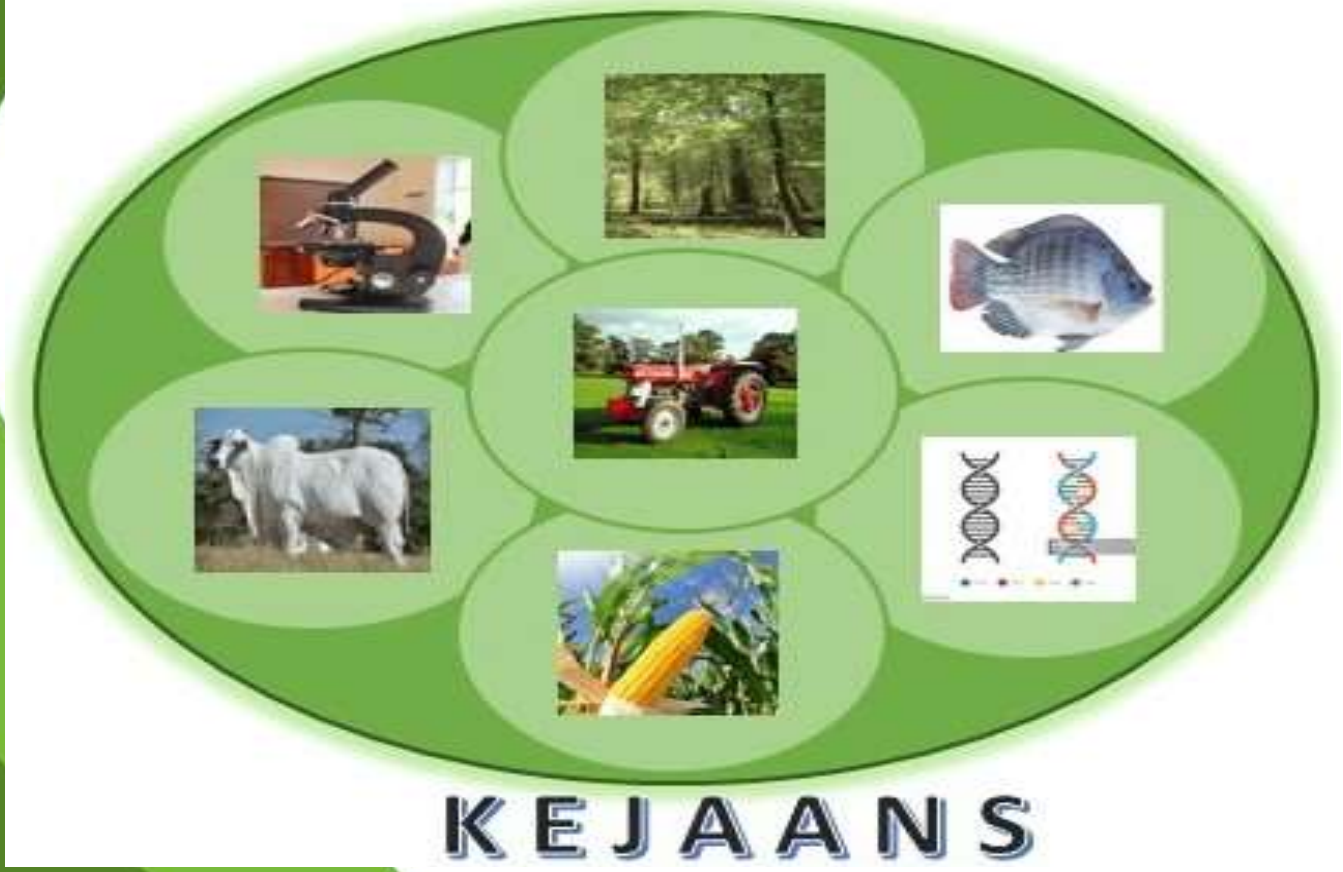
(KEJAANS)

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES

September, 2025, Vol. 1, issue 2



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ISSN: 1595-5776

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)

September, 2025; Volume 1, Issue 2

OFFICIAL JOURNAL OF THE

FACULTY OF AGRICULTURE

ABDULLAHI FODIO UNIVERSITY OF SCIENCE AND TECHNOLOGY, ALIERO

ISSN: 1595-5776

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KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)
September, 2025: Volume 1, Issue 2
p-ISSN:1595-5776

EVALUATION OF PROXIMATE AND SENSORY QUALITIES OF BEEF BALANGU SMOKED WITH DIFFERENT FUEL WOOD SPECIES

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ABSTRACT

This study investigated the proximate and sensory qualities of beef *balangu* smoked with different fuel wood species. The research consisted of five (5) treatments involving one kilogram (1kg) each of beef smoked with *geza* (*Combretum micratum*), *kalgo* (*Piliostigmathonningii*), *malga* (*Cassia sieberiana*), *sabara* (*Guiera senegalensis*) and oven. After smoking, each meat from the treatments was carefully cut into 13 pieces of approximately equal weight. Three samples from each treatment group were used for proximate analysis, while ten (10) samples from each treatment group were used for sensory analysis using a panel of 10 untrained judges. Data on proximate and sensory analysis were subjected to analysis of variance (SPSS) using IBM SPSS (version 20) significant means were separated using the Tukey test at 5%. The proximate composition of Balangu meat varied with the different fuel wood species used. Oven dry treatment performed best overall with the highest crude protein (26.58%) and balanced nutrient profile, followed closely by *sabara* which also had high protein (26.40%) and the highest ash content (1.31%), indicating better mineral retention. *Kalgo* and *malga* showed moderate protein values (23.65% and 23.63% respectively), with *kalgo* being richer in fat and minerals than *malga*. *Geza* had the poorest performance nutritionally, with the lowest protein content (20.15%) despite having the highest fat level (4.28%). Thus, the order of performance in terms of overall nutritional quality is: Oven Dry >Sabara>Kalgo>Malga> Geza. Sensory results showed that, the panelist sensory judgment established significant differences ($p<0.05$) on acceptability scoring (13.47) and aroma (11.84) on a 15-point scale, while flavor, juiciness and Tenderness shows no significant difference ($P>0.05$) across the treatment. It was concluded that from all the treatment assessed, meat samples smoked with *sabara* and roasted in oven have higher protein content (26.397 and 26.583, respectively). It is recommended that, *sabara* wood and oven should be utilized by the meat processors and households especially during festivities, this is due the fact that they have higher protein content.

Keywords: proximate, sensory, Beef Balangu, fuel wood smoke

Introduction

Beef consumption as part of balanced diet worldwide will promote nutritional security. Thomas *et al., (*2014) stated the importance of animal agriculture not only for the production of high-quality proteins but also for sustaining rural livelihood and possibly contributing to food security. Also, fresh meat is a highly perishable product due to its biological composition and several factors such as storage temperature, packing conditions, endogenous enzymes, moisture, light and microorganisms can affect shelf life and freshness. Therefore, a meat processing and preservations technology plays essential roles in food security in or to supply the expanding populations with sufficient qualities of good quality and affordable meat product (Zhang *et al.*,2010).The method of meat processing and the type of fuel wood employed play vital roles in determining the nutritional and sensory attributes of Balangu. Smoking, aside from serving as a preservation method by reducing microbial load and extending shelf life, also imparts desirable flavor, texture, and color to the meat. However, variations in fuel wood species may affect the extent of nutrient retention, smoke deposition, and the overall acceptability of the final product. Evaluating the proximate composition (such as protein, fat, ash, moisture, and fiber content) alongside sensory qualities (such as taste, aroma, tenderness, and general acceptability) provides scientific evidence on the best processing method for producing safe, nutritious, and consumer-preferred balangu. This study, therefore, seeks to assess the proximate and sensory qualities of beef balangu smoked with different fuel wood species, with a view to identifying the most suitable fuel wood for producing balangu of high nutritional and sensory quality. Understanding the influence of fuel wood species on the proximate composition and sensory attributes of balangu is important for both consumers and producers. For consumers, it ensures better nutritional value, taste, and safety, while for processors, it provides guidance on selecting the most appropriate fuel wood for achieving desirable product quality, longer shelf-life, and market competitiveness.

This study is therefore justified as it provides evidence-based recommendations that can improve the quality of balangu production, promote food safety, enhance consumer satisfaction, and support the preservation of this culturally important meat delicacy.

Materials and Methods

Study area

The experiment was conducted at Animal Science Laboratory, Abdullahi Fodiyo University of Science and Technology Aliero. Aliero LGA is located in Kebbi state of Nigeria and lies at latitude $12^0 1644^i$ N and longitude 4^0 27^i 6 E of the Equator. The annual temperature varies considerable but usually ranges between 26^0 to 38^0C occurring between April to June, while the mean annual rainfall is about 500mm to 650mm occurring between April and September. The relative humidity ranges from 21-47% and 51-79% during the rainy and dry seasons respectively. The town has the largest onion market in Northwest Nigeria. The predominant ethnic group of the area is Hausa (KARDA, 2006).

Sources of Experimental materials

Fresh semi-membranous beef from an apparently healthy bull was purchased from Birnin kebbi central Abattoir in the morning immediately after slaughter. Fuel wood species were purchased from nearby villages where they are available.

Treatment and Experimental Design

The experiments were laid in a completely randomized design consisting of five (5) treatment represented by four fuel wood

species Kalgo (*Piliostigma thonningii)*, Sabara (*Guiera senegalensis*), Geza (*Combretum micranthum*), Malga (*Cassia arereh*) and control (oven) to represent T1, T2, T3, T4 and T5, respectively. All the treatments were replicated 3 times to give a total of 15 observations.

Sample Preparation

Five kilograms (5kg) of meat was purchase and trimmed of all visible fat and connective tissues. The meats were divided into five (5) groups containing 1kg each. The meat from each group was sliced to a thickness of 2cm according to the established methods of preparing (balangu). After slicing, each group of meat was subjected to smoking with a corresponding fuel wood species. Treatment one (T1) was smoked with Kalgo Treatment two (T2) was smoked with Sabara (*Guiera senegalensis*), Treatment three (T3) was smoked with Geza (*Combretum micranthum*), Treatment four (T4) was smoked with Malga (*Cassia arereh*), And Treatment five (T5) was roasted in the oven to serves as control. After Smoking the Meat, each group were collected and carefully cut into 13 pieces of equal weight. The pieces were served as the sample. One sample each from the treatment group were used for proximate analysis one sample each from the treatment group were used for chemical analysis while ten (10) samples each was used for sensory analysis.

Determination of Proximate Composition

Proximate composition that was measured includes relative proportion of moisture, crude protein, Ash, and Ether extracts in head and feet were determined according to AOAC (2016).

processed with different fuel wood species

Determination of Sensory Properties

Quantitative Descriptive Analysis (QDA) as described by Stone and Sidel (2004) was employed using 10 members pre-trained panel. The Panelist to be utilized were non-smokers and was drawn from the student population of faculty of Agriculture Abdullahi Fodiyo State University of Science and Technology Aleiro. Samples were blind coded and randomized for order of presentation. Samples were compared for tenderness, juiciness and flavor using a 15cm line scale. Pure water and crackers biscuits was made available to Panelist for mouth cleansing between sample testing.

Statistical Analysis

Data obtained from both proximate and sensory analysis were subjected to Analysis of Variance (ANOVA) using the General Linear Model (GLM) in SPSS Statistical package (SPSS Version 20). The means were separated using Duncan's Multiple Range Test at 5% probability level.

Results and Discussion

Proximate Composition of *Balangu* meat processed with different fuel wood species

Table 1 shows that, dry matter content of the product were statistically the same across the treatment. This could be due to the fact that the products were source from the same animal and were grilled with fuel wood except one treatment that was grilled with oven. The dry matter values reported for the current research were lower for the products processed with geza, kalgo, malga. Oven dry and sabara with the following values respectively 32.670, 32.70, 32.680, and 32.673.

Table 1: Proximate Composition of *Balangu* meat

Treatments	DM	ASH	EE	CF	CP
GEZA	32.670^{b}	1.017^{c}	4.283^{a}	0.027^{b}	20.147^{e}
KALGO	32.670^{b}	1.230^{b}	4.123^{b}	0.020^{b}	23.647^{c}
MALGA	32.673^{ab}	0.687^{c}	3.557^{c}	0.017^{b}	23.627^{d}
OVEN	32.680^{a}	1.007^{d}	1.073^{d}	0.017^{b}	26.583^{a}
SABARA	32.673^{ab}	1.310^{a}	0.650^{e}	0.317^{a}	26.397^{b}
SE	0.002	0.004	0.003	0.003	0.003

abc= means with different superscripts along columns differ significantly ($p<0.05$)

The values reported by the previous research were higher for instance, Abubakar *et al*. (2011) who reported 95.9% for mutton dambu, Balarade*et al. (*2018) who reported 90.01% for beef (minced meat) Dambun Nama. However the values 29.73% reported by Balarabe *et al.* (2016) were nearly similar to the values obtained in current research.

The ash content of the products show that, the meat product processed with Sabara constituted the highest value of (1.310%) followed by Product processed with Kalgo (1.230%), and then Geza, oven dry, and Malga with values of (1.017%), (1.007%) and (0.687%) respectively. This result however shows lower ash content when compared to previous research works on different processed meat products. For instance Abubakar *et al.* (2011) who reported 7.4% for Rabit Dambu, Eke *et al.* (2013) who reported 5.18% for Dambun Nama, Balarabe *et al.* (2018) that reported 5.7% for beef (minced meat), Balarabe *et al.* (2016) who reported 2.41% for Dambun Nama, Jegede *et al.* (2018) who reported 3.27%, 4.34% for suya and kundi respectively. Ogunsola *et al*, (2007), and Fakolad*et al.* (2017) all reported ash content values of between 2.41% to 9.13% for different processed meat product in their works. However, Ribah *et al*. (2023) reported that Ash content of processed meat products can be up to 18%. The ash content values of current study were found to be within the range of 0.687% to 1.310%.

The protein contents of Oven dry were highest with the values 26.58%, followed by Sabara and Kalgo with 26.39% and 23.64% respectively. Meanwhile, Geza and Malga has the least values 20.14% and 23.62% respectively. The higher values reported here for the products processed by Oven dry method could be attributed to the fact that dry products has higher protein concentration. The results obtained in the current research lower than the results reported by the previous research such as Eke *et al*. (2013) who reported 41.9% for Dambun Nama, Omojola*et al*. (2014) who reported 39.95% for meat floss, Balarabe *et al*. (2018) that reported 50.8% for beef (minced meat), Balarabe *et al*. (2016) who reported 48.38% for Dambun Nama, Ribah *et al*. (2013) who reported 49.47% for Gade, Nuhu *et al*. (2021) who reported 54.95% for Kilishi, Fakolade*et al*. (2014) who reported 66.43% for beef Kundi. However, the results reported by Jegede *et al*. (2018) is nearly similar to the results obtained in the current research.It could be observed that, the products grilled with Geza has the highest values 4.283% followed by the product grilled with Kalgo and malga with values of 4.123% and 3.557% respectively. Meanwhile Oven dry and Sabara has the least values of 1.073% and 0.650% respectively. The results obtained in the current study are nearly similar to the previous

research reported by Omojola*et al*. (2014) who reported 3.12% for meat floss. However, higher values was reported by Eke *et al*. (2023) who reported 11.35% for Dambun Nama, Ribah *et al*. (2023) who reported 9.00% for Gade, Fakolade*et al*. (2014) who reported 6.94% for beef kundi.

The crude fiber content was higher in the products smoked with sabara as fuel wood source with the values 0.317% followed by geza and kalgo, with the following values 0.027%, 0.02%, respectively. Meanwhile, the product smoked with ovendry and malga had the same values as 0.17%. The results obtained in the current research in line with the previous research reported by Andrew *et.al* (2023) that reported 0.40% for beef kilishi and Emmanuel *et.al* (2020) also reported same values 0.40% for beef jerky. However, higher values 1.39% reported by Inusa *et al*. (2021) for camel kilishi and also Abubakar*et al*., (2022) reported 2.29% for catfish kilishi.

Sensory properties of meat product Processed with different fuel wood

Table 2 indicate that Oven dried samples had the total highest scores in all parameters evaluated, these could be probably attributed to the product grilled without fuel wood smoked, followed by sample smoked with *kalgo* fuel wood. Meanwhile sample smoked with sabara has the least scores. In tenderness, flavor and juiciness there is no significant different across the treatment. In Aroma, samples smoked with *Geza* and Malga differ significantly with scores of (9.67% and 7.81% followed by sample smoked with *Sabara* values of 7.46% respectively). Similarly, Acceptability values shows significant different betweent sample smoked with Kalgo and Sabara, with scores of (12.07% and 8.82% respectively).

Table 2. Sensory properties of meat product Processed with different fuel wood.

Treatment	Sensory parameters (cm)				
	Flavor	Tenderness	Juiciness	Aroma	Acceptability
Geza	9.51	8.78	9.87	9.67^{ab}	10.07^{bc}
Kalgo	11.31	10.99	9.17	9.89^{ab}	12.49^{ab}
Malga	10.06	10.11	7.62	7.81^{ab}	10.43^{abc}
Oven	12.28	12.10	11.09	11.84^{a}	13.47^{a}
Sabara	8.98	7.65	7.04	7.46^{b}	8.82^{c}
SE	0.99	1.16	1.09	1.01	0.78

abc= means with different superscripts along columns differ significantly ($p<0.05$)

The current research is relatively similar with previous research reported by Abubakar *et al*. (2011), for flavor who recorded 7.8 for Beef Dambu (BDM), Ekpo *et al*.(2022) recorded 7.40 for rabbit processed meat, and Balarabe *et al* (2016) recorded 7.10 for Chevon meat Dambu and Bahago*et al*. (2023). Recorded 8.7 for Danbutari. On Juiciness, this results was found to be nearly similar with Ekpo *et al*. (2022) recorded 6.0 for rabbit meat, Balarabe *et al.(*2018) recorded 7.3 for Mutton Dambunnama and Abubakar *et al*. (2011) who recorded 8.4 for Beef Dambu. On Tenderness this result was found to be similar with Bahago*et al*. (2023) recorded 7.7 for Danbutari, Sani A A (2024) who recorded 11.81 for Head and Feet meat preserved with Animal Fat. And Abubakar *et al*. (2011) recorded 8.4 for Beef Dambu.

Conclusion

In conclusion, it was found out that the meat smoked with sabara and in oven have high nutritive values, recording crude protein of 26.39% and 26.58% respectively. Similarly, the meat roasted with Oven and smoked with Kalgo was found to exhibit positive sensory properties by recording 13.4 and 12.49 respectively on acceptability, using a 15cm line rating scale.

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