



RESEARCH ARTICLE

BACTERIAL BURDEN OF SUYA AND SUYA SPICE INGREDIENTS SOLD IN SOME PARTS
OF PORT HARCOURT, NIGERIA

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ABSTRACT

Samples of ready to eat suya and suya spice ingredients obtained from suya sellers in five zones of Port Harcourt were examined to assess their bacterial burden. The mean colonial counts from the suya samples were: Diobu; 4.71 cfu/g, Rumuokuta; 4.53 cfu/g, Rumueme; 4.33 cfu/g, Rumuokoro; 4.87 cfu/g and Rumuola; 4.85 cfu/g; while the mean colonial counts from suya spiced ingredients were: Diobu 5.81 cfu/g, Rumokuta 5.29 cfu/g, Rumueme 5.32 cfu/g, Rumuokoro 5.78 cfu/g and Rumuola 5.81cfu/g. From the r+esults, four genera of bacteria were isolated from roasted suya meats and five genera of bacteria from suya spice ingredients. Statistical analysis did not show significant difference at $P>0.05$ in mean counts of bacteria from suya and suya spice ingredients sold at different locations. Suya and suya spice ingredients sold in the above parts of Port Harcourt are bacteriologically unsafe; the isolation of possible potential pathogens are of public health concern.

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INTRODUCTION

Suya is a spicy, barbecued, smoked or roasted meat product. It originated from the Hausa people of Northern Nigeria, where cattle rearing are an important preoccupation and major source of livelihood (Edema *et al.*, 2008). This had led to the production of ready to eat beef or cow products such as suya, kilishi, balangu and kundiare which are very popular street vended foods from meat products. However, suya is the most commonly consumed as it has spread to all parts of Nigeria and West Africa (Inyang *et al.*, 2005). In big cities and small towns, suya sellers are very prominent with their grill stands, turning very busy from about mid-day until late night. It has made way into the elite circles where it is a delicacy served in occasions, ceremonies, parties etc. Suya is prepared basically from boneless meat of animals (Abdullahi *et al.*, 2004). The preparation of suya is carried out under unhygienic conditions and the corresponding risk of contamination is high. The fact that there are sporadic cases of gastroenteritis and symptoms of food infection after consumption of suya by some individuals, indicates that the product constitute food hazard risk (Odusote and Akinyanju, 2003; Inyang *et al.*, 2005). Spice ingredients do not have marked bacteriostatic effect in the concentration used for meat products and they may serve as source of contamination to the products. Suya and the spice ingredients

used for suya preparation are considered one of the major causes of gastrointestinal disturbances, resulting from the consumption of suya (Ejeikwu and Ogbonna, 1998). Suya, termed traditionally stick meat, although chicken and pork can be used; is spice with peanut cake, salt, vegetable oil and other flavoring agents; followed by roasting on a glowing charcoal fire. The smoke from the fire had been shown to have bacteriostatic preservative effect on the suya meats (Ogunbanwo *et al.*, 2004). Suya, is sliced red meat, spleen or liver roasted with added oil and spice ingredients made from ground groundnuts, garlic, ginger etc., the suya is served hot with some chopped onions, tomatoes and fresh pepper after roasting (Jay, 2000).

The meat cut into small slices were first mixed with peanut spices and allowed for about 30 minutes or more for peanut cake to stick and after which, the sliced meat are treated in skewer and brushed with vegetable oil and roasted on a glowing charcoal fire. It is finally removed from the skewer and served hot on a newspaper or aluminum foil with sliced onions, tomatoes, cabbage and ground peanut as spiced ingredients (Judge *et al.*, 2002). Suya and suya spiced ingredient preparation processes are unhygienic. Some bacteria isolated from suya and suya spice ingredients are *E.coli*, *Staphylococci*, *Bacillus*, *Klebsiella*, *Pseudomonas*, *Salmonella* and *Proteus* (Egbebi and Seidu, 2011). The aim of this study is to determine the bacteria burden of suya and suya spice ingredient sold in Port Harcourt, indentify the bacteria isolated, and their percentage occurrences.

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MATERIALS AND METHODS

Areas of Study: This study was conducted in Port Harcourt, Rivers State, Nigeria. Port Harcourt is the capital of Rivers State, one of the most populated cities in South-South part of Nigeria. The research covered both Port Harcourt and part of Obio/Akpor Local Government Areas of Rivers State in Port Harcourt.

Spice ingredients: The already processed spice ingredients that was ready for use by the suya sellers (be added to roasted suya) were bought from suya sellers, transferred directly into sterile screw capped container, and taken to the laboratory for bacteriological examinations.

Identification of bacterial Isolates: Isolated bacteria were identified by using their colonial characteristics, Gram staining reactions, chemical and biochemical tests. The test employed were: motility test, indole test, methyl red, Voges-Proskauer, coagulase, catalase, oxidase and citrate utilization test according to (Cheesbrough, 2002).

RESULTS

The mean colony forming units (cfu/g) from suya meats were: Diobu 4.71 cfu/g, Rumuokuta 4.53 cfu/g, Rumueme 4.33 cfu/g, Rumuokoro 4.87 cfu/g and Rumuola 4.85 cfu/g respectively. The mean colony counts from suya spice ingredients were: Diobu 5.84 cfu/g, Rumuokuta 5.29 cfu/g, Rumueme 5.32

Table 1. Maximum colonial counts of bacteria from Suya and suya spice ingredients

Location/number samples	Suya	Suya Spice ingredients
Diobu 10	0.00- 4.71	0.00-5.84
Rumuokuta 10	0.00- 4.53	0.00-5.29
Rumueme 10	0.00-4.33	0.00-5.32
Rumuokoro 10	0.00-4.87	0.00-5.78
Rumuola 10	0.00-4.85	0.00-5.81

Table 2. Maximum values of bacteria isolated from suya in the zones (log₄ cfu/g)

Isolated Bacteria	Diobu	Rumuokuta	Rumueme	Rumokoro	Rumuola	Mean
<i>Staphylococcus aureus</i>	3.53	3.84	3.72	3.36	4.10	3.71
<i>Escherichia coli</i>	3.00	3.10	3.81	3.08	3.55	3.31
Coag. negative <i>Staphylococci</i>	2.10	2.75	2.18	2.26	2.20	2.30
<i>Klebsiella spp.</i>	3.34	2.52	2.18	3.24	3.15	2.89
<i>Pseudomonas aeruginosa</i>	2.31	0.00	0.00	2.00	2.22	1.31
Mean	2.86	2.44	2.38	2.79	3.04	

Table 3. Maximum values of bacteria counts isolated from suya spice ingredients from the zones (log⁵ cfu/g)

Isolated Bacteria	Diobu	Rumuokuta	Rumueme	Rumokoro	Rumuola	Mean
<i>Staphylococcus aureus</i>	4.24	4.67	4.33	4.20	4.98	4.48
<i>Bacillus spp.</i>	4.71	4.34	4.22	4.62	4.54	4.49
<i>Escherichia coli</i>	4.30	4.10	4.52	4.80	4.66	4.48
Coag. negative <i>Staphylococci</i>	2.55	2.26	2.05	2.42	2.46	2.35
	3.95	3.84	3.75	4.01	4.16	

Suya: The roasted suya meats (ready to eat) were bought from the suya sellers; these were taken to the laboratory also for bacteriological analysis.

Preparation of Samples for Bacteriological Examination

Suya Meats: Ten grams (10g) of ground suya (meat) was weighed on sterile aluminum foil and added to 90ml of sterile normal saline. This was properly mixed and serial diluted by transferring 1ml of the supernatant to 9ml of sterile diluent in test tubes up to 10⁴. Finally, 0.1ml of 10⁴ dilutions were taken from each of the preparations and dropped on dried nutrient and MacConkey agar plates in duplicate. The drops were evenly spread with the aid of a sterile glass rod spreader, starting with nutrient agar. The inoculated plates were incubated at 37°C for 18 – 24 hours and examined for growth.

Spice ingredients: Ten grams (10g) of each suya spice ingredient was also weighed on a sterile aluminum foil with the aid of a sterile spatula. Each weighed suya spice ingredient was carefully added to 100ml of sterile distilled water in test tube, mixed properly and serial diluted to 10⁵. These were plated just as the suya meat, incubated for 18-24 hour at 37°C and examined for growth.

cfu/g, Rumuokoro 5.78 cfu/g and Rumuola 5.81 cfu/g respectively (as shown in Table 1). The mean counts of bacteria isolated from suya samples were: *Staphylococcus aureus* 3.71 cfu/g, Coagulase negative *Staphylococci* 2.30 cfu/g, *Klebsiella spp.* 2.89 cfu/g and *E. coli* 3.31 cfu/g; *Pseudomonas* 1.31 cfu/g. The mean bacteria counts per zone were: Diobu 2.86 cfu/g; Rumuokuta 2.38 cfu/g Rumueme 2.44 cfu/g; Rumuokoro 2.79 cfu/g Rumuola 3.04 cfu/g. The bacterial load per zone is shown in table 2. The mean counts of bacteria isolated from suya spice ingredients includes: *Staphylococcus aureus* 4.48 cfu/g, *Bacillus spp.* 4.49 cfu/g, Coagulase negative *Staphylococci* 2.35 cfu/g, *E. coli* 4.48 cfu/g, *Klebsiella spp.* 3.35 cfu/g and *Pseudomonas spp.* 2.51cfu/g. The percentage occurrences of bacteria isolated from the three (5) areas were: Diobu 3.74 cfu/g, Rumuokuta 3.48 cfu/g, Rumueme 3.32 cfu/g, Rumuokoro 3.74 cfu/g Rumuola 3.36 cfu/g.

The counts of isolated bacteria from the zones per bacteria species is as shown on table 3. The mean percentage occurrences of bacteria isolated from suya were: *Staphylococcus aureus* 8(36.36%), *E. coli* 6(27.73%), Coagulase negative *Staphylococci* 3(13.64%), and *Pseudomonas aeruginosa* 1(4.55%) respectively. The mean percentage occurrences of bacteria from suya spiced

ingredients were: *Staphylococcus aureus* 10(20.00%), *Bacillus* 6(19.35%), *E. coli* 5(18.52%) Coagulase negative *Staphylococci* 4(22.22%), *Klebsiella spp.* 4(22.22%) *Pseudomonas aeruginosa* 1(7.15%) as shown in table 4.

safe for consumption. Post roasting handling, storage, rearrangements, addition of spiced ingredients and other additives such as fresh tomatoes, onions, pepper and serving may increase the bacterial load.

Table 3. The percentage occurrences of isolated bacteria from suya meats

Isolates	Diobu	Rumuoeme	Rumuokuta	Rumuokoro	Rumuola	Mean
<i>Staphylococcus aureus</i>	9(33.33)	8(38.10)	6(30.00)	10(43.48)	9(39.13)	8(36.36)
<i>Escherichia coli</i>	7(25.93)	5(23.81)	6(30.00)	7(30.43)	7(30.43)	6(27.73)
Coagulase negative <i>Staphylococci</i>	4(14.81)	3(14.29)	2(10.00)	2(6.96)	3(13.04)	3(13.64)
<i>Klebsiella spp.</i>	5(18.52)	4(19.05)	4(20.00)	3(13.04)	3(13.04)	4(18.18)
<i>Pseudomonas aeruginosa</i>	2(7.41)	1(4.76)	2(0.00)	1(4.34)	1(4.34)	1(4.55)
Total	27(23.68)	21(18.42)	20(17.54)	23(20.18)	23(20.18)	

Table 4. Percentage occurrences of isolated bacteria from Suya spice ingredients

Isolates	Diobu	Rumueme	Rumuokuta	Rumuokoro	Rumuola	Mean
<i>Staphylococcus aureus</i>	10(27.78)	9(34.62)	8(38.10)	12(34.29)	11(36.67)	10(20.00)
<i>Bacillus spp.</i>	8(22.22)	6(23.10)	4(19.05)	7(20.00)	6(20.00)	6(19.35)
<i>Escherichia coli</i>	8(22.22)	4(15.38)	4(19.05)	6(17.14)	5(16.67)	5(18.52)
Coagulase-ve <i>Staphylococci</i>	4(11.11)	3(11.54)	2(7.69)	3(8.57)	3(10.00)	4(22.22)
<i>Klebsiella spp.</i>	4(11.11)	4(15.38)	3(14.29)	4(11.43)	3(10.00)	4(22.22)
<i>Pseudomonas aeruginosa</i>	2(5.56)	0(0.00)	0(0.00)	3(8.57)	2(6.67)	1(7.15)
Total	36(24.32)	26(17.57)	21(14.19)	35(23.65)	30(20.27)	

DISCUSSION

Suya originated from Northern Nigeria, but today the consumption of suya has spread from the Sahara desert in the Northern part of Nigeria to the Atlantic Ocean in the South-South. Suya is a popular delicacy in Nigeria and West Africa, used for entertainment of friends and visitors. The mean bacterial counts from suya and suya spice ingredient, ranges from 4.33-4.87 log₁₀cfu/g and 5.32-5.84 log₁₀ cfu/g (table 1). In a similar study, (Ogbonna *et al.*, 2012) had mean value of 3.36- 6.23 log₁₀ cfu/g in Maiduguri, Nigeria; (Hassan *et al.*, 2014., Manyi *et al.*, 2014) had mean counts ranging from 2.8-5.47log₁₀ cfu/g in Lagos, Nigeria. The mean count of bacteria in this study is within values obtained by other workers. The mean counts indicate the levels of bacterial contamination of suya and suya spice ingredients. The poor unhygienic preparation processes and improper storage may have aided contamination. Statistical analysis at P<0.05 did show significant difference in mean count of bacteria isolated from suya and suya spice ingredients obtained from the different zones. Other workers, had also noted, that the preparation processes of suya were carried out under very unhygienic conditions, and the corresponding risk of contamination was very high (Odusote and Akinyanju, 2003).

Inyang *et al.*, (2005) observed that, there were sporadic cases of gastroenteritis and symptoms of food infection after consumption of suya by some individuals, which is an indication of food hazard risks. Since most suya sellers were uneducated and lack understanding in the basic principles of food preservation and contamination, the adequate measures to reduce the bacterial burden of suya and suya spice ingredients remains a major problem to address. Government should mobilize suya sellers to form unions, for the purpose of using the union as a platform to educate them on food handling and processing. Suya is produced from boneless meat hung on a stick and spiced with peanut cake, salt, vegetable oil, and other ingredients before roasting. The roasting renders suya sterile (Ogunbanwo *et al.*, 2004). The roasting process is the only critical control point (CCP) in suya preparation which is designed to eliminate all contaminating bacteria and render it

Bacteria might contaminate suya from built up bacterial load in storage equipment or the slicing surface before serving, thereby exposing the final product to serious contamination. The spice ingredients added to roasted suya which comprises of roasted ground peanut (groundnut), fresh pepper, salt, ground ginger and ground garlic, were processed without any treatment to reduce or eliminate their bacterial contents to innocuous levels. The presence of bacteria capable of causing gastrointestinal infections isolated from suya and suya spices were considered major causes of gastrointestinal disturbances resulting from the consumption of suya (Ejeikwu and Ogbonna, 1998). Statistical analysis at P<0.05 did not show significant difference in the load of bacteria isolated from suya and suya spice ingredients from the zones. The zones sampled were densely populated, hence the demands for suya meat were more and the stress to meet demands may create room for more unhygienic processes that may aid contaminations of suya. Sometimes, in the process of preparing raw meats for suya, buyers could be served the "ready to eat suya" (roasted suya meat) with unwashed hands from the previous processes (slicing of raw meat); the knives used to slice the raw meat might be mixed up and used for the "ready to eat suya meat" and other additives such as sliced onions, peppers and tomatoes; thereby transferring bacteria from these sources to contaminate suya. Also, the water used to rinse several of the additives enumerated above, may have built up of bacteria for onward transmission to the roasted suya. These processes surely aid the contamination of "the ready to eat suya meat".

Spice ingredients had been shown to have some antimicrobial activities and yet meat treated with spices have high microbial load (Shamsudeen and Ameh, 2008). The spiced ingredients used for suya are mainly compounded from legumes which are associated with the soil, isolation of *Bacillus spp.* from spice ingredients alone, might suggest contamination from soil. The results of percentage occurrences of isolated bacteria from suya meat and suya spices showed *Staphylococci* was the most prevalent bacteria. *Staphylococci* are normal flora of humans and animals, they colonize human skin, hands, nostrils, etc. The presence of *Staphylococci* in suya meat and suya spice ingredients might suggest contamination from preparation

process and post roasting handling. Some strains of *Staphylococci* have been shown to be halo-tolerant, therefore the addition of sodium chloride to the spiced ingredients and meat may not prevent their multiplication (Boles *et al.*, 2000). The ready to eat suya meat (roasted suya meat) do not show evidence contamination with *Bacillus spp.*, indicating their elimination during the heating process (roasting); which is the only critical control point (CCP) in suya preparation. The complete elimination of *Bacillus spp.* in the processes of roasting, suggests that suya when properly roasted, heat could reduce its microbial contents to almost zero. Bacteria such as *Staphylococci*, *E. coli* etc. isolated from suya, might be as a result of improper roasting or post roasting contaminations.

The most predominant aerobic bacterium in humans and animal intestines is *E.coli*, their presence in suya and suya spice ingredients may suggest direct or indirect contamination with animals or human faecal matters. Bacteria isolated from suya and suya spice ingredients are of public health importance since some of the organisms are associated with food infection, food poisoning and or intoxication. Suya prepared from beef meat had been shown to harbour viable *Taenia saginata* cysticercia and haemolytic anemia had been associated with the consumption of suya due to the reaction of the consumer to some of the additives (Mosimaale and Belino, 1980; Williams *et al.*, 1988). This was a proof that the risk associated with consumption of suya may not only be bacterial.

Conclusion

Suya meat and suya spice ingredients sold in some parts of Port Harcourt, are contaminated with bacteria capable of causing food poisoning. The preparation processes of suya and suya spice ingredients are carried out under very unhygienic conditions. The post roasting handling and poor storage facilities are associated with re-contamination of roasted suya meat, coupled with poor knowledge of suya seller in food handling and processing.

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