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NUTRITIONAL PROPERTIES AND MICROBIOLOGICAL LOADS OF MEAT FLOSS PREPARED FROM MUTTON OF FOUR BREEDS OF RAMS

[1]Sule Bamidele, Akinleye, [1]Kolawole Daniel, Afolabi, [1]James S., Luka, [2]Nureni Niran, Ayanniyi and [2]Saheed Abimbade, Adeyemi

[1]Meat Science Laboratory, Department of Animal Science, University of Ibadan, Ibadan, Nigeria; Department of Animal Science, University of Uyo; [2]National Cereals Research Institute, Badeggi, Niger State,Nigeria; [2]Department of Animal Science, Faculty of Agriculture, Al-Hikmah University, Ilorin, Kwara State, Nigeria
Corresponding Author E-mail Address: bamideleakinleye@yahoo.com
Telephone Number: +234-080-8073-5893

ABSTRACT: *Mutton plays a useful role in providing nutrients to the general population, with a potential for demand. This study tried to appraise the eating quality of meat floss (MF) from mutton as affected by breeds of rams. Forty-eight Semitendinosus muscles were harvested from the carcasses of West Africa Dwarf, Yankasa, Ouda and Balami for the preparation of Meat Floss (MF) in a completely randomized design. The samples were examined for the physical, proximate composition and sensory properties of meat floss to ascertain the quality and safety of the product. The result obtained showed that MF from the breeds were significantly different in crude protein with a value ranging from 46.75 to 49.60% while the ether extract (27.35%) and cholesterol (29.00mg/100g) were highest in BMF. The water holding capacity (71.76%) and product yield (74.44%) were highest in BMF.. Meat floss from Yankasa (YMF) contained lowest percentage of lipid (25.46%), while BMF contained a high percentage of lipids (27.35%). Meat floss from Ouda (UMF) appeared to have highest contents of ash (7.96%), while the lowest contents was in WMF (7.28%).The TAC on the MF ranged from 1.37 x10^2 - 6.76 x10^2 cfu/g while TCC and TFC ranged between 1.18 x10^2 – 3.58 x10^2 cfu/g and 1.20 x 10^2 - 6.18 x 10^2 cfu/g for WMF, BMF and WMF, respectively. Based on the above proximate, sensorial and microbiological parameters and due to its high product yield value, Semitendinosus muscle from Balami breed may be an ideal choice for meat floss production.*

KEYWORDS: product yield; water holding capacity; thio-barbituric acid reactive substances; biological value; semitendinosus; organoleptic properties

INTRODUCTION

Meat is the most valuable product of livestock for many people and serves as their first-choice of animal protein. Meat is either consumed as a component of food preparations or as processed meat products. Most processed meat products are conventionally prepared from beef, pork, or a combination of both. Mutton is a decent protein source and low-fat content than beef and a reduced risk of contamination. Meat floss is a meat-based product in different

and diverse cultures of the world (Savadkoohi *et al*., 2014). With changes in lifestyle, people are no longer satisfied with the traditional foods but in search of food which is not only fulfilling their nutritional requirements but simultaneously is easy to prepare. Meat floss is a good source of high biological value nutrients. Processors may need to take a new mark area and develop new products to combat the decrease in mutton consumption. Mutton has the potential of becoming value-added convenience products of good palatability. Trends toward healthier diets could increase the demand for value-added products from traditional meat sources, to supply products with decreased fat and lower cholesterol (Dawkins *et al*., 1999). The capacity to preserve meat products is directly related to the processing and preservation of meat involves meat to prolong its shelf-life and improve its acceptability (Eyas-Ahmed *et al*., 2006). All handling, processing, and storage methods are therefore primarily concerned with minimizing microbial contamination, retarding microbial growth, and activity. This study was designed to investigate the use of mutton from different breeds of rams in processing acceptable meat floss. The cooking losses, proximate composition, sensory attributes, and microbiological quality of the meat floss made from mutton of different breeds of rams were also studied.

MATERIALS AND METHODS

Location, animals and diets

The experiment was conducted in the Teaching and and Research Farm, University of Ibadan Forty-eight rams (12 to 14 months) comprising of Balami, Ouda, Yanks and West African Dwarf breeds with an initial body weight of 17.00±1.87 to 19.38±0.85. The rams were distributed into four treatment groups based on breed and each treatment was replicated twelve times in a completely randomized block design. The rams were ear tagged and each kept in a separate pen equipped with watering and feeding facilities throughout the ninety days feeding trials. The feeding experiment lasted 90 days and was preceded by an adaptation period of 15 days wherein the animals were treated for internal and external parasites (Ranger LA, IvermectinV R 3.5% w/v, 1mL for 50kg of body weight, Salvador, Brazil). The experimental animals were weighed at the end of the fattening. The diets were composed by 60% of a concentrated feed, constituted by Dusa, BDG, cassava peel meal, wheat offal, palm kernel meal, dicalcium phosphate, sodium chloride and premix and hay (*Panicum maximum*) constituted 40% of the diet. The diets were formulated according to the guidelines from the National Research Council (NRC 2007).

Sources of Meat

Semitendinosus muscles were harvested from the skinned carcasses of four breeds of rams (Balami, Ouda, Yankasa, and West African Dwarf) intensively fattened for ninety days and exsanguinated at the slaughterhouse of the Department of Animal Science were used for the study.

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Non-meat Ingredients

Seasoning mixes on the desired finished product characteristics (common salt, thyme, curry, red pepper, African Nut Meg, cloves, thyme leaves, onion, ginger, garlic, Monosodium glutamate, and sweet pepper) were purchased from Bodija Market, Ibadan, Nigeria. The cooking recipe presented in table 1 was prepared by adopting the recommendations of Omojola *et al*. (2014).

Table1: Composition of the cooking and shredding recipe used for meat floss production (g/100g)

Ingredient	Scientific Names	Quantity (g/100g)
Common Salt	Sodium Chloride	10.00
Maggi	Monosodium glutamate	15.00
Thyme	*Thymus vulgaris*	12.50
Curry	*Murraya koenigii* L.	12.50
Onions	*Allium cepa*	50.00
Total		100.00
	Shredding recipe	
Red Pepper	*Piper nigrum*	35.00
Maggi	Monosodium glutamate	30.00
African Nut Meg	*Monodora myristica*	2.50
Ginger	*Zingiber officinale*	4.00
Garlic	*Allium sativum L.*	3.00
Cloves	*Syzygium aromaticum*	2.50
Curry Powder	*Murraya koenigii L.*	3.50
Thyme Leaves	*Thymus vulgaris*	2.50
Salt	Sodium Chloride	5.00
Onions	*Allium cepa*	12.00
Total		100.00

Production Process

Size Reduction

Three kilograms of *semitendinosus* muscles from each (carcass) were trimmed of blood vessels, any surface dirt and visible fat and sliced to chunks of an average weight of 150g, and rinsed in flowing water .

Thermal Processing:

The slices were mixed thoroughly with the spices before thermal processing through a mechanical method at 8^{o}C for twenty minutes in a stainless steel pot.The cooking was done at an internal temperature between 80^{o}C and 90^{o}C for 60 minutes. After thermal processing, the meat samples were removed, allowed to cool to room temperature (18^{o}C). The cooked meat was pounded with improvised local device (mortar and pestle) and shredding recipe was added in the ratio of 50g of spice to 1000 g of meat while 120g onion on dry matter basis was

added to every 100g spice used. After pounding, the matrixes were separated manually. The separated matrix was allowed to cool at ambient temperature for 20 minutes and then fried until a golden-brown colour was obtained. The fried sample was then dried for the second time for 4-5 hours at 60°C to a moisture content of 5-10%. The product obtained was cooled and packaged in airtight containers (plastic) for subsequent analysis. The composition of shredding recipe used for meat floss production was based on the recommendation of Omojola *et al*. (2014) as shown in table 1

Cooking Properties

Cooking loss

Cooking loss was determined in *Semitendinosus* samples in triplicate. Samples were weighed, placed in plastic bags and cooked in boiling water (82-85ºC) for 20min, and then allowed to cool (23ºC) on absorbent paper at room temperature. Samples were subsequently weighed, and the difference between initial weight and final weight corresponded to cooking loss (Honikel, 1987). Yield analysis was determined by dividing the cooked weight by sliced weight Kumar and Sharma (2004).

Water holding capacity (WHC)

WHC was evaluated using the method of Hamm (1960), based on meat water loss when pressure is applied on the muscle. WHC was determined by the press method described by Tsai and Ockerman (1981). Samples of each muscle from each breed were used. Approximately 1g of sample was weighed onto a 9cm Whatman No 1 filter paper (Model C, Carver, Inc, Wabash, IN, USA) and pressed between two 10.2X 10.2 cm Plexi glasses at approximately one minute. The area of free water was measured using a compensatory plani-meter (Plannix 5000, Tamaya Technics, Inc, Tokyo, Japan) and percent free water was estimated based on sample weight and moisture content with a modified Grau and Hamm technique (1953).

Thermal Shortening

This was carried out according to the procedure described by Mahendraker *et al*. (1988). Cores of 0.5 cm in diameter were taken from each muscle. The length was measured prior to broiling for 20 min, after broiling, the broiled meat was allowed to cool to room temperature and the length measured again. The difference in the length was expressed as percentage of thermal shortening.

Chilling Loss

The muscle samples were chilled at 20ºC for 24 hours immediately after cutting. The chilling loss was determined as the difference between the warm weight and the chilled weight.

Proximate Composition

The moisture content, crude protein, ether extract, crude fibre, and ash content were determined using AOAC (2005) method while the carbohydrates were calculated using

equation 1 according to reference. Lipid oxidation during the storage of the meat product was measured by determination of the thiobarbituric acid reactive substances (TBARS) according to the method of Mercier *et al*. (1998). TBARS was expressed in mg-malonaldehyde per kg (MDA/kg meat). Triplicate meat floss samples were analyzed in duplicate for each treatment.

Sensory evaluation

The organoleptic quality assessment of the four samples was evaluated using a 9-point hedonic scale. A thirty semi-trained panellists were used and a bottle of table water was made available to the assessors to rinse the mouth after each taste. The evaluation was based on colour, aroma, texture, tenderness, juiciness, hottiness and general acceptability according to according to guidelines of American Meat Science Association (1995).

Microbiological evaluation

Twenty grams each of the breed samples was removed from MF at room temperature and their microbial load was analyzed using Nutrient Agar, MacConkey agar and Potato Dextrose Agar to determine Total Aerobic Count (TAC), Total Coliform Counts and Total Fungal Count, respectively. All analyses were done following the procedures described by ICMSF (1986) and AOAC, (2000). Isolates were identified by cultural and morphological characteristics as well as biochemical tests in accordance with the methods of (Cheesbrough, 2004).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using SAS (1999) package. The differences between means were determined by the least significant difference test and significance was defined at $P<0.05$.

RESULTS AND DISCUSSION

Cooking yield and physical properties

Cooking yield and physical measured traits of the mutton used in the production of meat floss are presented in Table 2. There were statistical differences ($P<0.05$) in all the parameters measured. Product yield varied between 67.07 and 74.44%. BMF (74.44%) and UMF (72.31%) had the highest cook yield ($P<0.05$). The lowest product yield (67.07%) was obtained in WMF which might be attributed to the excessive fat separation and water released during cooking. The cooking loss was significantly higher ($P<0.05$) for the *Semitendinosus* muscles from Yankasa (39.59%) and WAD (38.19%). Cooking loss occurs as the muscle coagulates and muscle fibres were broken during cooking. Ultimate pH has a marked influence in muscle capacity to retain natural water. The depletion of glycogen might have been the reason for low acid production which improves space availability for more water within the myofibrillar proteins. The ability of meat to keep its natural or added moisture during processing is called water-holding capacity. The knowledge of water holding capacity of meat is important for the quality of meat and considerable economic interest. Water holding capacity values were significantly higher in mutton samples from Balami (71.60%)

and Ouda (65.60%) and significantly lowest in WAD (61.97%) and Yankasa (59.97%). Water holding capacity varies with water in myofibrillar fraction, denaturation of sarcoplasmic and myofibrillar protein (Purslow *et al*., 2016). *Semitendinosus* muscles from Balami breed had higher (P<0.05) water holding capacity, indicating that mutton derived from Balami breed was more tender compared to the mutton produced from other breeds in this study.

Table 2: Product yield and physical characteristics of *Semitendinosus* muscle of four breeds of fattened ram used in meat floss production

Parameter	WMF	YMF	UMF	BMF	SEM	Pr
Water Holding Capacity	61.49^{c}	59.97^{c}	65.60^{b}	71.76^{a}	0.14	0.0001
Cooking Loss	38.19^{a}	39.51^{a}	34.70^{b}	30.20^{c}	0.25	0.0001
Thermal Shortening	34.67^{a}	33.34^{a}	29.62^{b}	26.40^{c}	0.18	0.0001
Chilling Loss	7.81^{a}	7.03^{a}	5.27^{b}	4.34^{b}	0.15	0.0001
Product Yield (%)	67.07^{b}	68.42^{b}	72.31^{a}	74.44^{a}	0.58	0.027

^{a,b,c}: Means with different superscripts in the same row differ signifcantly (P<0.05).

Proximate composition of raw mutton used for the production of meat floss

Mutton contains high biological protein and micronutrients that are needed for growth in life, The crude protein of raw mutton ranged between 22.58 to 23.16%, protein percentage differ significantly (P>0.05) from one another (Table 3). This is evidence that sarcoplasmic protein and myofibrillar proteins were higher in Balami and Ouda and this could be attributed to the greater muscle content of the carcasses. The highest fat content (6.53%) was observed in the Ouda followed by WAD (6.44%), while Balami had the least ether extract (5.83%). It was observed that mutton from Ouda had the highest (1.30%) ash content compared to mutton from other breeds. Analyzed parameters (crude protein, ash, ether extract, and cholesterol) were characterized by high variability, indicating low uniformity of mutton from which muscle tissues were sampled for analysis.

Table 3: Proximate composition of mutton from the carcass of four breeds of fattened rams used in meat floss production

Parameter %	WMF	YMF	UMF	BMF	SEM	Pr
Moisture Content	69.75	69.75	69.57	69.86	0.06	0.1368
Crude Protein	22.64^{b}	22.73^{b}	22.58^{b}	23.16^{a}	0.05	0.0001
Ash	1.17^{bc}	1.23^{b}	1.13^{c}	1.30^{a}	0.03	0.0001
Ether Extract	6.44^{ab}	6.29^{b}	6.53^{a}	5.85^{c}	0.05	0.0001
Cholesterol mg/g	10.11^{ab}	8.33^{c}	11.33^{a}	9.00^{bc}	0.01	0.0001

^{a,b,c} : Means with different superscripts in the same row differ signifcantly (P<0.05).

Proximate composition and TBARS of meat floss prepared mutton from four breeds of rams intensively fattened

There was a noticeable increase in the nutrient profile of the MF over their raw meat counterparts (Table 4). The moisture content in MF ranged from 10.49% to 10.63%. The breeds were similar in moisture content with approximately 10.46%; however, BMF (10.20%) had the lowest moisture content. The loss of moisture during cooking was as a result of the evaporation of moisture and the replacement of water by oil in the fried products. As moisture content and lipid are inversely related meat products, the percentage of lipids in the BMF (27.35%) was higher than the percentage of lipid in the MF produced from other breeds. There was a significant difference ($P<0.05$) in the protein contents, the highest protein contents were shown in BMF (49.60%) and YMF (48.73%) while the lowest content was recorded in WMF (46.75%). The crude protein followed the same trend as recorded in the raw mutton. The average ash content was significantly higher for all the treatments which might be due to proportionate moisture loss during frying and drying of meat floss. Frying removes internal water and allows a level of oil absorption. The average total ash values for the MF in the present study are in agreement with the reported values in food composition tables of the National Food Institute, (2009).

MF varied in cholesterol content from 21 to 29mg/100g. The WMF (29.00mg/100g) was highest in cholesterol than the MF evaluated from the other three breeds. Analysis of variance of cholesterol content showed significant ($P<0.05$) effects of the breed. The increasing level of cholesterol in processed samples might be caused by the conversion of other substances into cholesterol from food during processing. WHO/FAO (2003) has set recommendations for a maximum intake of cholesterol not to exceed 300mg per day which is above the values recorded in this study. Lipid oxidation is a major cause of food deterioration as it decreases the nutritional properties of foods since it involves the loss of essential nutrients and the generation of potentially toxic reaction products such as cholesterol oxidation products (Tang *et al*., 2001). TBARS values are used to determine the oxidative rancidity of meat products. TBARS values were 1.14MDAmg/kg for BMF and UMF,1.12MDAmg/kg for YMF and 1.17MDAmg/kg for WMF, respectively. All samples of meat floss exhibited low values which were below the minimum threshold (1-2mg malonaldehyde/kg meat) of TBARS (Watts, 1962). Some spices which contain antioxidants are potential sources of natural antioxidants among the ingredients reduced lipid oxidation-induced food deteriorations and inhibit the growth of microorganisms (Tanabe *et al*., 2002).

Table 4: Proximate composition of meat floss from mutton of four breeds of rams intensively fattened

Parameter	WMF	YMF	UMF	BMF	SEM	Pr
Moisture Content	10.52[a]	10.49[ab]	10.63[a]	10.20[b]	0.05	0.0200
Crude Protein	46.75[d]	48.73[c]	47.82[b]	49.60[a]	0.04	0.0001
Ether Extract	25.69[c]	25.46[d]	25.88[b]	27.35[a]	0.03	0.0001
Ash	7.28[c]	7.31[c]	7.96[a]	7.75[b]	0.03	0.0001
Crude Fibre	0.00[c]	0.27[b]	0.00[c]	0.4[a]	0.02	0.0001
Cholesterol mg/100g	29.00[a]	25.00[b]	21.00[c]	25.00[b]	0.13	0.0003
TBARS mgMDA/kg	1.14	1.12	1.14	1.17	0.03	0.8166

[a,b,c] : Means with different superscripts in the same row differ signifcantly (P<0.05).

Sensory Evaluation

The results of the sensory evaluation presented in Table 5 revealed that flavour, juiciness, texture, hotties, and overall acceptability of the MF were not significantly (P<0.05) influenced by the breed of the rams. The relatively similar results obtained for MF in all the treatments could be since the animals were of the same age and equally treated. The results of the sensory evaluation on MF observed by the panelists show that BMF had bright colours (6.65) and flavour (6.93) than MF from other breeds. For the overall acceptability attribute, similar results were obtained; this clearly showed that meat floss was well accepted by panelists without breed effect. Tenderness is a reflection of muscle fibre and connective tissues connected with better solubility, large differences existed between sensory evaluations of the tenderness of the samples. All the MF samples were rated tender by the majority of the participants. BMF (6.93) and UMF (6.88) were rated as the most tender meat floss, closely followed by YMF (5.89) and WMF (5.53), respectively. This result is a reflection that the meat products become more tender with the increase of intramuscular fat with the raw mutton (Marti *et al*., 2013 and Dominguez *et al*., 2015).

Table 5: Organoleptic properties of meat floss from mutton of four breeds of rams intensively fattened

Parameter	WMF	YMF	UMF	BMF	SEM	Pr
Colour	3.94[c]	3.24[c]	5.93[b]	6.65[a]	0.07	0.0001
Flavour	4.94	5.18	5.59	5.71	0.08	0.6539
Tenderness	5.53[b]	5.89[ab]	6.88[a]	6.93[a]	0.07	0.0471
Texture	6.11	6.24	6.65	6.64	0.06	0.3177
Juiciness	5.78	6.12	6.47	5.93	0.09	0.6776
Hottiness	5.94	5.71	4.94	5.14	0.10	0.3645
Overall Acceptability	6.22	6.71	7.12	6.36	0.07	0.1931

[a,b,c] : Means with different superscripts in the same row differ signifcantly (P<0.05).

Microbiological Quality

Meat products are a nutrient-rich food, but highly perishable because they provide the nutrients needed for the growth of a lot of proteolytic and lipolytic microorganisms.

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Microbial examination of food samples is generally recommended to verify the efficiency of food safety and quality control (ICMSF, 2011; IFST, 1997). Microbial counts can provide a general indication of the microbiological quality of food (Table 6). TAC for all the samples on the zeroth day of production ranged from 1.37 to 6.76 × 10^2 CFU/g and 1.18 to 3.58 × 10^2 CFU/g for TCC. The highest values of TAC and TCC were 6.76 × 10^2 CFU/g and 3.58 × 10^2 CFU/g for WMF and BMF, respectively. TAC increased significantly (P<0.05) from the seventh day onwards in all the samples. WMF and UMF have a significantly higher count than the meat floss from YMF (3.23), (2.83), and BMF (2.72), (2.34) on the seventh and fourteenth day of storage. Total plate count of the products showed a gradually increasing trend from zero to the fourteenth day of storage; however, these counts were well below the permissible limit (log10^6 CFU/g) (EOS, 2005). The microorganisms isolated could have come from contaminated spices and water used. Fat content acts as a hurdle for the growth of many microorganisms except lipolytic organisms (Kumar and Sharma, 2004). Bacillus spp, Pseudomonas spp, Proteus sp, and *Aspergillus* sp. and *Salmonella* spp which were isolated from all the samples are described as an index of food hygiene (Adesokan *et. al*., 2008).

Table 6: Microbiological Quality of Meat Floss during the Period of Storage under Refrigerated Condition (×10^2cfu/g)

		Breed					
Period (Day)	Microbes	WMF	YMF	UMF	BMF	SEM	Pvalue
Zeroth	Total Aerobic Count	2.87^{b}	1.90^{d}	3.28^{a}	2.09^{c}	0.07	0.0001
	Total Coliform Count	ND	ND	ND	ND		
	Total Fungal Count	1.44^{a}	1.30^{c}	1.35^{b}	1.32^{c}	0.02	0.0001
Seventh	Total Aerobic Count	3.23^{b}	2.83^{c}	3.61^{a}	2.72^{c}	0.01	0.0001
	Total Coliform Count	ND	ND	ND	ND		
	Total Fungal Count	1.84^{a}	1.65^{b}	1.58^{c}	1.47^{d}	0.04	0.0001
Fourteenth	Total Aerobic Count	3.52^{a}	2.83^{bc}	3.33^{ab}	2.34^{c}	0.50	0.0800
	Total Coliform Count	ND	ND	ND	ND		
	Total Fungal Count	2.19^{b}	2.35^{a}	2.15^{c}	1.67^{d}	0.02	0.0001

^{a,b,c,d} : Means with different superscripts in the same row differ significantly (P<0.05).

CONCLUSION

Mutton products are nutritionally as good as the major sources of meat products. It may even have advantages over other meat products due to its high protein content. The nutritional and microbial evaluation indicated that meat floss was beneficial and acceptable. The microbiological quality remained acceptable in all the products, irrespective of the breed. However, *Semitendinosus* muscle from Balami breed may be an ideal choice for meat floss production due to its high nutritive value.

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Authors' Contributions:

SB Akinleye: Conceived and designed the experiments.
AB, Omojola: Supervision
James S., Luka: Collection of Data
SB Akinleye and NN Ayanniyi: Execution of the experiment.
SB Akinleye and SA Adeyemi: Interpretation and statistical analysis of the data and results.

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