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J Anim Prod Adv 2012, 2(5): 221-232

Online version is available on: www.pjcnet.com

Original Article

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Abstract

Kilishi is a ready to eat intermediate moisture meat which is highly relished. The product is traditionally prepared from beef infused with spices and defatted groundnut paste. This study tried to appraise the eating quality of *kilishi* as affected by meat types and ingredient formulation. Three different *kilishi* recipes viz fresh, frozen and oven dried groundnut paste representing recipes 1, 2 and 3 respectively were formulated and used for the preparation of pork and beef *kilishi* in a completely randomized design. The nutrient composition and eating qualities of each *kilishi* type were evaluated. The result obtained showed that *kilishi* from the recipes were similar in crude protein with a value ranging from 55.47 – 62.33% while the ash content was highest ($P<0.05$) in beef *kilishi* from recipe 1. The colour rating was highest in all pork *kilishi* irrespective of the recipe. The panelist also rated pork *kilishi* higher in juiciness with a value range of 3.50 – 4.30 as against values of 1.80 – 4.40 for beef *kilishi*. Beef *kilishi* from recipe 1 had the highest flavour rating while the overall acceptability was highest in both products from recipe 1 with values of 6.30 and 5.20 for beef and pork *kilishi* respectively. The result obtained in this study showed that the use of recipe 1 with fresh groundnut paste was better in product qualities than frozen or oven dried groundnut paste.

Key words: Groundnut paste, pork, beef, *kilishi*

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Received on: 22 Feb 2012
Revised on: 01 May 2012
Accepted on: 08 May 2012
Online Published on: 30 May 2012

Introduction

Kilishi is an intermediate moisture meat that has a suitable concentration of dissolved solids that binds the moisture in it sufficiently to inhibit the growth of spoilage organism, thus it is a ready-to-eat convenience meat product possessing excellent shelf stability at room temperature, making handling and marketing of the product convenient for consumers and retailers alike (Igene *et al*., 1990; Olusola, 2006). It is a traditional, sun dried Nigerian and Saharan African meat product processed using lean beef in combination with plant ingredients. It contains about 46% meat and 54% non-meat ingredients. A finished product contains about 50% protein, 7.5% moisture, 18% lipid and 9.8% fibre/ash respectively (Igene, 1988; Igene *et al*. 1993).

The product came about as a means of preserving meat in the absence of facilities for refrigerated storage, by the early Fulani and Hausa herdsmen. In Northern Nigeria, the producing states of *kilishi* include: Borno, Kano, Sokoto, Kaduna and Bauchi. This is made possible because the weather is favourable, consumer demand is high and more than 70% of the Nigerian cattle population of 10 million can be found in these states (Alaku and Igene 1983). However its production in the southern states is limited to the dry season (between October and December). The product has gained popularity even today in all major urban as well as rural centres particularly in the Northern parts of Nigeria where it is sold in the streets and in some supermarkets – the only traditional Nigerian meat product to attain such status (Igene *et al*., 1990).

Studies however have shown that the quality of *kilishi* produced by the traditional processors varies from one producer to the other and from one batch to another from the same producer due to the lack of standardized ingredient mix and unit operation that would ensure consistent product quality (Igene, 1988; Olusola, 2006). There is yet to be a standard recipe for *kilishi* preparation. There are differences in the quality of products from one location to another due to the wide range of ingredients used. As reported by (Omojola et al, 2003), one or two of the spice ingredients used in production could replace each other without marked difference in the organoleptic and overall acceptability of the final product.

Beef is the most consumed of all meat types, this has placed a high demand on it. It becomes imperative therefore to explore the possibility of producing kilishi from other meat types. Freshly prepared defatted groundnut paste (DGP) is a principal ingredient in *kilishi* production, however due to its unstable nature at ambient temperature, preserved DGP (frozen and oven dried) were alternatives used in the study.

This study therefore is aimed at comparing the proximate composition and the sensory evaluation of pork and beef *kilishi* prepared from three different ingredient formulations.

Materials and Methods

Experimental Materials

Meat (Semimembranosus or Semitendinosus muscles) from the lean hindquarter of freshly slaughtered, cow and pig were used for the study. The muscles were excised.

and the meat was trimmed free of fat, nerves, blood vessels and excess connective tissues with a sharp knife. The chunk of meat was cut into smaller portions about the size of the palm (about 150-200g). Slicing was done along the fibre axis of each portion giving very thin slices of about 2mm thickness in continuous sheets. For ease in slicing each small cut was placed on the table longitudinally. This first stage drying usually lasted for 7 hours spanning over one or two days depending on the relative humidity, intensity of the sun and air velocity. The meat slices were turned over every hour to allow for even drying and to prevent them from getting stuck to the drying surface. The weights of the fresh meat slices were taken before and after the first stage drying. The dried pieces were kept in airtight containers for the next step in processing. The meat samples were assigned to each of the three recipes in a completely randomized design with a 2x3 factorial arrangement.

Ingredient formulation

The main ingredients used in *kilishi* production is the groundnut paste, salt, sugar, spices such as cloves, ginger, red and sweet pepper; black pepper, african nutmeg and alligator pepper. Others were

onions, curry, maggi cubes and water. Groundnut bought from the open market was properly dry cleaned, roasted slightly for 2mins at 85-100°C and cooled. The testa was removed and cleaned. The groundnut was milled, put in a saucepan on the fire for a period, and the oil got extracted while turning. Alternatively the milled peanut paste was put in a bowl, on the table and kneaded; the oil was extracted as the kneading proceeded. The paste obtained after the extraction was used in *kilishi* preparation. The paste was placed in a bowl and other ingredients were measured and added to it with salt to taste these were then mixed with specified quantity of water enough to make slightly thick slurry for the dried meat pieces to absorb when soaked in. The infusion time was for one hour. The dried meat slices were weighed before infusion, and after subsequent drying.

Three recipes were used. The traditional recipe R1 came about from portions of ingredients that were traditionally prepared. Recipes II and III were formulated for comparative purposes. The percentage ingredients used in the slurry were calculated on basis of dried meat weight.

Product composition

Table 2 gives the percentages of ingredient used for the three formulations R_1, R_2, and R_3. Groundnut past represented 30.0%, 32.0% and 35.0% in recipe 1, 2 and 3 respectively in the ingredient formulation (though there appeared to be many variations in the recipe formulated, the aim was to simulate the traditional recipe). Meat was thinly sliced to 0.16cm – 0.26cm thick and spread out on flat steel trays on a raised platform till sun dried. The infusion slurry was prepared as shown in Table 2. Fresh peanut paste was used for recipe 1, frozen for recipe 3 and oven dried one for recipe 3. The dried meat pieces were soaked in this slurry for one hour, after which they were removed and carefully spread out one by one on steel trays; a wide mosquito net was thinly spread over the closely touching trays to keep off houseflies from perching on the meat slices. After a few hours of drying, the infused meat slices were slightly roasted for a minute or 2 to heat-seal the ingredients in the products. After cooling in trays the product was packaged until when needed.

Table 1: Percentages of ingredients used for slurry

S/No	Ingredients	Traditional Recipe 1	Recipe 2	Recipe 3
1	Ginger	3.50	3.00	2.00
2	Cloves	2.50	2.50	1.50
3	Black pepper	3.40	3.40	1.70
4	Red pepper	2.10	2.00	2.20
5	Sweet pepper	2.10	2.00	2.20
6	Alligator pepper	1.80	2.00	1.20
7	Onion	8.40	8.40	12.0
8	Garlic	0.50	0.20	0.20
9	African nutmeg	1.00	0.50	0.50
10	Curry	0.70	0.70	0.70
11	Salt	0.10	0.20	0.20
12	Maggi	4.10	4.10	2.10
13	Sugar	3.50	3.00	2.50
14	Groundnut paste	30.0*	32.00**	35.0***
15	Water	36.0	36.00	36.0

*Fresh groundnut paste **Frozen groundnut paste ***Ovendried ground nut paste

Sensory evaluation

A group of ten panelist cutting across staff and students (aged between 25and 45) from the Faculty of Agriculture and Forestry were used to evaluate the pork and beef products as affected by the recipes used. The Meat Science laboratory was used for the evaluation, the room though well lit and aerated was equipped with fluorescent light fixtures to enhance visual appraisal by participants and to create an atmosphere free from distractions for the studies.

Sessions started by seating participants around the rectangular laboratory tables in each partition

facing the source of light, with the moderator standing at one end. *Kilishi* strips of 2cm by 1cm of each meat type from the three recipes were used for the evaluation. A glass of table water was made available to the assessors to rinse the mouth after each tasting.

A nine point hedonic scale where 1 = disliked extremely and 9 = liked extremely was used in scoring (Lammond, 1977). Organoleptic properties evaluated included colour, tenderness, juiciness, flavour, hotness, saltiness, and overall acceptability. Sensory evaluation was done on freshly prepared *kilishi* samples.

Table 2: Sensory evaluation rating as affected by the meat type and ingredient formulation (Recipes)

	Recipe 1		Recipe 2		Recipe 3	
	Beef	Pork	Beef	Pork	Beef	Pork
Colour	2.10 ± 0.31^{b}	3.10 ± 0.66^{ab}	2.20 ± 0.33^{b}	3.50 ± 0.52^{ab}	2.70 ± 0.47^{b}	4.50 ± 0.70^{a}
Tenderness	3.30 ± 0.75^{ab}	3.30 ± 0.56^{ab}	2.90 ± 0.67^{ab}	4.80 ± 0.74^{a}	2.10 ± 0.46^{b}	3.20 ± 0.51^{ab}
Juiciness	4.40 ± 0.85^{a}	4.30 ± 0.70^{ab}	2.60 ± 0.34^{bc}	4.00 ± 0.45^{ab}	1.80 ± 0.29^{c}	3.50 ± 0.54^{ab}
Flavour	6.50 ± 0.48^{a}	4.80 ± 0.57^{b}	3.00 ± 0.30^{c}	4.90 ± 0.55^{b}	2.40 ± 0.45^{c}	3.70 ± 0.52^{bc}
Hotness	5.20 ± 0.61^{a}	5.20 ± 0.57^{a}	3.20 ± 0.88^{ab}	2.80 ± 0.73^{b}	2.40 ± 0.79^{b}	3.10 ± 0.67^{ab}
Saltiness	4.00 ± 0.33^{ab}	3.50 ± 0.40^{b}	5.10 ± 0.53^{a}	4.80 ± 0.39^{ab}	3.70 ± 0.42^{b}	3.60 ± 0.40^{b}
Overall acceptability	6.30 ± 0.47^{a}	5.20 ± 0.47^{ab}	3.40 ± 0.40^{bc}	4.10 ± 0.46^{ab}	2.20 ± 0.39^{d}	3.60 ± 0.58^{c}

N = 10

[a-d] Means with different superscripts in the same row are significantly different ($P<0.05$).

Proximate composition of kilishi and the non-meat ingredients used in its Production

Weighed samples of fresh pork and beef from those which were to be used for *kilishi* production and taken from the hindquarters of the carcasses were put in the oven to dry until constant weight was achieved. These were kept aside and representative samples were taken from them to carry out the proximate analysis. These samples were labelled dried pork and dried beef samples. Representative samples were obtained from each product batch of pork and beef *kilishi* for the three different recipes (R1, R2, and R3). These were subjected to proximate analysis.

Individual key spices were also evaluated for their proximate chemical analysis using the standard procedure of A.O.A.C. (1990). Determinations done included: moisture content, crude protein, ether extract (or total fat), crude fibre and total ash. All the spices were cleaned and ground in the dry compartment of a Marvel Japan blender.

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) of SAS (1991). The Duncan multiple range test subjected treatment means to comparison.

Results and Discussions

Presented in Table 2 are the sensory evaluation ratings as affected by the meat type and ingredient formulation (Recipe).

The means for beef under the three regimes of preparation did not exhibit any significant difference in colour. The means for pork *kilishi* across the three recipes did not differ significantly too. However, while all the beef *kilishi*, irrespective of the recipe were clearly different from that of pork *kilishi* in recipe 3, pork *kilishi* with recipes 2 or 3 were not different ($P>0.05$) from those for beef *kilishi* with the three recipes.

Table 3 shows the proximate analysis of the dried raw beef and pork samples along side that of the finished product for the three different recipes used.

The dried raw beef *kilishi* had a moisture percentage of 35.85 ± 0.24 while that of the dried raw pork *kilishi* was higher with 46.51±0.30. These differences were significant at $P<0.05$. There was also a significant difference at $P<0.05$ between the beef product from recipe 1 which was 8.99±0.23 and

that of pork *kilishi with* 5.33±0.11. There was no significant difference (P>0.05) observed in both products from recipe 2 while there was significant difference for *kilishi* products in recipe 3. The finished beef product had a moisture percentage of 8.67±0.06 while that of pork had 8.11±0.10.

The trend of results here obtained for crude protein content was similar to that of moisture content. Values obtained for the dried raw beef and pork samples were significantly different at 45.22±0.22 and 33.88±0.36 respectively. Recipes 1 and 3 showed significant differences between the final beef and pork protein for *kilishi* products while there were no significant differences for both products. in protein from recipe 2 for beef (60.32±0.02%) and pork (59.41±0.63%).

The lipid content of dried raw beef differed significantly from that of dried raw pork. Recipe 1 showed no significant difference (P<0.05) between the beef product with 6.90±0.10% fat and pork product with 6.88±0.43% on the contrary. There were significant differences between the lipid content of beef and pork products from recipes 2 and 3. Percentages obtained were 14.24±0.10 and 13.22±0.21 for beef *kilishi* and 13.33±0.13 and 12.83±0.11 for beef and pork products respectively.

The dried raw beef and pork meat had no crude fibre content. Significant differences were observed between products from the three recipes used. There were significant differences among the products and from the different recipe regimes and between the crude fibre content of pork and beef products. this might be due to the differing rates of absorption of the ingredients from the slurry by the dried meat pieces.

The ash content is an indicator of the mineral content of the meat. The dried raw meat samples had the lowest ash content. The percentages obtained for the dried raw beef and pork were 4.42±0.23 for beef and 3.78±0.50 for pork. All values were significantly different from each other except for pork kilishi in recipe 1 and beef kilishi in recipe 2. The highest ash content was obtained in the recipe1 with 10.31±0.11% for beef *kilishi*. followed closely by beef kilishi in recipe 3 with 9.11±0.10%.

Table 4 gives the proximate analysis of the key ingredients in *kilishi* production. The moisture content of the ingredients used in *kilishi* production ranged from 8.47±0.45% for groundnuts to 79.05±0.55% for onions.

The crude protein values obtained for all the ingredients varied from 5.43±1.00% for cloves to 33.45±2.47% for groundnuts. The crude protein of the groundnut paste was 47.57±2.05%. Cloves and alligator pepper had the lowest percent crude protein 5.43±1.00% for the cloves and 5.63±0.25% for the alligator pepper. For ether extract the highest value was obtained in groundnuts with a value of 29.35±0.55 %. red pepper equally gave the highest % value of 22.93±2.27 % for crude fibre while the least value of 3.43±0.76% was obtained in garlic. The least percentage of ash was obtained in the alligator pepper with a value of 1.30±0.20 while ginger gave the highest percentage of 6.53±1.32.

The sensory evaluation data gave the palatability attributes of *kilishi* prepared with three different recipes. The components evaluated for were colour, tenderness, juiciness, flavour, hotness, saltiness and overall acceptability. Colour is a major determinant of consumer acceptability of meat product at the retail counter: therefore one of the most important considerations in meat product merchandising is that of maintaining an optimum colour or appearance (Hedrick *et al*., 1994).

The sensory rating for tenderness was from 1 (extremely tough) to 9 (extremely tender). Badau *et al*., (1997) reported no significant difference for colour and tenderness when a standardized *kilishi* mix powder was compared to traditional *kilishi* slurry. Igene *et al*., (1990) on the other hand reported s significant differences when colour and tenderness were evaluated for, in two prepared products in comparison to a commercial product. The tenderness of meat can be defined as the sensory manifestation of the structure of meat and the manner in which this structure reacts to the force applied during biting and the specific senses involved in eating. (Moloney, 1999). It is how meat feels in the mouth during manipulation and mastication.

According to Moloney (4999), meat juiciness is an important component of meat tenderness and palatability and it has two major components – the first is the impression of wetness produced by the release of fluids from the meat during the first few chews. while the second is the more sustained juiciness that apparently results from the stimulating

effect of fat on the production of saliva and the coating of fat that builds up on the tongue, teeth and other parts of the mouth. Meat juices play a vital role in conveying the overall impression of palatability to the consumer. Principally sources of juiciness as detected by the consumer are the intramuscular lipids and water content. When these two combined, the melted lipid constitutes a broth which when retained in the meat is released upon chewing. Such broth may also stimulate the flow of saliva, and thus improve the meat's apparent juiciness (Hedrick et al., 1994). In *kilishi* inherent muscle water is of less importance in juiciness because of its low water activity. However the apparent juiciness observed would be due to the ability of the *kilishi* to elicit copious flow of salivary juice to moisten the *kilishi*.

Several factors are interwoven which cannot be separated when discussing flavour. It is suspected that many constituents of the tissue become flavour compounds upon being heated. Physiologically, the perception of flavour involves the detection of four basic sensations including saltiness, sweetness, sourness and bitterness) by the nerve endings on the surface of the tongue (Hedrick et al., 1994). Thus it is the meaty flavour and aroma that stimulate the flow of saliva and gastric juices. The flavour of meats can be associated with either the water or the fat components of the tissue. The chemical components responsible for meat flavour per se are found in the water-soluble fraction and this flavour is essentially the same for all meat types (Moloney, 1999). The several spices used in *kilishi* production also added to the flavour of the products.

Hotness refers to how peppery or spicy the product was. In the traditional recipe the percentage inclusion of the spices was higher for ginger, black pepper, the red and sweet pepper and the alligator pepper – these spices must have contributed much to the hotness of *kilishi* from recipe 1

According to Coon (2003) people were probably not supposed to eat chillies – the pungency is supposed to deter us, but strangely enough humans continue to cultivate these very pungent wild chillies. Chillies are the only cuisine that can initiate pain and pleasure in one sitting, they are also said to exhibit addictive qualities.

From these studies spices (including the chillies) contributed to the flavour and acceptability of the *kilishi* so much so that if there were no spices then there would be no *kilishi*. The blend of these spices with the groundnut paste gave the product a unique pleasant taste.

Other workers on meat product have reported on ingredient inclusion in formulations and taste panel evaluation (Igene *et al.*, 1990; Igene, 1988; Egbunike and Okubanjo, 1999) but little is known of the combined effects of the chillies on the final product. Omojola *et al.*, (2003) reported that one or more spices in *kilishi* making could replace each other without any marked difference in flavour, juiciness, pungency, tenderness and overall acceptability.

The rating for saltiness had 1 as extremely salty and 9 as extremely salt less. *Kilishi* recipe includes salt, sugar and maggi in its preparation, these three with others combined to give the desired taste. The percent composition of maggi and sugar were highest in traditional recipe but this did not give it an edge over the other finished product. Salt and sugar provide a characteristic flavour to impart a cured taste in meat. According to Marriot and Graham (2000), salt acts as a preservative through growth inhibition and destruction of micro organism by dehydrating meat tissue thereby lowering the a_w while sugar acts to counteract the harshness of salt as well as imparting a characteristic flavour.

The evaluators of *kilishi* made from the three different recipes did not seem to give a true reflection of their perception of the product. The only explanation that can be deduced from this is that *kilishi* is a dried meat product, so the evaluators did not feel it is juicy (as in boiled or stewed meat) where moist cooking has softened and released the intramuscular fats into the taste buds to give an immediate perception of the flavour of the product. Fresh groundnut paste was used to prepare *kilishi* in recipe 1; the freshness of this in the product is reflected. This gives it a significant preference over that of frozen or dried groundnut paste of recipes 2 and 3 respectively.

Fernandez *et al.* (1999a) reported that pork tenderness and taste are enhanced at intramuscular fat levels up to 3.25%. The sensory evaluation score for tenderness in beef and pork *kilishi* did not differ significantly. This is partly due to the fact that lean portions were used in *kilishi* preparation. Novakofski (1987) stated that while low levels of

intramuscular lipid are detrimental to palatability. levels over the thresh hold do not result in a linearly increasing beneficial effect. In the same vein. Devol *et al.* (1988) found that tenderness was significantly correlated with intramuscular fat (r = 0.34) when evaluated by a trained taste panel.

The juiciness of pork *kilishi* was significantly higher (scoring slightly dry). than that of beef *kilishi* (table 2).Fernandez *et al.* (1999a) reported that highly marbled chops were more juicy and tender than lean chops. therefore as intramuscular fat increased from <1.5% to >3.5% juiciness also increased. Juiciness tends to be associated with marbling: hence heavier. fatter animals produce meat. which seems juicer. Juiciness tends to decline as animal ages (Moloney, 1999). Meat juices play an important role in conveying the overall impression of palatability to the consumer. They contain many of the important flavour components. and assist in the process of fragmenting and softening the meat during chewing. (Hedrick et al., 1994).

Flavour is influenced by the deposition of compounds from the feed in the fat of the animal (Moloney. 1999). It is supposed that many constituents of the animal tissue become flavour components upon heating. Inosine monophosphate (IMP) and hypoxanthine enhance flavour: these are breakdown products of ATP, thus muscles with large energy stores would have a more pronounced flavour – (Hedrick et al., 1994). The result obtained supports the observation of Melton (1990) that as the fat of meat increases so does flavour. The diet that an animal consumes can cause changes in the fatty acid composition and volatile substances in muscle. Changes in the latter are often very subtle and may not be detected by consumers. The more highly marbled chops in pork had higher flavour intensity scores compared to less marbled chops. It was also reported that consumer-evaluated flavour increased dramatically up to 3.5% intramuscular fat (Fernandez *et al.* 1999b).

The more common trend is to cook meat to improve palatability of the product. However. lipids have been found to influence flavour value through their effect on flavour perception (mouth feel. taste and aroma). flavour stability and flavour generation (De Roos. 1997). In general flavour release from the oil/fat phase of meat proceeds at a lower rate (as in dried meat products) than from the aqueous phase (as in stewed or boiled meat). This is attributable to the higher resistance to mass transfer in fat and oil than in water and to the fact that with oil in water emulsions. flavour compounds are first to be released from the fat to the aqueous phase before they can be released from the aqueous phase to the head space. Because of the delayed release of the fat-soluble flavour compounds in the mouth. the maximum flavour intensity of these compounds is perceived at a later moment than that of their water-soluble counterparts (Hedrick *et al.*, 1994). Consequently there is a change in flavour character and intensity with time. resulting in the perception of two or more flavour characters in succession (De Roos. 1997).

The hotness of *kilishi* is an evaluation of the pungency of the product. Different spices in their different proportions released their pungency into the *kilishi* differently. Both products in recipe 1 were rated the same to give an intermediate scoring (Table 2). Beef *kilishi* in recipe 2 and pork in recipe 3 were rated equally (moderately hot) while pork *kilishi* in recipe 2 was scored to be the same as beef in recipe 3 (slightly hot to moderately hot). Omojola *et al.*, (2003). reported that there was no significant ($P>0.05$) difference in the pungency of *kilishi* when the spice mixture was used and their composition varied. While the spices contribute a little to pungency. it can be conclusive to say that the chillies have a greater contribution to this. Chillies have been widely used throughout the world as a pungent spice for domestic. culinary purposes (Purseglove. 1981. Coon. 2003).

The highest scoring for salt in beef *kilishi* of recipe 2 was significantly different from that of beef and pork in recipe 3 and pork in recipe 1 which all attracted the same scoring (moderately salty to slightly salty). In table 2. Pork *kilishi* in recipe 1 and that of recipe 2 were rated the same (moderately salty – slightly salty). Salt in *kilishi* was added to taste not solely for preservative purpose. Sodium chloride gives a dry harsh. dark coloured and unattractive product (Kramlich *et al.*, 1980). A reduction in sodium intake in diets in most industrialized countries is highly recommended in order to lower the blood pressure of sodium sensitive individuals (Law *et al.*, 1991).

The consumer preference was highest for the traditionally prepared beef *kilishi* (recipe 1) and was least for the beef product in recipe 3. which was

disliked very much (Table 4). This is likely due to the fact that recipe 1(traditional recipe) utilized the fresh groundnut paste, therefore the freshness of the paste imparted its flavour on the product along with the spices to make it most acceptable. In recipe 3, the oven dried groundnut paste was used in the composition making it the least accepted *kilishi* (beef in recipe 3) and also had the lowest score for juiciness. The varied ingredient composition of the recipe could also be responsible for the product preference by consumers.

The proximate composition of the raw dried beef and pork and that of the *kilishi* produced with the three different recipes gave the moisture content of the raw dried beef to be significantly lower than that of the raw dried pork (Table 3). Only recipe 2 did not differ in moisture content for pork or beef *kilishi*, there were significant differences in the moisture contents of recipes 1 and 3. Contrary to expectation the moisture content of *kilishi* in recipe 3 (dried groundnut paste) was not the lowest, that of the pork product in recipe 1 (fresh groundnut paste) was. Water activity (a_w) is related to moisture reduction in a product.

Pork *kilishi* from the traditional recipe recorded the highest crude protein mean of 69.02± 0.03 percent; this differed significantly from the mean protein percent of the raw dried beef and pork (Table 3). This indicates that processing meat as in *kilishi* production improves the percent protein of the product thus making it nutrient dense. The beef *kilishi* in recipes 1and 3 and both products in recipe 2 did not differ significantly in their protein content from the highest protein percent obtained in the pork product of recipe 1. Igene *et al.* (1990) reported a value of 50.02% crude protein for traditional *kilishi* after roasting. The major part of the protein comes from the groundnut cake which has 55.85% (Badau *et al.*, 1997). All other ingredients contributed their quota of protein too.

The fat content of 16.72% in the raw dried pork meat was highest and significantly differed from the fat level of all others. The observations in the lipid content of *kilishi* products did not follow an expected trend. The lipid content of *kilishi* from recipe 1 did not differ significantly while that of recipes 2& 3 differed from one another (Table 3). Igene (1988a) noted that *kilishi* is very high in lipid content on dry weight basis (25.23%) this consisting mostly of triglycerides. While the level of fat in the fresh meat was less than 10.0%, the final product usually contains a very high level of fat, contributed principally by the groundnut cake powder which represents a considerable proportion of the product (Igene, 1988a).

A study of the traditional processing of *kilishi* gave a fat percentage of 17.8% (Igene *et al.*, 1990). Jones *et al.* (2001) reported a fat content of as high as 25.36±1.35%. Ockerman and Li (1999) reported that the level of lard addition in a dehydrated meat product is the main effect that influences the meaty flavour. The type of oil or fat used as well as its level of inclusion could also influence flavour positively or negatively.

Fresh meat has no crude fibre content, this determination was done because the elements that constitute the spices in *kilishi* production are of plant origin hence are likely to be fibrous. The highest crude fibre content obtained in pork *kilishi* from recipe 2 was significantly different from that of pork *kilishi* with recipe 1 and for beef kilishi in recipe 2. The beef *kilishi* from recipe 1 did not differ much from the pork products. The crude fibre content of beef *kilishi* from recipe 2 (3.43±0.23%) differed significantly from that of recipe 3 (2.96±0.06%) as seen in table 5. Badau *et al.* (1997) reported crude fibre range of 6.1-25.0% for ingredients used in *kilishi* production. Though the recipes were constituted from virtually the same ingredients, differences were obtained in the crude fibre values of *kilishi* products. It can therefore be deduced that the varied rate of absorption and adsorption of the dried raw meat slices in the different spice mixture is responsible for the significant differences observed in the crude fibre content of *kilishi* produced.

Fresh meat has an ash content of about 1% (wet basis), processing increases this level significantly. On dry weight basis it contains 3.5% mineral components (Jones *et al.*, 2001). High ash content is indicative of the individual mineral levels of the spices to give a cumulative mineral level minus the loss during processing. In this study the ash content of the final beef kilishi differed significantly from that of the raw dried pork. All the beef *kilishi* in the 3 recipes differed significantly from one another. The same trend followed for all the pork *kilishi*. Similarly pork kilishi in recipe 1 did not differ

significantly in ash content from beef kilishi in recipe 2. The beef *kilishi* in recipe 1 gave the highest mean ash content while the pork kilishi in recipe 2 had the least (Table 3). 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% for the finished product and 7.83% for the dried infused product prior to roasting. *Kilishi* supplies a significant proportion of desirable nutrients as far as minerals are concerned.

The proximate composition of the spices differs from the range of values reported by Farrel (1990); Badau *et al.* (1997) and Thompson *et al.* (2005). Badau *et al.* (1997) reported a moisture range of spices used in production to be 4.9% for onions to 11.9% for cloves while the crude protein % ranged from 5.5% in cloves to 55.8% in the peanut paste. Thompson *et al.*, (2005) on the other hand reported dry matter content of 10.6% (89.4% moisture) regardless of age for onions in a study that compared the composition of spring onions grown hydroponically or in potted soil. Ingredients used in this study were purchased from the open market. grains (like corn) and spices must have a residual moisture level of as low 10-15% to disallow mould growth while they are put for sale. this might be responsible for the seemingly low values obtained for clove. pepper and the African nutmeg (*Monodora myristica*). While all these spices are important in *kilishi* making, it has been reported that one or more of the spices could replace each other without any marked difference in flavour, juiciness, pungency, tenderness and overall acceptability (Omojola *et al.*, 2003). However, there is no replacement for groundnut since it is the key ingredient forming a major part of other processed Nigerian meat products (Igene and Ekanem, 1985).

The present study has also shown that the *Capsicum* spp. (red pepper) which is among the major condiments employed for seasoning freshly cooked and prepared vegetable and used in the meat industry for curing and preservation of meat is a must in kilishi preparation. *Capsicum annum* (tatase) is used as a spice and has been found to contain substantial levels of vitamin C (Grubben, 1977). they owe their pungency to the presence of a phenolic compound closely related to vanillin, known as capsaicin (Agboola 1973) and are responsible for the slightly bright colour it gives kilishi. Black pepper on the other hand is mostly used for its characteristic delicate penetrating aroma and pungent, biting taste (Kairalee, 2003). Cloves, black pepper, red pepper, African nutmeg and alligator pepper are known to have contributed to the pungency of the pork and beef *kilishi* products in this study. Atanda *et al.*, (1990) reported a moisture content of 2.2% and 25.02% for *Capsicum annum* stored for sale. Mould colony counts ranged from 0.67×10^2 to 1.6×10^5 cfu/gm while *Aspergillus niger*, *Aspergillus flavus* and *Geotrichum candidom* were the dominant species of mould isolated

From the study, garlic (*Allium sativum*) was found to be an important but optional ingredient amongst kilishi processors it is usually available in three different forms: fresh, dehydrated, and extracted. It is one of the most common spices which are frequently used in sausages and other meat products. Fresh garlic bulbs were used in all the recipes. 4% fresh garlic extract is reported to have inhibited the growth of *Escherichia coli*, *Shigella dysenteriae*, *Salmonella typhi* and *staphylococcus aureus* (Al-Delaimy and Ali, 1970). Fresh garlic ground with meat prolongs the shelf-life of fresh meat (Al Delaimy and Barakat, 1970). De-wit *et al.*, (1978) reported that 1500 ug/g of garlic in a meat slurry inhibited toxin production by Clostridium botulinum type A but not by types B or E. The inhibition of *Bacillus cereus* by garlic extracts has also been reported (Saleem and Al-Delaimy (1982). Farrell (1990) stated that commercial oil of garlic, undiluted, has 200 times the strength of dehydrated garlic or 900 times the strength of fresh garlic.

Onions (*Allium cepa*) is a major ingredient in the preparation of most ready to 'eat meat products', it was found in this study to be a very vital ingredient in kilishi processing. It sometimes replaces garlic. Its availability in the dehydrated form is thought by the meat industry to be more uniform in quality than onions purchased from the market, probably because the dehydrated onion powder eliminates the labour connected with the use of fresh onions and gives a ready to use powder that can be mixed easily with spices in meat processing. However, fresh onions were preferably used in this study to offer the freshness in aroma that most of the other ingredients (which were mostly dried spices) lacked.

Table 3: Proximate composition of dried raw beef and pork and *kilishi* produced therefrom after infusion in three different recipes

Treatment	% Moisture	% Protein	% Fat	% C F	% Ash	% Carbohydrates
Dried raw meat						
Dried Beef	35.85±0.24^{b}	45.22±0.22^{c}	14.53±0.23^{b}	0.00±0.0^{e}	4.42±0.23^{f}	0.06
Dried Pork	46.51±0.30^{a}	33.88±0.36^{d}	16.72±0.22^{a}	0.00±0.0^{e}	3.78±0.50^{g}	0.89
Final Kilishi product						
Recipe 1						
Beef	8.99±0.23^{d}	62.33±17.05^{ab}	6.90±0.10^{f}	4.12±0.01^{ab}	10.31±0.11^{a}	7.35
Pork	5.33±0.11^{g}	69.02±0.03^{a}	6.88±0.43^{f}	3.87±0.31^{b}	09.11±0.10^{c}	5.79
Recipe 2						
Beef	10.00±0.15^{c}	60.32±0.02^{ab}	14.24±0.10^{c}	3.43±0.23^{c}	08.78±0.13^{c}	3.23
Pork	09.92±0.22^{c}	59.41±0.63^{ab}	13.33±0.13^{d}	4.42±0.22^{a}	06.96±0.24^{e}	5.96
Recipe 3						
Beef	8.67±0.06^{e}	59.70±0.22^{ab}	13.22±0.21^{d}	2.96±0.06^{d}	9.38±0.12^{b}	6.07
Pork	8.11±0.10^{f}	55.47±0.07^{bc}	12.83±0.11^{e}	3.94±0.02^{b}	7.59±0.11^{d}	12.06

*Means in the same column bearing different superscripts are significantly (P< 0.05) different.

Table 4: Proximate analysis of ingredients used in *kilishi* production (n=3)

Ingredients	% Moisture	%CP	%EE	%CF	%Ash	Total Carbohydrate
Ginger	74.00±0.90	07.53 ±1.59	05.83± 0.25	7.13± 1.05	6.53 1±.32	
Cloves	12.38± 0.40	05.43_±1.00	07.37 2±.04	9.47± 0.50	5.60 ±0.82	59.75
Black pepper	14.47± 0.86	10.63 ±0.64	02.17 ±0.23	9.70 ±4.69	5.60 ±1.04	57.43
Red pepper	10.71± 1.26	11.80 ±1.40	14.59± 1.26	22.93 ±2.27	6.13 ±0.94	33.84
Onion	79.05±0.55	8.47±0.61	2.27±0.55	1.6±0.85	2.9±0.10	5.71
Garlic	69.50± 1.66	8.50 ±1.15	06.17± 0.42	3.43 ±0.76	3.30±.0.53	9.10
African nutmeg	11.92 ±0.15	9.40 ±0.62	06.30± 0.72	16.70 1.6±5	2.13 ±0.55	53.55
Alligator pepper	10.58 ±0.20	5.63 ±0.25	02.87± 0.25	13.47 0.74±	1.30± 0.20	66.15
Groundnut	8.47 ±0.45	33.45 ±2.47	29.35.± 0.55	16.44± 0.26	2..93± 0.15	9.36
Infusion slurry	40.03± 0.60	47.57± 2.05	19.60±0. 70	08.30 ±0.15	4.13 ±0.25	

Conclusion

The two meat types used in the study were acceptable to the consumers, and the groundnut paste in any of the forms used did not significantly affect the product quality. *Kilishi* from both meat types irrespective of the recipe used was nutrient dense. Recipe 1 gave the best results in terms of its effect on fat content by lowering the fat considerably.

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