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Isolation and Identification of Microorganisms Found in Roasted Dog Meat Within Wukari Metropolis, North-East Nigeria

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Abstract

This study evaluated the microbiological quality of roasted dog meat sold within Wukari Metropolis, Taraba State, to determine its safety for human consumption. Eight samples of roasted dog meat were collected and analyzed for Total Viable Count (TVC), coliform count, and bacterial identification using standard biochemical methods. The findings revealed varying levels of microbial contamination, with several samples exceeding the acceptable microbial load limits established by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO). Notably, the highest TVC values were observed in samples YM2 (3.00×10^6 cfu/g), YM1 (1.56×10^6 cfu/g), and AS1 (1.20×10^6 cfu/g), indicating significant bacterial presence. Coliform counts confirmed fecal contamination, with *Escherichia coli* identified in multiple samples. Biochemical analysis further revealed the presence of *Salmonella* spp. (20%), *E. coli* (13.33%), *Staphylococcus aureus* (13.33%), *Pseudomonas aeruginosa* (6.67%), *Chromobacterium violaceum* (13.33%), and *Neisseria mucosa* (6.67%). The identification of these pathogenic organisms underscores

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serious public health concerns linked to inadequate hygiene, poor handling practices, and environmental contamination. The study emphasizes the urgent need for stricter food safety regulations, vendor hygiene training, and improved meat handling protocols. Additionally, public health awareness campaigns are recommended to educate both vendors and consumers on the risks associated with consuming improperly handled street-vended meat.

Keywords: Food Safety; Roasted Dog Meat; Microbial Contamination; Public Health; Wukari Metropolis

INTRODUCTION

Meat has been known for its nutritive composition which is why it is being consumed by many people worldwide. The protein profile of meat consists of amino acids which have been described as excellent due to the presence of all essential ones required by the body. A large proportion of the world's population relies on meat as a source of food. Enteric bacteria can cause infections in humans when undercooked meat products are consumed [1]. It has also been proved that protein and vitamins (especially A and B12) in meat could not be substituted by plant sources, this is further justifying the nutritive importance of the former [2].

Dog meat contamination occur by a variety of ways, including bowel rupture during evisceration, indirect contamination with tainted water and also handling and packaging of finished roasted dog meat products. Sources for contamination of the dog meat can be abattoir, storage at the retailer's stall or shop, heavily contaminated utensils and benches used for the handling of meat [2].

Raw dog meat may harbour many important pathogenic microbes i.e. *Salmonella* spp., *Campylobacter jejuni*, *Yersinia enterocolitica*, *E. coli*, *S. aureus* and to some extent, *Listeria monocytogenes*, making the meat a risk for human health, as without the proper handling and control of these pathogens, food borne illnesses may occur [2]. While also several researchers have reported that the meats sample were contaminated with high level of *Klebsiella pneumoniae*, *Enterobacter* sp, *Pseudomonas aeruginosa*, *E. coli*, *Salmonella* sp, *Serratia marcescens* and *Proteus vulgaris*, *Staphylococcus aureus* and *Bacillus* spp. [1]. On the other hand, food-borne pathogens are able to disseminate from contaminated meat to the surfaces and can spread infections in the community.

Food habits of society have substantially changed due to rapid urbanization and hurried way of living, resulting in increased demand for ready to cook and ready to eat meat products. Consumers have become more selective conscious of quality, concerned about value for money, freshness and health aspects of meat food products [3].

There are many organisms, which cause food borne diseases in human beings, among which *salmonella* spp, *listeria monocytogenes*, and *clostridium perfingens* to *Staphylococcus* species are of importance. Staphylococci are found to be normal flora and mucous membrane of warm-blood animals, but they are also isolated from a wide range of foodstuffs such as meat, cheese or milk and from environments source such as soil, dust, air or natural water. The large numbers of these organisms tends to be found in the nasal passages, axillae and perineal areas [4]. Meat is not only highly susceptible to spoilage, but also frequently implicated to the spread of food-borne illness, various biochemical changes and microorganisms are associated with meat, during the process of slaughter, processing and preservation [3].

The consumption of dog meat is a globally popular culinary practice; however, there is a critical gap in our understanding of the microbial composition of this widely consumed food product. The presence of microorganisms in roasted dog meat can significantly impact its safety and quality, posing potential health risks to consumers. Despite the potential implications for public health, there is limited scientific research on the isolation and identification of microorganisms in roasted dog meat. Therefore, this research seeks to bridge these gaps by systematically isolating and identifying microorganisms in roasted dog meat, assessing their potential pathogenicity, and providing evidence-based recommendations for improving food safety and quality in the preparation and consumption of this Wukari popular meat product. There also the study aimed to ascertain the kind of microorganism found in roasted dog meat marketed within Wukari Metropolis.

MATERILS AND METHODS

Study Area

The study area was in and around Wukari metropolis, which is lies between latitude 7° 53' 42" North and longitude 9° 47' 59" East [5]. The Wukari's vegetation is similar to that of the Savannah zone, with grass predominating and a few stray tree species. The

climate has two different seasons: a wet season from April to October and a dry season from November to March during which there is no rain at all. The predominant occupations of the people are agriculture, commerce and civil service. The major spoken languages in Wukari include, Jukun, Hausa, Fulani and Tiv. [6].

Sample Collection

The samples used for this research work were collected from six (6) different selling points in some of the major roads in Wukari metropolis. These selling points are located on the busiest roads where many customers patronize them. These samples points were Wukari Rice Mill (WRM), Police Station Area (PSA) Wukari Old Market (WOM), Wukari Yam Market (WYM), Teaching Hospital Site (THS) and East Primary School (EPS), all in Wukari metropolis, Taraba State, Nigeria. At each selling point, two (2) types of pork are sold; freshly prepared and exposed roasted dog (FPERD) and dried and exposed roasted dog (DERD). The FPERD is the meat produced and kept within a day while the DERP are that leftover of the freshly prepared that are subjected for heat treatment until they become dry. The two samples were kept opened and exposed without any covering materials even in the busiest environments for consumers to see and buy. The samples were collected aseptically, wrapped in a sterile foil paper and put in sterile containers to prevent contamination, and immediately transported to the Federal University Wukari Microbiology laboratory for microbial analysis.

Pretreatment and Processing of Samples

The roasted dog meat samples were collected processed aseptically in the Laboratory. Serial dilution method for pour plate technique was adopted. Each roasted dog meat sample was ground using a blender or mortar and pestle. One (1) grams of each sample was weighed out, and homogenized into 9ml of sterile distilled deionized water and vigorously shaken to dislodge adhered bacteria, after which a ten-fold serial dilution was performed.

Determination of Bacterial Count

Tenfold dilution of the homogenates was made using sterile pipettes and one (1) ml from the aliquot was transferred serially to other test tubes containing 9ml of distilled water up to 10^{-5}. One (1) ml of the diluents of 10^{-4} and 10^{-5} was aseptically dispensed into sterile Petri dishes containing 20 ml of the already prepared molten agar. The media was used were Nutrient Agar, MacConkey Agar. A culture of each sample was done in duplicates. All plates were incubated at 37ºC for 24 hours in an incubator. The plates were observed and

the colonies were counted using colony counter to obtain the total viable counts (TVC), total coliform count (TCC) respectively. The average numbers of colonies were taken since the culture was in duplicate. The number of colonies counted was multiplied by the reciprocal of the dilution factor to determine the microbial load in colony forming unit per gram (CFU/g).

Isolation of the Organisms

The samples were innoculated aseptically with a wire loop on the prepared MacConkey and Nutrient agar plates and incubated at 37°C between 18-24 hours, after which the plates were observed for growth of organisms.

Identification of the Organisms

The colonies of sample culturing after 24 hours were subcultured to obtain pure colonies. Pure isolates of bacterial colonies were Gram differentiated and biochemically characterized and identified using the standard taxonomic schemes of Cheesbrough [7]. The isolates were characterized and identified based on their colonial characteristics and biochemical reactions as follows:

Gram Reaction

A wire loop was sterilized in Bunsen burner and allowed to cool then, a loopful of growth was collected from the agar plate and applied on a clean grease-free slide, after which a drop of normal saline was added, emulsified and heat fix by passing over flame three times. The smear was flooded with crystal violet for 60 seconds and wash off with clean water, it was also covered with iodine for 60 seconds and still wash off, after which it was decolorized with acetone for 5 seconds and was rinsed immediately. The slide was covered with Safranin for 60 seconds, then washed off with clean water and kept in a rack to air dry [7].

The stain smear was then examined microscopically under oil immersion at X100 objective lens. Gram-positive bacteria were appeared dark purple while Gram-negative bacteria were appeared red or pink [7].

Biochemical Tests

- *Catalase Test*

Three (3) mL of hydrogen peroxide solution was pour into a test tube. With the aid of sterile glass rod several colonies of the test organism was carefully remove and immerse into 3 mL solution of hydrogen peroxide. Immediate bubbling within few seconds was recorded to be positive test [8].

- *Coagulase Test*

This test is used to identify organisms that produce the enzyme coagulase that clumps the blood plasma by converting fibrinogen to fibrin. Example of organisms that produce coagulase include; *Staphylococcus aureus* [7].

- *Oxidase Test*

A clean filter paper was moistened with few drops of kovacs' oxidase reagent and a small amount of bacterial growth was smeared onto the moist filter paper with a platinum loop. In a positive test a purple coloration develops immediately or within 10 seconds [7].

- *Indole Test*

The colony of the 24 hours culture of the test organism (after been checked by Gram staining) was inoculated in a bijou bottle containing 3 mL of sterile tryptone water. It was incubated at 35-37°C for up to 48 hours, then it was tested for production of indole by dispensing 0.5 mL of Kovac's reagent. After gently shaking it, red colour in the surface layer within ten (10) minutes indicated positive result [7].

- *Citrate Test*

A slant of Simmons Citrate Agar was prepared in bijou bottles, one of the sets was used to identify organism. Then with the aid of sterile wire loop, normal saline suspension of the test organisms was streaked on the slants and was incubated at 37°C for 48 hours. A bright blue colour on the agar slants indicated positive result [7].

- *Motility Test*

A drop of normal saline was placed on a sterile slide and colony of test organism was suspended and emulsified and covered with a cover slip. The slide was examined microscopically using X10 and X40 objective lens. Movement in different directions gave a positive test.

Statistical Analysis

Consider adding basic statistical analysis (e.g., chi-square test or confidence intervals) to validate differences in prevalence rates.

RESULTS

The results presents the microbiological analysis of roasted dog meat samples collected from different locations within Wukari Metropolis, Taraba State. The results include the total viable count, coliform count, and the identification of bacterial isolates from the samples. These findings provide insight into the microbial load and potential health risks associated with the consumption of roasted dog meat.

The total viable count (TVC) results (Table 1) show significant variations in microbial load among the samples. Some samples recorded high bacterial counts, such as YM2 (3.00×10^6 cfu/g) and YM1 (1.56×10^6 cfu/g), while others had bacterial loads below detectable limits (TFTC). The presence of Too Numerous to Count (TNTC) values in DSK1 suggests heavy microbial contamination in certain samples.

Similarly, the coliform count (Table 2) reveals a notable presence of coliform bacteria in some samples, indicating possible fecal contamination. YM1 exhibited the highest coliform load (1.28×10^6 cfu/mg), followed by AS2 (9.6×10^5 cfu/mg), whereas other samples had low or undetectable coliform counts.

The biochemical identification of bacterial isolates (Table 3) identified a variety of microorganisms, including genera of *Salmonella*, *Escherichia*, *Staphylococcus*, *Pseudomonas*, *Chromobacterium*, *Neisseria* and *Moraxella*. The frequency analysis (Table 4) indicates that *Salmonella spp.* was the most prevalent (20%), followed by *Staphylococcus aureus* and *Escherichia coli* (13.33% each). The presence of potential pathogens suggests possible health risks associated with the consumption of roasted dog meat, particularly if proper hygiene and handling practices are not observed.

Table 1: Enumeration of Total Viable Count of the Roasted Dog Meat

Sample	Dilution Factor	Microbial Count	CFU/g
AS2	10^{-4}	44	4.4×10^5
PS2	10^{-4}	TFTC	-
DSK2	10^{-4}	TFTC	-
YM1	10^{-4}	156	1.56×10^6
PS1	10^{-4}	TFTC	-
YM2	10^{-4}	300	3.00×10^6
AS1	10^{-4}	120	1.20×10^6
DSK1	10^{-4}	TNTC	-

Key: CFU/g = Colony Forming Unit/gram, TFTC = Too Few To Count, TFTC = Too Numerous To Count

Table 2: Enumeration of Coliform Count of the Roasted Dog Meat

Sample	Dilution Factor	Microbial Count	CFU/g
AS2	10^{-4}	96	9.6×10^5
PS2	10^{-4}	TFTC	-
DSK2	10^{-4}	TFTC	-
YM1	10^{-4}	128	1.28×10^6
PS1	10^{-4}	30	3.0×10^5
YM2	10^{-4}	41	4.1×10^5
AS1	10^{-4}	TFTC	-
DSK1	10^{-4}	TFTC	-

Key: CFU/g = Colony Forming Unit/gram, TFTC = Too Few To Count, TFTC = Too Numerous To Count

Table 3: Biochemical identification of Roasted Dog Meat

Sample	Morphology	Gram test	Catalase	Oxidase	Coagulase	M. red	Citrate	Indole	Probable Microorganism
AS2A	Punctiform circular, smooth, flat, Colourless, shiny, balack	- cocci scatter	-	-	-	+	-	-	*Salmonella spp.*
AS2B	Small circular, smooth, rise, entire, milky, dry.	- cocci scatter	+	+	+	+	+	-	*Pseudomonas aeruginosa*
AS2C	Small circular, smooth, rise, entire, milky, shiny.	+ diplococci in scatter	+	+	+	+	+	-	*Staphylococcus aureus*
PS2A	Small circular, smooth, rise, entire, milky, shiny.	- cocci scatter	+	+	+	-	+	-	*Moraxella catarrhalis*
DSK2	Small circular, smooth, rise, entire, milky, shiny.	+ diplococci in scatter	+	+	+	+	+	-	*Staphylococcus aureus*
YM1A	Punctiform,	rod in	+	-	+	-	+	-	*Chromobacteriu*

Sample	Morphology	Gram test	Catalase	Oxidase	Coagulase	M. red	Citrate	Indole	Probable Microorganism
	smooth, flat, entire, yellow, shiny.	scatter							*m violaceum*
YM1B	Small round, smooth, pale pink, entire, milky, opaque	- cocci scatter	+	-	-	+	-	+	*Escherichia coli*
PS1A	Punctiform, smooth, flat, entire, yellow, shiny.	rod in scatter	+	-	+	-	+	-	*Chromobacteriu m violaceum*
PS1B	Small irregular, umbonate, endulate, mucoid rough, creamy	- cocci cluster	-	+	-	+	+	-	*Neisseria mucosa.*
AS1A	Medium filamentous , rise, filiform, creamy, smooth, shiny	- cocci scatter	-	-	-	-	+	-	*Neisseria elongate*

Table 4: Bacterial Isolate from Roasted Dog Meat Samples with Frequency and Percentage of Frequency of Occurrence.

Isolate	Frequency	Percentage Frequency (%)
Salmonella spp.	03	20.00
Pseudomonas aeruginosa	01	6.67
Staphylococcus aureus	02	13.33
Moraxella catarrhalis	01	6.67
Staphylococcus aureus	02	13.33
Chromobacterium violaceum	02	13.33
Neisseria mucosa.	01	6.67
Neisseria elongate	01	6.67
Escherichia coli	02	13.33
Total	**15**	**100**

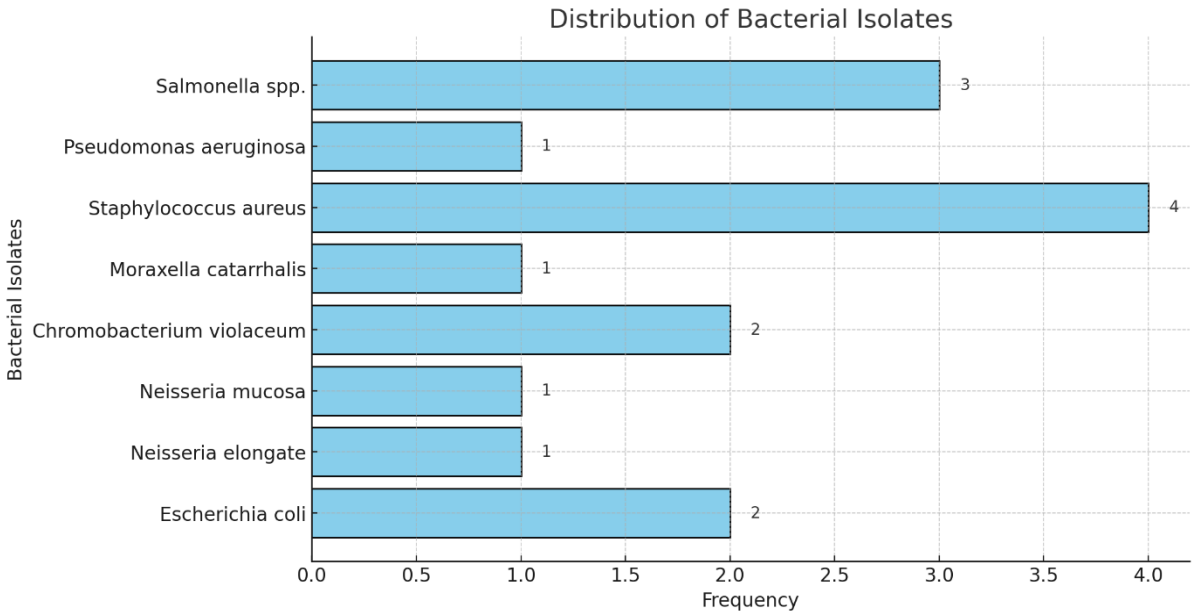


Figure 1: Samples with Frequency and Percentage of Frequency of Occurrence

DISCUSSION

The study on the microbiological quality of roasted dog meat within Wukari Metropolis, Taraba State, provides significant insights into the microbial contamination associated with this type of street-vended meat. The results obtained from the total viable count (TVC), coliform count, and biochemical identification of bacterial isolates indicate varying degrees of contamination, suggesting both environmental and handling factors contributing to microbial presence[9, 10].

The total viable count (TVC) results show that some of the roasted dog meat samples had microbial loads exceeding the acceptable limits set by regulatory bodies such as the WHO and FAO. For instance, sample YM2 recorded the highest microbial count (3.00×10^6 cfu/g), followed by YM1 (1.56×10^6 cfu/g) and AS1 (1.20×10^6 cfu/g). The presence of Too Numerous to Count (TNTC) and Too Few to Count (TFTC) values in certain samples suggests significant variations in contamination levels, which may be attributed to differences in handling, processing, and exposure to environmental contaminants[11].

Similarly, the coliform count analysis further confirms the presence of fecal contamination in some of the samples, with YM1 having the highest coliform load (1.28×10^6 cfu/g). The presence of coliform bacteria is a strong indication of poor hygienic

practices during slaughtering, processing, and post-roasting handling. The isolation of *Escherichia coli*, a well-documented fecal indicator organism, further corroborates this assertion [12].

The biochemical identification results revealed the presence of a range of bacterial species, including *Salmonella spp.*, *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Chromobacterium violaceum*, *Neisseria mucosa*, *Neisseria elongata*, and *Moraxella catarrhalis*. The presence of these bacteria is of public health concern, as some of them are well-known pathogens associated with foodborne illnesses [13]. Notably, *Salmonella spp.* was the most frequently occurring organism (20%), followed by *Staphylococcus aureus* and *Escherichia coli* (each at 13.33%). The detection of *Chromobacterium violaceum* and *Neisseria spp.* is an unusual finding in meat microbiology studies, suggesting possible environmental or human-related contamination sources [3].

The presence of high microbial loads in some roasted dog meat samples suggests that hygiene and safety measures in the preparation and selling of this meat in Wukari Metropolis may not be adequately maintained [14]. The detection of *Salmonella spp.* is particularly concerning, as this bacterium is a well-documented cause of foodborne illnesses, leading to symptoms such as diarrhea, fever, and abdominal cramps. The presence of *Escherichia coli* further supports the likelihood of fecal contamination, which could have resulted from the use of contaminated water, unsanitary slaughtering processes, or improper handling practices [11].

The isolation of *Staphylococcus aureus*, a bacterium capable of producing heat-stable enterotoxins, suggests that even though the meat was roasted, improper post-cooking handling could have facilitated recontamination. The detection of *Pseudomonas aeruginosa* and *Chromobacterium violaceum* indicates possible environmental contamination, as these bacteria are commonly found in soil and water [15]. Their presence in the meat samples suggests that cross-contamination may have occurred from handling surfaces, air exposure, or utensils used in the roasting process.

From a food safety perspective, the findings highlight the need for stricter hygiene regulations and monitoring of roasted dog meat vendors in the Wukari area. The high coliform counts suggest that basic sanitary measures, such as proper hand washing, clean processing environments, and adequate cooking temperatures, are not being adequately followed. These results align with previous studies that have found high microbial

contamination in street-vended meat due to poor hygiene practices and exposure to environmental contaminants [16].

Several studies on the microbial quality of street-vended meat have reported findings similar to those observed in this study. A study conducted on street-vended roasted meat in Nigeria found a high prevalence of *Escherichia coli*, *Salmonella spp.*, and *Staphylococcus aureus*, supporting the assertion that microbial contamination in ready-to-eat meat is a common public health concern [17]. However, in contrast to that study, the presence of *Neisseria mucosa* and *Chromobacterium violaceum* in the current study is a novel finding that has not been widely reported in meat microbiology research.

Similarly, a study on grilled chicken in Kenya found that *E. coli*, *Klebsiella spp.*, and *Pseudomonas spp.* were predominant contaminants, but *Neisseria* species were absent. This indicates that while fecal and environmental contamination are common factors across different types of street-vended meat, specific bacterial species may vary based on geographical location, hygiene practices, and the meat processing environment [18].

The study reported high microbial loads in some samples (e.g., YM2: 3.00×10^6 cfu/g, YM1: 1.56×10^6 cfu/g). Similarly, a study conducted in Port Harcourt, Nigeria, found that grilled pork samples exhibited a maximum TVC of $\log_{10}$ 7.40 CFU/g, and grilled beef had a TVC of $\log_{10}$ 6.06 CFU/g, both exceeding acceptable limits [19]. The findings indicated significant coliform contamination in certain samples, with YM1 showing the highest count (1.28×10^6 cfu/mg). In contrast, research assessing roasted and fried meat in Gumel town reported no growth of coliform groups in both sample types, suggesting better hygienic practices in that context by Salisu *et al.* [20].

The study identified various bacterial species, including *Salmonella spp.*, *Escherichia coli*, and *Staphylococcus aureus*. Similarly, research by Amaeze *et al.* [21] on suya (a traditional roasted meat) in Abuja found *Staphylococcus aureus* (54%), *Escherichia coli* (4%), and *Salmonella* species (26%) among the isolates, indicating potential health risks associated with these ready-to-eat meats. The presence of pathogenic bacteria in the research samples underscores potential health risks. This concern is echoed in studies from Benin City, Nigeria, by Osemwowa *et al.* [22] where raw beef samples were frequently contaminated with *Salmonella*, Shiga toxin-producing *Escherichia coli* (STEC), and cephalosporin-resistant *E. coli* (CREC), highlighting significant public health implications.

CONCLUSION

The microbiological analysis of roasted dog meat sold in Wukari Metropolis, Taraba State, reveals significant microbial contamination, posing potential public health risks. The presence of *Salmonella spp.*, *Escherichia coli*, and *Staphylococcus aureus* suggests that poor hygiene practices during slaughtering, processing, and post-roasting handling contribute to contamination. The high coliform counts indicate possible fecal contamination, likely due to unsanitary water sources, improper meat handling, and cross-contamination. Additionally, the detection of unusual bacteria such as *Chromobacterium violaceum* and *Neisseria spp.* suggests environmental and human-related contamination. These findings emphasize the urgent need for strict hygiene protocols, proper food handling practices, and regulatory oversight to ensure the safety of roasted dog meat. Without improved sanitation measures, consumers remain at risk of foodborne illnesses linked to contaminated meat products.

Recommendations

Based on the research work, the recommendations are as:

1. Government agencies (e.g., NAFDAC, SON, and Public Health Authorities) should enforce strict hygiene standards for vendors selling roasted dog meat. Regular inspection and monitoring of meat vendors should be implemented.

2. Vendors should be trained on proper meat handling, personal hygiene, and sanitary processing techniques. Use of clean water for meat preparation, washing utensils, and hand washing should be mandated.

3. Public health campaigns should educate consumers on the risks associated with contaminated meat and encourage safe meat consumption habits. Consumers should be advised to purchase properly cooked meat from hygienic sources.

4. Vendors should adopt safe storage methods to prevent cross-contamination. Cooked meat should be protected from dust, flies, and other environmental contaminants.

5. Future studies should focus on antibiotic resistance patterns of isolated bacteria to assess potential public health risks. Investigations into alternative preservation methods (e.g., refrigeration or improved packaging) should be explored to enhance meat safety and quality.

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