

# Influence of Storage Duration on Stability and Sensorial Quality of Dried Beef Product (*Kilishi*)

Iheagwara MC<sup>1\*</sup> and Okonkwo TM<sup>2</sup>

<sup>1</sup>Department of Food Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria

<sup>2</sup>Department of Food Science and Technology, University of Nigeria, Nsukka, Enugu State, Nigeria

## Abstract

This study was designed to investigate the influence of storage duration on the stability and sensorial quality of *kilishi* samples. The conventional traditional *kilishi* (TK) and sausage-type (SK) at varying percentage of ingredients were processed. Chemical and sensorial analyses were performed to investigate quality changes and to determine the shelf stability of the *kilishi* samples stored at 28 ± 2°C for 150 days. The proximate, peroxide value (PV), free fatty acid (FFA) and thiobarbituric acid (TBA) were found statistically significant ( $P \leq 0.05$ ) in the *kilishi* samples throughout storage. The lowest PV (8.24 mEq/kg), FFA (3.12% oleic acid) and TBA (0.26 mgMDA/kg) were recorded in SK7 (115% ingredients), while the highest PV (35.11mEq/kg), FFA (11.18% oleic acid) and TBA (1.57 mgMDA/kg) occurred in SK2 (85% ingredients). Highest protein (55.84 ± 0.05%), fat (19.20 ± 0.09%) and ash (5.58 ± 0.08%) were obtained from SK7, SK2 and SK7 respectively and the organoleptic results showed that SK2 had the best acceptance and was significantly different ( $P \leq 0.05$ ) compared to the other *kilishi* samples.

**Keywords:** Storage; Stability; Meat; Quality; *Kilishi*

## Introduction

Meat is an animal tissue used as food [1]. It is composed of tissue or muscle fibre cells, fat and connective tissue, it can also be composed of pieces of bone [2,3]. Meat plays an important role in nutrition as a contributor of high quality protein. However, meat is a highly perishable food item due to abundance of a number of nutrients that favor the establishment, growth and multiplication of microorganisms [4]. In the tropics, meat spoils quickly a few hours after the outset of rigor-mortis and post-mortem handling, hence meat needs to be preserved. A major meat preservation technique whose use dates back to records from 12<sup>th</sup> Century is sun drying [5,6]. Today, a variety of sun-dried meat products exist. They include amongst others: the *Pemmican* that is prepared by exposing strips of lean meat to the sun, the *Charqui*, which is native to South American and *Biltong* found in South Africa [7]. In Nigeria, the dried meat product *kilishi* constitute one of daily delicacies and is equivalent to *Pemmican* and *Charqui*. *Kilishi* is a traditional sun dried Nigerian and Sahara 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, 75% moisture, 18% lipid and 9.8% fibre/ ash respectively [8,9]. It is a rich nourishing snack and a source of supplementary animal protein formulated using hurdle technology. Salting, dehydration or sun drying and packaging are hurdles applied in sequence to inhibit deteriorating microorganism [10]. Traditionally, *Kilishi* is prepared from boneless lean meat that is sliced in sheet of 2 mm thickness and partially dried in the sun followed by immersion in a slurry of ingredients before a second period of sun drying and brief roasting to stabilize the protein [11,12]. As a ready-to-eat convenience meat product, *Kilishi* possess an excellent shelf-life. According to Igene et al. [13] and Isah and Okubanjo [14], *Kilishi* has a shelf life of 12 months at room temperature. The ability of the product to keep for several months at room temperature is fast making the product a household name. This study therefore is aimed at evaluating the influence of storage duration on the stability and sensorial quality of *Kilishi*.

## Materials and Methods

### Raw materials procurement

The fresh beef muscles (*Longissimus dorsi*) used for the study was

purchased from butchers at central Abattoir in Owerri, Nigeria. Spices such as ginger (*Zingiber officinale*), alligator pepper, (*Aframomum meleguata*), black pepper (*Piper guineense*), red pepper (*Capsicum frutescens*), sweet pepper (*Capsicum annum*), African nutmeg (*Monodora myristica*) as well as ingredients such as groundnut paste (*Arachis hypogea*), garlic (*Allium sativum*), onion (*Allium cepa*), sugar, salt and magi seasoning were bought from a grocery shop in Owerri, Nigeria.

### Sample preparation and processing

**Meat preparation:** The semitendinosus muscle of beef (9 kg) used for the study was trimmed of all visible fat, bone and connective tissue and then weighed. About 1kg of the resultant lean beef (8.2 kg) was sliced into thin sheets of 0.17 cm to 0.20 cm thick and 60 cm to 80 cm long along the fibre direction and dried for the traditional *kilishi* (TK). While 1 kg each of the remaining resultant lean beef will be comminuted with different percentage of the infusing ingredients to form the sausage-type *kilishi* (SK).

**Preparation of infusing ingredients:** Infusion slurry was prepared following the procedures of Igene [8] using the ingredients as shown in Table 1. The fresh groundnut paste was prepared from grains of dry uncooked groundnut after extraction of oil by pressing. The various ingredients were ground and mixed thoroughly with water to form slurry.

**Preparation of *kilishi*:** The dried thin sheets of meat were soaked in the infusion slurry for about 30 min, after which it was taken out

**\*Corresponding author:** Iheagwara MC, Department of Food Science and Technology, Federal University of Technology, Owerri, P.M.B 1526 Owerri, Imo State, Nigeria, Tel: +2348032922630; E-mail: [marcquin.iheagwara@futo.edu.ng](mailto:marcquin.iheagwara@futo.edu.ng)

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Ingredients	TK	SK1	SK2	SK3	SK4	SK5	SK6	SK7
Ginger ( <i>Zingiber officinale</i> )	3.30	3.30	2.81	2.97	3.14	3.47	3.63	3.80
Alligator pepper ( <i>Aframomum meleguata</i> )	1.20	1.20	1.02	1.08	1.14	1.26	1.32	1.38
Black pepper ( <i>Piper guineense</i> )	3.00	3.00	2.55	2.70	2.85	3.15	3.30	3.45
Red pepper ( <i>Capsicum frutescens</i> )	2.00	2.00	1.70	1.80	1.90	2.10	2.20	2.30
Sweet pepper ( <i>Capsicum annum</i> )	2.00	2.00	1.70	1.80	1.90	2.10	2.20	2.30
Onion ( <i>Allium cepa</i> )	12.00	12.00	10.20	10.80	11.40	12.60	13.20	13.80
Garlic ( <i>Allium sativum</i> )	0.50	0.50	0.43	0.45	0.48	0.53	0.55	0.58
African nutmeg ( <i>Monodora myristica</i> )	1.00	1.00	0.85	0.90	0.95	1.05	1.10	1.15
Groundnut paste ( <i>Arachis hypogea</i> )	31.50	31.50	26.78	28.35	29.93	33.08	34.65	36.23
Magi seasoning	1.50	1.50	1.28	1.35	1.43	1.56	1.65	1.73
Salt	3.00	3.00	2.55	2.70	2.85	3.15	3.30	3.45
Sugar	3.00	3.00	2.55	2.70	2.85	3.15	3.30	3.45
Water	36.00	36.00	30.60	32.40	34.20	37.80	39.60	41.40
TK - Traditional <i>kilishi</i> (100% ingredients)								
SK1 - Sausage-type <i>kilishi</i> (100% ingredients)								
SK2 - Sausage-type <i>kilishi</i> (85% Ingredients)								
SK3 - Sausage-type <i>kilishi</i> (90% ingredients)								
SK4 - Sausage-type <i>kilishi</i> (95% ingredients)								
SK5 - Sausage-type <i>kilishi</i> (105% ingredients)								
SK6 - Sausage-type <i>kilishi</i> (110% ingredients)								
SK7 - Sausage-type <i>kilishi</i> (115% ingredients)								

Table 1: Composition of infusion mixtures used in *kilishi* preparation (kg/100kg).

and spread out on flat steel trays on a raised platform till sun dried to generate the traditional *kilishi*. For the sausage-type *kilishi*, the meat was comminuted with various percentages of the infusing ingredients, spread into thin sheets of approximately 2mm thickness on steel trays, cut into long strips and dried. After drying, the traditional *kilishi* (TK) and respective sausage-type *kilishi* (SK) were roasted in an oven at a temperature of 100°C for 10-15min. Finally, the finished products were cooled at room temperature, packed and heat sealed in high density polyethylene (HDPE) bags and stored at ambient temperature (28 ± 2°C) for further analysis.

### Storage stability and sampling

The traditional *kilishi* and sausage-type *kilishi* were stored for 150 days at ambient temperature and samples were drawn at specified days and subjected to proximate, chemical and organoleptic analysis.

### Chemical analysis

The samples used for the analysis were assayed in duplicate. The moisture, protein, fat and ash contents of the *kilishi* samples were determined using the standard methods of AOAC [15] and Nielsen [16]. Peroxide value (PV), free fatty acid (FFA), and thiobarbituric acid (TBA) were determined according to the method described by Nielsen [16].

### Organoleptic analysis

Organoleptic attributes of flavour, juiciness, tenderness, pungency and overall acceptability of the *kilishi* samples were evaluated by a 30-member in-house consumer panelist selected from among students and staff of Department of Food Science and Technology of the University. A 9-point hedonic scale was used with 9 for like extremely down to 1 for dislike extremely [17].

### Statistical analysis

All the analysis was carried out in triplicates and data obtained were analyzed using analysis of variance (ANOVA) method. Where the variance ratio (F-values) proved significant, Fishers least significant difference (LSD) was used to separate the means.

## Results and Discussion

### Proximate composition

The proximate composition of the *kilishi* samples are presented in Table 2. There were significant differences ( $P \leq 0.05$ ) in all the proximate parameters evaluated. The moisture content of the *kilishi* samples ranged from 10.02% - 12.02% with SK 6 having the highest moisture content of 12.02% and SK2 the lowest moisture content of 10.02%. The reduction in moisture content of SK2 is desirable as this can affect the quality of the sample positively in relation to other *kilishi* sample [12]. Generally, the moisture content of the *kilishi* samples indicates that the *kilishi* samples were sufficiently dried to minimize microbial growth though moisture values of 6.92%, 9.87% and 10.00% were recorded by Jones et al. [18], Apata et al. [12] and Olusola et al. [19] respectively. The protein content of the entire *kilishi* samples ranged from 51.62% in SK2 to 55.84% in SK7. The range of values obtained with regards to the crude protein content was similar to the values (53.41%-64.53%) reported by Isah and Okubanjo [14]. However, significant difference ( $P \leq 0.05$ ) occurred in the protein content of the *kilishi* samples. SK7 had the highest protein content (55.84%) and SK2 the lowest protein content (51.62%). The high crude protein content obtained can be attributed to the various ingredients utilized in the *kilishi* preparation and is in agreement with report by Igene et al. [9]. The fat content of the *kilishi* samples differed significantly ( $P \leq 0.05$ ) and ranged from 17.34% in TK to 19.20% in SK2. Generally, the fat content of the *kilishi* samples were high and this can be attributed to the groundnut cake powder which represent a considerable proportion of the product [13]. The ash content is an indicator of the mineral content of the meat. The ash content of the *kilishi* samples ranged from 4.54% in SK2 to 5.58% in SK7. The pattern of ash content observed in this study revealed that the higher the slurry infused into the meat during *kilishi* preparation, the higher the level of ash content in the product. This indicated that most of the ingredients in the slurry might have lost their mineral contents into the slurry hence, into the meat and product and this agrees with the report of Elizabeth [20] who observed that the ash content of any processed meat would be the content of the muscle tissue in addition to that of ingredients used.

Kilishi samples	Proximate Composition (%)			
	Protein	Fat	Ash	Moisture
TK	54.10 ± 0.08 <sup>d</sup>	18.38 ± 0.28 <sup>cd</sup>	4.82 ± 0.01 <sup>b</sup>	11.30 ± 0.01 <sup>ab</sup>
SK1	53.70 ± 0.01 <sup>f</sup>	18.57 ± 0.18 <sup>bc</sup>	5.01 ± 0.01 <sup>bc</sup>	11.78 ± 0.28 <sup>ab</sup>
SK2	51.62 ± 0.14 <sup>n</sup>	19.20 ± 0.23 <sup>a</sup>	4.54 ± 0.05 <sup>c</sup>	10.02 ± 0.14 <sup>c</sup>
SK3	52.30 ± 0.28 <sup>g</sup>	19.03 ± 0.42 <sup>a</sup>	4.68 ± 0.01 <sup>bc</sup>	12.01 ± 0.18 <sup>a</sup>
SK4	52.84 ± 0.24 <sup>e</sup>	18.02 ± 0.11 <sup>d</sup>	4.73 ± 0.11 <sup>bc</sup>	11.66 ± 0.01 <sup>ab</sup>
SK5	54.78 ± 0.08 <sup>c</sup>	18.94 ± 0.16 <sup>ab</sup>	5.22 ± 0.23 <sup>ab</sup>	11.00 ± 0.01 <sup>b</sup>
SK6	55.20 ± 0.14 <sup>o</sup>	17.83 ± 0.44 <sup>d</sup>	5.41 ± 0.16 <sup>ac</sup>	12.02 ± 0.11 <sup>a</sup>
SK7	55.84 ± 0.05 <sup>a</sup>	17.34 ± 0.09 <sup>e</sup>	5.58 ± 0.08 <sup>a</sup>	11.26 ± 0.04 <sup>ab</sup>

<sup>a-n</sup>Means with different superscript along the column differ significantly at P ≤ 0.05.

TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

**Table 2:** Mean values of proximate composition of *kilishi* samples.

### Free fatty acid (FFA)

The FFA content in a product is an indication of the quality of the product. Lipid hydrolysis development strongly depends on the hydrolytic enzyme content and it is also influenced by different external and internal factors. The FFA content of the *kilishi* samples are presented in Figure 1. The FFA values ranged from 3.12%-11.18% oleic acid and the FFA content significantly increased (P ≤ 0.05) in all the samples during the 150 days of storage. However, SK2 showed higher FFA values and it is significantly different (P ≤ 0.05) when compared with the other *kilishi* samples. Also, it was observed that the FFA content of the *kilishi* samples decreased progressively as the percentage of ingredients used in processing the *kilishi* increases. SK7 had the lowest FFA content and SK2 the highest FFA content in all the storage days. This result obtained suggests that the various ingredients (concentration) used in processing of the *kilishi* samples especially the spices inhibited FFA production and is in agreement with the findings of Ogbonnaya and Imidobah [6] and Mgbemere et al. [21].

### Peroxide value

The changes of peroxide value as primary products of lipid oxidation of the *kilishi* samples are shown in Figure 2. The PV content significantly increased (P ≤ 0.05) in all the *kilishi* samples during the 150 days storage and there were significant differences (P ≤ 0.05) among the samples. The highest value (35/11 mEq/kg) of peroxide was recorded for SK2 while the lowest value (8.24 mEq/kg) was observed in SK7. Also, it was observed that the PV content decreased progressively as the percentage of ingredients inclusion used in processing the *kilishi* samples increases. Since peroxides are inversely related to development of rancidity, it is inferential that the sample with the highest inclusion of ingredients, SK7 (115% ingredients) was the most effective in slowing down primary oxidation when compared to the other *kilishi* samples. This result is in agreement with report by Mgbemere et al. [21]. It also agrees with the studies of Siripongvutikorn et al. [22] that spices activities as antioxidant are directly related to their concentration.

### Thiobarbituric acid (TBA)

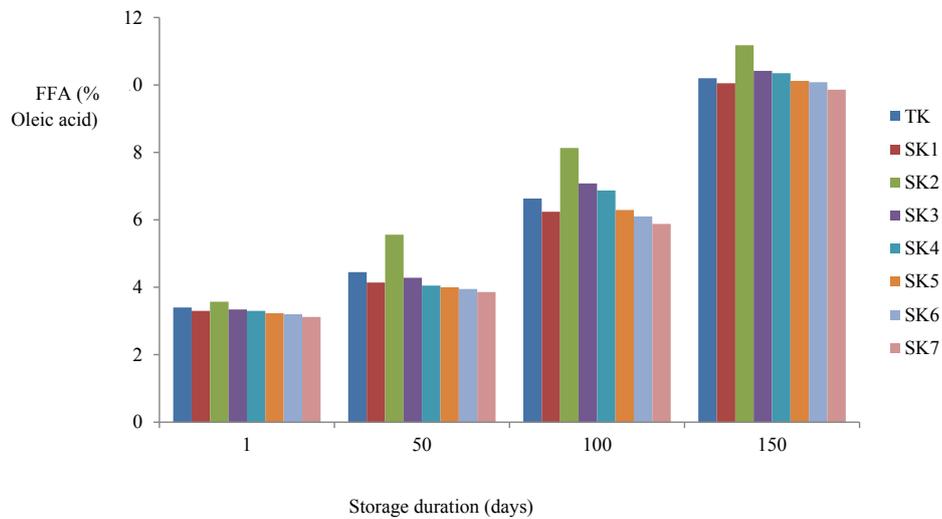
TBA is a widely used indicator for the assessment of degree of secondary lipid oxidation. It evaluates the second stage of autoxidation during which the peroxides are oxidized to aldehyde and ketones which impart the disagreeable rancid odours and flavour. The effect of

storage duration on TBA value of the *kilishi* samples stored at ambient temperature (28 ± 2°C) is shown in Figure 3. The TBA values increased in all the samples over time particularly in SK2. The initial TBA values ranged from 0.26 mgMDA/kg in SK7 to 0.33 mgMDA/kg in SK2. After 150 days of storage at 28 ± 2°C, the TBA values ranged from 0.97 mgMDA/kg in SK7 to 1.57 mgMDA/kg in SK2, thus indicating that TBA of SK7 increased by 0.71 mgMDA/kg, while the TBA of SK2 increased by 1.24 mgMDA/kg after 150 days. This result indicates that high concentration of spices is effective in retarding lipid oxidation and is in agreement with reports by Siripongvutikorn et al. [22]. However, the results obtained are within the acceptable limits of the maximum level of TBA value, indicating good quality of the *kilishi* samples during storage, which is 1-2 mgMDA/kg lipid.

### Organoleptic analysis

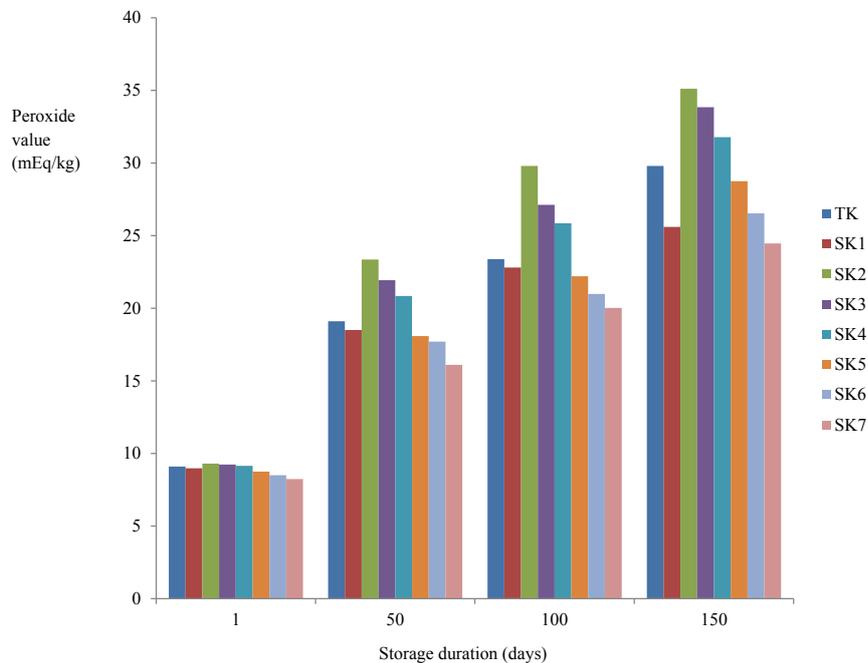
The organoleptic evaluation of food products to any food processing technology is very important in determining the consumer acceptability. The results of sensorial analysis for the *kilishi* samples stored at ambient temperature for 150 days are presented in Tables 3-6. The results obtained shows that there were significant variations (P ≤ 0.05) in all the sensory parameters evaluated. With regards to flavour, the highest flavor of 8.43 ± 0.56 for day one, 7.60 ± 0.36 for day 50, 6.30 ± 0.47 for day 100 and 5.55 ± 0.31 were observed in SK2. Physiologically, the perception of flavour involves the detection of four basic sensations including saltiness, sweetness, sourness and bitterness by the nerve endings of the surface of the tongue [23]. This result reveals that the flavour of SK2 was higher probably because the fat content of the product was relatively high and the moisture content was also low hence the high flavour of the product compared to the other *kilishi* samples and this is in conformity with the findings of Olusola et al. [19] and Apata et al. [12]. It also supports the observation of Melton [24] that as the fat of meat increases so does the flavour.

In relation to pungency, there were significant variations (P ≤ 0.05) among the *kilishi* samples. According to Olusola et al. [19], the hotness of *kilishi* is an evaluation of the pungency of the product. The results of pungency as shown in Tables 3-6 reveals that SK7 had the highest pungent scores compared to the other *kilishi* samples in all the respective days of storage evaluated. This suggests that as the percentage of the spices used in the infusing mixtures increases, the pungent level also increases. This agrees with the report of Isah and Okubanjo [14].



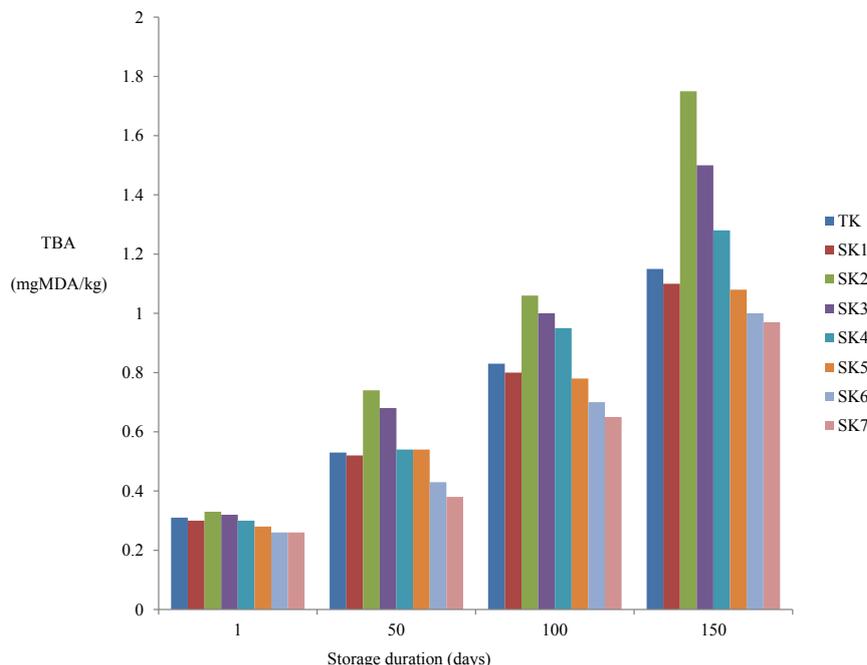
TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Figure 1: Effect of storage duration on free fatty acid (FFA) of *kilishi* samples.



TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Figure 2: Effect of storage duration on peroxide value (mEq/kg) of *kilishi* samples.



STK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Figure 3: Effect of storage duration on thiobarbituric acid (TBA) value of *kilishi* samples.

Kilishi samples	Sensory Parameter				
	Flavour	Pungency	Juiciness	Tenderness	Overall acceptability
TK	7.86 ± 0.52 <sup>f</sup>	7.18 ± 0.34 <sup>e</sup>	7.18 ± 0.45 <sup>b</sup>	7.15 ± 0.51 <sup>f</sup>	7.63 ± 0.28 <sup>f</sup>
SK1	8.06 ± 0.32 <sup>d</sup>	7.65 ± 0.42 <sup>d</sup>	7.13 ± 0.23 <sup>c</sup>	7.25 ± 0.37 <sup>e</sup>	7.75 ± 0.44 <sup>d</sup>
SK2	8.43 ± 0.56 <sup>a</sup>	7.64 ± 0.53 <sup>d</sup>	7.15 ± 0.33 <sup>bc</sup>	7.53 ± 0.49 <sup>b</sup>	8.00 ± 0.78 <sup>a</sup>
SK3	8.15 ± 0.46 <sup>b</sup>	7.78 ± 0.41 <sup>c</sup>	7.23 ± 0.48 <sup>a</sup>	7.62 ± 0.38 <sup>a</sup>	7.93 ± 0.37 <sup>b</sup>
SK4	8.10 ± 0.49 <sup>c</sup>	7.84 ± 0.42 <sup>b</sup>	7.12 ± 0.43 <sup>c</sup>	7.41 ± 0.52 <sup>c</sup>	7.88 ± 0.45 <sup>c</sup>
SK5	8.05 ± 0.34 <sup>d</sup>	7.85 ± 0.32 <sup>b</sup>	7.08 ± 0.23 <sup>d</sup>	7.26 ± 0.37 <sup>e</sup>	7.68 ± 0.49 <sup>e</sup>
SK6	8.00 ± 0.33 <sup>e</sup>	7.98 ± 0.41 <sup>a</sup>	7.00 ± 0.28 <sup>e</sup>	7.33 ± 0.32 <sup>d</sup>	7.50 ± 0.18 <sup>g</sup>
SK7	7.82 ± 0.48 <sup>f</sup>	8.00 ± 0.52 <sup>a</sup>	6.58 ± 0.49 <sup>f</sup>	7.04 ± 0.45 <sup>g</sup>	7.08 ± 0.33 <sup>h</sup>

<sup>a-h</sup>Means with different superscript along the column differ significantly at P ≤ 0.05.

TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Table 3: Mean sensory scores of *Kilishi* samples stored for one day.

According to Moloney [25], 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 fluid 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 coating of fat

that builds up in the tongue, teeth and other parts of the mouth. The results of juiciness of the *kilishi* samples were significantly different (P ≤ 0.05). For day one, SK3 had the highest (7.23 ± 0.48) juiciness score while for day 50, SK4 was juicier (6.81 ± 0.22) than the other *kilishi* samples. For day 100 and 150 respectively, SK2 had the highest juiciness scores of 5.64 ± 0.28 and 5.02 ± 0.43 respectively compared to the other

Kilishi samples	Sensory parameter				
	Flavour	Pungency	Juiciness	Tenderness	Overall acceptability
TK	7.30 ± 0.44 <sup>d</sup>	6.84 ± 0.23 <sup>h</sup>	6.41 ± 0.32 <sup>e</sup>	6.62 ± 0.48 <sup>e</sup>	6.71 ± 0.33 <sup>c</sup>
SK1	7.53 ± 0.33 <sup>b</sup>	7.20 ± 0.52 <sup>d</sup>	6.52 ± 0.21 <sup>cd</sup>	6.65 ± 0.36 <sup>de</sup>	6.80 ± 0.44 <sup>b</sup>
SK2	7.60 ± 0.36 <sup>a</sup>	6.92 ± 0.33 <sup>g</sup>	6.68 ± 0.42 <sup>b</sup>	6.76 ± 0.42 <sup>c</sup>	7.10 ± 0.38 <sup>a</sup>
SK3	7.42 ± 0.18 <sup>c</sup>	7.04 ± 0.41 <sup>f</sup>	6.76 ± 0.33 <sup>a</sup>	6.84 ± 0.33 <sup>b</sup>	6.84 ± 0.49 <sup>b</sup>
SK4	7.40 ± 0.24 <sup>c</sup>	7.12 ± 0.28 <sup>e</sup>	6.81 ± 0.22 <sup>a</sup>	6.93 ± 0.47 <sup>a</sup>	6.53 ± 0.21 <sup>d</sup>
SK5	7.38 ± 0.48 <sup>c</sup>	7.43 ± 0.33 <sup>c</sup>	6.54 ± 0.38 <sup>c</sup>	6.68 ± 0.32 <sup>d</sup>	6.41 ± 0.32 <sup>e</sup>
SK6	7.27 ± 0.51 <sup>de</sup>	7.51 ± 0.42 <sup>b</sup>	6.48 ± 0.41 <sup>d</sup>	6.34 ± 0.24 <sup>f</sup>	6.23 ± 0.24 <sup>f</sup>
SK7	7.24 ± 0.38 <sup>e</sup>	7.74 ± 0.38 <sup>a</sup>	6.25 ± 0.35 <sup>f</sup>	6.20 ± 0.43 <sup>g</sup>	6.08 ± 0.32 <sup>g</sup>

<sup>a-h</sup>Means with different superscript along the column differ significantly at P ≤ 0.05.

TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
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 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Table 4: Mean sensory scores of *kilishi* samples stored for 50 days.

Kilishi samples	Sensory parameter				
	Flavour	Pungency	Juiciness	Tenderness	Overall acceptability
TK	6.11 ± 0.36 <sup>c</sup>	6.30 ± 0.48 <sup>c</sup>	5.18 ± 0.23 <sup>c</sup>	5.48 ± 0.32 <sup>cd</sup>	5.59 ± 0.21 <sup>c</sup>
SK1	6.18 ± 0.19 <sup>b</sup>	6.27 ± 0.35 <sup>d</sup>	5.20 ± 0.11 <sup>c</sup>	5.52 ± 0.22 <sup>c</sup>	5.68 ± 0.45 <sup>b</sup>
SK2	6.30 ± 0.47 <sup>a</sup>	6.18 ± 0.47 <sup>f</sup>	5.64 ± 0.28 <sup>a</sup>	5.80 ± 0.43 <sup>a</sup>	5.88 ± 0.21 <sup>b</sup>
SK3	6.22 ± 0.51 <sup>b</sup>	6.20 ± 0.35 <sup>ef</sup>	5.43 ± 0.41 <sup>b</sup>	5.63 ± 0.35 <sup>b</sup>	5.70 ± 0.41 <sup>a</sup>
SK4	6.20 ± 0.22 <sup>b</sup>	6.23 ± 0.21 <sup>e</sup>	5.22 ± 0.32 <sup>c</sup>	5.51 ± 0.28 <sup>c</sup>	5.62 ± 0.28 <sup>c</sup>
SK5	6.18 ± 0.18 <sup>b</sup>	6.29 ± 0.31 <sup>d</sup>	5.11 ± 0.27 <sup>d</sup>	5.45 ± 0.34 <sup>de</sup>	5.53 ± 0.38 <sup>d</sup>
SK6	6.07 ± 0.34 <sup>c</sup>	6.35 ± 0.48 <sup>b</sup>	5.08 ± 0.12 <sup>d</sup>	5.40 ± 0.18 <sup>e</sup>	5.50 ± 0.42 <sup>d</sup>
SK7	5.96 ± 0.47 <sup>d</sup>	6.41 ± 0.32 <sup>a</sup>	5.01 ± 0.11 <sup>e</sup>	5.32 ± 0.21 <sup>f</sup>	5.48 ± 0.22 <sup>d</sup>

<sup>a-h</sup>Means with different superscript along the column differ significantly at P ≤ 0.05

TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Table 5: Mean sensory scores of *kilishi* samples stored for 100 days.

Kilishi samples	Sensory parameter				
	Flavour	Pungency	Juiciness	Tenderness	Overall acceptability
TK	5.32 ± 0.43 <sup>cd</sup>	5.43 ± 0.32 <sup>b</sup>	4.84 ± 0.21 <sup>c</sup>	4.70 ± 0.32 <sup>c</sup>	4.48 ± 0.24 <sup>d</sup>
SK1	5.40 ± 0.22 <sup>b</sup>	5.30 ± 0.25 <sup>c</sup>	4.91 ± 0.33 <sup>b</sup>	4.78 ± 0.26 <sup>b</sup>	4.56 ± 0.33 <sup>c</sup>
SK2	5.55 ± 0.31 <sup>a</sup>	5.20 ± 0.22 <sup>c</sup>	5.02 ± 0.43 <sup>a</sup>	4.98 ± 0.41 <sup>a</sup>	4.80 ± 0.22 <sup>a</sup>
SK3	5.35 ± 0.43 <sup>c</sup>	5.24 ± 0.31 <sup>de</sup>	4.94 ± 0.45 <sup>b</sup>	4.92 ± 0.34 <sup>a</sup>	4.68 ± 0.23 <sup>b</sup>
SK4	5.30 ± 0.21 <sup>d</sup>	5.29 ± 0.42 <sup>cd</sup>	4.80 ± 0.31 <sup>c</sup>	4.62 ± 0.25 <sup>d</sup>	4.61 ± 0.35 <sup>c</sup>
SK5	5.24 ± 0.22 <sup>e</sup>	5.32 ± 0.26 <sup>c</sup>	4.68 ± 0.42 <sup>d</sup>	4.50 ± 0.18 <sup>e</sup>	4.50 ± 0.22 <sup>d</sup>
SK6	5.20 ± 0.36 <sup>e</sup>	5.48 ± 0.33 <sup>ab</sup>	4.60 ± 0.22 <sup>e</sup>	4.42 ± 0.23 <sup>f</sup>	4.41 ± 0.26 <sup>e</sup>
SK7	5.08 ± 0.24 <sup>f</sup>	5.50 ± 0.24 <sup>a</sup>	4.53 ± 0.26 <sup>f</sup>	4.28 ± 0.33 <sup>g</sup>	4.35 ± 0.24 <sup>f</sup>

<sup>a-h</sup>Means with different superscript along the column differ significantly at P ≤ 0.05.

TK - Traditional *kilishi* (100% ingredients)  
 SK1 - Sausage-type *kilishi* (100% ingredients)  
 SK2 - Sausage-type *kilishi* (85% Ingredients)  
 SK3 - Sausage-type *kilishi* (90% ingredients)  
 SK4 - Sausage-type *kilishi* (95% ingredients)  
 SK5 - Sausage-type *kilishi* (105% ingredients)  
 SK6 - Sausage-type *kilishi* (110% ingredients)  
 SK7 - Sausage-type *kilishi* (115% ingredients)

Table 6: Mean sensory scores of *kilishi* samples stored for 150 days.

*kilishi* samples. However, the juiciness of all the *kilishi* samples were inversely proportional to the storage duration though the juiciness as detected by the consumer are dependent on the intramuscular lipids and water content of the meat [19].

The tenderness of meat can be defined as the secondary 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 [25]. It is how meat feels in the mouth during manipulation and mastication [19]. The result of tenderness of the *kilishi* samples as shown in Tables 3-6 shows that there were significant differences ( $P \leq 0.05$ ) in the tenderness of the *kilishi* samples. For day one, SK3 was more tenderly ( $7.62 \pm 0.38$ ) than the other *kilishi* samples. For day 50, SK4 had the highest tenderness score of  $6.93 \pm 0.47$  compared to others. For days 100 and 150, SK2 had the highest tenderness of  $5.80 \pm 0.35$  and  $4.98 \pm 0.34$  respectively compared to the other *kilishi* samples. This variation in tenderness of the *kilishi* samples can be attributed to a large extent on the variations in the ingredients used since the same semitendinosus muscle and processing method were adopted throughout the experiment especially for the sausage-type *kilishi* samples. Also, this result confirms the report of Moloney [25] who said that meat juiciness is an important component of meat tenderness and palatability. Similarly, the tenderness of the *kilishi* samples was inversely proportional to the storage duration.

The mean panel ratings for the overall acceptability of the *kilishi* sample as shown in Tables 3-6 reveals that there were significant ( $P \leq 0.05$ ) differences among the *kilishi* samples. The result obtained in relation to the overall acceptability indicates that the panelist preferred SK2 greatly compared to other *kilishi* samples in all the storage days. Among the *kilishi* samples, SK7 had the least rating in overall acceptability. This result obtained indicates that the level of inclusion of the spices used in the *kilishi* production affected the consumer preference as the panelist preferred SK2 (8.5% ingredients) to the hot pungent SK7 (115% ingredient). This result is in agreement with the findings of Isah and Okubanjo [14].

## Conclusion

The present study has demonstrated that inclusion of infusion ingredients to a level of 115% possesses anti-oxidative property that retards oxidative rancidity thus extending the shelf stability of the *kilishi*. This is justified by the low peroxide, free fatty acid and thiobarbituric acid levels of *kilishi* sample processed using 115% ingredient inclusion compared to other percentage ingredients inclusion.

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