# Effects of *Acacia karroo* supplementation on the quality of meat from Xhosa lop-eared goats

**By**

**Simthembile NGAMBU**

**Dissertation submitted in fulfilment of the requirements for**

**MASTERS OF SCIENCE IN AGRICULTURE**

**(ANIMAL PRODUCTION SCIENCE- MEAT SCIENCE)**

**Faculty of Science and Agriculture**

**Department of Livestock and Pasture Science**

**University of Fort Hare**

**P/Bag X1314**

**Alice**

**South Africa**

**September 2011**

**Alice, South Africa**

**Supervisors: Professor V. Muchenje**

**Dr U. Marume**

## Declaration

I, **Simthembile Ngambu**, declare that this dissertation has not been submitted to any University and that is my original work conducted under supervision of Prof. V. Muchenje and co-supervisor Dr. U. Marume. All assistance towards the production of this work and all the references contained herein have been duly accredited.

_____ _____

Simthembile Ngambu **Date**

**Approved as style and content by:**

_____ _____

Prof. V. Muchenje Dr. U. Marume

September 2011

## Abstract

**Effects of *Acacia* *karroo* supplementation on meat quality of Xhosa Lop-Eared goats**

The objective of the study was to determine the effects of *A. karroo* supplementation on the quality of meat from Xhosa lop-eared goats. Eighteen castrated 4-month-old Xhosa lop-eared male kids were kept at the University of Fort Hare Farm until slaughter. At the beginning of the experiment the goats had a mean body weight of 13.5 ± 0.31 kg (mean ± S.E.) and a mean body condition score (BCS) of 3.3 ± 0.16 (mean ± S.E.). From birth until weaning the kids were kept on natural pastures with their mothers. After weaning the goats were housed in an open sided barn for a period of 60 days, and were fed 500 g/head/day of *Medicago sativa* hay covering their maintenance and growth needs. For the purpose of the experiment, the goats were randomly divided into two balanced treatment groups of nine goats each, supplemented group (AK) and non-supplemented group (NS). The supplemented group received an additional 200g per head per day of fresh *A. karroo* leaves collected each day for two months. Supplementary feed was given to the goats individually in feeding troughs. The kids were slaughtered at 60 days old and samples for meat quality assessment were taken from the *Longistimus dorsi* muscle. The effect of *A. karroo* supplementation on meat quality measurements such as ultimate pH, colour and cooking losses of meat from indigenous Xhosa lop-eared goats were determined. The effect of *A. karroo* supplementation on the consumer sensory characteristic scores of the meat from the indigenous Xhosa lop-eared breed was also determined. There was a significant effect of the *A. karroo* supplementation on the meat quality measurements except for $L^*$ and $a^*$ colour coordinates. Meat from the *A. karroo* supplemented goats had lower pH and cooking loss scores than that of the non-supplemented goats. *Acacia karroo* supplementation improves meat tenderness and juiciness. There were no significant effects of *A. karroo* supplementation on the flavour and off-

flavours of the meat from the supplemented goats. However, thermal preparation and consumer background had a significant effect on the meat sensory characteristics. The cooked meat had significantly higher sensory scores than the roasted meat. Female consumers reported higher sensory scores than male consumers. Consumers of different tribes and ages also reported significantly different sensory scores of meat from indigenous Xhosa lop-eared goats. Therefore, this study indicated that *A. karroo* supplementation can be fed to the Xhosa lop-eared goats to improve their meat quality.

**Keywords:** meat quality, thermal preparation, meat sensory scores, *Longistimus dorsi*, chevon.

List of abbreviation

*a** = Redness

AK= *Acacia karroo*

ACT = Amount of connective tissue,

AI = aroma intensity;

ATF = Off-flavour score.

*b** =Yellowness

BCS = body condition score

C.M= Cooking method,

C=Cooked,

CL= Cooking losses

F= Female,

IJ =Initial juiciness;

NS= not supplemented,

*L** = lightness

M= Male,

MFT = Muscle fibre and overall tenderness,

NS= Not Significant

OF = Overall flavour score,

R= Roasted

SJ = sustained juiciness,

Table of Contents

**List of tables**

**Acknowledgements**

The field studies were conducted at the university of Fort Hare Honeydale research farm. The meat quality measurements and sensory characteristics were done at the University of Fort Hare Livestock and Pasture Meat Science laboratories. My honest acknowledgements go to my supervisors, Professor V. Muchenje and Dr. U. Marume, who have both encouraged and supported me in wonderful ways during my studies.

I also take this opportunity to thank my colleagues, Mr. C. S. Gajana, Miss Z. Rani, Miss. M. N. Xazela and Mr. C. T. Mpendulo who all gave excellent assistance during the data collection i.e. meat quality measurements and sensory characteristics. My work would have been impossible to carry out in practice without your support. Most of all, I want to thank my Mother, Miss N. Saba for her lifelong support and encouragement. However, I dedicate this work to my late father, Mr. J. L. Ngambu. I also want to thank my brother Siyavuya and my nephew Siseko for their unconditional support in my life. I thank God for every step in this work.

# CHAPTER 1: INTRODUCTION

## 1.1 Background

Of the 6 441 000 goats that are found in South Africa, about 3 million, dominated by indigenous genotypes, are found in rural areas of the Eastern Cape Province (Shabalala & Mosima, 2002). Goats play a major role in the provision of meat (Simela, 2005), manure, milk, mohair and cash from sales of goats and their by-products (Thornton *et al*., 2002; Rumosa-Gwaze, Chimonyo, & Dzama, 2009). They are also used in traditional ceremonies (Ayalew, Rischkowsky, King, & Bruns, 2003; Rumosa-Gwaze *et al*., 2009).

Communal goat production is among the activities used for quick and easy income for communal households. The advantage of goats in low income households is that they are both grazers and browsers and therefore, can effectively utilize a wide range of feed resources with minimal supplementation. There are a number of constraints facing smallholder goat production. Underfeeding has been said to be the major source of problems such as diseases, poor growth and reproduction. Browsable plants have been observed to be a good source of feed, particularly protein, for goats in resource poor areas. Besides being a source of protein, brown species such as *acacia* species contain some polyphenolic compounds with an acaricidal effect on disease causing pathogens in the gastrointestinal tract such as gastrointestinal parasites (Xhomfulana, Mapiye, Chimonyo, & Marufu, 2009). *Acacia karroo* is among plant species which is abundant in most communal rangelands and is preferred by goats for browsing. This plant species is easily accessible by farmers and can be prepared and fed as leaf meal (Mapiye *et al.*, 2009). *Acacia karroo* contains up to 230g/kg CP and can be considered as a cheap source of proteins in communal goat and beef production (Mapiye *et al*., 2009).

Additional protein supplementation (Hoste *et al*., 2005; Hoste, Torres-Acosta, & Aguilar-Caballero, 2008) primarily through the use of protein sources such as *A. karroo* leaf meal (Mapiye *et al.*, 2009) in ruminant nutrition, improves animals' body weights and body condition scores (Arsenos *et al*., 2009). An improved body weight leads to heavier carcasses, thus improving the quality and quantity of meat produced (Arsenos *et al*., 2009). Feeding on *A. karroo* leaf meal has been reported to improve nutritional status, growth performance and carcass traits in cattle (Mapiye *et al.*, 2009).

Goat meat has been established as lean meat with desirable fatty acids (Safari, Mushi, Mtenga, Kifaro, & Eik, 2009) and favourable nutritional quality (Simela, 2005), as they deposit a relatively higher quantity of polyunsaturated fatty acids compared to other ruminants (Safari *et al.*, 2009). Consumer meat sensory characteristics are used to evaluate meat quality on the basis of meat palatability parameters such tenderness, juiciness, colour and flavour (Tshabalala, Strydom, Webb, & de Kocka, 2003), which are strongly affected by quantity and composition of fat in the meat (Muchenje *et al*., 2009) and pH (Priolo, Micol, & Agabriel, 2001). Meat sensory characteristics tend to be affected by meat quality measurements such as pH and cooking losses. Higher ultimate pH values produce meat that is darker in colour (Priolo *et al.*, 2001), and negatively affect meat tenderness, thus that can be attributed to low glycogen reserves caused by poor animal diet (Safari *et al.*, 2009).

## 1.2 Justification

The overwhelming use of sheep in many research studies has resulted in the scarcity of relevant information on goats (Hoste *et al*., 2005). There is a necessity to conduct such studies on goats, as naturally, they do not behave in the same way as sheep do in their growth and development, resulting to a difference in their meat sensory characteristics (Arsenos *et*

*al*., 2009). The Xhosa lop-eared genotype will be used in the study, since it is among goat genotypes recommended for meat production, given that it has a big framed body and is highly resistant to parasitic infections (Xazela, Chimonyo, Muchenje, & Marume, 2011).

Studies have been conducted on goats focusing on the effect of dietary supplementation on growth and meat quality of indigenous goats (Marume, 2010), consumer sensory evaluation of meat from South African goat genotypes fed sunflower cake (Xazela *et al*., 2011) and correlations among sensory characteristics from four different goat breeds (Ngambu, Muchenje, Chimonyo, & Marume, 2011). Simela (2005) also conducted a study on meat characteristics and acceptability of chevon from South African indigenous goats. In addition, the effect of *A. karroo* leaf meal supplementation on the meat quality of Nguni beef steers has been established (Mapiye *et al*., 2009). However, no studies have been conducted on the effect of *A. karroo* supplementation on meat sensory characteristic scores of Xhosa lop-eared goat breed. Hence, there is a necessity to conduct this study on the effect of *A. karroo* supplementation on meat sensory characteristics of Xhosa lop-eared goat breed.

## 1.3 Objectives

The major objective of the study was to determine the effect of *A. karroo* supplementation on the quality of meat from Xhosa lop-eared goats. The specific objectives were:

1. To determine the effect of *A. karroo* supplementation on ultimate pH, colour and cooking losses of meat from goats*;*

2. To determine the effect of *A. karroo* supplementation on consumer sensory characteristics of meat from goats;

## 1.4 Hypotheses

1. There is no effect of *A. karroo* supplementation on ultimate pH, colour and cooking losses of meat from goats;

2. There is no effect of *A. karroo* supplementation on consumer sensory characteristics of meat from goats.

## 1.5 References

Arsenos, G., Fortomaris, P., Papadopoulos, E., Sotiraki, S., Stamataris, C., & Zygoyiannis, D. (2009). Growth and meat quality of kids of indigenous Greek goats (Capra prisca) as influenced by dietary protein and gastrointestinal nematode challenge. *Meat Science*, 82 (3), 317-323.

Ayalew, W., Rischkowsky, B., King, J. M., & Bruns, E. (2003). Crossbreds did not generate more net benefits than indigenous goats in Ethiopian smallholdings. *Agricultural Systems*, 73, 1137–1156.

Hoste, H., Torres-Acosta, J. F., Paolini, V., Aguilar-Caballero, A., Etter, E., Lefrileu, Y., Chartier, C., & Broqua, C. (2005). Interactions between nutrition and gastrointestinal infections with parasitic nematodes in goats. *Small Ruminant Research*, 60, 141–151.

Hoste, H., Torres-Acosta, J. F. J., & Aguilar-Caballero, A. J. (2008). Nutrition-parasite interactions in goats: Is immunoregulation involved in the control of gastrointestinal nematodes? *Parasite Immunology*, 30, 79-88.

Mapiye, C., Chimonyo, M., Dzama, K., Strydom, P. E., Marufu, M. C., & Muchenje, V. (2009). Nutritional status, growth performance and carcass characteristics of Nguni steers supplemented with *Acacia karroo* leaf-meal. *Livestock Science*, 126, 206–214.

Marume, U. (2010). Effect of *Acacia karroo* on growth and meat quality of indigenous goats. PhD Thesis. University of Fort Hare, South Africa.

Muchenje, V., Hugo, A., Dzama, K., Chimonyo, M., Strydom, P. E., & Raats J. G. (2009). Cholesterol levels and fatty acid profiles of beef from three cattle breeds raised on natural pasture. *Journal of Food Composition and Analysis*, 22, 354–358.

Ngambu, S., Muchenje, V., Chimonyo, M., & Marume, U. (2011). Correlations among sensory characteristics and relationships between aroma scores, flavour scores, off-flavour scores and off-flavour descriptors of chevon from four goat genotypes. *African Journal of Biotechnology*, 10 (34), 6575-6580.

Priolo, A., Micol, D., & Agabriel, J. (2001). Effects of grass feeding systems on ruminant meat colour and flavour. A review. *Animal Research*, 50 (56), 185–200.

Rumosa-Gwaze, F. G., Chimonyo, M., & Dzama, K. (2009). Communal goat production in Southern Africa: A review. *Tropical Animal Health Production*, 41, 1157-1168.

Safari, J., Mushi, D. E., Mtenga, L. A., Kifaro, G. C., & Eik, L. O. (2009). Effects of concentrate supplementation on carcass and meat quality attributes of feedlot finished Small East African goats. *Livestock Science*, 125, 266–274.

Shabalala, N., & Mosima, B. (2002). Report on the survey of large and small scale agriculture/ Statistics South Africa. Statistics S.A Library Cataloguing-in-Publication (CIP) Data Pretoria: Statistics South Africa.

Simela, L. (2005). Meat characteristics and acceptability of chevon from South African Indigenous goat. Ph.D. Thesis, University of Pretoria, South Africa.

Thornton, P. K., Kruska, R. L., Henninger, N., Kristjanson, P. M., Reid, R. S., Atieno, F., Odero, A., & Ndegwa, T. (2002). Mapping poverty and livestock in developing countries. *International Livestock Research Institute*, Nairobi, Kenya, 132.

Tshabalala, P. A., Strydom, P. E., Webb, E. C., & de Kocka, H. L. (2003). Meat quality of designated South African indigenous goat and sheep breeds. *Meat Science*, 65, 563-570.

Xazela, N. M., Chimonyo, M., Muchenje, V., & Marume, U. (2011). Consumer sensory evaluation of meat from South African goat genotypes fed on a dietary supplement. *African Journal of Biotechnology*, 10 (20), 4436-4443.

Xhomfulana, V., Mapiye, C., Chimonyo, M., & Marufu, M. C. (2009). Supplements containing *Acacia karroo* foliage reduce nematode burdens in Nguni and crossbred cattle. *Animal Production Science*, 49 (08), 646–653.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

Goat production constitutes an important subsystem of animal production, especially in semi-arid and arid areas (Simela, 2005). Productivity indicators such as sales and home slaughter reveal that goat productivity in smallholder areas is low. This could be due to negative perceptions of chevon by consumers (Webb, Casey, & Simela, 2005). The majority of consumers do not accept chevon in their day-to-day consumption because they perceive it as smelly (Simela, 2005). South African urbanites associate chevon with traditional and religious ceremonies rather than with daily consumption (Simela *et al.*, 2008; Rumosa-Gwaze, Chimonyo, & Dzama, 2009). Despite the generally negative perception of chevon, consumers and trained taste panelists in sensory studies have found that chevon is desirable and of satisfactory quality (Simela, 2005). Sensory evaluations have shown that goat meat is acceptably palatable and desirable to consumers.

Diet has been shown to be one of the main factors influencing carcass yield and qualities in many livestock species (Wood *et al.*, 2008), specifically in goats (Warmington & Kirton, 1990; Webb *et al.*, 2005). Feed accounts for the highest single cost of the majority of livestock meat production operations. Goat meat production requires a high quality and balanced diet of mainly proteins. Conventional feeds are expensive and are out of the reach of resource poor farmers. Therefore, profitable goat meat production can only be achieved by optimizing the use of high quality forage and browse instead of more expensive concentrate feeds (Matthew & Jean-Marie, 2002). Browse trees such as *A. karroo* are gaining importance as a protein supplement for grazing ruminants because they are widespread and abundantly available during the dry season (Mokoboki, Ndlovu, Ngambi, Malatje, & Nikolovav, 2005). This chapter will place emphasis on the sensory and consumer evaluation of meat and the sensory characteristics of chevon such as meat juiciness, tenderness and flavour. The meat

quality measurements and the use of browse plants such as *A. karroo* as supplement in ruminants and specifically, in goats and its effect on chevon quality will be dealt.

## 2.2 *Acacia karroo* as a supplement on meat producing goats

### *2.2.1 Browse trees to grass species preference by goats*

Goats are known to be browsers (Moleele, 1998; Ngwa *et al*., 2000; Omphile *et al.*, 2003). They thrive better on tree leaves, while grazing is not a major component in their diets (Budisatria *et al.*, 2010). Goats held under communal farming commonly have a wide range of different types of feeds available to them, as they generally prefer to alternate between different feeds (Abdel-Moneim & abd-Alla, 1999). Goat feed preference is affected by season and nutritional needs. They prefer browsing than grazing during summer and increase preference when nutritional needs are covered (Provenza, 1995). The effect of season on feed preference is shown in Table 2.1.

Table 2.1: Effect of season on goat browse to grass consumption

| **Month** | **Shrubs (%)** | **Forbs (%)** | **Grasses (%)** |
|---|---|---|---|
| Summer | 84 | 11 | 5 |
| Winter | 79 | 13 | 8 |
| Annual means | 82 | 11 | 7 |

Adapted from Ramirez (1999)

According to Ramirez (1999), grasses represented the group of plants that were less consumed by goats (Table 2.1) throughout the year. In winter, goats select the highest amount of grasses, probably because of the growth of grasses during this period. Papachristou and Nastis (1993) experimentally demonstrated that goats exhibit very rapid seasonal shifts between shrubs, grasses and forbs, depending on their availability and their seasonal nutritive value. Similar results on the preference of grass to browse species were also reported in earlier studies (Pfister & Malechek, 1986).

The ability of ruminants to select feed depends greatly on past experience, as familiar feed is always preferred to new feed. Goat preference for shrubby species is also affected by the abundance of shrubby species in particular zones and accessibility (le Houerou, 1980). Goats rely on browse species, which do not decline in quality to the same degree as herbaceous species (Sanona *et al*., 2007), to supplement the protein, minerals and vitamins in their diet (le Houerou, 1980). The nutritive value of browse species is known to be high, with lower variation over time, when compared to grasses (Fadel Elseed *et al*., 2002).

### *2.2.2 Intake of browse plants (Acacia karroo) by goats*

Goats prefer the leaves and twigs of trees containing condensed tannins (CT) and digest them better than other forage eating ruminants (Villena & Pfister, 1990; Lee, Lee, Lee, 1990; Silanikove, 2000). Goats are primarily browsers, and in most areas browse constitutes 60-80% of goat diets (Kababya, 1995). They are able to consume larger amounts of tannin-rich browse than sheep under similar conditions (Gilboa, Nir, Nitsan, Silanikove, & Perevolotsky, 1995; Silanikove, Gilboa, Perevolotsky, & Nitsan, 1996). They inevitably select the leaves in preference to the stems, as leaves have much higher concentration of CT.

The voluntary intake and leaf selection of tannin plants such as *A. karroo* is, however, highly disturbed by the presence of thorns (Mapiye, Chimonyo, Marufu, & Dzama, 2011), which restrict the accessibility of the leaves and phenolic compounds (Teague, 1989). Reduced intake, degradability and nutrient availability (Mokoboki *et al.*, 2005), as well as the intestinal absorption of proteins and carbohydrates (Giner-Chavez, 1996) are associated with the Phenol compounds present in tannin plants.

Robbins *et al.* (1987); Silanikove, Nitsan, and Perevolotsky (1994); Silanikove *et al.* (1996) established a relationship between the intake of a high level of tannin forage plants, palatability, digestibility and nitrogen (N) retention in small ruminants. Unfortunately; the relationship that was found produced negative effects of tannins in ruminants as it resulted in reduced feed intake, palatability, low rate of evacuation of digesta out of the rumen and toxic effects (Kumar & Singh, 1984; Provenza, 1995). Tannins increase the-N-content of faeces and decrease urinary N output (Waghorn & McNabb, 2003). The low intake of *ad libitum* browse containing tannins by goats can further be improved by the provision of polyethylene glycol (PEG) (Waghorn, 2008). Villalba, Provenza, and Banner (2002) reported that access to PEG resulted in an increased intake of a pelleted tanniniferous diet by sheep and goats. Recently, the use of PEG to diminish the negative effects of condensed tannins offers good potential to improve goat production (Waghorn, 2008).

Condensed tannins are secondary plant compounds generally regarded as toxic to animals when consumed in large amounts (Rojas *et al.*, 2006). Normally, animals consuming tannin-rich feeds appear to develop defensive mechanisms against tannins (Makkar, 2003) given that, under very high levels of tannin intake by animals, the tannin compounds might

negatively affect protein utilization (Pell, Mackie, Mueller-Harvey, & Ndlovu, 2001). However, they can produce toxicity and can even cause death (Garg *et al.,* 1992). Animals in tropical and dry environments are more prone to this, since trees and shrubs are an important source of fodder for livestock (Topps, 1992) though they tend to contain higher amounts of tannin than temperate plants (Rojas *et al.,* 2006). Niezen, Waghorn, Raufaut, Robertson, and McFarlane (1994) reported that levels of condensed tannins vary between different plant species.

*2.2.3 Nutritive value of browse plants and beneficial effect on meat quality of goats.*

According to Mandal (1997), nutritive value is a function of feed intake (FI) and the efficiency of extraction of nutrients from the feed during digestion. Fodder trees and shrubs represent an enormous potential source of protein for ruminants in the tropics (Ngongoni, Mapiye, Mwale, & Mupeta, 2007). Some of these species are highly digestible, providing nutrients to rumen microorganisms (Umunna, Nsahlai, & Osuji, 1995) and can increase voluntary intake. The main features of browse plants are their high crude protein (CP) (100–250 g/kg DM) and mineral contents (Mokoboki *et al.,* 2005; Devendra & Sevilla, 2002), however they have antihelmintic properties (Xhomfulana, Mapiye, Chimonyo, & Marufu, 2009) and a high content of secondary plant metabolites (Monforte-Briceño, Sandoval-Castro, Ramírez-Avilés, & Capetillo, 2005).

The *Acacia* species are reported to be a valuable source of forage for ruminants where feed quality is a production constraint (Goodchild & McMeniman, 1994). This could be attributed to the fact that the *Acacia* species can easily meet nutrient requirements, mainly proteins (Aganga, Tsopito, & Adogla-Bessa, 1998; Kahiya, Mukaratirwa, & Thamsborg, 2003;

Mokoboki *et al*., 2005) and minerals (Aganga *et al*., 1998; Mokoboki *et al*., 2005) relative to other palatable indigenous plants without condensed tannins.

According to Rubanza, Shem, Otsyina, and Fujihara (2005), the concentration of crude protein in leaves of the majority of fodder trees and shrubs is above 10% even in the dry season when it tends to decrease. Generally, calcium and potassium contents are higher than other minerals. The role of trees and shrubs in the supply of vitamins is indirectly demonstrated by the fact that browsers such as goats contract photophobia, which many large ruminants such as cattle are prone to during the dry season. In ruminants dietary condensed tannins (2–3%) have been shown to impart beneficial effects (Hoste, Jackson, Athanasiadou, Thamsborg, & Hoskin, 2006) that are associated with their anthelminthic properties and anti-oxidant effects (Saura-Calixto, Serrano, & Goñi, 2007). The dietary tannins reduce the wasteful protein degradation in the rumen by the formation of a protein-tannin complex (Barry, 1987; Min & Hart, 2003).

The complex appears to dissociate post-ruminally at a low pH where, apparently, the protein becomes available for digestion (Cossalter, 1986). However, free condensed tannins would probably be available to form a complex with digestive enzymes such as pepsin and also with the protein of gut wall. In addition, tannin plants such as *A. karroo* improve the nutritional status, growth performance and carcass traits (Mapiye *et al.*, 2009), and reduces nematode burdens (Niezen *et al.*, 1998; Xhomfulana *et al*., 2009) in ruminants. Tannin plants affect the biology of the *H. contortus* especial in larval stage three. In that way, it controls the parasitic populations (Niezen *et al.*, 1998).

## 2.3 Meat quality measurements

### *2.3.1 The effect of browse plant diet on the meat colour of goats*

The first impression consumers have of any meat product is its colour, thus, colour is of most importance (Faustman & Cassens, 1990; Glitsch, 2000; Mancini & Hunt, 2005). Meat colour varies from the deep purplish-red of freshly cut beef to the light gray of faded cured pork. Moreover, meat discoloration limits the shelf life after retail preparation (Jeyamkondan, Jayas, & Holley, 2000). The colour of meat can be controlled if factors that influence it, such as meat pH and diet, are understood (Priolo *et al*., 2005). Higher pH values produce meat that is darker in colour (Priolo, Micol, & Agabriel, 2001).

In the study conducted by Priolo *et al*. (2005), it was reported that tanniniferous fed small ruminants produce meat of a light colour compared to other animals given same diet, but with eliminated tannin effect. The same results were reported by Verna, Pace, Settineri, Di Giacomo, & Nanni (1989) on lambs fed the strain containing the higher level of tannins. Tannins from different plant species have similar effects on lamb meat colour (Priolo, Ben Salem, Atti, & Nefzaoui, 2002). The effect of tannins on meat colour could be due to a reduced microbial biosynthesis of vitamin $B_{12}$ which is a precursor for the synthesis of haeme pigments (Vasta, Nuddab, Cannas, Lanza, & Priolo, 2008).

### *2.3.2 The effect of diets containing browse plants on goat meat cooking losses*

Cooking loss, which is one of the parameters of meat quality, refers to the reduction in weight of meat during the cooking process (Jama *et al*., 2008). Among factors affecting cooking loss is animal species (Pike, Smith, Carpenter, & Shelton, 1973), water holding capacity (Adam, Atta, & Ismail, 2010) and fat content (Lawrie, 1998). Cooking losses are possibly stimulated

by the limited fat content and water holding capacity (Lawrie, 1998). The water-holding capacity of fresh meat is its ability to retain inherent water. It is a very important meat quality attribute that has an influence on product yield, which in turn has economic implications, but is also important in terms of consumption quality. Early postmortem activities including rate and extent of pH decline, proteolysis and even protein oxidation are factors that affect the ability of meat to retain moisture (Huff-Lonergan & Steven, 2005).

Higher cooking losses are an indication of a decrease in water holding capacity. It is because of these cooking losses that chevon has been found less juicy than other animal species such as sheep (Pike *et al*., 1973). Adam *et al.* (2010) reported no effect of diet on cooking losses. The same author reported cooking losses on an average of 34.2% and this is assumed to be attributed to other production parameters such as animal species and breed.

### 2.4 Sensory and consumer evaluation of meat

Diet has been shown to be one of the main factors influencing carcass yield and qualities in many livestock species (Warmington & Kirton, 1990; Webb *et al.*, 2005; Wood *et al*., 2008). Ruminants supplemented by browse plants produce meat of a light colour compared to other diet (Priolo *et al*., 2005). Browse plants such as *Acacia* species can easily meet nutrient requirements, mainly proteins and minerals (Kahiya *et al*., 2003; Mokoboki *et al*., 2005) which could lead to developing marbled meat muscles. However, meat sensory characteristics such as tenderness, juiciness and flavour are produced. The sensory evaluation of meat is a scientific discipline used to measure, analyse, and interpret meat quality. Meat quality is, therefore, perceived by the senses of flavour, aroma, juiciness and tenderness and are highly affected by diet (Arsenos *et al*., 2009), breed (Muchenje *et al*., 2008) age (Simela,

2005) and animal species (Stone & Sidel, 1993). Meat sensory characteristics can be evaluated by objective methods i.e. instrumental or sensorial, with trained panels and by subjective methods with a consumer panel (AMSA, 1995). According to Risvik (1995), there is a fundamental difference in the sensory evaluation performed by trained or instrumental analysis and that performed by a consumer panel.

Consumer meat evaluation permits the evaluation of different treatments as well as determining their effect on a particular characteristic. It can also tell about the acceptability of the meat (Destefanis, Brugiapaglia, Barge, & DalMolin, 2007). For this reason, consumer opinion is a key factor in establishing meat value, as it justifies purchase decisions. Therefore, consumer meat evaluation for meat quality is suggested (Destefanis *et al.*, 2007). The use of consumers from different backgrounds is encouraged when sensory evaluation of meat is being conducted, given that consumers from different countries, different segments affluence with different preferences and reasons (Sveinsdóttir *et al.*, 2009). The differences between and within countries might be explained by different consumption patterns of chevon. For example, in countries such as South Africa, chevon is assumed to be more suitable for traditional activities (Mahanjana & Cronje, 2000). While some countries discriminate against goat meat, in tropical regions, goat meat is preferred to beef (Dhanda, Taylor, Murray, & McCosker, 1999)

Meat evaluation using consumer panels is considered disadvantageous because it is time consuming, expensive and difficult to organise (Harris, 1976; Boccard *et al.*, 1981; Brady & Hunecke, 1985; Platter *et al.*, 2003). As a result, many attempts have been made to invent instrumental methods of assessing meat sensory characteristics (Boccard *et al.*, 1981), whose results can predict sensory characteristics mainly tenderness obtained by a taste panel (Lawrie & Ledward, 2006).

Instrumental analysis of meat can permit the evaluation of different treatments as well as determine their effect on a particular characteristic. The Texture Profile Analysis (TPA) and the Warner-Bratzler Shear Force (WBSF) are among the invented instruments for meat sensory evaluation (Caine, Aalhus, Best, Dugan, & Jeremiah, 2002). Previous reports indicate that the TPA and WBSF have similar capabilities to evaluate sensory characteristics of meat, primarily tenderness. However, there is limited information comparing these two instrumental methods under similar test conditions (Caine *et al.,* 2002). The pH meter and calorimeter are used for measuring meat pH and meat colour respectively. These instruments are indirect measures of some meat sensory characteristics. Among those is meat juiciness for meat pH and meat tenderness for meat colour.

### *2.4.1 Sensory characteristics of chevon*

The sensory properties of meat have an impact on consumer appreciation of the meat. This also determines their perception of its acceptability and quality (Simela, 2005). Sensory properties are pivotal in this respect because consumers need to be entirely satisfied with the sensory properties before other elements become relevant. The acceptability of meat can be predicted from tenderness, juiciness and flavour. Tenderness has been identified as the most important factor influencing the acceptability of beef. Juiciness and flavour have a greater effect on consumer satisfaction as toughness increases (Miller *et al.,* 2001).

#### *2.4.1.1 Meat tenderness*

Tenderness appears to be the most important sensory characteristic of meat and a predominant quality determinant (Sebsibe, 2006). Meat tenderness is rated as the most important attribute of eating quality and is the factor that determines the consumers continued interest in the meat (Simela, 2005). It is a function of the collagen content, heat stability and

the myofibrillar structure of muscle **(**Muchenje *et al*., 2009). Factors affecting meat tenderness include animal species, breed **(**Muchenje *et al*., 2008), diet (Arsenos *et al*., 2009), age (Simela, 2005), aging, fatness and muscle location (Sebsibe, 2006).

Goats may have less intramuscular fat because they deposit more fat around visceral organs than in the muscles and this results in poor tenderness (Swan, Esguerra, & Farouk, 1997). Tenderness varies, mainly due to changes in the myofibrillar protein structure of muscle in the period between animal slaughter and meat consumption (Muir, Wallace, Dobbie, & Bown, 2000). This happens when the carcass is refrigerated too hastily immediately after slaughter. The muscle fibres contract severely, resulting in cold-shortening which will require a force to shear the fibres after cooking (Razminowicz, Kreuzer, & Scheeder, 2006). Tenderness is also affected by the degree to which the meat is cooked (Simela, Webb, Bosman, & Pienaar, 2002). It has been shown that, during cooking, (between 52°C and 70°C) collagen shrinks.

Tenderness improves with muscle ageing (Simela, 2005). Sarcomere length, connective tissue and the proteolysis of myofibrillar proteins are said to explain most of the variation observed in tenderness of aged meat **(**Muchenje *et al.*, 2009). However; proteolysis is the main biochemical factor contributing to the variation in tenderness **(**Muchenje *et al.*, 2009). Therefore, ageing can be intentionally used to decrease shear force values during post-mortem storage. Meat muscle tenderness can also be determined from the content and state of the connective tissue and the structure and state of the myofibrils (Simela, Webb, & Bosman, 2003). Connective tissue contributes to meat toughness. Effect of Myofibrillar to meat tenderness depends on the extent of shortening during rigor development and proteolysis during conditioning (Simela, 2005).

The breed and the animal species greatly affect variety in meat tenderness **(**Muchenje *et al*., 2008). There is variation among animal species such as sheep and goats and among breeds within a species (Sebsibe, 2006). Variation among breeds reared in the same environment and slaughtered at the same age, weight, and degree of finish suggests a genetic cause for some tenderness variation (Sebsibe, 2006). In beef, there is a heritability value of 60% for tenderness suggesting that heredity may be a major influence (Sebsibe, 2006).

*2.4.1.2 Meat juiciness*

Meat juiciness is one of the major parameters considered in the assessment of meat quality (Muchenje *et al.,* 2008). Meat juiciness is the wetness during first bite and sustained juiciness due to the fat in the meat. The sensation of juiciness in chevon is closely related to the quantity and composition of intramuscular fat (Muchenje *et al.,* 2008) and the age of the animal (Simela, 2005). Chevon has been reported to be less juicy, especially for sustained juiciness (Tshabalala, Strydom, Webb, & de Kocka, 2003), given that goat carcasses have a low fat content. Within animal species, meat juiciness is affected by the age of the animal given that goat carcasses ranging from 10 to 25kg were juicier than older goats with carcasses ranging from 15 to 30kg (Simela *et al.,* 2008).

Muchenje *et al*. (2008) reported that meat juiciness is high in well marbled carcasses. This agrees with Webb *et al*. (2005) who reported that meat Juiciness is directly related to the intramuscular lipids and moisture content of the meat. Juiciness can also be determined by the sensory evaluation from the measures of water in the meat such as water holding capacity and cooking losses (Simela, 2005). The water holding capacity is defined as the ability of

meat to retain its water during the application of external forces, such as cutting, heating, grinding or pressing (Lawrie & Ledward, 2006).

*2.4.1.3 Aroma and meat flavour*

Flavour is a general term used to define the taste and aroma of the meat during chewing (Moody, 1983). Meat flavour consists of taste-active compounds, flavour enhancers and aroma components (Stelzleni & Johnson, 2007). Flavour and aroma are two complex attributes of meat palatability (Calkins & Hodgen, 2007). The natural flavour of meat can be influenced by the animal species (Lee *et al*., 2004), the age of an animal (Melton, 1983), the lipid content (Miller, Moeller, Goodwin, Lorenzen, & Savell, 2000), the gender, diet (Sitz, Calkins, Feuz, Umberger, & Eskridge, 2005), meat pH (Calkins & Hodgen, 2007) and the thermal treatment (Webb *et al.*, 2005). The animal species is the most important genetic factor, and the feed source is the most important environmental factor (Carmack, Kastner, Dikeman, Schwenke, & Garcia Zepeda, 1995).

There are large numbers of compounds in meat, and their complex interactions influence the perception of the meat. Many of these compounds are transformed primarily during cooking and storage (Calkins & Hodgen, 2007). Lipids play several roles in flavour development. They act as a solvent for the volatile compounds that develop during production, handling, and thermal processing (Moody, 1983). They undergo thermal oxidative change to produce compounds that influence beef flavour and react with components of lean tissue to give distinct flavour compounds (Mottram & Edwards, 1983).

Meat flavours also develop during the Maillard reaction where pH plays a role (Calkins & Hodgen, 2007). This reaction produces gylcosylamine which is rearranged and dehydrated to

form furfural, furanone derivatives, hydroxyketones, and dicarbonyl compounds. All of these compounds contribute to flavour development (Calkins & Hodgen, 2007). Flavour intensity increases with the age of an animal although reports disagree on which age group are the most acceptable (Simela *et al.*, 2003). Flavour was found to be the most important factor affecting consumer meat buying habits and preferences when tenderness was held constant as it is the most considered (Sitz *et al.*, 2005).

### 2.5 Summary

Browse plants such as the *A. karroo* can be used to escape diet problems faced by communal goat meat producers. This is supported by the fact that the *A. karroo* can provide meat nutrient requirements for growth and can also improve carcass traits in ruminants, thus improving meat quality. Meat sensory characteristics are the major components used to decide on meat quality. These sensory characteristics are affected by several factors. Among these are diet, thermal preparation and consumer background. However; the use of browse plants were proved to be a key solution in ruminant supplementation. The levels of tannin in browse plants provided to ruminants have to be monitored, given that excess tannin consumption has anti- nutritional effects. Browse plants affect the meat quality of ruminants such as pH, colour and cooking losses. Browse plant fed to ruminants produce bright red meat colour. The bright red meat colour could be attributed to the potential of browse plants to provide proteins and minerals that are utilised as energy during lactic acid production to monitor muscle pH. The desirable muscle pH produced affects both meat colour and cooking losses.

## 2.6 References


Abdel-Moneim, A. Y., & abd-Alla, M. S. (1999). Feed preference by Baladi goats. *Applied Animal Behaviour Science,* 65, 63-72.

Adam, A. A. G., Atta, M., & Ismail, S. H. A. (2010). Quality and sensory evaluation of meat from Nilotic male kids fed on two different diets. *Journal of Animal and Veterinary Advances*, 9 (15), 2008-2012.

Aganga, A. A., Tsopito, C. M., & Adogla-Bessa, T. (1998). Feed potential of *Acacia species* to ruminants in Botswana. *Arch. Zootec*, 47, 659–668.

AMSA. (1995). Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Chicago, Illinois: *American Meat Science,* Association in cooperation with National Live Stock and Meat Board.

Arsenos, G., Fortomaris, P., Papadopoulos, E., Sotiraki, S., Stamataris, C., & Zygoyiannis, D. (2009). Growth and meat quality of kids of indigenous Greek goats (*Capra prisca*) as influenced by dietary protein and gastrointestinal nematode challenge. *Meat Science*, 82(3), 317-323.

Barry, T. N. (1987). Secondary compounds of forages. In: Nutrition of herbivores. Hacker, J. B. & Ternouth, J. H. (eds.) A. P. Sydney, 91–120.

Boccard, R., Buchter, L., Casteels, M., Cosentino, E., Dranseld, E., Hood, D. E., Joseph, R. L., MacDougall, D. B., Rhodes, D. N., SchoÈ n, I., Tinbergen, B. J., & Touraille, C. (1981). Procedures for measuring meat quality characteristics in beef production experi- ments.

Report of a Working Group in the Commission of the Eur- opean Communities' (CEC) Beef Production Research Programme. *Livestock Production Science*, 8, 385-397.

Brady, P. L., & Hunecke, M. E. (1985). Correlation of sensory and instrumental evaluations of roast beef texture. *Journal of Food Science*, 50,300–303.

Budisatria, I. G. S., Udo, H. M. J., Eilers, C. H. A. M., Baliarti, E. and Van der Zijpp A. J., 2010. Preferences for sheep or goats in Indonesia. *Small Ruminant Research*, 88:16–22.

Caine, W. R., Aalhus, J. L., Best, D. R., Dugan, M. E. R., & Jeremiah, L. E. (2002). Relationship of texture profile analysis and Warner-Bratzler shear force with sensory characteristics of beef rib steaks. *Meat Science*, 64,333–339.

Calkins, C. R., & Hodgen, J. M. (2007). A fresh look at meat flavour. *Meat Science*, 77(1), 63-80.

Carmack, C. F., Kastner, C. L., Dikeman, M. E., Schwenke, J. R., & Garcia Zepeda, C. M. (1995). Sensory evaluation of beef flavour -intensity, tenderness, and juiciness among major muscles. *Meat Science*, 39(1), 143–147.

Cossalter, C. (1986). Introducing Australian *Acacias* in dry, tropical Africa. In: Australian *Acacias* in developing countries. Proceedings of an international workshop held at the Forestry Training Centre, Gympie, Queensland, Australia, 4– 7.

Destefanis, G., Brugiapaglia, A., Barge, M. T., & DalMolin, E. (2007). Relationship between beef consumer tenderness perception and Warner–Bratzler shear force. *Meat Science*, 78(3), 153-156.

Devendra, C., & Sevilla, C. C. (2002). Availability and use of feed resources in crop-animal systems in Asia. *Agricultural Systems*, 71(12), 59–73.

Dhanda, J. S., Taylor, D. G., Murray, P. J., & McCosker, J. E. (1999). The influence of goat genotype on the production of Capretto and Chevon carcasses. 2. Meat quality. *Meat Science*, 52,363-367.

Fadel Elseed, A. M. A., Amin, A. E., Khadiga, A., Abel Ati, J., Sekine, M., Hishinuma, M., & Hamana, K. (2002). Nutritive evaluation of some fodder tree species during the dry season in Central Sudan. *Asian-Australasian Journal of Animal Science*, 15, 844–950.

Faustman, C., & Cassens, R. G. (1990). The biochemical basis for discoloration in fresh meat: A review. *Journal of Muscle Foods*, 1,217–243.

Garg, S. K., Makkar, H. P. S., Nagal, K. B., Sharma, S. K., Wadhwa, D. R., & Singh, B. (1992). Toxicological investigations into oak (*Quercus incana*) leaf poisoning in cattle. *Veterinary Human Toxicology*, 34,161–164.

Gilboa, N., Nir, I., Nitsan, Z., Silanikove, N., & Perevolotsky, A. (1995). Effect of polyethylene glycol on feed intake, body weight and digestibility in goats fed tannin-rich leaves. *Hassadeh*, 75, 72-73.

Giner-Chavez, B. I. (1996). Condensed tannins in tropical forages. Ph.D. Thesis, Cornell University, Ithaca, New York, United States of America.

Glitsch, K. (2000). Consumer perceptions of fresh meat quality: crossnational comparison. *British Food Journal*, 102,177–194.

Goodchild, A. V., & McMeniman, N. P. (1994). Intake and digestibility of low quality roughage when supplemented with leguminous browse. *Journal of Agricultural Science*, 122,151–160.

Harris, P. V. (1976). Structural and other aspects of meat tenderness. *Journal of Texture Studies*, 7, 49–63.

Hoste, H., Jackson, F., Athanasiadou, S., Thamsborg S. M., & Hoskin, S.O. (2006). The effects of tannin-rich plants on parasitic nematodes in ruminants. *Trends Parasitology*, 22, 253–261.

Huff-Lonergan, E., & Steven, M. L. (2005). Mechanisms of water-holding capacity of meat: The role of postmortem biochemical and structural changes. *Meat Science*, 71(1), 194-204.

Jama, N., Muchenje, V., Chimonyo, M., Strydom, P. E., Dzama, K., & Raats, J. G. (2008). Cooking loss components of beef from Nguni, Bonsmara and Angus steers. *African Journal of Agricultural Research*, 3(6), 416-420.

Jeyamkondan, W., Jayas, D. S., & Holley, R. A. (2000). Review of centralized packaging systems for distribution of retail-ready meat. *Journal of Food Protection*, 63, 796–804.

Kababya, D. (1995). Grazing behaviour and nutrition of goats in Mediterranean woodland. M.Sc. thesis. The Hebrew University of Jerusalem, Jerusalem, Israel.

Kahiya, C., Mukaratirwa, S., & Thamsborg, S. M. (2003). Effects of *Acacia Nilotica* and *Acacia karroo* diets on *Haemonchus Contortus* infection in goats, *Veterinary Parasitology*, 115, 265–274.

Kumar, R., & Singh, M. (1984). Tannins, their adverse role in ruminant nutrition. *Journal of Agricultural Food Chemestry*, 32, 447-453.

Lawrie, R. A. (1998). Lawrie's Meat Science. 6th edition, woodhead publishing Ltd., Cambridge, England.

Lawrie, R. A., & Ledward, D. A. (2006). Lawrie's meat science, Woodhead Publishing Ltd, Cambridge, England.

le Houerou, H. N. (1980). The role of shrubs and trees in the sahelian and sudanian zone. In: le Hou´erou, H. N. (Ed.), Browse in Africa: The Current State of Knowledge. Papers presented at the International Symposium on Browse in Africa. Addis Ababa, April 8–12. ILCA, Addis Ababa, Ethiopia, 85–101.

Lee, J. H., Lee, I. D., Lee, H. S. (1990). Studies on the utilization of browse for the Sika Deer (*Cervus Nippon*): II. Chemical composition digestibility and dry yield of browse. *Korean Journal of Animal Science*, 32, 109–118.

Lee, M. R. F., Winters, A. L., Scollan, N. D., Dewhurst, R. J., Theodorou, M. K., & Minchin, F. R. (2004). Plant-mediated lipolysis and proteolysis in red clover with different polyphenol oxidase activities. *Journal of the Science of Food and Agriculture*, 84(13), 1639–1645.

Mahanjana, A. M., & Cronje, P. B. (2000). Factors affecting goat production in a communal farming system in the Eastern Cape region of South Africa. *South African Journal of Animal Science*, 30, 149–154.

Makkar, H. P. S. (2003). Effects and fate of tannins in ruminant animals, adaptation to tannins and strategies to overcome detrimental effects of feeding tannin-rich feeds. *Small Ruminant Research*, 49, 241–256.

Mancini, R. A., & Hunt, M. C. (2005). Current research in meat colour. *Meat Science*, 71, 100–121

Mandal, L. (1997). Nutritive values of tree leaves of some tropical species for goats. *Small Ruminant Research*, 24, 95- 105.

Mapiye, C., Chimonyo, M., Dzama, K., Strydom, P. E., Marufu, M. C., & Muchenje, V. (2009). Nutritional status, growth performance and carcass characteristics of Nguni steers supplemented with *Acacia karroo* leaf-meal. *Livestock Science*, 126, 206–214.

Mapiye, C., Chimonyo, M., Marufu, M. C., & Dzama, K. (2011). Utility of *Acacia karroo* for beef production in Southern African smallholder farming systems: A review. *Animal Feed Science and Technology*, 164, 135–146.

Matthew, H. P., & Jean-Marie, L. (2002). Improving Meat Goat Nutrition with Forages and Supplementation. *Kentucky Ruminant Nutrition*, 11-20

Melton, S. L. (1983). Effect of forage feeding on beef flavour. *Food Technology*, 37(5), 239–248.

Miller, R. K. (2001). Beef flavour: A white paper, National Cattlemens, Beef Association, Centennial, CO.

Miller, R. K., Moeller, S. J., Goodwin, R. N., Lorenzen, C. L., & Savell, J. W. (2000). Consistency in meat quality. In Proceedings of the 46th international congress of meat science & technology, Buenos Aires, Argentina, 566–580).

Min, B. R., & Hart, S. P. (2003). Tannins for suppression of internal parasites. *Journal of Animal Science*, 81, 102–109.

Mokoboki, H. K., Ndlovu, L. R., Ngambi, J. W., Malatje, M. M., & Nikolovav, R.V. (2005). Nutritive value of *Acacia* tree foliages growing in the Limpopo Province of South Africa. *South African Journal of Animal Science*, 35(4), 221–228.

Moleele, N. M. (1998). Encroacher woody plant browses as feed for cattle. Cattle diet composition for three seasons at Olifants Drift, South-east Botswana. *Journal of Arid Environment*, 40, 255–268.

Monforte-Briceño, G. E., Sandoval-Castro, C. A., Ramírez-Avilés L., & Capetillo, L. C. M. (2005). Defaunating capacity of tropical fodder trees: Effects of polyethylene glycol and its relationship to *in vitro* gas production. *Animal Feed Science Technology*, 123–124, 313–327.

Moody, W. G. (1983). Beef flavour. A review. *Food Technology*, 37(5), 227, 232-238.

Mottram, D. S., & Edwards R. A. (1983). The role of triglycerides and phospholipids in the aroma of cooked beef. *Journal of the Science of Food and Agriculture*, 34(5), 517–522.

Muchenje, V., Dzama, K., Chimonyo, M., Strydom, A., Hugo, P. E., & Raats J. G. (2008). Sensory evaluation and its relationship to physical meat quality attributes of beef from Nguni and Bonsmara steers raised on natural pasture. *Animal*, 2(11),1700–1706.

Muchenje, V., Hugo, A., Dzama, K., Chimonyo, M., Strydom, P. E., & Raats J. G. (2009). Cholesterol levels and fatty acid profiles of beef from three cattle breeds raised on natural pasture. *Journal of Food Composition and Analysis*, 22,354–358.

Muir, P. D., Wallace, G. J., Dobbie, P. M., & Bown, M. D. (2000). A comparison of animal performance and carcass and meat quality characteristics in Hereford, Hereford x Friesian, and Friesian steers grazed together at pasture. *New Zealand Journal of Agricultural Research*, 43,193-205.

Ngongoni, N. T., Mapiye, C., Mwale, M., & Mupeta, B. (2007). Effect of supplementing a high-protein ram press sunflower cake concentrate on smallholder milk production in Zimbabwe. *Tropical Animal Health Production*, 39(4), 297–307.

Ngwa, A. T., Pone, D. K., Mafeni, J. M., 2000. Feed selection and dietary preferences of forages by small ruminants grazing natural pasture in the Sahelian zone of Cameroon. *Animal Feed Science Technology*, 88, 253–266.

Niezen, J. H., Charleston, W. A. G., Hodgson, J., Miller, C. M., Waghorn, T. S., & Robertson, H. A. (1998). Affect of plant species on the larvae of gastro-intestinal nematodes which parasitise sheep. *International Journal of Parasitol*ogy, 28, 791–803.

Niezen, J. H., Waghorn, T. S., Raufaut, K., Robertson, H. A., & McFarlane, R. G. (1994). Lamb weight gain and faecal egg count when grazing one of the seven herbages and dosed with larvae for six weeks. *Proceedings of New Zealand Society of Animal Production*, 54, 15–18.

Omphile, U. J., Aganga, A. A., Malamba, B., 2003. Diet and forage preference of communally grazed range goats in an *Acacia* bush savannah in southeast Bostwana. In: Allsopp, N., Palmer, A.R., Milton, S. J., Kirkman, K.P.,Kerley, G. I. H., Hurt, C. R., Brown, C. J. (Eds.), Proceedings of the VIIth International Rangeland Congress, 26 July–1 August. Durban, South Africa, pp. 1301–1305.

Papachristou, T. G., & Nastis, A. S. (1993). Nutritive value of diet selected by goats grazing on kermes oak shrublands with different shrub and herbage cover in Northern Greece. *Small Ruminant Research*, 12, 35–44.

Pell, A. N., Mackie, R. I., Mueller-Harvey, I., & Ndlovu, L. R. (2001). Introduction. *Animal Food Science Technology*, 91, 1.

Pfister, J. A., & Malechek, J. C. (1986). The voluntary forage intake and nutrition of goats and sheep in the semi-arid tropics of northeastern. *Brazilian Journal of Animal Science*, 63, 1078-1086.

Pike, U. I., Smith, G. C., Carpenter, Z. L., & Shelton, M., (1973). Effect of maturity and fatness on the palatability of goat meat. *Journal of Animal Science*, 37, 269-269.

Platter, W. J., Tatum, J. D., Belk, K. E., Chapman, P. L., Scanga, J. A., & Smith, G. C. (2003). Relationship of consumer sensory ratings, marbling score, and shear force value to consumer acceptance of beef strip loin steaks. *Journal of Animal Science,* 81(29), 2741–2750.

Priolo, A., Bella, M., Lanza, M., Galofaro, V., Biondi, L., Barbagallo, D., Ben Salem, H., & Pennisi, P. (2005). Carcass and meat quality of lambs fed fresh sulla (Hedysarum coronarium L.) with or without polyethylene glycol or concentrate. *Small Ruminant Research,* 59,281–288.

Priolo, A., Ben Salem, H., Atti, N., & Nefzaoui, A. (2002). Polyethylene glycol in concentrate or feedblock to deactivate condensed tannins in *Acacia Cyanophylla* Lindl. Foliage 2. Effects on meat quality of Barbarine lambs. *Animal Science,* 75,137-140.

Priolo, A., Micol, D., & Agabriel, J. (2001). Effects of grass feeding systems on ruminant meat colour and flavour. A review. *Animal Research*, 50(56), 185–200.

Provenza, F. D. (1995). Postingestive feedback as an elementary determinant of food preference and intake in ruminants. *Journal of Range Management*, 48, 2–17.

Ramirez, R. G. (1999). Feed resources and feeding techniques of small ruminants under extensive management conditions. *Small Ruminant Research,* 34, 215-230.

Razminowicz, R. H., Kreuzer, M., & Scheeder, M. R. L. (2006). Quality of retail beef from two grass-based production systems in comparison with conventional beef. *Meat Science,* 73,351-361.

Risvik, E. (1995). Sensory quality of meat as evaluated by trained taste panels and consumers. In: K. Lundstro˝m, I. Hansson and E. Wiklund, Editors, Composition of meat in relation to processing nutritional and sensory quality: From farm to fork, ECCEAMST, 87–93.

Robbins, C. T., Hartley, T. A., Hagerman, A. E., Hajeljord, O., Baker, D. L., Schwartz, C. C., & Moutz, W.W. (1987). Role of tannins in defending plants against ruminants: reduction in protein availability. *Ecology*, 68, 98-10.

Rojas, D. K., L´opezb J., Tejadaa I., V´azquez, V., Shimadad A., S´anchezb, D., & Ibarrae, F. (2006). Impact of condensed tannins from tropical forages on *Haemonchus contortus* burdens in Mongolian gerbils (Meriones unguiculatus) and Pelibuey lambs. *Animal Feed Science and Technology*, 128, 218–228.

Rubanza, C. D. K., Shem, M. N., Otsyina E. R., & Fujihara, T. (2005). Performance of Zebu steers grazing on western Tanzania native forages supplemented with *Leucaena leucocephala* leaf meal. *Agro-forestry System*, 65,165–174.

Rumosa-Gwaze, F. G., Chimonyo, M., & Dzama, K. (2009). Communal goat production in Southern Africa: A review. *Tropical Animal Health Production*, 41, 1157-1168.

Sanon, H. O., Kabor´e-Zoungrana C., & Ledin, I. (2007). Behaviour of goats, sheep and cattle and their selection of browse species on natural pasture in a Sahelian area. *Small Ruminant Research*, 67, 64–74.

Saura-Calixto, F., Serrano, J., & Goñi, I. (2007). Intake and bioaccessibility of total polyphenols in a whole diet. *Food Chemistry*, 101,492–501.

Sebsibe, A. (2006). Sheep and Goat Meat Characteristics and Quality. Ph.D. Thesis. University of Pretoria, South Africa.

Silanikove, N., Nitsan, Z., & Perevolotsky, A. (1994). Effect of a daily supplementation of polyethylene glycol on intake and digestion of tannin-containing leaves (*Ceratonia siliqua*) by sheep. *Journal of Agricultural Food Chemistry*, 42, 2844-2847.

Silanikove, N., Gilboa, N., Perevolotsky, A., & Nitsan, Z. (1996). Goat fed tannin-containing leaves do not exhibit toxic syndromes. *Small Ruminant Research*, 21,195–201.

Silanikove, N. (2000). The physiological basis of adaptation in goats to harsh environments. *Small Ruminant Research*, 35,181–193.

Simela, L., Webb, E.C., Bosman, M. J. C., & Pienaar, E. (2002). Meat quality of chevon from unimproved indigenous goats and its acceptability to South African consumers. In: Presented at the British Society of Animal Science Conference, Merida, Mexico, 12, 15.

Simela, L., Webb, E. C., & Bosman, M. J. C. (2003). Retailer and consumer perceptions of chevon and its quality in Zimbabwe and South Africa, In: Consistency of Quality, 11th International Meat Symposium, ARC

Simela, L. (2005). Meat characteristics and acceptability of chevon from South African Indigenous goat. Ph.D. Thesis, University of Pretoria. South Africa.

Simela, L., Webb, E. C., & Bosman, M. J. C. (2008). Acceptability of chevon from kids, yearling goats and mature does of indigenous South African goats: A case study. *South African Journal of Animal Science*, 38, 3.

Sitz, B. M., Calkins, C. R., Feuz, D. M., Umberger, W. J., & Eskridge, K. M. (2005). Consumer sensory acceptance and value of domestic, Canadian, and Australian grass-fed beef steaks. *Journal of Animal Science*, 83(12), 2863-2868.

Stelzleni, A. M., & Johnson, D. D. (2007). Effect of days on concentrate feed on sensory off-flavorscore, off-flavour descriptor and fatty acid profiles for selected muscles from cull beef cows. *Meat Science*, 79, 382-393.

Stone, H., & Sidel, J. L. (1993). Sensory Evaluation Practices. 2nd ed. Academic Press: San Diego.

Sveinsdóttir, K., Martinsdóttir, E., Green-Petersen, D., Hyldig, G., Schelvis, R., & Delahunty, C. (2009). Sensory characteristics of different cod products related to consumer preferences and attitudes. *Food Quality and Preference*, 20, 120–132.

Swan, J. E., Esguerra, C. M., & Farouk, M. M. (1997). Some physical, chemical and sensory properties of chevon products from three New Zealand goat breeds. *Small Ruminant Research*, 28, 273-280.

Teague, W. R. (1989). Patterns of defoliation of *Acacia karroo* by goats and changes in tannin levels and in vitro digestibility following defoliation. *Journal of the Grasslands Society of Southern Africa*, 6,230–235.

Topps, J. H. (1992). Potential, composition and use of legume shrubs and trees as fodder for livestock in the tropics. *Journal of Agricultural Science Cambridge*, 118, l-8.

Tshabalala, P. A, Strydom, P. E., Webb, E. C., & de Kocka, H. L. (2003). Meat quality of designated South African indigenous goat and sheep breeds. *Meat Science*, 65,563-570.

Umunna, N. N., Nsahlai, I. V., & Osuji, P. O. (1995). Degradability of forage protein supplements and their effect on the kinetics of digestion and passage. *Small Ruminant Research*, 17,145–152.

Vasta, V., Nuddab, A., Cannas, A., Lanza, M., & Priolo, A. (2008). Alternative feed resources and their effects on the quality of meat and milk from small ruminantsm. *Animal Feed Science and Technology*, 147, 223–246.

Verna, M., Pace, V., Settineri, D., Di Giacomo, A., & Nanni, A. (1989). Impiego di Sorgo a diverso tenore di tannini nell'alimentazione degli agnelli. II - Considerazioni sulla dissezione della coscia, sulla qualità delle carni e sui rilievi istologici ed istochimici degli organi. *Zootec*, 22, 1-14.

Villalba, J. J., Provenza, F. D., & Banner, R. E. (2002). Influence of macronutrients and polyethylene glycol on intake of a quebracho tannin diet by sheep and goats. *Journal of Animal Science*, 80, 3154–3164.

Villena, F., & Pfister, J. A. (1990). Sand shinnery oak as forage for Angora and Spanish goats. *Journal of Range Management*, 43,116–122.

Waghorn, G. C., & McNabb, W. C. (2003). Consequences of plant phenolic compounds for productivity and health of ruminants. *Proceedings of Nutrition Society*, 62, 383–392.

Waghorn, G. (2008). Beneficial and detrimental effects of dietary condensed tannins for sustainable sheep and goat production—Progress and challenges. *Animal Feed Science and Technology*, 147,116–139.

Warmington, B. G., & Kirton, A. H. (1990). Genetic and nongenetic influence on growth and carcass traits of goats. *Small Ruminant Research*, 3, 147-165.

Webb, E. C., Casey, N. H., & Simela, L. (2005). Goat meat quality. *Small Ruminant Research*, 60,153-166.

Wood, J. D., Enser, M., Fisher, A. V., Nute, G. R., Sheard, P. R., Richardson, R. I., Hughes, S. I., & Whittington, F. M. (2008). Fat deposition, fatty acid composition and meat quality: A review. *Meat Science*, 78, 343-358.

Xhomfulana, V., Mapiye, C., Chimonyo, M., & Marufu, M. C. (2009). Supplements containing *Acacia karroo* foliage reduce nematode burdens in Nguni and crossbred cattle. *Animal Production Science*, 49 (08), 646–653.

# 3 Chapter 3

## Effect of *Acacia karroo* supplementation on ultimate pH, colour and cooking losses of meat from indigenous Xhosa lop-eared goats


### Abstract

The objective of the study was to determine the effect of *A. karroo* supplementation on ultimate pH, colour and cooking losses of meat from indigenous Xhosa lop-eared goats. Eighteen castrated 4-month-old kids were used for the study and were kept at the University of Fort Hare, Honeydale farm until slaughter. The kids were subdivided in two treatment groups *A. karroo* supplemented (AK) and non-supplemented (NS). The supplemented goats were given 200g per head per day of fresh *A. karroo* leaves. The kids were slaughtered on day 60 and sample cuttings for meat quality assessment were taken from the *Longistimus dorsi* muscle. *Acacia karroo* supplemented goats produced higher *b** (yellowness) value, but had no significant effect on *L** (lightness) and *a** (redness) of the meat from goats. *Acacia karroo* supplementation also affected meat pH and cooking losses ($P < 0.05$). The meat from the *A. karroo* supplemented goats had lower ultimate pH and cooking loss than the meat from the non-supplemented goats. Therefore, *A. karroo* supplementation improves the quality of meat from goats.



Keywords: meat quality, cooking losses, meat pH, meat colour, *Acacia karroo* supplementation, chevon.

## 3.1 Introduction

The use of goats as meat animals has increased in recent years, as evidenced by the increased demand for goat meat by consumers (Gipson, 1999; Simela, 2005; Rumosa-Gwaze, Chimonyo, & Dzama, 2009). The major advantage of chevon is its lower fat content compared to other types of red meat (Park, Kouassi, & Chin, 1991). Meat quality is a highly subjective issue. Strikingly, there are no universally accepted criteria for defining meat quality throughout the world (Monin, 2004). A decision on good meat quality is dependent on the consumer and may vary according to culture (Borggaard & Andersen, 2004; Xazela, Chimonyo, Muchenje, & Marume, 2011). There are a number of important traits that consumers consider to decide on meat quality. At purchase point, consumers consider meat colour as an important meat quality indicator. Beef and mutton are expected to be bright red, while pork is expected to be more or less pink (Monin, 2004).

Meat colour, pH and cooking losses are also among measurements that are used to determine the quality of meat. Meat quality measurements are said to be affected by diet and thermal preparation. Under-feeding, which is a result of the inadequate availability of high quality feed in poorly resourced goat producers is the major diet defect in goat productivity (Collins-Luswet, 2000). However; browse plants such as the *Acacia* species are reported to be an enormous potential source of protein supplementation (100–250 g/kg DM) for ruminants in the tropics (Ngongoni, Mapiye, Mwale, & Mupeta, 2007) and can easily meet nutrient requirements, mainly proteins (Aganga, Tsopito, & Adogla-Bessa, 1998; Devendra & Sevilla, 2002; Kahiya, Mukaratirwa, & Thamsborg, 2003; Mokoboki, Ndlovu, Ngambi, Malatje, & Nikolovav, 2005), minerals (Aganga *et al.*, 1998; Mokoboki *et al.*, 2005) and they have antihelmintic properties (Xhomfulana, Mapiye, Chimonyo, & Marufu, 2009).

In studies conducted by Priolo *et al.* (2005); Yayneshet, Eik, and Moe (2008); Marume (2010), it was reported that tanniniferous-fed small ruminants produce meat of a lighter colour than other animals given same diet with no tannin effect. Tannins from different plant species have similar effects on lamb meat colour (Priolo, Ben Salem, Atti, & Nefzaoui, 2002). The effect of tannins on meat colour could be the result of a reduced microbial biosynthesis of vitamin $B_{12}$ which is a precursor for the synthesis of haeme pigments (Vasta, Nuddab, Cannas, Lanza, & Priolo, 2008). Meat colour is indirectly affected by meat pH. Meat pH also influences meat quality indicators such as meat tenderness, shelf-life and meat flavour (Honikel, 2004; Muchenje *et al*., 2008). Meat pH plays a role in the development of flavours in the Maillard reaction (Calkins & Hodgen, 2007). Diet is among the factors that affect levels of pH in meat (Calkins & Hodgen, 2007). Properly fed animals will retain the recommended energy which will be converted after slaughter to produce a recommended pH range of 5.5 to 6.0 (Calkins & Hodgen, 2007). Supplementation with browse plants, particularly *A. karroo* leaves, improves the body condition score, slaughter weight (Mapiye *et al*., 2009) and average daily gain (Nyamukanza & Scogings, 2008).

High pH levels were reported to decrease meat flavour intensity (Mottram & Madruga, 1994). Meat pH is also said to affect meat cooking losses (Jama *et al*., 2008). As pH increases in meat, the proteins have increased water binding properties. During cooking fewer water-soluble proteins are lost from high pH meat since there is less cooking loss (Miller, 2001). Excessive drip is generally considered undesirable (Monin, 2004). The conversion of muscle to meat has a significant effect on its microstructure and its quality traits. Among these is its water-holding capacity (WHC) (Palka, 2004). The lower the cooking losses, the better the

juiciness of the meat (Sebsibe, 2006). Cooking losses are also affected by the ratio of muscle to fat of the carcass (Yu *et al*., 2005).

*Acacia karroo* has been reported to improve the quality of meat from Nguni cattle (Mapiye *et al.*, 2009). The Xhosa lop-eared goat breed, which is big framed (Bakare & Chimonyo, 2011), has been used since it is among the indigenous goat breeds known to produce meat (Xazela *et al*., 2011). While Marume (2010) determined the nutrient composition and anthelminthic effects of *A. karroo*, there are no studies which have been done to evaluate its effect on meat quality measurements of Xhosa lop-eared goats. Therefore the objective of the current study is to determine the effect of *A. karroo* supplementation on the quality of meat from indigenous Xhosa lop-eared goats.

## 3.2 Materials and methods

### *3.2.1 Study site description*

The study was conducted at the University of Fort Hare Honeydale Farm. The farm is 520 m above sea level and is located 32.8° S and 26.9° E. The farm receives an average annual rainfall of 480 mm and has a mean annual temperature of 18.7 °C. It is situated in the False Thornveld of the Eastern Cape (Acocks, 1975). The topography of the area is generally flat with a few steep slopes. The vegetation is a mixture of several trees, shrubs and grass species. The predominant plant species on the farm are *A. karroo, Themeda triandra, Panicum maximum, Digitaria eriantha, Eragrostis spp., Cynodon dactylon and Pennisetum clandestinum*.

### *3.2.2 Animal management*

Eighteen castrated 4-month-old goats with a mean body weight of 13.5 ± 0.31 kg (mean ± S.E.) and a mean body condition score (BCS) of 3.3 ± 0.16 (mean ± S.E.) were kept with their mothers on natural pastures and after they were moved to open sided barns where they were fed on 500g/head/day of medicago sativa hay. The goats were then randomly split into two balanced treatment groups, one of which was supplemented while the other was not. The supplemented group was fed individually with an additional 20g/head/day of fresh daily collected *A. Karoo* leaves on feeding troughs.

### *3.2.3 Collection and nutrient composition of the Acacia karroo browse plant*

Fresh leaves of *A. karroo* were hand harvested each day and dried for the determination of nutritional composition such as DM, crude protein (CP), Crude fibre (CF), ether extract (EE) and tannin levels in the leaves. The dried leaves were fed to goats individually in feeding troughs for the period of 60 days. The Folin-Ciocalteau assays described by Terrill, Rowan, Douglas, & Barry (1992) were performed to determine the total polyphenolic content of the dried *A. karroo* whilst the butanol-HCl assay as described by Giner-Chavez *et al.* (1997) was done to determine the condensed tannins (CT). The Approximate analysis and tannin levels of *A. karroo* leaves are shown in Table 3.1.

**Table 3.1: Nutritional composition of the experimental diets (% DM basis)**

| **Component** | ***Acacia karroo*** |
|---|---|
| Dry matter | 91.9 |
| Crude protein | 23.2 |
| Crude fibre | 25.9 |
| Neutral detergent fibre | 50.2 |
| Acid detergent fibre | 28.9 |
| Ether extract | 3.95 |
| Calcium | 4 |
| Phosphorus | 0.08 |
| Ash | 5.1 |
| CT (Butanol-HCL assay) | 2.1 |
| Total Phenolics (Folin assay) | 0.5 |

*3.2.4 Slaughter procedure*

After 8 weeks, all the goats were humanely slaughtered complying with the local regulations of animal welfare. In the morning of the day of slaughter, the goats were transported from the Honeydale farm to the Adelaide commercial abattoir which is 60 km away. The goats were electrically stunned and immediately bled. The carcases were kept in the refrigerator overnight at a temperature of -4°C. Sample cuttings for meat tasting were made from the *Longistimus dorsi* muscle.

**3.3 Meat quality Measurements**

The meat colour was measured through instrumental colour measurements using the colour-guide 45/0 BYK-Gardener GmbH. The instrumental meat colour measurements represented by three coordinates: $L^*$ (lightness), $a^*$ (redness) and $b^*$ (yellowness) were measured on the *Longistimus dorsi* muscle using the colour-guide 45/0 BYK-Gardener GmbH machine with 20 mm diameter measurement area and illuminant D65-day light, 10°standard observer. The final meat colour value was calculated as the average value for the three readings taken from the colour guide. The guide was calibrated before use with the green standard.

The meat pH was measured on the *Logistimus dorssi* muscle after 24hrs using the pH meter (CRISON pH25, CRISON instruments SA, Spain) which was calibrated using pH 4, pH 7 and pH 9 standard solutions before measurements.

Cooking losses (CL) were measured in the *Logistimus dorssi* muscle, kept for 24hours. The meat muscles were allowed to defrost and their weight before cooking was recorded. Samples of meat from each treatment were then roasted for a period of 10 minutes on each side to make 20 minutes in total and cooled. After cooling, the sample weights were recorded. Cooking loss was calculated using the following formula: Cooking loss % = [(weight before cooked – weight after cooked) ÷ weight before cooked] × 100.

### 3.4 Statistical analysis

The general linear model procedure of the SAS (2003) program was used to analyse the effect of *A. karroo* supplementation on meat quality. Turkey's HSD procedure was used for the comparison of means. The model used was as follows:

Model: $Y_{ij} = \mu + D_i + E_{ij}$

Where: $Y_i$ = response variable (meat pH, cooking losses and meat colour)

$\mu$ = overall mean common to all observations

$D_i$ = effect of *A. karroo* supplementation

$E_{ij}$ = random error.

## 3.5 Results

### *3.5.1The effects of Acacia karroo supplementation on meat quality measurements of the Xhosa Lop-eared goat breed.*

The effect of *A. karroo* supplementation on meat quality is shown in Table 3.2. The ultimate pH ($pH_u$) of meat from the *A. karroo* supplemented goats was significantly lower ($P < 0.05$) than that from the non-supplemented goats. There were no significant differences ($P > 0.05$) in the $L^*$ and $a^*$ values of meat from the *A. karroo* supplemented goats and non-supplemented goats. *Acacia karroo* supplementation produced meat that was more yellow than the one from non-supplemented goats. Meat from the non-supplemented goats had higher ($P < 0.05$) cooking losses than the one from the *A. karroo* supplemented goats.

**Table 3.2: Effect of *A. karroo* supplementation on meat quality attributes of Xhosa lop-eared goats**

| Parameters | | AK | NS | Significance |
|---|---|---|---|---|
| **Ultimate pH** | | 5.4 ± 0.55 | 6.6 ± 0.55 | * |
| **Cooking loss** | | 27.4 ± 4.41 | 33.6 ± 4.41 | * |
| **Colour** | $L^*$ | 44.1 ± 1.95 | 39.8 ±1.95 | NS |
| | $a^*$ | 12.5 ± 1.90 | 8.2 ± 1.90 | NS |
| | $b^*$ | 10.1 ± 0.64 | 4.4 ± 0.64 | * |

AK= Acacia *karroo* supplementation, NS= Non-supplemented

*L*= Lightness of the meat colour, *a**= redness of meat, *b**= Yellow meat colour.

*= Significant difference (P< 0.05)

### 3.6 Discussion

*Acacia karroo* had a positive influence on meat pH of the supplemented goats. This is due to its high nutritive value mainly proteins and minerals.(Ngongoni, Mapiye, Mwale, & Mupeta, 2007; Mapiye *et al.*, 2009; Marume, 2010*)* on goat muscle development, given that the nutritional level of an animal's diet can be influential on its ability to maintain productivity (Albers *et al*., 1987). The adequate amount of proteins (Ngongoni *et al*., 2007) in *A. karroo* browse plant improved the ability of the goats to retain desirable muscle energy (Marume, 2010). The retained muscle energy, the result of the high average daily gain and slaughter weight of *A. karroo* supplemented goats (Mapiye *et al*., 2009), have assisted in lactic acid development, resulting in the lower $pH_u$ of the supplemented goats than that of the non-supplemented goats.

These results suggest that the consumption of tannin browse plant species has a positive influence on chevon pH. This, however, contradicts the results reported by Priolo *et al.* (2002), who reported that the consumption of tannin plants will not affect chevon pH. This argument may have arisen because of the type of browse plant used, given that; the browse plants differ in tannin content. The other reason could be the season in which the browse plant was consumed, as natural pastures vary in their chemical composition and structure with the seasons (Bakare & Chimonyo, 2011). Goats adapt to the changes that occur in the chemical composition and structure of vegetation with the seasons (Silanikove, 2000). This also suggests further research to establish the cause of the difference in the effect of browse plants on chevon pH, since this was not investigated in the current study. Meat pH affects meat colour and it has been reported that higher pH values produce meat that is darker in colour (Priolo, Micol, & Agabriel, 2001).

A number of studies have been published reporting the effect of diet on meat quality, particularly meat colour (Nyamukanza & Scogings, 2008). Priolo and Vasta (2007) reported that tanniniferous fed ruminants produce meat of a light colour. The effect of tannins on meat colour can be explained as a reduced microbial biosynthesis of vitamin $B_{12}$ which is a precursor for the synthesis of haeme pigments. Diet has been reported to have an influence on slaughter weight and the cold dress weight of four goat breeds (Xazela *et al*., 2011). However; in the current study *A. karroo* supplementation does not influence the *L** value of supplemented goats. The two groups; the *A. karroo* supplemented and non-supplemented groups had similar results on the *L** value and this can be attributed to the effect of the intensive production system used. Intensively fed ruminants have been reported to produce light colour in meat (Vestergaard, Oksbjerg, & Henckel, 2000). Mapiye, Chimonyo, Dzama, Strydom, and Muchenje (2010) also reported no differences in water holding capacity, tenderness and cholesterol values of meat from Nguni cattle supplemented with *A. karroo* and those relied on rangelands.

Therefore, the *L** value in the current study seems to be affected by external factors such as age and gender which were not considered in the current study, since the age of an animal affects meat quality (Simela, 2005). A similar situation applied in *a**-coordinate where *A. karroo* supplemented goats were not significantly different from the non-supplemented goats. However; the positive effect of *A. karroo* on the redness (*a**) of meat from Nguni cattle was reported (Mapiye *et al*., 2010). The argument arising could be attributed to the effect of animal species. The other reason supporting the difference in *a** can be associated with the variation in the nutrient content of *A. karroo* leaves which is attributed to differences in

climate, season and stage of growth in which the plants were harvested (Rubanza, Shem, Otsyina, & Fujihara, 2005)

They can differ according to the environmental factors such as the season of grazing (Bakare & Chimonyo, 2011). Likewise; in the current study, the effect of *A. karroo* supplementation on meat colour was observed in yellowness. Higher *b** values of meat from the supplemented goats imply that *A. karroo* supplementation has improved the yellow colouring of chevon. The findings agree with the report by Priolo and Vasta (2007) who reported that tannins can be responsible for the differences found in meat colour. Moreover, the improvement observed from the *A. karroo* supplemented goats was attributed to additional dietary protein, energy and mineral intake (Mapiye *et al*., 2009). In addition, the use of *A. karroo* as a supplement might increase the proportions of desirable fatty acids (Mapiye *et al*., 2011) which could, therefore, interfere in the yellow colouring of the meat. Furthermore; increase in fat and muscle marbling could affect the muscle cooking losses (Yu *et al*., 2005).

The cooking loss levels of the supplemented goats in the current study were slightly higher than those reported by Jama *et al*. (2008) which averaged 23% but lower than those reported by Razminowicz, Kreuzer, and Scheeder (2006) which averaged 30%, while the cooking losses of the non-supplemented goats were higher than those of Razminowicz *et al*. (2006) from steers reared in pasture. Low cooking losses in the supplemented goats is attributed to the effect of reported $pH_u$ in this study which, however, improves the potential of proteins deposited from the *A. karroo* supplement (Marume, 2010) to retain more water in the meat (Miller, 2001). The ability of ultimate pH to influence muscle capability to retain natural water has been reported by Bruce, Stark, and Beilken (2003). Therefore, a muscle of lower water holding capacity is associated with higher cooking losses hence lower juiciness and a

less tender muscle (Sheard, Nute, Richardson, & Wood, 2005). The low amount of cooking losses in the current study can also be attributed to the fact that goats produce lean meat and they are the major sources of proteins (Devendra, 1981; Simela, 2005) therefore, water holding capacity will be improved. The results have shown that the meat has a higher water holding capacity which therefore suggests juicier meat. Levels of fat in meat generally affect cooking losses (Yu *et al*., 2005; Jama *et al*., 2008). Goats store fat in visceral organs and the carcass is generally lean (Park *et al*., 1991; Simela, 2005) and that supports lower cooking losses.

### 3.7 Conclusion

The current study revealed that *A. karroo* supplementation improves the quality of meat from goats. These findings can be practically implemented by emerging goat producers since *A. karroo* is easily accessible and the plant species is preferred by goats across seasons. The physico-chemical meat quality attributes tend to affect meat sensory characteristics, such as tenderness and juiciness. It is therefore important to also study the effects of the *A. karroo* supplementation on meat sensory characteristics.

### 3.8 References

Acocks, J.P.H. (1975). Veld Types of South Africa, Member of Botswana Survey. South Africa. 2nd edition vol. 40. National Botanical Institute, Pretoria.

Aganga, A. A., Tsopito, C. M., & Adogla-Bessa T. (1998). Feed potential of *Acacia species* to ruminants in Botswana, *Arch. Zootec*, 47, 659–668.

Albers, G. A. A., Gray, G. D., Piper, L. R., Barber, J. S. F., LeJambre, L. F., & Barger, L. A. (1987). The genetics of resistance and resilience to *Haemonchus contortus* infection in young Merino sheep. *International Journal of Parasitology*, 17, 1355-1367.

Bakare, A. G., & Chimonyo, M. (2011). Seasonal variation in time spent foraging by indigenous goat genotypes in a semi-arid rangeland in South Africa. *Livestock Science*, 135, 251–256.

Borggaard, C., & Andersen, J. R. (2004). Instrumental Measurement of meat quality, Danish Meat Research Institute, Roskilde, Denmark.

Bruce, H. L., Stark, J. L., & Beilken, S. L. (2003). The effect of finishing diet and post mortem ageing on the quality of *M. longissimus thoracis* of the electrically stimulated Brahman steer carcasses. *Meat Science*, 67(2), 261-268.

Calkins, C. R., & Hodgen, J. M. (2007). A fresh look at meat flavour. *Meat Science*, 77(1), 63-80.

Collins-Luswet, E. (2000). Performance of Nguni, Afrikander and Bonsmara cattle under drought conditions in North West province of Southern Africa. *South African Journal of Animal Science*, 30, 33–41.

Devendra, C. (1981). Meat production from goats in developing countries. In: Smith, A. J., Gunn, R.G. (Eds.), Intensive Animal Production in Developing Countries. BSAP (British Society of Animal Production) Occasional Publication 4. BSAP, Edinburgh, UK, 395-406.

Devendra, C., & Sevilla, C. C. (2002). Availability and use of feed resources in crop-animal systems in Asia. *Agricultural Systems*, 71(12), 59–73.

Giner-Chavez, B. I., Van Soest, P. J., Robertson, J. B., Lascano, C., Reed, J. D., & Pell, A. N. (1997). A method for isolating condensed tannins from crude protein plant extracts with trivalent ytterbium. *Journal of Science of Food and Agriculture*, 74, 359-368.

Gipson, T. A. (1999). Demand for goat meat: implications for the future of the industry. In: Proceedings of the 14th Annual Goat Field Day, Langston, 23–29.

Honikel, K. O. (2004). Chemical and physical characteristics of meat pH measurement. *Federal Research Centre for Nutrition and Food*, Kulmbach, Germany.

Jama, N., Muchenje, V., Chimonyo, M., Strydom, P. E., Dzama, K., & Raats, J. G. (2008). Cooking loss components of beef from Nguni, Bonsmara and Angus steers. *African Journal of Agricultural Research*, 3(6), 416-420.

Kahiya, C., Mukaratirwa, S., & Thamsborg, S. M. (2003). Effects of *Acacia Nilotica* and *Acacia karroo* diets on *Haemonchus Contortus* infection in goats. *Veterinary Parasitology*, 115, 265–274.

Mapiye, C., Chimonyo, M., Dzama, K., Strydom, P. E., Marufu, M. C., & Muchenje, V. (2009). Nutritional status, growth performance and carcass characteristics of Nguni steers supplemented with *Acacia karroo* leaf-meal. *Livestock Science*, 126, 206–214.

Mapiye, C., Chimonyo, M., Dzama, K., Strydom, P. E., & Muchenje, V. (2010). Meat quality attributes of Nguni steers supplemented with *Acacia karroo* leaf-meal. *Meat Science*, 8, 621–627.

Marume, U. (2010). Effect of *Acacia karroo* on growth and meat quality of indigenous goats. PhD Thesis. University of Fort Hare, South Africa.

Miller, R. K. (2001). Beef flavour: A white paper, National Cattlemens, *Beef Association*, Centennial, CO.

Mokoboki, H. K., Ndlovu, L. R., Ngambi, J. W., Malatje, M. M., & Nikolovav, R. V. (2005). Nutritive value of *Acacia* tree foliages growing in the Limpopo Province of South Africa. *South African Journal of Animal Science*, 35(4), 221–228.

Monin, G. (2004). Colour and texture deviations, Institute National de la Recherche.

Mottram, D. S., & Madruga, M. S. (1994). Important Sulfur containing aroma volatiles in meat. In: C. J. Mussinan and M. E. Keelan, Editors, Sulfur compounds in foods, ACS symposium series. *American Chemical Society*, Washington, DC, 564, 180–187.

Muchenje, V., Dzama, K., Chimonyo, M., Strydom, A., Hugo, P. E., & Raats, J. G. (2008). Sensory evaluation and its relationship to physical meat quality attributes of beef from Nguni and Bonsmara steers raised on natural pasture. *Animal*, 2(11), 1700–1706.

Ngongoni, N. T., Mapiye, C., Mwale, M., & Mupeta, B. (2007). Effect of supplementing a high-protein ram press sunflower cake concentrate on smallholder milk production in Zimbabwe. *Tropical Animal Health Production*, 39(4), 297–307.

Nyamukanza, C. C., & Scogings, P. F. (2008). Sprout selection and performance of goats fed *Acacia karroo* coppices in the False Thornveld of the Eastern Cape, South Africa. *South African Journal of Animal Science*, 38, 83–90.

Palka, K. (2004). Heat effects on meat. Agricultural University of Kraków, Poland.

Park, Y. W., Kouassi, M. A., & Chin, K. B. (1991). Moisture, total fat and cholesterol in goat organ and muscle meat. *Journal of Food Science*, 56, 1191–1193.

Priolo, A., Micol, D., & Agabriel, J. (2001). Effects of grass feeding systems on ruminant meat colour and flavour. A review. *Animal Research*, 50(56), 185–200.

Priolo, A., Ben Salem, H., Atti, N., & Nefzaoui, A. (2002). Polyethylene glycol in concentrate or feedblock to deactivate condensed tannins in Acacia Cyanophylla Lindl. Foliage 2. Effects on meat quality of Barbarine lambs. *Animal Science*, 75, 137-140.

Priolo, A., Bella, M., Lanza, M., Galofaro, V., Biondi, L., Barbagallo, D., Ben Salem, H., & Pennisi, P. (2005). Carcass and meat quality of lambs fed fresh sulla (Hedysarum coronarium L.) with or without polyethylene glycol or concentrate. *Small Ruminant Research*, 59, 281–288

Priolo, A., & Vasta, V. (2007). Effects of tannin-containing diets on small ruminant meat quality. *Italian Journal of Animal Science*, 6(4), 527-530.

Razminowicz, R. H., Kreuzer, M., & Scheeder, M. R. L. (2006). Quality of retail beef from two grass-based production systems in comparison with conventional beef. *Meat Science*, 73, 351–361.

Rubanza, C. D. K., Shem, M. N., Otsyina, E. R., & Fujihara, T., 2005. Performance of Zebu steers grazing on western Tanzania native forages supplemented with Leucaena leucocephala leaf meal. *Agro-forest System*, 65, 165–174.

Rumosa-Gwaze, F. G., Chimonyo, M., & Dzama, K. (2009). Communal goat production in Southern Africa: A review. *Tropical Animal Health Production*, 41, 1157-1168.

SAS. (2003). SAS User's Guide: Statistics (Version 6 Ed.). SAS Inst. Inc., Cary, NC.

Sebsibe, A. (2006). Sheep and Goat Meat Characteristics and Quality. Ph.D. Thesis. University of Pretoria. South Africa.

Sheard, P. R., Nute, G. R., Richardson, R. I., & Wood, J. D. (2005). Effect of breed and marination on the sensory attributes of pork from Large White and Hampshire-sired pigs. *Meat Science*, 70(4), 699-707.

Silanikove, N. (2000). Effects of heat stress on the welfare of extensively managed domestic ruminants: A review. *Livestock Production Science*, 67, 1–18.

Simela, L. (2005). Meat characteristics and acceptability of chevon from South African Indigenous goat. Ph.D. Thesis, University of Pretoria, South Africa.

Terrill, T. H., Rowan, A. M., Douglas, G. B., & Barry, T. N. (1992). Determinations of extractable and bound condensed tannin concentration in forage plants, protein concentrate meals and cereal grains. *Journal of Science of food and Agriculture*, 58, 312-329.

Vasta, V., Nuddab, A., Cannas, A., Lanza, M., & Priolo, A. (2008). Alternative feed resources and their effects on the quality of meat and milk from small ruminantsm. *Animal Feed Science and Technology*, 147, 223–246.

Vestergaard, M., Oksbjerg, N., & Henckel, P. (2000). Influence of feeding intensity, grazing and finishing feeding on muscle fibre characteristics and meat colour of *semitendinosus*, *longissimus dorsi* and *supraspinatus* muscles of young bulls. *Meat Science*, 54, 177-185.

Xazela, N. M., Chimonyo, M., Muchenje, V., & Marume, U. (2011). Consumer sensory evaluation of meat from South African goat genotypes fed on a dietary supplement. *African Journal of Biotechnology*, 10(20), 4436-4443.

Xhomfulana, V., Mapiye, C., Chimonyo, M., & Marufu, M. C. (2009). Supplements containing *Acacia karroo* foliage reduce nematode burdens in Nguni and crossbred cattle. *Animal Production Science*, 49(08), 646–653.

Yayneshet, T., Eik, L. O., & Moe, S. R. (2008). Feeding *Acacia Etbaica* and *Dichrostachys cinerea* fruits to smallholder goats in Northern Ethiopia improves their performance during the dry season. *Livestock Science*, 11, 31–41.

Yu, L. H., Lee, E. S., Jeong, J. Y., Paik, H. D., Choi, J. H. & Kim, C. J. (2005). Effects of thawing temperature on the physicochemical properties of pre-rigor frozen chicken breast and leg muscles. *Meat Science*, 71, 375- 382.

# 4 Chapter 4

## The effect of *Acacia karroo* supplementation and thermal preparation on consumer sensory scores of meat from indigenous Xhosa lop-eared breed


### Abstract

The objective of the current study was to determine the effect of *A. karroo* supplementation and thermal preparation on consumer sensory scores of meat from indigenous Xhosa lop-eared breed. Eighteen castrated 4-month-old Xhosa lop-eared kids were kept at the University of Fort Hare Farm until slaughter. Sample cuttings for meat tasting were made from the *Longistimus dorsi* muscle. *Acacia karroo* supplementation improves meat tenderness and juiciness. There were no significant effects of *A. karroo* supplementation on meat flavour of the supplemented goats. Thermal preparation and consumer background had a significant effect ($P < 0.05$) on meat sensory characteristics. Results from this study show that *A. karroo* supplementation and thermal preparation have an effect on meat quality attributes such as tenderness and juiciness.



**Key words**: boiling, roasting, protein supplement, meat tenderness, thermal preparation, goat meat, consumer background.

## 4.1 Introduction

Consumer decision on the quality of meat is based on meat palatability components such as tenderness, juiciness and flavour (Tshabalala, Strydom, Webb, & de Kocka, 2003; Muchenje *et al*., 2008; Xazela, Chimonyo, Muchenje, & Marume, 2011). There is a relationship between meat sensory characteristics and meat quality measurements such as pH, colour and cooking losses (Muchenje *et al*., 2008). Sensory characteristics are used by consumers to decide on meat quality and there is a relationship between sensory characteristics and consumer acceptability (Muchenje *et al*., 2008). Some of the factors that affect meat palatability components are diet (Arsenos *et al*., 2009), breed **(**Muchenje *et al*., 2008), age (Simela, 2005), aging, fatness and muscle location (Sebsibe, 2006). Meat juiciness is the wetness during first bite and sustained juiciness likely due to fat in meat. Its sensation in chevon is closely related to the quantity and composition of the intramuscular fat (Muchenje *et al.*, 2008) and age of an animal (Simela *et al.*, 2008). Meat juiciness together with flavour and meat tenderness accounts for the overall eating quality. Flavour is the most important component of the eating quality of meat after cooking and is affected by lipid content (Webb, Casey, & Simela, 2005; Calkins & Hodgen, 2007), cooking method, age and gender (Webb *et al.*, 2005), oxidation, myoglobin, and pH (Calkins & Hodgen, 2007).

Meat tenderness is a function of the collagen content, heat stability and the myofibrillar structure of the muscle **(**Muchenje *et al*., 2009) and is the most important sensory characteristic of meat (Strydom, Naude, Smith, Scholtz, & van Wyk, 2000; Sebsibe, 2006). Tenderness varies with the animal species **(**Muchenje *et al*., 2008), while the consumer sensory characteristics have shown that is less in goats since they have less intramuscular fat because they deposit more fat around visceral organs than in the carcass (Swan, Esguerra, & Farouk, 1997).

The consumer background is important and needs to be considered in the assessment of preference and quality of meat (Worch Lê & Punter, 2010). Dyubele, Muchenje, Nkukwana, & Chimonyo (2010) reported no significant effect of consumer age and gender on meat sensory characteristics. However, there is a significant difference in the perception of consumer tribes of meat sensory characteristics (Dyubele *et al*., 2010). The way consumers perceive meat depends on several factors including the animal's diet. The cooking method is also among the factors affecting consumers' decision on the quality of meat. Nour, Gomide, Mills, Lemenager, and Judge (1994) reported that the cooking method affects meat quality attributes such as cooking losses and thawing.

Many studies have been conducted on the effect of diet on the meat quality of ruminants (Priolo *et al.*, 2005; Muchenje *et al*., 2008; Mapiye *et al*., 2009). *Acacia karroo* is among browse plants which have been studied (Mapiye *et al*., 2009; Mapiye, Chimonyo, Dzama, Strydom, & Muchenje, 2010; Marume, 2010; Bakare & Chimonyo, 2011). It is a browse plant which is characterised by its high crude protein (CP) and mineral contents (Devendra & Sevilla, 2002; Kahiya, Mukaratirwa, & Thamsborg, 2003; Mokoboki, Ndlovu, Ngambi, Malatje, & Nikolovav, 2005). *Acacia karroo* supplementation has been reported to improve nutritional status, growth performance and carcass traits (Mapiye *et al.*, 2009; Arsenos *et al*., 2009). This leads to heavier carcasses thus improving quality and quantity of meat produced (Arsenos *et al*., 2009).

Xazela *et al*. (2011) have studied the sensory characteristics of meat from four goat breeds while authors such as Marume (2010) and Bakare & Chimonyo (2011) have conducted studies on the Xhosa lop-eared goat breed. Of these authors, none have studied the effect of *A. karroo* supplementation and thermal preparation on meat sensory characteristics of the Xhosa lop-eared goat breed. Hence, the objective of the current study was to determine the

effect of *A. karroo* supplementation and thermal preparation on consumer sensory scores of meat from Xhosa lop-eared goat breed.

## 4.2 Materials and method

### *4.2.1* Study site description

Study site is as described in Chapter 3, Section 3.2.1

### *4.2.2* Collection and nutrient composition of *Acacia karroo* browse plant

Collection and nutrient composition of *Acacia karroo* browse plant was as described in Chapter 3, Section 3.2.2.

### *4.2.3* Animal management

Animal management was as described in Chapter 3, Section 3.2.3.

### *4.2.4* Slaughter procedure

Slaughter procedure was as described in Chapter 3, Section 3.2.4.

### *4.2.5* Meat sample preparation

Meat sensory evaluation was done on meat from *A. karroo* supplemented goats and non-supplemented goats. Meat sampling was done on the *Logistimus dorssi* muscle.The meat samples were prepared using two thermal treatments: boiling and roasting. An average period of 45 minutes was used for cooking and roasting of the meat. Salt was added to taste.

### *4.2.6* **Meat sensory evaluation**

Meat sensory evaluation was done from boiled and roasted meat. A meat consumer sensory characteristics evaluation was done by individuals from different tribes (Xhosa, Shona, Ndebele and Zulu), different age groups (≤ 20, 21-25, 26-30, ≥ 30) and gender (female, male). Tasters were taught how to evaluate the meat samples and complete the available forms. The tasters were requested to rinse their mouth with drinking water after each taste so as to limit a crossover of the treatments.

A meat sensory characteristic evaluation form containing an eight-point rating scale of meat characteristics was used to give scores to different meat sensory characteristics. Sensory characteristics that were evaluated were: aroma intensity (AI) where score 1 is extremely bland and score 8 is extremely intense, initial impression of juiciness (IJ) at score 1 extremely dry and score 8 = extremely juicy, sustained impression of juiciness (SJ) at score 1 is extremely dry and score 8 is extremely juicy, first bite (FB) at score 1 is extremely tough to score 8 being extremely tender), muscle fibre and overall tenderness (MFT) at score 1 being extremely tough and score 8 is extremely tender, overall flavour intensity (OF) at score 1= extremely bland to score 8 = extremely intense, amount of connective tissue (ACT) at score 1= extremely abundant to 8 = none, and off- flavour (ATF) at score 1= none and score 8 = extremely intense.

### *4.2.7* **Statistical analysis**

The general linear model procedure of the SAS (2003) program was also used to determine the effects of *A. karroo*, age, gender, tribe and thermal preparation on meat sensory characteristics of goats. The model is:

$$Y_{ifjkl} = \mu + D_i + C_j + T_k + G_l + A_f + (C_j \times D_i) + (C_j \times T_k) + (C_j \times G_l) + (C_j \times A_f) + E_{ifjkl}$$

Where $Y_{ijk}$ = 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 flavour),

$\mu$ = overall mean common to all observations

$D_i$ = effect of *A. karroo* supplementation

$C_j$ = effect of thermal treatment (boiled, fried)

$T_k$ = effect of tribe (Xhosa, Shona, Zulu, Sesotho)

$G_l$ = effect of consumer gender (Male, Female)

$A_f$ = effect of consumer age

$(C_j \times T_k)$ = effect of thermal treatment and tribe

$(C_j \times G_l)$ =effect of thermal treatment and gender

$(C_j \times A_f)$ = effect of thermal treatment and age

$(C_j \times D_i)$ = effect of thermal treatment and *A. karroo* supplementation

$E_{ifjkl}$ = random error.

## 4.3 Results

Table 4.1 shows the effect of *A. karroo* supplementation on the sensory characteristics of meat from Xhosa lop-eared goats. Meat from the supplemented goats had significantly higher sensory scores than the one from non-supplemented goats. There were no significant effects of *A. karroo* supplementation on meat flavour and off-flavour scores. Table 4.2 shows the effect *A. karroo* supplementation and thermal preparations (cooked and roasted meat) on sensory characteristics of meat from goats. The highest scores for meat juiciness and tenderness were recorded in cooked meat from *A. karroo* supplemented goats. Roasted meat had the lowest sensory scores across treatment groups. The cooked meat from supplemented and non-supplemented goats had higher sensory scores than the roasted meat.

The effects of thermal preparation and consumer gender on meat sensory characteristics are shown in Table 4.3. Female consumers gave higher sensory scores for all sensory characteristics for both cooked and roasted meat. Both male and female consumers gave higher sensory scores for the cooked meat than the roasted meat. Table 4.4 shows the effect of tribe and thermal preparation on the sensory characteristics of meat from Xhosa lop-eared goats. The highest sensory scores for aroma intensity, first bite, and amount of connective tissue and sustained impression of juiciness in cooked meat were given by the Shona consumers while the Zulu consumers gave high sensory scores for overall flavour, off-flavour and muscle fibre and overall tenderness from cooked meat. Ndebele and Xhosa consumers gave the highest scores for initial juiciness and muscle fibre and overall tenderness respectively from the cooked meat.

**Table 4.1: Effects of *A. karroo* supplementation on meat sensory characteristics of Xhosa lop-eared goat breed.**

| Parameters | AK | NS | Significance |
|---|---|---|---|
| **AI** | 4.3 ± 0.30 | 4.5 ± 0.30 | NS |
| **IJ** | 4.9 ± 0.24 | 3.8 ±0.24 | * |
| **FB** | 4.5 ± 0.26 | 4.1 ± 0.26 | * |
| **SJ** | 5.1 ± 0.24 | 4.2 ± 0.24 | * |
| **MFT** | 4.5 ± 0.23 | 4.1 ± 0.23 | * |
| **ACT** | 3.9 ± 0.24 | 3.9 ± 0.24 | NS |
| **OF** | 4.2 ± 0.27 | 4.3 ± 0.27 | NS |
| **ATF** | 2.2 ± 0.29 | 3.2 ± 0.29 | NS |

AI = aroma intensity; IJ =Initial juiciness; SJ = sustained juiciness, MFT = Muscle fibre and overall tenderness, ACT = Amount of connective tissue, OF = Overall flavour score, ATF = Off-flavour score. AK= *Acacia karroo* supplemented, NS= not supplemented.

*= Significant different (P< 0.05), NS= not significant (P> 0.05)

**Table 4.2: Effect of *A. karroo* supplementation and cooking methods on sensory scores of Xhosa lop-eared goat genotype.**

| **Sensory characteristics** | **Treatments** | | | |
|---|---|---|---|---|
| | Not supplemented | | *Acacia karroo* supplemented | |
| | *Cooked* | *Roasted* | *Cooked* | *Roasted* |
| **Aroma intensity** | 4.9 ± 0.41[b] | 4.1 ± 0.41[a] | 4.6 ± 0.41[b] | 3.9 ± 0.42[a] |
| **Overall flavour** | 4.6 ± 0.37[b] | 4.0 ± 0.38[a] | 4.4 ± 0.37[ab] | 3.9 ± 0.38[a] |
| **Initial impression of juiciness** | 4.8 ± 0.33[b] | 2.7 ± 0.33[a] | 5.1 ± 0.33[b] | 2.9 ± 0.33[a] |
| **Sustained impression of juiciness** | 5.2 ± 0.33[b] | 3.2 ± 0.33[a] | 5.5 ± 0.33[b] | 3.6 ± 0.33[a] |
| **First bite** | 5.1 ± 0.36[b] | 2.9 ± 0.37[a] | 5.8 ± 0.36[c] | 3.3 ± 0.37[a] |
| **Amount of Connective Tissue** | 4.4 ± 0.34[b] | 3.3 ± 0.34[a] | 4.3 ± 0.34[b] | 3.6 ± 0.34[a] |
| **Muscle Fibre and Tenderness** | 4.8 ± 0.32[b] | 3.4 ± 0.32[a] | 5.3 ± 0.31[b] | 3.6 ± 0.32[a] |
| **Off-flavour score** | 3.4 ± 0.40[b] | 2.9 ± 0.41[a] | 3.2 ± 0.40[ab] | 2.6 ± 0.41[a] |

[abcd] Means with different superscripts in the same row are significantly different ($P < 0.05$).

**Table 4.3: The effect of gender group and cooking method on meat sensory characteristics of the Xhosa lop-eared goat genotype**

| Sensory characteristics | Gender | | | |
|---|---|---|---|---|
| | Female | | Male | |
| | *Cooked* | *Roasted* | *Cooked* | *Roasted* |
| **Aroma intensity** | 5.5 ± 0.39[b] | 4.6 ± 0.40[a] | 4.1 ± 0.39[a] | 4.1 ± 0.40[a] |
| **Overall flavour** | 4.7 ± 0.36[b] | 4.5 ± 0.37[ab] | 4.1 ± 0.36[a] | 4.1 ± 0.37[a] |
| **Initial impression of juiciness** | 5.3± 0.32[c] | 3.7 ± 0.32[a] | 4.8 ± 0.31[b] | 3.2 ± 0.32[a] |
| **Sustained impression of juiciness** | 5.5 ± 0.32[b] | 4.1 ± 0.32[a] | 5.1 ± 0.31[b] | 3.7 ± 0.32[a] |
| **First bite** | 5.5 ± 0.35[b] | 3.7 ± 0.35[a] | 4.9 ± 0.34[b] | 3.5 ± 0.35[a] |
| **Amount of Connective Tissue** | 4.3 ± 0.32[b] | 3. 8 ± 0.33[a] | 4.2 ± 0.32[ab] | 3.8 ± 0.33[a] |
| **Muscle Fibre and Tenderness** | 5.1 ± 0.30[c] | 4.0 ± 0.31[a] | 4.6± 0.30[b] | 3.7 ± 0.3[a] |
| **Off-flavour score** | 3.6 ± 0.39[b] | 2.8 ± 0.39[a] | 3.5 ± 0.38[b] | 2.8 ± 0.39[a] |

[abcd]Means with different superscripts in the same row are significantly different ($P < 0.05$).

**Table 4.4: sensory scores for the effect of tribe and cooking method on meat sensory characteristics of the Xhosa lop-eared goat breed**

| Sensory characteristics | Tribes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Xhosa | | Shona | | Zulu | | Ndebele | |
| | *Cooked* | *Roasted* | *Cooked* | *Roasted* | *Cooked* | *Roasted* | *Cooked* | *Roasted* |
| **AI** | 4.9 ±0.25$^{b}$ | 4.6 ±0.25$^{b}$ | 5.9 ±0.68$^{c}$ | 4.7 ±0.79$^{b}$ | 4.8 ±0.61$^{b}$ | 3.7 ± 0.55$^{a}$ | 4.7±1.16$^{b}$ | 3.8 ± 1.16$^{a}$ |
| **OF** | 4.9 ±0.23$^{b}$ | 4.5±0.23$^{ab}$ | 5.0 ±0.62$^{b}$ | 4.4±0.72$^{ab}$ | 5.1 ±0.56$^{b}$ | 3.7 ± 0.51$^{a}$ | 3.6±1.06$^{a}$ | 3.8 ± 1.06$^{a}$ |
| **IJ** | 5.1 ±0.21$^{b}$ | 3.4 ±0.21$^{a}$ | 5.0 ±0.55$^{b}$ | 3.5 ±0.64$^{a}$ | 5.9  0.49$^{c}$ | 3.2 ± 0.45$^{a}$ | 6.1±0.95$^{c}$ | 3.1 ± 0.94$^{a}$ |
| **SJ** | 5.6 ±0.20$^{b}$ | 3.7 ±0.21$^{a}$ | 6.1 ±0.55$^{c}$ | 4.0 ±0.63$^{a}$ | 5.9±0.49$^{bc}$ | 3.5 ± 0.44$^{a}$ | 5.4±0.94$^{b}$ | 3.6 ± 0.94$^{a}$ |
| **FB** | 5.9 ±0.22$^{c}$ | 2.9 ±0.22$^{a}$ | 6.1 ±0.60$^{c}$ | 3.5 ±0.69$^{a}$ | 5.8 ±0.54$^{c}$ | 3.6 ± 0.49$^{a}$ | 4. ±1.03$^{b}$ | 3.4 ± 1.03$^{a}$ |
| **ACT** | 4.7±0.21$^{bc}$ | 3.3 ±0.21$^{a}$ | 5.3 ±0.56$^{c}$ | 3.9 ±0.65$^{a}$ | 4.6 ±0.50$^{b}$ | 3.8 ±0.45$^{ab}$ | 3.5±0.96$^{a}$ | 3.5 ± 0.96$^{a}$ |
| **MFT** | 5.8 ±0.19$^{c}$ | 3.3 ±0.19$^{a}$ | 5.7 ±0.52$^{c}$ | 3.8±0.61$^{ab}$ | 5.8 ±0.47$^{c}$ | 3.4 ± 0.43$^{a}$ | 3.6±0.89$^{a}$ | 4.0 ± 0.89$^{b}$ |
| **ATF** | 3.4±0.24$^{bc}$ | 3.0 ±0.25$^{b}$ | 3.7 ±0.66$^{c}$ | 4.4 ±0.77$^{d}$ | 4.3 ±0.59$^{d}$ | 3.7 ± 0.54$^{c}$ | 2.9±1.14$^{b}$ | 0.3 ± 1.14$^{a}$ |

$^{abcd}$Means with different superscripts in the same row are significantly different ($P < 0.05$)., AI = aroma intensity; IJ =Initial juiciness; SJ = sustained juiciness, MFT = Muscle fibre and overall tenderness, ACT = Amount of connective tissue, OF = Overall flavour score, ATF = Off-flavour score.

Consumer age group had a significant effect on the meat sensory scores across thermal preparations (Table 4.5). The sensory scores for cooked meat were generally higher than those for roasted meat across age groups. The consumer age group between 26-30 years old gave the highest sensory scores for aroma intensity, initial juiciness, sustained juiciness, muscle fibre and overall tenderness from the cooked meat. The highest sensory scores for overall flavour and off-flavours from the cooked meat were given by consumer age group between 21-25 years and consumers less than 20 years old respectively while the highest sensory scores for first bite and amount of connective tissue from the cooked meat were given by consumers more than 30years old.

**Table 4.5: The effect of age and cooking method on meat sensory characteristics of Xhosa lop-eared goat genotype**

| Sensory characteristics | AGE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ≤20 | | 21-25 | | 26-30 | | ≥30 | |
| | *Cooked* | *Roasted* | *Cooked* | *Roasted* | *Cooked* | *Roasted* | *Cooked* | *Roasted* |
| **AI** | 5.3±0.51$^{bc}$ | 4.7±0.50$^{b}$ | 5.0±0.42$^{b}$ | 3.9 ±0.42$^{a}$ | 5.7±0.63$^{c}$ | 4.1±0.64$^{a}$ | 4.2±0.51$^{a}$ | 4.1 ±0.52$^{a}$ |
| **OF** | 4.5 ±0.46$^{b}$ | 3.9±0.46$^{a}$ | 4.9±0.38$^{c}$ | 3.9 ±0.39$^{a}$ | 4.8±0.58$^{c}$ | 3.9±0.59$^{a}$ | 4.4±0.47$^{ab}$ | 4.6±0.48$^{bc}$ |
| **IJ** | 5.6 ±0.41$^{c}$ | 2.9±0.41$^{a}$ | 5.5±0.34$^{c}$ | 3.4±0.34$^{ab}$ | 5.7±0.51$^{c}$ | 3.6±0.52$^{b}$ | 5.3 ±0.42$^{c}$ | 3.2 ±0.42$^{a}$ |
| **SJ** | 5.6 ±0.41$^{c}$ | 3.4±0.41$^{a}$ | 5.2±0.34$^{c}$ | 3.7±0.34$^{a}$ | 6.2±0.51$^{d}$ | 4.3±0.52$^{b}$ | 5.8±0.41$^{cd}$ | 3.5 0.43$^{a}$ |
| **FB** | 5.6±0.45$^{cd}$ | 2.9±0.45$^{a}$ | 5.3±0.37$^{c}$ | 3.3±0.37$^{a}$ | 5.7±0.56$^{d}$ | 3.9±0.57$^{b}$ | 6.0 ±0.46$^{d}$ | 3.2 ±0.46$^{a}$ |
| **ACT** | 4.1±0.42$^{ab}$ | 3.7±0.41$^{a}$ | 4.6±0.35$^{bc}$ | 3.7±0.35$^{a}$ | 4.5±0.52$^{b}$ | 3.4±0.53$^{a}$ | 4.9 ±0.43$^{c}$ | 3.6 ±0.43$^{a}$ |
| **MFT** | 5.4 ±0.39$^{c}$ | 3.5±0.39$^{a}$ | 4.7± 0.32$^{b}$ | 3.6±0.32$^{a}$ | 5.4±0.49$^{c}$ | 4.2±0.49$^{b}$ | 5.4 ±0.39$^{c}$ | 3.2 ±0.40$^{a}$ |
| **ATF** | 4.3 ±0.49$^{c}$ | 2.5±0.49$^{a}$ | 3.6± 0.41$^{b}$ | 2.8±0.41$^{a}$ | 2.8±0.62$^{a}$ | 2.1±0.63$^{a}$ | 3.6 ±0.50$^{b}$ | 4.0±0.51$^{bc}$ |

$^{abcd}$Means with different superscripts in the same row are significantly different ($P < 0.05$). AI = aroma intensity; IJ =Initial juiciness; SJ = sustained juiciness, MFT = Muscle fibre and overall tenderness, ACT = Amount of connective tissue, OF = Overall flavour score, ATF = Off-flavour score.

## 4.4 Discussion

Supplementation with dietary protein particularly from browse trees in the diet of ruminants produces carcasses of good quality (Arsenos *et al*., 2009; Mapiye *et al*., 2009). In the current study, the positive effect of *A. karroo* supplementation on meat sensory characteristics, particularly meat tenderness and juiciness from the supplemented goats is attributed to the effect of *A. karroo* nutrient composition (Mapiye *et al*., 2009). The *A. karroo* browse plant is reported to be a good source of proteins and minerals (Mokoboki *et al*., 2005; Ngongoni, Mapiye, Mwale, & Mupeta, 2007) which are the dietary requirements for the development of meat sensory attributes.

Meat juiciness is directly related to the intramuscular fat content of the meat (Webb *et al.*, 2005), however, it is highly affected by animal species (Tshabalala *et al*., 2003; Muchenje *et al*., 2008). In the current study, meat juiciness had generally lower sensory scores across treatment groups. This could be because chevon has been reported to be less juicy, especially for sustained juiciness (Tshabalala *et al*., 2003), since goat carcasses have low fat content (Simela, 2005). But, the meat juiciness scores from the *A. karroo* supplemented goats were significantly higher ($P < 0.05$) than the meat juiciness scores of meat from the non-supplemented goats. The difference, in the improvement in meat juiciness scores from the *A. karroo* supplemented goats could be attributed to the effect of *A. karroo* supplementation since it is known to improve the resilience of meat producing animals (Arsenos *et al*., 2009; Marume, 2010) and is a source of proteins (Mokoboki *et al*., 2005).

In the current study, there was no significant effect of *A. karroo* supplementation on meat flavour. Several authors have reported diverse results on the effect of diet on meat flavour. Bowling *et al.* (1978); Melton (1983); Berry, Leddy, Bond, Rumsey, & Hammond (1988)

reported a significant effect of diet on meat flavour while Bidner, Montgomery, Bagley, and McMillin (1985); French *et al.* (2001) reported no significant effect of diet on meat flavour. The variety of results could be due to the variety of feedstuff used, such as silage and pasture (Melton, 1983), corn diets to corn silage diets (Berry *et al*., 1988), grass and grain-fed (French *et al*., 2001). The results may be influenced by the type and intensity of fatty acid developed. For example, when levels of polyunsaturated fatty acids (PUFA) become too high, off-flavours can develop, especially during cooking (Elmore, Campo, Enser, & Mottram, 2002).

There was a significant effect of thermal preparation on meat sensory characteristics scores. Highest sensory scores for cooked meat, not the roasted meat reported in the current study could be attributed to the difference in cooking losses from the two thermal preparations. This could be the result of the extent to which protein denaturing takes place and is assumed to be higher in roasted meat than in cooked meat (Garcia-Segovia, Andres-Bello, & Martinez-Monzo, 2006). Therefore, with higher protein losses there will be higher cooking losses since protein was reported to increase water binding properties (Jama *et al*., 2008). However, lower sensory scores could result since higher cooking losses result in lower juiciness and less tender muscle (Sheard *et al*., 2005). Dyubele *et al*. (2010) also reported a significant effect of thermal preparation on sensory scores of chicken where the roasted meat had higher sensory scores than the cooked meat. The argument could be attributed to the effect of animal species (Muchenje *et al*., 2008). Differences observed on meat sensory characteristics between cooked and roasted meat can be associated with consumer experience and familiarity with a particular thermal preparation of meat (Sveinsdóttir *et al*., 2009; Xazela *et al*., 2011). Normally, communal home meat preparation is through cooking. Therefore, with the lack of experience of roasted meat, consumers might not properly identify

differences among sensory characteristics of roasted meat. The effect of consumer background was also studied in the current study.

There is also a significant effect of consumer age, gender and thermal preparation on meat sensory scores. Highest sensory scores recorded by female consumers in the current study is in agreement with findings by Simela (2005), Dyubele *et al*. (2010), Xazela *et al.* (2011) who all reported a significant effect of consumer gender on sensory characteristics, where females reported higher scores of meat juiciness than males consumers.

Different tribes reported different intensity in sensory scores across sensory characteristics of cooked meat. This can, however, be associated with consumer familiarity with and availability of goat meat (Sveinsdóttir *et al.*, 2009) and the influence of the consumer's country of origin (Shabalala & Mosima, 2002). Preference for animal species for meat production is directly affected by consumer background (Sañudo, Alfonso, San Julian, Thorkelsson, & Valdimarsdottir, 2007). The differences between and within countries might be explained by different consumption patterns of chevon. However, its consumption is affected by religious restrictions (Jaturasitha, 2004). For instance in some countries such as South Africa consumption of chevon is assumed as to be as more suitable for traditional activities (Mahanjana & Cronje, 2000; Ayalew, Rischkowsky, King, & Bruns, 2003; Rumosa-Gwaze, Chimonyo, & Dzama, 2009).

## 4.5 Conclusion

*Acacia karroo* supplementation significantly improved the tenderness and juiciness of meat from goats. However; there were no significant effects of *A. karroo* supplementation on chevon flavour and off-flavours. Thermal preparation affected meat quality attributes, where cooked meat had higher sensory scores than the roasted meat. Background had an effect on the consumer's perception of meat quality attributes.

## 4.6 References


Arsenos, G., Fortomaris, P., Papadopoulos, E., Sotiraki, S., Stamataris, C., & Zygoyiannis, D. (2009). Growth and meat quality of kids of indigenous Greek goats (*Capra prisca*) as influenced by dietary protein and gastrointestinal nematode challenge. *Meat Science*, 82(3), 317-323.

Ayalew, W., Rischkowsky, B., King, J. M., & Bruns, E. (2003). Crossbreds did not generate more net benefits than indigenous goats in Ethiopian smallholdings. *Agricultural Systems*, 73, 1137–1156.

Bakare, A. G., & Chimonyo, M. (2011). Seasonal variation in time spent foraging by indigenous goat genotypes in a semi-arid rangeland in South Africa. *Livestock Science*, 135,251–256.

Berry, B. W., Leddy, K. F., Bond, J., Rumsey, T. S., & Hammond, A. C. (1988). Effects of silage diets and electrical stimulation on the palatability, cooking and pH characteristics of beef loin steaks. *Journal of Animal Science*, 66(4), 892–900.

Bidner, T. D., Montgomery, R. E., Bagley, C. P., & McMillin, K. W. (1985). Influence of electrical stimulation, blade tenderization and postmortem vacuum aging upon the acceptability of beef finished on forage or grain. *Journal of Animal Science*, 61(3), 584–589.

Bowling, R. A., Riggs, J. K., Smith, G. C., Carpenter, Z. L., Reddish, R. L., & Butler, O. D. (1978). Production, carcass and palatability characteristics of steers produced by different management systems. *Journal of Animal Science*, 46(2), 333–340.

Calkins, C. R., & Hodgen, J. M. (2007). A fresh look at meat flavour. *Meat Science*, 77(1), 63-80.

Devendra, C., & Sevilla, C. C. (2002). Availability and use of feed resources in crop-animal systems in Asia. *Agricultural Systems*, 71(12), 59–73.

Dyubele, N. L., Muchenje, V., Nkukwana, T. T., & Chimonyo, M. (2010). Consumer sensory characteristics of broiler and indigenous chicken meat: A South African example. *Food Quality and Preference*, 21, 815–819.

Elmore, J. S., Campo, M. M., Enser, M., & Mottram, D. S. (2002). Effect of lipid composition on meat-like model systems containing cysteine, ribose, and polyunsaturated fatty acids. *Journal of Agricultural and Food Chemistry*, 50(5), 1126–1132.

French, P., O'Riordan, E. G., Monahan, F. J., Caffrey, P. J., Mooney, M. T., & Troy, D. J. (2001). The eating quality of meat of steers fed grass and/or concentrates. *Meat Science*, 57(4), 379–386.

Garcia-Segovia, P., Andres-Bello, A., & Martinez-Monzo, J. (2006). Effect of cooking method on mechanical properties, colour, and structure of beef muscle (*M. pectoralis*). *Journal of Food Engineering*, 80(3), 813–821.

Jama, N., Muchenje, V., Chimonyo, M., Strydom, P. E., Dzama, K., & Raats, J. G., 2008. Cooking loss components of beef from Nguni, Bonsmara and Angus steers. *African Journal of Agricultural Research*, 3(6), 416-420.

Jaturasitha, S. (2004). Meat management. Mingmuang Press, Chiang Mai, Thailand.

Kahiya, C., Mukaratirwa, S., & Thamsborg, S. M. (2003). Effects of *Acacia nilotica* and *Acacia karroo* diets on *Haemonchus contortus* infection in goats, *Veterinary Parasitology*, 115, 265–274.

Mahanjana, A. M., & Cronj´e, P. B. (2000). Factors affecting goat production in a communal farming system in the Eastern Cape region of South Africa. *South African Journal of Animal Science*, 30, 149–154.

Mapiye, C., Chimonyo, M., Dzama, K., Strydom, P. E., Marufu, M. C., & Muchenje, V. (2009). Nutritional status, growth performance and carcass characteristics of Nguni steers supplemented with *Acacia karroo* leaf-meal. *Livestock Science*, 126, 206–214.

Mapiye, C., Chimonyo, M., Dzama, K., Strydom, P. E., & Muchenje, V. (2010). Meat quality attributes of Nguni steers supplemented with *Acacia karroo* leaf-meal. *Meat Science*, 8, 621–627.

Marume, U. (2010). Effect of *Acacia karroo* on growth and meat quality of indigenous goats. PhD Thesis. University of Fort Hare, South Africa.

Melton, S. L. (1983). Effect of forage feeding on beef flavour. *Food Technology*, 37(5), 239–248.

Mokoboki, H. K., Ndlovu, L. R., Ngambi, J. W., Malatje, M. M., & Nikolovav, R. V. (2005). Nutritive value of *Acacia* tree foliages growing in the Limpopo Province of South Africa. *South African Journal of Animal Science*, 35(4), 221–228.

Muchenje, V., Dzama, K., Chimonyo, M., Strydom, A., Hugo, P. E., & Raats J. G. (2008). Sensory evaluation and its relationship to physical meat quality attributes of beef from Nguni and Bonsmara steers raised on natural pasture. *Animal*, 2, 1700–1706.

Muchenje, V., Hugo, A., Dzama, K., Chimonyo, M., Strydom, P. E., & Raats J. G. (2009). Cholesterol levels and fatty acid profiles of beef from three cattle breeds raised on natural pasture. *Journal of Food Composition and Analysis*, 22,354–358.

Ngongoni, N. T., Mapiye, C., Mwale, M., & Mupeta, B. (2007). Effect of supplementing a high-protein ram press sunflower cake concentrate on smallholder milk production in Zimbabwe. *Tropical Animal Health Production,* 39(4), 297–307.

Nour, A. Y. M., Gomide, L. A., Mills, E. W., Lemenager, R. P., Judge, M. D. (1994). Influence of production and post-mortem technologies on comparison and palatability of USDA Select Grade Beef. *Journal of Animal Science*, 72(5), 1081-1386.

Priolo, A., Bella, M., Lanza, M., Galofaro, V., Biondi, L., Barbagallo, D., Ben Salem, H., & Pennisi, P. (2005). Carcass and meat quality of lambs fed fresh sulla (Hedysarum coronarium L.) with or without polyethylene glycol or concentrate. *Small Ruminant Research*, 59, 281–288.

Rumosa-Gwaze, F. G., Chimonyo, M., & Dzama, K. (2009). Communal goat production in Southern Africa: A review. *Tropical Animal Health Production*, 41, 1157-1168.

Sañudo, C., Alfonso, M., San Julian, R., Thorkelsson, G., & Valdimarsdottir, T. (2007). Regional variation in the hedonic evaluation of lamb meat from diverse production systems by consumers in six European countries. *Meat Science,* 77(4), 610-621.

Sebsibe, A. (2006). Sheep and Goat Meat Characteristics and Quality. Ph.D. Thesis. University of Pretoria. South Africa.

SAS. (2003). SAS User's Guide: Statistics (Version 6 Ed.). SAS Inst. Inc., Cary, NC.

Shabalala, N., & Mosima, B. (2002). Report on the survey of large and small scale agriculture/ Statistics South Africa. Statistics S.A Library Cataloguing-in-Publication (CIP) Data Pretoria: Statistics South Africa.

Sheard, P. R., Nute, G. R., Richardson, R. I., Wood, J. D., 2005. Effect of breed and marination on the sensory attributes of pork from Large White and Hampshire-sired pigs. *Meat Science*, 70(4), 699-707.

Simela, L. (2005). Meat characteristics and acceptability of chevon from South African indigenous goats. Ph.D. Thesis. University of Pretoria. South Africa.

Simela, L., Webb, E. C., & Bosman, M. J. C. (2008). Acceptability of chevon from kids, yearling goats and mature does of indigenous South African goats: A case study. *South African Journal of Animal Science*, 38, 3.

Strydom, P. E., Naude, R. T., Smith, M. F., Scholtz, M. M., & van Wyk, J. B. (2000). Characterisation of indigenous African cattle breeds in relation to meat quality traits. *Meat Science*, 55, 79–88.

Sveinsdóttir, K., Martinsdóttir, E., Green-Petersen, D., Hyldig, G., Schelvis, R., & Delahunty, C. (2009). Sensory characteristics of different cod products related to consumer preferences and attitudes. *Food Quality and Preference*, 20, 120–132.

Swan, J. E., Esguerra, C. M., & Farouk, M. M. (1997). Some physical, chemical and sensory properties of chevon products from three New Zealand goat breeds. *Small Ruminant Research*, 28, 273-280.

Tshabalala, P. A., Strydom, P. E., Webb, E. C., de Kocka, H. L., 2003. Meat quality of designated South African indigenous goat and sheep breeds. *Meat Science*, 65, 563–570.

Webb, E. C., Casey, N. H., & Simela, L. (2005). Goat meat quality. *Small Ruminant Research*, 60, 153–166.

Worch, T., Lê, S., Punter, P. (2010). How reliable are the consumers? Comparison of sensory profiles from consumers and experts. *Food Quality and Preference*, 21, 309-318.

Xazela, N. M., Chimonyo, M., Muchenje, V., & Marume, U. (2011). Consumer sensory evaluation of meat from South African goat genotypes fed on a dietary supplement. *African Journal of Biotechnology*, 10(20), 4436-4443.

# 5 Chapter 5

## General discussion, conclusion and recommendations

### 5.1 General discussion

The objective of the study was to determine the effects of *A. karroo* supplementation on quality of meat from Xhosa Lop-Eared goats. The effect of *A. karroo* supplementation on meat pH, colour and cooking losses of meat from goats were determined in Chapter 3 while the effect of *A. karroo* supplementation and thermal preparation on meat sensory scores of meat from goats was determined in Chapter 4.

There were no significant differences on the *L** and *a** colour coordinates of the meat from *A. karroo* supplemented goats and non-supplemented goats. However, the supplemented goats had a higher *b** value than the non-supplemented goats and this suggest that *A. karroo* supplementation improved the yellow colouring of chevon. The findings agree with the report by Priolo and Vasta (2007), who reported that tannins can be responsible for the differences found in meat colour.

*Acacia karroo* supplementation had a significant effect on meat $pH_u$ of Xhosa lop-eared goats, where the meat $pH_u$ of the *A. karroo* supplemented goats was significantly lower than that of non-supplemented goats. Cooking losses in the meat from the *A. karroo* supplemented goats was lower than that of the meat from the non-supplemented goats. The lower cooking losses could also be attributed to the effect of *A. karroo* supplementation which is regarded as a source of protein (Ngongoni, Mapiye, Mwale, & Mupeta, 2007) contributing in retaining more water within a meat muscle (Miller, 2001). Goats are also known to produce lean meat with a reasonable amount of protein and in that way, the effect of animal species could

contribute to the lower cooking losses reported in the current study (Simela, 2005; Muchenje *et al*., 2008). Meat from the *A. karroo* supplemented goats had higher tenderness and juiciness scores than meat from the non- supplemented goats. The improved meat juiciness and tenderness could be attributed to the lower meat cooking losses reported in Chapter 3 due to the effect of *A. karroo* supplementation (Sheard, Nute, Richardson, & Wood, 2005). The improved meat juiciness has also been influential in the improved meat tenderness since these two meat attributes are positively correlated (Ngambu, Muchenje, Chimonyo, & Marume, 2011). The sensory scores of the meat quality attributes were also reported to be affected by the cooking method (Dyubele, Muchenje, Nkukwana, & Chimonyo, 2010).

The thermal preparation of meat is an important tool in the sensory perception of meat by consumers (Jama *et al*., 2008). In the current study, thermal preparation had an effect on meat quality attributes, where cooked meat had higher sensory scores than the roasted meat. Consumer gender, tribe and age had a significant effect on meat quality attributes (Dyubele *et al*., 2010; Xazela, Chimonyo, Muchenje, & Marume, 2011). Female consumer's gives higher sensory scores than the male consumers. Both male and female consumers reported higher sensory scores for the cooked meat than the roasted meat.

Shona and Zulu consumers reported higher sensory scores for the majority of sensory characteristics from the cooked meat than the roasted meat. The majority of meat sensory characteristics from the roasted meat had significantly lower sensory scores than that of the cooked meat across different tribes. The consumer age group between 26-30 years old reported the cooked meat with the highest sensory scores of all the other age groups.

## 5.2 Conclusion

*Acacia karroo* supplementation had a significant effect on meat colour, $pH_u$ and cooking losses. *Acacia karroo* supplementation improves physico-chemical meat quality and meat sensory attributes such as tenderness and juiciness. The cooked meat had higher sensory scores than the roasted meat and therefore, cooking can be said to improve the eating quality of meat. Consumers of different genders, tribes and ages had different perceptions of meat sensory characteristics across thermal preparations. All the different categories of consumers gave higher sensory scores for the cooked meat than the roasted meat.

## 5.3 Recommendations

Based on the findings from this study, the use of *A. karroo* as a supplement by farmers for meat producing small ruminants is recommended especial after grazing. Proper feed monitoring such as weighing has to be considered given that, in excess quantities, browse plants can negatively affect protein degradability and availability. *Acacia karroo* is a low cost source of protein feed; therefore it can be used as a tool over increased feeding inputs for poor resourced livestock producers. This will, however; improve small ruminant production, ensuring merit output especially for the smallholder farmers through high quality carcasses.

The following areas need further research investigations:

- Goat consumption of the *A. karroo* browse plant between leaf meal supplementation and own browsing. This is important for scientist to consider because

browsing is the culture of goats, therefore, consumption and preference can be disturbed when they are provided leaf meal instead of browsing themselves.

● The recommended daily allowance of the *A. karroo* browse plant consumption for goats to shift from protein bind caused by excess consumption.

● The meat Production performance of different livestock species supplemented by *A. karroo.*

## 5.4 References


Dyubele, N. L., Muchenje, V., Nkukwana, T. T., & Chimonyo, M. (2010). Consumer sensory characteristics of broiler and indigenous chicken meat: A South African example. *Food Quality and Preference*, 21, 815–819.

Jama, N., Muchenje, V., Chimonyo, M., Strydom, P. E., Dzama, K., & Raats, J. G. (2008). Cooking loss components of beef from Nguni, Bonsmara and Angus steers. *African Journal of Agricultural Research*, 3(6), 416-420.

Miller, R. K. (2001). Beef flavour: A white paper, National Cattlemens, *Beef Association*, Centennial, CO.

Muchenje, V., Dzama, K., Chimonyo, M., Strydom, A., Hugo, P. E., & Raats, J. G. (2008). Sensory evaluation and its relationship to physical meat quality attributes of beef from Nguni and Bonsmara steers raised on natural pasture. *Animal*, 2(11), 1700–1706.

Ngambu, S., Muchenje, V., Chimonyo, M., & Marume, U. (2011). Correlations among sensory characteristics and relationships between aroma scores, flavour scores, off-flavour scores and off-flavour descriptors of chevon from four goat genotypes. *African Journal of Biotechnology*, 10(34), 6575-6580.

Ngongoni, N. T., Mapiye, C., Mwale, M., & Mupeta, B., 2007. Effect of supplementing a high-protein ram press sunflower cake concentrate on smallholder milk production in Zimbabwe. *Tropical Animal Health Production*, 39(4), 297–307.

Priolo, A., & Vasta, V. (2007). Effects of tannin-containing diets on small ruminant meat quality. *Italian Journal of Animal Science*, 6(4), 527-530.

Sheard, P. R., Nute, G. R., Richardson, R. I., & Wood, J. D. (2005). Effect of breed and marination on the sensory attributes of pork from Large White and Hampshire-sired pigs. *Meat Science*, 70(4), 699-707.

Simela, L. (2005). Meat characteristics and the acceptability of chevon from South African indigenous goats. PhD Thesis, University of Pretoria, South Africa.

Xazela, N. M., Chimonyo, M., Muchenje, V., & Marume, U. (2011). Consumer sensory evaluation of meat from South African goat genotypes fed on a dietary supplement. *African Journal of Biotechnology*, 10(20), 4436-4443.

**Appendix**: **meat sensory evaluation form**

Sensory analysis of Chevon

**Age: ≤ 20------., 21-25------., 26-30-------., ≥ 30-----.**

**Tribe: Xhosa------., Zulu-------.,Shona-------., Ndebele---------., Other--------.**

**Gender: Male--------., Female---------.**

**Name:……..** **Date:……**

**Please evaluate the following samples of chevon for the designated characteristics.**

| | **Characteristics** | **Rating scale** | | **Cooking method** | |
|---|---|---|---|---|---|
| | | | | **Cooked** | **Roasted** |
| **1** | **Aroma intensity**<br>Take a few short sniffs as soon as you remove the foil. Typical beef aroma | **1= Extremely bland**<br>**2= Very bland**<br>**3= Fairly bland**<br>**4= Slightly bland**<br>**5=Slightly intense**<br>**6= Fairly intense**<br>**7= Very intense**<br>**8=Extremely intense** | **AK** | | |
| | | | **NS** | | |
| **2** | **Initial impression of juiciness**<br>The amount of fluid exuded on the cut surface when pressed between the thumb and forefinger | **1= Extremely dry**<br>**2= Very dry**<br>**3= Fairly dry**<br>**4= Slightly dry**<br>**5=Slightly juicy**<br>**6= Fairly juicy**<br>**7= Very juicy**<br>**8=Extremely juicy** | **AK** | | |
| | | | **NS** | | |
| **3** | **First bite**<br>The impression that you form on the first bite | **1= Extremely tough**<br>**2= Very tough**<br>**3= Fairly tough**<br>**4= Slightly tough**<br>**5=Slightly tender**<br>**6= Fairly tender**<br>**7= Very tender**<br>**8=Extremely tender** | **AK** | | |
| | | | **NS** | | |
| **4** | **Sustained impression of juiciness**<br>The impression of juiciness that you form as you start chewing | **1= Extremely dry**<br>**2= Very dry**<br>**3= Fairly dry**<br>**4= Slightly dry**<br>**5=Slightly juicy**<br>**6= Fairly juicy** | **AK** | | |
| | | | **NS** | | |

| | | | | | |
|---|---|---|---|---|---|
| | | **7= Very juicy**<br>**8=Extremely juicy** | | | |
| **5** | **Muscle fibre & overall tenderness**<br>Chew sample with a light chewing action | **1= Extremely tough**<br>**2= Very tough**<br>**3= Fairly tough**<br>**4= Slightly tough**<br>**5=Slightly tender**<br>**6= Fairly tender**<br>**7= Very tender**<br>**8=Extremely tender** | **AK** | | |
| | | | **NS** | | |
| **6** | **Amount if connective tissue (Residue)**<br>The chewiness of the meat | **1=Extremely abundant**<br>**2= Very abundant**<br>**3= Excessive amount**<br>**4= Moderate**<br>**5= Slight**<br>**6= Traces**<br>**7= Practically none**<br>**8= None** | **AK** | | |
| | | | **NS** | | |
| **7** | **Overall flavour intensity**<br>This is the combination of taste while chewing and swallowing-referring to the typical beef flavour | **1= Extremely bland**<br>**2= Very bland**<br>**3= Fairly bland**<br>**4= Slightly bland**<br>**5=Slightly intense**<br>**6= Fairly intense**<br>**7= Very intense**<br>**8=Extremely intense** | **AK** | | |
| | | | **NS** | | |
| **8** | **A- Typical flavour intensity** | **1= None**<br>**2= Practically none**<br>**3= Traces**<br>**4= Moderate**<br>**5= Slightly intense**<br>**6= Fairly intense**<br>**7= Very intense**<br>**8= Extremely intense** | **AK** | | |
| | | | **NS** | | |

**Please evaluate the following off-flavour characteristics.**

| | **Characteristics** | | **Cooking method** | |
|---|---|---|---|---|
| | | | **Cooked** | **Roasted** |
| **1** | LIVER/BLOODY | **AK** | | |
| | | **NS** | | |
| **2** | COOKED VEGETABLE | **AK** | | |
| | | **NS** | | |
| **3** | PASTURE/ GRASSY | **AK** | | |
| | | **NS** | | |
| **4** | ANIMAL-LIKE/KRAAL ( MANURE) | **AK** | | |
| | | **NS** | | |
| **5** | METALLIC | **AK** | | |
| | | **NS** | | |
| **6** | SOUR | **AK** | | |
| | | **NS** | | |
| **7** | UNPLEASANT | **AK** | | |
| | | **NS** | | |
| **8** | GOAT ODOUR | **AK** | | |
| | | **NS** | | |