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Full Length Research Paper

Safety of street vended meat products - chicken and beef suya

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Suya chicken (A) and beef (B) samples classified according to state: TA_1 B_1 - raw; TA_2 B_2 - spiced; TA_3 B_3 - spiced and roasted; TA_4 B_4 - left over, unheated, spiced and roasted suya of the following day, TA_5 B_5 - leftover, heated, spiced and roasted suya of the following day, were collected from three locations in Ibadan metropolis, to identify the specific microorganisms in street vended chicken and beef suya and measure the microbial count at each stage of handling from the raw state to marketing and consumption. The plate count of *Escherichia coli* in raw chicken (10^8/g) and beef suya (10^7/g) dropped to 10^6 and 10^3/g, respectively after processing from the University staff suya spot. In the Sabo area suya spot samples, *E. coli* counts were observed in processed chicken suya (10^4/g), before and after heating the second day (10^7 and 10^5/g, respectively). However, neither *E. coli* nor *Salmonella* nor *Shigella* sp. was isolated from both types of "suya" samples from the General gas area. On the whole, *E. coli* counts were highest in spiced beef (3.3 x 10^7/g) and chicken suya (3.4 x 10^5/g) before roasting, whilst second day after heating gave *E. coli* counts of 3.3 x 10^6/g. *Staphylococcus aureus* was isolated from chicken suya (10^5 and 10^5/g and beef suya (10^2/g) before and after heating the following day from the University Staff Club suya spot. *S. aureus* was also isolated from raw, spiced, before and after heating the second day beef suya samples from Sabo. It was again isolated from the General gas area processed chicken suya (10^3/g), the second day before (10^2/g) and after heating (10^4/g). On the whole, *S. aureus* counts the second day after heating produced in beef suya 3.3 x 10^3/g. *Shigella*, *Salmonella* and *Klebseilla* sp. were not isolated from the University of Ibadan staff club suya. The situation differed from that of Sabo. *Klebseilla* sp. counts of 10^6 and 10^7/g from raw and spiced chicken suya dropped to zero after processing and before and after heating the second day. Beef suya microbial counts showed a high prevalence of *Klebseilla* sp. in raw beef suya (10^7/g), but then dropped after spicing and processing. It was however observed in beef "suya" the second day before and after heating (10^6 and 10^5/g, respectively). Neither *Salmonella* nor *Shigella* was isolated from both types of suya. Generally, the results showed that *Klebsiella* sp. had the highest count of 6.7 x 10^5/g in raw chicken suya samples. It was observed that microbial counts of chicken and beef suya were at levels that pose health implications for consumers.

Key words: Suya, microbial count, safety, street vended meat, beef, chicken.

INTRODUCTION

Chicken and beef suya are common delicacies to many Nigerians. Chicken and beef suya vendors are found in almost every neighborhood with a dense population for various daily formal or informal economic activities. Suya is a street processed, roasted and vended meat product (Son, 1996). In Nigeria, sale of beef suya first started before that of chicken, which emerged just recently and is not as widespread as the former. These foods are bought and eaten without further processing or cooking. Street vending of foods is a common characteristic of countries with high unemployment, low salaries and poor social security programme (Bryan et al., 1988).

However, consumers of street vended meat are little aware of the high health risks they face. Street foods are

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exposed to various forms of contamination at every stage of handling. Etok (1998) identified insufficient roasting /heating duration, uneven temperature distribution and exposure to unhygienic environments as crucial factors of infection and contamination. It is the aim of the venders to minimize shrinkage of the meat during roasting to maximize profit but at the same time satisfy the demand and appetite of the buyers. So the foods are usually prepared in a rush when the buyers are in a rush, or they are roasted, kept exposed and cold to await would-be consumers. Whichever way, the suya would not be properly roasted or kept under safe condition for consumption.

Several workers had reported mean total plate counts and coliform MPN levels of 6.24×10^7 - 1.4×10^9 and 8.5×10^2 - 2.0×10^3/g, respectively in "suya" products (Igene, 1983; Igene and Abulu, 1984). Idio (1995) reported total plate count and coliform level of 6.5×10^6 - 8.0×10^6 and 3.0×10^6 - 3.62×10^6 cfu/ml in roasted meat. Harris et al. (1975) had earlier reported on pathogens like *Salmonella*, *Shigella*, *Staphylococcus* and enthero-pathogenic *Escherichia coli* in beef suya. These values far exceeded the recommended total count (10^5/g) and coliform level (10^2/g) for delicatessen products. Thus, contamination of suya with pathogens is inevitable.

Therefore, the objective of this paper is to identify the specific microorganisms in street vended chicken and beef suya and measure the microbial count at each stage of handling from the raw state to marketing and consumption.

MATERIALS AND METHODS

Sample collection and experimental design

Chicken and beef suya samples were obtained from three locations in Ibadan metropolis, Oyo State: the University of Ibadan staff club, Sabo (a major suya spot) and General gas suya spot. Five treatments in a completely randomized design of collected samples of chicken (A) and beef (B) suya were placed in sterile sample bottles and labeled accordingly: TA_1 B_1 - raw; TA_2 B_2 - spiced; TA_3 B_3 - spiced and roasted; TA_4 B_4 - left over, unheated, spiced and roasted suya of the following day, TA_5 B_5 - leftover, heated, spiced and roasted suya of the following day. Each sample was taken immediately to the laboratory for analysis after collection.

Microbial identification and assessment

50 g of each sample was homogenized in 100 ml nutrient broth and dilutions of 1:10, 1:100 and 1:1000 made in the same broth. 50 ml of the homogenate dilutions was added to 50 ml of Selenite F broth with ingredients at double strength. The microbial cultures were incubated for 24 h at 37 and 43°C, respectively. The cultures were plated out on deoxycholate citrate agar (DCA) and brilliant green Mac Conkey agar and incubated at 37°C.

Grown colonies of bacteria on the agar media were examined microscopically after 24 and 48 h of incubation at 37°C. Colony morphology, shape, size, elevation, color and odor were noted. Smears were made from the colonies on clean slides and examined under the microscope using the oil immersion objective for Gram reaction determination. The plate counts of the dilutions were carried out on blood and Mac Conkey agar by incubating the plates aerobically for 18 h at 37°C, followed by examination of the coliform's colonies.

Biochemical tests

Biochemical tests including sugar fermentation (lactose, glucose, manitol, sucrose, salian and ducitol), citrate utilization, urea decomposition and oxidase tests were performed on gram negative bacillus to differentiate between lactose and non-lactose fermenting ability on Mac Conkey agar. Growth in peptone water was used for indole and mortality tests. Methyl red, Voges Proskauer (VP) and nitrate reduction tests were also carried out according to Cowan and Steel (1974).

Bacterial counts (surface viable counts)

The plates were dried for 2 h at 37°C prior to inoculation. Ten fold dilutions - 1:10, 1:100 and 1:1000 of the bacterial suspension were made and 0.2 ml of each set pipetted onto the surfaces of three plates (Blood agar, Mac Conkey agar and DCA). These were immediately spread out with a sterile glass spreader. The viable count was calculated from the average colony count/plate and a total of 1000 per gram or less was considered satisfactory.

Statistical analysis

Results obtained were subjected to analysis of variance (ANOVA) using the generalized linear model (GLM) procedure (Snedecor and Cochran, 1989) and to Duncan's multiple range procedure to determine the significant differences among treatments.

RESULTS AND DISCUSSION

It was evident that street vended chicken and beef suya get infected with micro organisms, which might pose health hazards to regular consumers. *E. coli*, *S. aureus* and *Klebsiella* sp. were isolated from suya samples collected as shown in Tables 1 to 4.

The fact that street food consumption has serious health implications for such consumers has been presented in other reports (Harris et al., 1975; Tjoa et al., 1977; Eriscon et al., 1980). The authors implicated poultry foods as major vehicles of disease transmission in countries with surveillance program. Results obtained from this study are in agreement with those reported by Igene (1983) and Igene and Abulu (1984). According to the authors, the mean total count and coliform MPN levels of 6.24×10^7 - 1.4×10^9 and 8.5×10^2 - 2.0×10^3/g were observed in suya products, emphasizing that Entero-bacteria are good meat contaminants.

The plate count of *E. coli* in raw chicken (10^8/g) and beef suya (10^7/g) dropped to 10^6 and 10^3/g, respectively after processing for the University staff suya spot. In the Sabo area suya spot samples, *E. coli* counts were observed in processed chicken suya (10^4/g), before and after heating the second day (10^7 and 10^5/g respectively). *E. coli* counts of 10^5/g was observed in spiced and

Table 1. Microorganisms of the University Staff Club chicken and beef suya.

Sampling stage	*Escherichia coli*		*Staphylococcus aureus*		*Klebseilla* sp.		*Salmonella/Shigella*		Total aerobic plate count	
	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken
Raw meat	10^7	10^8	0	0	0	0	0	0	10^7	10^8
Spiced meat	10^8	10^8	0	0	0	0	0	0	10^8	10^8
Processed (ready-to-eat)	10^3	10^6	0	0	0	0	0	0	10^3	10^6
Processed (2^{nd} day before heating)	0	0	10^2	10^5	0	0	0	0	10^2	10^5
Processed (2^{nd} day after heating)	0	0	10^2	10^3	0	0	0	0	10^2	10^3

Total aerobic plate count (colonies/g).

Table 2. Microbial counts of "Sabo" chicken and beef "suya" samples.

Sampling stage	*Escherichia coli*		*Staphylococcus aureus*		*Klebseilla* sp.		*Salmonella/Shigella*		Total aerobic plate count	
	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken
Raw meat	0	0	0	0	10^7	10^6	0	0	2×10^7	10^6
Spiced meat	10^5	0	0	0	0	10^7	0	0	10^6	10^7
Processed (ready-to-eat)	10^5	10^4	0	0	0	0	0	0	1.2×10^6	10^4
Processed (2^{nd} day before heating)	0	10^7	0	0	10^6	0	0	0	2×10^6	10^7
Processed (2^{nd} day after heating)	0	10^5	0	0	10^5	0	0	0	10^5	10^5

Total aerobic plate count (colonies/g).

processed beef suya. However, neither *E. coli* nor *Salmonella* nor *Shigella* sp. was isolated from both types of suya samples from the General gas area most probably because the area was less populated and rate of pollution was low. On the whole, *E. coli* counts were highest in spiced beef ($3.3x10^7$/g) and chicken suya (3.4×10^5/g) before roasting, whilst second day after heating gave *E. coli* counts of 3.3×10^6/g.

The prevalence of *E. coli* could be attributed to the use of contaminated water during the different stages of processing. On the other hand, hands, utensils and knife used in processing the suya could be implicated as mediums for cross contamination of processed suya. The initial contaminated water used for washing the raw meat is also used for washing hands and utensils used in production. Water is a major means by which *E. coli* are spread. Insufficient heating of the suya during processing and just before selling to the consumer is a possible reason for the survival of these pathogens in suya Thus, the possibility of food poisoning outbreaks is highly probable (Mermeistein, 1993). In addition, the processed suya is always kept exposed while awaiting buyers, making it naturally vulnerable to infection with different pathogens. Besides, not all consumers are patient enough to wait for the vendor to re-heat the suya before purchasing.

S. aureus was isolated from chicken suya (10^5 and 10^3/g) and beef suya (10^2/g) before and after heating from the University Staff Club suya spot. No *S. aureus* was isolated from all category of beef suya, samples from Sabo while the only *S. aureus* isolated from the General gas area beef suya was from processed ready eat product (10^2/g). Chicken "suya" from the same spot however contained 10^3/g, *S. aureus* for the ready to eat suya while the second day chicken suya before and after roasting contained 10^2 and 10^4/g *S. aureus* respectively. On the whole, *S. aureus* counts the second day after heating produced in beef suya was 3.3×10^3/g.

Though *S. aureus* was not found in the raw suya samples, subsequent contamination might

Table 3. Microbial count of the "General Gas" area chicken and beef "suya".

Sampling stage	*Escherichia coli*		*Staphylococcus aureus*		*Klebseilla* sp.		*Salmonella/Shigella*		Total aerobic plate count	
	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken
Raw meat	0	0	0	0	10^7	10^6	0	0	10^7	10^6
Spiced meat	0	0	0	0	10^5	10^5	0	0	10^6	10^5
Processed (ready-to-eat)	0	0	10^2	10^3	10^3	10^3	0	0	1×10^5	10^6
Processed (2^{nd} day before heating)	0	0	0	10^2	10^5	10^4	0	0	10^5	10^6
Processed (2^{nd} day after heating)	0	0	0	10^4	10^5	10^3	0	0	10^5	10^7

Total aerobic plate count (colonies/g).

Table 4. Microorganisms isolated from the three locations for both "suya".

Sampling stage	*Escherichia coli*		*Staphylococcus aureus*		*Klebseilla* sp.		*Salmonella/Shigella*		Total aerobic plate count	
	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken	Beef	Chicken
Raw meat	3.3×10^6	3.3×10^7	0	0	6.7×10^6	6.7×10^5	10^7	3.4×10^6	3.3×10^6	3.3×10^7
Spiced meat	3.3×10^7	3.3×10^7	3.3×10^4	0	3.0×10^4	3.4×10^6	8.3×10^7	3.67×10^5	3.3×10^7	3.3×10^7
Processed (ready-to-eat)	3.3×10^4	3.4×10^5	3.3×10^1	3.3×10^2	3.3×10^2	3.3×10^2	3.4×10^4	3.4×10^5	3.3×10^4	3.4×10^5
Processed (2^{nd} day before heating)	0	0	3.3×10^1	3.3×10^4	6.7×10^4	3.7×10^5	6.6×10^4	4.0×10^5	0	0
Processed (2^{nd} day after heating)	0	3.3×10^6	3.3×10^3	3.4×10^2	3.3×10^2	3.3×10^3	3.7×10^7	3.3×10^6	0	3.3×10^6

Total aerobic plate count (colonies/g).

be due to improper handling by the vendor. *Staphylococcus* observed in the second day before and after heating could be as a result of the old news papers used in wrapping the previous day's suya before storage. These newspapers must have passed through many hands before eventually getting to the suya vendors. It could also be due to improper heating on the second day. Likewise, careless sneezing and coughing among vendors can result in contamination of the products. In addition, hand picking of nose and improper washing of such hands before handling suya or utensils could also be a good source of contamination.

Shigella, *Salmonella* and *Klebseilla* sp. were not isolated from the University of Ibadan staff club suya. The situation differed from that of Sabo. *Klebseilla* sp. counts of 10^6 and 10^7/g from raw and spiced chicken suya dropped to zero after processing and before and after heating the second day. Beef suya microbial counts showed a high prevalence of *Klebseilla* sp. in raw beef suya (10^7/g), but then dropped after spicing and processing but was however observed in the product the second day before and after heating (10^6 and 10^5/g, respectively). Neither *Salmonella* nor *Shigella* was isolated from both types of suya In the General gas area samples, *Klebseilla* sp. was isolated from raw beef suya (10^7/g), spiced (10^5/g) and second day before (10^3/g) and after heating (10^5/g); that obtained for chicken suya was 10^6/g - raw, 10^5/g - spiced, 10^3/g - processed, 10^4/g - second day before heating and 10^3/g - second day after heating. Generally, the result showed that *Klebsiella* sp. had the highest count of 6.7×10^6/g in raw beef suya samples.*Klebsiella* sp. is ubiquitous in surface water and reservoirs. It is also present in the gut and epithelial lining of cattle. Improper handling of cattle during slaughtering can result in contamination of the carcass which is bought for suya production. Unfortunately, suya vendors have little concern and knowledge about the quality of water to use. This calls to question the hygiene and sanitation practices of these locations where suya is produced as well as the quality of the water used. Thus, the issue of cross-contamination of the product is quite certain. For instance, bare hands

used in handling meat, utensils and money at the same time could be greatly implicated.

The reduction of microbial count in processed suya was due to heating during roasting. *E. coli* counts were reduced from $3.3x10^6$/g in the raw suya to 3.3×10^4/g in the processed suya. This value still exceeds the tolerance level (10^5/g total count) reported in literature (Pace, 1975; Solberg et al., 1975). Similar results were obtained for *Klebsiella* sp. in beef and chicken suya (3.3×10^2/g and *S. aureus* with 3.3×10^1/g in beef and 3.3×10^4/g in chicken suya). Heating the second day before sales was done in a way to minimize shrinkage of the suya and thus, the insufficient heating would not destroy the micro organisms which had contaminated the suya overnight.

Conclusion

It was observed that the microbial counts of chicken and beef suya were at levels that pose health implications for consumers. The results also buttressed the need to educate suya vendors on personal hygiene and environmental sanitation practices during handling products to prevent cross contamination, thereby making available to consumers quality snacks

REFERENCES

Bryan FL, Michanie SC, Alvarez P, Paniagua A. (1988). Critical control points of street vended foods in the Dominican Republic. J. Food Production. 51: 373-383

Cowan ST, Steel KJ (1974). Manual for the Identification of Medical Bacteria, 2nd Edition. Cambridge University Press, Cambridge, U.K.

Eriscon CD, Pickering LK, Sullivan P, Dupont HL (1980). The Role of Location of food Consumption in the Prevention of Traveler's Diarrhea in Mexico. Gastroenterol. J. 79: 812-816.

Etok OE (1998). The Street Food Trade in Africa: Safety and Socio-Environmental Issues. Food Contr. J. 9 (4); 211-215.

Harris ND, Martin SR Ellias L (1975). Bacteriological quality of Selected Delicatessen Foods. J. MilkFood Technol. 38: 759-764.

Idio ES (1995). Nutritional Sensory and Bacteriological Evaluation of Ready-to-eat clam meat. B.Sc. Project. University of Uyo, Nigeria.

Igene JO (1983). Total Plate count and Coliform Density for Retail suya (tsire) Tropical Vet. J. 1: 85-91.

Igene JO, Abulu EO (1984). Nutritional and Bacteriological Characteristics of Tsire-type suya a Popular Nigerian Meat Product. J. Food Prod. 47: 193-196

Mermeistein NH (1993). Controlling *Escherichia coli* 0157: H7 in Meat. Food Technol. J. 47: 90-91.

Pace PJ (1975). Bacteriological quality of delicatessen foods: Are Standards needed? J. Milk Food Technology, 38: 135-137.

Snedecor GM, Cochran (1989). Statistical Methods. Iowa State. University Press. Ames. Iowa, pp. 297-388.

Solberg M, Miskinuri DK, Martin BA, Page G, Golderer S, Libfield M (1975). What do Microbiological Tests Tell Us about the Safety of Foods? Food Production Development J. 10: 72-74.

SON (Standards Organization of Nigeria) (1996). Standards. Organization of Nigeria and Consumer Protection. Paper delivered at a Workshop on Street Food Organized by Nigerian Institute of Science and Technology, University of Agriculture Umulike, Nigeria. 5-6 March.

Tjoa WS, Dupont HL, Sullivan P (1977). Location of Food Consumption and Traveler's Diarrhea. Am. J. Epidemol, 106: 61-66.