



INFLUENCE OF MEAT TYPE ON PROCESSED MEAT (KILISHI) QUALITY

Ndife J., *Onwuzuruike, U. A., Ebeleagu, S. B., Okwunodulu, N. I.

Department of Food Science and Technology, College of Applied Food Sciences and Tourism, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

*Corresponding authors' email: onwuzuruike.uzochukwu@mouau.edu.ng Phone: +234 (0) 8033981164

ABSTRACT

Meat is a good source of quality protein but undergoes rapid deterioration due to physical, chemical and microbial influence. Hence, the need to develop a nutrient-dense product like kilishi with significant storage stability, increased cost efficiency, increased variety and promote food security. Kilishi was produced from different meat sources; beef (KB), chicken (KC), chevon (KV) and mutton (KM) and was assessed for proximate, physicochemical, mineral compositions, microbial quality and sensory properties using standard methods. The result showed proximate composition to range from 8.97 to 11.34%, 3.94 to 6.31%, 16.21 to 27.31%, 21.38 to 23.12% and 37.43 to 45.90% for moisture, ash, fat, protein and carbohydrate contents. Physicochemical properties ranged from 0.08 to 0.18 meg O₂/kg for peroxide value, 0.06 - 0.41 μmol TBARS/g for thiobarbituric acid value, 6.91 to 7.54 for colour, 6.65 to 7.30 for pH and 61.25 to 69.40 mg/ml for solubility. Mineral composition showed that mutton meat kilishi (KM) had higher calcium (51.14 mg/100 g), magnesium (40.04 mg/100 g) and sodium (132.75 mg/100 g) contents while beef kilishi (KB) had the highest iron (8.24 mg/100 g) contents. Microbiologically, the kilishi samples were fit and safe for consumption. The organoleptic study revealed consumers' preference for beef samples. Kilishi production improved the nutrient density, stability and safety of meat from their respective meat sources, and will serve as a viable means of meat storage in low-income countries.

Keywords: Beef, Chevon, Chicken, Kilishi, Meat, Mutton, Quality

INTRODUCTION

Meat is an edible part of animal that comprised principally of fat, muscle, connecting tissues and used as food (Iheagwara and Okonkwo, 2016). Meat is rich in quality protein (Shamsudden, 2009), significant amount of minerals, appreciable essential vitamins as well as enough carbohydrate and fat for energy production (boost nutritive value on humans) (Ahmad *et al.*, 2018). It contains a myriad of valuable nutrients which supports the proliferation of spoilage organisms when handled inappropriately, making meat very perishable, therefore preservation is required to ensure that the keeping quality is extended (Shamsudden, 2009). An average Nigerian citizen consumes below the recommended intake for animal protein. Animal protein can be obtained from meat and meat-derived products, egg and egg-derived products, etc. Only 17% is consumed by an ordinary Nigerian citizen which could be improved by empowering the meat industry and the development of meat-derived products (Edema *et al.*, 2009). According to Apata *et al.* (2013) meat spoilage soon begins after obtaining the raw material as a result of physical, chemical and microbial processes in the meat. Processed meat refers to meat that has been subjected to one or more unit operations like cooking, frying, toasting in order to modify its inherent nutritional properties with or without the addition of one or more seasonings as in the case of kilishi production (Jabaka, 2020). Kilishi is a processed meat product that has been traditionally sun-dried and partial smoked and it is produced in Nigeria using lean beef meat type with the addition or inclusion of plant ingredients. It is intermediate in moisture content or semi-dry meat product. It contains varying constituents of protein, moisture, lipid, fibre and ash respectively, depending on the quantity of meat used. It is a rich snack (meat crackers) that has a nourishing and satisfying sensation as they are formulated from morsel technology which may include salting, dehydration, sun-drying and packing with a retort to inhibit deteriorating microbes (Mgbemere *et al.*, 2011). In

areas where preservative and storage facilities are absent or limited such as in Northern Nigeria occupied by Fulani and Hausa herders, production of kilishi is a way of developing stable meat products with significant storage stability (Isah and Okunbanjo, 2012), however, the storage stability of kilishi is season, production and location dependent (Fonkem *et al.*, 2010).

The research focus of this study is centred on the fact that meat from different sources such as beef, chevon, chicken and mutton comparatively deteriorates faster under poor storage. Notably, refrigeration storage in Nigeria needed for meat storage is challenged by poor electricity supply. This has hampered the possibility of cold storage by meat vendors and consumers, thereby, reducing the shelf life and wholesomeness of meat, hence, the need to process meat into a more stable form such as kilishi. This will contribute immensely to reducing meat deterioration and wastage, increase cost efficiency, expand the market for kilishi through increased variety and promote food security.

MATERIALS AND METHODS

Study area

The study was carried out in the laboratory of the Food Science and Technology Department, Michael Okpara University of Agriculture, Umudike. The study was carried out from February 2021 to November 2021 in order to exhaustively execute the aim of the research.

Material collection

Fresh beef, mutton, chicken and chevon were purchased from a meat store in Umuahia North local government area. Local spices and condiments including onions, alligator pepper, cloves, chillies, ginger, African nutmeg, black pepper, locust bean, and groundnut powder were procured from a spice shop in Ubani Industrial market Abia state.

Sample preparation

Meat preparation

The method described by Iheagwara and Okonkwo (2016) was adopted with slight modifications for meat preparation. The semi tendinous muscle beef, mutton, chevon and chicken were trimmed of all visible fat, bone and connective tissues and then weighed. The weighed meats were sliced into thin sheets of 1-2 cm thick and 60-80 cm long. The thin sheets of meats were dried using a locally fabricated smoking kiln.

Preparation of Infusing Ingredients

The method described by Iheagwara and Okonkwo (2016) was adopted with slight modifications and used. Each spice was ground into powder using a blender. Onions were sliced into small thin cubes (2 x 2 cm). Fresh peanut paste was prepared from fresh peanuts. The peanuts were cleaned, sorted and dried using an oven (Model no.SX3-4.5-15: made in China) at 60 °C for 48 hrs. The dried peanuts were milled using an attrition mill and oil extracted through a screw press to obtain peanut paste. The peanut paste was divided into two portions; one portion was used as the paste while the second

portion was dried in an oven at 60 °C for 72 hrs and milled to obtain defatted peanut powder. The prepared ingredients were mixed using the formulation presented in Table 1 to produce an infusion slurry.

Preparation of Kilishi

The method described by Ogunsola and Omojola (2008) was adopted with slight modifications and used for kilishi production (Figure 1). The dried thin sheets of meats were soaked into the infusion slurry for about 30 min, after which it was taken out and placed on a tray. The infused meats were dried in a smoking kiln at 60°C for 35 min. The meats were further dried in an oven (Model no.SX3-4.5-15: made in China) at a temperature range of 60-80 °C for 7 hrs to obtain kilishi. The finished products (Figure 2a-d) were allowed to cool to room temperature, labelled as beef (KB), chicken (KC), chevon (KV) and mutton (KM), were packaged in cellophane bags and kept at room temperature before analysis.

Table 1: Ingredient Formulation

Ingredient	Weight (g)	(%)
Curry powder	10	1.37
Defatted groundnut	500	68.5
Dried (hot pepper)	50	6.85
<i>Eugenie caryophyllata</i>	20	2.34
Ginger	50	6.85
Maggi	10	1.37
Onion	50	6.85
<i>Piper guinensis</i>	30	4.12
Salt	10	1.37
Total	730	100

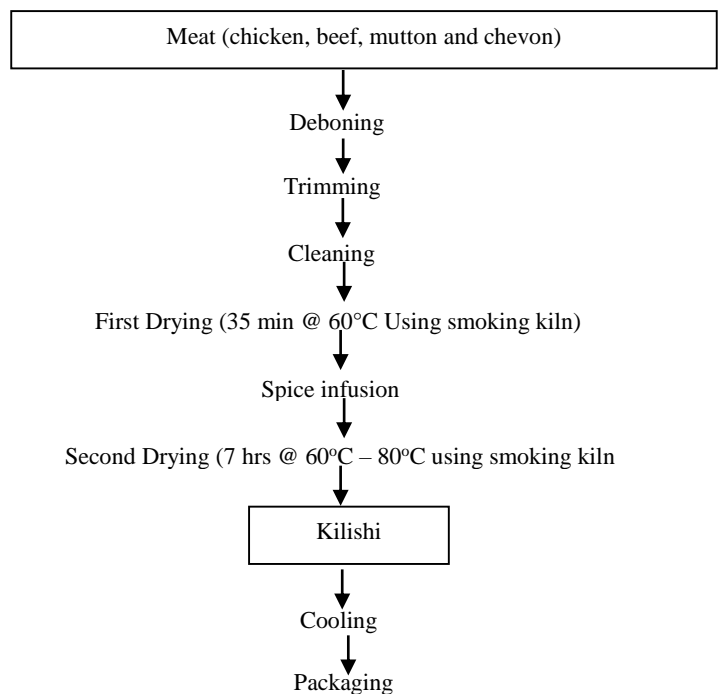


Figure 2: Flow chart for Kilishi processing

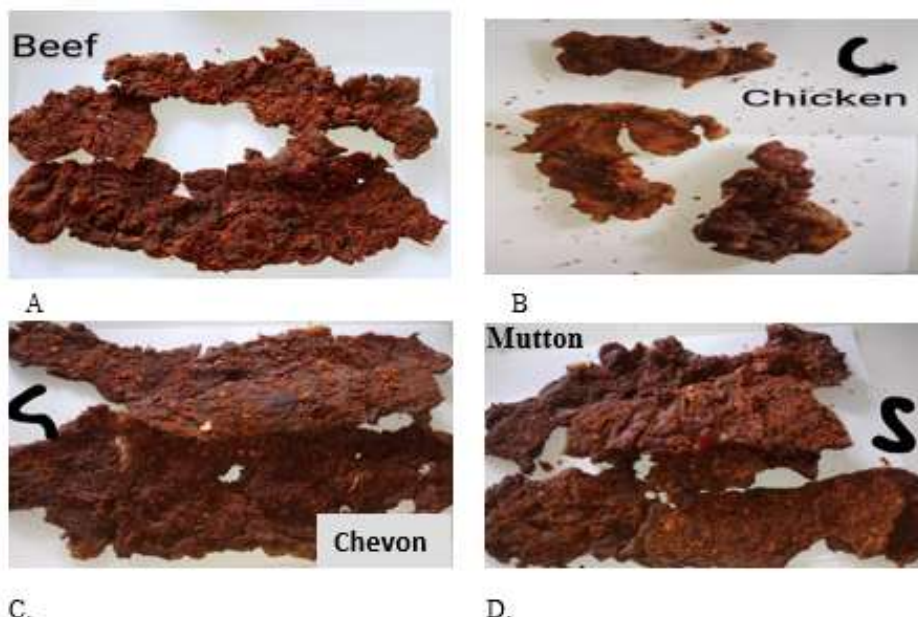


Figure 2a-d: Kilishi samples from different meat sources.

Footnote: A: Beef Kilishi. B: Chicken Kilishi. C: Chevon kilishi. D: Mutton Kilishi.

ANALYSES

Proximate determination

The method described by Onwuka (2018) was used for moisture, crude protein, crude fibre, ash and carbohydrate contents determination. The determination of moisture content was done by the gravimetric method. Crude protein is done by the Kjeldahl method. Fat content was determined using the soxhlet method while carbohydrate was determined by the difference method expressed as Nitrogen free extract (NFE).

Physicochemical analysis

The method described by Ratsimba *et al.* (2020) was used to determine the peroxide value and meat colour of the kilishi samples. Thiobarbituric acid (TBA) was determined according to the method described by Cobos and Diaz (2014). pH and colour variance was determined by the method described by Onwuka (2018). Protein solubility was determined using the procedure described by Fellows (2017).

Mineral analysis

The mineral contents were determined by the dry ash extraction method described by Fellows (2017). The EDTA titrimetric method of Fellows (2017) was used to determine calcium and magnesium. The O-phenanthroline method was used to determine iron. Sodium and selenium were determined by flame photometry as described by Fellows (2017).

Microbial analysis

Sample of 5 g each was dissolved in 45 ml of distilled water. One (1) ml of each sample suspension was diluted using a six-fold serial dilution then inoculated on nutrient agar, MacConkey agar and potato dextrose Agar respectively. The dilution used is 10^{-6} . The organisms inoculated on nutrient agar were incubated for 24 hrs at 37 °C. The plates were observed for growth after the incubation period and were purified. The microbial load was counted and calculated. The purified cultures were then transferred onto MacConkey agar (a selective media) and incubated for 24 hrs at 37 °C. The samples were equally plated on potato dextrose agar (PDA)

for the isolation of fungi. Thereafter the organisms (bacteria) were characterized biochemically. The fungi isolates were characterized with the microscope and concerning mycological manuals (Mat Roni *et al.*, 2020).

Sensory analysis

A 25-member semi-trained panellist conducted a descriptive sensory evaluation on the kilishi samples. The panellists were trained using (Mat Roni *et al.*, 2020) and Hui (2012), with some modifications as described by Protonotariou *et al.* (2013). Each kilishi sample was placed on a white saucer, coded with random 4-digit numbers and presented to the panellists for analysis. The kilishi were analysed for appearance, taste, aroma, texture and general acceptability using the 9-point hedonic scale with 1 for disliked extremely and 9 for liked extremely. Panellists were provided with distilled water to rinse the mouth between tastes to avoid carry-over taste. Kilishi samples scored 5 and above (neither liked nor disliked to extremely liked) for overall acceptability were considered acceptable.

Statistical Analysis: Data obtained were subjected to descriptive statistics and means subjected to one-way analysis of variance (ANOVA). Means that are significantly different at $p < 0.05$ were separated using Duncan's Multiple Range Test (DMRT) with Statistical Package for the Social Science Version 15.0.

RESULTS AND DISCUSSION

Proximate composition of raw meat and Kilishi samples.

The proximate composition of raw meat and kilishi samples are presented in Table 2. The moisture content of the raw meat samples ranged from 68.78 to 73.12% and was higher than the kilishi samples (8.97 to 11.34%). Beef kilishi (KB) had the lowest moisture value, which is desirable as will affect the storage quality of the sample positively to other kilishi samples. Apata *et al.* (2013). The presence or absence of moisture causes spoilage in food depending on the food products. Kilishi samples had low moisture content compared to fresh meat samples.

Table 2: Proximate Composition (%) of Raw Meats and Kilishi samples.

Sample	Moisture	Ash	Fat	Protein	CHO
Raw meat					
RB	73.12 ^a ±0.01	1.07 ^c ±0.03	1.66 ^d ±0.01	20.48 ^{ab} ±0.76	3.68 ^{bc} ±0.81
RC	68.78 ^d ±0.22	4.27 ^a ±0.01	5.29 ^a ±0.06	18.97 ^c ±0.01	2.71 ^c ±1.77
RM	72.65 ^b ±0.21	0.73 ^d ±0.01	1.77 ^c ±0.01	19.67 ^{bc} ±0.01	5.19 ^a ±0.24
RV	70.84 ^c ±0.04	1.73 ^b ±0.36	1.91 ^b ±0.02	20.84 ^a ±0.02	4.70 ^{ab} ±0.37
Kilishi					
KB	8.97 ^d ±0.02	3.99 ^d ±0.01	27.31 ^a ±0.01	22.31 ^b ±0.01	37.43 ^d ±0.00
KC	10.26 ^b ±0.01	5.46 ^b ±0.14	24.16 ^b ±0.01	21.42 ^c ±0.21	38.71 ^c ±0.04
KM	11.34 ^a ±0.21	5.18 ^c ±0.28	16.21 ^d ±0.01	21.38 ^c ±0.28	45.90 ^a ±0.01
KV	9.68 ^c ±0.01	6.31 ^a ±0.01	21.32 ^c ±0.21	23.12 ^a ±0.01	39.58 ^b ±0.03

Values are mean ± SD of duplicate determinations; Means with different superscript letters along each column are significantly different ($p < 0.05$); RB - Raw Beef, RC - Raw Chicken, RM - Raw Mutton, RV - Raw Chevon. KB - Beef Kilishi, KC - Chicken Kilishi, KM - Mutton Kilishi, KV - Chevon Kilishi; CHO – Carbohydrate.

The reason is that the intermittent drying technique or stepwise drying may have accounted for the higher moisture loss, suggesting a positive impact of the processing technique on the water content during kilishi production. Hence, the moisture content of the kilishi samples may not encourage microbial growth, consequently, resulting in improved stability. The findings of this study were in agreement with the findings of Inusa and said (2017), Apata *et al.* (2013) and Olusola *et al.* (2012) who reported moisture values of 8.70-11.50%, 9.87% and 10.00% respectively. Gao *et al.* (2003) suggested that when the moisture content of fresh lean meat is reduced to 20%, the possibility of microbial growth (bacteria, yeast and mould) will be grossly minimized while fungi will be inhibited at a 15% moisture level.

The ash content depicts the concentration of elemental properties of a food material. Ash content is an indication of food quality such that, the higher the mineral composition the higher the propensity of the food material to supply micronutrients. The ash content of the raw meat samples ranged from 0.73 to 1.73% and was lower than the values for the kilishi samples (3.99 to 6.31%). This trend was also recorded by Hidayat *et al.* (2017). The high ash content of the kilishi might be as a result of the ingredient added which is similar to the observation of Khalid *et al.* (2012), Ogunsola and Omojola (2008) and Jones *et al.* (2001). Each spice used contains an individual mineral content which when aggregated, excluding the losses accounted for during processing, results to increased mineral level which is represented by high ash content. The processing of raw meats into kilishi's alters the ash content of the meat as reported by Ogunsola and Omojola (2008), and Olagunju and Taiwo (2020). Ash content of 6.72% was reported for traditionally prepared Kilishi (Jones *et al.*, 2001) while Weiss *et al.* (2010) reported a value of 9.6% for the finished kilishi product and 7.83% for the dried infused product before roasting. The values obtained in this study showed that chevon kilishi (KV) had the highest value which signifies the presence of a higher amount of mineral content compared to other studied kilishi samples.

Fat is principally utilized by food processors to ascertain the energy value of food products (2018). The fat content of the raw meat samples is significantly ($p < 0.05$) lower than the fat contents of the kilishi samples. The values for raw meat ranged from 1.66 to 5.29% and was lower compared to the values for the kilishi samples (16.21 to 27.31%). The high-fat content of the kilishi samples could be principally contributed by the groundnut cake powder which probably contains residual fat and represents a considerable amount of the product. Seydou *et al.* (2019) and Jones *et al.* (2001) noted that kilishi is very high in lipid content on a dry matter basis

(about 25.30%), consisting mostly of triglycerides while the level of fat in fresh meat was less than 10.0%. Notably, Chevon kilishi (KV) had the highest fat content followed by chicken kilishi (KC). This could be due to the type and composition of the animal meat.

The protein content ranged from 21.38 to 23.12% for kilishi samples and 18.97 to 20.84% for raw meat samples. The kilishi samples had more protein compared to raw meat. The difference in value might be due to the large reduction in the moisture content²¹. Kilishi from chevon (KV) had the highest protein while kilishi from chicken (KC) and mutton (KM) did not differ significantly ($p > 0.05$) from each other. Contrary to the findings of Hidayat *et al.* (2017), Ogunsola and Omojola (2008) and Iheagwara and Okonkwo (2016) who reported kilishi values of 30.64%, 33.88 to 60.33% and 51.62 to 55.84% respectively, the values obtained in this study are significantly ($p < 0.05$) lower which may be attributed to the variation in the slurry preparation. However, the protein content of the kilishi samples obtained in this study is considerably high which implied that the kilishi samples might be able to contribute significantly towards achieving the daily human protein requirements, usually about 23-56 g as recommended by Ospina *et al.* (2012). Protein content results demonstrate kilishi the value and potential of kilishi as a high protein food product, however, the production process has been reported to lead to the loss of some soluble proteins Arihara (2006).

The Carbohydrate Content of the kilishi samples increased significantly ($p < 0.05$) from the values obtained in the raw meat samples. The values of the raw meat ranged from 2.71 to 5.19% and from 37.43 to 45.90% in the kilishi samples. This increase could be attributed to different ingredients contributions present in the slurry. These ingredients are of plant origin and high in common sugars. Hence might contribute significantly to the energy demand of the body.

Physicochemical properties of kilishi samples

The results of the physicochemical properties of kilishi samples are presented in Table 3. The results for peroxide value ranged from 0.08 to 0.18 meq O₂/kg. Peroxide value (PV) is a measure of the extent to which oxidation has progressed during storage. It also provides information on the freshness of food samples with lipid constituent (Nettleton *et al.*, 2016). It is a measure of the extent of glycerides constituent decomposition which is aided by light, air and moisture (Jimenez *et al.*, 2000). The higher the peroxide value, the lower the quality of the food sample. Peroxides are the main primary oxidation products. High amounts of peroxides amount to low oxidative stability (Marquez *et al.*, 2009). Peroxide value decreases as secondary oxidation

products appear as such, low PV could suggest the occurrence of advanced oxidation (Saldana *et al.*, 2015). Chicken kilishi (KC) had the lowest PV to other kilishi samples. However, the PV of the samples are generally low which is an indication of low levels of oxidative rancidity. The low PV could be attributed to the influence of the spices used which may

contain antioxidant properties. The findings of this study correspond with the findings of Mgbemere *et al.* (2011) and the findings of Keefe and Wang (2006) who reported that spices activities as an antioxidant influence the stability of kilishi against oxidation.

Table 3: Physicochemical Properties of Kilishi Samples

Sample	PV (Meg/kg)	TBA ($\mu\text{mol/g}$)	CV (%)	pH	Solubility (mg/ml)
KB	0.15 ^b ±0.01	0.18 ^c ±0.01	6.91 ^d ±0.01	7.30 ^a ±0.14	69.40 ^a ±0.14
KC	0.08 ^d ±0.01	0.06 ^d ±0.00	7.54 ^a ±0.01	6.81 ^{bc} ±0.01	61.25 ^d ±0.07
KM	0.12 ^c ±0.00	0.28 ^b ±0.01	7.03 ^c ±0.01	6.91 ^b ±0.01	66.05 ^b ±0.07
KV	0.18 ^a ±0.01	0.41 ^a ±0.01	7.27 ^b ±0.01	6.65 ^c ±0.07	64.25 ^c ±0.07

Values are means \pm SD. Means with different superscript letters along each column are significantly different ($p < 0.05$); PV- Peroxide Value; TBA- Thiobarbituric acid; CV- Colour Variance; KB=Beef Kilishi, KC=Chicken Kilishi, KM=Mutton Kilishi, KV= Chevon Kilishi

The result obtained for thiobarbituric acid (TBA) content of the samples ranged from 0.06 - 0.41 $\mu\text{mol TBARS/g}$. Thiobarbituric acid, TBA is the most widely used method for the measurement of secondary oxidation products. The secondary stage of oxidation occurs when the hydroperoxides decompose to form carbonyls and other compounds, particularly aldehydes which gives the food product a rancid smell (Ogbonnaya and Imodiboh, 2009). Chicken kilishi (KC) had the lowest TBA suggesting the lowest occurrence of secondary oxidation. Generally, the TBA values are very low and are within the acceptable maximum limits for TBA value (1-2 mg MDA/kg lipid) for kilishi, which can be attributed to the processing method for kilishi particularly the removal of visible fat, since fat is a promoter of oxidation. More so, the result also indicates the antioxidant properties and potential of spices against lipid oxidation (Keefe and Wang, 2006). The variance in colour of the kilishi samples differs significantly ($p < 0.05$) from each other. This variation could be due to differences in the meat type and composition. The values ranged from 6.91 to 7.54%. Chicken kilishi (KC) had the highest colour rating which signifies brighter colouration. The pH of the kilishi samples ranged from 6.65 to 7.30 and differ significantly ($p < 0.05$) from each other. Beef kilishi (KB) had the highest value, while chevon kilishi (KV) had the lowest value. The kilishi samples produced from meat sources other than beef are weakly acidic and may contribute to their preservation. Acidic products are more shelf-stable than their non-acidic counterpart (Jo *et al.*, 2018). Hence, chevon kilishi (KV) may exhibit better shelf stability. However, the pH values of the kilishi samples exceed the maximum limit of 6.0 suggested by Ramatou *et al.* (2019) which indicated that the kilishi may have been produced from stock that was not well nourished nor well-rested.

The solubility of kilishi indicates the ease of softening when in contact with saliva in the mouth. The higher the solubility, the faster the rate of softening (Rahman *et al.*, 2005). The

solubility of meat is directly related to its tenderness, juiciness and palatability. It influences the wetness and release of fluid from the meat and sustained the juiciness that develops during chewing. The solubility value ranged from 61.25 to 69.40 mg/ml and differ significantly ($p < 0.05$) from each other. Beef meat kilishi (KB) had the highest value and indicated higher juiciness compared to other samples.

Mineral content of kilishi samples

The mineral content of the kilishi samples is presented in Table 4. The calcium content obtained from the samples ranged from 8.11 to 51.14 mg/100 g. Mutton meat kilishi had the highest value. There was significant ($p < 0.05$) differences among the samples, indicating that the type of meat used for kilishi production significantly influenced the calcium content of the end product. Calcium is an important mineral in human nutrition, being important for bone density. Calcium salts provide rigidity to the skeleton and calcium ions play many roles in most metabolic processes (Ratsimba *et al.*, 2019). Nearly 99.0% of the Ca in the human body is found in the bones (Lorenzo *et al.*, 2008). The calcium contents of the samples are considerably low and below the recommended calcium daily intake of 525 mg for infants, 450 mg for children, 700 mg for adults and 1250 mg for lactating mothers.

The magnesium content obtained for the sample ranged from 26.53 to 40.04 mg/100 g. Mutton kilishi (KM) had the highest concentration of magnesium content. There was a significant difference ($p < 0.05$) in all the samples. Magnesium is an essential component of all cells and is necessary for the functioning of enzymes involved in energy utilization and it is present in the bone (Ayodele *et al.*, 2019). The values obtained in this study was lower than the Recommended Daily Allowance (RDA) of is 400 mg/day (Marušić *et al.*, 2014).

Table 4: Mineral Composition (mg/100 g) of Kilishi Samples

Sample	Calcium	Magnesium	Iron	Sodium	Selenium
KB	8.11 ^d ±0.02	29.22 ^b ±0.02	8.24 ^a ±0.01	58.50 ^c ±0.14	0.02 ^b ±0.00
KC	46.10 ^b ±0.14	26.53 ^d ±0.01	2.06 ^d ±0.01	31.70 ^d ±0.28	0.01 ^b ±0.00
KM	51.14 ^a ±0.01	40.04 ^a ±0.01	6.03 ^b ±0.01	132.75 ^a ±0.07	0.02 ^b ±0.00
KV	17.14 ^c ±0.01	28.14 ^c ±0.02	5.02 ^c ±0.01	69.10 ^b ±0.14	2.97 ^a ±0.01

Values are means \pm SD duplicate determinations. Means with different superscript letters along each column are significantly different ($p < 0.05$); KB=Beef Kilishi, KC=Chicken Kilishi, KM=Mutton Kilishi, KV= Chevon Kilishi

The iron content of the samples ranged from 2.06 to 8.24 mg/100 g with the highest value observed in kilishi beef (KB). There was a significant difference ($p < 0.05$) in all the kilishi samples. Iron is required for the synthesis of haemoglobin and myoglobin, which are oxygen carriers in the blood and muscle respectively (Mirade et al., 2020). The recommended daily allowance of iron ranged from 8-18 mg /100 g as stated by Yang et al. (2009). Beef kilishi (KB) was within the recommended limit and may contribute significantly to the dietary iron needs of the body.

The results show that the sodium content of the kilishi samples ranged from 31.70 to 132.75 mg/100 g. Mutton kilishi (KM) had the highest value. Sodium regulates the water content of the body, as well as aiding in transporting CO₂ and maintains osmotic pressure of bodily fluids (Ahmad et al., 2018). However, intake above recommended value has been associated with high blood pressure and stiffening of arterial walls and therefore is a risk factor for coronary heart disease (Ahmad et al., 2018). The values obtained in this study are lower than the < 2 g/day sodium (5 g/day salt) in adults reported by (Najjari et al., 2008). The low sodium content might be beneficial since a low sodium diet has been reported to be beneficial in the prevention of high blood pressure (Ogunsola and Omojola, 2008).

The selenium content of the kilishi samples ranged from 0.01 to 2.97mg/100g. Chevron kilishi (KV) had the highest value

but no significant ($p > 0.05$) difference exist between beef kilishi (KB), chicken kilishi (KC) and mutton kilishi (KM). The findings of this study are in agreement with the findings of (Ahmad et al., 2018). Selenium prevents cancer, the poisonous effect of heavy metals and helps the body after vaccination (Ahmad et al., 2018).

Microbial quality of kilishi samples

The results of microbial analysis of the kilishi samples are presented in Table 5. The total bacteria count was determined for all prepared kilishi. The control commercial sample, had the highest bacteria count of 1.2×10^8 cfu/ml followed by chevon kilishi (KV) with a bacterial count of 1.0×10^8 cfu/ml. No growth was recorded for beef kilishi (KB), chicken kilishi (KC) and mutton kilishi (KM). *Staphylococcus aureus* and *salmonella* were isolated from the control sample while *Staphylococcus aureus* was isolated from chevon kilishi (KV). The total fungal count was also determined on all samples. The total fungal count of the control sample was 2.4×10^8 cfu/ml while other samples had no growths in them. *Aspergillum spp* was isolated from the control sample. The levels of microbial contamination revealed in the current research are minimal and fit for consumption since the level of the bacterial and fungal count are below the tolerable limit of 2.5×10^5 - 1.0×10^8 cfu/g for viable bacteria count and 1.0×10^4 for fungal growth (Peter, 2018).

Table 5: Total Viable Bacterial and Fungal Count of Kilishi Samples

Sample	Bacterial colony count (cfu/ml)	Isolated bacterial organisms	Fungal colony count (cfu/ml)	Isolated Fungi organism
CTRL	1.2×10^8	<i>S. aureus, Salmonella spp</i>	2.4×10^8	<i>Aspergillum spp</i>
KB	No growth	None	Nil	None
KC	No growth	None	Nil	None
KM	No growth	None	Nil	None
KV	1.0×10^8	<i>S. aureus</i>	Nil	None

KB=Beef Kilishi, KC=Chicken Kilishi, KM=Mutton kilishi, KV=Chevon Kilishi

Sensory properties of kilishi samples

The results for sensory analysis are presented in Table 6. The scores for appearance, taste, aroma, texture and general acceptability ranged from 7.45 to 8.50, 7.10 to 8.20, 7.05 to 7.65, 7.05 to 7.85 and 7.37 to 8.25 respectively. The results revealed that the sensory scores of the kilishi samples differ significantly ($p < 0.05$) from each other. Notably, the control samples had higher sensory scores compared to the

experimental samples to the sensory parameters, thereby suggesting better sensory appeal and acceptability to panellists. Among the experimental samples, beef kilishi (KB) was most accepted as revealed by the sensory scores which may be attributed to familiarity of kilishi from beef to panellists. The control sample and beef kilishi (KB) had a score of 8.25 and 8.00, which implied that both kilishi samples are liked very much by the panellist.

Table 6: Sensory Scores of Kilishi Samples

Sample	Appearance	Taste	Aroma	Texture	GA
COKL	$8.50^A \pm 0.61$	$8.20^a \pm 0.77$	$7.65^a \pm 0.93$	$7.60^{ab} \pm 1.14$	$8.25^a \pm 0.64$
KM	$7.70^b \pm 1.30$	$7.35^{bc} \pm 0.93$	$7.50^a \pm 1.00$	$7.35^{ab} \pm 1.04$	$7.40^b \pm 0.82$
KV	$7.95^{ab} \pm 0.89$	$7.45^{bc} \pm 1.10$	$7.35^a \pm 1.04$	$7.65^{ab} \pm 0.88$	$7.70^{ab} \pm 0.98$
KB	$7.85^{ab} \pm 1.09$	$7.85^{ab} \pm 0.93$	$7.65^a \pm 1.14$	$7.85^a \pm 1.04$	$8.00^{ab} \pm 1.03$
KC	$7.45^b \pm 1.15$	$7.10^c \pm 1.33$	$7.05^a \pm 1.15$	$7.05^b \pm 1.36$	$7.35^b \pm 1.23$

Means with different superscript letters along each column are significantly different ($p < 0.05$); COKL=Control Kilishi, KB=Beef Kilishi, KC=Chicken Kilishi, KM=Mutton Kilishi, KV=Chevon Kilishi. GA=General Acceptability

CONCLUSION

The study revealed that processing meat into kilishi improves its nutritional composition. The fat, protein, ash and carbohydrate contents increased significantly after processing. The mineral contents also increased but were below the recommended daily intake value. The peroxide and thiobarbituric acid values showed that the kilishi samples are still fresh and have not developed rancid flavour. Microbiologically, the kilishi samples are fit and safe for consumption due to the absence of fungal growth and minute bacterial growth in chevon kilishi that lies well below the tolerance limit. The organoleptic study reveals consumers' preferences for the control and beef kilishi (KB) samples.

Conflict of interest: We the authors hereby affirm that there are no conflict of interest.

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