Effect of breed, chilling duration and processed product on the quality characteristics of mutton

*¹Salihu, D. Y., ²Duru, S., ²Abdu, S. B., ³Munza, B. M., ¹Abdu, M. B., ⁴Sadiq, A. A. and ²Bamus, O. A.

¹Federal College of Animal Health and Production Technology, Vom, Jos, Nigeria

²Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria

³Department of Animal Science, University of Maiduguri, Maiduguri, Nigeria

⁴Department of Agricultural Education, Federal College of Education, Zuba-Abuja, Nigeria,

*Corresponding author:bellomunza@gmail.com; +2347038737250

Abstract

An experiment was conducted to evaluate the effect of breed, chilling duration and processed product on the quality characteristics of mutton. A total of nine (9) mature rams of 12 months of age (25 Kg) managed on the same system were used. The animals were kept for 24 hours where only water was provided to clear the gut content before slaughter. The experiment was carried out in a factorial arrangement (3 x 3 x 3) of a completely randomized design consisting of three breeds of sheep (Balami, Uda and Yankasa), three chilling durations (0, 24 and 48 hours) and three processed products (Balangu, Tsire and Tukunya). The result revealed that there was no significant ($P > 0.05$) effect of breed on proximate composition of fresh mutton. There was significant ($P < 0.05$) effect of processed product on the proximate composition of mutton. Moisture content was higher in Balangu (54.93 %), followed by Tukunya (51.74 %) and lower in Tsire (41.00 %). Crude protein content was higher in Balangu (33.83 %), followed by Tukunya (29.63 %) which was at par with Tsire (29.51 %). Ash content was higher in Tsire (6.61 %), followed by Balangu (5.71 %) and lower in Tukunya (3.69 %). Significant ($P < 0.05$) chilling duration effect was obtained for bacteria count which was higher at 0 hours (2.25×10^3 cfu/g) chilling, followed by 24 hours (1.86×10^3 cfu/g) chilling. The same trend was observed for coliform count in which higher value was obtained at 0 hours (4.49×10^2 cfu/g) chilling, followed by 24 hours (3.04×10^2 cfu/g) chilling and 48 hours (2.93×10^2 cfu/g) chilling. Sensory properties of mutton from different breed differed significantly ($P < 0.05$) among processed products. The overall acceptability indicates that Tsire (7.60) product was more acceptable, followed by Tukunya (7.20) product while Balangu (6.86) product was less acceptable. The microbial count obtained from the study was within the acceptable range (< 3.5 log HACCP 2002). It can be concluded that processed meat products (Tsire, Balangu and Tukunya) obtained from different breeds of Nigerian sheep (Balami, Uda and Yankasa) were not homogenous in their proximate composition. It is therefore recommended that fresh mutton should be chilled for 24 to 48 hours with little or no bacteria while fresh meat from the three breed of sheep (Balami, Uda and Yankasa) can be chilled for 24 to 48 hours with little or no bacteria and can be processed into different products (Tsire, Balangu and Tukunya).

Keywords: Breed, chilling, mutton, processed product and quality

Introduction

The domestic meat demand in Nigeria is increasing with increase in nutrition awareness and dispensable income.

Concern for quality meat is also increasing due to growing awareness and health concern. The main objection to consumption of locally processed meat

products lies with the poor sanitary conditions associated with their production and handling practices. It has been reported that high micro-flora count observed in meat products is indicative of poor hygiene and handling practices (Bube, 2003; Kalla *et al.*, 2005; Zahraddeen *et al.*, 2007). However, it is suggested that the interval between processing and delivery to market be reduced, as this would limit the time for microbial multiplication. Ojewola and Onwuka (2001) stated that consumers are becoming increasingly prepared to pay for improved and better quality product from the local meat industry. The main livestock species producing red meat in Nigeria are sheep, goats, cattle and camels. Sheep play an important role in the social economic life of the people in Nigeria. In Sub Saharan Africa, sheep provide almost 30% of the meat consumed and around 16% of the milk produced (Bourn *et al.*, 1994). Sheep contributes about 50% of the total domestically produced meat in Nigeria (Bourn *et al.*, 1994). There are four main breeds of sheep native to Nigeria and these are Balami, Uda, Yankasa and West African Dwarf. Balami and Uda are kept in the semi-arid regions; West African Dwarf sheep in the south and Yankasa throughout the country (Bourn *et al.*, 1994). These four breeds differ considerably in size, coat colour and other characteristics (Adu and Ngere, 1971). K'Opondo (2011) observed that methods of preserving meat include the use of high temperature (canning), low temperature (freezing), drying (sun-drying, smoking, use of radiation and chemical preservatives). This author also reported that drying reduces the moisture content to a level that prevents the growth of microorganisms especially fungi and bacteria. Chilling freshly harvested meat carcasses is necessary for food safety and quality purposes. Before mechanical refrigeration, meat either had to be

consumed immediately after slaughter or be preserved through salting, curing, and/or smoking (Savell, 2012). With the advent of mechanical refrigeration and networks of refrigerated carriers, the production, processing, and distribution of carcasses and cuts were made more convenient and practical. It has been known for about a half century that cold temperatures at early postmortem could cause cold shortening or cold toughening of meat (Locker, 1985). K'Opondo (2011) reported that all handling and storage methods are therefore primarily concerned with minimizing microbial contamination and retarding microbial growth and activities. Meat products that are properly handled through good sanitation, maintenance of a clean production environment and heat treatment are prerequisites for extended shelf-life, reduced microbial load and improved acceptability.

Various methods are employed locally for the processing of meat for human consumption. But there is little information on these local indigenous meat products (*Tsire, Balangu, Tukunya, ganda* etc). Hence, it is therefore necessary to determine the effect of breed, chilling duration and processed meat products on meat quality.

Materials and methods

Experimental site

The study was conducted at the Animal Products Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria. Zaria is located on Latitude 11° 12' N, Longitude 07° 33' E at an altitude of 660 m above sea level, along Zaria-Funtua Road in the Northern Guinea Savannah zone of Nigeria (Ovimap, 2015). The climate is characterised by a defined wet and dry season. Wet season starts from April to early May and ends in late September to early October while the dry season lasts from October to April. The total annual rainfall

ranges from 748.6 – 1156.7 mm with a long-term average of 1058.60 mm. Maximum air temperature of 37°C are recorded in May and minimum air temperature of 11.5°C recorded in December/January and relative humidity of approximately 70% during the rainy season (IAR, 2018).

Experimental design and management of animals

The experiment was carried out in a Complete Randomized Design with factorial arrangement (3 x 3 x 3) consisting of three breeds of sheep (Balami, Uda and Yankasa), three chilling durations (0, 24 and 48 hours slaughtering) and three processed products (*Balangu*, *Tsire* and *Tukunya*).

A total of nine (9) matured rams of twelve (12) months of age with an average body weight of 25 kg raised on the same diets and the same system were used. The animals were raised on semi intensive system of management. Concentrate (Table 1) was provided in the morning while the animals grazed on lush grasses in the evening. The animals were fattened for 90 days. Proper housing and sanitation was maintained

throughout the period. The animals were sorted according to the three breed groups (Balami, Uda and Yankasa) group comprising of three (3) rams per group. The animals were inspected for diseases and disabilities. The animals were fasted for 24 hours without feed but water was made available before slaughtering.

Slaughter and carcass dissection

The animals were slaughtered according to the *Halal* standard procedure by severing the jugular vein and carotid arteries. The hair was removed by flaying as described by Fasae and Adelegan (2011). The internal organs (kidney, liver, heart and spleen) were carefully excise and weighed. The carcass was cut into primal cuts (shoulder, rack, loin, breast shank and flank) and each part was weighed. The dressing percentage was calculated as the ratio of dressed carcass weight to live weight in percentage.

Mutton chilling

Haier® Thermocool freezer model CCF-319T at the Meat Science Laboratory was used for chilling between 2 – 7 °C. The mutton was removed after each 24 and 48 hours for subsequent analyses (microbial count and characterization).

Table 1: Composition of concentrate supplement fed to experimental rams

Ingredients	Percentage (%)
Maize	40.0
Wheat offal	31.5
Cotton seed cake	25.0
Bone meal	2.5
Salt	1.0
Total	100
<i>Calculated analysis (%)</i>	
Crude Protein	13.63
Metabolizable energy (Kcal/kg)	2679.0

Meat processing

Tsire

The preparation of the *Tsire* was as shown in Figure 5 as described by Igene and Mohammed (1983) and Uzeh *et al.* (2006). The spices comprised of *Masoro*,

kanunfari, *chitta*, *borkono*, *chittmai*yatsu, maggi, thyme and *gishiri* (Table 2). The fire was first set by burning the fire wood into red hot charcoal before staking the meat for roasting. The roasting was done on a local *tukuba*, a heap of soil built for the same

Effect of breed, chilling duration and processed product on the quality characteristics of mutton

purpose. The fresh meat staked on skewer was fixed into the soil around the glowing charcoal fire to roast (Figure 1).

Balangu

Balangu is prepared from boneless meat of a sizeable cut, which was placed on a wet brown paper on a wire mesh over fire to roast. The pieces of meat were sliced into thin sheets not less than 1 cm in thickness. Groundnut oil and spices (Table 2) were

added during roasting. The meat was turned continuously until it was well roasted as reported by Bube (2003) and Kalla *et al.* (2005) as shown in Figure 2.

Tukunya

This is similar to *Balangu* except that the sizeable cuts are enwrapped in a wet brown paper after adding groundnut oil and spices (Table 2). It was then placed on a wire mesh over fire to roast (Zahraddeen *et al.*, 2006).

Figure 1: Preparation of *Tsire*

Source: Bube (2003)

Table 2: Ingredient composition of spices used in the experiment

Local/ Hausa name	Botanical/ English name	Proportion in mixture
Masoro	<i>Piper guinease</i>	12.0
Kanunfari	<i>Eugenia caryophyllata</i>	5.0
Chitta	<i>Aframomum meleginata</i>	5.0
Borkono	<i>Capsicum frutescens</i>	30.0
Chitt maiyatsu	<i>Zinginer officinale</i>	18.0
Seasoning cube	Seasoning	20.0
Thyme	Seasoning	5.0
Gishiri	Salt (NaCl)	5.0
Total		100

Figure 2: Preparation of Balangu

Source: Bube (2003)

Sensory evaluation

Balangu, *Tsire* and *Tukunya* were subjected to sensory evaluation for their acceptance. Thirty (30) panelists were trained for the assessment procedure two days prior to the evaluation; this was done using the method described by Bube (2003).

Proximate composition

For the proximate composition of the meat, about 50g of meat cut from the loin was used for analysis. The indices analysed included moisture, dry matter, crude protein, ether extract and ash using AOAC (2005) procedure. The proximate analyses were carried out in the Nutritional Biochemistry Laboratory, National Veterinary Research Institute Vom, Plateau State.

Microbial analysis

Twenty five grams of the meat samples

were put into 225 mL of 0.1 per cent buffered peptone water (diluent) and blended for 2 minutes. Serial dilutions were prepared by adding 1 ml of the previous dilution to 9 ml of the sterile diluents and homogenized in a stomacher for 2 minutes. This was carried out in the Scientific and Industrial Research Department, National Research Institute for Chemical Technology, Bassawa-Zaria, Kaduna State.

Determination of total plate counts

1 mL of each dilution was added to a sterile Petri dish and Plate Count Agar (kept at 45°C in a water bath) added and mixed thoroughly. The preparations were then allowed to gel and were finally incubated at 37°C for 24 hours and isolated distinct colonies were counted. Average counts obtained were multiplied by the dilution factor and expressed as colony forming unit

per gram (cfu/g) (Fawole and Oso, 2001).

Isolation of bacterial pathogens

This was done by streaking on selective media for the most common meat bacterial pathogens. These include *Salmonella* spp., enteropathogenic *E. coli* and coagulase positive *staphylococcus aureus*.

Detection of *Salmonella*

A 10 mL of the homogenate was enriched by adding into 100 mL tetrathionate brilliant green broth and incubated at 37°C for 18 hours. The enrichment was sub-cultured onto Brilliant green agar, MacConkey agar and Salmonella-Shigella agar. Pink colonies on Brilliant green, colourless on MacConkey and pale colonies with black centres on Salmonella-Shigella agar were taken into consideration (Fawole and Oso, 2001). The colonies were confirmed by biochemical test; TSI, Simmon's citrate agar and urea (Fawole and Oso, 2001). The TSI was examined for characteristics reactions that included alkaline slant/acid butt with hydrogen sulphide production. Typical *Salmonella* cultures show alkaline (red) slants and acid (yellow) butts with gas formation (bubbles) and (in about 90% of the cases) formation of hydrogen sulphide (blackening of the agar) (Yah *et al.*, 2007).

Detection of *Escherichia coli*

For isolation of *E. coli*, 10 mL of the homogenate were inoculated on 1.5% peptone water and incubated at 37°C for 18-24 hours before being inoculated on MacConkey Sorbitol agar and MacConkey agar. Pathogenic *E. coli* produces colourless colonies (Alam *et al.*, 2010). All isolates were identified as *E. coli* based on morphological and confirmed by biochemical characteristics (March and Ratnam, 1986; Bopp *et al.*, 1999). Enteropathogenic *E. coli* was characterized by colourless colonies on MacConkey Sorbitol agar and indole positive test.

Detection of *Staphylococcus aureus*

A 10 mL diluents of the samples were

inoculated on Mannitol salt agar and incubated at 37°C for 18-24 hours (Okonko *et al.*, 2010). Typical large, round, creamy and smooth colonies with golden yellow halo were isolated and sub-cultured. Presumptive diagnosis involved mannitol fermentation with an accumulation of acid production indicated by phenol red indicator turning yellow. These colonies were further confirmed by Gram staining, catalase test and coagulase test (Fawole and Oso, 2001).

Detection of *Pseudomonas aeruginosa*

Pseudomonas aeruginosa produced colourless colonies with characteristics greenish colour on MacConkey agar. The colonies were confirmed by biochemical tests; TSI, Simmon's citrate agar, urea and oxidase test. *Pseudomonas aeruginosa* was characterized by alkaline slant and butt and the colonies were oxidase positive.

Detection of *Proteus vulgaris*

Proteus vulgaris produced characteristics pale dark centred colonies with swarming ends on Salmonella-Shigella agar and colourless colonies on MacConkey agar. Indole, citrate, urease test, reaction on TSI and Gram stain were further done to confirm the pathogen. Colonies with acidic slant and butt with hydrogen sulphide production on TSI were characterized as *Proteus vulgaris* and were distinguished from *Proteus mirabilis* as they are indole positive. The landmark characteristic of *Proteus* spp., is the utilization of urea noted by the change of media to pink within a period of 2 hours.

Statistical analysis

The data collected from all the experiment were subjected to analysis of variance (ANOVA), using the General Linear Model Procedure of SAS (2005). The significant differences among the treatment means were separated using the Duncan's Multiple Range Test (Duncan, 1955) in the SAS Package.

Results and discussion

Proximate composition of mutton as influenced by breed and processed products

The result revealed that there was no significant ($P>0.05$) effect of breed on proximate composition (Table 3). The proximate composition of fresh/raw meat did not vary with respect to moisture, crude protein, ether extract and ash among the breeds of sheep. The moisture, crude protein, ether extract and ash contents obtained in this study were in conformity with the findings of Balarabe (2016). It was however, reported that fresh adult mammalian muscle is about 75 % moisture which varies considerably within species, breeds, muscle type and as intramuscular (marbling) reported by Sivasanker (2005). The non-significant ($P>0.05$) effect of breed in this study may be partly attributed to same species, sex, age, nutrition and other management practices. Balarabe (2016) reported mean moisture content of 72.54 % in raw mutton which was in agreement with the values obtained in this present study with respect to moisture content values of Balami, Uda and Yankasa. The protein content values obtained in this

study were higher than the values reported by Bube (2003) and Muhammed *et al.* (2010) but were similar with the values reported by Williams (2007) and Balarabe (2016) for mutton. The differences could be due to variation in intramuscular fats. However, ether extract contents in this study were lower than the values (15.37 and 19.33 %) reported by Muhammad *et al.* (2010) but higher (5.30 – 7.80 %) than the findings of Bube (2003) and similar with the values (6.98 %) of Balarabe (2016). These variations may be attributed to the inherent nature of the various breeds in these studies. The ash content values in this study were similar to values reported by Muhammad *et al.* (2010) and Balarabe (2016). Proximate composition mutton differed significantly ($P<0.05$) with processed products (Table 3). Moisture content and crude protein of *Balangu* were 5.81% and 25.36% and 12.42% and 12.77% higher ($P<0.05$) than *Tukunya* and *Tsire* of processed product, respectively. Ether extract of *Tsire* was 10.57% and 18.19% higher ($P<0.05$) than *Tukunya* and *Balangu*, respectively. While ash content obtained for *Tsire* was 13.62% and 44.18% higher than *Balangu* and *Tukunya*, respectively.

Table 3: Proximate composition of mutton as influenced by breed and processed products

Treatments	Moisture (%)	Crude protein (%)	Ether extract (%)	Ash (%)
<i>Breed</i>				
Balami	72.54	20.93	6.98	2.50
Uda	70.48	21.00	8.13	3.12
Yankasa	72.43	20.55	6.77	2.81
SEM	1.20	1.30	1.20	1.20
<i>Processed Product</i>				
Balangu	54.93 ^a	33.83 ^a	15.79 ^c	5.71 ^b
Tsire	41.00 ^c	29.51 ^b	19.30 ^a	6.61 ^a
Tukunya	51.74 ^b	29.63 ^b	17.26 ^b	3.69 ^c
SEM	1.20	1.30	1.20	1.20
<i>Interaction</i>				
B x P	1.000	1.000	1.000	1.000

^{abc} means within column having different superscripts differed significantly ($P<0.05$), SEM = Standard error of mean, B = Breed, P = Processed product

The values of moisture content and ash obtained in this present study was higher than 35.00 – 39.09% and 1.80 and 2.86% reported by Ogbonna *et al.* (2012) for *Suya*. Whereas the crude protein recorded in this study was within 28.33 – 35.10% reported for *Suya* by Ogbonna *et al.* (2012). The ether extract was below 20.90 – 28.26% reported by the author. There was non-significant ($P>0.05$) interaction effect between breed and processed product.

Sensory properties of mutton as influenced by breed and processed product

Sensory properties of mutton differed significantly ($P<0.05$) among breeds (Table 4). Balami meat is the most preferred for colour and with a slight high score (7.59). The preferences of Balami meat than other breeds may be due to breed difference. Adam *et al.* (2010) observed that meat colour is considered as an important parameter that attracts consumers to buy meat. Meat colour is also affected by method of slaughter as the level of blood left in the carcass. Meat colour has a powerful influence on consumer acceptance on food products especially meat products and serve as a visual indicator of meat quality (James, 1993). Similarly, Wheeler *et al.* (1991) reported that traditionally, meat colour has been the main criterion for evaluating freshness of retail meat which is a key component of consumer purchase decision of retail beef. Sensory properties of mutton differed significantly ($P<0.05$) among processed products (Table 4). Sensory attributes such as colour, flavour, tenderness, juiciness and acceptability are important components of consumer preference and meat consumption which may vary from breed, product and also the locality of the meat product. Meat colour is an important

attribute in meat consumption as it positively relates to their sensory attribute of meat. Flavour is an index reported to be considered in meat sensory evaluation for its value in overall meat acceptance (Kalla *et al.*, 2005). The processing method might have also influence its significant contribution on local meat industry and also for basis of meat products comparison in nutritional values as well as consumer acceptance in which Balami and Uda had the highest flavour among panelists. Balami (7.15) and Uda (7.31) were most preferred in terms of tenderness among the panelists. This could be due to the marbling effect of muscle fat. This was similarly reported by Bube (2003) and Balarabe (2016) who reported that the high score for mutton was due to marbling effect of muscle fat and that mode of marbling had a significant effect on meat tenderness. However, the sensory properties of meat like tenderness may have a significant impact on meat quality acceptability. This attribute (tenderness) is among the primary factors influencing consumer satisfaction. Tenderness of fat in meat is also considered as one of the decisive factors influencing the sensory quality of meat (Hocquette *et al.*, 2010). Therefore, the observed difference in meat colour and tenderness in the present investigation might have being due to difference in marbling content in of these breeds. Balami meat had high score in juiciness and acceptability among panelists. This might be due to the marbling effect which has great influence on the colour, flavour and tenderness which lead to the overall acceptance of Balami meat. The high score values obtained for *Tsire* over other products for the sensory parameters evaluated might be due to the familiarity of the panelists to the product against *Balangu* and *Tukunya*.

Table 4: Sensory properties of mutton as influenced by breed and processed product

Treatments	Colour	Flavour	Tenderness	Juiciness	Acceptability
<i>Breed</i>					
Balami	7.59 ^a	7.03 ^a	7.15 ^a	7.35 ^a	7.48 ^a
Uda	7.38 ^b	7.19 ^a	7.31 ^a	6.86 ^b	7.23 ^b
Yankasa	7.24 ^b	6.72 ^b	6.76 ^b	6.61 ^c	6.95 ^c
SEM	0.09	0.09	0.09	0.09	0.09
<i>Processed Product</i>					
Balangu	7.21 ^b	6.64 ^c	6.76 ^b	6.53 ^c	6.86 ^c
Tsire	7.72 ^a	7.29 ^a	7.19 ^a	7.33 ^a	7.60 ^a
Tukunya	7.27 ^b	7.01 ^b	7.37 ^a	6.96 ^b	7.20 ^b
SEM	0.09	0.09	0.09	0.09	0.09
<i>Interaction</i>					
B x P	0.066	0.036	0.063	0.079	0.286

^{abc} means within column having different superscripts differed significantly (P<0.05), SEM = Standard error of mean; B = Breed, P = Processed product

Microbial count of mutton as influenced by breed and chilling duration

Microbial count of mutton differed significantly (P<0.05) among breeds (Table 5). The total viable bacteria count and coliform count obtained in this study were below the Nigeria Agency for Drug Administration and Control (NAFDAC) recommendation. The standard recommended by NAFDAC for public health is between 5.0×10^5 and 1.0×10^6 cfu/g. The meat obtained in this study was fit and safe for consumption. Coliforms are indicator organisms signifying contamination of the product by faecal matter (Taiwo *et al.*, 2017). Significant (P<0.05) chilling duration effect was obtained for bacteria count (Table 5). The variation obtained during chilling duration for bacteria count and coliform count might be attributed to the chilling effect in which higher bacteria and coliform count were obtained before chilling. This agrees with the report of Taiwo *et al.* (2017) that the kind and number of microorganisms found on frozen fish depend on freezing temperature during storage and severity of freezing process with respect to lethality to

microorganisms. Most food spoilage microorganisms grow rapidly at temperatures above 10°C while some food poisoning organisms grow slowly between 4.4°C and -9.4°C provided the food is not solidly frozen (Sivasanker, 2005). These organisms will not produce food poisoning or disease but even below -3.9°C cause the deterioration of the food quality. Below -9.4°C there is no significant growth of microorganisms in the food and there is a gradual reduction in their numbers due to slow death. But complete death of all the microorganisms does not occur merely due to low temperatures and when the food is thawed there can be a rapid multiplication of microorganisms (Sivasanker, 2005).

Identified bacteria in mutton as influenced by breed and chilling duration

Bacteria identified in mutton as influenced by breed and chilling duration is presented in Table 6. The bacteria identified are a matter of public health importance that the presence of bacteria capable of causing food poisoning and/or infection be eliminated in animal product through improved handling processes.

Effect of breed, chilling duration and processed product on the quality characteristics of mutton

Table 5: Microbial count of mutton as influenced by breed and chilling duration

Treatment	Bacteria count (cfu/g)	Coliform count (cfu/g)
<i>Breed</i>		
Balami	4.60 x 10 ^{3a}	3.46 x 10 ^{2b}
Uda	8.90 x 10 ^{2b}	1.10 x 10 ^{2c}
Yankasa	5.35 x 10 ^{2c}	5.90 x 10 ^{2a}
SEM	1.02 x 10 ²	0.44 x 10 ²
<i>Chilling Duration (hrs)</i>		
0	2.25 x 10 ^{3a}	4.49 x 10 ^{2a}
24	1.92 x 10 ^{3b}	3.04 x 10 ^{2b}
48	1.86 x 10 ^{3 b}	2.93 x 10 ^{2 b}
SEM	1.02 x 10 ²	0.44 x 10 ²
<i>Interaction</i>		
B x C	0.014	0.696

^{abc} means within column having different superscripts differed significantly (P< 0.05), SEM = Standard error of mean, B = Breed, C = Chilling duration; Total Viable Bacteria: Satisfactory = <10⁴, Acceptable = 10⁴ - <10⁶, Unsatisfactory = >10⁶; Coliform count: = <10², Acceptable = 10² - <10⁴, Unsatisfactory = >10⁴

Table 6: Identified bacteria in mutton as influenced by breed and chilling duration

Bacteria	Balami			Uda			Yankasa		
	0 hrs	24 hrs	48 hrs	0 hrs	24 hrs	48 hrs	0 hrs	24 hrs	48 hrs
<i>Bacillus cereus</i>	✓	✓	✓	x	x	x	x	x	x
<i>Enterobacter aerogenes</i>	x	x	✓	✓	✓	x	x	x	x
<i>Escherichia coli</i>	✓	✓	x	✓	✓	✓	✓	x	✓
<i>Klebsiella oxytoca</i>	✓	✓	✓	x	x	✓	x	x	x
<i>Proteus mirabilis</i>	x	x	x	✓	✓	✓	x	✓	x
<i>Pseudomonas aeruginosa</i>	x	x	x	✓	x	x	x	x	✓
<i>Salmonella typhi</i>	✓	✓	✓	x	✓	✓	x	x	x
<i>Serratia marcescens</i>	x	x	x	x	x	x	✓	✓	✓
<i>Staphylococcus aureus</i>	x	x	x	x	x	x	✓	✓	✓
<i>Streptococcus faecalis</i>	x	x	x	x	x	x	✓	✓	x

✓ = Identified, x = Unidentified

Microbial count of mutton as influenced by breed and processed product

Breed significantly (P<0.05) affected microbial count in mutton (Table 7). There was an increased in the number of total viable bacteria count and coliform count from the satisfactory range of (<10⁴) to acceptable range (10⁴ to <10⁶) in mutton as influenced by breed and processed product. This increase might be attributed to contamination by handlers and processors

of the meat during processing. There was significant (P<0.05) effect of processed product on microbial count of mutton (Table 7). As influenced by processed products, *Tsire* had the highest microbial count and coliform count though it was within the acceptable range. This could be attributed to the fact that *Tsire* and *Balangu* have no protection unlike *Tukunya* which is wrapped. This agrees with Igene and Abulu (1984).

Table 7: Microbial count of mutton as influenced by breed and processed product

Treatment	Bacteria count (cfu/g)	Coliform count (cfu/g)
<i>Breed</i>		
Balami	1.73 x 10 ^{5a}	1.58 x 10 ^{3c}
Uda	7.12 x 10 ^{4b}	5.11 x 10 ^{3a}
Yankasa	4.20 x 10 ^{4c}	2.48 x 10 ^{3b}
SEM	1.11 x 10 ⁴	0.18 x 10 ³
<i>Processed Product</i>		
Balangu	3.72 x 10 ^{4b}	2.14 x 10 ^{3b}
Tsire	2.14 x 10 ^{5 a}	5.83 x 10 ^{3a}
Tukunya	3.43 x 10 ^{4b}	1.20 x 10 ^{3 c}
SEM	1.11 x 10 ⁴	0.18 x 10 ³
<i>Interaction</i>		
B x P	0.000	0.051

^{abc} means within column having different superscripts differed significantly (P<0.05), SEM = Standard error of mean, B = Breed, P = Processed product; Total Viable Bacteria: Satisfactory = <10⁴, Acceptable = 10⁴ - <10⁶, Unsatisfactory = >10⁶; Coliform count: = <10², Acceptable = 10² - <10⁴, Unsatisfactory = >10⁴

Identified bacteria in mutton as influenced by breed and processed product

Bacteria identified in mutton as influenced by breed and processed product is presented

in Table 8. The identified bacteria indicate the presence of food poisoning pathogens of public health significance.

Table 8: Identified bacteria in mutton as influenced by breed and processed product

Bacteria	Balami			Uda			Yankasa		
	Balangu	Tsire	Tukunya	Balangu	Tsire	Tukunya	Balangu	Tsire	Tukunya
<i>Bacillus cereus</i>	x	✓	✓	x	x	x	✓	✓	x
<i>Enterobacter aerogenes</i>	x	x	✓	✓	x	✓	x	x	x
<i>Escherichia coli</i>	x	✓	✓	x	✓	x	✓	✓	x
<i>Klebsiella oxytoca</i>	✓	x	x	x	x	x	✓	✓	✓
<i>Proteus mirabilis</i>	x	x	✓	x	✓	✓	x	x	✓
<i>Pseudomonas aeruginosa</i>	✓	x	x	✓	✓	x	x	x	x
<i>Salmonella typhi</i>	✓	✓	x	✓	x	x	✓	x	x
<i>Serratia marcescens</i>	x	x	x	x	x	x	x	x	x
<i>Shigella dysenteriae</i>	x	x	x	x	x	x	x	✓	x
<i>Staphylococcus aureus</i>	✓	x	x	✓	x	✓	x	x	x
<i>Streptococcus faecalis</i>	x	✓	x	x	✓	✓	x	x	✓

✓ = Identified, x = Unidentified

Conclusion

It was concluded that proximate composition of mutton from the three breeds of sheep (Balami, Uda and Yankasa) show no difference among the breeds. Processed meat products (*Tsire, Balangu and Tukunya*) obtained from different breeds of Nigerian sheep (Balami, Uda and

Yankasa) are not homogenous in their proximate composition. *Tsire* from the three breeds (Balami, Uda and Yankasa) has the overall acceptability among the processed product. Fresh mutton can be chilled for 24 to 48 hours with little or no bacteria. The microbial count obtained from the study was within the satisfactory and acceptable range < 3.5 log.

Recommendation

It was therefore recommended that meat from the three breed of sheep (Balami, Uda and Yankasa) can be consumed fresh or processed into different products (*Tsire, Balangu and Tukunya*). Also, fresh mutton should be chilled for 24 to 48 hours with little or no bacteria.

References

- Adam, A. A. G., Atta, M. and Ismail, S. H. A. 2010.** Quality and sensory evaluations of meat from Nilitic male kids fed on two different diets. *Journal of Animal and Veterinary Advances*, 9: 2008-2012
- Adu, I. F. and Ngere, L. O. 1971.** The indigenous sheep of Nigeria. *World Review of Animal Production*, (3):51-62.
- Alam, M. J., Rahman, M. T., Siddique, M. S., Khan, P., Rand, M. F. and Rahman, M. B. 2010.** Antibioqram and plasmid profiling of *E. coli* isolates. *Journal of Biological Research*, 3: 1-7.
- AOAC. 2005.** Official Method of Analysis. International, Association of Official Analytical Chemists, 24th edition Washington D.C. USA. Pp 200-210.
- Balarabe, S. 2016.** Chemical composition and sensor evaluation of fried minced (*Dambun nama*) processed from different animal species. MSc. Thesis, Animal Production Programme, Abubakar Tafawa Balewa University, Bauchi. Pp. 1-81
- Bopp, C. A., Brenner, F. W., Wells, J. G. and Strockbine, N. A. 1999.** *Escherichia, Shigella* and *Salmonella*. In: Murray, P. R., Baron, E. J., Pfaller, M. A., Tenover, F. C. and Tenover, R. H. (Eds.), *M-Tech Environmental Health Dissertation*. Technikon Pretoria.
- Bourn, D., Wint, W. B. R and Wooley, E. 1994.** Nigerian Livestock Resource Survey. *World Animal Review*, 78(1): 49-58.
- Bube, M. M. 2003.** Nutritional evaluation of meat from various animal species processed by different methods. PhD Thesis, Animal Production Programme, Abubakar Tafawa Balewa University, Bauchi. Pp. 1-115
- Duncan, D. B. 1955.** Multiple Range and Multiple F-tests. *Biometric*, 11:1-42.
- Fasae, O. A. and Adelegan, M. 2011.** Growth and faecal egg count response of village managed goats to wilted and sun-dried cassava foliage. *Journal of Agricultural Science and Environment*, 2315 – 7453.
- Fawole, M. O. and Oso, B. A. 2001.** Laboratory manual of Microbiology: Revised edition spectrum books Ltd, Ibadan. Pp. 1-27.
- Hocquette, J. F., Gondret, F., Isaeza, A., Mcdale, F., Jurie, C. and Pethick, D. W. 2010.** Intramuscular fat content in meat producing animals: Development, genetic and nutritional control and identification of putative markers. *Animate*, 4: 303-319.
- IAR 2018.** Institute for Agricultural Research, Ahmadu Bello University, Zaria. Meteorological Data Information of Samaru and its Environs.
- Igene, J. O. and Abulu, O. E. 1984.** Nutritional and Bacteriological Characteristics of *Tsire*-Type *Suya*, a Popular Nigerian Meat Product. *Journal of Food Protection*, 47(3):

- 193-196.
- Igene, J. O. and Mohammed, I. D. 1983.** Consumers' attitudes towards suya meat product. *Annal of Borno*, 1: 1-4
- James, G. 1993.** Packaging, storage and delivery of ingredients. *Journal of Food Technology*, 47(8): 54-63.
- K' Opondo, F. B. O. 2011.** Influence of drying methods and fruit position on the mother plant on seed quality of spider plant (*Cleomn gynandra* L. Morphotypes) from Western Kenya. *Advances in Applied Science Research*, 2(3): 74-83.
- Kalla, D. J. U., Zahraddeen, D., Abubakar, M., Oladotun, F. B. and Jibia, S. D. 2005.** Influence of species and processing method on red meat acceptance among panelists of various cultural background in Bauchi. *Journal of Agriculture, Business and Technology*, 3(2): 51-57.
- Locker, R. H. 1985.** Cold-induced toughness of meat. In: Pearson, A. M. and Dutson, T. R. eds. *Advances in Meat Research*, Publishing Company, Inc., Westport, CT. 1:1-44
- March, S. B. and Ratnam, S. 1986.** Sorbitol-MACConkey medium for the detection of *Escherichia coli* 0157:H7 associated with hemorrhagic colitis. *Journal of Clinical Microbiology*, 23: 869-872.
- Muhammad, B. F., Muhamood, A. B. and Mustapha, A. 2010.** Effects of processing method on composition and consumer acceptability of camel (*Camelus dromedaries*) meat and beef. *Nigerian Journal of Animal Production*, 38: 135–143.
- Ogbonna, I. O., Danladi, M. S., Akinmusire, O. and Odu, C. E. 2012.** Microbiological safety and proximate composition of *Suya* stored at ambient temperature for six hours from Maiduguri, northern Nigeria. *Internet Journal of Food Safety*, 14: 11-16.
- Ojewola, G. S. and Onwuka, G. I. 2001.** Evaluation of the organoleptic properties of suya produced from various sources of meat. *Nigerian Journal of Animal Production*, 28(2): 199-201.
- Okonko, I. O., Ukut, O. E., Ikpoh, I. S., Nkang, A. O., Udeze, A. O., Babalola, T. A., Mejeha, O. K. and Fajobi, E. A. 2010.** Assessment of bacteriological quality of fresh meats sold in Calabar Metropolis, Nigeria. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 9: 89-100.
- Ovimap, 2015.** Ovi location map: Ovi Earth Imagery Data.
- SAS. 2005.** Statistical Analysis Software (CD-ROM), Version 8.1, SAS Institute Inc., Cary, N.C., USA.
- Savell, J. W. 2012.** Beef Carcass Chilling: Current Understanding, Future Challenges. *White Paper: Cattlemen's Beef Board and National Cattlemen's Beef Association*
- Sivasanker, B. 2005.** *Food Processing and Preservation*. Prentice-Hall of India Private Limited. Pp. 1-360.
- Taiwo, I. O., Olopade, O. A. and Bamidele, N. A. 2017.** Microbial load of some imported frozen fish species in Lagos, Nigeria. *Nigerian Journal of Animal Production*, 44(3): 152-160.
- Uzeh, R. E., Ohenhen, R. E. and Adeniji, O. O. 2006.** Bacterial contaminations of tsire-suya, a

- Nigerian meat product. *Pakistan Journal of Nutrition*, 5(5): 458-460.
- Wheeler, T. I., Koohmaraie, M. and Crouse, I. D. 1991.** Effects of calcium chloride injection and hot-boning on the tenderness of round muscle. *Journal of Animal Science*, 69(12): 4511-4875.
- Williams, P. G. 2007.** Nutritional composition of red meat. *Nutrition & Dietetics*, 64(4): S113-S119.
- Yah, S. C., Chineye, H. U. and Eghafona, N. O. 2007.** Multi-antibionese-resistant plasmid profile of enteric pathogens in pediatric patients from Nigeria. *Biochemistry*, 19: 35-42.
- Zahraddeen, D. 2006.** Reproductive performance and milk productivity of goats in Bauchi. PhD thesis, Animal Production Programme, Abubakar Tafawa Balewa University, Bauchi. Pp. 1-145.
- Zahraddeen, D., Butswat, I. S. R. and Mbap, S. T. 2006.** Preferences for goat meat and milk products consumption in Bauchi State, Nigeria. *Animal Production Research Advances*, 2(1): 6-11.
- Zahraddeen, D., Butswat, I. S. R. and Mbap, S. T. 2007.** Comparative study of goat production and management in Bauchi State, Nigeria. *International Journal of Tropical Agriculture and Food Systems*, 1(4): 310-315.

Received: 22nd November, 2019

Accepted: 20th February, 2020