PHYSICOCHEMICAL AND ORGANOLEPTIC CHARACTERISTICS OF *KILISHI* AS AFFECTED BY MEAT TYPES

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Abstract
This study was conducted to evaluate the effect of meat type on physicochemical and organoleptic properties of *kilishi* stored at 25±2°C over 21 days. *Kilishi* samples were made from beef and pork using the conventional traditional method. Subsequently, they were subjected to physical, chemical and organoleptic analysis. The result obtained showed that there were no significant differences ($p > 0.05$) in the moisture, protein and fat contents of the *kilishi* samples while significant differences ($p < 0.05$) existed in the crude fibre and ash contents. Organoleptically, the pork *kilishi* was rated better in all the parameters evaluated except for pungency and tenderness but differ significantly ($p < 0.05$) in colour and juiciness. However, both samples were appealing to the panelist based on the overall acceptability score of 7.2 and 7.1 for pork and beef *kilishi* respectively. The pH, water activity (a_w), trimethylamine (TMA), reduced as the storage duration increased while the perodixe value (PV), thiobarbituric acid (TBA) and total volatile basic nitrogen (TVBN) increased as the storage duration increased. The beef *kilishi* had the highest score of these parameters within all the storage period. There were no significant variation ($p > 0.05$) between the beef and pork *kilishi* samples in terms of PV, TBA and TVBN contents. However, the a_w, pH and TMA differed significantly ($p < 0.05$) between the beef and pork *kilishi* samples within the storage period.

Key words: Physicochemical, beef, organoleptic, pork, *kilishi*, meat.

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INTRODUCTION

Meat and meat products are high in nutritive value and because of this high nutritive value, fresh meat can only remain fresh for a short time before spoilage and to prevent this meat is processed into products. Processed meat is that in which its fresh properties are modified by the use of one or more seasonings, heat treatment or drying. Processing helps to enhance meat quality as well as elongate its shelf-life, encourages variety and availability of meat, renders it and its product easier to handle, package, distribute and market (Igene *et al*., 1990).

Kilishi is one of the processed meat product which is highly relished. It is a ready-to-eat convenient meat product that is traditionally prepared from beef slices infused with spices and defatted groundnut paste (Ogunsola and Omojola, 2008; Olusola *et al*., 2012). As a ready-to-eat convenient meat product, *Kilishi* possesses an excellent shelf life. According to Igene *et al*. (1990) and Isah and Okubanjo (2012), *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. It is mostly prepared from beef owing to wide preference and acceptability of beef (Apata *et al*., 2013). As beef is the most consumed of all meat types, this puts it on a very high demand and also makes it to be very expensive, hence the need to explore other meat types in processing of *kilishi* becomes eminent. Therefore, the present study is designed to evaluate the physicochemical and orgenoleptic characteristics of *kilishi* prepared from beef and pork.

MATERIALS AND METHODS

Procurement of Raw Material

Meat (beef and pork) used for the study were obtained from the central abattoir in Owerri,

Imo State, Nigeria. The groundnut, onions, red pepper, black pepper, alligator pepper, sweet pepper, African nutmeg, garlic, ginger, clove, sugar, salt and magi seasoning were obtained from Relief market, Owerri, Imo State, Nigeria.

Meat Preparation

The beef and pork (5kg respectively) used for the study were trimmed off of all visible fat, bone and connective tissue and then weighed. The resultant lean beef (4.72kg) and pork (4.65kg) were sliced into thin sheets of 0.17 – 0.20cm thick and 60-80cm long along the fibre direction of the meat.

Preparation of Infusing Ingredients

Infusion slurry was prepared following the procedures of Igene (1988) with some modifications 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 a slurry.

Preparation of *Kilishi*

The dried thin sheets of meat (beef and pork) were soaked in the infusion slurry for 30min after which it was taken out and spread out on flat steel trays on a raised platform till sun dried to generate the beef and pork *kilishi* respectively. After drying, the beef and pork *kilishi* were roasted in hot air 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.

Proximate Analysis

Proximate analysis of the beef and pork *kilishi* were conducted in accordance with standard methods of AOAC (2010).

Physicochemical Properties

The free fatty acids content (FFA), peroxide value (PV) and thiobarbituric acid (TBA) of the beef *kilishi* and pork *kilishi* were determined as described by Nielsen (2003). The total volatile basic nitrogen (TVBN) was determined according to the method of Safari and Yosefian (2006). The trinethylamine (TMA) content of the *kilishi* samples were determined by the Conway micro-diffusion method described by Siripongvutikorn *et al*. (2009) with modification. The water activity (a_w) was determined according to the method described by Frank *et al*. (2014) and pH according to the method described by Mohamed *et al*. (2011).

Organoleptic Quality Assessment

Sensory analysis were carried out as described by Carbonell *et al*. (2002). Appropriate sensory descriptors were defined for the sensory experiment and questionnaires were designed including these descriptors. The *Kilishi* (beef and pork) samples were evaluated by a 30-members 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. The parameters evaluated by the assessors on the *kilishi* samples were flavour, colour, tenderness, juiciness, pungency and overall acceptability.

Statistical analysis

All the analysis were carried out in triplicates and conventional statistical methods were used to calculate means and standard deviation (SD). Results were evaluated statistically using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Proximate Composition

The mean composition of *kilishi* as affected by meat type is shown in Table 2. There were significant variation ($p < 0.05$) in the ash and fibre contents of the *kilishi* samples while the moisture, protein and fat contents were statistically equivalent ($p = 0.05$). The moisture content of the pork *kilishi* (7.63%) was lower compared to the beef *kilishi* (9.50%). The reduction in moisture content of the pork *kilishi* is desirable as this can affect the quality attributes of the sample positively compared to the beef *kilishi*. However, the moisture content of the *kilishi* samples (beef and pork) is sufficiently low to inhibit microbial proliferation as drying of lean meat to about 20% moisture has been observed to inhibit most bacteria, yeasts and moulds while a level of 15% moisture inhibits some species of fungi

(Ogbonnaya and Imodiboh, 2009; Iheagwara and Okonkwo, 2016a). The protein content of the pork *kilishi* (61.72%) is slightly higher than that of beef *kilishi* (61.30%) though they appear not to be significantly different ($p > 0.05$). The high protein content can be attributed to the groundnut paste used in the processing of the *kilishi* as groundnut has a crude protein content of 55.85% as reported by Badau *et al*. (1997). Also this result confirms the report of Igene *et al*. (1990; 1993) that the various ingredients used in *kilishi* production improves the protein content thus making it a nutrient dense product. Fat is extremely important in flavour development of meat. The fat content of the pork *kilishi* and beef *kilishi* were 10.11% and 10.57% respectively. This level of fat is reasonable for the product to acquire good flavour, juiciness and consumer acceptability. Most consumers are apathetic to fat consumption but not at reasonable level which they require for palatable meat. The range of fat content obtained in this study was within the range reported by Badau *et al*. (1997) and Apata *et al*. (2013).

The ash content of the beef *kilishi* (9.55±0.29%) was significantly ($p < 0.05$) higher than the pork *kilishi* (7.54±0.47%). Ash content of any meat or meat products indicates the mineral content of the meat. The high ash level obtained may be a reflection of the ingredients used in the *kilishi* production. Also, it indicates that most of the ingredients in the slurry might have lost heir mineral contents into the slurry hence into the meat and product and this agrees with the report of Elizabeth (1995) 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. The value of the crude fibre was higher ($p > 0.05$) in beef *kilishi* (3.61±0.55%) compared to the pork *kilishi* (2.44±0.49%). Tough meat contains little or no fibre, it is obvious that this regime of fibre obtained in the beef *kilishi* and pork *kilishi* respectively can be attributed to the infusing ingredients utilized in the *kilishi* production as they are of plant origin. This is in conformity with the reports of Olusola *et al*. (2012) and Apata *et al*. (2013).

Physicochemical Properties

Peroxide value:

The peroxide value of a substance is an initial evidence of rancidity in unsaturated fat and oils (Choe and Oh, 2015). The changes of peroxide value as primary products of lipid oxidation in *kilishi* sample are shown in Fig. 1. The peroxide value (PV) content significantly ($p < 0.05$) increased in both *kilishi* samples during the 21 days storage. The highest value (1.80mEq/kg) of peroxide was recorded for the beef *kilishi* while the lowest value (1.56mEq/kg) was recorded for pork *kilishi*. The peroxide value of the beef *kilishi* was higher than the pork *kilishi* in all the days of storage. However, the peroxide values for both beef and pork were generally low. This can be attributed to the antioxidative properties of the spices used in the production of the *kilishi* and is in agreement with the report of Siripongvictikon *et al*. (2009) and Iheagwara and Okonkwo (2016b).

Thiobarbituric acid (TBA)

The thiobarbituric acid value of the beef *kilishi* and pork *kilishi* stored at ambient temperature (28±2°C) are shown in Fig. 2. The thiobarbituric acid value which is used to assay the malnoaldehyde which result from lipid peroxidation of polyunsaturation fatty acid for the beef *kilishi* and pork *kilishi* were not significantly different ($p > 0.05$). The TBA values for both *kilishi* samples (beef and pork) ranged from 1.49mg/MDA/kg to 1.68mgMDA/kg though the TBA values of the beef *kilishi* were higher than the pork *kilishi* in all the storage days. The TBA values obtained in this study is within the acceptable limits of the maximum level (1-2mgMDA/kg) of value, thus indicating that both *kilishi* (beef and pork) samples were of good quality during storage.

pH

The effect of storage duration on hydrogen ion concentration (pH) of beef *kilishi* and pork *kilishi* are shown in Fig. 3. The pH of the beef *kilishi* and pork kilishi as shown in Fig. 3 ranged from 4.89-5.03 and 4.12-4.42 respectively. The pH of both *kilishi* (beef and pork) samples differ significantly ($p < 0.05$) from each other and increased as the storage

duration increased. This is in agreement with report of Iheagwara and Okonkwo (2016b). The pH values for the *kilishi* (beef and pork) samples were below the maximum accepted limits of 6.0 suggested by Bennani *et al*. (2000) and Jones *et al*. (2001) for fresh meat and this is suggestive that the meat was produced from well nourished and rested stock (Ogbonnaya and Imodiboh (2009).

Water activity (a_w)

Water activity is the measure of the amount of water in a food that is available for the growth of microorganisms including pathogens. It is the current volume and available free water in a sample and should be directly compared to with the moisture content, though the lower the moisture content the lower the water activity tends to become. The effect of storage duration on the water activity of the beef *kilishi* and pork *kilishi* are presented in Fig. 4. The result obtained showed that the water activity of the beef *kilishi* differ significantly ($p < 0.05$) from the pork *kilishi*. The a_w of the beef *kilishi* ranged from 0.32 - 0.80 and pork *kilishi* from 0.10 - 0.60. The water activity of both *kilishi* samples decreased as the storage duration increased. The reducing water activity may be followed by reductive changes signifying that the rate of deteriorative reactions including microbial growth in both *kilishi* samples will be reduced during storage. This result is in agreement with the report of Carpo *et al*. (2010) and Iheagwara and Okonkwo (2016b).

Trimethylamine (TMA) value

Trimethylamine is a reduction product of trimethylamine oxide and is a useful index in characterizing the quality of fresh and processed meat (Arashisar *et al*., 2004). The TMA concentration of meat and meat products is a contributing factor of the fishy off flavor problem in low concentration (Mohammed *et al*., 2014) and an ammonia-like odour at higher concentration (Falony *et al*., 2015). The effect of storage duration on the trimethylamine values of beef *kilishi* and pork *kilishi* are shown in Fig. 5. The result obtained shows that there were significant variations ($p < 0.05$) between the beef and pork *kilishi* samples. The TMA value of the beef *kilishi* ranged from 1.80mgN/100g to 1.85mgN/100g and pork *kilishi* from 1.34mgN/100g to 1.39mgN/100g. These values indicates that the TMA values of both *kilishi* samples were still under the standard limit (<35mgN/100g). Also, the TMA values of both kilishi samples decreased as the storage duration increased. The decrease in value of TMA over storage may be due to the low moisture content of the beef and pork *kilishi* samples and the antioxidant compound derived from the spices used in the *kilishi* production and this is in agreement with the report of Yang *et al*. (1993).

Total volatile basic nitrogen (TVBN)

Fig. 6 shows the TVBN values of beef and pork *kilishi* samples stored for 21 days. Total volatile nitrogen contains total amount of volatile nitrogen bases together with nitrogen which is synthesized by reaction from protein. The values obtained varied from 1.56mgN/100g to 1.90mgN/100g for beef *kilishi* and 1.32mgN/100g to 1.63mgN/100g for pork *kilishi*. These values indicate that the TVBN of the *kilishi* samples did not exceed the legal limit of 50mgN/100g muscle and were still under the standard limit (<35mgN/100g) as reported by Siripongvutikorn *et al*. (2009). However, the values of TVBN obtained in this study were low for both *kilishi* samples and this suggests that the level of protein decomposition or breakdown in both beef and pork *kilishi* samples were low.

Organoleptic Properties

The results of the mean sensory characteristics of beef and pork *kilishi* samples are presented on Table 3. The parameters evaluated were flavour colour, tenderness, juiciness, pungency and overall acceptability. Flavour is a general term used to define the taste and aroma of the meat during chewing. It is the chemical sensation caused by the molecules released during chewing of food (Voilley and Etievant, 2006). The flavour of the pork *kilishi* (7.0±1.06) was higher than the beef *kilishi* (6.7±1.34), though there was no significant difference ($p > 0.05$) between the two samples. The higher flavour score of the pork *kilishi* relative to the beef *kilishi* can be attributed to the high fat content and low moisture content

of the pork *kilishi* and this is in agreement with the report of Olusola *et al*. (2012), Apata *et al*. (2013) and Iheagwara and Okonkwo (2016c).

With regards to colour, there were significant variation ($p < 0.05$) between the pork and beef *kilishi* samples. Meat colour is an important quality property which contributes to its sensory acceptability (Garcia-Esteban *et al*., 2003). It influences the consumers' satisfaction and purchase decision (Mancini and Hunt, 2005). The colour of the pork *kilishi* (7.0±1.49) was significantly higher than the beef *kilishi* (5.4±1.50). As the colour of any meat or meat product is its visual perception (Omojola *et al*., 2003) and is dependent on the amount of water held by the meat or meat product, it is inferential that the higher colour scores of pork *kilishi* can be attributed to the low moisture content of the pork and this agrees with the findings of Apata *et al*. (2013).

Tenderness appears to be the most important sensory characteristics of meat and a predominant quality determinant (Sebside, 2006). It is rated as the most important attribute of dating quality and is the factor that determines the consumers continued interest in the meat (Simela, 2005. The sensory score for tenderness of pork *kilishi* (5.6±1.08) and beef *kilishi* (6.7±1.70) did not differ significantly ($p > 0.05$) though the beef *kilishi* was rated higher in tenderness. This can be attributed to the absorption tendency of the dried beef slice in relation to the dried pork slice.

In relation to juiciness, the pork *kilishi* (6.3±1.21) was significantly ($p < 0.05$) higher than he beef *kilishi* (4.4±1.71). The sensation of juiciness in meat is closely related to the quantity and composition of intramuscular fat (Muchenje *et al*., 2008). It is evident from the result that the high juiciness score of the pork *kilishi* can be attributed to the high marble nature of the pork as juiciness tends to be associated with marbling. Also this agrees with the findings of Webb *et al*. (2005) who reported that meat juiciness is directly related to the intramuscular lipids and moisture content of the meat.

With regards to pungency, there was no significant variation ($p > 0.05$) between the beef and pork *kilishi* samples. The hotness of *kilishi* is an indication of the pungency of the product (Olusola *et al*., 2012). The result of pungency as shown in Table 3 indicates that beef *kilishi* had a high score (6.7±0.67) than pork *kilishi* (6.2±0.93) though both are statistically the same ($p = 0.05$). The acceptability of meat and meat products is as a result of high colour, flavor, tenderness and juiciness of that meat or meat product as well as the level of moisture content in them (Omojola *et al*., 2003). The overall acceptability score of the pork *kilishi* (7.2 0.79) was slightly higher than the beef *kilishi* (7.1±0.23) though there was significant difference ($p < 0.05$) between them. The acceptability of pork *kilishi* over beef *kilishi* can be attributed to the fact that it had very high sensory attributes in all the parameters evaluated except for tenderness.

Table 1: Ingredients Composition of *kilishi* infusion slurry

Ingredients	Proportion (g)
Black, pepper (*Piper guineense*)	3.0
Red pepper (*Capsicum frutescens*)	3.5
Sweet pepper (*Capsicum annum*)	3.5
Ginger (*Zingiber officinale*)	3.0
Onion (*Allium* cepa)	10.5
Garlic (*Allium sativum*)	0.5
African nutmeg (*Monodora myristica*)	1.0
Groundnut paste (*Arachis hypogea*)	33.5
Alligator pepper (*Afromonium melegueta*)	1.0
Clove (*Eugenia caryophyllata*)	1.5

Seasoning	3.5
Salt	3.0
Sugar	2.0
Water	30.5

Table 2: Proximate composition of Beef and Pork *kilishi* samples

Kilishi	Proximate Composition (%)				
Samples	**Protein**	**Moisture**	**Fat**	**Ash**	**Fibre**
Beef	61.30±0.01[a]	9.50±0.71[a]	10.11±0.56[a]	9.55±0.29[a]	3.61±0.55[a]
Pork	61.72±0.03[a]	7.63±1.25[a]	10.57±0.19[a]	7.54±0.47[b]	2.44±0.49[b]
LSD*	**4.475**	**4.613**	**0.959**	**1.081**	**1.028**

[a-b] Means with different superscript along the column differ significant at $p < 0.05$
* Least significant difference

Table 3: Mean sensory scores of *kilishi* made from beef and pork

Kilishi	Sensory Parameter					
Samples	**Flavor**	**Colour**	**Tenderness**	**Juiciness**	**Pungency**	**Overall acceptability**
Beef	6.7±1.34[a]	5.4±1.50[b]	6.7±1.70[a]	4.4±1.71[b]	6.7±0.67[a]	7.1±0.23[a]
Pork	7.0±1.16[a]	7.0±1.49[a]	5.6±1.08[a]	6.3±1.21[a]	6.2±0.93[a]	7.2±0.79[a]
LSD*	**1.174**	**1.408**	**1.338**	**1.860**	**2.189**	**1.574**

[a-b] Means with different superscript along the column differ significant at $p < 0.05$
* Least significant difference

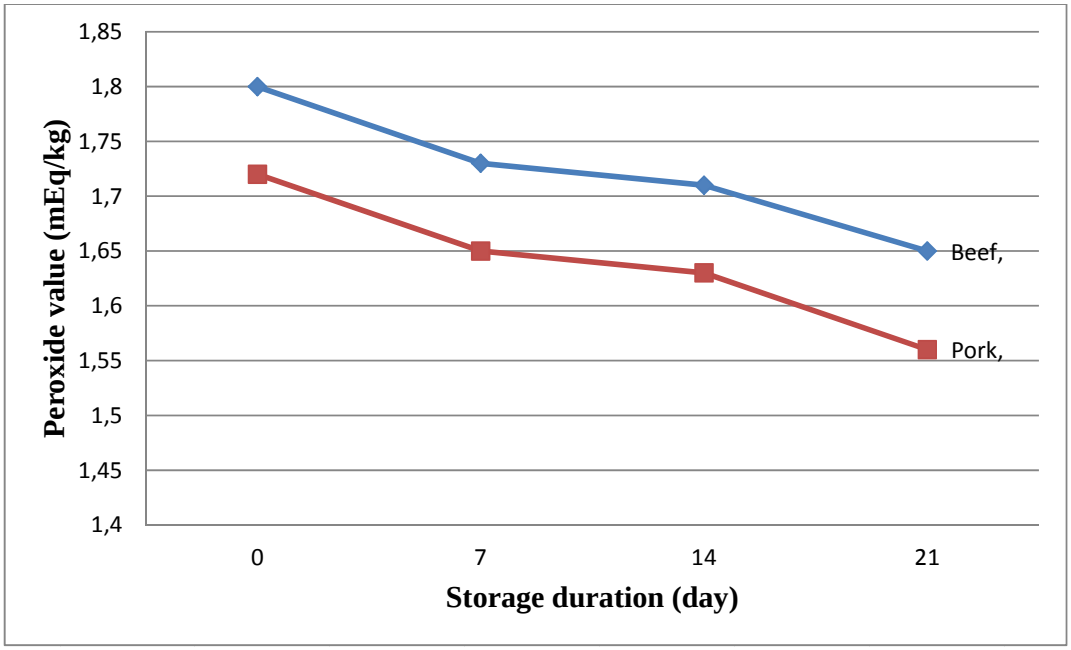

Figure 1: Effect of storage duration on peroxide value (mEq/kg) of *kilishi* samples from Beef and Pork

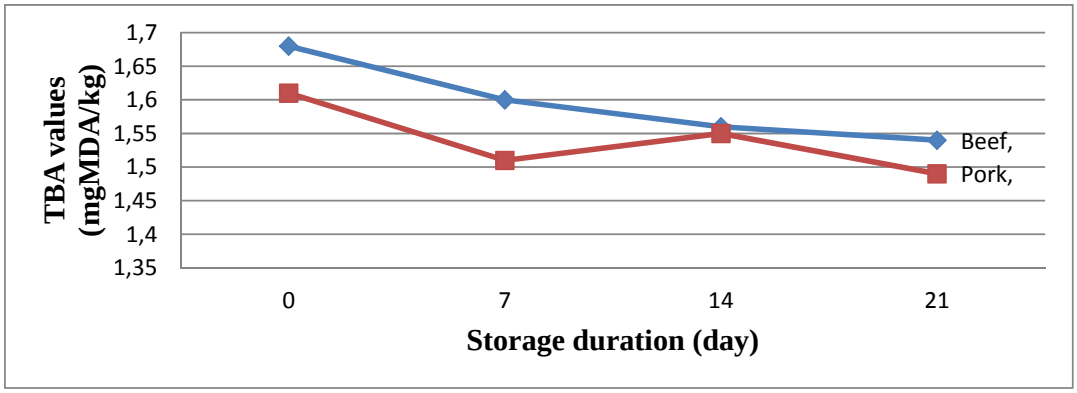

Figure 2: Effect of storage duration on Thiobarbituric acid (TBA) value of *kilishi* samples from Beef and Pork

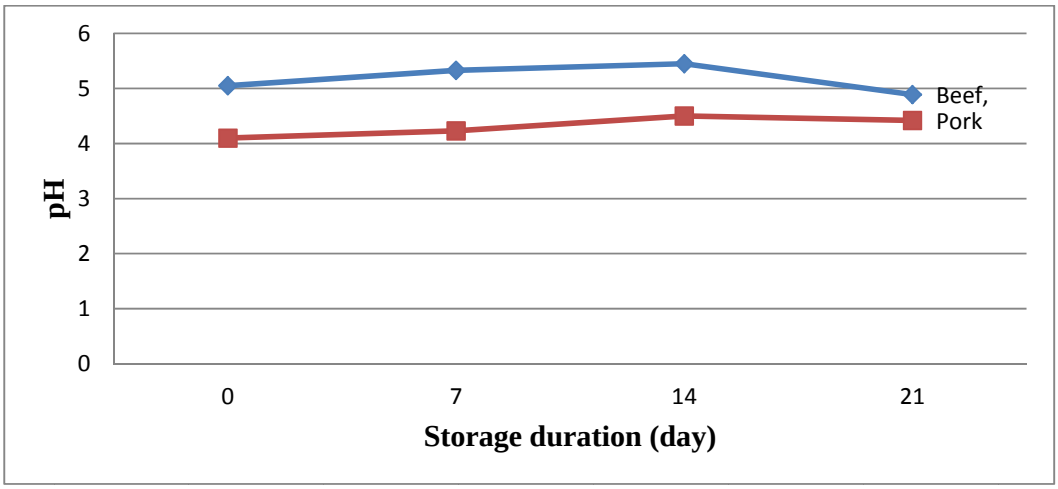

Figure 3: Effect of storage duration on pH value of *kilishi* made from Beef and Pork

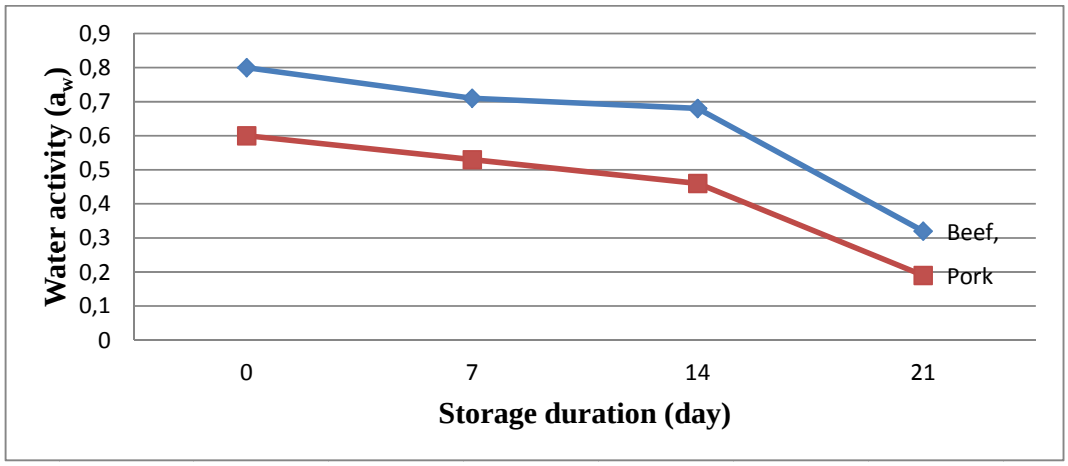

Figure 4: Effect of storage duration on water activity (a_w) of *kilishi* made from Beef and Pork

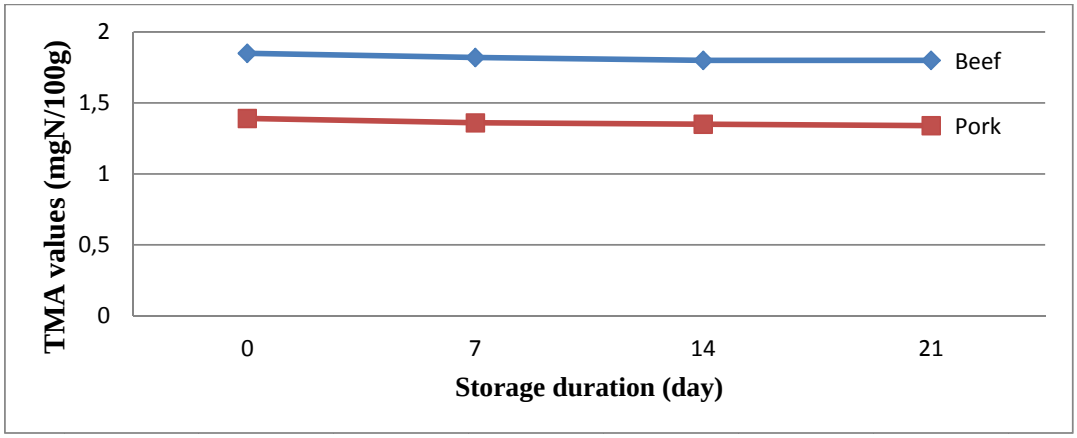

Figure 5: Effect of storage duration on Trimethylamine (TMA) of *kilishi* made from Beef and Pork

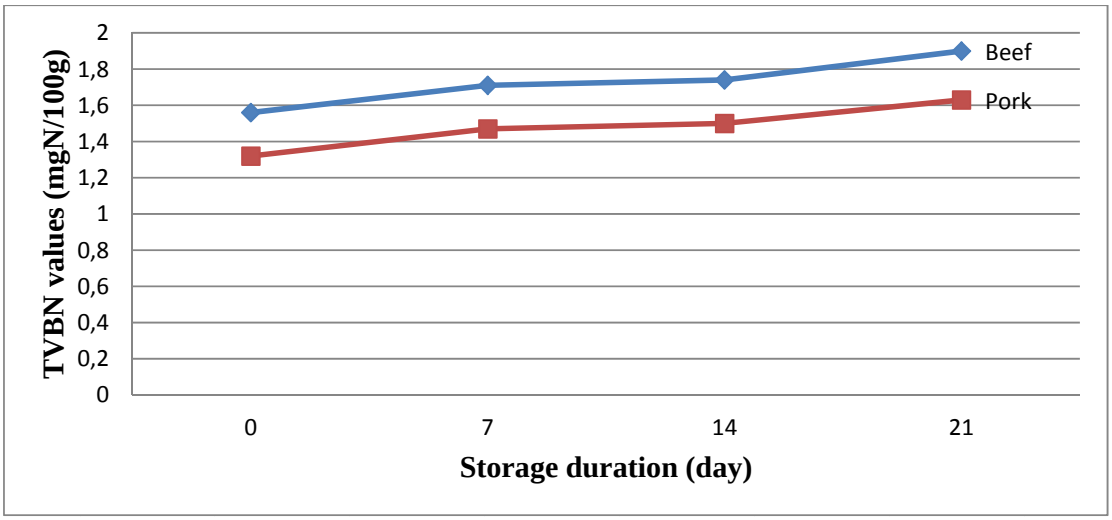

Figure 6: Effect of storage duration on Total Volatite Basic Nitrogen (TVBN) of *Kilishi* made from Beef and Pork

CONCLUSION

This study which was aimed at evaluating the effect of meat type on the physicochemical and organoleptic properties of *kilishi* reveals that *kilishi* from pork had similar moisture, protein and fat contents with that of beef. Organoleptically, the beef *kilishi* and pork kilishi samples compared reasonably well in all the sensory attributes evaluated thus indicating that both samples can be substituted well in relation to flavour, tenderness pungency and taste. However, there was greater consumer preference for pork *kilishi* in relation to colour and juiciness. Grossly, the study has inferentially shown that *kilishi* can be processed from other meat types besides beef.

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