Effects of processing methods and packaging materials on the quality attributes of Suya meat

Joshua Olanrewaju Olaoye, Obafemi Ibitayo Obajemihi, Temiloluwa Charity Metiboba

Department of Food Engineering, Faculty of Engineering and Technology, University of Ilorin, Ilorin, Nigeria

Keywords:

Suya
Grilling
Roasting
Glass jar
Aluminium foil
Yaji

Article history:

Received 14.10.2016
Received in revised form 11.11.2016
Accepted 30.12.2016

Corresponding author:

Olaoye Joshua Olanrewaju
E-mail:
jolanoye@unilorin.edu.ng

DOI: 10.24263/2310-1008-2016-4-2-7

Abstract

Introduction. This study was conducted to determine the effects of processing techniques and packaging materials on the quality of *Suya* meat.

Materials and Methods. Grilling and roasting techniques were used to process lean beef meat each weighing 1.5 kg. After processing, the samples were packaged in four different materials, Glass jar, Aluminium foil, Cling film and Paper up to a period of seven days and the proximate composition of the samples were analysed for ash, crude protein and fat. The moisture content of each sample was also determined in the laboratory. A 2 x 5 factorial experiment was designed to investigate the treatment combination of two methods of *suya* processing (grilling and roasting) with five packaging materials (Glass Jar, Aluminium foil, Cling film, Newsprints and a Control) in a completely randomized design with three replicates.

Results and Discussion. Findings showed that roasting and grilling techniques used in processing of *Suya* meat have effects on its quality. Results showed that the values of crude protein for roasting and grilling were 41.82% and 39.91% respectively while for fat the values were 9.92% and 8.36% respectively, which were significantly different from each other. Furthermore the results also showed that the packaging materials used in handling and preservation of the *Suya* meat samples have significant effect its quality. The results showed that samples stored in Glass jars, Aluminium foil, Cling film and Paper have average values of 6.42%, 6.24%, 5.45% and 5.28% of ash respectively; 40.18%, 38.79%, 38.46% and 37.92% of crude protein respectively; 10.69%, 9.38%, 10.17%, and 11.61% of fat respectively, and 8.06%, 8.17%, 7.33% and 8.13% for moisture respectively. Analysis of Variance (ANOVA) table further revealed that the effect of packaging material is significant at $p \leq 0.05$ on the ash, crude protein, fat and moisture content of the stored *Suya* meat samples.

Conclusions. Processing techniques and packaging materials were found to have effects on the quality of processed and stored *Suya m*eat. In order to have a high quality *Suya* meat, roasting technique should be used for processing and the products are to be handled and stored in Glass jars or Aluminium foils.

Introduction

Suya is a form of processed stick-meat consumed by people in West Africa. It is produced from boneless meat hung on stick and spiced with peanut cake, salt, vegetable oil and other flavourings followed by roasting around a glowing charcoal fire [1]. It originated from the northern part of the country where the population of animals found in the area is large compared with other areas. The processed meat has a unique taste, flavour, colour and texture that distinguish it from other meats which are products of other processing techniques. *Suya* meat is produced from beef or mutton. There are three types of *Suya* namely, T*sire*, *Balangu* and *Kilishi*. The process of preparation of *Suya* meat involves a few steps, first is the grounding of peanut. The shell and the skin are removed from the peanut before grinding into fine powder using mortar and pestle or crushed with a rolling pin. If the powder is oily; it is wrapped with an absorbent paper and squeezed for a minute or two. Next, the grinded pepper, garlic, ginger are stirred into the peanut powder and mixed properly. The meat is then cut into small sizes or thin sliced, dipped and rolled in a bowl containing the mixed peanut-spice and allowed to coat completely. The minced meat are then kept for thirty minutes or more for the peanut cake to stick to it after which the meat slices are threaded unto skewer and brushed with vegetable oil and roasted on the glowing charcoal fire for fifteen to twenty minutes [2].

Today *Suya* meat has gained wide popularity and it is been consumed by majority. Most of the processors of this meat were found in strategic locations and were people who does not have much formal education and as a result still uses traditional methods of handling, processing and packaging the products, which are considered to be unhygienic, unsafe and can result in rapid deterioration of the processed meat if not consumed within a short period of time. The processors have been accustomed to collecting old newspapers from different homes and using same to package *Suya* meat for their customers, which are considered to be dirty and dusty, also in some homes where chemicals were being used to control insects like cockroaches and mosquitoes, there is tendency of the chemicals being sprayed on the newspapers, which the chemicals when in contact with the meat and being consumed can poised serious health issues. Besides the fact that the use of old newspapers in packaging of *Suya* meat product does not give a good professional image to the processor, the printed inks on the papers contain pigments, colorants, binders, additives and photo initiators [3] which can be harmful to the health of the consumer.

Packaging does not only ensure that foods contains and maintains the amount and forms of the required ingredient and nutrients but also improves the sensory quality and colour stability. It has been demonstrated that food packaging can retard product deterioration, retain the beneficial effects of processing, extend shelf-life and maintain or increase the quality and safety of food [4]. Therefore it is important that food packaging materials should possess proper mechanical, thermal and optical properties for foods. In addition anti-microbial and barrier functions against gases, vapour and aroma are also important in food packaging materials [5]. *Suya* meats are to be stored between 50 to 60^0C to disfavour the growth of microbes [6].

The principal roles of packaging are to protect food products from outside influences and damages, to contain the food, and to provide consumers with ingredient and nutritional information [7]. Packaging maintains the benefits of food processing after the process is completed, enabling food to travel safely for long distances from their point of origin and still be wholesome at the time of consumption. It is in view of these that this study was conducted to investigate the effects processing methods and packaging materials on the quality attributes of *Suya* meat.

Materials and methods

The materials and equipment that were used to carry out this research and the basis for their selection and also some of their standard properties were discussed. This is with reference to existing packaging materials in Nigeria for processed *suya* meat [8, 9, 10, 11] and the details are as follow:

Glass Jar. A glass jars which are impervious to moisture, gases and microorganism were used. It has a density of 2.52 kg/m^3 [12].

Aluminum foil. Aluminum foil is used as the second packaging material with a thickness of 0.0065 mm with a specific gravity of 2.7, melting point of 660^0C and a thermal conductivity of 235W/m.K. The molecular structure of the metal provides a high performance barrier. The naturally occurring oxide acts as a shield in the presence of oxygen in the atmosphere which makes it to be corrosion resistant. It is chemically resistant when in contact with substances with in the pH scale of range 4-9. It is non-absorbent and proof against water, oil and grease and other liquids.

Cling film. A thin film of flexible transparent polymer that clings to itself and to food containers to form a tight seal, which offers strong tear resistance, it is highly impermeable to oxygen and water and also has excellent organoleptic properties which does not affect the taste of the product.

Paper (Newsprint). Paper made from thin material produced by pressing together moist fibres of cellulose pulp derived from wood and being dried into flexible sheets was used.

Processing Techniques. Two processing techniques were used in the preparation of *Suya* meat. These techniques were grilling and roasting. Two processing techniques are appropriate for meat conditioning and processing that can mitigate spoilage [11, 13].

Grilling Method. The grilling method for the Preparation of *Suya* meat was carried out at a *Suya* processor spot at Tanke Oke-odo, Ilorin, Kwara State, Nigeria. The process of preparation involved the following unit operations as earlier adopted by [13]. The procedure includes spice mixing, cleaning, size reduction, placing on grill, grilling and cooling.

Spice Mixing. The spices used in preparing the ingredient were purchased from specialized spice market. They included red pepper (*Capsicum fructescens*), Seasoning (*Monosodium glutamate*), Maggi (*Levisticum officinales*) Curry powder (*Trigonella foenum*), salt (*Sodium chloride*) and *Yaji* sauce.

Cleaning. 1.5 kilogram lean meat from beef was bought from the meat market and cleaned in a potable water to get rid of all dirt

Size Reduction. The meat was sliced into thin fillets manually by the use of a sharp edge of knife in order to remove undesirable materials and to increase the surface area

Placing on Grill. The pieces of meat were placed on the grill and sprinkled with the ingredients and about 5ml of groundnut oil for grilling

Grilling (Heat Process). Grilling was achieved by the grill method where the pieces of meat were placed on the grill directly over a burning mass of charcoal and firewood. The meat pieces were allowed to stay on fire for about thirty minutes. The pieces of meat were turned and sprinkled with the ingredient and groundnut oil at regular intervals to avoid burning

Cooling. After the grilling process, the fillets of meat were cooled and sprinkled with *Yaji* sauce.

Roasting Method. The roasting method for the preparation of *Suya* meat was carried at the Food Science laboratory, Faculty of Agriculture, University of Ilorin following the processing steps highlighted by [13]. The process of preparation involved spice mixing, cleaning, size reduction, placement on oven rack, roasting and cooling.

Placement on Oven Rack. The pieces of meat were placed on the oven rack and sprinkled with the ingredients and about 5ml of groundnut oil for Roasting.

Roasting (Heat Process). Roasting was achieved by placing the thin fillet of meat on the oven rack and placed into the oven set at 150 ^{0}C.After twenty minutes; the fillets of meat were flipped and sprinkled with the ingredients and vegetable oil. The total roasting time for both sides of the meat was fifty minutes.

The spices were mixed together in a specific proportion as described in Table 1.

Table 1

Composition of *Suya* ingredient for grilling and roasting techniques

Ingredient constituents	Proportion by weight (g)	Percent proportion in mixture (%)
Curry powder	10	9.01
Seasoning	10	9.01
Condiment	36	32.43
Red pepper	5	4.50
Salt	50	45.05
Total	111	100.00

Packaging. After *Suya* meat was prepared by the grilling and roasting method. Fifty (50) grams of *Suya* meat samples were weighed and filled into the packaging materials [14]. Each packaging material was labelled based on the design setup.

Experimental Design. A 2 x 5 factorial experiment was designed to investigate the treatment combination of two methods of *suya* processing (grilling and roasting) with five packaging materials (Glass Jar, Aluminium foil, Cling film, Newsprints and a Control). The factorial experiment was carried out in a completely randomized design with three

replicates. The factors considered were five packaging materials and two treatment techniques for *suya* processing.

Methods for Evaluating *Suya* meat Quality. The packaged *Suya* meat was taken to chemistry laboratory, University of Ilorin for proximate analysis. The analysis was carried out at six hours interval for seven days.

Determination of Ash content of *Suya* meat. This was carried out as described by [15].The crucible was washed and dried in the oven and allowed to cool in a desiccator and weighed 2g of *Suya* sample was weighed into an empty porcelain crucible which had been previously ignited and weighed. The *Suya* sample was then ignited over a hot plate in the fume cupboard to char organic matter. The crucible was placed in a muffle furnace maintained at a temperature of 600 ^{0}C for hours and transferred directly to a desiccator, cooled and weighed immediately. The calculation of the percentage ash was determined using equation (1).

$$\%Ash = \frac{W_3 - W_1}{W_2 - W_1} \cdot 100 \quad (1)$$

where:

W_1 = Weight of empty crucible (g)

W_2 = Weight of crucible + suya sample (g)

W_3 = Weight of crucible +ash (g)

Determination of Moisture Content of *Suya*. This was carried out as described by [16]. 2g of *Suya* sample was weighed into a Petri-dish which has been weighed previously, and then the Petri-dish was transferred into the oven at 101 ^{0}C until constant weight was achieved. The Petri-dish and the *Suya* sample were reweighed after cooling. The calculation of the percentage ash was determined using equation (2)

$$\%Mc = \frac{W_2 - W_1}{W_3} \cdot 100 \quad (2)$$

where:

M_c = Moisture Content (%)

W_1 =Weight of dried Petri-dish (g)

W_2 = Weight of *Suya* sample + Petri-dish (g)

W_3 = Weight of dried *Suya* sample (g)

Determination of Crude protein of *Suya*. This was carried out as described by [15]. 2g of *Suya* sample was mashed in a sterile laboratory type mortar and pestle. The mashed *Suya* sample was shaken with 100ml of 0.05M of sodium hydroxide solution for fifteen minutes. It was then centrifuge for ten minutes in a 500ml graduated cylinder. 5ml clear extract was added to 50ml with 30% sulphur salicylic acid solution. It was inverted several times and immediately the degree of turbidity at 450nm in a 4cm cell read against sulphur salicylic acid solution as instrument blank. The percentage protein content was determined using the equation as shown in equation (3).

$$Y=2.53+18.20X \quad (3)$$

where:
Y = Calorimeter reading
X =% protein

Determination of Fat Content of *Suya*. This was carried out as described by [15]. 2g of the *Suya* sample was stirred with 2ml of alcohol and then 7ml of concentrated hydrochloric acid and 3ml of water was added. The *Suya* sample was heated at about 80^0C for about an hour. 10ml of alcohol was added to the cooled hydrolysed mixture followed by 25ml of light petroleum and the fat extracted three times of 25ml of the ether.

The percentage fat content was determined using the equation 4.

$$\%\, fat = \frac{W_1 - W_2}{W_3} \cdot 100\,, \quad (4)$$

Where:
W_1 = Weight of *Suya* sample in the flask before removal of fat (g)
W_2 = Weight of *Suya* sample in the flask after removal of fat (g)
W_3 = Weight of *Suya* sample (g)

Results and discussion

It can be seen in Table 2 the effects of method of processing, packaging materials and hours of preservation on the proximate compositions (ash, moisture, crude protein and fat) using Analysis of Variance (ANOVA). To check the level of significance at ($p \leq 0.05$).

Table 2
Effects of method of processing (M), packaging materials (P) and hours of preservation (H) on the quality attributes of *Suya* meat.

Quality attributes	M	P	H	M*P	M*H	P*H	M*P*H
Ash	0.452	0.000*	0.734	0.721	0.886	0.000*	0.975
Moisture	0.156	0.000*	0.002*	0.002*	0.233	0.308	0.360
Crude protein	0.000*	0.001*	0.004*	0.467	0.634	0.830	0.830
Fat	0.000*	0.000*	0.000*	0.000*	0.991	1.000	1.000

* Significant at $p \leq 0.05$

The analysis of variance test on Table 2 showed that the packaging materials (Paper, Cling film, Aluminum foil, Glass jar) are statistically significant on the dependent variables (ash, moisture, crude protein and fat) in which the p-values are 0.000, 0.000, 0.001 and 0.000 which are less than 0.05. Also the hours of preservation are statistically significant on the dependent variables (moisture, crude protein and fat) in which the p-values are 0.002, 0.004 and 0.000 which are less than 0.05. Meanwhile the interaction between the two study parameters (P and H) were also statistically significant on the dependent variable ash in

which the p-value is 0.000 and the interaction between the two study parameters (M and P) were also statistically significant on the dependent variable (moisture and fat) in which their p-values are 0.002 and 0.000 which are less than 0.05.

From Table 2 It can be inferred that all the variables of interest, method of processing, packaging materials (Paper, Cling film, Aluminum, Glass jar) and hours of preservation were statistically significant on all the dependent variables; ash, moisture, crude protein and fat except ash in which the method of processing and hours of preservation do not have any significant effect. Table 3 showed the multiple comparisons for packaging materials using Duncan's New Multiple Range Test (DNMRT).

Table 3

Multiple comparison using the Duncans' New Range Test for packaging materials

Quality attributes	Packaging materials				
	Glass jar	**Aluminium foil**	**Cling film**	**Paper**	**Control**
Ash	6.4212[a]	6.2474[a]	5.4476[b]	5.2831[b]	5.3450[c]
Moisture	8.0560[b]	8.1679[a]	7.3343[b]	8.1252[a]	5.3400[c]
Crude protein	40.1800[a]	38.7879[a]	38.4605[b]	37.9250[c]	38.3033[c]
Fat	10.6881[a]	9.8383[c]	10.1660[c]	11.6129[a]	12.3933[a]

Mean with the same alphabet are not significantly different from each other.

The Duncan New Multiple Range Test (DNMRT) for packaging materials on Table 3 showed the different mean values of the quality attribute in the materials. It can be inferred from Table 2 that the mean ash of *Suya* in Glass jar was 6.42 and Aluminium foil was 6.27 and were significantly higher than those in Cling Film of 5.45 and paper of 5.28. Ash refers to any inorganic material such as minerals, present in food; it is called ash because it is the residue that remains after heating removes water and organic materials such as fat and protein. The variation in the ash content may be as a result of the properties of the various packaging materials. The permeability of packaging materials is of importance in retaining the desirable nutrients or in permitting undesirable components to permeate through the Packaging materials from the ambient temperature [17].

The mean moisture of *Suya* in paper was 8.13 and was significantly higher than those in Glass jar which was 8.06, Aluminium foil was 8.16 and Cling Film was 7.33. Moisture refers to the presence of a liquid especially water in trace amount. A higher increase of moisture in paper is due to the highly porous cellulose fibers of paper, they readily absorb moisture from their environment or in contact with the food as reported by [18]. The decrease in moisture content of Glass jar, Aluminium foil may be as a result of their impermeability to gas and water. Moisture rich foods are easily susceptible to microbial attack which can affect the quality of the food material. The mean crude protein of *Suya* in Glass jar was 40.18 and Aluminium foil was 38.79 which were significantly higher than those in Cling Film which was 38.46 and 37.93 in paper. The high Crude protein content agrees with [19] who reported that meat with intermediate moisture contents are less bulky and have higher protein than those with high moisture content. The impermeablity properties of Glass jar and Aluminium foil brings about a variation in the crude protein content when compared to Cling film and Paper that has low permeability.

The mean fat of *Suya* in Paper was 11.61 and was significantly higher than those in Cling Film with a value of 10.17 and Aluminium foil has a value 9.84 while sample stored in Glass jar has a mean value of 10.69. An increase in the fat content of *Suya* in paper may be as a result of possible hydrolysis reaction due to the action of lipolytic enzymes or moisture [20]. Paper is not a good packaging material because it has poor barrier properties and they readily absorb moisture and air from their environment or in contact with the food. Oxidation of fat causes rancidity in food.

It was also found that the hours of preservation had effects on the moisture content of the stored samples as shown in Table 4, an increase in the hours of preservation leads to an increase in moisture content and crude protein but decrease in fat content of the samples.

Table 4

Multiple comparison using the duncan new range test for hours

Quality attributes	Time of preservation (hours)		
	6	**12**	**18**
Moisture	7.5979[b]	7.8633[a]	8.0148[a]
Crude Protein	38.4490[b]	38.8633[a]	38.8660[a]
Fat	10.7879[a]	10.6802[b]	10.6183[b]

Mean with the same alphabet are not significantly different from each other.

Method of processing also has effect on the quality of the processed samples. Table 5 shows the mean crude protein of *Suya* using the roasting technique and the value was 41.82 which was significantly higher than that of the grilling technique of 39.92 value. Roasting refers to cooking food in an oven with dry heat. Most nutrient losses are minimal with this cooking method [11].The decrease in the crude protein content using the grilling technique is due to the fact that grilling is one of the most popular cooking methods because of the great flavour it gives, However up to forty percent of nutrients may be lost during grilling when the nutrient rich juice drops from the meat [11].

The decrease in the fat content using the grilling technique is due to the fact that grilling is usually considered as a low fat cooking method because it renders out food's internal fat during the grilling process. Also grilled meats have a reduced fat content because the fat drips off as the meat is grilled [13].

Table 5

Multiple comparisons using the duncan new range test for method of production

Quality Attributes	Processing techniques	
	Roasting	**Grilling**
Crude Protein	41.8206[a]	39.9192[b]
Fat	9.9183[a]	8.3597[b]

Mean with the same alphabet are not significantly different from each other.

Conclusions

The following conclusions can be drawn from the result obtained in the course of this study:

1. Processing methods used in the preparation of *Suya* meat for consumption have effects on the quality attributes of the final products as the crude protein and fat content of roasted meat were 41.82 and 9.92 respectively which were significantly higher than that of the grilled meat which were 39.92 and 8.36 respectively. The use of roasting technique produced better products when compared with grilling technique.

2. Packaging materials have effects on the quality attributes of the final products of *Suya* meat during storage due to variation in their properties, as the results show that crude protein and ash contents of samples stored in Glass Jar and Aluminium foil were higher than those stored in Cling film and Paper. Results show that samples stored in Glass jar and Aluminium foil have higher qualities and were not found to be significantly different from each other but were significantly different from those stored in Cling film and Paper which were of lower qualities. Therefore in order to obtain the best quality of processed meat, *Suya* meat is to be stored in Glass jar or Aluminium foil. Further research should be focussed on improvement of Cling film and Paper for handling *Suya* meat during storage as they are considered to be more economical and affordable as compared to Glass jar and Aluminium foil which are more expensive.

References

1. Alonge D.O., Hiko, A.A. (1981), Traditional methods of meat preservation and preparation in Nigeria, West Africa farm food proceedings, pp. 19–21.
2. Judge D. M., Robert A. M., Morris M. (2002), Preparation of *Suya* in Africa, *Journal of African foods.* (20), pp. 52–55.
3. Rokade M. M., Rokade P. R., Thakare S. R., Rupvate N. B., Mahale I., Sanjay, R. C. (2012), Formulation design and evaluation of transdermal film of Losartan Potassium using hydrophilic and hydrophobic polymers. *American Journal of PharmTech Research*.8, pp. 22–28.
4. Marsh K., Bugusu B. (2007), Food packaging- roles, materials and environmental issues, *Journal of Food Science*, (72), pp. 23–36.
5. Chin, K.B., Han, S., Ramachandraiah, K. (2015), Nanotechnology in Meat Processing and Packaging: Potential Application –A Review. *Asian-Australasian Journal of Animal Sciences*, 28(2), 290–302. DOI: https://doi.org/10.5713/ajas.14.0607
6. Uzeh, R.E and Akinyemi, M.O (2012), Microbiological and physico-chemical characteristics of stored Tsire-Suya, a roasted meat product. International Journal of Biological Chemical Science (4), 1804-1809.
7. Coles R. (2003), Food packaging technology, London, Blackwell publishing CRC press pp. 1–31.
8. Lockamy A. (1995), A conceptual framework for assessing strategic packaging decisions, *International Journal of Logistics Management*, 6, pp. 51–60.
9. Lamberti M., Esher F. (2007), Aluminium foil as a food packaging material in comparison with other materials, *Journal of food Packaging Material,*pp. 23, 407–433.
10. Page B., Edwards M., May N. (2003), *Food Packaging technology,* London, U.K. Blackwell Publishing, CRC Press. pp 12–51.

11. Franziska S. (2012), How cooking affects the nutrient content of food, https://authoritynutrition.com/cooking-nutrient-content/.
12. Floros J. D., Dock L. L., Han J. H. (1997), Active packaging technologies and applications, *Food Cosmet Drug Packag,* 20, pp.10–7.
13. Becker F. (2014), The difference in roasting and grilling, available at: http://www.livestrong.com/article/457331-recommended-way-to-cook-boneless-sirloin-roast-beef/.
14. Adeyeye S. A. (2017), The role of food processing and appropriate storage technologies in ensuring food security and food availability in Africa, *Nutrition and Food Science*, 47(1), pp. 35–42.
15. Jekayinka S., Omisakin O. (2005),The energy potentials of some agricultural wastes as local fuel materials in Nigeria, *Agricultural Engineering International Journal*, (7).
16. AOAC (2000), *Official method of analysis of the Association of Official Analytical Chemists*, 15th Edition, Washington USA.
17. Floros J. D., Matsos K. I. (2005), Introduction to modified atmosphere packaging, In, Han J. H., editor. *Innovations in Food Packaging*, London , Elsevier Ltd., pp. 159–72.
18. Jong W.R. (2010), Effect of moisture content on tensile properties of paper based food packaging materials, *Journal of Food Science and Biotechnology*, (19), pp. 243–247.
19. Egbuike G.N., Okunbanjo A.O. (2000), *Effects of processing on the quality of Nigerian meat products, Livestock production science*, 59, pp.155–163.
20. Velasco J., Marmesat S., Dobarganes M.C. (2008), Chemistry of frying in deep fat, *Frying of Foods*, pp. 35–36.