**Original Research Article**

**EFFECT OF STORAGE PERIOD ON PROXIMATE AND SENSORY QUALITIES OF *KILISHI* PRODUCED WITH DIFFERENT SLURRIES**

**Abstract**

The study evaluated the effect of storage period on proximate and sensory qualities of *kilishi* produced with different slurries. Fresh beef was purchased, trimmed off of fats, sliced into thin sheet, washed and sundried. Thereafter the dried meat samples were divided equally into three groups and each of the groups was infused into different slurries prepared from defatted groundnut, soybean and bambara nut pastes which were seasoned with a blend of spices and seasoning for one hour. After which they were sun-dried, roasted, cooled, packaged and stored for 16th weeks. The experiment was replicated thrice and thereafter, proximate and sensory analyses were carried out on the 1st and 16th weeks of storage. Data obtained were statistically analyzed using 2-way Analysis of Variance in a 2x3 Factorial Arrangements. The findings revealed significant (*P<0* .05) interaction effect between the storage period and slurry types in most of the proximate parameters except on crude protein and nitrogen free extract. Moisture increased from 1st to 16th weeks of storage with *kilishi* made with bambaranut slurry having the highest moisture content (10.37%) at 16th weeks of storage. Additionally, fat content in *kilishi* made with bambara nut and soybean slurries drastically reduced while *kilishi* made with groundnut slurry increased from 14.90 to 17.46% as the samples were stored from 1st to 16th weeks of storage. Significant (*P <0*.05) interaction effect of the storage period and slurry types was observed in overall appearance, juiciness and overall acceptability across the treatment groups. *Kilishi* made with groundnut slurry was overall accepted (7.60 and 7.50) at both storage periods while *kilishi* made with bambara nut slurry showed a significant (*P* <0.05) increase (6.60 to 7.20) within the storage period. Therefore, bambara nut slurry can serve as viable alternative in *kilishi* production, offering nutritional and sensory stability similar to *kilishi* made with groundnut slurry.

**Keywords**: *Kilishi*, proximate composition, sensory quality, bambara nut, slurries

1. **Introduction**

The increasing population, urbanization, and changing dietary preferences have led to a rising demand for meat and meat products (Hawkes *et al*., 2017). However, in meeting these increasing demands, the meat industry has faced numerous challenges which include limited infrastructure such as poor power supply, low productivity, and inefficient value chains. Therefore, the need for improved production and processing techniques was reported by Tarrant (1998). Among the numerous methods that that have been employed to improve production is drying. Drying method has been used for ages to preserve meat. It prevents microbial growth and meat spoilage by reducing the moisture content of the meat (Mediani *et al*., 2022). Additionally, drying aids in storing and transporting food by reducing the size and weight of the products and contamination of the product (Ryoba *et al*., 2013).

*Kilishi* is one of the native meat products that are produced by drying. (Iyiola *et al*., 2023). It is a traditional sun-dried jerky made from beef, mutton or chevon (Adeyeye, 2016). It is an enrich snack with a supplemental plant protein that is formulated using hurdle technology (Iheagwara and Okonkwo, 2016). Other meats can be used in the production of *kilishi* but beef is mostly used (Yunusa *et al*., 2023, Abubakar *et al*., 2011). *Kilishi* is made from thinly sliced fresh lean strips or slices of muscle which is dipped into slurry made of defatted groundnut paste and spices and sundried (Olusola *et al*. 2017). *Kilishi* is produced by traditional people who resided in the northern parts of Nigeria (Kibbon, 2006). It is a rich source of protein, fat, minerals and vitamin B (Adeyeye, 2016). It is important part of Nigerian food culture, and its production and consumption have economic and social significance (Iheagwara and Okonkwo 2016). Slurries on the other hand are mixtures of ingredients use to marinate and flavor the meat before drying, and they can vary in composition and proportion (Iyiola and Bulus, 2024). Different slurries can affect the quality and shelf life of *kilishi*, and the choice of slurries depend on regional traditions, personal preferences, and availability of ingredients (Iyiola *et al*, 2021).

Furthermore, the quality of *kilishi* can be affected by various factors such as: meat type, marination process, drying method, and storage period (Iyioa *et al*., 2023; Iyiola and Aladi, 2023). In addition, the nutritional composition, sensory quality and microbial load of *kilishi* can be negatively or positively affected by the period of storage (Iyiola *et al*., 2023). Previous studies have shown that *kilishi* can be stored for six months to one year without significant changes in quality (Igene *et al*., 1988; Igene *et al*., 2016). Ihegwaram *et al.* (2019) reported variability in microbial stability of *kilishi* with certain processing methods yielding better microbiological profile while Iyiola *et al*. (2023) reported significant changes in some of the proximate parameters analyzed while no significant effect was found in microbial load of the *kilishi* samples. However, the effects of period of storage on the quality of *kilishi* produced with different slurries have not been fully investigated.

Despite the popularity of *kilishi* in Nigeria, consumers concern on its nutritional and sensory quality after a storage period has greatly increased (Iheagwara and Okonkwo, 2016). Additionally, there's little scientific knowledge on the effects of storage period on its quality, particularly when produced with different slurries. The lack of understanding of how storage period affects kilishi's quality poses a significant challenge to meat processors and *kilishi* industry. This knowledge gap may lead to inconsistent quality, reduced nutritional quality, shelf life, and potential food safety issues, ultimately affecting consumer’s health and satisfaction including the industry's economic viability. Understanding the effects of storage period on the quality of *kilishi* produced with different slurries can provide valuable information or insights that could help optimize production processes, improve storage practices, and ultimately ensure production of product that is nutritious and acceptable by the consumers. Given the growing demand for *kilishi*, both locally and internationally, ensuring its quality over time is essential for expanding its market and maintaining consumer acceptability. Therefore, this research holds practical significance for the consumer, meat processors, meat industry and economic development in the region. Hence the objective of the study is to evaluate the effects of storage period on proximate and sensory qualities of *kilishi* produced with different slurries.

1. **Materials and Methods**

**2.1 Study Area and Sources of Experimental Materials**

The research was performed at the Laboratory of Soil Science, Faculty of Agriculture and Life Sciences, Federal University Wukari, Nigeria. Fresh beef meat, and ingredients such as soybean, bambara nut and groundnut seeds, seasonings, spices and other equipment used in the study were bought from old market in Wukari Metropolis**,** Taraba State

**2.2 Samples preparation and processing**

**2.2.1 Meat Preparation**

This was done according to the method described by Alamuoye (2019) with little modification. 6 kg of fresh beef from the round of slaughtered carcass was trimmed free of fat, bones and excess connective tissues. The chunk was cut into smaller portions within the size of 150-200g. Thereafter, they were sliced along the fibre axis into thin slices of about 2 mm thickness in continuous sheets. The pieces of sliced meat were then sundried after spreading them on a new clean mat which was placed on a raised platform to avoid microbial contamination from dust and other contaminants from the environment. This is the first stage of drying and it lasted for about 7-8 hours depending on the relative humidity, intensity of the sun and air velocity. The meat stripes were turned over every hour for proper drying and to avoid them from getting fixed to the drying surfaces. The dried meat was kept in airtight containers for further processing**.**

**2.2.2 Slurry preparation**

This was done according to the procedure described by Iyiola *et al*. (2021) with little modification. Defatted groundnut paste which is the main ingredient used in the processing of kilishi paste was gotten from the dehulled groundnut seed, roasted for 10-15 minutes and cooled. It was cleaned, and milled into paste with grinding machine. Thereafter, oil was extracted from the milled paste as it was kneaded in a bowl on a table. The defatted groundnut paste gotten after the extraction was used in slurry preparation. The same procedure was used in the preparation of bambara nut and soybean pastes except addition of warm water for easy extraction of their oils. In order to avoid rancidity the pastes were prepared on the day of production. Blended spices and seasonings were added to the resultant pastes from defatted groundnut, bambara nut and soybean one after the other, as shown in Table 1. After which, 36 mL of clean water was used to mix the different mixtures using a mortar and pestle until a uniform paste was formed. The slurries were prepared on the day of kilishi production to hinder microbial spoilage and reduce the possible development of rancid flavour

**Table 1: Ingredient Composition of the Slurries**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ingredients** | **Groundnut Slurry (g)** | **Bambaranut Slurry** **(g)** | **Soybean Slurry (g)** |
| Groundnut | 36.00 | 0.00 | 0.00 |
| Soybeans | 0.00 | 0.00 | 36.00 |
| Bambaranut | 0.00 | 36.00 | 0.00 |
| Ginger | 3.00 | 3.00 | 3.00 |
| Garlic | 1.00 | 1.00 | 1.00 |
| Black pepper | 2.00 | 2.00 | 2.00 |
| Red pepper | 2.00 | 2.00 | 2.00 |
| Sweet pepper | 2.00 | 2.00 | 2.00 |
| Alligator pepper | 1.00 | 1.00 | 1.00 |
| Onion | 5.00 | 5.00 | 5.00 |
| African nut meg | 2.00 | 2.00 | 2.00 |
| Curry | 2.00 | 2.00 | 2.00 |
| Salt | 3.00 | 3.00 | 3.00 |
| Knorr © | 2.00 | 2.00 | 2.00 |
| Sugar | 3.00 | 3.00 | 3.00 |
| Water (mL) | 36.00 | 36.00 | 36.00 |
| Total | 100 | 100 | 100 |

**2.2.3 *Kilishi* Preparation**

This was done according to the procedure described by Iyiola *et al*. (2021). The dried beef samples of the same batch were weighed and divided equally into three treatment groups (1, 2 and 3). The first group of dried beef was infused into the groundnut slurry (Treatment 1) which serves as the control. The second group was infused into bambaranut slurry (Treatment 2) while the third group was infused into soybean slurry (Treatment 3). Each of the treatments was done one after the other and replicated thrice. In order to allow the slurries to penetrate the sliced beef they were left for 1 hour after which they were carefully spread out on the new clean wooden mat which was placed on elevated platform with flat surface and sundried for 10 - 12 hours. The infused beef slices were then roasted for 5 - 10 minutes to allow the ingredients in the products to fasten to it and destroy any microorganisms that might have contaminated the meat samples during sun drying. The *kilishi* samples were judged adequately dry when they became crispy to the touch and brown. Thereafter, they were cooled on a tray and using different air-tight plastic containers they were packaged and stored for 16 weeks at an ambient temperature of 28 ± 2ºC on a shelf for proximate and sensory analysis.

**2.3 Proximate Analysis of *Kilishi***

Proximate analysis was done according to the methods described by AOAC (2006) to determine moisture content, total ash, crude fat and crude fibre. Moisture content was determined by drying 5 g of kilishi sample in an oven at a temperature of 105 °C to a constant weight. Fat was obtained by Soxhlet extraction method using petroleum ether. The ash content of kilishi was obtained by igniting 1 g of kilishi sample in a Muffle furnace at 500°C for 5 - 6 hours until ashes were produced while crude protein of the kilishi samples was determined by Kjeldahl methods as described by ISO 20483(2006).

**2.4. Sensory Analysis of *Kilishi***

Sensory analysis was conducted at 1st and 16th weeks of storage period according to the method described by Nasiru *et al*. (2011). Ten samples of *kilishi* from each slurry treatment were served randomly to 15 staff panelists drawn from the Department of Animal Production and Health of the Faculty of Agriculture and Life Sciences, Federal University Wukari, Nigeria. Panel membership was voluntary, and panelists were selected based on their interests and ability to understand the test procedures. Each staff evaluated two *kilishi* samples and each of the samples was given one at a time and evaluated using the sensory questionnaires. Cabin biscuit and water were served in-between the treatments to clean the mouth so that the taste of a treatment will not affect the taste of another. The samples of the *kilishi* were evaluated for overall appearance, colour, tenderness, juiciness, flavour and overall acceptability characteristics using a 9-point hedonic rating scale as described by Ranganna (2001) on which 1=dislike extremely and 9=like extremely.

**2.5 Statistical Analysis**

The data generated were statistically analyzed using 2-way Analysis of Variance (ANOVA) in 2x3 factorial arrangements and the differences in means were separated using Least Significant Difference (LSD). The Statistical package SPSS 20 Version was used for this analysis.

1. **Results and Discussion**

**3.1 Proximate composition**

**3.1.1. Effects of Slurries on Proximate Compositions of *Kilishi***

The effects of slurries on proximate compositions of *kilishi* slurries presented in Table 2 showed significant difference (*P*<0.05) in all the parameters analyzed across the treatment groups except on moisture content, crude protein and nitrogen free extract where no significant difference (*P>0*.05) was observed. Generally low moisture content was found on the *kilishi* samples within the storage period. However, the highest moisture content was found in *kilishi* made with soybean slurry (8.10%) which was not significantly (*P*<0.05) different from other treatment groups while the lowest moisture content (7.76%) was found in *kilishi* made with groundnut slurry. The moisture content, ranged from 7.76 to 8.10%. This is lower than the range of 6.00±0.50 – 12.33±0.29% reported by Magawata and Faruk (2014) emphasizing the role of lower moisture in improving shelf stability and minimizing microbial growth. The slightly higher moisture content in *kilishi* made with soybean slurry may be attributed to the intrinsic properties of soybean seeds, which are known to retain more water during processing compared to groundnut and bambara nut (Iyiola and Bullus, 2024). The general low moisture content found in this study could be attributed to two steps wise drying which was employed during production. The low moisture content is an indication that the samples were properly dried to hinder microbial growth, proliferation and products spoilage, thereby extending their shelf life (Iyiola *et al*., 2023)

Highest crude protein content was found in *kilishi* made with groundnut slurry (46.67%), closely followed by *kilishi* made with bambara nut slurry (45.77%), while *kilishi* made with soybean slurry recorded the least crude protein (40.75%). This trend agrees with the findings of Idowu *et al*. (2010), which highlighted groundnut’s superior protein content compared to other legumes. Monitoring protein levels ensures consistency in product quality and nutritional composition (Gómez *et al*., 2020). Protein content influences the nutritional value and texture of *kilishi*. The high protein content in *kilishi* made with groundnut and bambara nut slurries could contribute in producing protein-dense *kilishi*, as noted by Magawata and Faruk (2014) who also reported that *kilishi* prepared with protein-rich slurries resulted in a higher crude protein percentage, enhancing its nutritional value. Studies have shown that kilishi contain high crude protein level of 63.4% making it a significant source of dietary protein for consumers (Adeyeye *et al*, 2020). Protein is crucial for building and repairing tissues, growth and immune function (Biesalski, 2005). The range of crude protein content (40.75-46.67%) in this study is lower than the range of 48.19 to 51.04% reported by Olusola *et al*. (2012), 51.62 to 55.84% reported by Iheagwara and Okonkwo (2016) and 66.61 to 69.92% reported by Iyiola *et al*. (2021) and 51.95 to 68.17% reported by Iyiola and Aladi (2023).

The fat content in this study ranged from 9.98 – 16.18% which was significantly (*P*<0.05) higher in *kilishi* made with groundnut slurry (16.18%) than in *kilishi* made with soybean slurry (11.91%). *Kilishi* made with bambara nut slurry (9.98%), had the least fat content due to bambara nut slurry low-fat composition (Iyiola and Bulus, 2024). This is consistent with Opio and Photchanachai (2018), who reported groundnut as a legume with lipid-rich composition, ranging from 40–50%. The reduced fat content in *kilishi* made with bambara nut and soybean slurries offer low-fat options for consumers that prefer low fat products due to health related issue that associate with consumption of animal fat product (Iyiola and Aladi, 2023; Youl *et al*., 2012). The high fat content found in *kilishi* made with groundnut slurry could enhance its sensory quality because fat has been reported to be related to flavor, juiciness and tenderness of a product (Resconi *et al*., 2013). According to Iyiola and Bulus.(2024), *kilishi* rich flavour is attributed to its moderate fat content (13.44 to 14.90%) The range of fat content in this study is lower than the range of (17.34 – 19.20%) reported by Iheagwara and Okonkwo (2016), 25.36% ± 11.35 reported by Jones *et al*. (2001) and 17.91% - 18.31% reported by Igwe *et al*. (2015). *Kilishi*’s fat content may offer vital fatty acids which are energy sources and membrane constituents necessary to influence cell and tissue metabolism, function, and responsiveness to hormonal and other (Calder, 2015).

Crude fiber content in this study ranged from 1.81 to 2.55% which differ significantly (P<0.05) and was higher in *kilishi* made with bambara nut slurry (2.55%) than in *kilishi* made with soybean (2.05%) and groundnut (1.81%) slurries. Meat has no or little crude fiber content. Therefore, crude fiber content found in this study could be attributed to the slurry ingredients used during production which are of plant origin (Olusola *et al*., 2017). The variations observed in the crude fibre contents of the samples could be attributed to the chemical composition of the slurries used (Iyiola and Bulus, 2024). This result aligns with Olanrewaju (2022), who noted bambara nut's high fiber composition, supporting its use in functional food formulations. The range of crude fiber in this study is higher than the range of 0.33 to 0.58% reported by Olusola *et al*. (2017).

Ash content was similar in *kilishi* made with bambara nut (5.85%) and soybean (5.83%) slurries but significantly higher than *kilishi* made with groundnut slurry (5.15%). This also could be attributed to the chemical composition of the slurry used. Bambara nut and soybean slurries have been reported to have higher ash contents compared to groundnut slurry (Iyiola and Bulus, 2024) which could have contributed to their higher ash contents. This finding is in agreement with Idowu *et al*. (2010) which emphasized the mineral richness contributed by legumes in *kilishi* production. Minerals from ash content are essential for dietary balance and health. Mgbemere *et al*. (2011) reported ash range of 4.54 to 3.50% in *kilishi* which is lower than the range of ash content found in this study.

Nitrogen-free extract (NFE), representing carbohydrate content, was highest in *kilishi* made with soybean slurry (31.36%), followed by made with bambara nut slurry (27.95%) while *kilishi* made with groundnut slurry had the lowest NFE content (22.44%), The high NFE found in *kilishi* made with soybean and bambara nut slurries could be attributed to the chemical composition of the slurries used (Iyiola and Bulus, 2024). Nitrogen-Free Extract (NFE) in *kilishi* made with soybean slurry found in this study is higher than the range of 26 - 30% reported by Magawata and Faruk (2014) and 19.12% reported by Iyiola *et al*. (2023). This makes soybean slurry a suitable choice for producing energy-rich *kilishi*, appealing to physically active consumers or those requiring high-energy snacks. The variations in the nutritional composition of *kilishi* varies could be due to different slurries used (Iyiola *et al*., 2021)

**Table 2. Effects of slurries on Proximate Composition of the *Kilishi* made with Different Slurries**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | *Kilishi* made with Groundnut slurry (%) | *Kilishi* made with Bambara nut slurry (%) | *Kilishi* made with Soybean slurry (%) | SEM | P. Value |
| Moisture | 7.76 | 7.90 | 8.10 | 0.24 | 0.62 |
| Crude Protein | 46.67 | 45.77 | 40.75 | 4.83 | 0.66 |
| Fat | 16.18a | 9.98b | 11.91b | 0.67 | 0.00 |
| Crude Fiber | 1.81b | 2.55a | 2.05ab | 0.16 | 0.02 |
| Ash | 5.15b | 5.85a | 5.83a | 0.18 | 0.03 |
| NFE | 22.44 | 27.95 | 31.36 | 4.55 | 0.40 |

abMeans in the same row with different superscripts are significantly different (*P* = .05),

SEM: Standard Error of Mean, NFE – Nitrogen Free Extract

**3.1.2. Effect of Storage Period on the Proximate Composition of *Kilishi***

The effect of storage period on the proximate composition of *kilishi* presented in Table 3, showed significant difference (*P*<0.05) in most of the parameters except in crude protein and nitrogen free extract content where no significant difference (*P*>0.05) was found, As the *kilishi* samples were stored from 1 - 16 weeks, moisture content, crude protein and crude fiber significantly (*P*<0.05) increased while significant (*P*<0.05) reduction was seen in fat, ash and Nitrogen free extract content. Moisture content increased significantly (*P* <0.05) from 5.85% at 1st week to 9.99% at 16th weeks due to moisture reabsorption from the environment over time. This trend aligns with findings by Magawata and Faruk (2014); Iyiola and Aladi (2023), who reported similar moisture increase in dried meat products and *kilishi* during extended storage due to environmental absorption. Moisture content is a critical factor influencing the texture, flavor, and shelf life of kilishi (Inusa and Muhammad, 2021). Elevated moisture levels can affect *kilishi*’s shelf stability by increasing susceptibility to microbial growth, emphasizing the need for optimal storage conditions. However, the moisture content found during the storage period is low to hinder microbial growth and this could be due to stepwise drying used during production. The moisture range in this study is lower than the range of 5.19 to 7.92 % reported by Olusola *et al*. (2017).

Crude protein content showed no significant differences (*P*>0.05), remaining relatively stable at 1st and 16th weeks of storage (44.31% and 44.48%) respectively. This suggested that protein was not degraded during storage. This could be due to drying techniques and low moisture content which enables high concentration of protein on the samples. This stability is consistent to the findings of Idowu *et al*. (2010) and Iyiola *et al*. (2023), who noted that protein in *kilishi* is well-preserved during storage due to its low moisture content and drying techniques. Protein retention ensures that *kilishi* continues to serve as a nutrient-dense snack over extended storage periods, Okonkwo *et al*. (2013) reported that *kilishi* retains a high protein content, ranging from 40 to 71%, even after prolonged storage while high protein content which ranges from 61.82– 65.91% was reported by Alamuoye (2019).

Crude fat content decreased significantly (P<0.05) from 14.34% at 1st week to 11.04% at 16th weeks. This could be attributed to lipid oxidation during storage which could be caused by high temperatures, oxygen exposure, and light which can accelerate fat degradation leading to the formation of off-flavors and unpleasant odors and reducing consumer’s acceptability (Casaburi *et al*., 2015). This reduction aligns with Iyiola *et al*. 2023; Okonkwo *et al*. (2013), who attributed similar decrease in fat to lipid oxidation during storage. Lower fat contents at 16th weeks may affect *kilishi*'s flavor and energy density since fat is related to flavour (Ojo *et al*., 2002; Resconi *et al*., 2013), highlighting the importance of proper packaging to reduce oxidation.

Crude fiber content increased significantly (*P*<0.05) from 1.67% at 1st week to 2.60% at 16th weeks. Meat which is the main component of *kilishi* has no crude fiber content. However, the crude fiber of *kilishi* is mainly from the ingredients used in its production which are of plants origin (Olusola *et al*., 2018). The increase in crude fibre could be due to concentration effects of the slurries as they integrated into the samples during storage as non-degradable fiber components become more pronounced over time and may impact texture, making *kilishi* tougher and less palatable over time. This rise is similar with the findings of Iyiola and Bullus (2024), who observed a range of 1.38 to 2.10% of crude fibre. Elevated fiber levels may enhance the functional and health benefits of *kilishi*, especially to consumers that prefer high-fiber diets.

Ash content decreased significantly (*P*<.05) from 1st – 16th weeks of storage (6.20 – 5.02%) respectively, indicating a reduction in mineral concentration during storage. This decline may result from volatilization or degradation of mineral-rich components, as noted in earlier studies by Idowu *et al*. (2010); Iyiola and Aladi (2023). Rodriguez-Estrada *et al*. (1997) also reported adverse changes leading to decrease in the nutritional value, particularly of mineral and vitamin and changes in the composition of fatty acid. Lower ash content could slightly reduce *kilishi*'s contribution to dietary mineral intake over extended storage. The range of ash content (5.02 – 6.20%) of *kilishi* in this study was lower than the range values of 6.75 – 9.5% reported by Jonathan *et al*. (2016), 9.55% reported by Iheagwara *et al*. (2019) and 4.60 – 10.08% reported by Iyiola and Aladi (2023).

Nitrogen-free extract (NFE), representing carbohydrate content, showed no significant differences (*P*>0.05) over the storage period, with values of 27.63% at 1st week and 26.87% at 16th weeks. This stability suggests that the carbohydrate components in *kilishi* were not significantly degraded or lost during the 16-week period due to the low moisture content and absence of enzymatic or microbial activity. The drying process effectively reduces water activity, preventing microbial fermentation or hydrolysis of carbohydrates, thereby maintaining the NFE levels throughout storage. This is in agreement with observations by Magawata and Faruk (2014), who found that carbohydrates in *kilishi* remain consistent during storage having his result ranging from 8.25 to 8.40%, maintaining its role as an energy-dense snack.

**Table 3 Effect of Storage Period on the Proximate Composition of *Kilishi***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Period (Wks) | 1st week (%) | 16th weeks (%) | SEM | P. Value |
| Moisture | 5.85b | 9.99a | 0.20 | 0.00 |
| Crude Protein | 44.31 | 44.48 | 3.94 | 0.98 |
| Crude fat | 14.34a | 11.04b | 0.54 | 0.00 |
| Crude Fiber | 1.67b | 2.60a | 0.13 | 0.00 |
| Ash | 6.20a | 5.02b | 0.14 | 0.00 |
| NFE | 27.63 | 26.87 | 3.72 | 0.89 |

abMeans in the same row with different superscripts are significantly different (p<0.05),

SEM: Standard Error of Mean, NFE: Nitrogen free extract

**3.1.3 Interaction effect of storage** **period and slurry types on the proximate composition of *kilishi***

The interaction effect of storage period and slurry types on the proximate composition of *kilishi* presented in (Table 4) showed significant effect (*P*<0.05) except on crude protein and Nitrogen free extract where no significant effect (*P*>0.05) was observed. The moisture content increased significantly (*P* <0.05) across the slurry types from 1st week to 16t weeks of storage with *kilishi* made with groundnut slurry increased from 5.98 to 9.54%, *kilishi* made with bambara nut from 5.43 to 10.37%, and *kilishi* made with soybean slurry from 6.13 to 10.07% . The increase was due to the varying water-binding capacities of the ingredients. This increase aligns with findings by Opio and Photchanachai (2018), who emphasized the role of moisture absorption during storage due to environmental exposure. Chukwu and Imodiboh (2009) reported that when a lean meat is dried to about 20% of moisture it inhibits most bacteria, yeasts and moulds growth while a level of 15% moisture inhibits only some species of fungi. Therefore, the moisture content observed in this study is low which indicates that the samples were properly dried to hinder microbial growth and spoilage over the storage periods. Moisture content is a critical factor influencing texture flavour and shelf life of *kilishi* (Inusa and Muhammad, 2021). Moisture contents found in this study is very low when compared to 60% moisture content of fresh meat (Afifah *et al*., 2021) indicating the importance of drying method in extending shelf life (Ryoba *et al*., 2013)

Crude protein content displayed no significant differences (*P*>0.05) over the interaction effect of storage period and slurry types across the kilishi samples. *Kilishi* made with groundnut slurry contained the highest crude protein content at 1st week (49.64%) but reduced to 43.70 at 16th weeks, while *kilishi* made with soybean slurry recorded the lowest at 1st week (34.72%) but increased to 46.78% at 16th weeks of storage. Reduction in crude protein content found in *kilishi* made with groundnut and bambara nut slurries during the period of storage could result from protein degradation due to prolonged exposure to light and also increase in moisture content during storage. This agrees with Iyiola and Aladi (2023) who reported decrease of crude protein over a storage period. However, increase in crude protein content found in *kilishi* made with soybean slurry having the highest crude protein at 16th weeks of storage could be due to oxidative stability of the slurry over time. This aligns with studies by Idowu *et al*. (2010); Iyiola and Bulus (2024), which noted that protein retention in dried meat products depends on storage conditions, slurry composition, and oxidative stability. Furthermore, the high protein content observed in this study is attributed to the lean meat and slurry composition. This is in agreement with studies that have shown that high crude protein content of *kilishi* is from the lean meat and leguminous plants that are rich in protein therefore making *kilishi* a significant source of dietary protein for consumers (Iheagwara *et al*., 2016, Iyiola and Bulus, 2024).

Contrarily, crude fat content showed a variable trend, with *kilishi* made with groundnut slurry increasing significantly (*P<0*.05) from 14.90 to 17.46% (1st - 16th weeks), while *kilishi* made with bambara nut and soybean slurries decreased significantly (*P*<0.05) within the storage period. Drastic reduction of crude fat from14.69 to 5.27% was found in *kilishi* made with bambara nut slurry. The decline in fat content of *kilishi* made with bambara nut and soybean slurries could be due the capacity of the fat contents of the slurries to leach away during storage causing the overall reduction of the fat content of the final product. This is similar to the report of Idowu *et al*. (2010) who attributed such reductions to lipid oxidation or rancidity during prolonged storage. Groundnut’s higher lipid stability may be due to its natural antioxidant content, as previously highlighted by Opio and Photchanachai (2018), who reported that groundnut contains significant amounts of natural antioxidants, such as polyphenols, tocopherols (vitamin E), and flavonoids, which help prevent lipid oxidation and rancidity in food products. The range of fat content in this study is lower than 17.34 – 19.20% reported by Iheagwara and Okonkwo (2016), 25.36 ± 1.69% reported by Jones *et al*., (2001) and 17.91 - 18.31% reported by Igwe *et a*l. (2015.) but higher than 10.11 – 10.57% reported by Iheagwara *et al*. (2019). The highest fat contents found in *kilish*i made with groundnut slurry could enhance its sensory qualities (Resconi *et al*., 2013) but less preferred by consumers that like low fat meat products due to health related issues associated to consumption of animal fat products.

Crude fiber content increased significantly (P<0.05) across all the slurry types *kilishi* within the storage period, with bambara nut slurry showing the highest values (2.10 and 3.00%) at both 1st and 16th weeks respectively. Crude fiber in *kilishi* represents the indigestible portion of plant material present in the leguminous plants, spices and seasoning used during its preparation Therefore, this increase may be attributed to the chemical composition of the slurry since it was of plant origin and also to the relative concentration effect of the slurries during storage as they migrated into the meat as other components such as moisture and ash fluctuate, Small amount of crude fiber in kilishi, can aid in enhancing the overall digestive benefits of the product (Inusa and Muhammad, 2021)

Ash content decreased over time for all slurry types *kilishi*, with the most notable drop observed in *kilishi* made with groundnut slurry (5.77 to 4.53%). This decline could be attributed to leaching or breakdown of mineral-rich components during storage. *Kilishi* made with soybean slurry had higher ash content (6.51 to 5.16%) compared to other treatment groups. This agrees with the report by Idowu *et al*. (2010) that a high mineral content of *kilishi* (7.10%) is due to contribution of soybean in food products. Ash content in food represents the total mineral composition, which plays a vital role in bone formation, enzyme activation, fluid balance, and overall metabolic functions in the human body (Soetan *et al*., 2010). Nitrogen-free extract (NFE), representing carbohydrate content, showed minimal variation especially in *kilishi* made with groundnut slurry and no significant differences (*P* >0.05) over the storage period across slurry types. The highest NFE (37.67%) was found in *kilishi* made with soybean slurry at 1st week while a notable increase in NFE from 22.89 to 33.02% was observed in *kilishi* made with bambara nut slurry within the storage period. The highest NFE found in *kilishi* made with soybean slurry at 1st week of storage could be attributed to the ability of the dried meat sample to absorb the slurry compare to other *kilishi* samples. This agrees with the report of Olusola *et al*. (2017) who reported that NFE content of *kilishi* is due to the rate of absorption of the dried raw meat slices in the slurry. Additionally, the most notable increase in NFE found in *kilishi* made with bambara nut slurry could be attributed to a relative concentration of carbohydrates from the slurry to the meat during storage. This aligns with Magawata and Faruk (2014), who observed similar increase in NFE during storage which ranged around from 0.67 – 2.17%. The spices and seasonings used in *kilishi* preparation, such as groundnut or bambaranut paste and other ingredients, add to the carbohydrate content, thereby enhancing its nitrogen free extract concentration (Iyiola *et al*. 2025). This carbohydrate component plays a crucial role in providing the caloric value of *kilishi*, making it not only a protein-rich snack but also a substantial energy provider.

**Table 4: Interaction Effect of Storage** **Period and Slurry Types on Proximate Composition of *Kilishi***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Slurry | *Kilishi* made with Groundnut slurry (%) | | *Kilishi* made with Bambaranut slurry (%) | | *Kilishi* made with Soya bean slurry (%) | | SEM | P-value |
| Storage Period  (wks) | **1** | **16** | **1** | **16** | **1** | **16** |  |  |
| Moisture | 5.98b | 9.54a | 5.43b | 10.37a | 6.13b | 10.07a | 0.34 | 0.05 |
| Crude Protein | 49.64 | 43.70 | 48.57 | 42.98 | 34.72 | 46.78 | 6.83 | 0.35 |
| Fat | 14.90ab | 17.46a | 14.69ab | 5.27d | 13.44b | 10.38c | 0.94 | 0.00 |
| Crude fiber | 1.38d | 2.23bc | 2.10bc | 3.00a | 1.53cd | 2.57ab | 0.23 | 0.05 |
| Ash | 5.77ab | 4.53c | 6.33a | 5.37b | 6.51a | 5.16bc | 0.25 | 0.05 |
| NFE | 22.33 | 22.54 | 22.89 | 33.02 | 37.67 | 25.04 | 6.44 | 0.25 |

abcdmeans in the same row with different superscripts are significantly different (p<0.05),

SEM: Standard Error of Mean, NFE: Nitrogen free extract

**3.2 Sensory Quality**

**3.2.1 Effects of Slurries on Sensory Quality of *Kilishi***

The effect of slurries on sensory quality of *kilishi* is shown in Table 5. A significant effect (*P* <0.05) was observed in overall appearance, juiciness and overall acceptability while no significant effect (*P*>0.05) was observed in colour, flavour, and tenderness across the treatment groups. The overall appearance of *kilishi* made with groundnut slurry was rated highest (7.60) compared to *kilishi* made with bambara nut slurry (6.40) and *kilishi* made with soybean slurry (6.35), with the latter showing a significantly (*P*<0.05) lower score. The highest score of overall appearance found in *kilishi* made with groundnut slurry could be attributed to its higher fat content (Table 2) which enhances the surface shine and improves the appealing golden-brown color of *kilishi* after drying (Egbo *et al*., 2001). *Kilishi* made with groundnut slurry's higher rating aligns with its established role in enhancing visual appeal due to its natural color and binding properties, as noted by Magawata and Faruk (2014). Products that appeal to consumers often gain higher acceptance. This caused *kilishi* made with groundnut slurry to have an advantage over other treatments group in sensory quality assessment.

The color scores showed no significant differences (*P*>0.05) among the *kilishi* samples, with values which ranged from 6.05 to 6.55 across the *kilishi* samples. This consistency may result from the uniform drying and roasting processes applied across treatments. These findings align with Idowu *et al*. (2010), who observed minimal color variation in *kilishi* produced using different slurry formulations. Meat colour is one of the most important sensory characteristics by which consumers make judgments on meat quality (Ruiz-Capillas, *et al*., 2021).However, the highest score found on the colour of *kilishi* made with groundnut slurry could be attributed to higher oil content of the slurry (Iyiola and Bulus. 2024) which enhances the surface shine and improves the appealing golden-brown color of *kilishi* after drying (Egbo *et al*., 2001).

Flavor was rated highest for *kilishi* made with groundnut slurry (7.05), with *kilishi* made with bambara nut slurry (6.85) which showed comparable results and *kilishi* made with soybean slurry which had the least score (6.05). The flavor profile of *kilishi* is significantly influenced by its fat content, which enhance the release of aromatic compounds during roasting (Idowu *et al*., 2010). *Kilishi* made with groundnut slurry's superior fat content (Table 2) likely contributed to its higher flavor rating and this is consistent with earlier observations by Opio and Photchanachai (2018) on the sensory impact of lipid-rich ingredients.

Tenderness scores ranged from 5.75 to 6.65 for the *kilishi* samples with no significant difference (*P*>0.05). The highest crude fibre content (6.65) was found in *kilishi* made with bambara nut slurry (6.65) while *kilishi* made with soybean slurry has lowest tenderness score (5.75) which may be attributed to its lower fat content, which can affect the mouth feel of *kilishi* (Iyiola and Bullus, 2024). Additionally, the highest crude fibre content found in *kilishi* made with bambara nut slurry could likely be due to its higher fiber and moisture retention properties, which prevent excessive drying and hardening of the meat. This implies that *kilishi* made with bambara nut slurry was tenderer compared to other samples which could be appealing to consumers that prefer tender meat products. This agrees with the report of Iyiola and Bulus (2024) who reported higher tenderness score in *kilish*i made with bambara nut slurry. Similarly, Aworh (2023) reported that excessively tough or dry *kilishi* was less preferred.

Juiciness was significantly (*P*<0.05) higher in *kilishi* made with groundnut slurry (6.85) compared to *kilishi* made with soybean slurry which had least score (5.35), with *kilishi* made with bambara nut slurry showing intermediate results (6.45). *Kilishi* made with groundnut slurry’s higher fat content (Table 2) likely enhanced the perception of juiciness, which agrees with Kumar *et al*. (2017) on the role of fats in improving sensory qualities. Resconi *et al*., (2013) also reported on fats ability to enhance juiciness and flavor.

The overall acceptability of *kilishi* followed a similar trend, with *kilishi* made with groundnut slurry having the highest score (7.55), followed by *kilishi* made with bambara nut (6.90) and soybean (5.75) slurries, with a significant difference (*P*<0.05) observed between *kilishi* made with groundnut and soybean slurries. The highest score of overall acceptability found in *kilishi* made with groundnut slurry reflects consumer’s preference for good sensory qualities provided by the product which agrees with the findings by Idowu *et a*l. (2010); Magawata and Faruk (2014). The overall acceptability of *kilishi* made with groundnut slurry is generally high due to its unique combination of flavor, texture, colour and appearance (Iyiola and Bulus, 2024).

**Table 5: Effects of Slurries on Sensory Quality of *Kilishi***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | *Kilishi* made with Groundnut slurry | *Kilishi* made with Bambaranut slurry | *Kilishi* made with Soya bean slurry | SEM | P-value |
| Overall Appearance | 7.60a | 6.40ab | 6.35b | 0.43 | 0.05 |
| Colour | 6.55 | 6.40 | 6.05 | 0.43 | 0.70 |
| Flavour | 7.05 | 6.85 | 6.05 | 0.36 | 0.12 |
| Tenderness | 6.30 | 6.65 | 5.75 | 0.39 | 0.26 |
| Juiciness | 6.85a | 6.45ab | 5.35b | 0.45 | 0.05 |
| Overall Acceptability | 7.55a | 6.90a | 5.70b | 0.27 | 0.00 |

abmeans in the same row with different superscripts are significantly different (p<0.05),

SEM: Standard Error of Mean

**3.2.2 Effect of Storage Period on the Sensory Quality of *Kilishi***

The effect of storage period on the sensory quality of *kilishi*, as presented in Table 6, indicated minor changes in sensory attributes over time, with no significant differences (*P*>0.05) in all the parameters analyzed. This stability underscores the resilience of *kilishi*'s sensory properties during extended storage when appropriate production and storage practices are applied. Overall appearance scores of the *kilishi* samples slightly increased within the storage period from 6.67 at 1st week to 6.90 at 16th weeks. This minor improvement could be attributed to the continued integration of slurry components into the *kilishi* matrix during storage, enhancing visual appeal. Similar findings were reported by Petrova *et al*., (2015), who noted that well-processed *kilishi* retains its appearance due to its dried surface and lipid content.

Color ratings of the *kilishi* samples also showed a slight increase within the storage period from 6.20 at 1st week to 6.47 at 16th weeks. The uniformity in color may result from effective drying and roasting techniques, which fix the surface color and resist pigment degradation over time. This stability reflects the minimal impact of storage on *kilishi*’s pigmentation. This is consistent with the observations by Idowu *et al*. (2010) who reported that *kilishi* maintains its color stability during storage due to the drying and roasting processes, which help fix surface pigments and reduce oxidative discoloration over time. Contrarily, Yusuf *et al*. (2020) reported that color of *kilishi* may darken slightly during storage due to oxidation and exposure to air, which affects its visual appeal.

Furthermore, flavor scores of the *kilishi* samples slightly decreased from 6.77 at 1st week to 6.53 at 16th weeks of storage, though not significantly. This slight reduction could be attributed to reduction of fat content (Table 3) of the samples as a result of lipid oxidation during storage. This is in agreement of the report of Petrova *et al*., (2015). Similarly, Kovac *et al*. (2020) reported that fat oxidation negatively impacts the flavor by producing off-flavors and reducing overall consumer acceptability. Prolonged exposure to air which can cause the spices to lose potency, leading to a blander taste in *kilishi* was reported by Igene and Mohammed (2014). However, *kilishi*’s low moisture content likely inhibits significant flavor deterioration, a finding supported by Kumar *et al*. (2017), who emphasized the role of drying in preserving meat flavor during storage. The range of flavour found in this study is higher than 6.1 – 6.3 reported by Aladi *et al*. (2022) but lower than 7.82 – 8.43 reported by Iheagwara and Okonkwo (2016).

Tenderness scores modestly declined within the storage period from 6.50 at 1st week to 5.97 at 16th weeks, reflecting the slight toughening of the *kilishi* over time which is primarily due to protein cross-linking, and oxidative changes. This trend is consistent with the reports Iyiola and Bullus (2024), who observed reduction in tenderness in dried meat products due to moisture redistribution and changes in protein structure. *Kilishi* tends to become tougher and drier as moisture is gradually absorbed from the environment, despite the initial dehydration process (Shamsuddeen, 2009). Therefore, prolonged storage can lead to a reduction in tenderness and juiciness, making the product less palatable over time. The range of tenderness in this study is higher than 2.80 – 3.60 reported by Alamuoye (2019) but lower than the range of 7.04 – 7.62 reported by Ihegwara and Okonkwo (2016) and 5.20 – 6.93 reported by Iyiola and Aladi (2023).

Furthermore, juiciness ratings also exhibited a slight decline over the storage period, from 6.40 at 1st week to 6.03 at 16th weeks. This is primarily caused by reduction of fat (Table 3) due to fat oxidation. This is similar to the report of Gomez *et al* (2020) who stated that reduction of fat in meat products can result to loss of juiciness and obtaining a hard and rubbery texture. Despite this decline, the changes are not significant, indicating that *kilishi* retains acceptable levels of juiciness over the period of storage. The range of juiciness in this study is lower than the range of 6.58 – 7.23 reported by Iheagwara and Okonkwo (2016) and 6.20 – 7.20 reported by Alamuoye 2019

Overall acceptability scores remained stable, increasing slightly from 6.67 at 1st weeks to 6.80 at 16th weeks. This consistency suggests that *kilishi* maintained its appeal to consumers throughout the storage period, which could be attributed to proper storage condition and spices acting as antioxidant and antibacterial to the samples (Zhang *et al*., 2019). Magawata and Faruk (2014), also emphasized the role of proper processing and storage conditions in preserving product quality.

**Table 6: Effect of Storage** **Period on Sensory Quality of *Kilishi* Produced with Different Slurries**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Storage Period | 1st week | 16th weeks | SEM | P-value |
| Overall Appearance | 6.67 | 6.90 | 0.35 | 0.64 |
| Colour | 6.20 | 6.47 | 0.35 | 0.59 |
| Flavour | 6.77 | 6.53 | 0.29 | 0.57 |
| Tenderness | 6.50 | 5.97 | 0.32 | 0.24 |
| Juiciness | 6.40 | 6.03 | 0.37 | 0.48 |
| Overall Acceptability | 6.67 | 6.80 | 0.27 | 0.72 |

abMeans in the same row with different superscripts are significantly different (p<0.05),

SEM: Standard Error of Mean

**3.2.3 Interaction Effects of Storage Period and Slurry Types on the Sensory Quality of *Kilishi***

The interaction effects of storage period and slurry types on the sensory quality of *kilishi* presented in Table 7 showed, significant (*P*<0.05) interaction effect on overall appearance, juiciness and overall acceptability of the *kilishi* samples while no significant (*P*>0.05) interaction effect was observed on colour, flavour and tenderness across the treatment groups. Overall appearance of *kilishi* made with groundnut slurry improved slightly from 7.30 at 1st week to 7.90 at 16th weeks of storage, indicating enhanced visual appeal during storage. Conversely, *kilishi* made with bambara nut slurry showed a slight decrease from 6.60 to 6.20, while *kilishi* made with soybean slurry demonstrated a significant increase (*P*<0.05) from 6.10 to 6.60 within the storage period. Increase in overall appearance of *kilishi* made with groundnut and soybean slurries could be attributed to their fat contents (Table 2). These changes align with findings by Iyiola and Bulus (2024) who noted that lipid content in groundnut-based products contributes to sustained visual appeal during storage. This indicates that *kilishi* made with groundnut and soybean maintained their appearance over time compare to *kilishi* made with bambara nut slurry

Color ratings showed no significant differences (P>0.05) across storage periods for all slurry types *kilishi* ranging from 5.90 to 6.70. The ratings of the colour of the samples increased as the *kilishi* samples were stored. Color is an important factor in *kilishi*’s evaluation, as it indicates freshness and the extent of drying or roasting This stability of colour observed in this study suggests that the colour of the *kilishi* samples were not negatively affected during the period of storage which could be attributed to proper drying of the samples since low moisture content was observed across the treatment (Table 2). This in agreement with the report of Faustman *et al*. (2010) that pointed out that the amount of moisture on a meat surface will affect the amount of light that it reflected and the brightness or lightness that an observer perceives. Therefore, consistency in color ratings reflects enhancement of pigment concentration during storage which can be attributed to Maillard browning reactions and moisture loss. The range of colour ratings observed in this study is similar to the range of 5.27 – 6.73 reported by Iyiola and Aladi (2023).

Flavor of the *kilishi* samples were similar across storage periods, with no significant differences (P>0.05) across the treatment groups. *Kilishi* made with groundnut slurry had the highest flavor scores (7.30) at 1st week and decreased (6.80) at 16th weeks while *kilishi* made with soybean slurry recorded the lowest score (6.20) at 1st week and (5.90) at 16th weeks of storage, which could be attributed to the lowest fat content found in kilishi made with soybean slurry within the storage period (Table 4) leading to less flavor retention and intensity during storage (Resconi *et al*., 2013) and natural oils in groundnut, which act as flavor carriers, enhanced the perception of taste and aroma over time (Iyiola. And Bulus, 2024). These results align with Opio and Photchanachai (2018), who noted that the lipid profile of groundnut enhances flavor retention during storage.

Furthermore, tenderness declined within the storage period for *kilishi* made with groundnut slurry from 6.80 at 1st week to 5.80 at 16th weeks. *Kilishi* made with bambara nut slurry showed a slight decrease (6.90 to 6.40), while soybean slurry maintained consistently lower scores (5.80 to 5.70). The decline in tenderness of *kilishi* during storage is primarily due to moisture loss, protein cross-linking, and oxidative changes. As storage progresses, dehydration leads to increased muscle fiber rigidity, while protein-protein interactions and lipid oxidation further contribute to texture hardening. This aligns with Kumar *et al*. (2017), who observed that prolonged storage can reduce tenderness due to moisture loss or protein structure changes.

Juiciness decreased significantly (*P*<0.05) for all slurry types *kilishi* over the storage period. *Kilishi* made with groundnut slurry experienced a moderate decline from 7.20 to 6.50, while *kilishi* made with bambara nut and soybean slurries declined more sharply, from 6.90 to 6.00 and 5.10 to 5.60, respectively. The reduction in juiciness over time is primarily caused by lipid oxidation, and protein denaturation, which leads to a drier texture and reduced water-holding capacity in *kilishi*. These trends align with Iyiola *et al*. (2025), who attributed reductions in juiciness to moisture redistribution and lipid oxidation during storage.

Overall Acceptability remained high for *kilishi* made with groundnut slurry (7.60 and 7.50 at 1st and 16th weeks) respectively while *kilishi* made with bambara nut slurry showed a significant (*P<0*.05) increase (6.60 to 7.20). *Kilishi* made with soybean slurry had the lowest ratings, declining significantly (*P<0*.05) from 5.80 at 1st week to 5.70 at 16th weeks. This highest score of overall acceptability found in *kilishi* made with groundnut slurry can be attributed to their rich flavor, higher fat content, and better texture retention, which enhance taste, mouth feel, and consumer preference. These findings underscore *kilishi* made with groundnut slurry's ability to sustain consumer preference during storage, consistent with Iyiola and Bullus (2024), who emphasized groundnut’s superior sensory attributes in *kilishi* production.

**Table 7: Interaction Effects of Storage Period and Slurry Types on Sensory Quality of *Kilishi***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Slurry types | *Kilishi* made with  Groundnut slurry | | *Kilishi* made with  Bambara nut slurry | | *Kilishi* made with  Soybean slurry | | SEM | P-value |
| Storage Period (wks) | **1** | **16** | **1** | **16** | **1** | **16** |  |  |
| Overall  Appearance | 7.30ab | 7.90a | 6.60ab | 6.20ab | 6.10b | 6.60ab | 0.61 | 0.05 |
| Colour | 6.40 | 6.70 | 6.30 | 6.50 | 5.90 | 6.20 | 0.61 | 1.00 |
| Flavour | 7.30 | 6.80 | 6.80 | 6.90 | 6.20 | 5.90 | 0.50 | 0.83 |
| Tenderness | 6.80 | 5.80 | 6.90 | 6.40 | 5.80 | 5.70 | 0.54 | 0.71 |
| Juiciness | 7.20a | 6.50ab | 6.90a | 6.00ab | 5.10b | 5.60ab | 0.55 | 0.05 |
| Overall  Acceptability | 7.60a | 7.50a | 6.60ab | 7.20a | 5.80b | 5.70b | 0.63 | 0.05 |

abMeans in the same row with different superscripts are significantly different (p<0.05),

SEM: Standard Error of Mean

**4.0 Conclusion**

The results revealed that storage period significantly influenced the proximate composition of *kilishi* produced with different slurries. Moisture content increased across the treatment groups. *Kilishi* made with bambara nut slurry had the highest moisture content while *kilishi* made with groundnut slurry had the lowest moisture content as the samples were stored from 1st to 16th weeks. Crude fat content significantly decreased in *kilishi* made with bambara nut and soybean slurries, indicating lipid oxidation as a factor during extended storage. Crude protein and nitrogen-free extract (NFE) remained stable, ensuring that *kilishi* retained its nutritional value as a protein- and energy-rich snack. Ash content slightly decreased reflecting minor mineral losses, while crude fiber increased in all the *kilishi* samples, enhancing their functional properties. The sensory evaluation demonstrated that *kilishi* maintained its sensory appeal over the 16th weeks of storage with minimal declines in attributes such as flavour, juiciness and tenderness. *Kilishi* made with groundnut slurry consistently outperformed the other slurry types *kilishi* in flavor, juiciness, and overall acceptability, retaining its sensory quality more effectively during storage. This was followed by *kilishi* made with bambara nut slurry which showed intermediate sensory quality while *kilishi* made with soybean slurry showed least sensory appeal, particularly in flavor and juiciness. Despite slight changes, overall acceptability scores for *kilish*i remained high especially in *kilishi* made with groundnut slurry, emphasizing its resilience to quality degradation during storage. Therefore, bambara nut slurry can serve as viable alternative in *kilishi* production, offering nutritional and sensory stability similar to *kilishi* made with groundnut slurry

**Ethical Approval**

All protocols adhered to the ethical approval by the Board of Examiners of the Department of Animal Production and Health, Federal University Wukari, Taraba State, Nigeria.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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