EFFECT OF GROUNDNUT FLOUR SUBSTITUTION ON YIELD, QUALITY AND STORAGE STABILITY OF *KILISHI* – A NIGERIAN INDIGENOUS DRIED MEAT PRODUCT

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ABSTRACT

Kilishi, a traditionally sun-dried roasted meat product usually produced using raw meat, *Tunkusa* (a locally defatted groundnut cake paste), in combination with spices and condiments in the mix was produced after substitution with conventional defatted groundnut flour. This study was undertaken to establish the potential use of conventional defatted groundnut flour in place of *Tunkusa* in making a better quality and shelf - stable *Kilishi*. The yield, quality and storage stability of the product were evaluated using standard assay techniques. Yield was estimated as the ratio of weight of *Kilishi* over the fresh beef. Quality was measured in terms of proximate composition which included protein, fat, carbohydrate, fibre and ash contents, and the amount of calorie obtained from the *Kilishi* was calculated based on these constituents. Sensory quality attributes were also measured in terms of colour/appearance, flavour, crispiness, texture and overall acceptability. Microbial counts such as total plate, yeast and mould and coliform were measured. Storage stability was evaluated in terms of thiobarbituric acid (TBA), free fatty acid (FFA) and Peroxide value (PV) values prior and following storage in ambient (25-32°C) or refrigerator (7±1°C) for 12 weeks. Yield of the *Kilishi* (GFK) produced from conventional defatted groundnut flour ingredients was 87.3% compared to 83.7% of traditionally defatted groundnut cake (*Tunkusa*) *Kilishi* (TK) (control). The GFK had 12.1% moisture, 51.8% protein, 13.4% fat, 5.1% ash, 2.8% crude fibre and 14.8% carbohydrate compared to TK 11.6%, 49.8%, 11.4%, 5.2%, 3.1%, and 18.9% for these constituents, respectively. GFK also had 387.0 Kcal/100g energy value compared to 377.4 for TK. Both GFK and TK were highly rated in sensory attributes, however, TK had lesser acceptability. Microbial counts were non detectable in the fresh *Kilishi* products until week 12 and were within standard safe limits (10^6 CFU/g aerobic and 10^7 anaerobic counts) thereafter. At week 12, microbial counts were 2.1×10^1 CFU/g bacteria and 3.0×10^0 moulds for GFK stored at ambient (25-32°C) condition and 4.5×10^1 CFU/g bacteria for GFK stored at refrigerator (7±1°C) conditions, whereas TK had 1.6×10^1 CFU/g bacteria, 1.0×10^1 moulds and 1.1×10^1 CFU/g bacteria. Storage for 12 weeks slightly decreased sensory scores, protein and fat contents and also TBA, FFA, PV but moisture increased slightly. It is possible to produce high quality and yield as well as acceptable and shelf stable *Kilishi* using conventional defatted groundnut flour. Also GFK *Kilishi* had better quality attributes when compared with TK, *Tunkusa Kilishi*.

Key words: Meat, *Tunkusa*, *Kilishi*, Groundnut flour, Quality

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INTRODUCTION

Kilishi is a traditionally processed, sun-dried, roasted ready-to-eat (RTE) meat product. It is popular especially in Northern Nigeria, Cameroun, Chad, Niger Republic and other countries in the sahelian region of Africa. *Kilishi* also has been an important export commodity to Saudi Arabia and other Asian countries where it is also widely consumed [1]. *Kilishi* is brownish in colour, light in weight, rich in protein and contains other vital nutrients [1]. It is mostly consumed as a snack food and as part of a main dish. Its consumption seems to have no age, religious or ethnic barrier.

Processing of *Kilishi* comprises the use of fresh meat such as beef, lamb, mutton, goat or other essential animal flesh/muscle in combination with *Tunkusa* (locally defatted groundnut cake paste), spices and condiments in the mix. In the process, fat is trimmed and removed before the meat is sliced / cut into flat thin sheets using a sharp knife. The sheets are spread on raffia mat or wooden tray and sun dried (first stage drying), to reduce the moisture content and condition the meat for ingredient infusion. The pre-dried meat is then coated/infused with the ingredient mix powder (*Tunkusa*, spices and condiments ground into powder form) slurry and dried again (second stage drying) and finally roasted in a smokeless glowing fire [1]. The resultant *Kilishi* is often wrapped in a cardboard paper, hawked and sold along the streets, in the filling stations, retail shops, restaurants, hotels, markets and airports.

Use of edible plant material such as flour/protein in comminuted meat product increases yield and lowers cost. Since the cost of conventional animal product is high, plant protein becomes an alternative source. It is cheap and affordable with acceptable organoleptic qualities [2, 3]. Conventional defatted groundnut flour has been used as a valuable ingredient in many high protein food formulations such as convenience food, snacks soups and beverage [4]. The preparation method of groundnut flour is hygienic, unlike the traditionally defatted groundnut cake paste, *Tunkusa,* that lacks adequate hygienic practices and, therefore, it is prone to unsafe levels of microorganisms. Also excessive production processes of *Tunkusa* exposes nutrients especially protein to loss of functionalities, but the utilization of groundnut flour in fabricated foods largely depends on its functional properties [4, 5, 6].

Nutrients and functional properties would be preserved, and also safer microbiological acceptable levels and better *Kilishi* would be produced using conventional defatted groundnut flour compared to *Tunkusa Kilishi*. The objective of this study was to ascertain the effect of conventional defatted groundnut flour substitution on yield, quality and storage stability of *Kilishi*.

MATERIALS AND METHODS

Materials
Groundnut seed (*Arachis hypogeae L.*), black pepper (*Piper guineas*), hot pepper *(Capsicium frutecens),* sweet pepper *(Capsicium anum), Clove (Eugenia carphylatta*), ginger (*Zingiber officinale*), maggi cubes (Bullion), meleguenta *(Afromomium*

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meleguentg), onion (*Allium cepa),* table salt and sugar were purchased from Wurukum market in Makurdi, Benue State, Nigeria. Groundnut (*Arachis hypoggea*) cake paste: *Tunkusa* and potable water were obtained from *kilishi* factory in Ekewan Campus University of Benin, Edo State, Nigeria. Beef was purchased from Aduewagh abattoir in Benin City, Edo State, Nigeria.

Preparation of conventional groundnut flour and the defatted flour
Clean 5kg groundnut seeds were mildly roasted in an air oven at 48±2°C, decuticled by hand abrasion, winnowed and the hulls removed. The kernels were oven dried at 55±2°C for 5 hours and milled into flour with a kitchen blender (Philip, HR 1702), sieved to a particle size of 225μm, spread on a tray (45x45cm) at a loading depth of 10mm and toasted in the oven at 105±1°C. The resultant flour was defatted by placing the flour in a muslin cloth, screw pressed to maximum pressure (20 psi), and oil extracted until a fat content of 19.8% was attained. The defatted flour was toasted in an oven at 105±1°C, packaged in cellophane bags 20μm thick and stored in a refrigerated at 7±1°C [7, 8].

Preparation of ingredient powder mix
Clean dry spice or condiment (100g of each) was dried further in an air oven at 40±2°C for six hours and ground using a kitchen blender. The resultant feed/powder was sieved with standard mesh and the average particle size was 225μm. One kg of fresh onion was sliced and spread on a tray (45x45cm) to a loading depth of 50mm and dried at 40±2°C for 12 hours, ground, sieved, proportioned and blended into the ingredients mix [9].

Production, packaging and storage of the *kilishi*
Four and half (4.5) kg of fresh beef was trimmed and the fat was removed. The resultant lean beef (4.3kg) was sliced into thin sheets of 0.15 - 0.20cm thick, arranged on a cleaned stainless tray (45x100cm) to a loading depth of 0.15-0.20cm, dried in an air oven 50±1°C for 4 hours to 25.2±0.3% moisture content. Total 2.4kg of the ingredient powder mix including 1.84kg of defatted groundnut flour or *Tunkusa* was weighed using a digital scale (FP-300 Fisher Sci. Edu. USA) into a clean plastic bowl (45cm diameter x 20cm depth) and mixed with 5.6L of boiled, cooled water at 50±1°C to form a slurry. About 2.39kg of the pre-dried sliced beef was immersed in the slurry for 30 minutes and the beef was infused. The infused beef (10.25kg) was arranged on the cleaned tray (45x100cm) to a loading depth of 0.4-0.55cm and dried in the oven at 50±1°C for 4 hours, arranged on the tray and placed on an oven glowing with smokeless charcoal fire at 250±1° C and roasted for 5 minutes. The resultant *Kilishi* was cooled under the revolving ceiling fan and weighed. *Tunkusa Kilishi* (TK) (control) and conventional defatted groundnut flour *Kilishi* (GFK) were packaged 100g per pack, respectively using sterile 20μm thickness cellophane bags and vacuum sealed (KOCH Ultravac UV 250 equip, Inc, USA) and placed into a plastic container (20cm diameter x 30cm depth) and stored at ambient (25-32°C) or refrigerator (7±1°C) for 12 weeks.

Determination of yield, proximate composition and energy value

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Moisture content was determined using moisture analyzer (MB 35 Halogen OHAUS) at 105°C. Five (5) grams *Kilishi* sample was placed into clean dry analyzer cabinet dish. The heater was turned on and the sample was heated, the moisture content was attained and heating stopped automatically. The actual yield was expressed as the ratio of final weight of *Kilishi* to the fresh sliced beef sheets [10]. Protein (Nx6.25), fat, ash and crude fibre contents of the *Kilishi* were determined according to AOAC [11]. Carbohydrate was calculated by difference [12]. Energy value (Kcal/100g) was evaluated thus: (4 x Carbohydrate + 4 x Protein + 9 x Fat) [13].

Determination of peroxide value (PV), thiobarbituric acid (TBA), free fatty acid (FFA) and hydrogen ion concentration (pH) value
Peroxide value: 5g *Kilishi* sample was weighed into a 250ml Erlenmeyer flask. Exactly 30ml of acetic acid-chloroform (2:1) solution was added and swirled to dissolve. Exactly 5ml of saturated solution of potassium iodide was added and allowed to stand for one minute with occasional shaking. The mixture was added to 30ml of distilled water and titrated with 0.1ml sodium thiosulphate with vigorous shaking until the yellow colour nearly faded away. Then 0.5ml of 1% starch solution was added and titration continued until the blue colour first disappeared. A blank consisting of distilled water in place of the extract was also prepared and titrated. From these, the PV was calculated [11].

For the thiobarbituric acid: 10g of *Kilishi* sample was blended in a kitchen blender and transferred into a clean-dried conical flask. To it 50ml distilled water was added, mixed thoroughly and filtered using filter paper (whatman). 5ml of the extract was mixed in a test tube with 5ml of 0.2g 2-thiobarbituric acid (Sigma-Aldrich Inc.) in 100ml of distilled water. A blank consisting of 5ml of the 2-thiobarbituric acid dissolved with 5ml distilled water in a test tube was prepared. Both the sample and the blank were stoppered with aluminum foil and allowed to stay at ambient temperature 25-32°C for 24 hours. The absorbance was measured at 538 nm using a spectrophotometer (Spectronic 20) and converted to TBA number [14].

For free fatty acid: neutral solvent was prepared by mixing 25ml of diethyl ether with 25ml ethanol plus 1ml of 1% phenolphthalein indicator and carefully neutralized with 0.1M sodium hydroxide solution. Exactly 5g *Kilishi* sample was dissolved in the neutral solvent and titrated against aqueous 0.1M solution of sodium hydroxide with shaking until the pink colour that lasted about 15 sec. was obtained [15].

Hydrogen ion concentration (pH) value was determined by blending 5g *Kilishi* sample using kitchen blender (Philips HR, 1702). This was transferred into a 100ml beaker and mixed with deionized water. The mixture was filtered and the pH measured using single electrode digital pH meter (Philip), [16]. All determinations were in triplicate.

Microbial evaluation
Glass wares were aseptically prepared. About 1g *Kilishi* was randomly selected from each *Kilishi* samples and blended thoroughly with 9ml sterile distilled water in a test tube. Subsequently, serial dilutions were prepared appropriately. About 1ml of each diluent was then aseptically transferred into coded sterile Petri dishes. For total plate

Scholarly, Peer Reviewed
ISSN 1684 5374
Volume 11 No. 2
March 2011
Published by ASSCAT

AJFAND ONLINE
African Journal of Food, Agriculture, Nutrition and Development

counts: 7g of nutrient agar (Anteg. Diagnostic T^m U.K), and for yeast and mould counts, 9.75g potatoes dextrose agar (PDA) (Int. Diagnostic group Plc ideg) was dissolved in 250ml of distilled water and sterilized in an autoclave at 121°C for 20 minutes and allowed to cool to 40-44°C before 10ml was poured to each of the coded Petri dishes containing the diluents, respectively. These were swirled gently and allowed to solidify. The plates were inverted and incubated, for total plate counts at 32°C for 44 - 48 hours and for yeast and mould counts at 36°C for four days in a Gallenkamp incubator. After incubation, counts were determined using digital colony counter (JP secter S.A). The total bacteria counts were reported as CFU/g. For coliform counts: McConkey media was used [17].

Sensory evaluation
*Kilish*i sample was placed in a coded dish and presented to a 25-member panel consisting of 10 who are familiar with *Kilishi* and 15 who are not familiar with *Kilishi*. The panel evaluated the *Kilishi* based on colour, flavour, texture, crispiness and overall acceptability using a 9-point hedonic scale [18].

Analysis of data
The mean scores obtained from the yield, proximate composition, sensory evaluation and microbiological data were tested for significant difference at 5% probability level using analysis of variance (ANOVA). Turkey's least significant difference (LSD) test was used to separate means with significant differences [19].

RESULTS

Ingredient proportion
Table 1 shows the proportion of ingredients/raw materials used in the *Kilishi* processing. Proportion of the ingredients ranged from 1.3g (0.13%) in clove to 459.14g (45.9%) in *Tunkusa* or conventional defatted groundnut flour.

Proximate composition (dry weight basis), yield and energy value of the *Kilishi* products
Table 2 shows proximate composition, yield and energy value of *Tunkusa* (TK) (control) and conventional defatted groundnut flour (GFK) *Kilishi*. The *Kilishi* products had low moisture contents which ranged from 11.6% in TK to 12.1% in GFK. Both GFK and TK had high protein contents with GFK containing higher protein content of 51.4% compared to TK 49.8%. For fat content, TK had 11.4% which was significantly (P 0.05) lower when compared to 13.4% in GFK. Ash contents of the *Kilishi* products were high. TK had slightly higher ash content of 5.2% than 5.1% ash content of GFK. The crude fibre contents were low. It ranged from 2.8% in GFK to 3.1% in TK. Carbohydrate contents ranged from 14.8% in GFK to 18.9% in TK. The carbohydrate contents differed significantly (P 0.05).

Table 2 also shows the yield of *Tunkusa* (TK) (control) and conventional defatted groundnut flour (GFK) *Kilishi*. The yield ranged from 83.7%-87.3%. Yield of GFK *Kilishi* was significantly (P 0.05) higher than yield of TK. Also Table 2 shows the energy value of TK and GFK *Kilishi*. Groundnut flour *kilishi* (GFK) had higher

energy value of 387.0 Kcal/100g than 377.4 Kcal/100g of TK *Kilishi*. The energy value also differed significantly (P 0.05).

Sensory scores of the *Kilishi* product
Table 3 shows the mean sensory scores of *Tunkusa Kilishi* (TK) (control) and conventional defatted groundnut flour *Kilishi* (GFK). Although there were significant differences (P   0.05) between GFK and TK in the sensory attributes, both products had very high scores in all the attributes. The GFK (groundnut flour *Kilishi*) (GFK) had scores higher than TK in appearance, texture, flavour, crispiness and overall acceptability.

Effect of storage at ambient (25-32°C) refrigerator (7±1°C) on sensory score of the *Kilishi* products
Table 4 shows the effect of storage at ambient (25-32°C) and refrigerator (7±1°C) on sensory score of the *Kilishi*. During storage, the mean sensory scores of both *Kilishi* products maintained high ratings in all the attributes. However, *Tunkusa Kilishi* (TK) (control) had slightly lower rating than groundnut flour *Kilishi* (GFK).

Effect of storage on hydrogen ion concentration value (pH), free fatty acid (FFA), thiobarbituric acid (TBA) and peroxide value (PV) of the *Kilishi* products
Table 5 shows the effect of storage on hydrogen ion concentration (pH) value of the *Kilishi* products. The pH values slightly increased more in the *Kilishi* stored in the refrigerator (7±1°C) temperature than *Kilishi* stored at ambient temperature. Hydrogen ion concentration (pH) values for *Tunkusa Kilishi* (TK) (control) ranged from 6.09 to 6.64 at ambient (25-32°C) and 6.09 to 6.28 at refrigerator (7±1°C) temperatures storage period (week one to week 12). Similarly, GFK had a pH range of 6.18 to 6.28 at ambient (25-32°C) and 6.18 to 6.30 at refrigerator (7±1°C) temperatures storage for a period of one to 12 weeks.

Figure 1 shows the effect of storage on free fatty acid (FFA). The free fatty acid values were relatively reduced in the *Kilishi* products stored in refrigerator and at ambient temperatures over the storage period. In the first week, both GFK and TK *Kilishi* (control) had FFA 1.86 and 1.89 % oleic acid, respectively. However, FFA of TK *Kilishi* reduced to 1.64 and 1.61 % oleic acid while FFA of GFK reduced to 1.72 at ambient (25-32°C) temperature and 1.69 (% oleic acid) at refrigerator (7±1°C) temperature in week twelve during storage period.
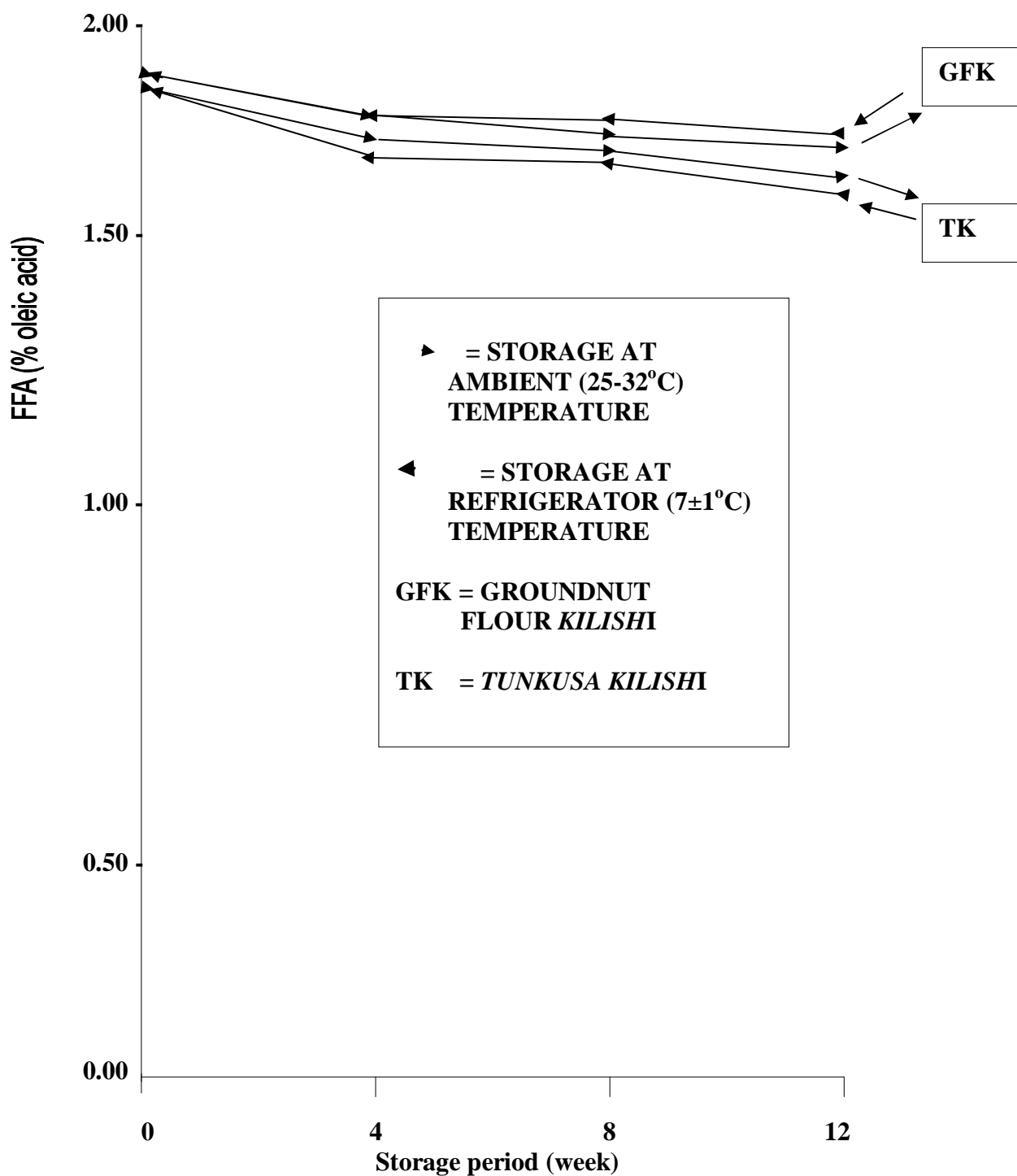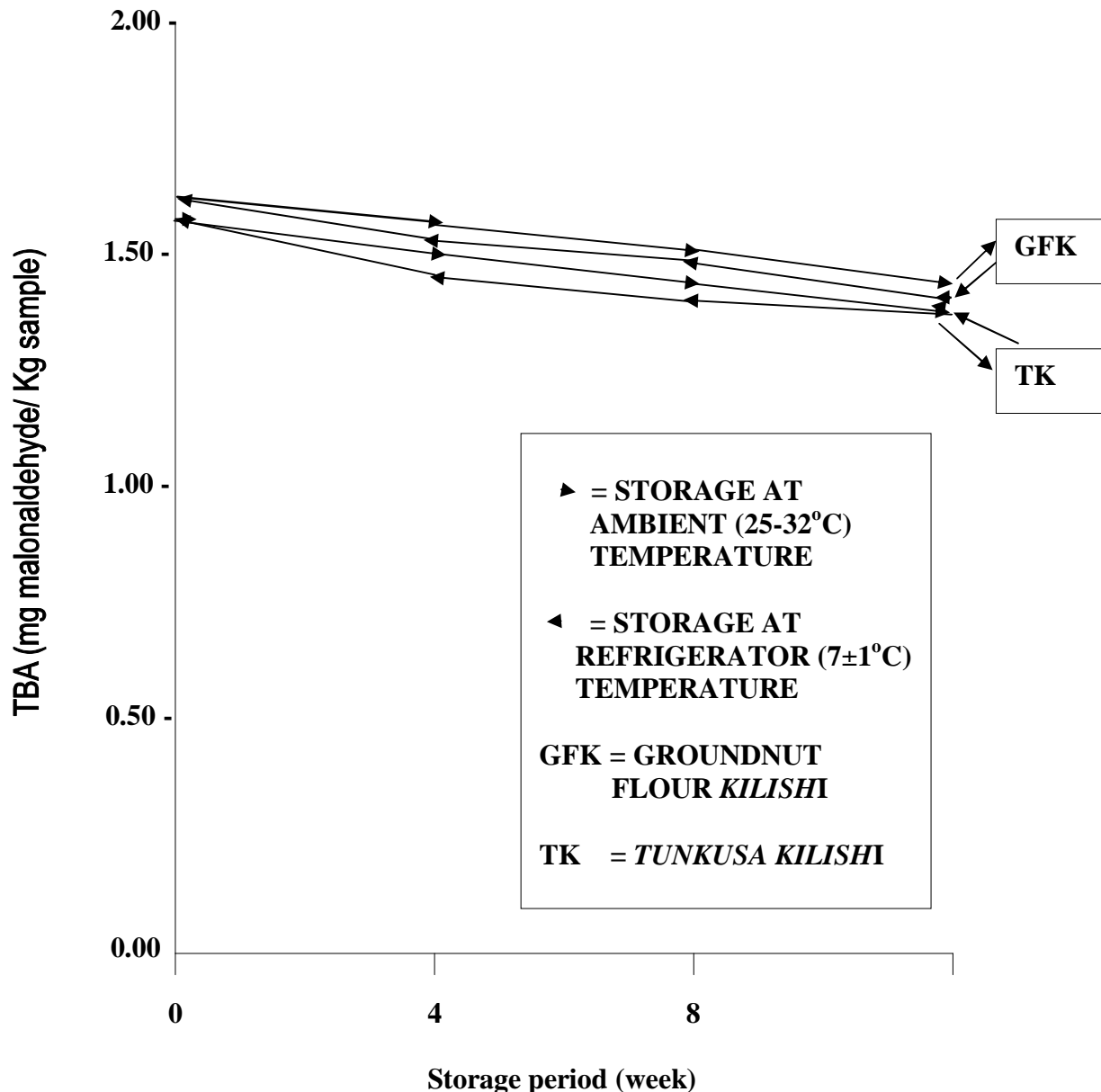
Figure 1: Effect of storage at ambient (25-32°C) and refrigerator (7±1°C) temperatures on free fatty acid (FFA) of (GFK) groundnut flour and (TK) *tunkusa kilishi*

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Figure 2 shows the effect of storage on thiobarbituric acid (TBA) of the *Kilishi* products. TBA values were higher at week zero but lowered subsequently during storage. Groundnut flour *Kilishi* (GFK) had higher TBA values than *Tunkusa* (TK) (control). For samples stored at ambient, the TBA value ranged from 1.58 to 1.45 mg malonaldehyde/Kg sample in GFK and 1.56 to 1.40 mg malonaldehyde/Kg sample in TK *Kilishi* while refrigerated samples values ranged from 1.58 to 1.41 in GFK and 1.56 to 1.39 mg malonaldehyde/Kg sample in TK *Kilishi*. *Kilishi* samples stored at refrigerator (7±1°C) had slightly lower changes in TBA than samples stored at ambient (25-32°C) temperature.

Figure 2: Effect of storage at ambient (25-32°C) and refrigerator (7±1°C) temperatures on thiobarbituric (TBA) of (GFK) groundnut flour and (TK) *tunkusa kilishi*

Figure 3 shows the effect of storage on peroxide value (PV) of the *Kilishi* products. Peroxide values (PV) were higher at week zero and decreased during storage. The PV values ranged from 1.52 to 1.72meq/Kg sample across *Kilishi* stored at both ambient and refrigerator temperatures. Groundnut flour *Kilishi* (GFK) had lower PV ranging from 1.73 to 1.64meq/Kg sample while TK (control) *Kilishi* had PV ranging from 1.70 to 1.52meq/Kg sample. Also, *Kilishi* samples stored at refrigerator (7±1°C) temperature had slightly lower changes in PV than *Kilishi* stored at ambient (25-32°C) temperature.
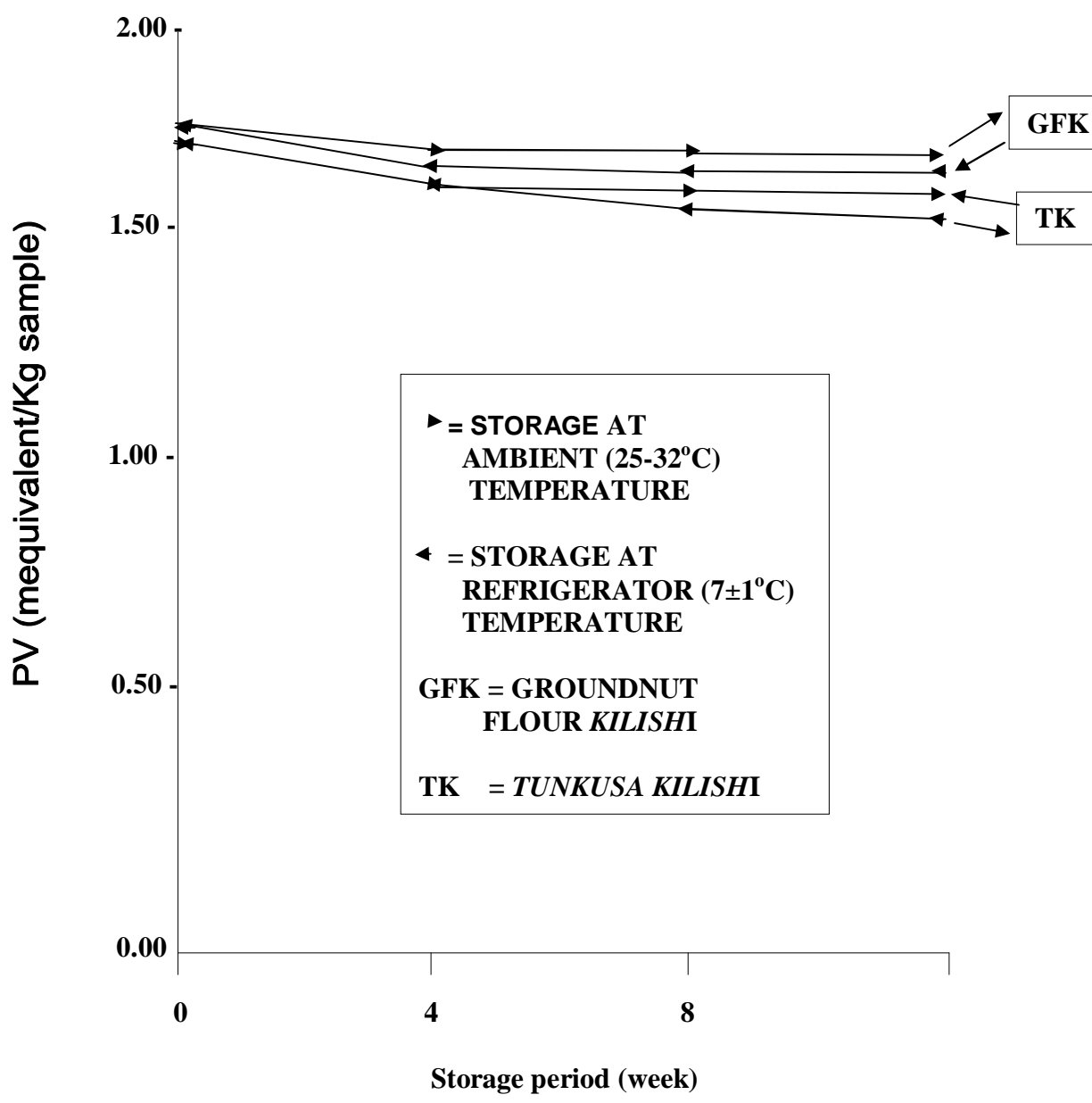
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Figure 3: Effect of storage at ambient (25-32°C) and refrigerator (7±1°C) temperatures on peroxide value (PV) of (GFK) groundnut flour and (TK) *tunkusa kilishi*

Effect of storage at ambient (25-32°C) refrigerator (7±1°C) on microbial load of *Kilishi*

The microbial counts in both GFK and TK (control) during storage were non detectable (ND) until week twelve. *Tunkusa Kilishi* (TK) stored at ambient had bacterial counts of 1.6×10^1 CFU/g and mould counts 1.0×10^1 CFU/g while the samples stored at refrigerator had bacterial counts 1.1×10^1 CFU/g. Similarly, GFK stored at ambient had bacterial counts 2.1×10^1 CFU/g and mould counts 3.0×10^1. Groundnut flour *Kilishi* (GFK) samples stored at refrigerator had bacterial counts of 4.5×10^1 CFU/g. At week twelve, the microbial counts were higher in GFK than in TK (control).

DISCUSSION
Ingredient proportion

The proportion of the ingredient probably indicates their essentiality in *Kilishi* production. Ingredients with high proportions might be major contributors to the physio-chemical properties of the processed *Kilishi* product. Earlier studies on *Kilishi* indicated that high proportion of *Tunkusa* (traditionally defatted groundnut cake) used in *Kilishi* processing contributed significantly to the physio-chemical properties of the *Kilishi* product [20]. In the same vein, the conventionally defatted groundnut flour would greatly influence the overall characteristic of its *Kilishi*.

Proximate composition (dry weight basis), yield and energy value of the *Kilishi* products

The low moisture content of the *Kilishi* indicates that the products were well dried. If the products are packaged, at this moisture level with materials that are low in moisture permeability, the products would be at water activity level that may protect it from microorganism spoilage. Both GFK and TK had high levels of protein contents. However, GFK had higher protein content 51.4% compared to TK (control) 49.8%. If both products were dried to the same level of moisture content, GFK might have had much more protein than TK. A significant quantity of protein might have been lost from *Tunkusa* due to its production process, which involved repeatedly hand squeezing of the groundnut cake paste and extraction of the oil with warm water. The higher level of protein obtained in GFK *Kilishi* suggests that conventional defatted groundnut flour would be a potential replacement of *Tunkusa* for a protein rich *Kilishi*. Fat content of TK, 11.4% was significantly (P 0.05) lower when compared to 13.4% in GFK. The reason for lower fat content in TK was because the *Tunkusa* used was defatted to a lower fat content (12.2%) compared to 19.8% in conventional defatted groundnut flour. Lower fat content in TK might have contributed to lesser rating of TK in flavour attribute since fat usually influences flavour of meat products. High ash contents recorded in the *Kilishi* products particularly in TK *Kilishi* (control) might be due to contamination of *Tunkusa* by foreign bodies such as dirt. Contamination resulting from production process of *Tunkusa* might influence the mineral content of traditional processed meat such as *Kilishi* [21]. Crude fibre as well as carbohydrate might be contributed by flour, spices and condiment such as ginger, onion and pepper used in the *Kilishi* production [22]. The higher value of carbohydrate in TK might be because the carbohydrate was calculated by difference (the sum total of the other constituents subtracted from 100). The result of proximate

composition in this study indicated that GFK is a potential replacement for protein rich and other essential nutrients in *Kilishi* product.

The yield (87.3%) of the GFK *Kilishi* was significantly (P 0.05) higher than TK (83.7%). This might be because the conventional defatted groundnut flour bound more of the ingredients. Yield (87%) has been recorded in *Tunkusa Kilishi* produced with sodium tripolyphosphate (STPP). The STPP was meant to improve the yield of *Kilishi* [12]. Production process of *Tunkusa* could affect its functionality adversely including the capacity to bind ingredients. This result on yield suggests that conventional defatted groundnut flour could improve yield in *Kilishi.*

Calculated energy value of 387.0 Kcal/100g in GFK was higher than 377.4 Kcal/100g in TK *Kilishi*. This energy value differed slightly from 510Kcal/125g energy value for *Kilishi* product previously reported [23]. The difference might be from the constituents such as protein, fat and carbohydrate from which the energy value was evaluated. This high energy values apparently suggest that both GFK and TK *Kilishi* products are potential sources of vital energy for human consumption.

Sensory scores of the *kilishi* product

Table 3, shows the mean sensory scores of *Tunkusa Kilishi* (TK) (control) and conventional defatted groundnut flour *Kilishi* (GFK). Although there were significant differences (P 0.05) between GFK and TK in the sensory attributes, both products had very high scores in all the attributes evaluated. Groundnut flour *Kilishi* (GFK) was more highly scored than TK in all the attributes (appearance, texture, flavour, crispiness and overall acceptability). Due to the manner of production process of *Tunkusa,* oxidation might set in and affect adversely the flavour of its product. The overall acceptability of the *Kilishi* products might be due to flavour and other attributes contributed by meat, oil, protein, spices and flavonoids which influence palatability and acceptability of products. The result of this study suggests consumers' greater preference of GFK to TK. During storage the mean sensory scores (Table 4) of the *Kilishi* products maintained high ratings. This suggests that storage for 12 weeks did not adversely affect the products.

Effect of storage on hydrogen ion concentration (pH) value, free fatty acid (FFA) thiobarbituric acid (TBA) and peroxide value (PV) of the *Kilishi* products

Hydrogen ion concentration (pH) values (Table 5) slightly increased more in the *Kilishi* stored in the refrigerator than *Kilishi* stored at ambient temperature probably due to protein degrading microorganisms such as *Pseudomonas* that predominates at low temperature. Proteolytic microorganism aided by lactic acid bacteria could cause sourness in meat and meat products [24]. Also the result of this study suggests some degree of stability of the *Kilishi* products.

The FFA values (Figure 1) were relatively reduced in the *Kilishi* products stored in refrigerator and at ambient over the storage period. This result differs from high FFA value in *Kilishi* produced with undefatted groundnut cake paste, *Tunkusa* [25]. The reduced FFA values in this study might be because both the *Tunkusa* and groundnut flour used in the production of *Kilishi* were defatted. Also this result suggests high oxidative stability of these *Kilishi* products.

TBA values also were higher at week zero probably because of high rate of oxidation stimulated by the method of *Kilishi* such as heat drying. Groundnut flour *Kilishi* (GFK) had higher TBA than TK. Higher fat level recorded in GFK than TK *Kilishi* could provide more substrate for lipid oxidation. Thiobarbituric acid (TBA), however, declined progressively at subsequent storage weeks. This might be that the spices and condiments used in the production provided antioxidant effect on the products. *Kilishi* products stored in the refrigerator (7±1°C) had lower TBA values compared to products store at ambient (25-32°C). This might be because low temperature slowed down lipid oxidation. This trend in TBA agrees with higher TBA values that declined during storage of *Kilishi* [26]. Thiobarbituric acid (TBA) values, highest ranges (1.58 to 1.45 mg malonaldehyde/Kg sample) obtained before and after storage in this study were within the threshold of 1.8mg malonaldehyde/Kg sample suggested in previous reports [27]. This suggests stability of the *Kilishi* products.

PV values were higher in week zero and decreased during storage. The low moisture contents of the *Kilishi* products might be responsible for the decreased PV values. Water inhibits incipient oxidation of lipid but promote secondary reaction of lipid degradation products with protein at increasing water activity (*aw*) [28]. The PV values range of 1.52 to 1.72meq/Kg sample across *Kilishi* stored both at ambient and refrigerator is within the acceptable limits of 10.0 to 20meq/Kgsample [29].

Effect of storage at ambient (25-32°C) refrigerator (7±1°C) on microbial load of *Kilishi* products

The microbial counts in both GFK and TK during storage were non detectable (ND) until week 12. However, the microbial counts observed at week 12 storage periods might be due to post processing contamination probably from the air in the environment and other medium during packaging. The microorganisms probably succeeded the hurdle of non-access to moisture and / or other growth factors. The highest microbial counts (4.5×10^1 CFU/g) obtained in this study were lower than the limit (10^6 CFU/g counts for aerobic and 10^7 CFU/g count for anaerobic microorganisms) suggested for dry meat products [29, 30].

CONCLUSION

The result of this study has shown that conventional defatted groundnut flour base *Kilishi* (GFK) can enhance the yield and quality of *Kilishi* products. Conventional defatted groundnut flour base *Kilishi* had more protein and yield than *Tunkusa Kilishi* (TK) (control). Even though both *Kilishi* products compared well in organoleptic qualities, GFK was more acceptable than TK. Also storage indices were better in the conventional defatted groundnut flour base *Kilishi* than *Tunkusa Kilishi* (TK) (control). These appreciable attributes make the groundnut flour a potential for *Kilishi* production. Further study on *Kilishi* processing using other locally available edible beans would help to make *Kilishi* product abundant for consumption.

Table 1: Ingredient proportion for the *kilishi* production

English/scientific/local name of spices and condiments	Proportion (g)
Black pepper, *Piper guineese* (masoro)	2.5
Hot Pepper, *Capsicium frutecens* (Barkono)	5.3
Sweet Pepper, *Capsicium anum* (Tattashe)	11.0
Clove, *Eugenia carphylatta* (kanufari)	1.3
Ginger, *Zingiber officinale*	17.9
Groundnut Paste, *Arachis hypogeae* (*Tunkusa*)/	
Groundnut flour, *Arachis hypogeae*	459.14
Maggi cubes (Bullion)	53.5
Onion *Alluim cepa* (Albasa)	12.5
Table salt (Sodium chloride)	23.0
Sugar (Sucrose)	10.3
Meleguenta *Afromomum meleguenta* (Chitta miya)	3.7
Water	400.0
Total	1000

Table 2: Proximate composition (%) yield (%) and energy value of the *kilishi* products (dry weight basis

Kilishi sample	Moisture	Protein	Fat	Ash	Crude fibre	Carbo-hydrate*	Yield (%)	Energy Value (Kcal/100g)
TK	$11.6^a \pm 0.4$	$49.8^a \pm 0.2$	$11.4^b \pm 0.3$	$5.2^a \pm 0.2$	$3.1^a \pm 0.2$	$18.9^b \pm 0.3$	$83.7^b \pm 0.4$	$377.4^b \pm 0.4$
GFK	$12.1^a \pm 0.3$	$51.4^a \pm 0.3$	$13.4^a \pm 0.2$	$5.1^a \pm 0.3$	$2.8^a \pm 0.3$	$14.8^a \pm 0.4$	$87.3^a \pm 0.3$	$387.0^a \pm 0.2$

(a) Values are means ± standard deviations of triplicate determinations;

(b) Values not followed by the same superscript on the same column are significantly different (P 0.05).

KEY: GFK = Groundnut flour *kilishi*

TK =*Tunkusa kilishi* (Control)

* = By difference

Table 3: Mean sensory scores of the *kilishi* products

Kilishi sample	Appearance	Texture	Crispiness	Flavour	Overall acceptability
GFK	7.3[a]	7.0[a]	7.0[a]	7.4[a]	8.0[a]
TK	6.1[b]	6.4[b]	6.7[b]	6.1[b]	6.3[b]

(a) Values are means of triplicate determination;

(b) Values not followed by the same superscript on the same column are significantly different (P 0.05)

KEY: TK = *Tunkusa Kilishi* (Control)

GFK = Groundnut flour *Kilishi*

Scholarly, Peer Reviewed
ISSN 1684 5374
Volume 11 No. 2
March 2011
African Journal of Food, Agriculture, Nutrition and Development
Published by African Scholarly Science Communications Trust

Table 4: Mean sensory scores of *kilishi* stored at ambient (25-32°C) and refrigerator (7±1°C)

Kilishi Sample	Storage period (Week)	Ambient (25-32°C) Attributes					Refrigerator (7±1°C) Attributes				
		Appearance	Texture	Crispiness	Flavour	Overall-acceptability	Appearance	Texture	Crispiness	Flavour	Overall-acceptability
TK	0	6.1ᵃ±0.05	6.4ᵃ±0.03	6.7ᶜᵈ±0.04	6.1ᵃ±0.04	6.3ᵃ±0.03	6.1ᵃ±0.05	6.4ᵇ±0.03	6.7ᵃᵇ±0.04	6.1ᵇ±0.04	6.3ᵃ±0.03
	4	5.8ᵃᵇ±0.03	6.3ᵃᵇ±0.01	6.4ᵇ±0.03	6.3ᵃ±0.03	6.4ᵃ±0.04	6.2ᵃ±0.02	6.4ᵇ±0.02	6.8ᵃᵇ±0.03	6.0ᵃᵇ±0.03	6.4ᵃ±0.02
	8	5.8ᵃᵇ±0.02	6.1ᵃᵇ±0.03	5.9ᵃ±0.04	6.0ᵃᵇ±0.02	6.3ᵃ±0.03	6.0ᵃ±0.03	6.2ᵃᵇ±0.03	6.5ᵃ±0.02	5.8ᵃ±0.04	6.5ᵃ±0.03
	12	5.6ᵇ±0.02	6.0ᵇ±0.02	5.6ᵃ±0.02	5.7ᵇ±0.03	5.6ᵇ±0.04	5.9ᵃ±0.04	5.9ᵃ±0.02	6.5ᵃ±0.03	5.7ᵃᵇ±0.03	5.7ᵇ±0.02
GFK	0	7.3ᵈ±0.02	7.0ᶜᵈ±0.03	7.0ᵈ±0.02	7.4ᵈ±0.02	8.0ᵈ±0.02	7.3ᵇ±0.02	7.3ᵈ±0.02	6.9ᵇ±0.02	7.4ᵈ±0.02	8.0ᵈ±0.02
	4	7.0ᶜᵈ±0.04	7.3ᵈ±0.02	6.8ᶜᵈ±0.03	7.2ᶜᵈ±0.03	7.6ᶜᵈ±0.03	7.1ᵇ±0.03	7.2ᶜ±0.03	6.7ᵃᵇ±0.03	7.3ᵈ±0.03	7.5ᶜ±0.03
	8	6.8ᶜ±0.02	6.9ᶜ±0.02	6.5ᵇᶜ±0.02	7.0ᶜ±0.02	7.4ᶜ±0.04	7.2ᵇ±0.02	7.2ᶜ±0.02	6.8ᵃᵇ±0.02	7.1ᶜᵈ±0.02	7.3ᶜ±0.04
	12	6.8ᶜ±0.03	6.7ᶜ±0.03	6.3ᵇ±0.03	7.0ᶜ±0.03	7.4ᶜ±0.02	7.0ᵇ±0.03	7.0ᶜ±0.03	6.7ᵃᵇ±0.03	6.9ᶜ±0.03	7.6ᶜᵈ±0.03

(a) Values are means ± standard deviations of triplicate determinations
(b) Values not followed by the same superscript on the same column are significantly different (P 0.05)
KEY: GFK = Groundnut flour *Kilishi*
TK = *Tunkusa Kilishi* (Control)

Table 5: Effect of storage at ambient (25-32°C) and refrigerator (7±1°C) temperatures on pH of (GFK) groundnut flour and (TK) *tunkusa kilishi*

Kilishi Sample	Storage Period (Week)	pH value	
		Ambient (25 -32°C)	**Refrigerator (7±1°C)**
TK	0	$6.09^a \pm 0.07$	$6.09^a \pm 0.07$
	4	$6.20^b \pm 0.05$	$6.22^b \pm 0.05$
	8	$6.23^{bc} \pm 0.03$	$6.26^{bc} \pm 0.04$
	12	$6.24^{bc} \pm 0.04$	$6.28^c \pm 0.03$
GFK	0	$6.18^b \pm 0.04$	$6.18^b \pm 0.04$
	4	$6.21^b \pm 0.03$	$6.21^b \pm 0.03$
	8	$6.25^{bc} \pm 0.03$	$6.28^c \pm 0.02$
	12	$6.28^c \pm 0.02$	$6.30^c \pm 0.03$

(a) Values are means ± standard deviations of triplicate determinations

(b) Values not followed by the same superscript on the same column are significantly

different   (P 0.05)

   KEY: GFK = Groundnut flour *Kilishi*

   TK = *Tunkusa Kilishi* (Control)

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REFERENCES

1   **Igene JO, Farouk MM and CT Akanbi** Preliminary studies on the traditional processing of "kilishi" *J. Sci. Food Agric.* 1990; **50:** 89-98.

2   **McWatters KH** Performance of defatted peanut, soybean and field pea meals as extenders in ground beef patties. *J. food Sci.* 1997; **42 (6):** 1492-1494.

3.   **Woodroof JG** Peanuts. **In:** Desrosier NW (Ed). Bean, Nut and Seed Technology. Elements of Food Technology AVI Pub. CO. Inc. Westport Connecticut. 1977: 193-196.

4   **Kinsella JE** Functional properties of proteins in foods: a survey. *CRC Critical Reviews in Food Science and Nutrition* 1976; **7**: 219-280.

5   **Negbenebor CA, Igene JO, Maigoge SP and EK Collison** Microbial Quality of "kilishi" Meat Product. *J. Anim. Prod. Res.* 1990; **10 (2):** 91-107.

6   **Sexull AA and RL Ory** Rapid method for partial hydrolysis of oil seeds proteins for food uses. *Journal of American Oil Chemists Society* 1977; **54:** 32-35.

7   **Bhagya S and I Srinivasan** Effect of Different Method of Drying on the Functional Properties of Enzyme Treated Groundnut flour. *Lebensm-Wiss. U. Technol*. 1989; **22:** 329-333.

8   **Fasina OO and OO Ajibola** Mechanical expression of oil from conophornut (Tetrarpidium conophorum). *J. Agric. Eng. Res.* 1989; **44:** 275-287.

9   **Abubakar UM and PA Sopade** Viscosity of *Kilishi* Slurry at 30 to 70° C. *J. Agric. Sci. Technol*. 1994; **4(1):** 72-75.

10   **Igene JO, Abubakar U, Akanbi T and A Negbenebor** Effect of Sodium Tripolyphosphate and Moisture Level on the Drying Characteristics and Yield of *Kilishi* a sun-dried Beef product. *Journal of Agriculture, Science and Technology*, 1993; **3 (2):**166-175.

11   **AOAC.** "Official Methods of Analysis".16th edn.Association of Official Analytical Chemists. Washington, DC; 1995.

12   **Ihekoronye AI and PO Ngoddy** Integrated Food Science and Technology for the Tropics 1st edn. Macmillan Pub. Ltd, 1985.

13   **Osborn DR and P Voogt** The analysis of nutrients in foods. Academic Press London, 1978; 128.

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4736

14   **Tarladgis BG, Pearson AM and LR Dugan (Jr)** Chemistry of the 2-thiobarbituric acid (TBA) test for determination of oxidative rancidity in foods 11; formation of the TBA- Malonaldehyde complex with the acid-heat treatment.*J.Sci. Food Agric*.1964; **15:** 602-607.

15   **Pearson D** "Chemical Analysis of Food. 8th edition. Churchill Living Stone; 1981.

16   **Trout GR and GR Schmidt** Water binding ability of meat products. Effect of fat level, effective salt concentration and cooking temperature. *J. Food Sci*., 1984; **51(4):**1061-1062.

17   **Harrigan WF and ME McCance** Laboratory methods in Food and dairy microbiology. Suffolk St. Edmunburgh Press U. S.A. 1976.

18   **Larmond E** Laboratory Methods for Sensory Evaluation of Foods. Publication No. 1673. Department of Agriculture, Ottawa, Canada, 1977.

19   **Steele RGD and JH Torrie**   Principles and procedures of statistics 2nd edn. McGraw-Hill Book Co. Inc N.Y., 1980; 185-187.

20   **Badau MH, Igene JO, Collison EK and I Nkama** Studies on production, physiochemical and sensory properties of a standard *Kilishi* ingredient mix powder. *Int. Journal of Food Sci. and Nutri.* 1997; **48:** 165-168.

21   **Mbofung CMF** The effect of a traditional African method of meat processing on the availability of iron and other minerals from the finished product (Kilishi) following in vitro enzymolysis. **In**: Schlemer U (Ed) Bioavailability 93. Nutritional, chemical and food processing implication of nutrients availability, proceedings part 2, BFE. 1993; 169-174.

22   **Olapade AA, Ugokwe PU, Ozumba AU, Solomon HM, Olatunji O and SO Adelaja**   Physico-chemical properties of premixes for preparation of akara. *Nigerian Food Journal,* 2004; **22**: 54-59.

23   **Igene JO and HA Agboola** The development of a model pilot production system for improved processing of "kilishi". Commissioning Ceremony of the "Kilishi" model factory project. University Benin, Ekenwan Campus Benin city Nigeria. 2003**:** 29.

24   **Frazier WC and DC Westhoff** Food microbiology. 4th edn. New Delhi Tata Mc Graw Hill. Pub coy Ltd. New Delhi, 1988.

25   **Jones MJ, Tanya NV, Mbofiling DN and DE Silverside** A Microbiological and Nutritional Evaluation of the West African dried meat product, "kilishi". *The Journal of food Technology in Africa*, 2001; **6 (4):**126-129.

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4737

26   **Igene JO** Lipid, fatty acid composition and storage stability of *kilishi* a sun dried meat product. *Trop. Sci.* 1988; **28:** 153 –16.

27   **Pearson D** Application of Chemical Methods for the Assessment of beef quality part 11- method related to fat spoilage. *J Sci. Food Agric*.1968b; **19**: 553-556.

28   **Kranner AC and DD Karel** Mechanics of lipid oxidation in meat emulsions. **In:** Friberg S. (Ed), Food emulsions, Marcel Dekker Inc. NY. , 1990; 447.

29   **Pearson D** The Chemical Analysis of Foods. 7th edition, Churchill Living stone, 1977.

30   **ICMSF.** International Commission of Microbial Standards for Foods. Microorganisms in Food 2. Sampling for Microbial Analysis. Principles and Specific Applications. Toronto Canada, University Press, 1978; 92.

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