

## Evaluation of chemical properties of *Kilishi* prepared from fermented cattle and camel beef in semi-arid Nigeria



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### Abstract

Cattle and camels are major source of meat in semi-arid environments and fermentation could improve the nutritive and functional properties of products prepared from the two meat types. Studies were conducted to examine the chemical properties of fermented cattle and camel beef *Kilishi*. The effects of meat starter culture concentrations and meat type were examined. The experiment was conducted to optimize the inclusion level of lactic acid Bacteria (LA) meat starter culture for fermentation and examine the effect of meat type. The six month experiment was laid in a completely randomized design. Triplicate samples were collected for the chemical analyses. The data were analysed using SPSS Version 20.0 and GraphPadInstat and significantly different means separated with Tukey HSD test. The results of chemical analysis of fermented *Kilishi* revealed no significant ( $P > 0.05$ ) differences except in protein (75.37%) compared to the lower value (56.79%) in the fresh meat product. Similarly, no significant effect on meat type was recorded. A significantly ( $P > 0.05$ ) higher level of K (7.37 mg/100g) was found in the *Kilishi* prepared from fresh cattle beef compared to that in camel (5.27 mg/100g), indicating the effect of meat type. The levels of Zn (7.82 ppm) and Cu (2.72 ppm) were significantly higher in the *Kilishi* prepared with fermented cattle meat. The study revealed that *Kilishi* is a nutrient-dense meat product with an extended shelf-life of up to six months.

**Keywords:** Meat type, chemical properties, fermented beef, *Kilishi*

## Évaluation des propriétés chimiques du *Kilishi* préparé à partir de bovins fermentés et de bœuf de chameau au Nigeria semi-aride



### Résumé

Les bovins et les chameaux sont une source majeure de viande dans les environnements semi-arides et la fermentation pourrait améliorer les propriétés nutritives et fonctionnelles des produits préparés à partir des deux types de viande. Des études ont été menées pour examiner les propriétés chimiques du bœuf fermenté et du bœuf de chameau *Kilishi*. Les effets des concentrations de ferments lactiques et du type de viande ont été examinés. L'expérience a été menée pour optimiser le niveau d'inclusion de la culture de départ de viande de bactéries lactiques (LA) pour la fermentation et pour examiner l'effet du type de viande. L'expérience de six mois a été réalisée dans un plan complètement randomisé. Des échantillons en triple ont été prélevés pour les analyses chimiques. Les données ont été analysées à l'aide de SPSS Version 20.0 et GraphPadInstat et des moyennes significativement différentes séparées par le test Tukey HSD. Les résultats de l'analyse chimique du *Kilishi* fermenté n'ont révélé aucune différence significative ( $P > 0,05$ ), sauf au niveau des protéines (75,37 %) par rapport à la valeur inférieure (56,79 %) dans le produit à base de viande fraîche. De même, aucun effet significatif sur le type de viande n'a été enregistré. Un niveau de K significativement ( $P < 0,05$ ) plus élevé (7,37 mg/100 g) a été trouvé dans le *Kilishi* préparé à partir de bœuf frais de bovin par rapport à celui de chameau (5,27 mg/100 g), indiquant l'effet du type de viande. Les

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niveaux de Zn (7,82 ppm) et de Cu (2,72 ppm) étaient significativement plus élevés dans le Kilishi préparé avec de la viande bovine fermentée. L'étude a révélé que le Kilishi est un produit carné riche en nutriments avec une durée de conservation prolongée pouvant aller jusqu'à six mois.

**Mots clés :** Type de viande, propriétés chimiques, bœuf fermenté, Kilishi

### **Introduction**

The massive global population growth will pose even greater challenges in food production and distribution especially that of animal origin. Meat output per animal remains higher in developed countries than in developing ones. In the broadest sense, meat has been described as the edible postmortem component originating from live animals (Hui *et al.*, 2001). It is the whole or part of the carcass of animals such as buffalo, camel, cattle, goat, pig, poultry, rabbit and sheep slaughtered other than in a wild state, and intended for human consumption. Beef generally refers to the meat of a heifer, cow, bull, young bull, bullock and steer (Emokaro and Amadasun, 2012) and according to Wilson (1984), that of camel. Meat can be processed by several methods such as thermal treatments (smoking, boiling, frying, roasting, drying and cooking). Refrigeration and freezing; fermentation; shredding; curing; salting and canning techniques are other methods. A total of 465 million tons of meat is expected to be produced in 2050 (Worldwatch Institute, 2014). It was similarly stated that in the developing world, people eat about 30 kg of meat a year. Beef output rose by 2.3 percent, with nearly 67 million tons produced in 2007. Fermentation in food processing was defined as the conversion of carbohydrates to alcohols, carbon dioxide and organic acids using yeasts, bacteria, and combination thereof, under anaerobic conditions (Hutkins, 2006). Fermented meat products were defined as that inoculated with microorganisms during processing under controlled conditions to give desirable characteristics (Zakpaa *et al.*,

2009). Addition of starter cultures is most often used in meat fermentation. The genera of LAB mostly involved in meat fermentation include *Lactobacillus*, *Pediococcus*, *Leuconostoc*, *Streptococcus* and *Enterococcus* (Doyle *et al.*, 2001). Many fermented meat products can be produced from farm animals such as swine (Stajic *et al.*, 2011), cattle (Tamang and Kailasaphathy, 2010; Migowska-Calik *et al.*, 2014), camel (Kalalou *et al.*, 2004; Migowska-Calik *et al.*, 2014), sheep (McMillin and Brock, 2005), goat (Nassu *et al.*, 2003), chicken (Santchurn and Collignan, 2008) and horse (El-Malti and Amarouch, 2008).

*Kilishi*, a traditional dried meat product is made from meat infused with spices and defatted groundnut paste (Muhammad and Muhammad, 2007; Abubakar *et al.*, 2011; Olusola *et al.*, 2012) and is produced widely in most northern Nigerian States. The success of this endeavour can be seen in the new *Kilishi* product and process technology capable of structurally transforming the erstwhile, low technology-based traditional *Kilishi* industry to a more efficient, effective, timesaving, value-added and significantly higher quality product yielding processes. The present study evaluated the chemical compositions and nutritive properties of beef and camel meat *Kilishi* produced using lactic acid bacteria (LAB) fermentation.

### **Materials and methods**

The experiment was conducted at the Teaching and Research Laboratory of the Department of Animal Science, Bayero University Kano. Kano State is located in the semi-arid area of Northwestern Nigeria. It has a human population of 9,383,682

comprising of 4,844,128 male and 4,539,534 female (NPC, 2006). The State is the commercial nerve centre of Northern Nigeria. It is located between Latitude 10°33' and 12° 27' North of the equator and Longitude 7° 34' and 9° 29' east of the Greenwich meridian and as such is part of Sudano-sahelian zone of Nigeria. Kano has a hot semi-arid steppe climate which exhibits a tropical wet dry season with a mono modal rainfall distribution. Rain typically start in May with a few shower, stabilize in July, with highest amount in August and ends in September. The mean annual rainfall in Kano State fluctuates from south to north varying from 600 to 1200 mm and 300 to 600 mm respectively (KNSG, 2004). Ambient temperature varies sharply depending on the season, ranging between 19.6°C in December to January and 40°C in March to April (Olofin, 1987). The mean monthly sunshine varies from 220.1 to 266.6 hours (KNSG, 2004). Air humidity is high during the wet season and very low during the dry season. It ranges between 17 and 64% for the average daily low and high levels (Weatherspark, 2013). Meat animals, both large (cattle and camels) and small (sheep and goats) are slaughtered daily at various locations in the State including the Kano Main Abattoir. These animals are sourced from local, regional and international markets in Nigeria and neighbouring countries. The meat is either sold fresh or processed into various ready-to-eat snack products such as *Tsire*, *Balangu*, *Dambun-nama* and *Kilishi*.

#### ***Meat handling and processing for fermented kilishi production***

The study involved the use of raw cattle and camel meat. The beef (50 kg each) were obtained from the Kano Main abattoir very early in the morning and transported to the Teaching and Research Laboratory of the Department of Animal Science, Bayero

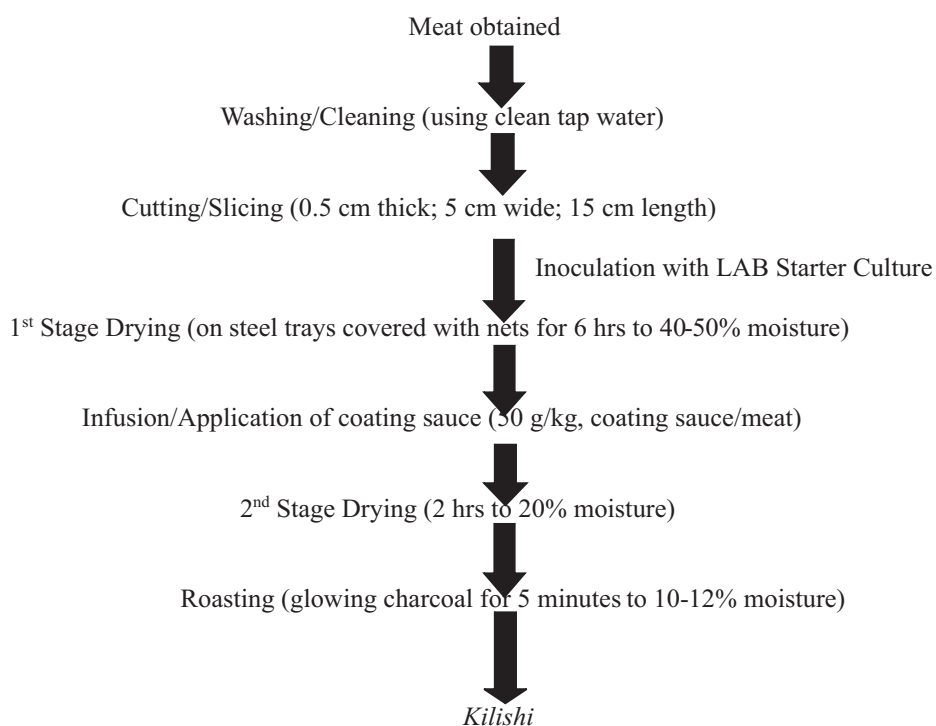
University Kano in clean piece of cloth wrapped with brown paper. After deboning, removal of visible fat and connective tissues, the chunks of meat were sliced and then inoculated with Lyocarni (SACCO Sri Cadorago Co., Italy) dried lactic meat starter culture at three different concentrations (2.5, 5.0 and 7.5 g /100 ml w/v).

The meat was thinly sliced to 0.5 cm thick, 5 cm wide and 15 cm length using Verniercaliper for proper inoculation. The meat slicing was done along the fibre axis of each portion. A solution of the starter culture was prepared in 100 mLsof distilled water (w/v). Meat samples from the semi membranous muscles of cattle and camel were smeared gently and thoroughly with the solution. The meat was inoculated in 100 mLs/kg and incubated for 4 hrs at 40°C (Olaoye and Ntuen, 2011) while the fresh untreated beef and camel meat samples were used as control.

#### ***Preparation of fermented beef Kilishi***

Thefermented cattle beef and camel meat were prepared into *Kilishi* according to a modification of the procedure described by Jones *et al.* (2001) as shown in Figure 1. The meat slices were reduced to a moisture content of 40-50% after a period of 4-5 hours drying. The dried pieces of meat were then soaked in a coating sauce of groundnut cake and condiments (Table 1) for 15 minutes. The soaked meat was removed and spread out again for the second stage drying. The infused meat slices were carefully turned over periodically to avoid sticking to the surface of the drying platform. The drying stages were undertaken under protective cover against dust and flies. After 4 hours of drying, the infused meat slices were roasted for 5 minutes over a glowing smokeless charcoal (80°-120°C) and packaged for analysis (first experiment) or kept for a six months storage period (second experiment).

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**Figure 1: Kilishi preparation procedure (Source: Abubakar *et al.*, 2011; Muhammad *et al.*, 2011).**

**Table 1: Proportions of ingredients used in the Kilishi coating sauce**

Ingredient	Proportion in mixture (g/Kg)
Black pepper ( <i>Piper guineense</i> )	15
Clove ( <i>Eugenia caryophyllata</i> )	10
Alligator pepper ( <i>Aframomum meleginata</i> )	10
Hot pepper ( <i>Capsicum frutescens</i> )	45
Sweet pepper ( <i>Capsicum annum</i> )	50
Onion ( <i>Allium cepa</i> )	130
Ginger ( <i>Zingiber officinale</i> )	25
Garlic ( <i>Allium sativa</i> )	15
African nutmeg ( <i>Myristica fragrans</i> )	5
Seasonings (Maggi <sup>R</sup> , Thyme <sup>R</sup> , Curry <sup>R</sup> )	30, 10 and 5 (respectively)
Decorticated groundnut ( <i>Arachis hypogea</i> )	10
Defatted groundnut cake ( <i>Kuli-kuli</i> )	350
Sugar	10
Water	400
Common Salt (Sodium chloride)	30

Source: Mgbemere *et al.* (2011); Muhammad *et al.* (2011); Olusola *et al.* (2012).

***Experimental lay-out, sampling procedure and analyses***

The experimental lay-out for the study was a completely randomised design. Triplicate samples were taken to the laboratory for

chemical analysis immediately after *Kilishi* preparation.

***Sample collection and analyses***

The experimental samples were kept for six months under ambient temperature.

Triplicates samples from the stored cattle and camel beef *Kilishi* were taken to the Biochemistry Laboratory, Faculty of Science, Bayero University, Kano for the chemical analyses according to the procedure of AOAC (2007).

**Statistical analysis**

The data obtained were analysed using the means of three replicates of each sample. The data generated from the results of the chemical analyses of the fermented cattle and camel beef *Kilishi* were subjected to analysis of variance (ANOVA) using the IBM SPSS Version 20.0 (2011) and GraphPadInstat (GraphPadInstat®, Version 3.05, 32 bits for Win 95/NT, GraphPad Software Inc., (2000) Statistical packages.

**Ethical issues**

All general programmes and practices to ensure safety and quality control of the fermented cattle and camel beef *Kilishi* as a ready-to-eat snack meat product were strictly observed. These include good manufacturing, sanitation and handling

practices.

**Results**

The effect of fermenting cattle and camel beef with different concentrations of meat starter culture was studied in respect of the chemical properties of *Kilishi* to ascertain its nutritional quality characteristics. The impact of using lactic acid bacteria (LAB) meat starter culture to ferment raw cattle and camel beef and subsequent processing of the beef into *Kilishi* on chemical composition of the product is shown in Table 2. From the results, there were no significant ( $P > 0.05$ ) differences in all the parameters evaluated as a result of LAB fermentation. The contents of moisture, fat, total ash, fibre and carbohydrate were numerically higher in *Kilishi* produced from cattle beef. However, the level of protein was slightly high in the product prepared from the beef obtained from the camel.

**Table 2: Effect of fermentation using meat starter culture on chemical composition (%) of cattle and camel beef *Kilishi***

Parameter (%)	Species Type		SEM (±)
	Cattle	Camel	
Moisture	8.12	7.12	0.34
Protein	70.18	70.27	0.65
Fat	10.04	10.01	0.58
Total Ash	6.97	6.33	0.26
Fibre	1.63	1.39	0.12
Carbohydrate	4.78	4.20	0.25

SEM= Standard Error of Means

The chemical compositions of *Kilishi* prepared from fermented cattle and camel beef using different levels of LAB meat starter culture are presented in Table 3. The various levels of inclusion of the LAB meat starter culture did not significantly ( $P > 0.05$ ) affect the chemical constituents of the experimental *Kilishi* with the exception

of the protein content. The contents of moisture and protein were high in *Kilishi* produced with the LAB meat starter culture at 5% level of inclusion. The three meat starter culture concentrations significantly ( $P < 0.05$ ) affected the protein content of the product in comparison with the control treatment.

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**Table 3: Effect of meat starter culture concentrations on chemical composition (%) of cattle and camel beef Kilishi**

Parameter (%)	Meat Starter Concentration				SEM(±)
	0	2.5	5.0	7.5	
Moisture	7.62	7.91	8.02	6.90	0.48 <sup>NS</sup>
Protein	56.79 <sup>b</sup>	74.19 <sup>a</sup>	75.37 <sup>a</sup>	74.55 <sup>a</sup>	0.92 <sup>NS</sup>
Fat	9.83	10.33	9.65	10.30	0.82 <sup>NS</sup>
Total Ash	7.12	6.77	6.97	6.95	0.37 <sup>NS</sup>
Fibre	1.53	1.76	1.36	1.39	0.16 <sup>NS</sup>
Carbohydrate	4.53	4.69	4.39	4.35	0.36 <sup>NS</sup>

<sup>NS</sup> Means with different superscripts in the same rows differ significantly ( $P < 0.05$ ); SEM= Standard Error of Means; NS= Not Significant

Results of the analysis of macro-nutrients composition of the experimental *Kilishi* (Table 4) showed that all the macro-nutrient elements except K for all meat starter culture concentration levels of both the cattle and camel beef were not affected significantly ( $P > 0.05$ ). However, all other

concentration levels for both types of meat were similar ( $P > 0.05$ ). Similarly, the results of the micro-mineral composition (Table 5) revealed no significant ( $P < 0.05$ ) effects for all the nutrient elements at all concentration levels in respect of the fermented cattle and camel beef *Kilishi*.

**Table 4: Macromineral composition (mg/100g) of Kilishi prepared from fermented cattle and camel beef**

Mineral	Species Type/Starter Concentration								SEM (±)
	Cattle				Camel				
	0	2.5	5.0	7.5	0	2.5	5.0	7.5	
Ca	1.95	1.86	1.84	1.82	2.25	1.95	1.78	2.13	0.15
P	11.40	10.53	10.07	11.53	10.93	11.87	10.37	11.40	0.71
K	7.37 <sup>a</sup>	7.40 <sup>a</sup>	7.07 <sup>a</sup>	6.77 <sup>b</sup>	5.27 <sup>c</sup>	7.57 <sup>a</sup>	7.83 <sup>a</sup>	6.77 <sup>b</sup>	0.79
Na	1.27	1.37	1.20	1.30	1.37	1.23	1.03	0.93	0.20
Mg	21.43	27.47	25.37	25.73	24.23	24.93	22.40	23.37	1.00

Means with different superscripts in the same rows differ significantly ( $P < 0.05$ ); SEM= Standard Error of Means

**Table 5: Micro-mineral composition (ppm) of Kilishi prepared from fermented cattle and camel beef**

Mineral	Species Type/Meat Starter Concentration								SEM(±)
	Cattle				Camel				
	0	2.5	5.0	7.5	0	2.5	5.0	7.5	
Fe	112.41	118.30	114.92	109.95	116.45	107.36	116.13	111.45	3.82
Zn	7.71	8.26	7.71	7.58	5.57	6.59	6.59	7.14	0.79
Cu	2.93	3.46	2.48	2.01	2.17	1.46	1.99	2.21	0.48
Mn	0.93	0.99	0.96	0.81	0.87	0.83	0.91	0.97	0.10

SEM= Standard Error of Means

The results of the chemical analysis (moisture, protein, fat, total ash, fibre and carbohydrate) of the fermented *Kilishi* did not reveal significant ( $P > 0.05$ ) differences with respect to meat type among the

parameters evaluated as shown in Table 6. However, the product prepared from cattle had numerically higher values of fat and fibre while that of camel recorded high levels of moisture, protein, ash and carbohydrate.

**Table 6: Effect of meat type on chemical composition (g/100g) of fermented cattle and camel beef Kilishi**

Parameter	Species		SEM(±)
	Cattle	Camel	
Moisture	3.07	3.14	0.05
Protein	67.23	67.88	0.25
Fat	10.97	10.62	0.20
Total Ash	5.46	5.60	0.10
Fibre	1.27	1.25	0.05
Carbohydrate	11.38	11.45	0.10

SEM= Standard Error of Means

### Discussion

The results of chemical analysis of the fermented *Kilishi* prepared from cattle and camel beef in the current study has revealed substantial decrease in moisture content (3-4%) irrespective of the influence of meat type, animal age, package and storage duration. This is lower than 6.92%, 9.87%, 10.00% and 12.5%, reported by Jones *et al.* (2001), Apata *et al.* (2013), Olusola *et al.* (2012) and Abbo and Raji (1999), respectively. A similar lower moisture level (4.2%) was however reported by Igene *et al.* (1990). The drastic reduction in moisture in the current study could be attributed to the fermentation of the raw meat with LAB starter culture. The protein levels (67-75%) obtained in this research was comparably higher than those reported in the literature. Values ranging from 55.47 to 62.33% were reported by Olusola *et al.* (2012). The finding of Mgbemere *et al.* (2011) revealed a crude protein range of 51.62% to 55.84%. Abbo and Raji (1999) reported a crude protein content of 51.3%. The high crude protein content may be attributed to the various ingredients utilized in *Kilishi* preparation (Igene *et al.*, 1993) and the impact of meat fermentation. The decrease in protein content during storage observed in this study is in agreement with the report of Hes *et al.* (2007). The fat content of *Kilishi* has also been examined by many researchers. Jones *et al.* (2001) reported a fat content of 25.36%. Igene (1988) noted that *Kilishi* is very high in lipid content on

dry weight basis (25.23%) pointing out that this consists mostly of triglycerides. A study of the traditional processing of *Kilishi* reported a fat level of 17.8% (Igene *et al.*, 1990). According to Mgbemere *et al.* (2011), the fat content of *Kilishi* ranged from 17.34 to 19.20%. The fat content in *Kilishi* is usually high as a result of the groundnut cake component which represents considerable proportion of the product (Igene *et al.*, 1990). The result of a research by Abbo and Raji (1999) revealed that the fat level in *Kilishi* was 15.1%. The fat content (11%) of the fermented *Kilishi* in the present study was found to be lower than the values reported in previous researches on the product. This could be attributed to differences in meat preparation and the use of LAB starter culture for fermentation. This is an important breakthrough for people that are conscious of their health as a result of consuming red meat with high fat content. Elizabeth (1995) observed that the ash content of any processed meat may be a function of the muscle tissue in addition to that of ingredients used. Thus the ash content in *Kilishi* is an indication of the individual mineral levels of the spices and condiments that give cumulative results. The value of ash in *Kilishi* was reported to range from 4.54 to 5.58% (Mgbemere *et al.*, 2011). An ash content of 6.72±0.13% was reported for traditionally prepared *Kilishi* (Jones *et al.*, 2001) while Igene *et al.* (1990) reported a value of 9.6%. Similarly, ash contents of 8.78 ± 0.13% and 6.96 ± 0.24

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were obtained in *Kilishi* from beef and pork respectively (Ogunsola and Omojola, 2008). Abbo and Raji (1999) reported an ash value of 7.2%. The total ash level recorded in the current study was 5 to 7% which is within the range reported in earlier studies. Low crude fibre level is a common attribute of meat products but their inclusion could have a functional effect (Biswas *et al.*, 2011). As a result of using plant-based ingredients, the presence of this chemical component was reported in *Kilishi*. Mgbemere *et al.* (2011) reported the fibre level to range from 2.8 to 3.1% in *Kilishi*. The level of fibre (1%) in the current study was found to be lower than the reported value. The amount of fibre may be contributed by groundnut flour, spices and condiments used in *Kilishi* production (Olapade *et al.*, 2004).

### **Conclusion**

The findings of this study demonstrated that cattle beef and camel meat could be used to prepare *Kilishi* without much difference in nutritive qualities. It was further concluded that fermentation improved the nutritive value of cattle and camel beef *Kilishi*. Meat fermentation can be practiced in *Kilishi* preparation as a means of value addition for enhancing the nutritive value of the product.

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