



Bacteriology of Suya Meat Sold in Bonny Local Government Area, Rivers State

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Authors' contributions

This work was carried out in collaboration between all authors. Author KFE designed the study, performed the experiment and statistical analysis, and wrote the protocol. Author MTP wrote the first draft of the manuscript and managed the literature searches. Author WGN managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Background: Suya Meat is made from roasted or smoked beef using the boneless parts of the meat. Suya meat microbial contamination can occur by air, human handlers, equipment, water, papers and utensils.

Aim: This study aimed at determining the level of bacterial contamination of roasted Suya meat sold in Bonny Local Government Area.

Materials and Methods: The sample locations were Tennis Hut, Golf Club, Ama-Hausa, Hospital Road (Junction), Finima market junction and Akiama in Bonny. Five different roasted meat samples were collected at random, from six locations in Bonny. Morphological characteristics of bacteria were noted after 24 hrs incubation period. Identifications of isolates were carried out using standard methods.

Results: The results show that six genera of bacteria which include *Bacillus cereus*, *Salmonella* species, *Staphylococcus aureus*, *Klebsiella* species, *Enterococcus* species and *Proteus* species were isolated. The total number of *Bacillus cereus* and *Salmonella* species presence were 10

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(34%) and 5 (17%) respectively, from the five Suya samples each, across the six Suya stand in Bonny. *Escherichia coli* have no growth. The total of 1 (3.4%) and 2 (6.8%) of *Staphylococcus aureus* and *Klebsiella* species respectively were also isolated. A total of 6 (20%) and 5 (17%) of *Enterococcus* species and *Proteus* species respectively were also isolated. The Tennis Hut and Golf club have a total of 3 (9.6%) and 2 (6.4%) of different types of microorganisms isolated. Finima, and Akiama have 7 (22%) and 6 (19%) respectively of the different kind of microorganisms isolated. Some of these microorganisms are contaminations from the environment while others are regular flora.

Conclusion: The findings show the contamination of the roasted meats with some pathogenic bacteria such as *Bacillus cereus*, *Salmonella* species, *Staphylococcus aureus*, and *Klebsiella* species.

Keywords: Bacteriology; Suya; meat; Bony Nigeria.

1. INTRODUCTION

Suya meat is obtained from roasted or smoked beef especially from the boneless parts of the meat. They are rich in protein, vitamin B12, zinc, Selenium, Phosphorus, Niacin, Iron and vitamin (pyridoxine). This meat is commonly found on most streets as a source of food in Nigeria and Sub-Saharan Africa [1]. Suya meat contamination is mostly associated with the exposure on the streets. It is easily contaminated with microorganisms and parasites due to the high protein content.

The meat is made from the fleshy parts of beef which are roasted and smoked to reduce the moisture content and increase the shelf-life of the meat. Suya meat could be contaminated with air, handlers, equipment, water, papers, and utensils such as spoon, trays, and knives. Also, Contamination could be due to the behavioural habits of meat handlers and sanitary nature of the surroundings the meat is prepared [2]. It is necessary to carry out some microbiological quality assessment on roasted meat to ascertain their safety for human consumption.

During slaughtering of the cattle in the abattoirs, there is a possibility of contaminating the meat with some opportunistic flora from humans, animals and the environment [3]. The raw consumption of uncooked meat could cause food poisoning due to the presence of some bacteria that can produce toxins in human resulting to the pathological condition such as diarrhoea and vomiting. However, the infectious doses of some common contaminations of meat were still under investigations [4]. Herbs are used as taste enhancers in the final preparation of Suya meat. Recently published studies by Monsi et al. [5,6] noted that upon the exposure of normal flora to herbal preparations; opportunistic microorganisms develop virulence by acquiring resistance. This observation has been seen

across both Gram-negative and Gram-positive microorganisms. Hence, herbs used to spice the meat could sensitise these opportunistic microbes as observed in Monsi et al. [5,6] and become more pathogenic. This could serve as a mechanism by which microorganisms contaminating meat become more virulent and cause disease.

Microorganisms are ubiquitous; hence unhygienic preparation of Suya meat could promote the presence of microorganisms which could cause infection to the consumers. This work was aimed at determining the level of bacterial contamination of roasted Suya meat sold in Bonny local government area.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in Bonny (Ibani) Local Government Area of Rivers state between November to December, 2016. Bonny is geographically located at latitude $40^{\circ} 26' N$ and $7^{\circ} 10' E$. This region is characterised by lengthy rainy seasons and short dry seasons with temperatures of 25-28°C. It is situated in the southern part of Rivers State in Nigeria. The primary occupations of the people living in the area are fishing and farming. The sample for this study was drawn from 6 selected Suya locations namely; Tennis Hut, Golf Club, Finima market junction, Akiama, Ama-Hausa and Hospital Road junction. A total of 30 samples were collected for the study; five samples from each Suya stand location at different times and day.

2.2 Sample Collection and Media Preparation

All Suya meat samples from each location were aseptically collected into labelled sterile containers. These were sent for identification to

Table 1. Biochemical tests used in the identification of the bacterial isolates

Morphology	Short rods	Short rods	Short rods	Cocci clusters	Short rods	Short rods
Maltose	+	+	+	+	+	+
Glucose	+	+	+	+	+	+
Gram Staining	-	-	-	+	-	-
Indole	+	-	-	-	-	-
Citrate	-	-	+	-	-	-
Oxidase	+	+	-	-	-	-
Catalase	+	+	+	+	-	+
Coagulase	-	-	-	+	-	-
Urease	+	+	-	-	+	-
Bacteria species	<i>Proteus</i> spp	<i>Enterococcc</i> us spp	<i>Klebsiella</i> spp	<i>S. aureus</i>	<i>Salmonella</i> spp	<i>Bacillus cereus</i>

Key: (-) Negative, (+) Positive

Bonny General Hospital’s Medical Laboratory and Department of Medical Laboratory Science of Rivers State University, Port Harcourt. The samples were cultured in various culture media using the protocol for media inoculation and organism identification guide for bacteriology culture described in Cheesbrough [7]. The materials used include sterile universal containers, bijou bottles, sterile disposable wire loops, Petri-dishes, media, peptone water, incubator, autoclave and test tubes. The media were prepared according to the manufacturer’s instruction and autoclaved at 121°C for 15 minutes. The sterile media were dispensed aseptically into disposable [petri dishes after cooling to about 50°C.

2.3 Microbial Identification

The samples were incubated aerobically in the incubator (Heating Incubator; DHP – 9053A) for 24 hrs. Subculture of the incubated sample was done the following day into various media. The plates were incubated at 37°C for 24 hrs and examined for bacterial growth, and Gram staining were also performed [7].

2.4 Biochemical Tests

Pure isolates of microorganisms grown on the different agar plates where further identified biochemically. The different biochemical tests used in this study were: maltose, glucose, Gram’s staining, indole, citrate, oxidase, catalase, coagulase and urease tests. The

protocols for these tests were adopted from Cheesbrough [7].

2.5 Data Analysis

The data were analyzed statistically using Excel Software.

3. RESULTS

3.1 Microorganisms Isolated from Six Different Suya Locations

Results show that all the 30 samples of Suya meat analysed from the six locations in Bonny Local Government Areas of Rivers state were all contaminated with different microbes. The microbes isolated were; *Bacillus cereus*, *Salmonella* species, *Staphylococcus aureus*, *Klebsiella* species, *Enterococcus* species and *Proteus* species. These microbes were isolated from the six Suya stand and their prevalence were 10 (34%), 5 (17%), 1 (3.4%), 2 (6.8%), 6 (20%) and 5 (17%) respectively for Tennis Hut, Golf Club, Finima, Akiama, Ama-Hausa and Hospital Road junction as shown in Table 2.

3.2 Microorganisms Isolated in Different Locations

Represented in Figs a-f are the charts showing the percentages of the microbes identified from Tennis Hut, Golf Club, Finima, Akiama, Ama-Hausa, and Hospital Road respectively. *Bacillus*

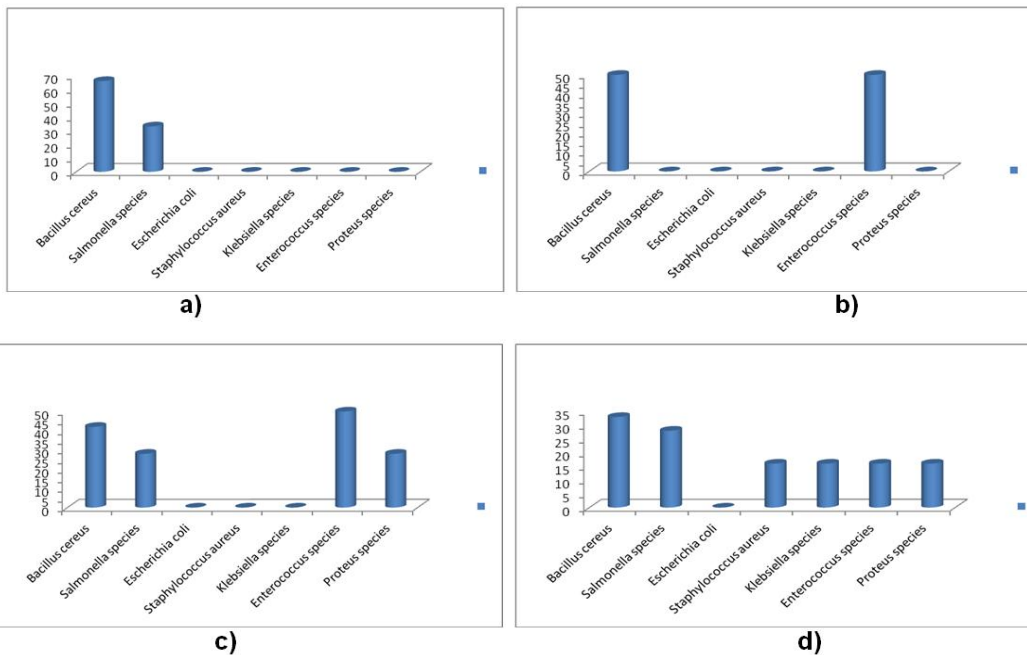
cereus and *Salmonella* species were the only organisms isolated from Tennis Hut. *Bacillus cereus* and *Enterococcus* species were isolated from samples obtained from Golf Club. *Bacillus cereus*, *Salmonella* species, *Enterococcus* species and *Proteus* specie were isolated from samples obtained from Finima and Ama-Hausa. *Bacillus cereus*, *Salmonella* species, *Enterococcus* species, *Proteus* species, *Klebsiella* species and *S. aureus* were identified from samples obtained in Akiama samples. *Bacillus cereus*, *Enterococcus* species and

Klebsiella species were isolated samples from Hospital Road junction. From the study, *Bacillus cereus* was identified in all the samples collected. The total numbers of microorganisms isolated at the different locations from the highest to the lowest were: Ama-Hausa (8), Finima (7), Akiama (6), Hospital Road junction (5), Tennis Hut (4), and Golf Club as seen in Fig 1g. The different types of microorganism isolated in the study were: *Bacillus cereus* (10), *Salmonella* species (5), *Enterococcus* species (5), *Proteus* species (5), *Klebsiella* species (2) and *S. aureus* (1).

Table 2. Microorganisms isolated from six different Suya locations in Bonny local government area

Organisms isolated	Tennis Hut (%)	Golf Club (%)	Finima (%)	Akiama (%)	Ama-Hausa (%)	Hospital Road (%)	Total (%)
<i>Bacillus cereus</i>	2 (66%)	1 (50%)	3 (42%)	2 (33%)	2 (25%)	2 (40%)	10 (34%)
<i>Salmonella species</i>	1 (33%)	00 (00)	2 (28%)	00 (00)	2 (25%)	00 (00)	5 (17%)
<i>Escherichia coli</i>	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
<i>Staphylococcus aureus</i>	00 (00)	00 (00)	00 (00)	1 (16%)	00 (00)	00 (00)	1 (3.4%)
<i>Klebsiella species</i>	00 (00)	00 (00)	00 (00)	1 (16%)	00 (00)	1 (20%)	2 (6.8%)
<i>Enterococcus species</i>	00 (00)	1 (50%)	00 (00)	1 (16%)	2 (25%)	2 (40%)	6 (20%)
<i>Proteus species</i>	00 (00)	00 (00)	2 (28%)	1 (16%)	2 (25%)	00 (00)	5 (17%)
Total	3 (9.6%)	2 (6.4%)	7 (22%)	6 (19%)	8 (25%)	5 (16%)	

*Percentages of Microorganisms Isolated from the Six different Locations; Tennis Hut, Golf Club, Finima, Akiama, Ama-Hausa and Hospital Road



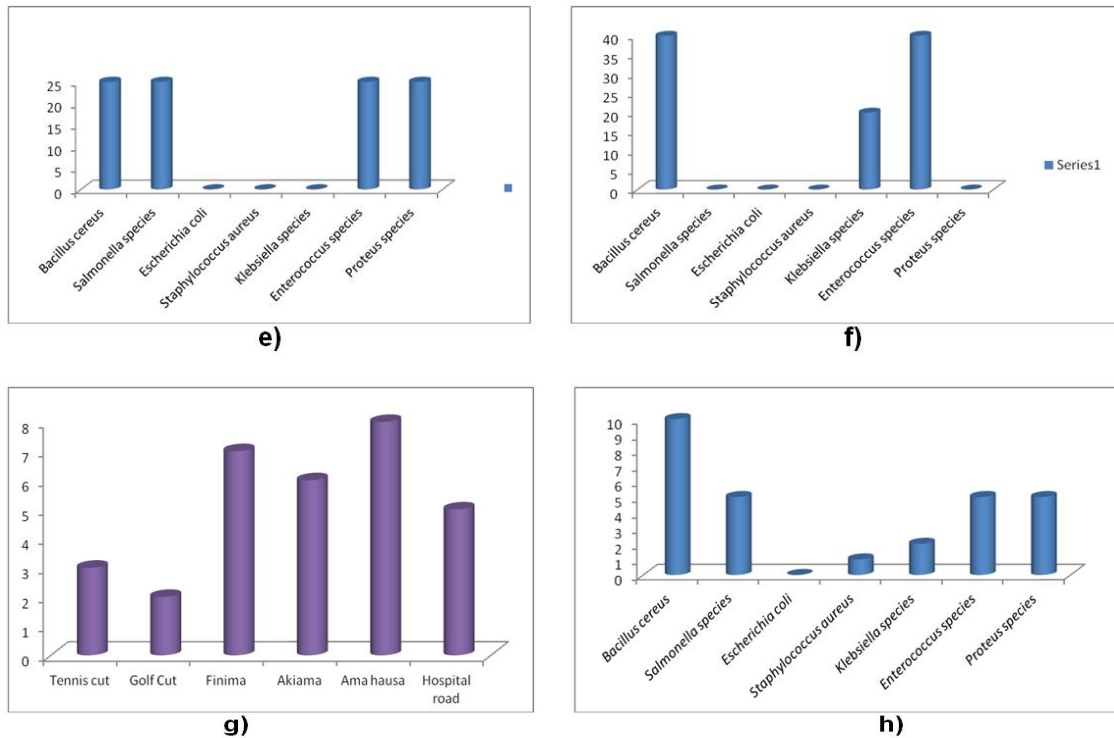


Fig 1. Percentages of organisms isolated are represented in a) Tennis Hut b) Golf Club c) Finima d) Akiama e) Ama-Hausa f) Hospital Road. Percentages of organisms isolated from areas and different types of microorganisms isolated are represented in g) and h) respectively

4. DISCUSSION

In Nigeria public foods are prepared in manners that expose the food to ubiquitous microbes in the surroundings. The preparation of Suya meat is not different from the way other public foods are prepared. This implies that adequate sanitary measures are necessary during the preparatory stage to avoid microorganisms from contaminating the food. This current investigation aimed at assessing the levels of microbial contamination on Suya meat.

Bacillus cereus and few other microorganisms isolated across the six Suya locations were also isolated in the work done by Egbebi and Seidu [8]. Contaminations with these microbes could be as a result of lack of adherence to Hazard Analysis Critical Control Point (HACCP), [9] which is essential for the control of some organisms such as *Salmonella* species, *Enterococcus* species and *Proteus* species. Adherence to this method could reduce the presence of potentially pathogenic microbes in

Suya meat through monitoring the hygiene levels of abattoir personnel and the surrounding [9].

The Golf Club Suya assayed indicates that 1 (50%) was contaminated with *Bacillus cereus* and 1 (50%) of *Enterococcus* species, given a total of 2 (6.4%) of different microorganisms of Suya contamination in Bonny. *Bacillus cereus* can cause two types of illnesses, characterized by diarrhea and vomiting using enterotoxins such as cereulide and tripartite hemolysin respectively [10]. The diarrheal enterotoxin is heat sensitive and could be inactivated. The emetic toxin which induces vomiting is very heat resistant [10]. *Bacillus cereus* is a gram positive, spore-forming organism which is different from other *Bacillus* species in their biochemical reactions. Their optimum growth temperature is about 30°C to 50°C with pH range of 4.3 to 9.3 and water activity (WA) of 0.912. *Bacillus cereus* is commonly found in nature usually in the soil and water. The infective dose of *B. cereus* could be more than 10 Colony Forming Unit (CFU) of visible cells consumed to cause disease [11].

The result obtained from Finima shows that 3 (42%) of *Bacillus cereus*, 2 (28%) of *Salmonella* species and 2 (28%) of *Proteus* species were positives given a total of 7 (22%). *Salmonella* species could be gotten from uncooked cow meat, or taking raw cow meat that is not properly cooked could be harmful to human health [12]. The results from others show that the isolation of *Salmonella* species from Suya meat sample also agreed with the fact that 2 (28%) of *Salmonella* species contamination can render the Suya meat unsafe for consumption [3].

The prevalences of the different isolates obtained from Akiama were *B. cereus* 2 (33%), *Staphylococcus aureus* 1 (16%), *Klebsiella* species 1 (16%), *Enterococcus* species 1 (16%) and *Proteus* species 1 (16%). These were similar to findings recorded in Riser and Marth [4]. The presence of *Staphylococcus aureus* in Suya meat from Akiama indicates possible infection of consumers of the suya within Akiama. This organism can produce toxins as seen in the case of Typhoid toxin in *Salmonella typhi* infection [14] which are heat resistant and cannot be destroyed through cooking. It is commonly contracted through food workers. An individual with weakened immune systems may also be vulnerable to these toxins [10]. As *Staphylococcus aureus* are commonly found on the skin, hair, nose and human throats, the bacteria could be found in up to 25% of healthy individuals and are more common in those with infections in these areas [11]. Ama-Hausa results show contamination of Suya meat of 2 (25%) *Bacillus cereus*, *Salmonella* species 2 (25%), *Enterococcus* species 2 (25%) and *Proteus* species 2 (25%) given a total of 8 (25%) of different microorganisms contamination in Bonny.

Suya meat collected from Hospital road shows that *Bacillus cereus* has 2 (40%), *Klebsiella* species shows 1 (20%) and *Enterococcus* species 2 (40%) from a total of 5 (16%) of different microorganisms isolated from Hospital road in Bonny Local Government area. The presence of *Proteus* species implies that the meat could have been contaminated with human intestinal normal flora. This organism could also be found in external habitats such as water bodies and soil. It is a gram-negative bacillus which colonizes both the skin and oral mucosa. *Bacillus cereus* with total of 10 (34%) was isolated from the six Suya meat-selling locations in Bonny making it the most commonly isolated microorganism from the Suya sample. Bonny is a

cold region as it is surrounded by the Atlantic Ocean which explains the ability of *B. cereus* to produce spores that germinate at lowered temperature which is in accordance with the work reported by Schoeni et al. [10].

Salmonella species and *Staphylococcus aureus* isolated were 5 (17%) and 1 (3.4%) respectively. These organisms can produce toxins whose infectious level could cause damage to the tissue in the human body. Diana et al. [3] has reported that the infective dose of toxin could be as low as 1.0 nanogram of toxin per gram of food or meat. Ingestion of 1 to 5 microgram of the toxin has been shown to be associated with outbreak of toxin-induced foodborne disease as observed by Chong et al. [14].

4. CONCLUSION

This study has demonstrated that roasted meat could be contaminated with microorganisms which are potentially pathogenic. These organisms are intestinal flora which implies the likely route of contamination is chef preparing Suya meat. Other possible sources of diseases could be via saliva and other body fluids as well as clothing.

5. RECOMMENDATIONS

To reduce contamination of meat with organisms that could be drug resistant, health regulatory bodies should ensure adequate inspection of abattoir meats and Suya processing by using thermometer to check the temperature of roasted meat. Suya meat should be stored below 'danger zone' temperatures of 50°C to 60°C. Suya meat should be reheated to about 75°C before consumption.

Hazard Analysis and Critical Control Point (HACCP) which represents a systematic preventive approach to food safety should be encouraged. Regular hand washing practices with soap and a running tap water should be encouraged. Suya handlers with wounds or skin infection should be strictly prohibited from selling Suya. Routine environmental sanitation practice, educational symposiums and disinfection of equipment used in Suya meat processing in Bonny should be encouraged.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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