Investigating the Proximate Composition and Mineral Elements of Kilishi (Roasted Beef) from Selected Areas in Kaduna State, Nigeria

[1]Erienu Obruche Kennedy, [2]Clark Poro David, [3]Paul Nnamdi Ogbu, [4]Njor Oru Ogar
[5]Ikechukwu Sampson Chikwe, [6]Okeke Maudline Uzoamaka, [7]Oguike Victor Chinwem

[1]*Department of Chemistry, Delta State College of Education, Mosogar, Delta State, Nigeria
[2]Department of Chemical Science, Edwin Clark University, Kiagbodor, Delta State
[3,5,7]Department of Science Laboratory Technology, Imo State Polytechnic, Omuma
[4]Department of Science Laboratory Technology, Federal Polytechnic, Ugep
[5]Department of Science Laboratory Technology, Federal College of Agriculture, Ishiagu, Ebonyi State
*Corresponding Author Email: kenkennedy767@gmail.com
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Abstract
The purpose of this study was to assess the proximate and mineral composition of contaminants. Samples of cow and Kilishi (Roasted beef) were gathered from six production locations in Kaduna state, Nigeria: Sabon Gari, Tudun Wada, Zaria city, Malali, Anguwan Sarki, and Kasuwa. Additionally, Kilishi prepared in the laboratory, which served as a control, was analyzed. A standard method from USEPA was employed for the proximate analysis, and a Flame photometer (PF9) was utilized to measure the mineral concentrations. The proximate composition results indicated that Kilishi is more nutrient-rich. The proximate parameters in the study samples were ranked as protein > crude fat > ash > moisture > carbohydrate > crude fiber. The laboratory Kilishi control had the lowest moisture percentage (7.22%) and lower protein and carbohydrate values. The mineral composition results revealed that Kilishi had the highest levels of Na, P, and K, while dried beef had the highest concentrations of Ca and Mg. Kasuwa Kilishi exhibited the highest Na (8281.00) and Mg (474.55) levels compared to other Kilishi samples. The highest P (8915.00) and K (9610.00) values were found in Malali Kilishi, while Tudun Wada Kilishi had the highest Ca content (459.55). The laboratory Kilishi had the lowest mineral contents of Ca, Mg, and P. The laboratory (control) Kilishi recorded the lowest levels of Ca, Mg, and P. The current findings indicated that the mineral elements were excessively present in all samples in the order of K > P > Na > Mg > Ca. The government should implement measures to ensure proper hygiene and sanitary standards at various slaughterhouses, abattoirs, and Kilishi processing locations, as well as promote good hygiene practices among producers.

Key words: *Beef, Kilishi, Proximate composition, Mineral elements, Zaria*

INTRODUCTION

Meat is typically defined as the flesh from domesticated animals, which includes the skeletal tissues or flesh of cattle, sheep, and other animals (Usio, 1979; Obruche et al., 2025). Therefore, meat is the edible part of animals that is suitable for food and consists of both lean and fatty tissues. In many developing countries, particularly Nigeria, meat is commonly consumed either

cooked or processed into other forms to prevent spoilage (Obasohan, 2008; Itodo et al., 2021). "Beef" refers to meat from fully grown cattle that are about two years old, while the meat from young cattle, less than three or four months old and fed on milk, is called "veal" (Odey et al., 2013). Typically, beef is red in color and is often referred to as 'red meat' because it has a higher myoglobin content (1-3 mg/g tissue in calves and 16-20 mg/g tissue in older beef cattle) and is more widely accepted compared to veal and other meats (Ogbonnaya & Linus, 2009). Kilishi is a traditional meat product that is sun-dried and primarily made from beef. It is an intermediate moisture meat that has a suitable level of dissolved solids to retain moisture and prevent spoilage. Kilishi is a ready-to-eat convenience meat product that maintains excellent shelf stability at room temperature. The handling and marketing of Kilishi products should be made easy for both consumers and retailers (Umudi et al., 2019). Erienu et al. (2022) found that Kilishi contains about 46% meat and 54% non-meat ingredients. Obruche et al. (2025) reported that the final Kilishi product has 50% protein, 7.5% moisture, 18% lipid, 9.8% fiber, and 14.7% ash. The popular sun-dried beef Kilishi has gained significant acceptance not only in Nigeria but also throughout the sub-Saharan region and beyond. Borno, Kano, Sokoto, Kaduna, and Bauchi in Northern Nigeria are the leading states in Kilishi production. Kilishi (local name for roasted beef) is typically made by partially drying thin slices of high-quality meat in the sun. This is followed by marinating the partially dried meat in a mixture of defatted groundnut paste and spices, then undergoing another round of sun drying and partial roasting. It can be made during both the dry and rainy seasons. Meat is chemically made up of four main components: water, protein, lipid, and carbohydrate, along with various minor components like vitamins, enzymes, pigments, and flavor compounds. According to Ogunsola and Omojola (2008), the chemical makeup of meat consists of 56-72% water, 15-22% protein, 5-34% fat, and 3.5% soluble non-protein substances, which include carbohydrates, organic salts, dissolved nitrogen substances, minerals, and vitamins. Okonko et al. (2013) found that meat contains 70% water, 19% protein, 5% fat, 3.5% non-protein substances, and 2.5% minerals and other materials. The moisture content in meat varies significantly based on several factors, including the age of the animal, species, fat content, and the specific tissue being examined (Greenfield et al., 1987). Muscle protein is categorized into three groups based on solubility: sarcoplasmic protein (30%), myofibrillar protein (55%), and stromal protein or muscle tissue (15%) (Okubanjo, 1997; Umudi et al., 2024). Akpoveta et al. (2024) noted that sarcoplasmic proteins mainly consist of glycolytic enzymes (such as glucosidase, diastase, pepsin, and trypsin) and play a role in converting stored energy into muscle power. The fat in meat is primarily in the form of triglycerides, which greatly influences the tenderness and texture of the meat. It serves as a crucial energy source, producing about twice the energy compared to proteins and carbohydrates. Organic substances are also present as soluble non-protein. The town is an industrial centre of Northern Nigeria manufacturing products like textiles, petroleum products, etc. The study areas has tropical wet and dry (savanna) climate with a pronounced dry season that lasts from November to mid-April and a rainy season that lasts from mid-April to November. The State extends from the tropical grassland known as the Guinea Savannah to Sudan Savannah. These two climatic conditions greatly influenced activities of the predominantly occupied people, who are primarily based on agriculture. It also favours animal keeping. In addition, the population of Nigerians recorded in Kaduna and Zaria towns of 760,084 and 695,089 respectively (2006 census) influenced business activities. Thus, Kilishi business is prominent in Kaduna and Zaria towns of Kaduna State. The town serves as an industrial hub in Northern Nigeria, producing items such as textiles and petroleum products. The climate in the study areas is tropical wet and dry (savanna), featuring a

distinct dry season from November to mid-April and a rainy season from mid-April to November. The State ranges from the tropical grassland known as Guinea Savannah to Sudan Savannah. These two climatic types significantly impact the activities of the mainly agricultural population. It also supports livestock farming. Furthermore, the population figures from the 2006 census show that Kaduna and Zaria have 760,084 and 695,089 residents, respectively, which affects local business activities. Consequently, the Kilishi trade is well-established in both Kaduna and Zaria towns of Kaduna State.

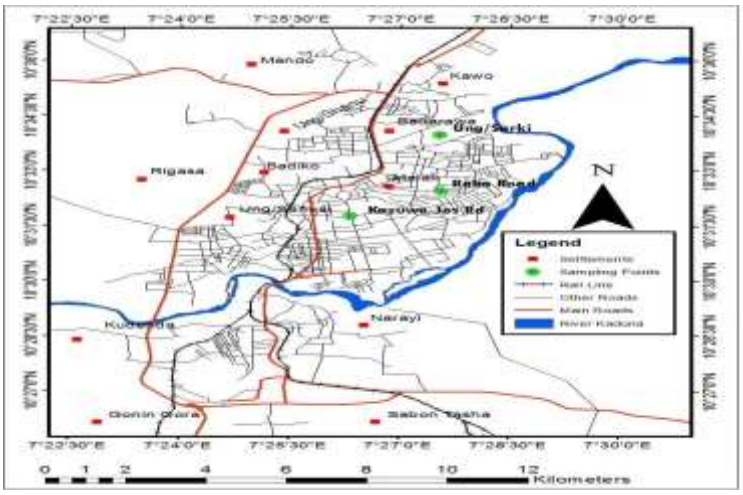

Figure 1: Map of Kaduna Metropolis (Town) Showing Sampling Points

Materials Procurements

The procurement was conducted following the procedures outlined by AOAC (2000). Fresh beef was sourced from Zangon Shanu abattoir located in Zaria, Kaduna State, Nigeria. A total of 2 kg of fresh beef was given to six commercial Kilishi (local name for roasted beef) producers at their respective production locations in the Zaria area and Kaduna town to make Kilishi meat. The study sites in the Zaria area included Sabon Gari-Kasuwan Mata, Tudun Wada-Kasuwa, and Zaria city-Durumin Maigarke (Figure 1), while the Kaduna town sites were Malali-Rabah Road, Anguwan Sarki-Sultan Bello Road, and Kasuwa-Jos Road (Figure 1). Additionally, 2 kg of fresh beef was prepared as Laboratory Kilishi. The spices for the Laboratory Kilishi were bought separately from specialized ingredient shops in Samaru and Sabon Gari markets in Zaria. All reagents used in this study were of high analytical quality.

Beef preparation

The preparation followed the methods described by FAO and WHO (2001). Exactly 2 kg of fresh semitendinosus muscle from hot boned beef was trimmed of fat and excess connective tissue. The resulting lean beef weighed 1.8 kg and was cut into smaller 200 g portions, then sliced into thin sheets of 2 mm thickness. These meat slices were laid out on a clean stainless steel wire mesh and dried in an oven at 50 °C for 4 hours. During the drying process, the meat slices were flipped every hour to ensure even drying and to prevent them from sticking to the drying surface. The weight of each meat slice was recorded before and after this initial drying stage, and the pre-dried meats were wrapped in aluminum foil and stored in an airtight container for the next processing step.

Preparation of Kilishi by commercial producers

The preparation followed the methods outlined by FAO and WHO (2011). The formulations of ingredients, infusion times, solar drying durations, and final roasting times varied among the commercial producers. The process of preparing Kilishi by these producers included: i. The fat was trimmed off the fresh beef. The trimmed meat was sliced into flat, thin sheets using a sharp knife. ii. The thin sheets were laid out on raffia mats and sundried (first stage drying) to lower the moisture content and prepare the meat for ingredient infusion. The pre-dried meat was infused with slurry made from a mixture of Tunkusa, spices, and condiments ground into powder. The sheets with the infused mixture were then spread on raffia mats and allowed to dry again (second stage drying). After this second drying, the products were roasted over a smokeless glowing fire. The resulting Kilishi (roasted beef) was wrapped in newspaper for analysis. Each sample of the oven-dried raw beef, the oven-dried Kilishi made in the Laboratory of the Department of Chemistry at Ahmadu Bello University, Zaria, and six samples of sun-dried Kilishi from various production locations in Kaduna State were labeled as follows: RB: Oven-dried raw beef from the Laboratory. CL: Oven-dried Kilishi from the Laboratory. SG: Sun-dried Kilishi from Kasuwan Mata, Sabon Gari, Zaria. TW: Sun-dried Kilishi from Tudun Wada, Zaria. ZC: Sun-dried Kilishi from Durumi Maigarke, Zaria City, Zaria. MK: Sun-dried Kilishi from Raba Road, Malali, Kaduna. UK: Sun-dried Kilishi from Anguwan Sarki, Kaduna. KK: Sun-dried Kilishi from Jos Road, Kasuwa, Kaduna. The samples that were collected were dried in an oven at 60 oC for 4 hours at the Laboratory of the Department of Chemistry, Ahmadu Bello University, Zaria. A part of each dried labeled sample was finely ground into powder with a ceramic pestle and mortar, then packaged and stored in polyethylene bags for further analysis.

Determination of Proximate Parameters

The proximate parameters such as protein, moisture content, crude fat, % ash, % crude fiber, and % carbohydrate were determined following the procedures outlined by (APHA, 2005) and (USEPA, 2006), with slight modifications to the method used. The drying process was repeated until a constant weight (W3) was achieved, and the percentage of moisture content, crude fiber, crude protein, and ash were calculated using equation 1.

$$\% = \frac{W2-w3}{\text{W}} \quad X \quad 100 \quad \ldots\ldots\ldots 1$$

Determination of Mineral Contents

Sodium and potassium levels were measured using flame photometry. Phosphorus was assessed through a colorimetric method, while calcium was determined via the EDTA Titrimetric Method (USEPA, 2006; Ekpo et al., 2025). The analysis of magnesium was performed using the Calculation Method (APHA, 2005). Magnesium was calculated as the difference between total hardness and calcium hardness. The formula for magnesium (mg/L) is: [Total hardness (mg CaCO3/L) - Calcium hardness (mg CaCO3/L)] x 0.243.

Statistical Analysis

The results were statistically analyzed using the statistical analytical systems (SAS, 1991) package with the following methods: Means of triplicate analyses were calculated using ANOVA, and standard deviations were separated using the Duncan Multiple Range Test. The student t-test was applied to rank means for significance levels at a 95% confidence level (P < 0.05).

RESULTS AND DISCUSSION

This section provides the analyzed results for proximate analysis and mineral contents in dried beef and its kilishi samples, as shown in tables 1 and 2.

Proximate Parameters of Dried Beef and its Kilishi Samples

The proximate composition results for moisture, crude fat, crude protein, ash content, fiber content, and carbohydrate content are displayed in Table 1. The percentage of moisture content was highest in Malali Kilishi at 9.23%, which is not significantly different from Zaria City Kilishi (roasted beef) at 8.83%. In contrast, the lowest moisture content was found in dried beef at 6.46%, which is not significantly different from Kilishi from Kasuwa at 7.22% and Laboratory at 6.93% at $P < 0.05$. The crude fat content varied between 17.07% and 22.42%. The highest amount of crude fat was found in Malali Kilishi, while the lowest was in dried beef. For crude protein, dried beef had the highest value at 67.94%, and Malali Kilishi had the lowest at 52.92%. No significant differences in crude protein values were noted among Kilishi samples from Anguwan Sarki, Laboratory, and Sabon Gari ($P < 0.05$). The lowest ash percentage was in dried beef at 6.81%, whereas the highest was in Anguwan Sarki at 9.42%. Tudun Wada Kilishi had the highest crude fiber percentage at 3.42%, while dried beef had the lowest at 0.75%. The highest carbohydrate percentage of 8.32% was found in Kilishi from Zaria City, which showed no significant difference from the values in Sabon Gari and Malali Kilishi ($P < 0.05$). Dried beef had the lowest carbohydrate value at 1.72%. These findings align with the research conducted by Ogwuche C.E and Obruche E.K. (2020) on proximate analysis in the same region.

Table 1: Means and Standard Deviations of the Proximate Composition of Dried Beef and its Kilishi Samples

S/C	%Moisture	%Crude fat	%Crude protein	%Ash	% Crude fiber	%Carbohy - Drate
RB	6.46 ± 0.46^{e}	17.07 ± 0.21^{d}	67.94 ± 0.65^{a}	6.81 ± 0.68^{e}	0.75 ± 0.31^{e}	1.72 ± 0.10^{e}
CL	6.93 ± 0.03^{de}	21.37 ± 0.92^{ab}	56.52 ± 0.62^{d}	8.70 ± 0.26^{bc}	1.36 ± 0.02^{cd}	6.48 ± 0.69^{c}
SG	7.88 ± 0.18^{bc}	21.43 ± 0.93^{ab}	55.80 ± 1.38^{d}	6.93 ± 0.05^{e}	1.26 ± 0.07^{d}	7.96 ± 0.58^{a}
TW	7.53 ± 0.63^{cd}	19.27 ± 1.03^{cd}	58.79 ± 0.79^{c}	8.24 ± 0.23^{cd}	3.42 ± 0.04^{a}	6.17 ± 0.62^{c}
ZC	8.83 ± 0.43^{ab}	20.39 ± 1.25^{bc}	53.45 ± 1.42^{e}	9.01 ± 0.08^{ab}	1.29 ± 0.04^{d}	8.32 ± 0.51^{a}
MK	9.23 ± 0.68^{a}	22.42 ± 0.91^{a}	52.92 ± 0.90^{e}	7.79 ± 0.04^{d}	2.24 ± 0.04^{b}	7.64 ± 0.53^{ab}
UK	7.85 ± 0.05^{bc}	17.63 ± 0.99^{d}	57.83 ± 0.14^{cd}	9.42 ± 0.45^{a}	1.34 ± 0.04^{d}	7.27 ± 0.39^{bc}
KK	7.22 ± 0.59^{cd}	17.27 ± 0.35^{d}	64.28 ± 1.73^{b}	6.85 ± 0.16^{e}	1.55 ± 0.04^{c}	4.38 ± 0.57^{d}
M	7.72 ± 0.94	19.61 ± 2.14	58.40 ± 5.04	7.98 ± 1.01	1.28 ± 0.25	6.26 ± 2.17
CV	5.93	7.13	1.95	3.02	1.01	8.16
SE	0.19	0.44	1.03	0.21	0.05	0.44

M = total mean, CV = coefficient variance, SE = standard error of means. a-f: means along the same column with different superscript are significantly different (P P<0.05)

Mineral Composition in Dried Beef and Kilishi Samples

The mineral makeup (macro elements) in dried beef and its Kilishi samples, in relation to the recommended daily dietary intake, is illustrated in table 2. All mineral element values in the samples were significantly different from one another at $P < 0.05$, except for phosphorus in Malali and Kasuwa Kilishi samples, and potassium in Anguwan Sarki and Laboratory Kilishi samples. Table 2 indicates that sodium contents in Kilishi samples range from 2,451.00 to 8,281.50 $mgkg^{-1}$, with the highest level in Kasuwa Kilishi and the lowest in Sabon Gari Kilishi. The sodium content in dried beef (785.00 $mgkg^{-1}$) was significantly lower than the values found in Kilishi samples ($p < 0.05$). According to table 2, dried beef had the highest calcium content at 564.30 $mgkg^{-1}$, while the lowest calcium value of 337.51 $mgkg^{-1}$ was found in Kilishi from the Laboratory. Magnesium content in table 2 was also highest in dried beef at 474.55 $mgkg^{-1}$ and lowest in Kilishi from the Laboratory at 357.51 $mgkg^{-1}$. Phosphorus (P) concentrations in the study samples (table 2) varied from 3,015.00 $mgkg^{-1}$ in dried beef to 8,915.00 $mgkg^{-1}$ in Malali Kilishi. The Laboratory Kilishi had a P value of 4,805.00 $mgkg^{-1}$, which was significantly lower than the values in the other Kilishi samples. The table shows that potassium (K) was highest in Malali Kilishi (9,610.00 $mgkg^{-1}$) and lowest in dried beef (5,405.00 $mgkg^{-1}$). Kilishi from the Laboratory had a K value of 4,005.00 $mgkg^{-1}$, which was not significantly different from the value obtained from the Anguwan Sarki sample ($p < 0.05$).

Table 2: Average and Standard Deviations in Mineral Contents (mgkg-1) of Dried Beef and its Kilishi Samples

Sample code	Na	Ca	Mg	P	K
RB	785.00 ± 7.07^{h}	564.30 ± 0.51^{a}	474.55 ± 0.01^{a}	3,015.00 ± 7.07^{g}	5,405.00 ± 7.07^{g}
CL	5,515.00 ± 7.07^{d}	337.51 ± 0.25^{h}	357.51 ± 0.01^{h}	4,805.00 ± 7.07^{f}	9,005.00 ± 7.07^{b}
SG	2,451.00 ± 1.41^{g}	368.26 ± 0.25^{g}	363.19 ± 0.15^{g}	5,505.00 ± 7.07^{e}	6,015.00 ± 21.21^{f}
TW	3,655.00 ± 7.07^{f}	459.55 ± 0.04^{b}	397.01 ± 0.01^{e}	6,810.00 ± 14.14^{c}	7,805.00 ± 7.07^{c}
ZC	6,220.00 ± 14.14^{c}	380.20 ± 0.01^{e}	406.83 ± 0.04^{d}	7,545.00 ± 7.07^{b}	6,755.00 ± 7.07^{e}
MK	4,440.50 ± 0.71^{e}	371.54 ± 0.06^{f}	450.64 ± 0.04^{c}	8,915.00 ± 7.07^{a}	9,610.00 ± 14.14^{a}
UK	7,430.50 ± 0.71^{b}	421.60 ± 0.01^{d}	379.46 ± 0.05^{f}	6,115.00 ± 7.07^{d}	9,015.00 ± 21.21^{b}
KK	8,281.50 ± 2.12^{a}	422.22 ± 0.29^{c}	452.42 ± 0.01^{b}	8,910.00 ± 14.14^{a}	7,010.00 ± 14.14^{d}

MEAN	4,847.31	415.64	410.21	6,452.50	7,202.50
CV	0.15	0.62	0.02	0.14	0.09
SE	7.14	0.26	0.06	9.26	6.27
RDI	2,400.00	1,300.00	420.00	1,250.00	4,700.00

RDI = Recommended daily intake (mg/day). a-f: means along the same column with different superscript are significantly different ($P < 0.05$)

DISCUSSION

Proximate Compositions in Dried Beef and its Kilishi Samples

From the data in Table 1, the moisture content percentage was found to be between 6.46 - 9.23%. This suggests that the samples studied can prevent microbial growth due to their lower moisture levels. Additionally, this finding aligns with the moisture content values in Kilishi samples (7.50% and 8.67 - 10.00%) noted by Umudi et al. (2018) and Obruche et al. (2019). In contrast, Umanah (2025) reported higher moisture content values of 16.65% and between 19.75 and 23.30% for dried meat and Kilishi samples, respectively. The increased moisture in Kilishi samples may be due to the gradual drying process used in their preparation. Environmental factors and the paste of infusion ingredients used during production could also contribute to this.

From Table 1, it is evident that crude fat content ranged from 17.07 to 22.42%. When compared to the findings of Festus-Amadi (2021) and Abeokuta et al. (2025), who found that Kilishi has a fat content of at least 25%, this study indicates that there was generally more separable fat in the trimmed raw beef before it was made into Kilishi. The results are consistent with the fat percentage in Kilishi (17.80% - 23.23%) reported by Umudi et al. (2022). However, Obruche et al. (2025) found lower fat percentages in Kilishi (13.4), and Umudi (2018) reported even lower values in Banda dried beef (1.86 - 6.21%). The higher fat content observed in Kilishi samples compared to the lower values in raw beef may also be explained by the inverse relationship between moisture and fat content.

From Table 1, the crude protein values were found to be between 52.92 and 67.94%. This study's findings align with the crude protein value of 54.20% in Banda beef products as reported by Ogwuche and Obruche (2020), and the range of 59.70 to 62.30% in Kilishi noted by Umudi et al. (2025). In contrast, Itodo et al. (2021) and Abeokuta (2025) reported higher protein content, ranging from 68.1 to 71.8% in Kilishi and 56.7 to 72.3% in beef cacina, respectively. Additionally, Obruche et al. (2025) found lower protein percentages of 50.0% and 49.0% in Kilishi samples. The variation in protein content among Kilishi samples may be due to the trimmed connective tissues of the raw beef, the groundnut cake, and other ingredients used in their production.

Table 1 also indicates that the ash content varied from 6.81 to 9.42%, which is comparable to the Kilishi samples reported by Obruche et al. (2018) at 6.72% and 7.80 - 9.60% by Umudi et al. (2022). The higher ash content in Kilishi samples might be attributed to the condiments used in their preparation. It could also result from dirt on the meat during sun drying in open areas or dirt adhering to the roasting surface. Researchers have noted that ash content reflects the mineral content in meat samples (Ogunsola and Omojola, 2008; Faleye and Fagbohun, 2012).

As presented in Table 1, the fibre content in this study ranged from 1.26 to 3.42%. Francis (2007) suggested that a low fibre content of 2.5% aids in the digestion of protein in meat. Based on this, it can be inferred that, except for the Kilishi from Tudun Wada with 3.42% crude

fibre, the Kilishi samples studied are beneficial in dietary fibre, promoting the easy digestion of high protein.

The findings of this study align with the fibre content in Kilishi (2.96 - 4.12%) as reported by Ese et al. (2024). The relatively high fibre levels in Kilishi may be due to how the dried raw meat slices absorb and adsorb the various spices used in its production.

Table 1 indicates that the carbohydrate content values (1.72 - 8.32%) of the dried beef and Kilishi samples showed significant variation ($p < 0.05$). Likewise, this study's findings are consistent with the carbohydrate content of 0.06% in dried beef and 7.35% in Kilishi samples as noted by Ogunsola et al. (2008).

Mineral Contents in Dried Beef and Kilishi Samples

As shown in Table 2, the Na content ranged from 785.00 to 8,281.50 mgkg-1. This finding does not match the lower Na content of 180.06 ppm in beef reported by Umudi et al. (2018). The higher Na levels may be due to the specific breeding feed given to the slaughtered cow used in this analysis. The elevated Na values in Kilishi samples are likely a result of the salt and spices added during processing. The recommended daily intake of Na is between 1500 and 2400 mg/day.

Table 2 also reveals that Ca contents varied from 337.51 to 459.55 mgkg-1. The Ca results from this study are comparable to those found in Kilishi meats by Obruche et al. (2025), who reported values of 55.69 and 54.69 mg100g-1. The lower Ca levels in Kilishi samples compared to the higher levels in dried beef may be due to moisture loss, which increases mineral concentration per gram. The significant differences in values ($P < 0.05$) observed in Kilishi samples are likely due to the different ingredients used in their production. The recommended daily dietary intake of Ca is between 800 and 1,300 mg/day.

The magnesium (Mg) content in this study (table 2) varied from 357.51 to 474.55 mgkg-1. Ogwuche and Obruche (2020) found higher Mg levels in Kilishi compared to the current finding of 114.97 mg100g-1. The lower Mg concentrations in Kilishi samples, when compared to the higher value in dried beef, may result from moisture loss, which increases the mineral content per gram. The relatively high Mg levels in Kilishi could be due to the proportions of ingredients used during processing. The World Health Organization (WHO, 2001) recommends a daily dietary intake of Mg for humans between 240 and 420 mg/day.

As shown in table 2, the phosphorus (P) concentrations in the study samples ranged from 3,015.00 to 8,915.00 mgkg-1. The P levels found in this study were greater than the 240.30 ppm reported by Festus-Amadi et al. (2021) in beef and 392.42 mg100g-1. The high P values could be attributed to the elevated protein content in the beef and the ingredients used in preparation, particularly garlic. According to FAO/WHO (2001), the recommended daily intake of P is between 700 and 1,250 mg/day.

Table 2 also shows the potassium (K) results, which ranged from 5,405.00 to 9,610.00 mgkg-1. The higher K values may be linked to the type and amount of feed consumed by the cattle before slaughter. However, Obruche et al. (2019) and Umudi et al. (2025) reported lower K values in beef and a beef product called Tinco, with values of 515.03 ppm and 47.39 mg100g-1, respectively. The higher K levels in Kilishi samples compared to the lower levels in dried beef could be due to the groundnut used in their production. According to FAO/WHO (2011), the daily recommended intake of K is 4,700.00 mg/day.

CONCLUSION

The research showed that turning meat into Kilishi in Kaduna State, Nigeria enhances the proximate parameters of the products, making them nutrient-rich. The findings indicate that the order of proximate parameters in the samples is protein > crude fat > ash > moisture > carbohydrate > crude fibre. The Kilishi made in the Laboratory, which acted as a control, produced the best results regarding moisture and fat, reducing their contents, but had lower protein levels. The current findings revealed that the mineral elements (Na, Ca, Mg, P, and K) were present in high amounts across all samples, with the order being K > P > Na > Mg > Ca. The Laboratory (control) Kilishi had the least amounts of Ca, Mg, and P. Among the study samples, the highest Na and Mg levels were found in Kilishi from Kasuwa, the highest Ca level was in Kilishi from Tudun Wada, and Kilishi from Malali had the highest P and K levels, while the lowest mineral levels were found in Sabon Gari Kilishi. The government should implement measures to maintain good hygiene and sanitary standards at slaughterhouses, abattoirs, and Kilishi processing locations, as well as promote good hygiene practices among producers, which may help reduce heavy metal and microbial contamination in the products.

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