Suya* meat samples analysed are presented in Tables 2 and 3. *Staphylococcus aureus* had the highest percentage occurrence of 26 (38.24), followed by *Bacillus* spp. 14 (20.59), then *Klebsiella aerogenes* 10 (14.71), while *Aeromonas* spp. 1(1.47) and *Enterobacter* spp. 1(1.47) had the lowest occurrence. Consequently, there was a very highly significant difference ($\chi^2 = 57.176$, df = 7, $p<0.001$) in the occurrences of bacterial species isolated from suya meat sold in Jos.

Susceptibility profile of gram-negative bacteria to antibiotics isolated from suya meat samples

The antibiotic susceptibility profile of the gram-negative bacteria isolated is presented in Table 4. The results revealed that *Proteus* spp. and *E. coli* were susceptible (completely/partially) to seven (7) antibiotics each, while *K. aerogenes* and *P. aeruginosa* were susceptible to two (2) antibiotics each.

Table 1. Viable cell count of bacterial isolates in suya meat samples sold within Jos South Local Government Area of Plateau State, Nigeria.

S/N	Sample ID	Raw count (10^{-3}) TBC	TBC (CFU/g)	Raw count (10^{-3}) TCC	TCC (CFU/g)
1	AD1	320	3.2×10^6	0	0
2	AD2	318	3.18×10^6	0	0
3	AD3	290	2.9×10^6	39	3.9×10^5
4	AD4	314	3.14×10^6	2	2×10^4
5	AD5	304	3.04×10^6	0	0
6	BM1	330	3.3×10^6	0	0
7	BM2	307	3.07×10^6	0	0
8	BM3	321	3.21×10^6	0	0
9	BM4	311	3.11×10^6	5	5×10^4
10	BM5	245	2.45×10^6	26	2.6×10^5
11	SL1	220	2.2×10^6	0	0
12	SL2	305	3.05×10^6	0	0
13	SL3	317	3.17×10^6	0	0
14	SL4	245	2.45×10^6	0	0
15	SL5	218	2.18×10^6	0	0
16	RF1	64	6.4×10^5	8	8×10^4
17	RF2	340	3.4×10^6	0	0
18	RF3	317	3.17×10^6	0	0
19	RF4	190	1.9×10^6	0	0
20	RF5	48	4.8×10^5	16	1.6×10^5
21	ZM1	310	3.1×10^6	27	2.7×10^5
22	ZM2	5	5×10^4	26	2.6×10^5
23	ZM3	280	2.8×10^6	0	0
24	ZM4	294	2.94×10^6	0	0
25	ZM5	60	6×10^5	11	1.1×10^5
26	MN1	235	2.35×10^6	26	2.6×10^5
27	MN2	308	3.08×10^6	29	2.9×10^5
28	MN3	340	3.4×10^6	0	0
29	MN4	144	1.44×10^6	5	5×10^4
30	MN5	260	2.6×10^6	53	5.3×10^5
31	FGT1	208	2.08×10^6	25	2.5×10^5
32	FGT2	176	1.76×10^6	19	1.9×10^5
33	FGT3	0	0	0	0
34	FGT4	110	1.1×10^6	0	0
35	FGT5	304	3.04×10^6	0	0
36	VM1	290	2.9×10^6	2	2×10^4
37	VM2	319	3.19×10^6	39	3.9×10^5
38	VM3	320	3.2×10^6	0	0
39	VM4	318	3.18×10^6	0	0
40	VM5	213	2.13×10^6	0	0

Key: TBC = Total bacteria count, TCC = Total coliform count, CFU/g = Colony forming unit per gram.

Susceptibility profile of gram-positive bacteria to antibiotics isolated from suya meat samples

The antibiotic susceptibility profile of the gram-positive bacteria isolated is presented in Table 5. *Bacillus* spp. And *Staphylococcus aureus* were susceptible (completely/ partially) to two (2) and one (1) antibiotic, respectively.

Antibiotic resistance pattern and Multi-Drug Resistance Index (MDRI) of bacteria isolated from suya meat

Table 6 presents the antibiotic resistance pattern and multi-drug resistance index (MDRI) of bacteria isolated from suya meat in Jos. The results show that isolates of *Bacillus* spp. (4) were resistant to 24 antibiotics,

Table 2. Prevalence of bacterial isolates from suya samples sold within Jos South Local Government Area of Plateau State, Nigeria.

S/N	Sample ID	Bacterial isolate
1	AD1	*Staphylococcus aureus*
2	AD2	*Staphylococcus aureus*
3	AD3	*Staphylococcus aureus*, *Klebsiella aerogenes*
4	AD4	*Staphylococcus aureus*, *Klebsiella aerogenes*
5	AD5	*Staphylococcus aureus*
6	BM1	*Staphylococcus aureus*
7	BM2	*Staphylococcus aureus*
8	BM3	*Bacillus* spp., *Staphylococcus aureus*
9	BM4	*Bacillus* spp., *Escherichia coli*
10	BM5	*Staphylococcus aureus*, *Escherichia coli*
11	SL1	*Bacillus* spp., *Staphylococcus aureus*
12	SL2	*Pseudomonas aeruginosa, Staphylococcus aureus*
13	SL3	*Staphylococcus aureus*
14	SL4	*Staphylococcus aureus*
15	SL5	*Staphylococcus aureus*
16	RF1	*Staphylococcus aureus*, *Escherichia coli, Proteus* spp.
17	RF2	*Staphylococcus aureus*
18	RF3	*Staphylococcus aureus*
19	RF4	*Staphylococcus aureus*
20	RF5	*Staphylococcus aureus*, *Escherichia coli*
21	ZM1	*Bacillus* spp., *Klebsiella aerogenes*
22	ZM2	*Bacillus* spp., *Staphylococcus aureus*, *Klebsiella aerogenes*
23	ZM3	*Bacillus* spp., *Staphylococcus aureus*
24	ZM4	*Staphylococcus aureus*
25	ZM5	*Staphylococcus aureus*, *Klebsiella aerogenes*
26	MN1	*Bacillus* spp., *Klebsiella aerogenes, Proteus spp.*
27	MN2	*Bacillus* spp., *Klebsiella aerogenes*
28	MN3	*Bacillus* spp., *Escherichia coli*
29	MN4	*Bacillus* spp., *Proteus* spp., *Staphylococcus aureus*
30	MN5	*Bacillus* spp., *Proteus* spp.
31	FGT1	*Escherichia coli, Proteus* spp., *Staphylococcus aureus*
32	FGT2	*Staphylococcus aureus, Escherichia coli*
33	FGT3	*Klebsiella aerogenes*
34	FGT4	*Klebsiella aerogenes, Bacillus* spp.
35	FGT5	*Bacillus* spp.
36	VM1	*Bacillus* spp., *Aeromonas* spp., *Klebsiella aerogenes*
37	VM2	*Pseudomonas aeruginosa, Enterobacter* spp.
38	VM3	*Pseudomonas aeruginosa, Aeromonas* spp.
39	VM4	*Pseudomonas aeruginosa*
40	VM5	*Pseudomonas aeruginosa*

Table 3. Prevalence of bacterial isolates from suya samples sold within Jos South Local Government Area of Plateau State, Nigeria.

Bacterial species	Number of occurrences (%)
Staphylococcus aureus	26(38.24)
Pseudomonas aeruginosa	4(5.88)
Escherichia coli	7(10.29)
Aeromonas spp.	1(1.47)
Enterobacter spp.	1(1.47)
Klebsiella aerogenes	10(14.71)
Proteus spp.	5(7.35)
Bacillus spp.	14(20.59)
Total	68(100)

(χ^2 = 57.176, df = 7, P<0.001).

Table 4. Susceptibility profile of gram-negative bacteria to antibiotics isolated from suya meat samples sold within Jos South Local Government Area of Plateau State, Nigeria

Bacterial species	No. of Isolated Bacteria	Antibiotics (ug)									
		AM (10)	CN (20/10)	S (10)	PEF (5)	OFX (5)	LEV (5)	CH (15)	AZ (30)	APX (5)	CPX (5)
Proteus spp.	2	2(100)	0(0.00)	2(100)	0(0.00)	1(50)	1(50)	1(50)	1(50)	1(50)	0(0.00)
E. coli	3	1(33.33)	0(0.00)	1(33.33)	1(33.33)	1(33.33)	3(100)	1(33.33)	0(0.00)	1(33.33)	0(0.00)
K. aerogenes	1	0(0.00)	0(0.00)	1(100)	0(0.00)	0(0.00)	0(0.00)	1(100)	0(0.00)	0(0.00)	0(0.00)
P. aeruginosa	1	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	1(100)	0(0.00)	1(100)	0(0.00)	0(0.00)

AM=Amoxicillin, CN=Gentamicin, S=Streptomycin, PEF=Pefloxacin, OFX=Ofloxacin, LEV=Levofloxacin, CH=Chloramphenicol, AZ=Azithromycin, APX= Ampiclox, CPX=Ciprofloxacin.

Table 5. Susceptibility profile of gram-positive bacteria to antibiotics isolated from suya meat samples sold within Jos South Local Government Area of Plateau State, Nigeria

Bacterial species	No. of Isolated Bacteria	Antibiotics (ug)									
		AM (30)	Z (20)	APX (30)	CN (10)	PEF (10)	E (10)	LEV (5)	AZ (15)	CPX (10)	R (25)
Bacillus spp.	4	2(50)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	2(50)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Staphylococcus aureus	2	0(0.00)	0(0.00)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)

AM=Amoxicillin, Z=Zinnacef (Cefuroxime), APX=Ampiclox, CN=Gentamicin, PEF=Pefloxacin, E= Erythromycin, LEV=Levofloxacin, AZ= Azithromycin, CPX=Ciprofloxacin, R=Rifampin.

Table 6. Antibiotic resistance pattern and Multi-Drug Resistance Index (MDRI) of bacteria isolated suya meat in Jos South, Plateau State, Nigeria

Bacterial Isolates	Number of isolates	Number of antibiotic resistant	Resistance pattern	Multi-Drug Resistance Index
Proteus spp.	2	7	AM, S, OFX, LEV, CH, AZ, APX	0.3
Escherichia coli	3	7	AM, S, PEF, OFX, LEV, CH, APX	0.2
Klebsiella aerogenes	1	2	S, CH	0.2
Pseudomonas aeruginosa	1	2	LEV, AZ	0.2
Bacillus spp.	4	2	AM, E	02
Staphylococcus aureus	2	1	PEF	02
Total number of antibiotics used		**10**		

AM=Amoxicillin, S=Streptomycin, PEF=Pefloxacin, OFX=Ofloxacin, LEV=Levofloxacin, CH=Chloramphenicol, AZ=Azithromycin, APX= Ampiclox, E= Erythromycin

Escherichia coli (3) were resistant to 15 antibiotics, *Staphylococcus aureus* (2) were resistant to 14 antibiotics, while *Pseudomonas aeruginosa* (1) was resistant to 5 antibiotics.

DISCUSSION

Viable cell count of bacterial isolates in suya meat samples

The results of this study provide a comprehensive analysis of the microbial contamination and antibiotic resistance profile of bacteria isolated from suya meat, a popular street-vended meat, and its implications for public health. The viable cell counts from the samples revealed significant bacterial contamination, with total bacterial counts (TBC) ranging from 1.1×10^5 to 6.4×10^5 CFU/g. These values indicate a high microbial load, with several samples exceeding 3.0×10^6 CFU/g, suggesting poor hygiene practices during preparation and handling (Okinedo *et al.,* 2024). Although total coliform counts (TCC) were zero in many samples, implying minimal faecal contamination, some samples exhibited detectable levels, further highlighting the risk of microbial contamination and the potential for foodborne illnesses. These findings align with the reports of Bello *et al.* (2018) and Gwinn *et al.* (2019), who also observed pathogenic bacteria in inadequately processed suya. Similarly, Hassan *et al.* (2021) emphasised that the prevalence of bacterial contaminants in suya products in Nigeria poses a significant public health concern. These results are further supported by Akinyele *et al.* (2024), who documented comparable contamination levels in street-vended grilled meats in Kaduna State, attributing high bacterial counts to insufficient vendor hygiene and improper meat handling. Moreover, Adoh and Ngozi (2025) demonstrated that temperature abuse and prolonged exposure of ready-to-eat meats to ambient conditions significantly increase microbial proliferation, corroborating the observations in this study.

Prevalence of bacterial isolates from suya samples

The isolation of various bacterial species from the suya meat samples is concerning. *Staphylococcus aureus* was the most frequently isolated organism, representing 38.24% of total bacterial isolates. This pathogen is well-known for its potential to cause food poisoning through enterotoxin production, making its presence in food products particularly alarming. Other notable isolates included *Klebsiella aerogenes* (14.71%) and *Bacillus* spp. (20.59%), both of which are capable of causing gastrointestinal infections (Jessberger *et al.,* 2021). These findings resonate with reports by Orogu and Oshilim (2017), who highlighted the consistent isolation of *S. aureus*, *E. coli*, and *Bacillus subtilis* from suya meat across various Nigerian regions. A high prevalence of *Staphylococcus* in suya has also been reported by Alcock *et al.* (2020), who noted that, as a normal flora of the skin, *Staphylococcus* is often transmitted through cross-contamination by meat handlers during processing. In support, Adoh and Ngozi (2025) found *S. aureus* as the dominant contaminant in street-vended meats in Benin City, reinforcing the critical role of vendor hygiene in preventing cross-contamination. Furthermore, Aboagye *et al.* (2023) documented similar isolate distributions in grilled meat products sold in open markets, linking high *Bacillus* counts to post-cooking contamination during display in their study in Ghana.

Susceptibility profile of gram-negative bacteria to antibiotics isolated from suya meat samples

The antibiotic susceptibility tests conducted on gram-negative bacterial isolates provide crucial insights into resistance patterns, with significant implications for public health and treatment strategies. The data reveal a concerning prevalence of antibiotic resistance among the Gram-negative bacteria tested. Resistance was observed against commonly used antibiotics such as Amoxicillin (AM), Streptomycin (S), and Chloramphenicol (CH). This trend is particularly alarming given the critical role these antibiotics play in treating bacterial infections.

Proteus species showed mixed susceptibility, being sensitive to Gentamycin (CN), Pefloxacin (PEF), and Ciprofloxacin (CPX) while resistant to several others, including Amoxicillin (AM) and Streptomycin (S). Intermediate sensitivity (I) to Pefloxacin suggests that, although some efficacy remains, cautious use is advised. The *E. coli* isolates demonstrated variable resistance patterns, with some isolates still sensitive to Gentamycin and Azithromycin but resistant to Amoxicillin and other antibiotics. Intermediate resistance to some antibiotics indicates that ongoing monitoring is essential to prevent progression to full resistance. The high resistance levels in *Pseudomonas aeruginosa* are particularly concerning given its role in hospital-acquired infections and severe morbidity (Lee *et al.,* 2020). Similar resistance trends were reported by Munim *et al.* (2024), who found high multidrug resistance among Gram-negative isolates from grilled meats in Bangladesh. Additionally, Akinyele *et al.* (2024) emphasised that overuse of broad-spectrum antibiotics in livestock production contributes significantly to the persistence of resistant strains in meat sold in informal markets.

Susceptibility profile of gram-positive bacteria to antibiotics isolated from suya meat samples

The antibiotic susceptibility tests conducted on Gram-positive bacterial isolates provide equally important insights into resistance profiles and therapeutic challenges. The results reveal a high prevalence of resistance among Gram-positive bacteria, particularly *Bacillus* spp. and *Staphylococcus aureus*. Resistance was observed against multiple commonly used antibiotics, raising concerns about treatment options for infections caused by these organisms. *Bacillus* spp. isolates displayed varying susceptibility patterns. For example, one isolate was sensitive to Gentamycin (CN), Zinnacef (Z), and Azithromycin (AZ), while resistant to Amoxicillin (AM), Erythromycin (E), and several other agents.

The *Staphylococcus aureus* isolates showed significant resistance to Pefloxacin (PEF), though sensitivity to Levofloxacin and Erythromycin suggests that some treatment options remain viable, albeit limited by widespread resistance. The high antibiotic resistance levels in Gram-positive bacteria are particularly concerning in the context of hospital-acquired infections, where *S. aureus* is a predominant pathogen. This observation is consistent with findings by Alabi *et al.* (2021), who reported high multidrug resistance among *S. aureus* isolates from meat vendors in Ibadan. Likewise, Awoyele *et al.* (2023) highlighted similar patterns in *Bacillus* spp. isolated from ready-to-eat foods, attributing resistance to poor hygiene and misuse of antibiotics in meat processing environments.

Antibiotic resistance pattern and Multi-Drug Resistance Index (MDRI) of bacteria isolated suya meat

While both Gram-negative and Gram-positive bacteria showed significant resistance patterns, the specific antibiotics to which they are resistant vary. This underscores the need for tailored treatment protocols based on the specific bacterial species implicated. These findings align with previous studies indicating that antibiotic resistance is an escalating challenge among foodborne pathogens, driven by genetic adaptation, horizontal gene transfer, and the misuse of antibiotics in human and veterinary contexts (Shao *et al.,* 2025). The current data show that multiple antibiotics exhibit high resistance rates; for example, Amoxicillin (AM) had a resistance occurrence of 25.07%. Other antibiotics such as Ampiclox (APX) and Pefloxacin (PEF) recorded resistance rates of 32.25% and 29.46%, respectively, indicating their reduced efficacy. Conversely, antibiotics like Levofloxacin (LEV) and Azithromycin (AZ) exhibited lower resistance rates (20.75% and 24.50%, respectively), suggesting they may remain effective options for treating infections caused by these isolates. These resistance trends closely mirror those reported by Ike and Akortha (2017), Orogu and Oshilim (2017), Jesus *et al.* (2019) and Fleming and Al-Jabri (2025), who independently observed comparable resistance patterns among bacterial isolates from meat products in various Nigerian cities.

Conclusion and Recommendations

This study highlights critical concerns regarding the microbiological safety of Suya meat sold in street markets within Jos South Local Government Area. The high total bacterial counts, ranging from 1.1×10^5 to 6.4×10^5 CFU/g, alongside the presence of pathogenic bacteria such as *Staphylococcus aureus*, *Klebsiella aerogenes*, *Escherichia coli*, and *Proteus* species, underscore poor hygiene practices during preparation and handling. While many samples showed zero total coliform counts, the detection of coliforms in some samples indicates a risk of faecal contamination. Furthermore, the antibiotic resistance profile demonstrated by isolates, especially *E. coli* and *Proteus* species, poses an emerging public health threat due to resistance to commonly used antibiotics, including Amoxicillin, Streptomycin, Chloramphenicol, and Ampiclox.

To address these risks, food vendors must adopt strict hygiene practices throughout the preparation and sales processes. Public health authorities should intensify routine inspections and provide targeted education and training for vendors on safe food handling. Additionally, there is a pressing need for continuous monitoring of antibiotic resistance trends in street-vended foods to inform evidence-based policy and intervention strategies. Future research should explore practical and cost-effective measures to minimise microbial contamination and mitigate the spread of antibiotic-resistant foodborne pathogens.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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