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Isolation and Identification of Bacteria Associated with Hawked Suya Meat: A Case Study of Bokkos Local Government Area, Plateau State, Nigeria

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ABSTRACT

Meat is a rich source of protein, vitamins, and mineral salts. However, it is perishable due to its ability to support the growth of various microorganisms. Therefore, this study was conducted to isolate and identify bacteria associated with 'Suya' meat in Bokkos Local Government Area of Plateau State. A total of 60 suya samples (15 from each location) were purchased from four different locations (Maikatako Market, Bokkos Central Market, Daho Market, Horop Market) within Bokkos local government for bacteriological analysis. One gram (1g) of each sample (suya meat) was inoculated into buffered peptone water and incubated at 37°C for 24 hours. Suya meat samples were plated on MacConkey and blood agar and incubated at 37°C for 24 hours. Single colonies were observed, and each colony was Gram-stained and examined microscopically. Biochemical tests were performed to confirm the presence of bacteria. A total of 12 bacteria were isolated. Bacteria isolated were Bacillus cereus, Micrococcus sp., Staphylococcus aureus, Proteus vulgaris, E. coli, Streptococcus faecalis, Bacillus lentus, Klebsiella aerogenes, Proteus mirabilis, Citrobacter freundii, Aeromonas sp and Staphylococcus epidermidis. Escherichia coli had the highest proportion of isolated bacteria at 23.3%, followed by Bacillus cereus (18.3%). Five bacteria (Micrococcus sp, Bacillus lentus, Citrobacter freundii, Streptococcus faecalis, and Staphylococcus epidermidis) had the lowest prevalence of 1.7% each. All isolated bacteria are pathogens that cause various diseases. This result suggests the presence of pathogens associated with Suya meat sold in the Bokkos local government of Plateau State.

Keywords: Bacteria, Meat, Suya, Bokkos

INTRODUCTION

Meat is a rich source of protein, vitamins, and mineral salts [1]. However, it can support the growth of various microorganisms that can cause spoilage, economic loss, prishable and a range of human infections [2,3]. Traditionally cooked meat products are consumed all over the world, including the Nigerian meat dish 'suya'.

Suya is grilled lean meat of boneless mutton, beef, goat, or chicken, usually coated with spices and oil and roasted over an open flame [4]. It is a street food that is the source of cheap, convenient, and nutritious menus for cities and rural areas. It is an important source of income for many people and creates opportunities

for self-employment. Native to northern Nigeria, suya is largely obtained through cattle farming which is an important occupation and source of income for the people [5]. However, research shows that its preparation, especially when sold on the street, is not done under strict hygiene conditions [4-7]. Meat is so nutritious that microbes can thrive in it. Inyang et al. [8] suggested that possible sources of contamination were slaughter sick animals, washing meat in contaminated water, improper meat handling by butchers, and mechanically mediated vectors such as flies, processing meat products near sewers or landfills, inorganically prepared spices, poor transportation, and use of contaminated tools such as knives and other utensils. Gram-negative enteric bacteria, such as Salmonella spp. and Escherichia coli, and Gram-positive lactococci associated with humans, animals, and the environment, are readily introduced into sterile animal tissues during the slaughter process [3-9]. Meat from healthy, freshly slaughtered animals is said to have no or very low microbial counts, but laboratory studies show that it can be contaminated to dangerous levels at the time of consumption [4]. The fact that sporadic cases of gastroenteritis and symptoms of food poisoning occur after consumption of Suya indicate that Suya products do indeed pose a food safety risk [8]. In Nigeria the product is highly consumed, therefore the need for microbial analysis of this meat product to avoid consumption infection and evaluate the microbial pollution level of the samples. Thus, this study was conducted to isolate and identify the bacterial pollution level of suya meat in Bokkos local government area of Plateau State.

MATERIALS AND METHODS

Study Area

Suya's samples were collected from four different vendors at four different locations (Bokkos Central Market, Maikatako Market, Daho Market and Horop Market) in Bokkos Local Government Area, Plateau State.

Sample Collection

In this study, 60 pieces of suya meat (15 pieces from each location) were collected from each location (Bokkos Central Market, Maikatako Market, Daho Market and Horop Market) within Bokkos Local Government area of Plateau State, Nigeria. Upon collection, samples were wrapped in sterile aluminum foil paper to prevent contamination and immediately transported to the National Veterinary Research Institute (NVRI) Vom Microbiology Laboratory for analysis.

Determination of the Total Number of Viable Cells

One gram of each sample of Suya was ground in a sterile laboratory mortar with a pestle. The ground samples were aseptically weighed and transferred into a test tube containing 9ml of sterile distilled water. The mixture was well shaken, followed by a 5-fold dilution in different test tubes. 1 ml each of dilution factors 103 and 104 were pipetted and plated onto blood agar (BA) or MacConkey agar (MCA) using the spread plate method. It was then incubated at 37°C for 24 hours. The total number of viable bacteria on each agar plate was obtained by counting the visible colonies to determine the total number of viable bacteria and the total number of coliform bacteria. Individual colonies were picked after morphological observation, and purified by re- streaking on nutrient agar plates, and stored on nutrient agar slants at 4 °C for further biochemical characterization and identification [6-10].

Characterization and Identification of Bacteria

The isolated test organisms were subjected to various biochemical tests such as gram staining, catalase test, motility test, indole test and triple sugar iron agar test for biochemical characterization and identification [6-10].

RESULTS

From this study, E. coli (23.3%) was the most prevalent bacterial isolated, followed by Bacillus cereus (18.3%) while Micrococcus spp., Streptococcus faecalis, Bacillus lentus, Citrobacter freundii and Staphylococcus epidermidis (1.7%) were the least encountered organisms (Table 1). The morphological and cultural characteristics of bacteria associated with hawked suya meat collected from the various study locations in Bokkos LGA of Plateau State are shown in (tables 2-5). Different morphologies were observed ranging from small, pink, pale, white, and dry colonies. Some were cocci, long rods, cluster shaped colonies with opaque, round creamy, or yellowish colours

Table 1: Checklist of Bacterial Isolated from Hawked Suya Meat from Different Locations in Bokkos LGA, Plateau State, Nigeria.

ORGANISMS	Maikatako	Bokkos Central Market	Daho Market	Horop Market	Total (%)
Bacillus cereus	4	3	2	2	11(18.3)
Micrococcus sp	1	0	0	0	1(1.7)
Staphylococcus aureus	3	1	0	1	5(8.3)
Proteus vulgaris	2	3	2	2	9(15.0)
E. coli	4	2	6	2	14(23.3)
Streptococcus faecalis	0	0	0	1	1(1.7)
Bacillus lentus	0	0	0	1	1(1.7)
Klebsiella aerogenes	0	4	0	2	6(10.0)
Proteus mirabilis	0	2	0	0	2(3.3)
Citrobacter freundii	0	0	1	0	1(1.7)
Aeromonas sp	1	0	3	4	8(13.3)
Staphylococcus epidermidis	0	0	1	0	1(1.7)
TOTAL	15	15	15	15	60

Table 2: The Morphological and Cultural Characteristics of Bacteria Associated with Hawked Suya Meat Collected from Maikatako Market of Bokkos LGA Plateau State.

SAMPLE ID	MORPHOLOGY ON MCA	MORPHOLOGY ON BA	GRAM REACTION	SHAPE
M1		β-haemolysis ground-glass colonies	+	Long rods in cluster
M2			+	Cocci in pair
M3	small pink colonies	Non haemolysis circular grey to white colonies with moist, glistening, colonies	+	Cocci in cluster
M4	with pale colonies swarming characteristics with foul smell	Swarming behavior	-	Rod in pairs
M5		β-haemolysis ground-glass colonies	+	Long rods
M6	flat, dry, pink, non-mucoid colonies.		-	Short Rods
M7	with pale colonies swarming characteristics with foul smell	Swarming behavior	+	Rod in pairs
M8	small pink colonies	β-haemolysis ground-glass colonies	+	Cocci in cluster
M9	flat, dry, pink, non-mucoid colonies.			Short rods
M10		β-haemolysis ground-glass colonies	+	Long rods
M11		β-haemolysis, circular grayish color	-	Rod
M12	flat, dry, pink, non-mucoid colonies		+	Short rod in single
M13	small pink colonies	β-haemolysis large opaque, round creamy, white-yellowish colonies	-	Cocci
M14		β-haemolysis ground-glass colonies	+	Long rod
M15	flat, dry, pink, non-mucoid colonies		-	Short rods

Note: Key: M = Maikatako Marke

1,2,3.=Sample identification numbers

Table 3: Morphological and Cultural Characteristics of Bacteria Associated with Hawked Suya Meat Collected from Bokkos Central Market.

SAMPLE ID	MORPHOLOGY ON MCA	MORPHOLOGY ON BA	GRAM REACTION	SHAPE
BK1		β-haemolysis ground-glass colonies	+	Short rods in single
BK2	pale colonies with swarming characterize foul smell	Swarming behavior	+	Rods in pairs and clusters
BK3	flat, dry, pink, non-mucoid colonies		-	Single rod in pairs
BK4	pale colonies with swarming characterize foul smell	Swarming behavior	-	Rod in pairs and singles
BK5	large mucoid with pink-red pigment	non haemolytic mucus colonies	-	Rods
BK6		β-haemolysis ground-glass colonies	+	Short rod in singles
BK7	pale colonies with swarming characterize foul smell	Swarming behavior	+	Rods in pairs and singles
BK8	mall pink colonies	β-haemolysis large opaque, round creamy, white-yellowish colonies	+	Cocci in clusters
BK9	flat, dry, pink, non-mucoid colonies		-	Rod in pairs
BK10	large mucoid with pink-red pigment	non haemolytic mucus colonies	-	Rod
BK11	large mucoid with pink-red pigment	non haemolytic mucus colonies	-	Rod
BK12	large mucoid with pink-red pigment	non haaemolytic mucus colonies	-	Rod
BK13	pale colonies with swarming characterize foul smell	Swarming behavior	+	Rods in pairs and clusters
BK14		β-haemolysis ground-glass colonies	+	Short rods in singles
BK15	pale colonies with swarming characterize foul smell	Swarming behavior	-	Rods in pairs and singles

Note: Key: BK = Bokkos Central Market

1, 2, 3. = Sample identification numbers.

Table 4: Morphological and Cultural Characteristics of Bacteria Isolated from Hawked Suya Meat Sold in Daho Market.

SAMPLE ID	MORPHOLOGY ON MCA	MORPHOLOGY ON BA	GRAM REACTION	SHAPE
D1	flat, dry, pink, non-mucoid colonies		-	Short rods in pairs
D3	flat, dry, pink, non-mucoid colonies		-	Short rods in pairs
D4		β-haemolysis, circular grayish color	-	Rods
D5		β-haemolysis ground-glass colonies	+	Short rods in singles
D6	small, circular, convex, dark pink colonies		+	Long rods in singles
D7		β-haemolysis ground-glass colonies	-	Rods
D8	pale colonies with swarming characterize foul smell	Swarming bahaviour	+	Rods in pairs and clusters
D9	small pink colonies	Non-haemolysis circular grey to white colonies with moist, glistening, colonies	-	Rods
D10		β-haemolysis ground-glass colonies	+	Short rods in singles
D11	pale colonies with swarming characterize foul smell	Swarming bahaviour	+	Rods in pairs and clusters
D12	flat, dry, pink, non-mucoid colonies		-	Rods in pairs
D13	flat, dry, pink, non-mucoid colonies		-	Rods in pairs
D14		β-haemolysis ground-glass colonies	-	Rods
D15	flat, dry, pink, non-mucoid colonies		-	Rods in pairs

Note: Key: D = Daho Market

1, 2, 3. = Sample identification number

Table 5: Morphological and Cultural Characterization of Bacteria Associated with Hawked Suya Meat Collected from Horop Market of Bokkos Local Government Area.

SAMPLE ID	MORPHOLOGY ON MCA	MORPHOLOGY ON BA	GRAM REACTION	SHAPE
HP1		β-haemolysis, circular grayish color	-	Rods
HP2		β-haemolysis, circular grayish color	-	Rods
HP3	flat, dry, pink, non-mucoid colonies		-	Short rods in pairs
HP4		β-haemolysis, circular grayish color	-	Rods
HP5		β-haemolysis,white-gryish colored colonies	+	Cocci in short rods and pairs
HP6	pale colonies with swarming characterize foul smell	Swarming bahaviour	+	Rods in pairs and clusters
HP7	small pink colonies	β-haemolysis large opaque, round creamy, white-yellowish colonies	+	Cocci in cluster
HP8		β-haemolysis ground-glass colonies	+	Short rod in single
HP9		β-haemolysis ground-glass colonies	+	Long rods in pairs
HP10	pale colonies with swarming characterize foul smell	Swarming bahaviour	+	Rods in pairs and clusters
HP11	flat, dry, pink, non-mucoid colonies		-	Single rods in pairs
HP12	large mucoid with pink-red pigment	non haemolytic mucus colonies	-	Rods
HP13		β-haemolysis ground-glass colonies	-	Rods
HP14	large mucoid with pink-red pigment	non haemolytic mucus colonies	-	Rods
HP15		β-haemolysis ground-glass colonies	+	Short rods in singles

Note: Key:H = Horop Market

1, 2, 3. = Sample identification number

Table 6: Biochemical Characteristics of isolated Bacteria in Hawked Suya Meat.

ORGANISMS	BIOCHEMICAL REACTIONS																				
	SW	MO	CI	GL	UR	AD	DU	I	LA	MAL	MA	RA	SA	SO	SU	TR	XY	IN	CA	CO	OX
Bacillus cereus			-	+	-				-		-				+		-	-			
Micrococcus sp		-	+	-	-				-						-		-	-	+	-	-
Staphylococcus aureus			-	+	-			-	+	-	+				-				+	+	-
Proteus vulgaris	+	+	-	+	+	-	-	-	-	+	-	-		+	+	+	+	+			
E. coli		+	-	+	-	-			+	+	+					+		+			-
Streptococcus faecalis		+	-	+	-				-		-				-				-		
Bacillus lentus		+	-		-														+		-
Klebsiella aerogenes		-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-			-
Proteus mirabilis	+	+	+	+	+				-		-				+				+	-	-
Citrobacter freundii		+	+	+	+				+		+				+			-	+	-	-
Aeromonas sp		+	+	+	-		-				+			-	+	+	-	+	+	-	+
Staphylococcus epidermis		+	-	+	+			-	+		+			-		+	-		+		+

Note: Key: + = indicates metabolism

- = indicates no metabolism

SW=swarms, MO=motility, CI=citrate, GL=glucose, UR=urease, AD=adonitol, DU=dulcitol, I=inositol, LA=lactose, MAL=maltose, MA=mannitol, RA=raffinose, SA= salicin, SO=sorbitol, SU= sucrose, TR=trehalose, XY= Xylose, IN=indole, CA=catalase, CO=coagulase, OX=oxidase.

DISCUSSION

The microorganisms isolated in this study are consistent with those isolated in Awka [11], Bauchi [12], Katsina [3] and in Ado-Ekiti [7]. This may be due to poor hygiene conditions when the meat products were manufactured, as discovered during sample collection when samples were sold and stored in places. This condition in which food products are sold and stored in open places encourages contamination and disease infection [13,14]. Escherichia coli was the most isolated microorganism in this study. This may be due to the use of non-portable water when washing raw meat and possible fecal contamination. This result agrees with that of Moshood et al. [12] and Adesoji et al. [6] who isolated more E. coli in their studies carried out in Bauchi and Katsina, respectively. However, the result does not conform with isolated bacteria in similar meat products from Ondo [5] where there was low prevalence of E. coli in the study area. Also, in a similar study conducted by Oluwatobi et al. [7] in Ado-Ekiti, there was a high prevalence of isolated Staphylococcus spp, as opposed to this study. This could be because of differences in handling and processing of the meat product from the different locations. E. coli can cause serious complications such as hemolytic uremic syndrome and gastrointestinal problems. This syndrome damages the lining of the tiny blood vessels in the kidneys and can lead to kidney failure. Older people, children under the age of 5, and people with weakened immune systems are at higher risk of developing this complication. Although the presence of some members of the Enterobacteriaceae family may be due to contamination of the meat from prolonged exposure to air, the microorganisms isolated in this study are usually suspected to be associated with meat contamination and spoilage. It is a microorganism that is known to cause cancer [15]. The study revealed a 1.7% occurrence of Staphylococcus epidermidis, a normal bacteria flora on human skin [16] on the suya samples. This may be due to cross-contamination of the Suya samples by the seller's hands during handling, especially after long-term storage.

CONCLUSION

Bacteria isolated and identified from Suya meat products are of public health concern. Therefore, their presence in such meat products continues to be considered a major cause of gastrointestinal disorders, food poisoning and food borne diseases. Given that suya meat is an excellent source of the protein needed to build the human body and repair worn-out tissues, appropriate measures should be taken to prevent microbial contamination and

spoilage. Therefore, it is very important to improve the microbial quality of suya and meat products.

RECOMMENDATION

A quality control department should be established in the meat processing industry in Nigeria and Hazard Analysis and Critical Control Points (HACCP) concepts should be applied to the processing of meat and meat products. This greatly helps reduce contamination and spoilage of meat and meat products.

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