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PHYSICOCHEMICAL AND SENSORY PROPERTIES OF BEEF HOTDOGS EXTENDED USING AFRICAN YAM BEAN (*SPHENOSTYLIS STENOCARPA*), LIMA BEANS (*PHASEOLUS LUNATUS*), PIGEON PEAS (*CAJANUS CAJAN*) AND SOYBEANS (*GLYCINE MAX*) FLOUR

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Abstract: This study investigated freshly minced-lean-beef of 12.5 kg allotted into 5 experimental models or samples of 2.5 kg each used in formulating beef hotdog without extender (T1) and beef hotdogs extended using flour from African yam bean (T2), lima beans (T3), pigeon peas (T4) and soybeans (T5) respectively for physicochemical and sensory properties on 0, 3, 6 and 9-days of refrigerated (4±1ºC) storage. The water holding capacity (WHC) and pH of the beef hotdog extended were higher than the non-extended beef hotdogs; with T5 significantly ($p<0.05$) best compared to the other samples. On day-9 the WHC varied significantly with T5 (94.00) > T2 (89.20) > T3 (87.50) > T4 (86.80) > T1 (83.90) while for pH; T5 (5.85) > T3 (5.80) > T4 (5.79) > T2 (5.79) > T1 (5.54). The extenders improved juiciness with T5 significantly most preferred while the non-extended (T1) was significantly least preferred. On day-9 the overall-acceptability varied significantly ($p<0.5$); with T1(5.80) > T3 (4.30) > T5 (3.00) > T2 (2.00) > T4 (1.40). Physicochemical properties were most desirable with soybeans flour while lima beans flour was most preferred among the extenders for sensory overall-acceptability.

Keywords: Meat product, refrigerated storage, meat extenders, legume sources

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Introduction

Meat and meat products play an invaluable role in the maintenance of human health by providing essential nutrients such as protein, vitamins, and minerals. Meat protein are not adequately consumed in Nigeria due to its inadequate supply and high cost with meat consumption rate being very low compared to animal protein intake requirement per person recommended for daily health living. Hence, to make meat products available at lower cost so as to enhance consumer affordability and consumption of meat products leading to increase protein intake among poor people the use of extenders in meat products have been encouraged (Asgar *et al.,* 2010).

Meat extenders are primarily plant proteins from legumes, with soybeans as the major source. There are various soybeans products such as soybeans flour, soybeans grits, textured soybeans protein, soybeans protein concentrates, soybeans protein isolates which are useful as extenders, binders and emulsifiers (Heinz and Hautzinger, 2007). Among these soy products extenders the most affordable is the soy flour. These cheaper plant proteins "extend" the more expensive meat proteins, resulting in acceptable overall protein contents of lower cost meat products. Extenders are added in sizeable amounts that increase the bulk of the meat products, but this may also alter their quality. There are various extended meat products such as chicken burger, meat roll, breakfast sausages and beef hotdogs sausages. From animal protein sources, whole milk and eggs can be considered as meat extenders but these are more expensive than the plant proteins sources as meat extenders.

Some important examples of legumes use in meat product are beans, peas, lentils, cowpeas and chick-peas. Whole seeds may be used only for certain indigenous products but are usually soaked in salted water for 1 to 2 hours prior to processing and products from them undergo immediate heat treatment at the processors level in order to avoid possible product spoilage caused by enzymatic reactions if stored without heat treatment. Although, in most cases legumes are used in meat processing in refined form (Tatiana and Gonzalo, 2020). The most common and most valued legume products are derived from soy beans which are used as extenders in processed meats (Heinz and Hautzinger, 2007). But the use of lesser known legumes (African yam bean, lima bean and pigeon pea) as meat extenders has not been explored. These legumes are under-utilized and this could be attributed to longer cooking time (Ofosu *et al.,* 2017).

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However, they are rich in protein with medicinal benefits as antioxidants (Gulzar and Minnaar, 2017).

Hence, to promote their utilization and reduced the cost of meat products the lesser known legumes could be used in processed form like flour and used as extender in meat product. Doing this will help to promote the use of these lesser known legumes which are under-utilized while ensuring adequate, cost effective, nutritious and safe meat consumption. Thus, this study focused on evaluating the physical and sensory quality properties of beef hotdog extended using African yam bean (*Sphenostylis stenocarpa*), lima beans (*Phaseolus lunatus*), pigeon peas (*Cajanus cajan*) and soybeans (*Glycine max*).

Materials and Methods

Experimental site

The study was conducted at the Agricultural Value Addition Programme in the Institute of Agricultural Research and Training, Moor plantation, Ibadan, Nigeria.

Source and processing of the legumes

African yam beans, pigeon pea and soya beans were obtained from a metropolitan market in Ibadan (Bodija market), Nigeria, while Lima bean was obtained from the Institute of Agricultural Research and Training (I.A.R. &T.). The legumes were clean from dirt, soaked for 24 hours and sundried for 36 hours then grind into powdery form.

Beef hotdog sausages preparation and experimental models

The source of the lean beef meat and cow intestines used for the beef hotdog sausages were obtained from the central abbatoir Akinyele, Ibadan, Nigeria. The Lean beef was deboned and were minced with the aid of a meat mincer having a crushing sieve hole diameter of 5.0 mm. The minced meat (12.5 kg) was mixed with spices, salt, monosodium glutamate, corn flour, fat, and were divided into five containers; each container represents a sample. The 12.5 kg of the minced meat was divided into 5 samples (each weighing 2.5 kg) namely: T1 = Beef hotdog without extender (control); T2 = Beef hotdog with African yam bean flour as extender; T3 = Beef hotdog with Lima beans flour as extender; T4 = Beef hotdog with Pigeon peas flour as extender; T5 = Beef hotdog with Soybeans flour as extender.

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Each legume flour as an extender was added to their respective samples at the ratio of 0.25 kg legume extender to 1kg of minced meat. Formulation of experimental beef hotdogs is presented in Table 1.

Table 1: Formulation of experimental beef hotdogs with and without extenders

	Samples				
Ingredients (%)	**T1**	**T2**	**T3**	**T4**	**T5**
Lean beef meat	93.75	75.00	75.00	75.00	75.00
Extender	0.00	18.75	18.75	18.75	18.75
[1]Binder	3.00	3.00	3.00	3.00	3.00
[2]Fat	1.25	1.25	1.25	1.25	1.25
[3]Spices	1.25	1.25	1.25	1.25	1.25
Monosodium glutamate	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100

[1]**Binder**: Corn flour, [2]**Fat**: Margarine, [3]**Spices**: Red chilli paste (30%), Green pepper (20%), Powdered nutmeg (20%), Garlic (10%), Ginger (10%), Onion (10%). T1: Beef hotdog without extender, T2: Beef hotdog extended with African yam bean flour, T3: Beef hotdog with Lima bean flour, T4: Beef hotdog extended with Pigeon pea flour, T5 Beef hotdog extended with Soya bean flour.

The proximate composition of each extender was determined using the procedure described by AOAC (1990) for moisture content, crude protein, crude fat, carbohydrate (CHO), crude fiber and ash content determination (Table 2). The moisture content assessment (oven drying method), involved weighing separately 10 g flour of each legume sources used in the sample formulation into a silica-dish. Thereafter the weighed samples at 105ºC oven temperature were dried for 24 hours to a constant weight. Each sample was cooled for 10 min. After cooling samples were reweighed and subsequently, moisture content was obtained being expressed in percentages as:

$$\% \text{ Moisture} = \frac{\text{Weight of flour sample before drying} - \text{Weight of flour sample after drying}}{\text{Weight of flour sample before drying}} \times 100$$

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The crude protein was assayed on 10 g flour from each of the legume sources using Khjedahl methods. The distillate obtained was titrated with 0.01N HCl. The derived crude protein was deduced by the conversion of nitrogen (%N) content of samples obtained when titrated with a constant (6.25). Thus, it was expressed as (6.25 x %N).

The crude fat was assayed on 10 g flour from each of the legume sources using a soxhlet extractor with petroleum ether as solvent. The apparatus containing the solvent was heated over a bursen burner and with a siphoning movement occurring 8 – 10 times in the flask. The oil released and flask itself was weighed and to achieve a constant weight; flask was dried in a preheated oven. The percentage crude fat was derived from this formula:

$$\% \text{ Crude fat} = \frac{\text{oil weight (g)}}{\text{Sample weight}} \times 100$$

The Ash content was assessed from 10g flour from each of the legume sources in crucibles was placed into a muffle furnace set at 550ºC for 4 hours. The crucibles and their contents were cooled in a desiccator to about (270ºC) and reweighed.

$$\% \text{ Ash} = \frac{\text{Ash weight (g)}}{\text{Sample weight (g)}} \times 100$$

The carbohydrate was assessed by spectrophotometric method using phenol after digestion in concentrated sulfuric acid (Agume *et al.*, 2017). The crude fiber content was determined on 10g flour from each of the legume sources put into a 500 ml titration flask and 100 ml of trichloroacetic acid (TCA) digestion reagent (Ikrang *et al.*, 2018).

Then each sample was stuff inside the casing then boiled inside a pot of boiling water (100 ± 1ºC) and were boiled for 20minutes to attain an internal temperature of 72ºC doneness. The casings preparation involved the use of cow intestine 'middles' which were about 7 m long, these were turned inside out and slimed and were prepared following the processes described by Heinz and Hautzinger, 2007. The treatments were stored in the refrigerator (4ºC) for nine days and samples from each treatment were taken for analysis on day 0, 3, 6 and 9 for physicochemical

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qualities [(i) cooking loss, (ii) cooking yield (iii) pH (iv) water holding capacity (WHC)] and sensory properties [colour, flavour, taste, texture, tenderness, juiciness and overall acceptability].

Table 2: Proximate composition (%) of flours from African yam bean, lima beans, Pigeon peas and soybeans respectively as extenders

Parameters (%)	African yam bean	lima bean	pigeon pea	soybean
Crude protein	21.93	20.44	20.14	36.84
Crude fat	2.00	11.16	1.04	15.94
Crude fiber	2.67	2.60	2.85	1.74
Ash content	1.02	1.18	1.14	2.15
Moisture content	13.76	14.87	15.00	6.93
CHO	52.39	49.76	59.83	29.42

The physicochemical properties of the beef hotdog sausages assessed included the following: (i) cooking loss, (ii) cooking yield (iii) pH (iv) water holding capacity (WHC).

The cooking loss was determined by using freshly beef hotdog sliced to approximately 10 cm thick, 100g and 30 cm long respectively. Three streaks beef hotdogs were obtained from the five treatments and were placed in sealed polytene bags immersed in boiling (100 ±1°C) water for 20 minutes to attain 72°C internal temperature of the sausage (doneness) and cooled to room temperature (25± 1°C) and were weighed after been cooked (Apata *et al.,* 2015). The cooking loss was expressed as a percentage of weight of raw beef hotdog relative to the weight of the cooked beef hotdog.

$$\text{Cooking loss \%} = \frac{\text{weight of raw meat (g)} - \text{weight of cooked meat (g)}}{\text{weight of raw meat (g)}} \times 100$$

Cooking Yield: This was calculated following the procedures of El-Nashi *et al.,* (2015) using the formula:

Cooking yield = (100% - cooking loss %)

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The pH: As a measure of the acidity and alkalinity (a physicochemical trait) of the beef hotdog extended using African yam bean (*Sphenostylis stenocarpa*), Lima beans (*Phaseolus lunatus*), Pigeon peas (*Cajanus cajan*) and Soybeans (*Glycine max*) were assessed by the use of the pH meter using a buffer of 4 as used by *Malav et al.,* (2013) with some modifications.

Water Holding Capacity (WHC) was assessed using press method as used by Apata *et al.,* 2015. Approximately 10 g of meat sample from the beef hotdog extended using African yam bean (*Sphenostylis stenocarpa*), Lima beans (*Phaseolus lunatus*), Pigeon peas (*Cajanus cajan*) and Soybeans (*Glycine max)* were placed between two previously weighed Whatman filter papers and pressed between two 10.20 x 10.20 cm^2 plexi-glasses using a vice for 60-seconds. Weight of wet filter paper was taken and water holding capacity of meat samples was obtained as:

$$WHC\ \% = 1 - \frac{\text{Weight of wet paper (g)} - \text{Weight of dry paper (g)}}{\text{Weight of sample (g)}} \times 100$$

Sensory properties assessment

The sensory properties (colour, flavour, taste, texture, tenderness, juiciness and overall acceptability) of the beef hotdog sausages were assessed by means of a 9-point hedonic scale rating described by Larmond (1977). The rating on the 9-point hedonic scale were: 1-Dislike extremely, 2-Dislike very much, 3 -Dislike moderately, 4-Dislike slightly, 5-intermediate, 6-Like slightly, 7-Like moderately, 8-Like very much and 9-Like extremely. The sensory questionnaires (Table 3) were distributed to ten-panellists. There were 20 semi trained panellists who evaluated the beef hotdogs for colour, flavour, taste, texture, tenderness, juiciness and overall acceptability using the 9-point hedonic scale; on the experimental formulated beef hotdogs which were blind coded with 2-digital random numbers and 2-random-letters and the order of serving were randomized. Water was offered to the panellists for the purpose of rinsing the mouth after tasting one experimental beef hotdog and before tasting another experimental beef hotdog. Panellists were arranged in such a way that ensured independence throughout the entire duration of product evaluation. The evaluation room was well illuminated and without noise or pungent odours that could cause distraction to the panellists (Omojola and Adediran, 2015).

Table 3. Nine-point hedonic scale for quality attributes

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	Quality attributes						
Point	**Colour**	**Flavour**	**Taste**	**Texture**	**Tenderness**	**Juiciness**	**Overall acceptability**
1	Extremely dark	Not perceptible	Extremely non-tasty	Extremely coarse	Extremely tough	Extremely dry	Dislike extremely
2	Just dark	Just perceptible	Just non-tasty	Very coarse	Very tough	Very dry	Dislike very much
3	Moderately dark	Moderately perceptible	Moderately non-tasty	Moderately coarse	Moderately tough	Moderately dry	Dislike moderately
4	Slightly dark	Slightly perceptible	Slightly non-tasty	Slightly coarse	Slightly tough	Slightly dry	Dislike slightly
5	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
6	Slightly light	Slightly strong	Just tasty	Slightly fine	Slightly soft	Slightly juicy	Like slightly
7	Moderately light	Moderately intense	Moderately tasty	Moderately fine	Moderately soft	Moderately juicy	Like moderately
8	Very light	Strongly intense	Very tasty	Very fine	Very soft	Very juicy	Like very much
9	Extremely light	Extremely intense	Extremely tasty	Extremely fine	Extremely soft	Extremely juicy	Like extremely

Source: Adopted after Heinz and Hautzinger (2007).

Data collected were analysed using the Analysis of variance (ANOVA) of the General Linear Model procedure available in SAS (version 8), 2012. Means differences were done using the Duncan's Multipe Range Test of the same software.

Results and discussion

The WHC (%) of non-extended beef hotdog and beef hotdog extended using African yam bean (*Sphenostylis stenocarpa*), lima beans (*Phaseolus lunatus*), pigeon peas (*Cajanus cajan*) and soybeans (*Glycine max*) were presented in Table 4. The highest WHC was in beef hotdog extended using Soya bean flour (T5) which was on day 0 (99.87%), day 3 (98.20%), day 6 (98.20%) and day 9 (94.00%) significantly higher compared to the non-extended beef hotdog

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(T1) and the beef hot dog extended using African yam bean, Lima bean and Pigeon pea (T2, T3 and T4) flour respectively. Conversely, the WHC (%) of non-extended beef hotdog on day 9 (83.90%) was least been significantly lower than the beef hotdogs extended using African yam bean (89.20%), lima beans (87.50%), pigeon peas (86.80%) and Soybeans (94.00%) flour respectively. Also, on day 9 there was non-significant difference observed for beef hotdogs extended using lima bean and pigeon pea flours respectively. It was observed that water holding capacity obtained in beef hot dogs with and without extenders for 9 days at 4ºC; decreases with storage days and this trend was similar to the report of Chowdhury *et al.* (2006) that water holding capacity of frozen chevon decreases from 18.06% to 3.24% over 15 days of cold storage. Water bound to the muscle protein affects the sensory (eating) and processing quality of the meat products. High water holding capacity observed among the experimental beef hotdogs is an indication of good product yields from processing point of view (Heins and Hautzinger, 2007). Thus, in harmony with this processing viewpoint the use of African yam bean, lima beans, pigeon peas and soybeans flour as extenders conferred better water holding capacity than the non-extended beef hotdogs. Notably, also were the proteins from the flour of each legume sources used in the experimental models as these add up to the meat protein in the beef hotdog samples. Thereby, influencing the water holding capacity since it is a direct interaction of protein molecules with water (Van Laack R. L. J. M., 2015).

Table 4. Effect of cold storage on WHC (%) of beef hotdog extended using African yam bean (*Sphenostylis stenocarpa*), Lima beans (*Phaseolus lunatus*), Pigeon peas (*Cajanus cajan*) and Soybeans (*Glycine max*)

	WHC (%) of Samples				
Storage days	**T1**	**T2**	**T3**	**T4**	**T5**
0	98.30±0.03^{a}	98.40±0.15^{a}	98.80±0.01^{b}	98.90±0.02^{b}	99.87±0.12^{c}
3	95.20±0.02^{a}	97.60±0.02^{c}	96.90±0.10^{b}	95.20±0.01^{a}	98.20±0.15^{d}
6	94.30±0.01^{a}	95.80±0.01^{b}	97.10±0.03^{c}	94.30±0.01^{a}	98.20±0.01^{d}

9	83.90±0.02[a]	89.20±0.12[c]	87.50±0.12[b]	86.80±0.01[b]	94.00±0.02[d]

Mean±standard deviation on the same row with same letters are not significantly different (p>0.05). T1: Beef hotdog without extender, T2: Beef hotdog extended with African yam bean flour, T3: Beef hotdog with Lima bean flour, T4: Beef hotdog extended with Pigeon pea flour, T5 Beef hotdog extended with Soya bean flour.

The pH of non-extended beef hotdog and beef hotdog extended using flour from African yam bean, lima beans, pigeon peas and soybeans respectively were presented in Table 5. The highest pH was in beef hotdog extended using Soya bean flour (T5) which was on day 0 (5.89), day 3 (6.03), day 6 (6.05) and day 9 (5.85) significantly higher compared to the non-extended beef hotdog (T1) and the beef hot dog extended using African yam bean, lima bean and pigeon pea flour (T2, T3 and T4) respectively. Conversely, the pH of non-extended beef hotdog on day 0 (5.58), day 6 (5.77) and day 9 (5.54) was least been significantly lower compared to the beef hot dog extended using African yam bean, Lima bean, Pigeon pea flour and soy bean flour (T2, T3, T4 and T5). The exemption to the least value of pH was observed on day 9 were the non-extended beef hotdogs (T1) and the extended beef hotdogs using African yam bean, lima beans and pigeon peas flour (T2, T3 and T4) respectively were not significantly different. Also, on day 9 there was non-significant difference observed for beef hotdogs extended using African yam bean, Lima beans and Pigeon peas flours respectively. Notably, the storage period did bring about significant changes in pH of the beef hotdogs both of the non-extended or with legumes flour extenders. The results of the present study were not in agreement with the results reported by Malav *et al*. (2013) in restructured chicken meat blocks extended with sorghum flour and potato during refrigeration storage.

The pH of meat and meat products is much related to the glycolytic cycle which starts immediately after slaughter in the muscle tissue, whereby glycogen, the main energy supplier to the muscle, is broken down to lactic acid. The build-up of lactic acid in the muscle produces an increase in its acidity, as measured by the pH. The pH of normal muscle at slaughter is about 7.0 but this will decrease in meat. In a normal animal, the ultimate pH (expressed as pH 24 = 24 hours after slaughter) falls to around pH 5.8-5.4 and the typical taste and flavour of meat can be detected after sufficient drop in pH down to 5.8 to 5.4 (Heinz and Hautzinger, 2007). Thus, from the processing point of view, meat products with pH 5.6 - 6.0 is an indication of good product quality where high-water holding capacity is required (Heinz and Hautzinger, 2007). In harmony

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with this viewpoint the experimental beef hotdogs extended using African yam bean, Lima beans, pigeon peas and soybeans flour fulfil this requirement of pH of 5.6 – 6.0 throughout the storage days. Also, the pH range of 5.6 to 6.0 as indication for good product quality which on day 9 of storage was more pronounced in the extended beef hotdogs using African yam bean, Lima beans, Pigeon peas and Soybeans flour than the non-extended beef hotdogs.

Table 5. Effect of cold storage on pH of beef hotdog extended using African yam bean, lima beans, pigeon peas and soybeans flour.

	pH of samples				
Storage Days	**T1**	**T2**	**T3**	**T4**	**T5**
0	5.58±0.01^{a}	5.67±0.02^{b}	5.70±0.02^{c}	5.67±0.01^{b}	5.89±0.01^{d}
3	5.93±0.12^{a}	5.83±0.01^{a}	5.89±0.15^{a}	5.87±0.02^{a}	6.03±0.02^{b}
6	5.77±0.03^{a}	5.85±0.02^{b}	6.02±0.01^{d}	5.97±0.02^{c}	6.05±0.01^{d}
9	5.54±0.02^{a}	5.79±0.01^{b}	5.80±0.03^{b}	5.79±0.15^{b}	5.85±0.15^{c}

Mean±standard deviation on the same row with same letters are not significantly different ($p>0.05$). T1: Beef hotdog without extender, T2: Beef hotdog extended with African yam bean flour, T3: Beef hotdog with Lima bean flour, T4: Beef hotdog extended with Pigeon pea flour, T5 Beef hotdog extended with Soya bean flour.

The sensory quality attributes of food products are crucial in determining consumer acceptability. Results of the sensory quality attributes for the non-beef hot dogs and the beef hot dogs extended using African yam bean (*Sphenostylis stenocarpa*), Lima beans (*Phaseolus lunatus*), Pigeon peas and Soybeans flours, stored at ambient temperature of 4°C in a refrigerator for 9 days are presented in Table 6. The results obtained indicated that there were significant variations ($p < 0.05$) in all the sensory parameters evaluated. Considering, colour the most preferred was the beef hotdog extended with soybeans flour (T5) which on the hedonic scale ranges between “Intermediate to Slightly light” as adjudged by the panellists throughout the storage periods of 9 days. The most preferred in colour (T5) was reckoned as been significantly ($p>0.05$) preferred to those of the other samples on 0, 3, 6 and 9 days of storage (Table 4). On the other hand, the least preferred in colour was observed for the beef hotdog extended with Pigeon

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peas flour (T4) which on the hedonic scale ranges between "Extremely dark to Slightly dark" as adjudged by the panellists throughout the storage periods of 9 days. The order of preference in colour for the experimental beef hotdogs was as follows: T5>T1≥T2>T3>T4. Notably, the preference in colour for non-extended beef hotdogs (T1) and beef hotdogs extended with African yam bean flour (T2) were not significant on 0, 3 and 6 days of storage but was significantly different on day 9 of storage with non-extended beef hotdogs been significantly higher than the beef hotdogs extended with African yam bean.

With regards to flavour, the most preferred was the non-extended beef hotdogs (T1) which on the hedonic scale ranges between "Slightly Perceptible to Moderately Intense" as adjudged by the panellists throughout the storage periods of 9 days. The most preferred in flavour (T1) was recorded as been significantly ($p<0.05$) preferred to those of the other samples on days 0, 3 and 6, except for on day 9 of storage where T1 (3.80), T3(3.50) and T4 (3.70) were not significantly different in flavour preference (Table 4). The most similar in terms of flavour (with non-significant difference) to the non-extended beef hotdog (T1) was the beef hotdog extended with the Pigeon peas flour (T4) throughout the storage periods. The least preference in flavour was observed for the beef hotdog extended with soybeans flour (T5) which on the hedonic scale was "Slightly Perceptible" as adjudged by the panellists on day 0 but there were no significant differences in flavour preference [(between T2 (3.30) and T5 (3.20)] on day 3 and on day 6 [(among T2 (3.80), T3 (3.90) and T5 (3.58)] and on day 9 [(between T2 (3.00) and T5 (2.80)] of storage. This least flavour preference observed in T5 could be due to the pronounce "beany" flavour associated with soya bean flour (Heinz and Hautzinger, 2007) The order of preference in flavour for the experimental beef hotdogs on day 9 of storage was as follows: T1≥T4≥T3>T2≥T5.

Considering taste, the least preferred were the experimental beef hotdogs extended with African yam bean flour (T2) and lima beans flour (T3) which on the hedonic scale ranges between "Just non-tasty to Slightly tasty" as adjudged by the panellists throughout the storage periods of 9 days. The least preferred in taste observed for both T2 and T3 were not significantly different from each other throughout the storage period. But taste in both T2 and T3 were significantly ($p<0.05$) less preferred to those of T1, T4 and T5 throughout the storage periods of days. The most preferred in taste was the non-extended beef hotdogs (T1) which on the hedonic scale ranges between "Intermediate to Very tasty" as adjudged by the panellists on days 0, 3 and 6, except for on day 9 of storage where T1 (4.90) and T5 (4.60) were not significantly different in taste preference (Table 4). The beef hotdog extended with pigeon pea (T4) was considered significantly ($p<0.05$) less preferred in taste to those non-extended (T1) and extended with soybeans flour (T5) while it was considered significantly ($p<0.05$) more preferred in taste than those extended with African yam bean flour (T2) and lima beans flour (T3) throughout the 9 days of storage periods. The order of preference in taste for the experimental beef hotdogs on day 9 of storage was as follows: T1≥T5>T4>T3≥T2.

Concerning juiciness, the most preferred was the experimental beef hotdogs extended with soya bean flour (T5) which on the hedonic scale ranges between “Intermediate to Very juicy” as adjudged by the panellist throughout the storage periods of 9 days. The most preferred in juiciness (T5) was significantly ($p<0.05$) preferred to those of the other samples (T1, T2, T3 and T5) throughout the storage periods of 9 days. The rating of ‘Very juicy’ observed for panellists for beef hotdogs extended using soybeans flour could be attributed to the oily nature of soya bean which was also observed to have the highest fat content among the legumes used in this study. These attributes of the soybeans have a direct relationship to meat juiciness which has two major mode of indicators viz: first is the perception of wetness produced by the release of fluid from the meat when the meat is chewed for few seconds, while the second is the more sustained juiciness that apparently results from the stimulating effect of fat on the production of saliva in the mouth (Iheagwara and Okonkwo 2016). In harmony with the second mode of indicators of juiciness in terms of the ‘stimulating effect of fat’; this could have contributed to the higher preference for juiciness reckoned in beef hotdogs extended with soybeans flour. The least preferred in juiciness were reckoned for non-extended beef hotdogs (T1) and beef hotdogs extended using African yam bean flour (T2) throughout the storage periods of 9 days. The order of preference in juiciness for the experimental beef hotdogs on day 9 of storage was as follows: T5>T4>T3>T2≥T1.

The texture of the experimental beef hotdogs was adjudged by the panellist with the most preferred been beef hotdogs extended with African yam bean (T2) which was adjudged as “Slightly fine to Moderately fine” on the hedonic scale. The most preferred in texture (T2) was reckoned has been significantly ($p>0.05$) preferred to those of the other samples (T1, T3, T4 and T5) on 0, 3, 6 and 9 days of storage (Table 4). The order of preference in texture of the beef hotdogs throughout the storage period of 9 days was as follows: T2>T5>T3≥T1>T4. The

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tenderness of the beef hotdogs was most preferred in beef hotdog extended with soybeans flour (T5) as adjudged by the panellists as "Slightly soft to Moderately soft" on the hedonic scale. The most preferred in tenderness (T5) was reckoned has been significantly (p>0.05) preferred to those of the other samples (T1, T3, T4 and T5) on 0, 3, 6 and 9 days of storage (Table 4). Conversely, the least preferred in tenderness was the beef hotdogs extended with African yam bean flour (T2) throughout the storage periods of 9 days. The order of preference in tenderness of the beef hotdogs on day 9 of storage was as follows: T5 (6.10) >T1 (4.00) = T3 (4.00) = T4 (4.00) > T2 (1.53).

Considering the overall acceptability of the experimental beef hotdogs the most preferred was the non-extended beef hotdogs as adjudged by the panellists as "Like slightly to Like Moderately" on the hedonic scale. The most preferred in overall acceptability (T1) was reckoned has been significantly (p>0.05) preferred to those of the other samples (T2, T3, T4 and T5) on 0, 3, 6 and 9 days of storage (Table 4). Conversely, the least preferred in the overall acceptability of the beef hotdogs was in beef hotdogs extended with Pigeon pea flour (T4) as adjudged by the panellists as "Dislike Extremely to Dislike Slightly" on the hedonic scale throughout the storage periods of 9 days. Notably, on day 9 of storage the order of preference for the overall acceptability in beef hotdogs was as follows: T1>T3>T5>T2>T4. The sensory evaluation (colour, taste, flavour, texture, tenderness, Juiciness and overall acceptability) analysis showed a similar trend on the 9-point hedonic scale in terms of preference value with increasing storage period the preference value tends from "*like moderately"* to less preference value of "*dislike slightly".* Similar to the findings of the present study, a decrease in the sensory scores of various meat products during refrigerated storage has been reported (Devatkal *et al.* 2004; Sudheer *et al.* 2011; Oshibanjo *et al.* 2019).

Table 6. Effect of cold storage on sensory quality attributes of beef hotdog extended using African yam bean, lima beans, Pigeon peas and soybeans flour.

	Quality attributes of samples				
	T1	**T2**	**T3**	**T4**	**T5**
Storage Days			**Colour**		

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0	5.50±0.50^{c}	5.27±1.00^{c}	4.60±1.60^{b}	4.00±1.92^{a}	5.92±0.04^{d}
3	4.60±1.02^{c}	4.50±0.85^{c}	3.60±1.05^{b}	2.40±1.92^{a}	5.40±0.05^{d}
6	4.60±0.95^{c}	3.50±1.15^{c}	3.10±1.25^{b}	2.30±1.93^{a}	5.00±1.01^{d}
9	3.90±1.02^{c}	3.30±1.11^{b}	2.10±1.45^{b}	1.40±1.84^{a}	4.80±0.95^{d}
			Flavour		
0	6.90±0.65^{c}	5.00±0.95^{b}	5.40±0.95^{b}	6.40±0.63^{c}	4.10±1.25^{a}
3	6.20±0.55^{c}	3.30±1.93^{a}	5.10±1.02^{b}	5.70±0.98^{bc}	3.20±1.91^{a}
6	4.18±1.72^{b}	3.80±1.63^{a}	3.90±1.65^{a}	4.00±1.35^{b}	3.58±1.95^{a}
9	3.80±1.03^{b}	3.00±1.02^{a}	3.50±1.02^{b}	3.70±0.95^{b}	2.80±1.45^{a}
			Taste		
0	7.70±045^{c}	4.09±0.87^{a}	4.17±0.95^{a}	4.70±0.75^{b}	5.30±0.65^{b}
3	6.40±0.35^{c}	2.30±1.65^{a}	2.50±1.34^{a}	4.30±1.03^{b}	4.90±0.98^{b}
6	5.70±0.22^{d}	2.00±1.89^{a}	2.20±1.45^{a}	3.60±0.95^{b}	4.80±0.58^{c}
9	4.90±1.01^{c}	1.90±1.48^{a}	2.20±1.34^{a}	3.20±1.01^{b}	4.60±1.01^{c}
			Juiciness		
0	4.60±0.97^{a}	5.09±0.73^{ab}	5.18±0.77^{b}	5.82±0.62^{c}	6.80±0.39^{d}
3	4.30±1.05^{a}	4.37±0.98^{a}	4.70±0.79^{b}	4.67±0.94^{b}	6.17±0.48^{c}
6	4.10±0.69^{a}	4.30±0.74^{a}	4.40±0.75^{a}	4.40±0.75^{a}	5.30±0.45^{b}
9	3.50±1.25^{a}	3.60±1.02^{a}	4.10±0.91^{ab}	4.20±1.01^{b}	5.27±0.95^{c}
			Texture		
0	4.70±1.20^{a}	6.60±0.74^{c}	5.00±0.86^{a}	4.60±1.15^{a}	5.90±0.96^{b}

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3	4.40±1.01^{b}	6.00±0.79^{d}	4.50±0.98^{b}	3.50±1.05^{a}	5.60±1.01^{c}
6	4.33±1.08^{b}	6.00±0.67^{d}	4.50±1.03^{b}	3.50±1.19^{a}	5.36±0.56^{c}
9	4.30±0.93^{b}	5.90±0.64^{d}	4.40±0.99^{b}	3.20±1.08^{a}	5.20±0.59^{c}
			Tenderness		
0	5.77±0.39^{c}	4.10±0.98^{a}	4.89±0.76^{b}	5.85±0.63^{c}	6.80±0.42^{d}
3	5.00±0.37^{b}	3.70±0.83^{a}	4.80±0.56^{b}	5.70±0.36^{c}	6.25±0.49^{d}
6	4.10±0.97^{b}	3.40±0.91^{a}	4.10±0.98^{b}	5.60±0.81^{c}	6.10±0.51^{c}
9	4.00±0.46^{b}	1.53±0.92^{a}	4.00±0.39^{b}	4.00±0.91^{b}	6.10±0.28^{c}
			Overall acceptability		
0	6.90±0.33^{c}	4.83±0.76^{b}	5.10±0.54^{b}	4.38±0.28^{a}	5.00±0.39^{b}
3	6.50±0.45^{d}	3.50±0.98^{b}	4.90±0.81^{c}	2.90±1.07^{a}	4.10±0.32^{bc}
6	6.00±0.77^{d}	2.50±0.89^{b}	4.40±0.92^{c}	2.00±1.09^{a}	3.70±0.95^{c}
9	5.80±0.35^{e}	2.00±1.03^{b}	4.30±0.69^{d}	1.40±1.92^{a}	3.00±0.69^{c}

Mean±standard deviation on the same row with same letters are not significantly different (p>0.05). T1: Beef hotdog without extender, T2: Beef hotdog extended with African yam bean flour, T3: Beef hotdog with Lima bean flour, T4: Beef hotdog extended with Pigeon pea flour, T5 Beef hotdog extended with Soya bean flour.

Conclusions

The physicochemical properties of the beef hotdogs in terms of water holding capacity and pH were more desirable in the beef hotdogs extended using the legumes flours than in the non-extended beef hotdogs. Also, the most desirable for physical properties among the extenders used in the experimental beef hotdogs is the soybeans flour which had the highest water holding capacity and pH throughout the 9 days cold (2ºC) storage. The extenders used in the experimental beef hot dogs improved sensory properties especially the juiciness which was more desirable among the beef hotdogs extended than the non-extended beef hotdogs. On day-9 the overall-acceptability varied significantly ($p<0.5$); with T1(5.80) > T3 (4.30) > T5 (3.00) > T2 (2.00) > T4 (1.40). Physicochemical properties were most desirable with soybeans flour while lima beans flour was most preferred among the extenders for sensory overall-acceptability.

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References

1. Agume A.S.N., Njintang N. Y. and Mbofung M. F. (2017) Effect of soaking and roasting on the physicochemical and pasting properties of soybean flour. Food 6, 12; doi: 10.3390/foods6020012.
2. Apata, E. S., Koleoso, I. M., Tijani, L. A., Obi, O. O. and Okere, I. A. (2015) Effect of sex on meat quality attributes of pigeon birds (*Columbia livia*) in Abeokuta metropolis. International Journal of Agricultural Sciences and Natural Resources, 2 (2), 19-23.
3. Asgar M. A., Fazilah A., Huda N., Bhat R. and Karim A. A. (2010) Nonmeat protein alternatives as meat extenders and meat analogs. Comprehensive reviews in food science and food safety, 9, 513 – 529.
4. Chowdhury, B.R., Mukherjee, R.S., Chakraborty, R., Chaudhuri U.R. (2006) Effect of combination pre-treatment on physicochemical, sensory and microbial characteristics of fresh aerobically stored minced goat (Black Bengal) meat organs. African Journal of Biotechnology, 5 (12), 5292 – 5305.
5. Devatkal, S.K., Mendiratta, S.K. and Kondaiah, N. (2004) Quality characteristics of loaves from buffalo meat, liver and vegetables. Meat Science, 67, 377-383.
6. El-Nashi, H. B, Fattah, A.F.A.K, Rahman, N.R.A. and El-Razik M. M. A. (2015) Quality characteristics of beef sausage containing pomegranate peels during refrigerated storage. Annals of Agricultural Science, 60 (2), 403 - 412.

7. Gulzar M. and Minnaar A. (2017) Underutilized protein resources from African legumes. *Sustainable Protein Sources*, pp. 197 – 208.
8. Heinz, G. and Hautzinger, P. (2007) Non-meat ingredients: In Meat processing technology for small-to medium scale producers, pp. 59 – 81.
9. Iheagwara, M. C. and Okonkwo, T. M. (2016) Influence of Storage Duration on Stability and Sensorial Quality of Dried Beef Product (Kilishi). Journal of Food Processing and Technology, 7 (4), 2157-7110.
10. Ikrang E. G., Okoko J. U., Akwa M. M. (2020) Effects of temperature and steeping time on the proximate compositions and selected physical properties of soybean flour. Nigerian Journal of technological development, 17 (1), 40 – 46.
11. Larmond, E. (1977) Laboratory methods for sensory evaluation of food. Research Branch, Canada Dept. of Agriculture.
12. Malav, O.P., Sharma, B.D., Talukder, S., Kumar, R. R. and Mendiratta, S.K. (2013) Shelf life evaluation of restructured chicken meat blocks extended with sorghum flour and potato refrigerated storage (4±1◦C). International Food Research Journal, 20 (1), 105-110.
13. Ofosu, I. W., Ellis, W. O., Nsiah k., Oduro, I. N. (2017) Neglected and underutilized legumes (NULs): Exposure assessment, habitual cooking and eating habits consumers' characteristics, Journal of food security, 5 (5), 169 – 175.
14. Omojola, A. B. and Adediran, A. O. (2015) Effects of ethanolic extract of garlic, roselle and ginger on quality attributes of chicken patties. African Journal of Biotechnology, 14 (8), 688-694.
15. Oshibanjo, O. D., Olusola, O. and Adepoju, G. (2019) Quality Assessment of Suya (Tsire) as affected by Moringa Olifera. International Journal of Meat Science, 9, 1-6.
16. Ruban, W., Rao, V.A., and kalakrishan, A. (2008) Effect of tapioca starch and potato flour on physico-chemical, sensory and microbiological characteristics of pork sausages during refrigerated storage (4±1˚C). Global Veterinaria, 5, 219-24.
17. Sudheer, K., Mandal, P.K., Das, C., Pal, U.K., Santhoshkumar, H.T. and Rao, V.K. (2011) Development of restructured chicken blocks utilising gizzard. Journal of Food Science and Technology, 48 (1), 96-101.

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18. Tatiana P. and Gonzalo D-P. (2020) Towards more sustainable meat products: extenders as a way of reducing meat content. Foods, 9, 1044; doi:10.3390/foods9081044.
19. Van Laack R.L.J.M. (1999) The role of proteins in water-holding capacity of meat, In: Y. Xiong, C. Ho and F. Shahidi, (eds.): Quality attributes of muscle foods, pp. 309-318 Springer, New York.