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# Proximate, organoleptic properties and lipid stability of *Suya* produced from mutton treated with *Allium sativum* powder

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**Abstract**
The study investigated the impact of *Allium sativum* powder on nutritional composition, eating and keeping qualities of *suya*, an intermediate moisture meat product derived from West African Dwarf (WAD) rams. Meat from *Biceps femoris* muscle of West African Dwarf rams were obtained and trimmed of all adhering muscles, fat and sliced into thin sheets. Muscles were portioned into five treatments of which *Allium sativum* powder was included at 0% (control), 15%, 20%, 25% and 30% in the ingredients constituents. Muscles were marinated with the treatments, skewed and labeled for identification. Skewed raw samples were allowed to stand for 6 hours and roasted in a glowing flame. *Suya* samples were analyzed for chemical properties; coded samples were evaluated for their sensory properties by untrained panelist using nine-point hedonic scale and lipid stability determined by the assessment of Thiobarbituric acid reactive substance. The study showed that inclusion of *Allium sativum* powder in suya marinade influenced significantly ($p<0.05$) nutritional, shear force and Thiobarbituric acid reactive substance (TBARS) values. Ash content and sensorial properties of suya were not significantly ($p>0.05$) influenced by the treatments. However, TBARs values of treatment 5 samples were significantly ($p<0.05$) lower than other treatments as storage period advanced. The study showed that *Allium sativum* powder at inclusion up to 30% in marinades for the processing of *suya*, improved chemical, organoleptic characteristics and delayed lipid oxidation during storage.

**Keywords:** antioxidants; moisture meat; marinades; muscles; sensory properties

## Introduction
Meat, a food rich in protein and other essential food nutrients has the tendency to deteriorate within few hours after slaughtering except it is preserved (Olaoye and Onilude, 2010; *Nychas et al.*, 2008) [1, 2] Meat preservation entails several processing procedures. One of the ways of preserving meat is by converting fresh meat to a more shelf –stable product in form of ready to eat delicacy such as *suya*. In order to produce edible meat products, consumers' interest in relation to their well-being and acceptability should be considered. This can be achieved by the incorporation of safe to eat plant sources such as spice and medicinal herbs into the ingredients. *Suya* is one of the ready-to-eat meat products of flesh and inerts from all animal species. It is traditional spiced, skewed and roasted boneless meat popular among Hausas in Northern part of Nigeria (Omojola, 2008) [3]. S*uya* is one of such intermediate moisture meat products that have short shelf life as a result of its handling during and after production (Adesokan *et al.*, 2008) [4]. The usage of synthetic chemicals as preservative in food is no more acceptable to the consumers even though they are effective, their use should be replaced with natural preservatives to reduce the possibility of residual effect on the consumers' physiological well-being (Yang and Ray, 1994) [5]. In order to reduce this menace research should be geared towards the inclusion of natural substances such as spice and herbs into the ingredients used for the meat processing in order to improve quality and safe guide the health of the consumers. *Allium sativum* (Garlic) is well known as spice and herbal medicine (Javendel *et al.*, 2008) [6] and spices are known to exhibit antioxidant activity due to presence of several phytochemicals (Kochhar, 2008) [7]. The mechanisms of action of spices are on cellular enzymatic pathways (Prasad *et al.*, 2004)) [8]. The aim of this study was to evaluate the impact of *Allium sativum* powder used as marinade on chemical composition, sensory properties and lipid stability of *suya*; an intermediate moisture meat derived from West African Dwarf ram.

## Materials and Methods
### Preparation of *suya* ingredients
The spices for suya ingredient were procured from a reputable source. Constituents of the ingredient were milled separately and mixed together in an appropriate proportion by the modified method of Omojola (2008) [3] (Table 1).

**Table 1:** Composition of *suya* ingredient (g100 $g^{-1}$)

| Items | Treatment 1 0% ASP | Treatment 2 15% ASP | Treatment 3 20% ASP | Treatment 4 25% ASP | Treatment 5 30% ASP |
|---|---|---|---|---|---|
| Red pepper | 6.50 | 3.5 | 2.5 | 2.0 | 1.5 |
| Bonnet pepper | 6.50 | 3.5 | 2.5 | 2.0 | 1.5 |
| White pepper | 6.50 | 3.5 | 2.5 | 2.0 | 1.5 |

| *Allium sativum* powder | 0.00 | 15.00 | 20.00 | 25.00 | 30.00 |
|---|---|---|---|---|---|
| Onions | 16.0 | 10.0 | 8.0 | 6.0 | 6.0 |
| Curry powder | 3.50 | 3.50 | 3.50 | 3.50 | 3.00 |
| Thyme | 3.50 | 3.50 | 3.50 | 3.50 | 3.00 |
| Salt | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Stock cubes | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Vegetable oil | 16.50 | 16.50 | 16.50 | 15.00 | 12.50 |
| Alligator pepper | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Groundnut paste | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

ASP- *Allium sativum* powder

**Preparation of *suya***

The *suya* samples were prepared with fresh *Biceps femoris* muscle (Apata *et al.*, 2013) [9]. 500g each of *Biceps femoris* muscle of WAD rams were cut into thin slices and threaded unto thin sticks (skewer) of about 13-15 cm long. Fifty (50) skewed *suya* were made from each treatment group and labeled for easy identification. These were rolled in a bowl containing the mixed ingredients and allowed to coat completely. The coated muscle was marinated for six hours, after which the skewed meat samples were sprinkled with about 5 $cm^3$ of groundnut oil on each *suya* sample prior to roasting.

**Roasting process of *suya***

*Suya* samples were prepared by the procedure of Omojola (2008) [3]. The labeled *suya* samples were set around a glowing, smokeless fire at 30 cm distance away from the fire point to obtain a desired product. *Suya* samples were turned at interval of twenty minutes to avoid over cooking with constant sprinkling of groundnut oil on the meat samples until they were cooked to internal temperature of 75°C.

**Determination of chemical composition of *suya***

Chemical composition of *suya* sample was determined by the procedures of AOAC (2005) [10]. Crude protein of *suya* samples was obtained using Kjeldahl method. Ether extract was determined by soxhlet extraction method using petroleum ether. Moisture content was determined by drying 10g of *suya* sample in an oven at temperature of 105°C to a constant weight. Ash content of *suya* was determined by igniting the *suya* samples in a Muffle furnace at 550-600°C for 24 hours until ashes were produced.

**Determination of lipid oxidation of *suya***

Lipid oxidative stability of *suya* samples was assessed by the determination of secondary products of lipid oxidation as 2-thiobarbituric acid reactive substances (TBARS) at 7-day, 14-day and 21-day post production, using cohesion bioscience assay kit.

**Measurement of shear force of *suya* samples**

*Suya* sample was sheared by the procedures described by Honikel (1998) [11], at three locations with Warner-Bratzler V-notch blade shearing instrument.

**Sensory evaluation of *suya* samples**

This was conducted according to the method of AMSA (1995) [12] as described by Apata *et al*. (2013) [9]. A 9-member semi-trained taste panel was used to conduct the sensorial properties of the samples. The panelists were provided with unsalted biscuits and water for cleansing of palate in between *suya* samples. *Suya* samples were coded and independently evaluated using a 9-point hedonic scale on where 1 = dislike extremely and 9 = like extremely for, aroma, flavour, tenderness, juiciness, texture and overall-acceptability.

**Experimental Design and Statistical Analysis**

The experimental design of the study was completely randomized design (CRD). Data obtained from this study were analyzed with (SAS, 2002) [13], while the means were separated using Duncan multiple Range test (Duncan, 1955) [14].

**Table 2:** Proximate composition of *suya* from mutton of WAD rams treated with *A. sativum* powder (%)

| **Items** | **Treatment 1 0%** ***A. sativum*** | **Treatment 2 15%** ***A. sativum*** | **Treatment 3 20%** ***A. sativum*** | **Treatment 4 25%** ***A. sativum*** | **Treatment 5 30%** ***A. sativum*** |
|---|---|---|---|---|---|
| Crude protein | 33.00±0.49$^b$ | 32.19±0.94$^c$ | 32.15±0.90$^c$ | 33.55±0.93$^b$ | 36.21±0.39$^a$ |
| Ether extract | 12.83±0.11$^a$ | 12.62±0.29$^a$ | 10.83±0.01$^b$ | 10.76±0.03$^b$ | 10.80±0.11$^b$ |
| Ash | 6.15±1.91 | 6.44±1.95 | 6.34±1.88 | 6.33±1.90 | 6.25±1.86 |
| Crude fibre | 1.01±0.01$^a$ | 0.05±0.01$^b$ | 0.02±0.00$^b$ | 0.02±0.01$^b$ | 0.02±0.00$^b$ |
| Moisture | 44.30±0.21$^a$ | 43.73±0.80$^a$ | 41.56±0.45$^b$ | 40.66±0.76$^b$ | 40.67±0.25$^b$ |

*A. sativum*- *Allium sativum*, mean± standard deviation; a, b, c – means in the same row with different superscripts are statistically significant (P<0.

**Table 3:** Sensory evaluation and shear force value of *suya* produced from mutton of WAD rams

| Items | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 | Treatment 5 |
|---|---|---|---|---|---|
| | 0% ASP | 15% ASP | 20%ASP | 25%ASP | 30%ASP |
| Aroma | 6.45±0.25 | 6.66±0.02 | 7.34±0.05 | 7.25±0.80 | 7.22±0.12 |
| Flavour | 6.23±0.33 | 6.00±0.02 | 6.50±0.04 | 7.00±0.01 | 7.55±0.22 |
| Tenderness | 6.00±0.00 | 6.20±0.12 | 7.10±0.01 | 7.40±0.19 | 7.50±0.08 |
| Juiciness | 6.20±0.44 | 7.60±0.14 | 6.80±0.24 | 7.60±0.14 | 6.60±0.14 |
| Texture | 6.11±0.80 | 6.20±0.61 | 6.00±0.02 | 6.06±0.51 | 6.60±0.30 |
| Overall acceptability | $7.00±0.25^{d}$ | $7.62±0.83^{b}$ | $7.50±0.19^{c}$ | $7.70±0.88^{a}$ | $7.69±0.44^{b}$ |
| Shear force($kg/cm^2$) | $4.19±0.21^{a}$ | $4.11±0.18^{a}$ | $4.20±0.04^{a}$ | $3.55±0.08^{b}$ | $3.96±0.57^{b}$ |

ASP- *Allium sativum* powder; mean± standard deviation, a, b, c, d – means in the same row with different superscripts are statistically significant (P<0.05)

**Table 4:** TBARS values of *suya* at different storage period (mg MDA/Kg meat)

| | Treatment 1 | Treatment 2 | Treatment 3 | Treatment 4 | Treatment 5 |
|---|---|---|---|---|---|
| Storage interval | 0% ASP | 15% ASP | 20% ASP | 25% ASP | 30% ASP |
| 7days | $0.30±0.10^{a}$ | $0.30±0.00^{a}$ | $0.30±0.10^{a}$ | $0.20±0.00^{b}$ | $0.20±0.00^{b}$ |
| 14days | $0.70±0.10^{a}$ | $0.50±0.00^{b}$ | $0.40±0.00^{c}$ | $0.30±0.10^{cd}$ | $0.20±0.00^{d}$ |
| 21days | $0.90±0.10^{a}$ | $0.60±0.00^{b}$ | $0.50±0.10^{b}$ | $0.40±0.10^{c}$ | $0.30±0.00^{c}$ |

ASP- *Allium sativum* powder; mean± standard deviation, a, b, c, means of different superscripts on same row are significantly (p<0.05) different

## Results and Discussion

The result of proximate composition shows that the mean crude protein values of *suya* samples of treatments 1 and 4 were similar. Also, similarity was observed in the crude protein of treatments 2 and 3 while crude protein of treatment 5 was significantly higher (p<0.05) than other treatments. The crude protein values obtained in the study were within the range 32.96 to 33.86% and 28.33 to 35.10% as reported by Oyadeyi *et al.* (2014) [15] and Ogbonna *et al.* (2012) [16] respectively. However, pork loin likely contain more protein than mutton (Soniran and Okubanjo, 2002) [17]. The relatively high level of crude protein value obtained in this study may be due to the effect of protein constituents in the ingredients used during processing (Omojola, 2008) [3]. The mean ether extract of treatments 3, 4 and 5 were significantly lower (p<0.05) than treatments 1 and 2. The result of ether extract obtained for all samples agreed with previous studies (Ogbonna *et al*., 2012; Apata *et al*., 2013; Oyadeyi *et al*., 2014) [16, 9, 15]. The result showed that an increase in the level of *Allium sativum* powder enhanced the reduction of excess fat in *suya* as a result of sulphur-containing bioactive compounds in *Allium sativum* (Chowdhury *et al*., 2002; Niel *et a*l., 1996) [18, 19]. The study revealed that there was no significance difference (p<0.05) in ash content among treatment groups. Ash content values of *suya* samples obtained in the study were closer to the findings of Apata *et al*. (2013) [9]. Ash content present at an appreciable amount in the *suya* samples may be due to the contribution of minerals present in *Allium sativum* powder and other spices used as ingredients. This indicates that *suya* could serve as a potential source of minerals in human diets. The mean moisture content of *suya* of treatments 3, 4 and 5 were significantly lower (p<0.05) than treatments 1 and 2. The results obtained for moisture of *suya* were similar to previous reports (Oyadeyi *et al.,* 2014) [15] however, values were higher than those reported by Ogbonna *et al*. (2012) [16]. The result also showed that moisture contents of *suya* were reduced at higher inclusion level of *Allium sativum* powder this may imply that *Allium sativum* powder has moisture absorption properties while substantial loss of moisture from the samples during roasting may be due to increase in temperature that enhanced moisture escape from the *suya* samples thereby, reducing the water activity ($a_w$) and prevent microbial spoilage in *suya* to certain extent (Odusole and Adeyanju, 2003; Inyang *et al*., 2005) [20, 21]. However, moisture content of *suya*, an intermediate moisture meat in this study is still high (Omojola *et al*., 2004) [22] and it may influence the reduction of its shelf stability where storage facilities are unavailable but on the other hand contributes positively to the sensory attributes such as juiciness, flavour and tenderness (Ogunsola, 2006) [23].

Table 3 shows the results of the sensory evaluation and shear force of *suya* samples. There was no significant difference (p>0.05) between sensory attributes of *suya* samples but significantly differs (p<0.05) in overall acceptability as evaluated by panelist using 9-hedonic scale. The study showed that the most accepted sample was obtained from treatment 4 (25% *Allium sativum* powder). The overall acceptability of *suya* samples as obtained in the study was not similar with earlier findings (Oyadeyi *et al*., 2014) [15]. The shear force of *suya* samples were significantly (p<0.05) influenced by the treatments with the shear force value of *suya* from treatments 1, 2 and 3 having higher value than 3 $kg/cm^2$, an acceptable limit of mutton tenderness, while *suya* from treatments 4 and 5 were closer to the acceptable limit (Bickerstaffe, 1996; Watanabe *et a*l., 1996) [24, 25].

The result of the TBARs of *suya* treated with *Allium sativum* powder is shown in Table 4. The results revealed that TBARs values significantly (p<0.05) differs among treatment as storage days advance. It was observed that lipid oxidation increased rapidly in *suya* samples across treatment groups from 7- day to 21 days. However, the rate of lipid oxidation reduced as the level of *Allium sativum* in the ingredients increases. *Suya* sample of treatment 5 (30% *Allium sativum* powder) had the least TBARS value at 21-day post-production. This implies that high concentration of *Allium sativum* powder enhanced low rate of lipid oxidation in the muscle, an indication that the powder may

be rich in phenolic compounds and flavonoids (Murakami and Ohigashi, 2007; Kochhar, 2008; Eke *et al*., 2012) [26, 7, 27]. Lipid oxidation is an important determinant of shelf life of meats and meat products (Morrisey *et al.,* 1994) [28]. TBARS values obtained in treatment 5 at different post-production days (7, 14 and 21 days) of *suya* samples in this study, were similar to the values of spiced mutton nugget (Mendiratta *et al.,* 2013) [29]. The TBARs values obtained across the treatment groups were below the MDA concentrations range 1.0 to 2.0 mg/kg as threshold values for meat rancidity (Verme and Sahoo, 2000) [30]. The composition of spices used for the control might be responsible for the relatively increase in TBARs values of *suya* from treatment 1 as the inclusion of *Allium sativum* powder in other treatments resulted in lower TBARS values than the control samples. This shows that *Allium sativum* is antioxidative in nature which probably delayed lipid oxidation in the *Allium sativum* treated *suya* muscles (Wood *et al.,* 2003) [31].

## Conclusion

The study concluded that the preparation of *suya* with *Allium sativum* powder at 30% inclusion into the ingredients had potential to increase the crude protein and ash and reduce the rate of lipid oxidation, while at 25% inclusion, sensorial properties were enhanced.

## Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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