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Full Length Research Paper

Consumer sensory evaluation of meat from South African goat genotypes fed on a dietary supplement

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The objective of the study was to evaluate the effect of genotype and supplementary feeding on sensory scores of chevon from different indigenous goat genotypes prepared using different thermal treatments. 48 6-month-old Xhosa lop-eared (XLE), Nguni (NGN), Xhosa-Boer cross (XBC) and Boer (BOR) castrated goats with a body weight range of between 20 and 25 kg was used in the study. Half of the goats were supplemented with 200 g per head per day of sunflower cake. A consumer sensory evaluation was done with consumers of different ages, tribes and gender. In the non-supplemented XLE and BOR goats, the aroma intensity scores of the fried meat were significantly higher than the cooked meat. Female respondents gave higher ($P < 0.05$) scores than male respondents for both cooked and fried meat on aroma intensity. Shona consumers gave higher ($P < 0.05$) aroma intensity scores than the Xhosa and the Zulu consumers for both cooked and fried meat. In the non-supplemented goats, fried meat for all the genotypes was superior ($P < 0.05$) to the cooked meat for initial impression of juiciness. The age and gender of respondents and thermal treatment influenced initial impression of juiciness scores ($P < 0.05$). In meat from the non-supplemented XLE and NGN goats, the consumers gave higher ($P < 0.05$) muscle fibre and overall tenderness scores in cooked meat than the fried meat.

Key words: Dietary supplementation, fried chevon, cooked chevon, Xhosa lop-eared goats, Nguni goats, Boer goats.

INTRODUCTION

Studies have been conducted on the palatability and acceptability of chevon (Simela et al., 2008). In most instances, however, the studies have employed trained taste panels (Tshabalala et al., 2003; Simela et al., 2008). Trained sensory panels function as laboratory instruments and hence, their judgment usually matches results of instrumental evaluations of chevon quality (Simela et al., 2008). Therefore, while laboratory methods can provide precise and reliable information concerning technical and sensory attributes, only consumers can provide reliable and appropriate information about the acceptability of the meat (Simela et al., 2008). Recently, Sveinsdóttir et al. (2009) established that trained panel assessments of food products can correspond with that of consumers. Consumers tend to evaluate cooked meat quality on the basis of tenderness, juiciness and flavour. The advantage of using consumers over panelists is that they are the end users of the meat and they give a real life assessment of meat quality. Unfortunately, their sentiments and perceptions are largely ignored in most studies. Meat tenderness and flavour appear to be the most important sensory characteristics that determine meat quality (Sañudo et al., 1996; Tshabalala et al., 2003). The more tender the meat, the more rapidly juices are released by chewing and the fewer residues remain in the mouth after chewing (Muchenje et al., 2008a).

There are various goat breeds that are used as meat breeds in South Africa. However, there is no information on their acceptability, palatability and sensory characte-

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ristics to consumers. In several studies, goat genotypes have been shown to show different organoleptic scores (Campo et al., 1999; Marlinez-Cerezo et al., 2005; Bureš et al., 2006). Consumers should, therefore, also consider possible breed differences when purchasing chevon (Esenbuga et al., 2009). The Boer, a meat breed, is the most popular breed that is commercially farmed in Southern Africa both in communal and commercial production systems. Other genotypes kept in the communal areas include the Nguni, an ecotype of the small-framed East African goat, the large-framed Xhosa lop-eared goat (commonly kept in northern eastern parts of South Africa, Namibia and southern Zimbabwe) and the crossbreds between Boer makes and Nguni and Xhosa lop-eared dams. The Xhosa lop-eared goat is believed to have been used to develop the modern improved Boer goat and other big framed genotypes. Its population size is, however, fast decreasing (Ramsey et al., 2000). There is a renewed interest in farmers that want to use this genotype for production purposes. The acceptability of its meat is not known.

Dietary supplementation is required in farm animals for body maintenance, growth, reproduction, pregnancy and production of products such as meat. Maphosa et al. (2009) showed that nutrition had an effect on milk production. Supplementation also improves carcass conformation and fatness (Mapiye et al., 2010). Diets that influence body condition score or amount of fat deposition are likely to have an effect on the flavor and juiciness of the chevon. Preparation of meat and thermal treatment varies widely between cultures, ethnic and age groups (Tornberg, 2005). Variations in the methods of cooking have been shown to affect sensory, mechanical and cooking properties of meat (Dzudie et al., 2000). Boiling, frying, roasting and grilling are the most common thermal treatment used. When testing products, it is important to use consumers from different backgrounds in tasting meat (Dyubele et al., 2010). Sveinsdóttir et al. (2009), for example, demonstrated that, within each country, different segment of consumers exist with different preferences, motives and demographic background. The differences in countries might be explained by different consumption patterns of chevon within countries. For example, goat meat in the Eastern Cape Province of South Africa is mostly consumed during traditional ceremonies (Mahanjana and Cronje, 2000; Masika and Mafu, 2004; Rumosa Gwaze et al., 2009).

In general, little goat meat is consumed in South Africa (Rumosa Gwaze et al., 2009). In addition, whether consumer acceptability would be influenced by cooking methods, breed and the body condition of the goat at slaughter has not been established. The objective of the study was, therefore, to evaluate the effect of goat genotype and supplementary feeding on sensory scores of chevon prepared using different thermal treatment methods. It has been hypothesized that there is no effect of genotype, supplementary feeding and thermal treatment on sensory scores of chevon.

MATERIALS AND METHODS

Site description

The study was conducted at the University of Fort Hare, Alice, Eastern Cape, South Africa. The site is 520 m above sea level and is located 32.48°S and 26.53°E. More details on vegetation and climate on this site were described by Muchenje et al. (2008b). In brief, the vegetation in this area is characterised by several trees, shrubs and grass species with *Acacia karroo, Themeda triandra, Panicum maximum, Digitaria eriantha, Eragrostis spp., Cynodon dactylon and Pennisetum clandestinum* being the dominant plant species. The average rainfall is approximately 480 mm per year and mostly comes in summer. Mean temperature of the farm is about 18.7°C per year. The topography of the area is generally flat with a few steep slopes.

Management of goats

48 6-month-old Xhosa lop-eared (XLE), Nguni (NGN), Xhosa-Boer cross (XBC) and Boer (BOR) castrated goats with a body weight range of between 20 and 25 kg were used in the study. The goats were housed in an open sided barn that complied with local welfare standards in the two pens (24 goats per pen), with free access to a basal diet of *Medicago sativa*. The nutritional composition of the basal diet is shown in Table 1. The basal diet met the needs for the goats for maintenance and growth (80 g/day CP; 5.69 MJ/day ME). The goats had free access to clean water. The goats were randomly divided into two balanced groups, with half of the goats provided with the supplementary feed. There were six goats per breed per pen. The supplemented group was given an additional 200 g per head per day of sunflower cake (Table 1), such that the supplemented diet would provide 160 g/day crude protein (CP); the apparent requirements of metabolisable protein (MP). The supplementary feed was given to the goats individually in individual crates. The goats were fed twice a day at 0800 and 1700 h and were weighed every two weeks.

The goats were kept for 90 days. At day 90, the goats were slaughtered humanly to evaluate the sensory characteristics. A day before slaughter, the goats were deprived of feed for 24 h, clean water was, however, provided *ad libitum*. The electrical stunner was used to stun the goats and then, slaughtered using standard procedures. Skinning, evisceration and washing procedures were completed while the carcasses were on the overhead rail. Dressed carcasses were stored at 2°C for 24 h before sample collection. The sample used for sensory evaluation was taken from the hind leg at the right side of each carcass and muscles were cut into cube shaped (about 2 x 2 cm).

Thermal treatments

Two thermal treatments were used in this study, namely boiling and frying. The sample from each carcass was split into two. The boiled meat was done by first deboning the meat and cut into small pieces approximately of 2 x 2 cm. Meat from each carcass was cooked alone. The pieces were put into the pot and water was added to cover the meat and cooked for 45 min. Salt was added to taste. Frying was done using frying pan. Cooking oil was added to the pan and filled half the pan. The meat was fried until it was firm.

Sensory evaluation

Meat tasting for each thermal treatment was done randomly by a

Table 1. Nutritional composition of the experimental diets (% DM basis).

Component	*M. sativa*	Sunflower cake
Dry matter	91.5	89.6
Crude protein	20.3	35.3
Crude fibre	33.5	25.9
Neutral detergent fibre	48.3	43.5
Acid detergent fibre	41.2	32.9
Ether extract	2.5	3.6
Calcium	1.4	0.9
Phosphorus	0.8	0.5

consumer panel composed of a total of 82 students and staff from the University of Fort Hare. The meat from each thermal treatment was randomly presented to the tasting panel. The consumers were invited verbally and also using e-mails. The panelists were of different gender (female, male), ages (≤ 20, 21-25, 26-30, ≥ 30) and tribes (Xhosa, Shona, Zulu). All the participants were trained on making inferences and recording the scores for each sample. The waiting period between meat sample tasting was about 10 min. After tasting each piece, the consumers would rinse their mouths with water before tasting the next sample, to reduce crossover effects.

Eight point descriptive scales were used to evaluate aroma intensity (1 =extremely bland to 8 = extremely intense), initial impression of juiciness (1 = extremely dry to 8 = extremely juicy), first bite (1 = extremely tough to 8 = extremely tender), sustained impression of juiciness (1 = extremely dry to 8 = extremely juicy), muscle fibre and overall tenderness (1 = extremely tough, to 8 = extremely tender), amount of connective tissue (1= extremely abundant to 8 = none), overall flavour intensity (1= extremely bland to 8 = extremely intense) and a-typical flavour intensity (1= none to 8 = extremely intense). The off-flavour indicators were livery/bloody, cooked vegetable, pasture/grassy, animal like/kraal (manure), metallic, sour and unpleasant.

Statistical analysis

The effect of thermal treatment, genotype and diet on the meat sensory scores was analyzed using the general linear model procedure of SAS (2003). The model was:

$$Y_{ijkl} = \mu + C_i + G_j + D_k + (G \times D)_{jk} + (G \times C)_{ij} + (D \times C)_{ik} + (G \times D \times C)_{ijk} + E_{ijkl}$$

Where, Y_{ijkl} is the response variable (aroma intensity, initial impression of juiciness, first bite, sustained impression of juiciness, fibre and overall tenderness, amount of connective tissue, overall flavour intensity and relevant a-typical flavor); μ, overall mean common to all observations; C_i, effect of thermal treatment (boiled, fried);
G_j, effect of genotype (XLE, NGN, XBC and BOR); D_k, effect of diet; $(G \times D)_{jk}$, interaction between diet and genotype; $(G \times C)_{ij}$, interaction between thermal treatment and genotype; $(D \times C)_{ik}$, interaction between diet and thermal treatment; $(G \times D \times C)_{ijk}$, interaction between diet, genotype and thermal treatment and E_{ijkl}, random error.

A separate model was used to test for the effects of cooking method, gender, tribe and sex of panelist on the sensory scores. The Tukey's HSD procedure was used for comparison of means.

RESULTS

The effects of thermal treatment, breed, diet and their interactions on various sensory attributes are shown on Tables 2, 3, 4 and 5. Tables 6, 7 and 8 show the influences of gender, tribe and sex on the sensory attributes of chevon. Thermal treatment and diet had an influence ($P < 0.05$) on aroma intensity. Genotype, however, had no influence ($P > 0.05$) on aroma intensity. There was an interaction ($P < 0.05$) between cooking method, genotype and diet on aroma intensity scores. Fried meat had higher scores ($P < 0.05$) than cooked meat. In the non-supplemented goats, the aroma intensity scores of the fried XLE and BOR meat were significantly higher than those of the cooked meat. In the supplemented XLE goats, however, no ($P > 0.05$) difference in the aroma intensity was observed between the cooked and fried meat. On the contrary, in supplemented BOR goats, cooked meat had stronger aroma intensity than the fried meat ($P < 0.05$). No differences in aroma intensity between the cooked and fried meat were observed in both the supplemented and non-supplemented NGN and XBC goats. Tribe and gender of respondents influenced aroma intensity scores ($P < 0.05$). Female respondents gave a higher score than males for both cooked and fried meat. Shona consumers gave higher score than the Xhosa and Zulu consumers for both cooked and fried meat.

The diet, genotype and thermal treatment significantly affected the initial impression of juiciness. Only diet, cooking method × diet and breed × diet interactions, however, affected sustained impression of juiciness ($P < 0.05$). In the non-supplemented goats, fried meat for all breeds was rated significantly ($P < 0.05$) superior to the cooked meat. On the contrary, in the supplemented goats, differences in initial impression of juiciness were observed for the meat from only the XBC and BOR goats. In the supplemented XBC goats, fried meat was juicier than the cooked meat, whilst, in contrast, cooked BOR meat was juicier ($P < 0.05$). Age, gender and thermal treatment of respondents influenced the initial impression of juiciness scores ($P < 0.05$). Female respondents gave a higher score than males for both cooked and fried meat. Fried meat had higher score than cooked meat for initial impression of juiciness. Respondents that were ≥ 30 of age gave the highest scores for cooked meat and the respondents between 26 to 30 years of age gave the highest scores for fried meat.

In all the non-supplemented goats, except for the NGN goats, the sustained impression of juiciness scores was higher for the fried meat when compared with the cooked meat. No differences in scores between the fried and cooked meat were observed for the NGN goats. Similarly to the initial impression of juiciness, in the supplemented goats, differences in sustained impression of juiciness were observed for the meat from only the XBC and BOR goats. Fried meat from the XBC goats was rated significantly higher and juicier than the cooked meat whereas,

Table 2. Levels of significance of factors affecting sensory characteristics.

Parameter	T	G	D	T × G	T × D	G × D	T × G × D
Aroma intensity	***	NS	***	NS	***	NS	**
Initial impression of juiciness	***	**	***	***	***	*	NS
First bite	**	NS	***	***	NS	***	NS
Sustained impression of juiciness	NS	NS	***	***	NS	***	NS
Muscle fibre and overall tenderness	**	NS	***	***	NS	***	NS
Amount of connective tissue (Residue)	**	NS	**	NS	NS	**	*
Overall flavour intensity	**	NS	NS	NS	**	NS	*
Atypical flavour intensity	NS	NS	NS	**	NS	NS	NS
Off- flavour character	**	**	NS	NS	NS	NS	NS

*, P < 0.05; **, P < 0.01;***, P < 0.001; NS, not significant (P > 0.05); T × G, thermal treatment × genotype; T × D, thermal treatment × diet; G × D, genotype × diet; T × G × D, thermal treatment × genotype × diet.

Table 3. Influence of breed, diet and thermal treatment on aroma intensity, initial impression of juiciness and first bite.

Parameter		XLE	NGN	XBC	BOR
Aroma intensity					
Non-supplemented	C	4.4 ± 0.16^{a}	4.3 ± 0.15^{a}	4.7 ± 0.15	4.0 ± 0.15^{a}
	F	5.2 ± 0.14^{c}	4.7 ± 0.14^{abc}	4.9 ± 0.14	4.9 ± 0.14^{cd}
Supplemented	C	4.7 ± 0.14^{ab}	4.8 ± 0.14^{bc}	4.9 ± 0.14	5.3 ± 0.14^{d}
	F	4.9 ± 0.15^{bc}	4.9 ± 0.15^{c}	5.0 ± 0.15	4.7 ± 0.15^{bc}
Initial impression of juiciness					
Non-supplemented	C	4.3 ± 0.15^{a}	4.3 ± 0.15^{a}	3.8 ± 0.14^{a}	4.2 ± 0.14^{a}
	F	5.1 ± 0.13^{d}	4.8 ± 0.13^{cd}	4.9 ± 0.13^{cd}	4.8 ± 0.13^{bc}
Supplemented	C	4.7 ± 0.13^{bc}	4.7 ± 0.13^{bcd}	4.4 ± 0.13^{b}	5.4 ± 0.13^{d}
	F	4.9 ± 0.14^{cd}	4.8 ± 0.14d	5.1 ± 0.14^{d}	4.9 ± 0.14^{c}
First bite					
Non-supplemented	C	5.1 ± 0.14^{b}	4.9 ± 0.14^{ab}	4.2 ± 0.14^{a}	4.4 ± 0.14^{a}
	F	4.6 ± 0.13^{a}	4.5 ± 0.13^{a}	4.6 ± 0.13^{ab}	4.2 ± 0.13^{a}
Supplemented	C	4.9 ± 0.13^{ab}	5.0 ± 0.13^{b}	4.6 ± 0.13^{b}	5.5 ± 0.13^{c}
	F	4.7 ± 0.14^{a}	4.5 ± 0.14^{a}	5.0 ± 0.14^{c}	4.9 ± 0.14^{b}

XLE, Xhosa lop-eared; NGN, Nguni; XBC, Boer × Xhosa; BOR, Boer; C, cooked; F, fried. Values within column with different superscript are significant different (P < 0.05).

in the BOR, cooked meat was rated as juicier than the fried meat (P < 0.05). Age and gender influenced the sustained impression of juiciness scores (P < 0.05). Respondents that were 26 to 30 of age gave the highest scores in cooked meat. Female respondents gave higher scores than males for both cooked and fried meat.

Thermal treatment, diet and the interactions between thermal treatment and diet; and genotype and diet significantly affected first bite. In the non supplemented goats, in all breeds except the XBC, first bite for the cooked meat was rated as superior (P < 0.05) when compared with the fried meat. In contrast, fried meat was rated higher (P < 0.05) in the fried XBC meat when compared with the cooked meat. A similar trend was also observed in the supplemented goats where the first bite was rated higher in cooked meat from all the breeds except the XBC meat which had high score (P < 0.05) for the fried meat when compared with the cooked meat. Age and gender influenced first bite scores (P < 0.05). Cooked and fried were rated significantly higher by ages 26 to 30 and ≥ 30 with slight differences for first bite. Female respondents gave higher scores than males for both cooked and fried meat for first bite.

Muscle fibre and overall tenderness were closely associated with thermal treatment, diet and the interactions between thermal treatment and breed, and diet and breed on muscle fibre and overall tenderness were significant. Muscle fibre and overall tenderness scores indicated that, the panelists regarded cooked meat from the non-supplemented XLE and NGN goats as more tender (P < 0.05) than the fried meat. No differences on tenderness were observed between fried and cooked

Table 4. Influence of breed, diet, and thermal treatment on sustained impression of juiciness, muscle fibre and overall tenderness and amount of connective tissue.

Parameter		XLE	NGN	XBC	BOR
Sustained impression of juiciness					
Non-supplemented	C	4.4 ± 0.14^{a}	4.8 ± 0.13	4.1 ± 0.13^{a}	4.3 ± 0.13^{a}
	F	4.5 ± 0.12^{abc}	4.6 ± 0.12	4.8 ± 0.12^{cd}	4.7 ± 0.12^{bc}
Supplemented	C	4.8 ± 0.13^{c}	4.7 ± 0.13	4.6 ± 0.12^{bc}	5.4 ± 0.13^{d}
	F	4.7 ± 0.13^{bc}	4.7 ± 0.13	$5.1 \pm 0,13^{d}$	$5.0 \pm 0,13^{c}$
Muscle fibre and overall tenderness					
Non-supplemented	C	5.1 ± 0.14^{b}	5.2 ± 0.13^{c}	4.6 ± 0.13^{a}	4.4 ± 0.13^{a}
	F	4.7 ± 0.12^{a}	4.7 ± 0.12^{ab}	4.6 ± 0.12^{a}	4.5 ± 0.13^{a}
Supplemented	C	5.0 ± 0.12^{ab}	5.0 ± 0.13^{bc}	4.7 ± 0.12^{a}	5.4 ± 0.13^{c}
	F	4.8 ± 0.13^{ab}	4.6 ± 0.13^{a}	5.1 ± 0.13^{b}	5.0 ± 0.13^{b}

XLE, Xhosa lop-eared; NGN, Nguni; XBC, Boer × Xhosa; BOR, Boer; C, cooked; F, fried. Values within column with different superscript are significant different (P< 0.05).

Table 5. Influence of breed, diet and thermal treatment on amount of connective tissue (residue) and overall flavour intensity.

Parameter		XLE	NGN	XBC	BOR
Amount of connective tissue (Residue)					
Non supplemented	C	4.5 ± 015^{a}	4.9 ± 0.15^{b}	4.4 ± 0.14	4.2 ± 0.15^{a}
	F	4.6 ± 0.14^{a}	4.4 ± 0.14^{a}	4.4 ± 0.14	4.3 ± 0.14^{a}
Supplemented	C	5.0 ± 0.14^{b}	4.6 ± 0.14^{ab}	4.4 ± 0.14	5.1 ± 0.14^{b}
	F	4.6 ± 0.14^{ab}	4.4 ± 0.14^{a}	4.5 ± 0.14	4.5 ± 0.15^{a}
Overall flavor intensity					
Non supplemented	C	4.7 ± 0.13	4.3 ± 0.13^{a}	4.7 ± 0.13^{a}	4.7 ± 0.13^{a}
	F	5.0 ± 0.12	4.9 ± 0.12^{d}	4.8 ± 0.12^{ab}	5.0 ± 0.12^{ab}
Supplemented	C	4.7 ± 0.12	4.7 ± 0.12^{bcd}	4.7 ± 0.12^{a}	5.2 ± 0.12^{b}
	F	4.7 ± 0.13	4.8 ± 0.13^{cd}	5.1 ± 0.13^{b}	4.9 ± 0.13^{ab}

XLE, Xhosa lop-eared; NGN, Nguni; XBC, Boer × Xhosa; BOR, Boer; C, cooked; F, fried. Values within column with different superscript are significant different (P < 0.05).

meat from the XBC and BOR goats. In the supplemented goats, cooked meat from the NGN and BOR breeds was rated as more tender (P < 0.05) than the fried meat. On the contrary, fried meat from the XBC goats was scored higher (P < 0.05) than the cooked meat. No significant difference was observed between cooked and fried meat from the XLE goats. Age, tribe, gender and thermal treatment influenced muscle fibre and overall tenderness scores (P < 0.05). Female respondents gave higher scores than males for both cooked and fried meat. Zulu and Shona consumers gave higher scores for cooked meat than Xhosas and Zulus gave the highest scores for fried meat.

As shown in Table 5, thermal treatment, diet and the three way interaction (thermal treatment × genotype × diet) affected the amount of connective tissue and overall flavor scores. Cooked meat from the non-supplemented NGN goats had more (P < 0.05) connective tissue than the fried meat. No differences in the amount of connective tissue scores were observed in other breeds in the same category. In the supplemented goats, the cooked XLE and BOR meat was found to be chewier when compared with the fried meat. No differences between the fried and cooked meat were, however, observed for the NGN and XBC goats. Age, tribe, gender and thermal treatment influenced the amount of connective tissue scores (P < 0.05). Female respondents gave higher scores than males for both cooked and fried meat. Respondents that were 21 to 25 of age gave the lowest amount of connective tissue scores for both cooked and fried meat. Cooked meat had higher amount of connective tissue scores than the fried meat. Zulu consumers found both cooked and fried meat to have the lowest amount of connective tissue.

In the non-supplemented goats, the overall flavor intensity was observed to be higher (P < 0.05) in the fried meat than in the cooked meat in all breeds except for the XBC goats. For the supplemented goats, no differences

Table 6. Influence of age, tribe, thermal treatment, tribe x thermal treatment, thermal treatment × age and gender × thermal treatment on sensory characteristics.

Parameter	A	Tb	G	Ttr	Tb × Ttr	Ttr × A	G × Ttr
Aroma intensity	NS	**	***	NS	NS	NS	*
Initial impression of juiciness	*	NS	***	***	NS	NS	**
First bite	***	NS	NS	***	NS	NS	**
Sustained impression of juiciness	***	NS	***	NS	NS	*	NS
Muscle fibre and overall tenderness	***	***	**	***	NS	NS	NS
Amount of connective tissue	***	***	**	***	NS	NS	NS
Overall flavour intensity	***	NS	***	*	NS	NS	*
A-Typical flavour intensity	***	***	*	NS	NS	NS	*
Off- flavour character	**	***	***	NS	NS	***	*

Tb × Ttr, tribe × thermal treatment; Ttr × A, thermal treatment × age; G × Ttr, gender × thermal treatment. *, P < 0.05; **' P < 0.01; ***, P < 0.00; NS, not significant (P > 0.05).

Table 7. Influence of gender and thermal treatment on sensory characteristics.

Gender	Cooked	Fried
Aroma intensity		
Male	4.6 ± 0.08^{a}	4.6 ± 0.07^{a}
Female	5.5 ± 0.11^{b}	5.8 ± 0.11^{b}
Initial and sustained impression of juiciness		
Male	4.5 ± 0.08^{a}	4.8 ± 0.08^{a}
Female	4.9 ± 0.11^{b}	5.6 ± 0.11^{b}
Muscle fibre and overall tenderness		
Male	5.1 ± 0.07^{a}	4.7 ± 0.07^{a}
Female	5.5 ± 0.09^{b}	5.3 ± 0.09^{b}
Amount of connective tissue (Residue)		
Male	4.8 ± 0.07^{a}	4.6 ± 0.06^{a}
Female	5.3 ± 0.10^{b}	4.9 ± 0.10^{b}
Overall flavour intensity		
Male	4.8 ± 0.07	4.9 ± 0.06^{a}
Female	5.0 ± 0.09	5.3 ± 0.09^{b}
Off- flavour character		
Male	4.9 ± 0.24^{b}	4.1 ± 0.13^{b}
Female	3.4 ± 0.24^{a}	3.6 ± 0.25^{a}

Values within column with different superscript are significant different (P < 0.05).

were observed between the cooked and fried meat in all breeds except the XBC where the fried meat had significant stronger overall flavor intensity when compared with the cooked meat. Age, gender and thermal treatment influenced the overall flavor intensity scores (P < 0.05). Female respondents gave higher scores than males for both cooked and fried meat.

DISCUSSION

The observed lack of influence of genotype on sensory attributes is contrary to the findings by Swan et al. (1998), Tshabalala et al. (2003) and Muchenje et al. (2008a) who observed breed differences in aroma intensity and tenderness. Tshabalala et al. (2003) observed that the aroma intensity of Boer goat meat was significantly higher than that of the indigenous goats. Furthermore, Boer goat meat had a stronger goaty aroma than indigenous goats. Generally, flavour and aroma are two complex attributes of meat affected by species, age, fatness and type of tissue, locality, gender, diet and method of cooking (Calkins and Hodgen, 2007; Muchenje et al., 2009; 2010). The observed significant effect of thermal treatment on aroma intensity is however, consistent with the observation by Tornberg (2005) that cooking normally changes the composition of animal fat and increases the meat's energy density thereby influencing sensory attributes. From the results in this study, it appears that supplementary feeding reduced variation of sensory scores due to the two thermal treatment methods.

Regardless of genotype, the initial impression and sustained impression of juiciness for the cooked meat was significantly higher in the supplemented goats than the non- supplemented ones. When an animal is supplemented, it accrues more intra-muscular fat than non-supplemented. Generally, juiciness of meat is directly related to the intramuscular lipids and moisture content of the meat (Muchenje et al., 2008a). It appears that the supplementation was able to increase the intra muscular fat thereby increasing the marbling of the meat. McMillin and Brock (2005) also observed that, high-energy intake increased fat content of chevon and hence increased the juiciness, tenderness and texture of chevon. Nevertheless, Webb et al. (2005) reported that goat meat and its products are reportedly less juicy when compared with mutton and this has been attributed to the lower intramuscular lipid content of goat meat. Unfortunately, the intramuscular fat content and fatty acid profiles were not determined in this study. It seemed deep frying also influenced the composition of meat fat such that the panelist could not detect the difference between chevon

Table 8. Influence of tribe and thermal treatment on sensory characteristics.

Characteristics	Xhosa	Shona	Zulu
Aroma intensity			
Cooked	4.7 ± 0.09[a]	5.3 ± 0.15[b]	5.1 ± 0.16[b]
Fried	5.1 ± 0.09	5.4 ± 0.13	5.2 ± 0.16
Juiciness			
Cooked	4.5 ± 0.09[a]	4.9 ± 0.14[b]	4.7 ± 0.15[b]
Fried	5.1 ± 0.08	5.1 ± 0.12	5.4 ± 0.15
Muscle fibre and overall tenderness			
Cooked	4.9 ± 0.08[a]	5.5 ± 0.13[b]	5.6 ± 0.14[b]
Fried	4.9 ± 0.08	4.9 ± 0.12	5.1 ± 0.14
Amount of connective tissue (Residue)			
Cooked	4.7 ± 0.09[a]	5.0 ± 0.14[a]	5.5 ± 0.15[b]
Fried	4.6 ± 0.08[a]	4.5 ± 0.13[a]	4.9 ± 0.15[b]
Overall flavor intensity			
Cooked	4.9 ± 0.08	4.9 ± 0.13	5.0 ± 0.14
Fried	4.9 ± 0.07[a]	5.1 ± 0.12[a]	5.3 ± 0.14[b]
Off-flavour character			
Cooked	3.9 ± 0.24[a]	3.9 ± 0.30[a]	5.4 ± 0.36[b]
Fried	3.9 ± 0.30	3.5 ± 0.58	4.9 ± 0.43

Values within a row with different superscript are significant different ($P < 0.05$).

from supplemented and non-supplemented goats in terms of juiciness. High scores for sustained impression of juiciness in the fried XBC and BOR meat when compared with the XLE and NGN are consistent with the findings by Webb et al. (2005) who observed that, indigenous goat patties were less juicy and greasy than those from Boer goats and the sheep breeds.

Ideally, meat quality levels should combine the capacity to retain high nutritional value in the cooked form and to excel in functional roles such as flavor development, tenderness and juiciness of the cooked product among other roles (Dzudie et al., 2000; Muchenje et al., 2008a). Cooked meat from the non-supplemented NGN and XLE goats appeared to be tenderer than that of the other two breeds. Supplementation however, seemed to improve the tenderness of both the cooked and fried meat of the Xhosa-Boer and Boer goats. Overall, all breeds cooked meat appeared to be tenderer than the fried meat. Generally, tenderness varied due to changes to the myofribrillar protein structure of muscle in the period between animal slaughter and meat consumption (Swan et al., 1998; Muchenje et al., 2008b). The two main components to meat tenderness are myofibrillar (muscle) and connective tissue (collagen) components. The size of the muscle fibres increases with increasing age and may be tougher. Factors such as fat content, muscle fibre composition, electrical stimulation, aging regime and cooking also can affect tenderness (Swan et al., 1998; Muchenje et al., 2008b).

The observed overall flavor intensity of the fried meat from non-supplemented goat was significantly higher than that of cooked meat. With supplementation, the aroma intensity of all the genotypes was similar. Lack of genotype effect on the flavor intensity was contrary to observation made by Martinez-Cerezo et al. (2005) who observed higher flavour intensity in cooked meat samples of Maltese kids which were related with direct effects of genotype. Tshabalala et al. (2003) found lower flavour intensity in indigenous goats when compared with Boer goats and they explained this result by higher proportions of unsaturated fatty acids in meat samples of indigenous goats. Generally, meat flavor is affected by a number of factors including animal age and genotype, feeding regime, carcass fatness level and slaughter weight (French et al., 2001; Martinez-Cerezo et al., 2005; Muchenje et al., 2009). Flavour can be influenced by the type of diet through the deposition of unique components in the fat and animal species. Muchenje et al. (2008a) reported that, the flavor depends on the quantity and composition of fat in the meat and meat with a desirable flavour tended to have higher levels of intramuscular fat and more intense marbling. Thermal treatment also affects the flavour through the alteration of fat composition and degree of saturation of the fats (Dzudie et al., 2000).

More often than not, consumer perceptions on the acceptability of meat are linked to socio-cultural factors, especially in the African context. Although, goat meat and its products are also of satisfactory eating quality, factors such as gender, tribe and age tend to affect acceptability of chevon from one community to the next (Mahanjana and Cronje, 2000; Dyubele et al., 2010). Results from this study suggest that, female consumers tended to give higher scores in most of the sensory attributes and hence, found chevon more acceptable. Similar observations were also made by Simela et al. (2008). The effect of tribe was clear as in most sensory scores, significances differences were observed. From the results, it seemed the Xhosa tribe could not distinguish between the fried and cooked meat unlike the other two tribes. Moreover, the Xhosas generally gave low scores in all the sensory attributes when compared with the other two tribes. This could be attributed to characteristic nature of the Xhosa tribe who generally prefer mutton over goat meat because of cultural reasons as observed in other studies (Dyubele et al., 2010). Generally, the common culture of a particular tribe in any community is most likely the overriding reason on the perceptions of the goat meat and the cooking methods used (Tornberg, 2005). The culture of a community is in itself a very complex phenomenon influenced by available resources, pragmatic practices and beliefs (Webb et al., 2005).

Conclusions

Thermal treatment and supplementation were observed to influence sensory scores. There was an interaction between cooking method, genotype and diet in some sensory characteristics aroma intensity; scores of fried non-supplemented XLE and BOR meat was higher than those of the cooked meat. In the supplemented BOR goats, cooked meat had stronger aroma intensity than the fried meat. Generally, there was lack of goat genotype influence on the sensory attributes of goat meat unlike in other studies. Fried meat was observed to have more flavor than cooked meat though the fried meat was rated as having more connective tissue than the cooked meat. It was also observed that consumer acceptability of meat was dependent on age, gender and tribe. More importantly, resources, pragmatic practices and beliefs of any tribe had a significant influence on the acceptability of goat meat as well as the cooking methods used. All these factors should therefore, be taken into consideration when developing marketing strategies for chevon.

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