Nutritional and Bacteriological Characteristics of Tsire-Type Suya, a Popular Nigerian Meat Product

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ABSTRACT

Tsire products were obtained from a number of retail producers (6 to 40) in Maiduguri, Nigeria, and examined for unit weight variations, nutrient composition changes due to processing and for their microbiological quality. Unit retail weight differed significantly (P<0.01) among producers. Each 116-g mean retail piece of finished product contained 68 g of protein and 19 g of fat. Total bacterial and coliform counts in tsire products exceeded acceptable limits for delicatessen items, suggesting unsanitary conditions. The level of organisms in the products was significantly (P<0.01) related to handling at the retail level. Identification of bacterial genera in tsire revealed the presence of Bacillus, Strep-tococcus, Staphylococcus, Escherichia, Proteus, Pseudomonas and Klebsiella.

Suya is a popular, traditionally processed, ready-to-eat Nigerian meat product, which may be served or sold along streets, in club houses, at picnics, 'state parties', restaurants and within institutions (12). Tsire is a delicatessen item since it does not receive any treatments designed to extend its shelf-life (9). It is a mass-consumer fast food whose consumption is now invariant with respect to ethnicity, religion, socio-economic factors or sex in Nigeria (11).

There are, however, three main forms of suya; namely tsire, kilishi and balangu. A comprehensive description of these products has been reported by Alonge and Hiko (2) and Igene and Mohammed (12). Of the three forms of suya products, tsire is the most commonly preferred. To most consumers, tsire is therefore synonymous with suya.

Tsiare is a roasted boneless meat of either mutton, beef or goat that is cooked around a glowing fire in which the meat pieces are staked on wooden sticks, spiced with peanut cake, spices, vegetable oil, salt or other flavorings (2). The sticks are then arranged around the fire for roasting (20-30 min).

Although technical progress is the key to increasing food production, research information is lacking about many aspects of suya production. Although Igene and Mohammed (12) have reported studies on consumer preferences and attitudes to tsire, there is a dearth of scientific information on the nutrient composition and quality of tsire meat products. In view of the growing importance of this indigenous fast food, it has become desirable (11) to elucidate its nutrient composite changes under various local processing conditions. Knowledge gained could help to promote sound nutrition and public health education regarding tsire consumption.

The tremendous growth in production and consumption of tsire products has also prompted a great deal of concern regarding their microbiological quality (12). An evaluation of the microflora of these products has therefore become necessary. Suya products can become contaminated microbiologically from raw materials, handlers and/or equipment. Other factors to consider include the type of suya, retail conditions, temperature and consumer handling practices. This study was therefore undertaken in part to assess the bacterial characteristics of tsire from the point of view of tsire - stand - location (environment) and storage conditions during preparation and retail. Microbial investigations determined total viable counts, coliform density and the identity of some of the contaminating microflora under the existing traditional methods of product delivery.

MATERIALS AND METHODS

Chemical analysis

Tsire samples (made of beef) were first obtained from 40 randomly selected tsire - stand - locations in the streets of Maiduguri, Nigeria. In each location, 3 - 5 samples of tsire (both raw and processed) were taken and weighed. In all, a total of 352 tsire samples were analyzed for weight variations. Analysis of variance (20) was performed on the net weight of tsire with respect to weight changes due to roasting and also in relation to product weight variations among producers.

Raw and roasted samples of tsire used for chemical analysis were also randomly selected from 10 different tsire producers in the Maiduguri metropolis. The chemical indices determined included moisture, protein, fat and ash. Each tsire (raw and roasted) was separately ground using a Kenwood meat grinder with 1/8 in. (3 mm) plate, thoroughly mixed and labelled.

Moisture. Moisture content was determined according to the AOAC method (4) using an air oven at 100°C for 12-18 h. Duplicate determinations were carried out for each sample.

Ash. A known weight (duplicates) of the oven-dried samples was used and ignited in a muffle furnace at 525°C for 9-12 h.
Microbial evaluation of product

Collection of samples. Tsire products (beef) used for the study were obtained from six randomly selected popular retail locations (with replication) also in the city of Maiduguri. All samples were transported immediately (max. 20 min) to the laboratory in sterile food flasks as secondary containers.

Experimental design. Samples were analyzed for their microbial quality using the following experimental treatments: (I) raw tsire, (II) freshly roasted tsire, (III) roasted tsire stored for 6 h, (IV) roasted tsire stored for 24 h, and (V) roasted tsire stored for 24 h, but reheated for 2-3 min.

All samples were stored at ambient temperature with the producers by special arrangement. Following preliminary trials, two replications each for locations and storage treatments (2 x 6 x 5) were adopted for evaluation of experimental objectives. Tsire samples were prepared for plating by blending 50 g of product in 450 ml of 0.1% peptone water for 2 min. Duplicate plates were prepared for each sample and samples were examined for their total aerobic plate count (APC) and coliform density. Four plates prepared with (3) blood agar base (Oxoid) were incubated at 37°C for 48 h and APC was determined. MacConkey broth (Oxoid) containing fermentation tubes (6,10) for MPN was used to estimate coliforms. Tubes showing gas within 48 h were considered positive for coliforms. A loopful of broth was transferred from the gas-positive tubes to tubes containing 2% brilliant green bile broth (BGBB). These tubes were incubated in a water bath at 44.5°C. Tubes showing gas within 48 h were considered positive for fecal coliforms, and were streaked onto Levine eosin methylene blue agar (BBL) to detect Escherichia coli.

Isolation and identification of bacteria. Six to eight typical and atypical colonies were randomly selected for identification from nutrient agar (Oxoid), MacConkey agar (Oxoid) and blood agar base (Oxoid) in relation to storage treatments after duplicate plating of the food samples and incubation at 37°C. Bacterial cultures were characterized on the basis of colony, cellular morphology and cultural tests. The following tests: gram stain, catalase test, carbohydrate fermentation tests, sulfide production, urea hydrolysis, motility test, coagulase test, nitrate reduction, anaerobic growth, MR-VP test, and starch hydrolysis where appropriate were used to identify isolated colonies (5).

Statistical analysis. Analysis of variance was performed on the logarithm of the total plate count per g and on the log of coliform density per g, using the method of Steel and Torrie (20). The significance between treatments was determined using Tukey’s test for multiple comparisons according to Steel and Torrie (20).

RESULTS AND DISCUSSION

Analysis of the chemical composition of tsire, indicated variations between the raw and roasted products, including product weight variations among producers. Results in Table 1 show that weight difference between raw and roasted products represents about 18% and was statistically (P<0.01) significant. Results showed that the weight of tsire differed significantly (P<0.01) among producers. It was reported that tsire products are not uniform or critically standardized in terms of size or quantity and type of lean meat, fat, spices, other seasonings, roasting time or temperature (1). Tsire has remained largely a traditional product, hence the lack of adequate standardization to date.

Chemical characteristics

The chemical composition of tsire is shown in Table 1. The moisture content in unroasted (raw) tsire varied from 67.5 to 70.5%, while the level in the roasted products varied from 20.7 to 26.8%. The ash content in the roasted products was higher (0.7 to 3.1%) than the ash content in unroasted (0.9 to 1.6%) products.

The level of protein varied from 19.2 to 23.3% in the raw product; following roasting the protein content increased from 56.9 to 60.6%. The fat content in the raw products varied from 6.2 to 10.3%, while in the roasted products fat levels were from 11.4 to 18.4%. From the data (Table 1) it is obvious that tsire is a valuable nutritional product, and an ideal source of good protein. Each 116-g mean retail piece of the product could supply about 68 g of protein and about 19 g of fat. The Nigerian food supply currently does not provide nutrients adequate both in terms of calorie/protein balance for the proper nutrition of the teeming population. One of the targets is therefore to increase the daily animal protein intake from the present low level of under 7 g/day to more than four times that figure by the end of the decade (17). Igene and Mohammed (12), in their recent study of consumer attitudes/preferences for tsire, reported that consumers show great preference for the product because they consider it a good source of dietary protein and energy. There is certainly a great need for detailed scientific information regarding the nutritional and health aspects of this popular fast food (11).

Bacteriological characteristics of tsire

Effects of storage treatment. Tsire is a product that is usually prepared in open places and in city streets. Consumers most often buy it as a take-away or eat it immediately. In most instances, consumers request that the roasted product, if cold, be reheated following selection and purchase. This part of the study sought to evaluate the effect of ambient storage conditions and holding-time on total bacterial number and coliform density of tsire prod-

<table>
<thead>
<tr>
<th>Table 1. Nutritional characteristics of tsire meat productsa,b. Values are in ± mean S.D.</th>
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</thead>
<tbody>
<tr>
<td>Nature or product</td>
</tr>
<tr>
<td>Raw tsire</td>
</tr>
<tr>
<td>Roasted tsire</td>
</tr>
</tbody>
</table>

aTsire samples (352) were obtained from 40 vendors, representing 176 each of raw and roasted samples; weight expressed in kilograms. 
bValues for chemical composition are expressed in percent.
products in relation to the surrounding environment of preparation and retail. Results in Table 2 indicate that raw tsire before roasting is of very poor bacterial quality, suggesting that reheating of cold products is essential from the public health stand point. This is probably the reason that a growing number of enlightened consumers insisted on a "hot" stick of tsire (12). Results in Table 2 show no significant differences among treatments II, III and V on the total bacterial quality of the product. The effects of treatment conditions regarding coliform density in tsire (Table 2) show that the raw product was also significantly (P<0.05) higher in coliform than the roasted product. Coliform density did not differ significantly (P>0.05) among treatments II and V.

According to Pace (18) and Solberg et al. (19), bacterial counts exceeding 10^5/g or coliform counts higher than 10^2/g in delicatessen food products are indicative of dangerous contamination. Mean APC and coliforms in tsire products varied from 6.24 x 10^3 to 1.4 x 10^9 and 8.5 x 10^2 to 2.0 x 10^3/g respectively. Bacterial quality of tsire products therefore appears to be below acceptable limits and the products may contain food poisoning pathogens of public health significance such as salmonellae, shigellae, staphylococci, etc. (9,15). However, it may be unrealistic to use bacterial quality guidelines developed for different product(s) and in other countries to judge the wholesomeness of tsire products. It is therefore imperative that for an objective assessment of the bacterial quality of tsire products, it is necessary to establish acceptable limits under the present Nigerian traditional methods of product delivery.

**Effect of product environment.** The analysis of variance regarding the influence of environmental sanitation on the microbial population (Table 3) showed that it was a highly significant (P<0.01) factor in the quality of retail tsire. There were significant (P<0.05) differences among tsire vendor locations in the city. The results of this study could well apply to any other Nigerian City, urban or rural. Most Nigerian towns and cities are currently plagued by congestion, domestic and industrial wastes, which could adversely affect the sanitation of foods, especially highly perishable and unpackaged, ready-to-eat food products. In a recent study by Igene and Mohammad (12), it was reported that consumers consider the prevailing poor sanitation of the product environment in most places as a significant (P<0.01) negative factor regarding the aesthetic appeal of suya products.

**Bacterial isolates.** Qualitatively, seven bacterial genera, Bacillus, Streptococcus, Staphylococcus, Escherichia, Proteus, Pseudomonas and Klebsiella were identified. All of the seven genera were detected in the raw unroasted products (I). Bacillus, Streptococcus, Staphylococcus and Klebsiella were found in the freshly roasted products (II). With the exception of Pseudomonas, all the other six genera were detected in treatments III and IV. However, only three genera, Bacillus, Klebsiella and Staphylococcus were found in treatment V. It is a matter of public health importance that the presence of bacteria capable of causing food poisoning and/or infection be eliminated in retail tsire through improved handling practices.

In terms of a quantitative relationship, E. coli constituted more than 30% of the isolates in storage treatments I, III and IV. E. coli was not detected in fresh-roasted products (II) or in products reheated following 24 h of storage (V). E. coli is considered a significant pathogen in cases of traveller's diarrhea and in gastrointestinal illness in developing nations and other localized areas characterized by poor personal hygiene (16). Consumers could therefore be advised to shun "cold" tsire and insist on "hot" tsire. Fecal coliforms were highest in the raw unroasted (I), least in treatment (V) and absent in the freshly roasted (II) products. Fecal coliforms appear to be more sensitive than other members of the coliform group to injury or destruction by dry-cure ingredients and/or curing conditions (14). They are also probably very sensitive to injury by heat, as observed in this study.

Bacillus, especially Bacillus cereus represented about 20-25% of the total isolates and was present in most treatments. B. cereus is known to be widely distributed in foods and has been implicated in two types of foodborne illness characterized by symptoms of vomiting and diarrhoea similar to those encountered in staphylococcal intoxications (8,13). The levels of this genera as Staphylococcus and Streptococcus, though rather low (5-15%), were detected in nearly all treatments.

### Table 2. Effect of storage treatment on bacterial number of tsire meat products at ambient temperature1. Values are in ± mean S.E.

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Experimental storage treatment</th>
<th>Mean log bacteria/g meat</th>
<th>Mean log coliforms/g meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Raw tsire before roasting</td>
<td>8.17 ± 0.19^b</td>
<td>3.24 ± 0.01^b</td>
</tr>
<tr>
<td>II</td>
<td>Freshly roasted tsire (under 1 h)</td>
<td>7.18 ± 0.26^a</td>
<td>2.92 ± 0.12^a</td>
</tr>
<tr>
<td>III</td>
<td>Roasted tsire stored for 6 h</td>
<td>7.47 ± 0.36^a</td>
<td>2.87 ± 0.10^a</td>
</tr>
<tr>
<td>IV</td>
<td>Roasted tsire stored for 24 h (cold)</td>
<td>7.59 ± 0.21</td>
<td>2.84 ± 0.18^a</td>
</tr>
<tr>
<td>V</td>
<td>Roasted tsire stored for 24 h but reheated</td>
<td>6.86 ± 0.29^a</td>
<td>2.86 ± 0.15^a</td>
</tr>
</tbody>
</table>

^Values between experimental treatments bearing the same superscript are not significantly different at the 5% level.

### Table 3. Effect of tsire vendor location on bacterial quality of the meat product. Values are in ± mean S.E.

<table>
<thead>
<tr>
<th>Experimental vendor locations in the city of Maiduguri</th>
<th>Mean log bacteria/g meat</th>
<th>Mean log coliform/g meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>8.45 ± 0.12^b</td>
<td>2.79 ± 0.11^ab</td>
</tr>
<tr>
<td>II</td>
<td>7.50 ± 0.36</td>
<td>2.90 ± 0.08^ab</td>
</tr>
<tr>
<td>III</td>
<td>8.27 ± 0.23^b</td>
<td>3.12 ± 0.06^bc</td>
</tr>
<tr>
<td>IV</td>
<td>8.40 ± 0.23</td>
<td>3.24 ± 0.01^c</td>
</tr>
<tr>
<td>V</td>
<td>6.79 ± 0.41</td>
<td>ND</td>
</tr>
<tr>
<td>VI</td>
<td>7.02 ± 0.36^a</td>
<td>2.68 ± 0.18^a</td>
</tr>
</tbody>
</table>

^Values between experimental treatments bearing the same superscript are not significantly different at the 5% level. ND = not determined.
It appears that the serious microbiological problem associated with tsire may be related to re-contamination following processing, especially due to lack of appropriate packaging. This calls for adequate reheating of products and better sanitary handling of products during retail. This provisional screening of microflora in tsire certainly requires further critical assessment of the extent of contamination under the various conditions of production, distribution and marketing. One cannot over-emphasize the poor aesthetic appeal of tsire from the public health aspects as far as consumers are concerned (12). A natural sequence of events would be to advocate microbiological guidelines for foods such as tsire to protect the consuming public.

However, an established microbial guideline for tsire could be difficult to enforce for the moment because Nigeria does not have any enforceable or known microbial criteria for indigenous commercial foods. Tsire production is still in its technological infancy because the production methods that have been in use for the past generations are yet to be upgraded or modernized to cope with the increasing consumer demand. The acute shortage of meat proteins, and for that matter a ready-to-eat form, makes it rather impossible for the "discriminating" consumer to make any impact regarding the upgrading of tsire. Although millions of people may be engaged in the production of suya or tsire in Nigeria, the industry is basically backward and has a slow improvement rate. At present there is no comprehensive scientific information about the nutritional and health effects of suya meat products nor is there any information as to the health hazards or otherwise which widespread consumption of the product might pose for the consuming population. Nevertheless, tsire remains a popular fast food in Nigeria.

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