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Microbiological and physico-chemical characteristics of stored *tsire-suya*, a roasted meat product

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ABSTRACT

The physico-chemical and microbiological characteristics of *tsire-suya*, a roasted meat product, stored at varying temperatures (4 ^{o}C, 28 ^{o}C, 40 ^{o}C, 50 ^{o}C, and 60 ^{o}C) for 5 days were studied. The bacteria isolated include *Bacillus subtilis*, *B. brevis*, *B. megaterium*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *S. albus*, *Klebsiella* sp, *Acinetobacter mullei* and *Corynebacterium* sp. The fungal isolates include *Saccharomyces cerevisiae*, *Candida* spp, *Rhodotorula* sp, *Aspergillus niger*, *A. Fumigatus*, *Fusarium moniliforme*, and *Penicillium* sp. Only *Bacillus subtilis* and *B. megaterium*, were isolated from *tsire-suya* stored at 50 ^{o}C and at 60 ^{o}C, and there were no physical signs of spoilage, unlike samples stored at 4 ^{o}C and 28 ^{o}C on which there was discolouration and production of off-odour on the 4th day and 2nd day respectively, and slime production on the 4th day in samples stored at 28 ^{o}C in addition to isolation of spoilage organisms like *Pseudomonas* and even pathogenic organisms like *S. aureus*. The microbial count decreased at all storage temperatures except at 28 ^{o}C where there was an increase. However, 50 ^{o}C and 60 ^{o}C were good for safe storage of *tsire-suya* as no spoilage organisms or pathogenic organisms were isolated at these temperatures. But we will recommend storage at 50 ^{o}C because samples here were not as hard as those stored at 60 ^{o}C. The usual practice of storing *tsire-suya* at 28 ^{o}C should be discouraged as the product is not safe and it is of poor quality when stored at this temperature. The development of the suya industry would be greatly enhanced by this study on time / temperature limits related to storing of *tsire-suya*.

Keywords: Physico-chemical, bacteria, fungi, temperature, *tsire-suya*.

INTRODUCTION

Meat can be processed and consumed in different forms such as boiled, stewed, fried, roasted, smoked and other ready to eat meat products, in all of these; heat treatment is given to the meat which alters its characteristics (Nwabueze and Nwabueze, 2001). *Tsire-suya* also known as "sticked meat" is an important ready-to-eat meat product consumed by a high population of Nigerians. It is a popular, nutritious item of human diet containing amino acids needed to build and maintain body tissues (Donald, 1994). Traditionally, *tsire-suya* is prepared by roasting the meat on fire after sticking and addition of ingredients like table salt, pepper, groundnut and groundnut oil. The unwholesome attitude of some producers and hawkers of the meat product which include processing in dirty environments, inadequate

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covering during sales and working with unclean hands bring about contamination by microorganisms of different species. Uzeh et al. (2006) reported that their isolation of *Escherichia coli* from *tsire-suya* could be as a result of poor hygiene by the producers. They also explained that coliform count of 1×10^2 - 42×10^2 cfu/g obtained by them calls for concern. It has been observed that most ready-to-eat meat products and meat are often displayed in Nigerian markets under poor hygienic conditions and hence contaminated by various microorganisms (Faparusi, 1981). Usually *tsire-suya* is not exhausted in a day which therefore necessitates storage overnight at ambient temperature or hawking of the product later in the night. The need for wholesome meat products cannot be overemphasized because of the ill effects or disease conditions emanating from contaminated meat products.

The objectives of this research therefore are to; isolate microorganisms present in stored *tsire-suya*, determine the microbial populations and assess the physico-chemical characteristics of *tsire-suya* stored at different temperatures and probably suggest the most suitable storage temperature in line with the safety and quality of this meat product.

MATERIALS AND METHODS

Collection of samples

Samples of *tsire-suya* were collected from Surulere, Lagos. Samples were collected in sterilized bottles and taken to the laboratory with minimum delay.

Storage of samples

The *tsire-suya* samples were stored at different temperatures of 4 ^oC in the refrigerator, 28 ^oC (room temperature), 40 ^oC , 50 ^oC and 60 ^oC in the oven for 5 days. Samples were analyzed for physico-chemical and microbiological characteristics every day.

Physico-chemical analysis

Physical characteristics

The stored samples were monitored for physical changes such as slime production, development of off-odour, and discolouration.

Determination of pH

From each sample 10 g were weighed, suspended in 90 ml of distilled water, shaken vigorously and the pH determined with a pH meter.

Determination of moisture content

From each sample 5 g were weighed into a dry and pre-weighed dish. The sample was dried in hot air oven at 100 ^oC for 4-6 hrs. Product moisture was determined in duplicate according to AOAC (1992) method. At regular intervals of 30 mins during the drying operation, samples were taken from the drying product, allowed to cool in a desiccator and weighed. This was repeated until a constant weight was obtained. Moisture was calculated in percentage from the following:

$$\% \text{ moisture} = \text{Loss in weight} / \text{sample weight} \times 100$$

Microbiological analysis of tsire-suya

From each *tsire-suya* sample 10 g were weighed and homogenized in 90 ml of distilled water. Serial dilutions were made. From each dilution 1 ml was plated on nutrient agar, MacConkey agar and potato dextrose agar in duplicates using the spread plate method. Nutrient agar and MacConkey agar plates were incubated at 37 ^oC for 24 hrs, while the potato dextrose agar plates were incubated at 25 ^oC for 72 hrs. Developed colonies were counted from plates having between 30 and 300 discrete colonies, and the mean counts were recorded. The different isolates obtained were sub cultured to obtain pure cultures.

Identification of microbial isolates

The microbial isolates were identified using cultural, morphological, and biochemical characteristics based on standard methods (Talbot, 1971; Buchanan and Gibbons, 1974; Adams and Moss, 2000). Cultural characteristics were as observed on the plates. After Gram staining for bacterial isolates and staining fungal isolates with lacto-phenol blue, morphology was observed under the light microscope- Nikon SE Japan, model number 132757. Biochemical tests done include catalase, oxidase, indole, methyl red,Voges-Proskauer, citrate utilization, urease, starch and gelatin hydrolysis, nitrate reduction, and carbohydrate fermentation.

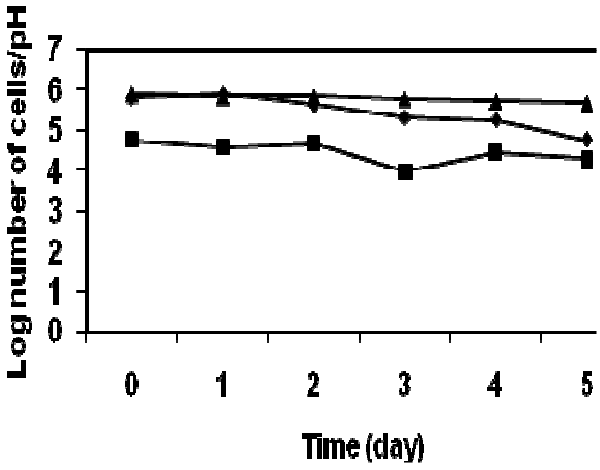
Statistical analysis

There was need to determine if there was any significant difference between the microbial populations in stored *tsire –suya* each day and throughout the storage period. All analyses were done in triplicate. Results of microbial count were analyzed statistically using analysis of variance (ANOVA) with Prism Graph Pad software. Significance was defined at $P < 0.05$

RESULTS AND DISCUSSION

During 5days storage period of *tsire-suya*, the pH was relatively stable (Figure. 1) but signs of spoilage such as green and black colouration, slime production and off-odour were observed in *tsire-suya* stored at 4 ^{o}C and 28 ^{o}C at the end of storage. The spoilage signs started appearing on the 4th day and 1st day in *tsire-suya* stored at 4 ^{o} C and 28 ^{o} C respectively. However, these spoilage signs were not observed in samples stored at 40 ^{o}C, 50 ^{o}C and 60 ^{o}C. These changes could be as a result of microbial activities since different types of microorganisms were isolated from these samples among which were *Pseudomonas* sp. and *Acinetobacter* sp. the organisms which may have played a major role in these changes. Adams and Moss (2000) reported that *Pseudomonas* and *Acinetobacter* are major genera associated with spoilage of meat but with *Pseudomonas* spp. predominating. Uzeh et al. (2006) reported that *Pseudomonas aeruginosa* was resistant to *Afromomum melegueta*, *Piper quineense* and *Capsicum fructescens* all of which are spices and part of the spices used in preparing *tsire-suya*. The bacteria isolated from *tsire-suya* stored at different temperatures include *Bacillus subtilis*, *Micrococcus roseus*, *Micrococcus luteus*, *Flavobacterium* sp., *Pseudomonas putida*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *Alcaligenes faecalis*, *Klebsiella* sp., *Staphylococcus albus*, *Acinetobacter mullei*, *Bacillus brevis*, *Corynebacterium* sp., *Streptococcus* sp., *Bacillus coagulans*, *Bacillus megaterium*, *Bacillus polymyxa*, and *Bacillus* sp. (Table 1). The fungi isolated include *Saccharomyces cerevisiae*, *Candida* sp., *Rhodotorula* sp., *Aspergillus niger*, *Aspergillus fumigatus*, *Fusarium moniliforme*, *Fusarium oxysporium*, and *Penicillium* sp. (Table 1). The samples stored in the oven (40 ^{o}C, 50 ^{o}C, and 60 ^{o}C) were hard and dark in colour. At higher storage temperatures and period, *tsire-suya* lost the highest moisture. Hence the lowest moisture content was recorded on the 5th day at 60 ^{o}C and the highest moisture content during storage was on day 1, at 4 ^{o}C. Generally, the moisture content ranged between 6.88% and 43.18% (Figure 2). *Tsire-suya* stored at 4 ^{o}C and 28 ^{o}C had both bacteria and fungi. However, only few bacterial species mostly of the genus *Bacillus* were isolated from the oven samples but no fungi were isolated. Oven temperatures helped to eliminate most of the microbial isolates present in *tsire-suya*. *Bacillus* spp., due to their sporing nature, were able to survive the oven temperatures. The microbial load of *tsire-suya* decreased all through storage at all storage temperatures except for samples stored at 28 ^{o}C where there was increase in microbial count with the highest count recorded on the 5th day, while the lowest count was obtained from samples stored at 4 ^{o}C (Figure 1). Statistical analysis revealed that there was significant difference in mean microbial load of stored *tsire-suya* at $P < 0.05$. Storage temperature of 28 ^{o}C was the most suitable temperature for most of the microbial isolates, and it is the usual holding or storage temperature for *tsire-suya*. This should therefore be discouraged among producers of this delicatessen meat product.

A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5
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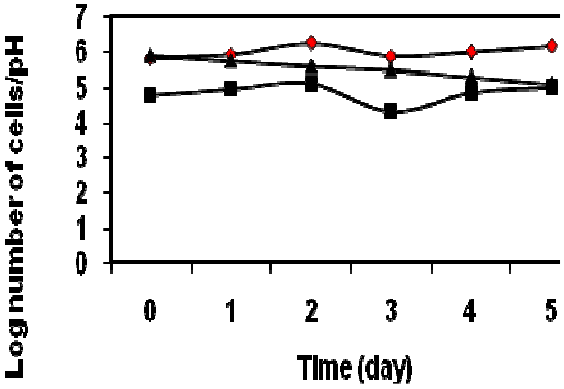
1
2
3
4
5
Time (day)

B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1
2
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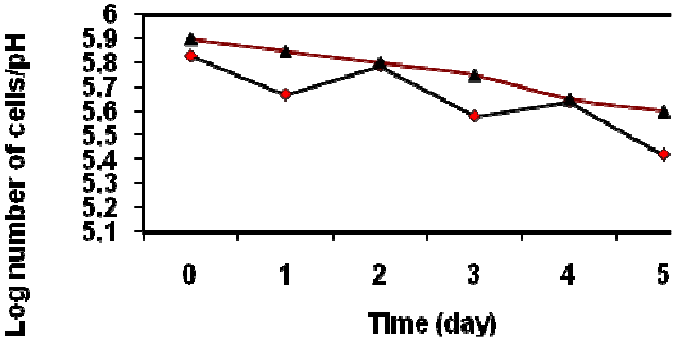
5
Time (day)

C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5
Time (day)

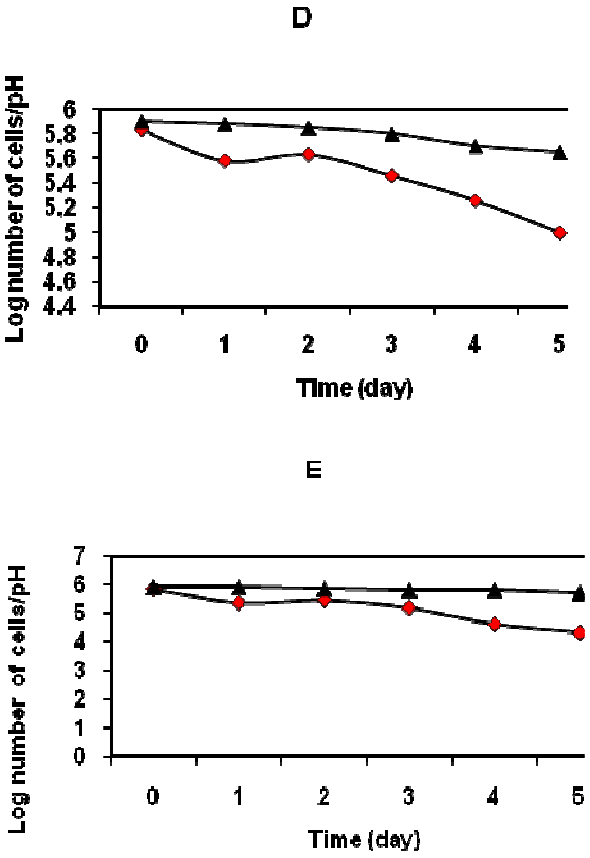

Figure 1: Changes in bacterial count ♦, fungal count ■, and pH ▲, of tsire-suya during storage at different temperatures (A= 4 ºC, B= 28 ºC, C= 40 ºC, D= 50 ºC, E= 60 ºC).

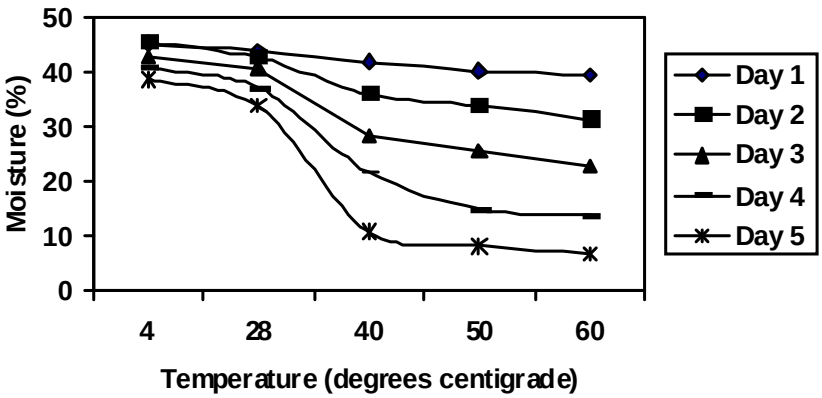

Figure 2: Changes in moisture content of *tsire-suya* during storage at different temperatures.

Table 1: Microorganisms isolated from *tsire-suya* stored at different temperatures.

4 °C	28 °C	40 °C	50 °C	60 °C
Bacteria				
Klebsiella sp.	*Bacillus subtilis*	*B. subtilis*	*B. subtilis*	*B. subtilis*
Staphylococcus albus	*Pseudomonas aeruginosa*	*B. brevis*	*B. megaterium*	*B. megaterium*
Acinetobacter mullei	*Enterobacter aerogenes*	*Corynebacterium* sp.		
	Staphylococcus aureus			
Fungi				
Rhodotorula sp.	*Saccharomyces cerevisiae*			
Saccharomyces cerevisiae	*Candida* sp.			
Candida sp.	*Aspergillus niger*			
Fusarium moniliforme	*Aspergillus fumigatus*			
Penicillium sp.	*Fusarium moniliforme*			

Conclusion

Both physical changes and results of microbiological analysis can be used to determine *tsire-suya* that is safe. We will like to recommend storage at 50 °C for *tsire-suya*. At this temperature only *Bacillus coagulans* and *B. megaterium* were isolated and the meat was not as hard as those stored at 60 °C. They are not food pathogens or spoilage organisms associated with meat or meat products. Although the lowest microbial count was obtained from samples stored at 4 °C, pathogenic and spoilage organisms were isolated and this makes *tsire-suya* not very safe at this storage temperature especially after 3 days.

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