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Development and Quality Evaluation of Danbunama (Meat Floss) - a Nigerian Shredded Meat Product

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Authors' contributions

This work was carried out in collaboration between all authors. Author ABO designed the study. Author ORK carried out the field work, performed the statistical analysis. Author ABO wrote the protocol and wrote the first draft of the manuscript and managed literature searches. Authors OOO, POA, JOA managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Danbunama (DB) is a shredded meat product that is light, easy to pack and nutrient retaining and is traditionally produced from beef. A completely randomized design was employed to study the effect of three meat types of beef, chevon and pork on quality attributes of DB. Proximate composition of the raw meats and their respective DB was determined using standard procedures. The Eating Quality (EQ) was determined using a 9-point hedonic scale. Thiobarbituric Acid Reactive Substances (TBARS) was employed to assess shelf stability of the product. Raw meat protein ranged from 21.2 to 22.9% while the moisture content varied from 64.14 to 71.98%. The product yields were 70.1, 74.1 and 68.9% for Beef *Danbunama* (BDB), Chevon *Danbunama* (CDB) and Pork *Danbunama* (PDB) respectively. Chevon *Danbunama* has the highest protein (46.73%) followed by PDB (41.78%) while BDB has the least value (39.75%). The overall acceptability for BDB (7.4) was higher ($P<0.05$) than for CDB (6.6) and PDB (6.2). Pork *Danbunama* had the least TBARS compared to BDB and CDB irrespective of the length

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of storage. *Danbunama* can be produced using any of the meat types without compromising yield and its nutritional value.

Keywords: Danbunama; nutritional quality; meat types; quality evaluation; shredded meat.

1. INTRODUCTION

Product development and innovation are necessary to offset the growth in the availability of food products competing for disposable income and the red meat industry is in a mature stage, where product development and innovation is necessary to bring about significant growth [1]. Meat floss belongs to the group of intermediate moisture meat products that have less than 20% moisture. *Danbunama* (Meat Floss), is an intermediate moisture meat product processed by cooking, pounding and pan frying with addition of spice [2]. It is peculiar to the Northern part of Nigeria where it is processed principally from the thigh muscle (semi-tendinosus) of cattle (beef). This meat product is commonly consumed by the elites in northern Nigeria. The product was developed as a means of preserving cooked meat in the absence of facilities for refrigeration storage.

Danbunama (meat floss) is a meat product that has good nutritive value and relative shelf stability at room temperature. It is consumed singly as snack or in combination with other food as part of daily diet for the general populace. The product is light weighted, easy–to –pack and ready to eat [3] and therefore, gives convenience to travelers and campers to travel with. *Danbunama* has its ally in other cultures: the meat floss made from lean pork meat called Machana in Mexico, a combination of cured meat and floss snacks called "Niu Rou Kang" is a product of Shanghai China. Travelers to these countries have access to these meat products and several other meat snacks in their general markets, super markets and stores [4].

The ability of the product to keep for several days at room temperature is fast making the product a household name. However, with increasing awareness and consumption of *Danbunama*, coupled with the high price of the product as a result of the high price of beef especially the choice part (the thigh muscle), it therefore, become necessary to produce DB from other meat types. This study was therefore designed to evaluate and compare the nutritive, eating and keeping quality of DB prepared from different meat types.

2. MATERIALS AND METHODS

2.1 Sample Collection

The meats used for this study were the thigh muscles (semi-tendinosus) of bull, goat and pig (with average age of 36, 18 and 12 months respectively) which were purchased from a commercial abattoir. The meat samples were excised from the carcass of singed animals within 1h Post Mortem (PM) and transferred in ice pack container to the laboratory for product development.

2.2 Meat Preparation and Experimental Design

The meats were trimmed off of all visible dirt's, fats, connective tissues and ligaments and washed with cool clean water. They were cut into chunks of average weight of 50 g each. A total of one hundred and twenty (120) chunks were randomly selected per meat type to give six (6) kg of fresh meat for respective meat type. These chunks of meat were randomly distributed into the three treatments in a completely randomized design. Each treatment was replicated five times.

2.3 Preparation of Spice Mixtures

Two spice mixtures (cooking recipe and shredding recipe) were formulated as shown in Tables 1 and 2. The ingredients used for the formulations were purchased from a local spice market within the study area. Each spice was dried and ground separately using a table top grinder (Model BLSTMG. PN133093-002) and the coarse particles removed using a sieve of 1.0 mm mesh diameter. The cooking and shredding recipes were separately stored in airtight plastic container for subsequent use.

Table 1. Composition of cooking recipe used for meat floss production (g/100g)

Ingredients /seasoning	Scientific/Botanical names	Quantity
Salt	Sodium Chloride	10.00
Maggi (Knorrs®)	Maggi	15.00
Thyme	*Thymus vulgaris* L.	12.50
Curry	*Murraya koenigii* (L.) Spreng.	12.50
Onions	*Allium cepa* L. var. *cepa*	50.00
Total		100.00

Table 2. Composition of shredding recipe used for meat floss production (g/100g)

Ingredients	Scientific/*Botanical names	Quantity
Red Pepper	*Piper nigrum* L.	35.00
Maggi (Knorr®)	Maggi	30.00
African Nut Meg	*Monodora myristica* (Gaertn.) Dunal	2.50
Ginger	*Zingiber officinale* Rosc.	4.00
Garlic	*Allium sativum* L.	3.00
Cloves	*Syzygium aromaticum* (L.) Merr. et L.M. Perry	2.50
Curry powder	*Murraya koenigii* L.	3.50
Thyme leaves	*Thymus vulgaris* L.	2.50
Salt	Sodium Chloride	5.00
Onions	*Allium cepa* L. var. *cepa*	12.00
Total		100.00

** Botanical names according to Rehm and Espig (1991)*

2.4 Cooking

Each meat type was cooked on an adjustable Pifco Japan Electric Hot Plate (Model Number ECP 2002). The cooking recipe was added in the ratio of 1 g of spice to 100 g of meat. Four (4) medium-sized (500 g) onions (approximately 50 g of onions on Dry Matter (DM) basis) were thinly sliced and added. Water was added at the ratio of 1.5 liters to 1.0 kg of meat. The meat samples were cooked to an internal temperature of 72ºC and the broth was allowed to dry with the meat. The meat samples were removed and allowed to equilibrate to room temperature and weighed.

2.5 Shredding

The cooked meat samples were shredded separately by pounding with a local mortar and pestle. The shredding recipe was added in the ratio of 1:20 (50g of spice to 1000g of meat) while 120g onion on DM basis was added to every 100g of spice used. These were weighed and added a little at a time as pounding progressed for uniform mixing of the recipe. The pounding was intense and consistent until the meat strands disengaged and were beaten to shreds.

2.6 Frying

The shredded meat from each meat type was separately deep fried in Soy bean oil (Grand®) which was pre-heated to 180ºC. The ratio of oil to meat was 1 liter to 500g of meat. The meat samples were fried at 70 strokes per minute until a golden brown colour was obtained (about 20 minutes).

2.7 Draining of Oil

The products were poured into a colander after frying and pressure applied to remove excess oil and prevent the final product from sticking together. The dry spongy product from each meat type was poured into separately marked flat containers, allowed to cool and separate into strands.

2.8 Meat Quality

2.8.1 Cooking loss

Cooking loss was measured by weighing approximately 10 g meat samples, wrapped loosely in polyethylene bags and cooked in pre-heated water until the geometric centre of meat samples reached 72ºC using an adjustable Pifco Japan electric hot plate (Model No. ECP2002). Meat samples were removed and allowed to equilibrate to room temperature (28ºC). Meat samples were reweighed and cooking loss calculated as:

$$\text{Cooking loss \%} = \frac{\text{Initial weight of meat} - \text{weight of cooked meat}}{\text{Initial weight of meat}} \times 100$$

2.8.2 Water holding capacity (WHC)

The WHC of meat samples was determined by the press method as slightly modified by [5]. An approximately 1g of meat sample was placed between two (9 cm Whatman No1) filter papers (Model C, Caver Inc, Wabash, USA). The meat sample was then pressed between two 10.2 X 10.2 cm^2 Plexi glasses at about 35.2 kg/cm^3 absolute pressure for 1 minute using a vice. The meat samples were removed and oven dried at 80^oC for 24 hours to determine the moisture content. The amount of water released from the meat samples was measured indirectly by measuring the area of filter paper wetted relative to the area of pressed meat samples. Thus, the water holding capacity was calculated as follows:

$$WHC = 100 - \frac{\{(Aw - Am \times 9.47)\}}{Wm - Mo}$$

Where: Aw = Area of water released from meat samples (cm^2)
Am = Area of meat samples (cm^2)
Wm = Weight of meat samples (g)
Mo = Moisture content of meat samples (%)
9.47 = a constant factor

2.9 Evaluation of Meat Floss

2.9.1 Product yield

The product yield of meat floss was calculated using the method described by [6].

$$\text{Product Yield (\%)} = \frac{\text{Weight of meat floss}}{\text{Weight of raw meat sample}} \times 100$$

2.9.2 Sensory evaluation

Sensory evaluation was carried out using a nine point hedonic scale from 1 (dislike extremely) to 9 (like extremely). Sample preparation was done using the method described by [7]. A total of twenty panelists comprising of 60% male and 40% female, from different background and age that are used to sensory evaluation participated in the study.

The meat floss from different meat types were presented sequentially to the panelists on a clean saucer. Meat floss from each treatment was evaluated independent of the other. The panelists were provided with unsalted cracker biscuits and water for use in-between treatment meat samples. Each panelist was presented the blind coded samples and asked to score each sample for flavour, tenderness, juiciness, aroma, colour, roppiness and overall acceptability.

2.9.3 Proximate analysis

Proximate analyses was carried out on the raw meat samples and freshly prepared meat floss according to the method described by [8].

2.9.4 Thiobarbituric acid reactive substances (TBARS)

Meat floss from different meat types were store in airtight acrylic bottles at 4^oC and the TBARS were determined on days 7, 14 and 21 of storage. Thiobarbituric acid test was determined through the extraction methods process described by [9,10].

2.9.5 Statistical analysis

Data obtained for TBRAS were subjected to two way statistical analysis while a one way analysis was employed for other data. All data were analyzed using [11] package while means were separated with Duncan Multiple Range Test. Statistical significance was set at P=0.05.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Raw Meat Types

The crude protein contents of the meat types that ranged between 21.23 and 22.89 % were not significantly (P>0.05) different from each other (Table 3) while the ether extract content of the meat ranged between 1.64% and 3.37% with chevon having the least values and pork the highest. It was noticed that chevon had the highest ash content compared to either beef or pork and this was in consonance with the report of [12] that goat meat are rich in minerals especially potassium compared to either beef or pork. The high nutritional properties obtained for Chevon in this study (Table 3) corroborates the reports of [13] that Chevon is higher in nutritional quality than mutton or beef. Gadivaram and Kannan [14] reported that chevon is a good source of red meat for the production of further-processed foods because of its superior water-holding capacity and nutritional properties. The variation noticed in the chemical compositions of the meat types could be influenced by different factors such as species, breed, age and nutrition [15].

Table 3. Physico-chemical properties of raw meat used in meat floss production

Parameters (%)	Meat type		
	Beef	**Chevon**	**Pork**
Moisture content	71.98±0.54^{a}	66.70±0.32^{ab}	64.16±0.32^{b}
Crude protein	22.89±1.10	21.23±0.85	22.66±0.72
Ash	1.52±0.02^{a}	1.60±0.12^{a}	1.14±0.02^{b}
Ether extract	1.81±0.12^{b}	1.64±0.01^{b}	3.37±0.06^{a}
Cooking loss	38.78±0.75	38.79±1.69	39.73±0.43
Water holding capacity	67.70±0.76^{b}	69.44±0.46^{a}	62.82±0.44^{c}

^{a,b,c} *Means in the same row with different superscripts are significantly different (P<0.05)*

3.2 Physical Properties of Raw Meat Types

Cooking loss is a combination of liquid and soluble matter which is lost from the meat during cooking. Loss of water from meat is due to the effect of heat, which induced protein denaturation during cooking and causes less water to be entrapped within the protein structures which are held by capillary forces. Author [16], concluded that water loss is of economic concern because it affects weight loss along the distribution chain and during cooking. While [17], reported that raw meat quality influenced the cooking loss at a certain temperature. Cooking loss is of interest to the meat processor because it is expected to explain in part the variations in juiciness, which also influences the appearance of the meat after processing. The cooking loss of the different meat used in this study were similar (P>0.05) to each other (Table 3). Chevon was observed to have a higher ability to retain its intrinsic water during cooking which corroborates the report of [18] that goat meat and mutton have higher water holding capacity in both pre and post rigor states than beef. It should be noted that meat with higher water holding capacity is more desired because it will result in a higher product yield. Chevon gave the highest (P<0.05) water holding capacity (69.44%) followed by beef (67.70%) while pork gave the least (62.82%).

3.3 Product Yield

The result (Table 4) showed that the PY of CDB (74.05 g/100g) was significantly higher ($P<0.05$) than that of BDB (70.07 g/100g) and PDB (68.88 g/100g). This might be due to the fact that chevon has the highest water holding capacity and meat with high water holding capacity is expected to have a high yield because it implies that the meat will releases less of its water upon cooking with resultant less cooking loss. Also, the volume of oil adsorbed during frying could possibly contribute to the trend observed in the product yield.

Table 4. Product yield and volume of oil absorbed by different meat types during meat floss production

Parameters	Meat type		
	Beef	**Chevon**	**Pork**
Yield (g/100g)	70.07 ± 0.80^{b}	74.05 ± 1.33^{a}	68.88 ± 5.48^{b}
Oil absorbed (%)	17.75 ± 3.89^{b}	22.75 ± 3.88^{a}	15.44 ± 0.62^{b}

^{a,b,c} *Means in the same row with different superscripts are significantly different (P<0.05)*

3.4 Proximate Composition of *Danbunama*

There was noticeable increase in the nutrient profile of the DB over their raw meat counterparts (Table 5). The CP increased by 74%, 120%, 84% and the ash content by18%, 94%, 135% while the ether extract increased by 72%, 34%, 17% for BDB, CDB and PDB over their respective raw meat. These indicated that DB is a nutrient dense product. The crude protein, ash and ether extract contents of the products were probably a reflection of what was in their corresponding raw meat. Significant difference existed among the CP of the products and this followed the report of [14] when beef, chevon and pork were used to make sausages. The fat content of meat floss in this study followed the trend observed in the sausages made with these three types of meat. This might be due to the fact that pork initially had a higher fat content than beef and during the process of frying, substance with initial high fat absorbs less fat from the frying medium and vice versa [19].

Table 5. Proximate composition of meat floss prepared from different meat types

Parameters	Meat type		
	Beef	**Chevon**	**Pork**
Moisture content (%)	17.69±0.68b	19.29±0.60a	19.59±1.01a
Crude protein (%)	39.75±0.38c	46.73±0.51a	41.78±0.48b
Ash (%)	1.79±0.08b	3.11±0.17a	2.68±0.34a
Ether extract (%)	3.12±0.18b	2.30±0.34c	3.95±0.15a

^{a,b,c} *Means in the same row with different superscripts are significantly different (P<0.05)*

The decrease in the moisture content and increase in the total fat content of the products (Table 5) agreed with the results of [19] who found that losses in the moisture content resulted in higher dry matter and increased content of total lipid and other components in cooked meat samples. The moisture content (17.69-19.59%) of the different DB obtained in this study is above the range value of 8.60-13.56% obtained for different Serunding (shredded meat) produced in Malaysia (Huda et al. [21]) but fell within the range values of intermediate moisture products [2]. The fat content of the products obtained in this study fell within the range of 3.20-31.14% obtained by [21] for different shredded meat.

3.5 Sensory Attributes

The most important contributing sensory attributes to eating quality are tenderness, flavour and juiciness [22]. Tenderness is defined as the ease of mastication, which involves initial penetration by the teeth, the breakdown of meat into fragments and the amount of residue remaining after chewing [15]. It is an integrated textural property composed of mechanical and chemical components. The mechanical characteristics include hardness, cohesiveness, elasticity, grittiness and fibrousness while the chemical characteristics include juiciness and oiliness [23]. Tenderness has also been shown to depend positively upon intramuscular fat [24]. Juiciness is an important factor in sensory evaluation as it facilitates the chewing process as well as brings the flavour component in contact with the taste buds [25]. It depends on the raw meat quality and the cooking procedure [25]. The two sensory descriptive words for juiciness, in cooked meat, are initial and sustained juiciness [26]. Initial juiciness is the amount of fluid released by the cut surface of meat, during compression between the forefingers and thumbs [27] and is positively correlated with the water holding capacity of meat [28]. Sustained juiciness is described as the perceived juiciness after a few seconds of mastication, due to the presence of intramuscular fat stimulating saliva secretion [15].

It would have been expected that the flavour and tenderness of BDB should be preferred to CDB because Chevon is considered to be lower in palatability than beef, pork, or lamb [29], but from the results obtained CDB and PDB were preferred by the panelists (Table 6). The preferred flavour of CDB could be as a result of the large volume of oil absorbed (the oil is rich in polyunsaturated fatty acid) compared to BDB.

Table 6. Sensory evaluation of meat floss prepared from different meat types

Organoleptic properties	Meat type		
	Beef	Chevon	Pork
Aroma	3.55±1.59^{b}	3.56±1.81^{b}	4.22±1.48^{a}
Flavor	5.11±1.69^{b}	6.00±1.23^{a}	6.33±1.13^{a}
Tenderness	6.89±1.73^{b}	6.44±2.22^{b}	7.22±1.85^{a}
Juiciness	5.56±1.95^{b}	6.22±1.64^{ab}	7.33±0.87^{a}
Texture	5.56±1.51^{b}	5.33±2.18^{b}	6.89±1.69^{a}
Roppiness	5.22±1.51	5.00±2.18	5.50±1.69
Overall Acceptability	7.44±0.88^{a}	6.56±1.13^{b}	6.22±1.72^{b}

^{a,b,c} *Means in the same row with different superscripts are significantly different (P<0.05)*

The aroma of the products was scored low probably due to the presence of garlic that has a characteristic pungent odour due to the presence of vanilloids, especially 6-gingerol [30]. The low aroma score for CDB agreed with the report of [12] that goat meat has a less desirable flavour, aroma, tenderness and juiciness than beef. However, the high overall acceptability score for BDB was not consistent with the result obtained for other attributes that were measured. The probable reason for the trend observed could be due to the fact that the consumers were accustomed to beef *Danbunama* since it was a popular product within the study area.

3.6 Keeping Quality of DB

It has been reported that lipid oxidation in meat products can be controlled or minimized by using either synthetic or natural food additives [31]. Furthermore, many studies had reported that phenol compounds in spices and herbs significantly contribute to their antioxidant and pharmaceutical properties [32,33]. The TBARS values have been commonly considered as an index of lipid rancidity. The TBARS value in this study increased as the day of storage lengthened probably due to the decomposition of oxidized lipids as postulated by [34,35]. The study revealed CDB had the highest TBARS (Table 7), which implied that rate of lipid oxidation in CDB is probably higher than either BDB or PDB. This might be due to the fact that oil absorption was highest in CDB during preparation. Also, chevon has a high proportion of unsaturated fatty acids in addition to being a source of conjugated linoleic acid [36]. Several intrinsic and extrinsic factors, including the content and composition of unsaturated fatty acid, the concentration and activity of antioxidant substances in meat muscle as factors that can affect its oxidative stability [37]. Mielnik et al. [38] asserted that meat with high polyunsaturated and a high degree of linoleic fatty acids have accelerated oxidative processes. This support the report of [39] that the baseline lipid oxidation status of raw meat was a very important determinant of the progression of lipid oxidation in cooked meat.

Table 7. TBARS (mg/100g) of meat floss from different meat types stored at room temperature {values are means ± SD (N = 5)}

Meat type	Storage time (Days)		
	7	**14**	**21**
Beef	1.74±0.22^{by}	1.87±0.03^{by}	1.92±0.03^{ay}
Chevon	1.89±0.01^{bx}	2.27±0.02^{ax}	2.33±0.08^{ax}
Pork	1.23±0.03^{bz}	1.44±0.01^{az}	1.48±0.02^{az}

a, b, c Means in the same row with different superscripts are significantly different (P<0.05)
x, y, z Means in the same column with different superscripts are significantly different (P<0.05)

The high TBARS value of CDB probably indicated a shorter shelf life than BDB or PDB (Table 7). This corroborates the report of [40,41] that the shelf life of chevon products may be shorter than beef products due to higher lipid oxidation rate. Pork *Danbunama* had the least TBARS value in this study probably because pork is rich in monounsaturated fatty acid as compared to fats in ruminants [42]. The monounsaturated fats contain lesser sites for oxidation furthermore, pork possess high saturated fat that is stable and less reactive. On the contrary, the fats in beef are high in unsaturated fatty acids which are more susceptible to oxidation. The phospholipids found in beef is higher than that of pork and reports had shown that phospholipids are considered to be responsible for about 90% of lipid oxidation [43,44].

4. CONCLUSION

Danbunama contained about twice the protein in their respective raw meat therefore, the product is nutritionally dense and light weighted, easy to carry and is stable at room temperature. Chevon gave the highest yield of *Danbunama* with the resulting product having the highest protein and the least fat content. Tenderness, texture and juiciness scores were highest in PDB and the product has the least TBARS values irrespective of the length of storage. *Danbunama* can be produced using any of the three meat types without compromising yield and nutritional value**.** This product could make a great contribution to food supply in West Africa sub region especially to mitigate the problem of animal protein intake.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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