

**Meat characteristics and acceptability of chevon
from South African indigenous goats**

by

Langelihle Simela

BSc (Agric.) Hons, MSc (Anim. Sc.)

Thesis submitted in partial fulfilment of the requirements for the degree
PhD (Animal Science)

in the Faculty of Natural & Agricultural Sciences

University of Pretoria

Pretoria

June 2005

Abstract

ABSTRACT

Effects of sex, age and pre-slaughter conditioning on the characteristics of South African indigenous goat carcasses (weight, dimensions, and joint and tissue composition) and quality of chevon (pH and temperature profiles, histological, histochemical, metabolic, proteolytic and physical) were determined. Effects of post-mortem ageing and electrical stimulation on the quality of chevon were also investigated. The nutritional quality of chevon in terms of fatty acid and amino acid content was assessed. The acceptability of chevon compared to mutton was tested by a panel of South African consumers.

The goats were large with live weight, carcass weight and carcass dimensions in the range of the large breeds of southern Africa. They had a high lean and low fat content that is typical of most goat breeds. Intact males were suited for high chevon yield because they were heavy, had a high lean and low fat content, and losses during dressing and chilling were reduced by improved nutrition. Goats between two and six teeth yielded heavy carcasses that were comparable to goats in the eight teeth group, and had proportionately more lean. The hind limb appeared to be ideal for high lean and low fat high value cuts but the dorsal trunk was bony and yielded less lean. Pre-slaughter conditioning improved the overall size of the goats and reduced the losses during slaughter and chilling. It also improved the lean/bone and lean and fat/bone indices.

The *M. longissimus thoracis* (LT) had a low glycolytic potential (GP), high initial lactate concentration, low initial pH and high ultimate pH (pHu) values, all of which indicated that peri-mortem handling of goats was a potent stressor. Chevon from carcasses with pHu<5.8 had higher initial GP, glycogen and ATP content. It had longer sarcomeres, low 96-hour shear force values and better colour quality than higher pH meat. Similarly, chevon from the 2-teeth group tended to have lower pHu values than contemporary groups and hence lower 96-hour shear force values and better colour quality. Conversely, mature does tended to have high pHu and hence a high mean 96-hour shear force value and a low mean a^* value associated with dark cutting meat. Only up to 20% of the muscle samples had a pHu<5.8. Pre-slaughter conditioning had no effect on GP and pHu but enhanced the rate of pH and temperature decline and resulted in more tender meat with higher a^* values.

Generally carcasses with a 3-hour pH (pH_3) of less than 6.1 were heavier, had more carcass fat, maintained a high temperature early post-mortem, had longer sarcomeres, better colour quality and lower 24-hour shear force values than those with a pH_3 of 6.3 or greater. *M. longissimus thoracis* and *M. semimembranosus* (SM) samples with pH_3 <6.1 constituted less than 22% of the samples.

The LT and SM had different myofibre proportions. Myofibre types were not useful indices of meat quality. The level of immediate post-slaughter calpastatin activity suggests that the proteolytic potential of chevon is not essentially different from that of other meat types.

Ageing and electrical stimulation improved tenderness and colour quality of chevon. Electrical stimulation increased the rate of pH decline to levels outside the risk of cold shortening as well

Abstract

as the ageing potential of chevon such that the meat attained tenderness that was within the acceptable limits for four days of ageing.

Chevon had high levels of PUFA, particularly C18:2, which were similar to values reported for ostrich. The high C18:2/C18:3 ratio suggested that the n-6/n-3 fatty acid ratio would be much higher than the recommended ratio of less than four. Most of the fatty acid proportions fell within the ranges that have been reported for chevon and other red meat species. Age and sex of the goats had no significant effect on the fatty acid profile but pre-slaughter conditioning resulted in lower levels of C14:0 and total SFA, and increased levels of C18:1 and hence MUFA. The amino acid proportions suggest that there is no variation in the amino acid profile between *M. longissimus lumborum* muscles from goats of different age or sex classes.

Level of education of the consumers was most important in determining consumer acceptance of the sensory attributes as well as the intended frequency of consumption for chevon and mutton. Population group was a significant factor only when the meats were of more variable acceptability.

Sensory evaluations indicated that chevon and mutton were highly acceptable to the consumers, who were willing to eat any of the meats at least once a week. The study indicated that chevon is acceptable to South African consumers and may be as acceptable as mutton if the meat is from goats of about two years old or younger.

South African indigenous goats may yield high quality chevon, with a low pHu and acceptable colour provided that the meat is from large carcasses (~15kg) with a high fat content (at least 7%) and is not from mature does.

Declaration

I declare that this thesis for the PhD (Animal Science) degree at the University of Pretoria has not been submitted by me for a degree at any other university.

Signed

Langelihle Simela

Summary

Meat characteristics and acceptability of chevon from South African indigenous goats

by

Langelihle Simela

Promoter: Prof E.C. Webb
Co-promoter: Prof M.J.C. Bosman

Department of Animal and Wildlife Sciences
Faculty of Natural and Agricultural Sciences
University of Pretoria
For the degree of PhD

Experiments were conducted to determine the effects of sex, age and pre-slaughter conditioning on carcass and chevon quality of South African indigenous goats. Effects of post-mortem ageing and electrical stimulation on chevon quality were also investigated. The nutritional quality of chevon in terms of fatty acid and amino acid content was assessed. The acceptability of chevon to South African consumers and in comparison to mutton was tested.

Eight-nine milk- to 8-teeth female and milk- to six-teeth intact male and castrated South African indigenous goats were procured and raised at the experimental farm on a maintenance diet of a pelleted concentrate mix fed at about 3% of total animal weight per pen. Clean water and *Eragrostis curvula* hay were available ad libitum. The goats were slaughtered at a research abattoir after 17 hours in liorage and under conditions similar to those employed in the meat industry in South Africa. All goats were electrically stunned and a subset of four castrates with 4-to-6 permanent incisors and nine 8-teeth does from both the non-conditioned and pre-slaughter conditioned groups were electrically stimulated immediately after exsanguination.

Temperature and pH profiles, sarcomere lengths (SL), myofibrillar fragment lengths (MFL) and myofibre types (MFT) were determined from both the *M. longissimus thoracis et lumborum* (LTL) and the *M. semimembranosus* (SM). Glycolytic potential (GP), ATP and creatine phosphate concentrations, calpastatin activity, fatty acid and amino acid profiles, crude fat and crude protein determinations and sensory analysis were carried out on LTL. Cooking losses, shear force values and colorimetric values of the SM were determined. Separable lean, bone and intermuscular and subcutaneous fat composition of the carcasses were determined from dissections of the right halves.

The goats were large with mean slaughter weights ranging from 27.83±3.81kg to 42.65±3.92kg and cold carcass weights (CCW) ranging from 11.81±2.43 kg to 16.91±2.88kg between the milk-teeth and 8-teeth groups. Chest girth ranged from 71.05±3.44 to 84.09±2.39cm and carcass length from 66.26±3.73 to 74.96±3.22cm between the milk- and 8-teeth groups. Slaughter weight, hot carcass weight (HCW), CCW and carcass dimensions all significantly increased with age of the goats ($P<0.0001$). Intact males and castrates had similar slaughter weight, HCW and CCW that were heavier than those of female goats ($P<0.01$). Intact males had the largest frames

Summary

with mean chest depth and carcass length that were bigger than those of castrates and females ($P<0.01$). Pre-slaughter conditioning resulted in increased slaughter and carcass weights, carcass dimensions and *M. longissimus thoracis* (LT) area ($P<0.05$).

Dressing out percentage (DO%) was not affected by sex and age of the goats ($P>0.05$). Pre-slaughter conditioning resulted in 16% higher DO% and 30% lower chilling losses ($P<0.0001$). Chilling losses did not vary with the sex of the goats ($P>0.05$) but were higher for the 2-teeth goats compared to the milk-teeth, 4-to-6 teeth and 8-teeth groups ($P<0.05$).

Proportionately, carcasses with a higher carcass fat percentage had lower lean percentage. Thus females and castrates had a 6.2% higher carcass fat percentage and 3.2% lower lean percentage than intact males. Similarly, the full-mouthed does had the highest carcass fat percentage of 16.08 ± 8.25 amongst the four age groups and a low lean percentage of 62.13 ± 5.81 ($P<0.05$). Non-carcass fat content was not affected by sex ($P>0.05$). There was more of this fat in carcasses of the 8-teeth does than those of younger goats ($P<0.001$) and in pre-slaughter conditioned than non-conditioned goats ($P<0.0001$).

Lean/bone and lean and fat/bone indices were not affected by sex and age of the goats ($P>0.05$). Overall means for the indices were 2.95 ± 0.38 lean/bone and 3.67 ± 0.68 lean-and-fat/bone ratios. Pre-slaughter conditioning resulted in lower percentages of lean and bone ($P<0.0001$), increased carcass and non-carcass fat content ($P<0.0001$) and higher lean/bone and lean and fat/bone yield indices ($P<0.001$).

Amongst the joints of the carcasses, the hind limb had the more ideal composition for high lean and low fat cuts. The dorsal trunk was bony and yielded less lean.

On average the intact males had a significant 2.4% units more weight in the neck and about 1.5% units less weight in the hind limb compared to the females and castrates ($P<0.01$). Fore limb, dorsal trunk and ventral trunk percentages did not differ significantly amongst the sexes ($P>0.05$). Overall mean proportions of these joints were $19.08\pm 1.39\%$, $20.74\pm 1.58\%$ and $18.31\pm 2.42\%$, respectively. The proportions of the hind limb and ventral trunk only varied with age. Hind limb percentage was highest in the younger goats and least in the 8-teeth does while ventral trunk proportions were in the reverse order.

Generally the goats had a low initial GP (mean = $101.74\pm 23.21\mu\text{mol/g}$), low initial pH (mean = 6.54 ± 0.29), high initial lactate concentration (mean = $30.19\pm 10.57\mu\text{mol/g}$) and high pHu (mean = 5.93 ± 0.14), which indicate that they suffered stress during peri-mortem handling. The GP metabolite concentrations, pH and temperature were not affected by the sex of the goats ($P>0.05$). However mature does had the highest *M. longissimus thoracis* pHu of 6.03 ± 0.19 ($P=0.04$), the lowest SM a* value of 11.41 ± 3.41 ($P=0.002$), and hence the lowest chroma value ($P=0.003$) and tendency to yield tougher chevon (96-hour shear force = $77.39\pm 18.54\text{N}$). Pre-slaughter conditioning did not improve the response to peri-mortem handling for any of the age and sex groups ($P>0.05$).

Summary

The average myofibre type ratios (red: intermediate: white) were 26:33:41 in the LTL and 29:37:34 in the SM. Pre-slaughter conditioning resulted in a higher intermediate myofibre percentage ($P=0.04$) only. Castrated males had a lower proportion of white myofibre than intact males at the 2-teeth stage ($P<0.05$). Red and intermediate myofibre proportions were not affected by age and sex ($P>0.05$). Myofibre types were not useful indices of meat quality.

The level of immediate post-slaughter calpastatin activity (mean = 3.18 ± 0.81 U/g sample) suggests that the proteolytic potential of chevon is not essentially different from that of other meat types. Calpastatin activity was not affected by the age of the goats ($P>0.05$) but was significantly higher for pre-slaughter conditioned intact males compared to the non-conditioned ones ($P<0.05$). Calpastatin activity in the LTL of castrates and females was not affected by pre-slaughter conditioning.

Intact males had a lower 24-hour a^* , and hence chroma value than the females and castrates ($P<0.05$). Pre-slaughter conditioning resulted in lower 96-hour shear force values, more so for castrates than females. Pre-slaughter conditioning reduced the variation of tenderness amongst the different age groups, leading to more uniform and lower 96-hour shear force values. Myofibrillar fragment lengths, cooking losses, L^* and b^* values of the SM were not affected by sex, age and pre-slaughter conditioning ($P>0.05$).

The rates of post-mortem glycolysis and carcass chilling and pHu were important determinants of chevon quality. Larger and fatter carcasses were glycolysing fast ($pH_3<6.1$), maintained high early post-mortem temperature (mean 3-hour LT temperature = $16.38 \pm 3.48^\circ\text{C}$) and resulted in significantly better SM colour (24-hour $a^* = 15.71 \pm 1.99$) and longer 24-hour SL (mean = $1.85 \pm 0.20\mu\text{m}$). The lower values of these traits were associated with muscles with $pH_3>6.3$. *M. longissimus thoracis* and SM samples with $pH_3<6.1$ constituted less than 22% and those with $pH_3>6.3$ more than 54% of the samples.

On average, carcasses with *M. longissimus thoracis* $pHu \leq 6.0$ had $27.73\mu\text{mol/g}$ higher GP, $11.5\mu\text{mol/g}$ more glycogen, $0.52\mu\text{mol/g}$ more ATP than carcass with a $pHu > 6.0$ ($P<0.05$). Carcasses with *M. semimembranosus* $pHu<5.8$ had the highest a^* , b^* and chroma ($P<0.01$) values at both 24- and 96-hours post-mortem. Low pHu chevon also had a mean 96-hour shear force value that was 18N ($P=0.005$) less than the average 70N of the carcasses with a SM $pHu > 5.8$. Up to 20% of the muscle samples had a $pHu<5.8$.

Ageing the meat for up to 96 hours improved the tenderness of both muscles. This was expressed in decreased MFL and shear force values of the SM. Ageing also improved colour quality such that differences that occurred at 24 hours post-mortem had disappeared by 96 hours post-mortem.

Electrical stimulation (ES) of chevon improved the rate of pH decline to levels outside the risk of cold shortening (mean *M. longissimus thoracis* $pH_3 = 6.37 \pm 0.25$ for NES vs. 5.90 ± 0.14 for ES carcasses). ES had no effect on LTL sarcomere and myofibrillar lengths. In the SM muscle, ES resulted in more tender meat 24 hours post-mortem (mean 24-hour shear force = 77.97 ± 17.26 N for NES vs. 50.39 ± 10.17 N for ES carcasses) and a greater rate of tenderisation to 96 hours post-mortem (Mean 96-hour shear force = 74.47 ± 16.96 N for NES and 40.86 ± 8.92 N for ES carcasses).

Summary

Electrical stimulation resulted in tenderness levels that were within the acceptable limits as defined for lamb and beef. Electrical stimulation also improved the colour of chevon (mean 24-hour a^* = 11.86 ± 3.31 for NES vs. 14.56 ± 1.99 for ES), even after ageing for 96 hours mean 96-hour a^* = 13.67 ± 2.23 for NES vs. 15.46 ± 1.38 for ES carcasses). Colour and tenderness were improved despite the high pHu of chevon.

The polyunsaturated fatty acid (PUFA), particularly C:18:2 content of chevon from the South African indigenous goats was high. The overall mean percentages were 18.35 ± 5.74 PUFA and 17.62 ± 5.45 C18:2. Consequently the PUFA/SFA and C18:2/C18:3 ratios were high and typical of grain-fed ruminants. Age and sex of the goats had no significant effect on the fatty acid profile. However, pre-slaughter conditioning resulted in a lower concentration of C14:0 and total saturated fatty acids (SFA), and increased concentration of C18:1, and hence monounsaturated fatty acids (MUFA). Pre-slaughter conditioning did not affect the PUFA content ($P > 0.05$).

There was little variation in amino acid profile with age-class of the goats. Alanine and tyrosine only were significantly affected by the class of the goats ($P < 0.05$). Both amino acids were least concentrated in LL of 2-to-4 teeth females and most concentrated in LL of mature does.

Level of education was the most important consumer characteristic in determining acceptance of the sensory attributes as well as the intended frequency of consumption for the meats. Consumer age and gender were important factors in some cases but population group was a significant factor in the judgement of meats of more variable sensory attributes.

The sensory evaluations indicate that chevon and mutton were highly acceptable (range of mean overall acceptability = 3.79 to 4.27) to consumers, who were willing to eat any of the meats at least once a week. The study indicated that chevon is acceptable to South African consumers and may be as acceptable as mutton if the meat is from goats of about two years old or younger.

It is concluded that South African indigenous goats belong to the large breed of southern Africa. The goats are highly prone to pre-slaughter stress and hence yield high pH meat with a dark colour. However the goats may yield chevon of acceptable quality with pHu of less than 5.8, high a^* values and acceptable tenderness provided that the carcasses are large (~15kg HCW), have a relatively high carcass fat content ($\geq 7\%$) and are not from old does. Chevon has healthful fatty acid and amino acid profiles regardless of age and sex of the goats. The meat is highly acceptable to South African consumers of diverse backgrounds, especially if it is from goats that are one to two years old.

Acknowledgements

My sincere gratitude and appreciation to the following persons and institutions for their indispensable contributions to the successful completion of this study:

- Prof E.C. Webb and Prof M.J.C Bosman for their support, encouragement and guidance throughout the study.
- The South Africa-Netherlands Research Programme on Alternatives in Development (SANPAD), Third World Organisation for Women in Science (TWOWS) and National Research Fund of South Africa (NRF; GUN 2053732) for their financial support.
- Mr Andre van Zyl, Livestock Manager; Mr Roelf Coetzee, Farm Manager; and the general workers at the small stock section for their assistance in procuring and keeping the goats at the Hatfield Experimental Farm. I thank Dr Christine van Rensburg, Mandla Lukhele and Hendry Ndhlovu for helping me look after the goats.
- The Agricultural Research Council (ARC) Meat Science Centre for assistance with the slaughter, sampling, sample storage and most of the laboratory analyses. Many thanks to Dr Lorinda Frylinck, Dr Philip Strydom, Hanlie Snyman and Jocelyn Anderson.
- The technical staff of the Department of Animal Science for their assistance with some of the laboratory analyses.
- Potchefstroom staff for assistance with the sensory analysis.
- Mr Jack Grimbeek and Mrs Rina Owen for their invaluable advice and assistance with the statistical analysis of the data.
- Dr Lindiwe Majele Sibanda for her support and push to embark on this course.
- My mom, Mrs Evelyn Simela, my sisters and brother for standing by me all the time.
- All the friends that I made during the course of my studies; thanks for keeping the non-academic side of life going.

List of Acronyms

LIST OF ACRONYMS

ADP	Adenosine diphosphate
AMP	Adenosine monophosphate
ATP	Adenosine triphosphate
BCFA	Branched chain fatty acids
BF	<i>M. Biceps femoris</i>
CCW	Cold carcass weight
DFD	Dark, firm and dry
DO%	Dressing out percentage
EFA	Essential fatty acids
ES	Electrical stimulation
G-6-P	Glucose-6-phosphate
GP	Glycolytic potential
HCW	Hot carcass weight
KKCF	Kidney knob and channel fat
LDH	Lactate dehydrogenase
LL	<i>M. longissimus lumborum</i>
LT	<i>M. longissimus thoracis</i>
LTL	<i>M. longissimus thoracis et lumborum</i>
MCP	Multicatalytic protease
ME	Metabolisable energy
MFI	Myofibrillar fragmentation index
MFL	Myofibrillar fragment length
MFT	Myofibre type/typing
MSA	Meat Standards of Australia
MUFA	Monounsaturated fatty acids
pH ₀	Initial pH
pH ₃	pH at 3 hours post mortem
pH ₆	pH at 6 hours post mortem
pH ₂₄	pH at 24 hours post mortem (same as pH _u)

List of Acronyms

pHu	Ultimate pH = pH ₂₄
PUFA	Polyunsaturated fatty acids
SAMIC	South African Meat Industry Co-operation
SDH	Succinate dehydrogenase
SFA	Saturated fatty acids
SL	Sarcomere length
SM	<i>M. Semimembranosus</i>
ST	<i>M. Semitendinosus</i>
TAG	Triacylglycerides
TCA	Tricarboxylic acid cycle
UFA	Unsaturated fatty acids
WBS	Warner-Bratzler shear force
WHC	Water holding capacity

TABLE OF CONTENTS

	Page
Abstract	i
Declaration	iii
Summary	iv
Acknowledgements	viii
List of acronyms	ix
List of Tables	xix
List of Figures	xxviii
1 INTRODUCTION	1
1.1 Project theme	1
1.2 Project title	1
1.3 Aims	1
1.4 Motivation	1
2 LITERATURE REVIEW	8
2.1 Determination of meat quality	8
2.1.1 Myofibre and muscle metabolic types.....	8
2.1.1.1 Implications of myofibre composition on sampling for meat quality evaluation.....	12
2.1.2 Conversion of muscle to meat.....	13
2.1.2.1 Development of rigor mortis.....	13
2.1.2.2 Post-mortem glycolysis.....	13
2.1.2.3 Rate of post-mortem glycolysis.....	14
2.1.2.4 Extent of post-mortem glycolysis.....	16
2.1.2.5 Post-mortem tenderisation.....	19
2.1.2.5.1 The calpains.....	20
2.1.2.5.2 Calpastatin.....	23

Table of Contents

	Page
2.1.2.5.3 Factors influencing concentration of calpains.....	23
2.2 Meat quality factors.....	24
2.2.1 Meat colour.....	25
2.2.1.1 The colour of chevon.....	26
2.2.2 Water in meat.....	27
2.2.2.1 Water losses in chevon.....	29
2.2.3 Fat in meat.....	30
2.2.3.1 Fat in chevon.....	32
2.2.4 Meat juiciness.....	33
2.2.4.1 Juiciness of chevon.....	33
2.2.5 Meat flavour and aroma.....	34
2.2.5.1 Flavour and aroma of chevon.....	35
2.2.6 Meat tenderness.....	36
2.2.6.1 Collagen and its contribution to meat tenderness.....	36
2.2.6.2 Myofibrillar contribution to tenderness.....	37
2.2.6.2.1 Pre-slaughter factors.....	37
2.2.6.2.2 Post-slaughter factors.....	38
2.2.6.3 Tenderness of chevon.....	44
2.2.7 Factors of production quality.....	46
2.2.7.1 Effect of nutritional history.....	46
2.2.7.2 Effect of physical exercise.....	47
2.2.7.3 Effect of peri-mortem treatment.....	47
2.2.7.4 Effect of post-slaughter handling.....	48
2.2.8 Implications of smallholder production systems on chevon quality.....	50
2.3 Sensory evaluation of meat quality.....	50
2.4 Summary.....	52

Table of Contents

	Page
3 MATERIALS AND METHODS.....	53
3.1 The experimental goats	53
3.2 Sampling and sample storage.....	55
3.3 Carcass measurements	56
3.4 Histological and histochemical analysis.....	57
3.4.1 Sarcomere length.....	57
3.4.2 Myofibrillar fragment length.....	60
3.4.3 Myofibre typing.....	61
3.5 Physical meat characteristics.....	61
3.5.1 Colour, cooking losses and shear force.....	61
3.6 Biochemical analyses.....	63
3.6.1 Glycolytic potential, ATP and creatine phosphate.....	63
3.6.2 Calpastatin.....	63
3.6.3 Fatty acids.....	64
3.6.4 Amino acids.....	66
3.6.5 Crude nitrogen and crude protein.....	66
3.7 Sensory evaluation.....	66
3.7.1 Preparation of samples for sensory evaluation.....	66
3.7.2 Sensory panels and sensory evaluation.....	67
3.8 Statistical analysis.....	68
3.8.1 Live animal carcass and meat quality characteristics.....	68
3.8.1.1 Live animal and carcass characteristics.....	68
3.8.1.2 Meat quality of chevon.....	69
3.8.1.3 Effects of electrical stimulation on chevon quality.....	70
3.8.2 Fatty acid and amino acid composition.....	70
3.8.3 Sensory evaluation.....	71

Table of Contents

	Page
4 LIVE ANIMAL AND CARCASS CHARACTERISTICS OF SOUTH AFRICAN INDIGENOUS GOATS.....	72
4.1 Introduction.....	72
4.2 Results.....	72
4.2.1 Live animal and carcass characteristics.....	72
4.2.1.1 Effect of sex on live animal and carcass characteristics.....	72
4.2.1.2 Effect of age on live animal and carcass characteristics.....	73
4.2.1.3 Effect of pre-slaughter conditioning on live animal and carcass characteristics.....	73
4.2.1.4 Interaction effects of sex, age and pre-slaughter conditioning on live animal and carcass characteristics.....	77
4.2.2 Carcass composition.....	81
4.2.2.1 Effect of sex on carcass composition.....	81
4.2.2.2 Effect of age on carcass composition.....	86
4.2.2.3 Effect of pre-slaughter conditioning on carcass composition.....	91
4.2.2.4 Interaction effects of sex, age and pre-slaughter conditioning on carcass composition.....	91
4.3 Discussion.....	98
4.3.1 Live animal and carcass characteristics.....	98
4.3.2 Joint and tissue composition of the carcasses.....	100
4.4 Summary.....	103
5 MEAT QUALITY CHARACTERISTICS OF CHEVON.....	104
5.1 Introduction.....	104
5.2 Results.....	104
5.2.1 Post-mortem pH, temperature, histological, histochemical, proteolytic and metabolic properties of chevon as determined from the <i>M. longissimus thoracis et lumborum</i>	104

Table of Contents

	Page
5.2.1.1	Effects of sex, age and pre-slaughter conditioning on pH and temperature..... 104
5.2.1.2	Effects of sex, age and pre-slaughter conditioning on histological, histochemical, metabolic and proteolytic characteristics..... 106
5.2.1.3	Interaction effects of sex, age and pre-slaughter conditioning on histological, histochemical, metabolic and proteolytic characteristics..... 114
5.2.1.4	Simple correlations between carcass and meat quality traits of the <i>M. longissimus lumborum et thoracis</i>119
5.2.2.5	Effects of early post-mortem and ultimate pH on some carcass and meat quality traits measured on the <i>M. longissimus lumborum et thoracis</i>124
5.2.2	Post-mortem pH, temperature, histological and physical properties of chevon as determined from the <i>M. Semimembranosus</i> 127
5.2.2.1	The effects of sex, age and pre-slaughter conditioning on pH and temperature..... 126
5.2.2.2	Effect of sex, age and pre-slaughter conditioning on the histological and physical properties.....127
5.2.2.3	Interaction effects of sex, age and pre-slaughter conditioning on histological and physical meat quality properties..... 136
5.2.2.4	Correlations between carcass and meat quality traits of the <i>M. semimembranosus</i> 140
5.2.2.5	Effect of early post-mortem and ultimate pH on some carcass, histological and physical meat quality traits measured on the <i>M. semimembranosus</i>144
5.2.3	Comparison between the <i>M. longissimus thoracis et lumborum</i> and the <i>M. semimembranosus</i> properties.....145
5.2.4	Effects of post-mortem ageing on chevon quality..... 147

Table of Contents

	Page
5.3 Discussion	148
5.3.1 Post-mortem metabolic state and pH profile.....	148
5.3.2 Myofibre types of chevon.....	154
5.3.2.1 Myofibre profiles of the <i>M. longissimus thoracis et lumborum</i> and the <i>M. semimembranosus</i>	154
5.3.2.2 Sex, age, pre-slaughter conditioning and interaction effects on myofibre properties.....	155
5.3.2.3 Relationships between myofibre types, carcass characteristics and meat traits.....	157
5.3.3 Tenderness, cooking losses and colour.....	158
5.3.3.1 Myofibrillar fragment lengths and calpastatin activity.....	158
5.3.3.2 Sarcomere lengths and effects of early post-mortem glycolysis....	161
5.3.3.3 Shear force values and the effect of pHu on tenderness.....	164
5.3.3.4 Cooking losses and colour.....	167
5.4 Summary	170
 6 THE EFFECT OF ELECTRICAL STIMULATION ON CHEVON QUALITY	 172
6.1 Introduction	172
6.2 Results	173
6.2.1 Live animal and carcass characteristics of experimental animals	173
6.2.2 Effect of electrical stimulation on chevon quality.....	173
6.2.2.1 Effect of electrical stimulation on post-mortem temperature, pH, histological, histochemical, glycolytic and proteolytic properties determined from the <i>M. longissimus thoracis et lumborum</i>	173
6.2.2.2 Effect of electrical stimulation on post-mortem temperature, pH, histological and physical properties of chevon determined from the <i>M. semimembranosus</i>	182

Table of Contents

	Page
6.2.2.3 Effects of electrical stimulation and ageing on chevon quality.....	185
6.3 Discussion.....	189
6.3.1 Effect of electrical stimulation on post-mortem metabolic state, pH profile and tenderness.....	189
6.3.2 Effect of electrical stimulation on cooking losses and colour.....	195
6.4 Summary.....	196
7 FATTY ACID AND AMINO ACID COMPOSITION OF CHEVON.....	198
7.1 Introduction.....	198
7.2 Results.....	199
7.2.1 Fatty acid composition.....	199
7.2.2 Amino acid composition.....	204
7.3 Discussion.....	210
7.3.1 Fatty acid composition.....	210
7.3.2 Amino acid composition.....	212
7.4 Summary.....	213
8 ACCEPTABILITY OF CHEVON TO SOUTH AFRICAN CONSUMERS.....	215
8.1 Introduction.....	215
8.2 Results.....	215
8.2.1 Meat quality characteristics of the chevon sample.....	217
8.2.2 Profile of consumer panels and effects on acceptability ratings.....	219
8.2.3 Acceptability of sensory attributes and consumption intent for the different meat types.....	227
8.2.4 Consumer preferences for the different meat types.....	230
8.3 Discussion.....	232

Table of Contents

	Page
8.4 Summary	236
9 INTEGRATION, CONCLUSIONS & RECOMMENDATIONS	237
9.1 Integration	237
9.1.1 Relationship between carcass and meat quality.....	237
9.1.2 Chevon quality.....	239
9.2 Conclusions	241
9.3 Implication of findings	242
LIST OF REFERENCES	244

LIST OF TABLES

	Page
Table 1.1	Goat populations, proportion in the rural areas and slaughter rate by Provinces in South Africa..... 4
Table 2.1	Intrinsic and extrinsic factors affecting the rate and extent of post-mortem glycolysis..... 14
Table 2.2	The major components and factors of meat quality..... 24
Table 2.3	Hunter colorimetric co-ordinates of goat <i>M. semimembranosus</i> and <i>M. longissimus thoracis</i>27
Table 2.4	Some reported ultimate pH values of chevon..... 39
Table 2.5	The effect of electrical stimulation on goat, lamb and beef loin eating quality. 43
Table 2.6	Average tenderness ratings for chevon compared to lamb/mutton..... 44
Table 2.7	Some shear force values reported for chevon..... 45
Table 2.8	Effect of pre-slaughter stress on the ultimate pH taken from the <i>M. longissimus</i>48
Table 3.1	Distribution of sample goats by age (dentition) class, sex and pre-slaughter conditioning.....54
Table 3.2	Distribution of the consumers by population category, gender, age and level of education within the first and second series of sensory analysis..... 67
Table 4.1	Effect of sex on live animal and carcass characteristics of South African indigenous goats (means \pm S.D.)..... 74
Table 4.2	Effect of age on live animal and carcass characteristics of South African indigenous goats (means \pm S.D.)..... 75
Table 4.3	Effect of pre-slaughter conditioning on live animal and carcass characteristics of South African indigenous goats (means \pm S.D.)..... 76

List of Tables

	Page
Table 4.4	<i>P</i> -values of the first order interaction effects of sex, age and pre-slaughter conditioning on live animal and carcass characteristic of South African indigenous goat..... 78
Table 4.5	Effect of sex on joint weights (kg) of the right carcass halves of South African indigenous goats (means \pm S.D.).....82
Table 4.6	Effect of sex on joint proportions (%) in the right carcass halves of South African indigenous goats (means \pm S.D.).....82
Table 4.7	Effect of sex on tissue content (g) and meat yield indices of the right carcass halves of South African indigenous goats (means \pm S.D.).....83
Table 4.8	Effect of sex on proportions of the dissectible tissues (%) in the right carcass halves of South African indigenous goats (means \pm S.D.).....83
Table 4.9	Effect of sex on proportions of the dissectible tissues (%) within joints of the right carcass halves of South African indigenous goats (means \pm S.D.)..... 85
Table 4.10	Effect of age on joint weights (kg) of the right carcass halves of South African indigenous goats (means \pm S.D.).....87
Table 4.11	Effect of age on the joint proportions (%) in the right carcass halves of South African indigenous goats (means \pm S.D.).....87
Table 4.12	Effect of age on dissectible tissue content (g) and meat yield indices of the right carcass halves of South African indigenous goats (means \pm S.D.)..... 88
Table 4.13	Effect of age on the proportions of dissectible tissues (%) in the right carcass halves of South African indigenous goats (means \pm S.D.).....89
Table 4.14	Effect of age on the proportions of the dissectible tissues (%) within joints of the right carcass halves of South African indigenous goats (means \pm S.D.)..... 90
Table 4.15	Effect of pre-slaughter conditioning on joint weights (kg) of the right carcass halves of South African indigenous goats (means \pm S.D.).....92

List of Tables

	Page
Table 4.16	Effect of pre-slaughter conditioning on proportions of the joints (%) in the right carcass halves of South African indigenous goats (means \pm S.D.)..... 92
Table 4.17	Effect of pre-slaughter conditioning on tissue content (g), and yield indices of the right carcass halves of South African indigenous goats (means \pm S.D.)..... 93
Table 4.18	Effect of pre-slaughter conditioning on proportions of the tissues (%) in joints of the right carcass halves of South African indigenous goats (means \pm S.D.)..... 93
Table 4.19	Effect of pre-slaughter conditioning on proportions of dissectible tissues in the joints of the right carcass halves of South African indigenous goats (means \pm S.D.)..... 94
Table 5.1	Effect of sex on pH and temperature ($^{\circ}$ C) profiles (means \pm S.D.) of the <i>M. longissimus thoracis</i> of South African indigenous goats 105
Table 5.2	Effect of age on pH and temperature ($^{\circ}$ C) profiles (means \pm S.D.) of the <i>M. longissimus thoracis</i> of South African indigenous goats..... 107
Table 5.3	Effect of pre-slaughter conditioning on pH and temperature ($^{\circ}$ C) profiles (means \pm S.D.) of the <i>M. longissimus thoracis</i> of South African indigenous goats..... 108
Table 5.4	Overall means (\pm S.D.) and range of values of the histological, histochemical metabolic and proteolytic attributes of chevon that were determined on the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats 109
Table 5.5	Effect of sex on chevon histological, histochemical, metabolic and proteolytic attributes (means \pm S.D.) that were determined on the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats 110
Table 5.6	Effect of age on chevon histological, histochemical, metabolic and proteolytic attributes (means \pm S.D.) that were determined on the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats..... 112

List of Tables

	Page
Table 5.7	Effect of the pre-slaughter conditioning on chevon histological, histochemical, metabolic and proteolytic attributes (means \pm S.D.) that were determined on the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats..... 113
Table 5.8	<i>P</i> -values of the first order interaction effects of sex, age and pre-slaughter conditioning on pH, histological, histochemical, metabolic and proteolytic attributes that were determined on the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats..... 115
Table 5.9	Simple correlations between myofibre types, carcass and chevon quality attributes that were determined on the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats..... 121
Table 5.10	Simple correlations of pH, carcass and chevon quality attributes determined on the <i>M. longissimus lumborum et thoracis</i> of South African indigenous goats..... 123
Table 5.11	Effect of pH ₃ on selected carcass and meat quality traits of the <i>M. longissimus thoracis et lumborum</i> (means \pm S.D.) of South African indigenous goats 125
Table 5.12	Effect of pH ₂₄ on selected meat quality traits of the <i>M. longissimus thoracis et lumborum</i> (means \pm S.D.) of South African indigenous goats.....125
Table 5.13	Effect of sex on pH and temperature ($^{\circ}$ C) profiles (means \pm S.D.) of the <i>M. semimembranosus</i> of South African indigenous goats.....128
Table 5.14	Effect of age on pH and temperature ($^{\circ}$ C) profiles (means \pm S.D.) of the <i>M. semimembranosus</i> of South African indigenous goats.....129
Table 5.15	Effect of pre-slaughter conditioning on pH and temperature ($^{\circ}$ C) profiles (means \pm S.D.) of the <i>M. semimembranosus</i> of South African indigenous goats..... 130
Table 5.16	Overall means (\pm S.D.) and range of values of chevon quality attributes that were determined on the <i>M. semimembranosus</i> of South African indigenous goats 131

List of Tables

	Page
Table 5.17	Effects of sex on the chevon quality attributes (means \pm S.D.) that were determined the <i>M. semimembranosus</i> of South African indigenous goats 133
Table 5.18	Effects of age on chevon quality attributes (means \pm S.D.) that were determined on the <i>M. semimembranosus</i> of South African indigenous goats... 134
Table 5.19	Effects of pre-slaughter conditioning on chevon quality attributes (means \pm S.D.) that were determined on the <i>M. semimembranosus</i> of South African indigenous goats 135
Table 5.20	<i>P</i> -values of the first order interaction effects on the traits measured on the <i>M. semimembranosus</i> of South African indigenous goats137
Table 5.21	Simple correlations between myofibre types, carcass and chevon quality attributes that were determined on the <i>M. semimembranosus</i> of South African indigenous goats 141
Table 5.22	Simple correlations of pH, carcass and chevon quality attributes that were determined on the <i>M. semimembranosus</i> of South African indigenous goats... 143
Table 5.23	Effect of pH ₃ on selected carcass and meat quality traits of the <i>M. semimembranosus</i> (means \pm S.D.) of South African indigenous goats 145
Table 5.24	Effect of pH ₂₄ on selected carcass and meat quality traits of the <i>M. semimembranosus</i> (means \pm S.D.) of South African indigenous goats 146
Table 5.25	Comparison of pH and temperature values (means \pm S.D.) of the <i>M. longissimus thoracis</i> (LT) and the <i>M. semimembranosus</i> (SM) of South African indigenous goats146
Table 5.26	Comparison of myofibre properties and calpastatin activities (means \pm S.D.)of the <i>M. longissimus thoracis et lumborum</i> (LTL) and the <i>M. semimembranosus</i> (SM) of South African indigenous goats..... 147
Table 5.27	Effects of post-mortem ageing on sarcomere and myofibrillar fragment lengths (μ m), cooking losses (%), shear force (N) and colour co-ordinates of South African indigenous goats 148

List of Tables

	Page
Table 5.28 Initial glycogen content ($\mu\text{mol/g}$ sample) and ultimate pH values of the <i>M. longissimus thoracis</i> of the goats in the present study compared to some published values for stressed cattle.....	149
Table 6.1 Live animal and carcass characteristics (means \pm S.D.) of 4-to-6 teeth castrate and 8-teeth female South African indigenous goats.....	174
Table 6.2 Comparison of the live animal and carcass characteristics (means (\pm S.D.) of the non-electrically stimulated and the electrically stimulated South African indigenous goats.....	175
Table 6.3 Comparison of histological, histochemical, metabolic and proteolytic characteristics of the <i>M. longissimus thoracis et lumborum</i> of electrically stimulated and non-stimulated carcasses of South Africa indigenous 4-to-6 teeth castrates and 8-teeth female goats (<i>P</i> -values).....	176
Table 6.4 Comparison of pH, histological, tenderness and colour of the <i>M. semimembranosus</i> of electrically stimulated and non-electrically stimulated carcasses of South Africa indigenous 4-to-6 teeth castrates and 8-teeth female goats (<i>P</i> -values).....	177
Table 6.5 The effect of electrical stimulation on pH and temperature ($^{\circ}\text{C}$) profiles (means \pm S.D.) of the <i>M. longissimus thoracis et lumborum</i> (means \pm S.D.) of South African indigenous goats.....	178
Table 6.6 Effect of electrical stimulation on histological, histochemical, metabolic and proteolytic characteristics of the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats (means \pm S.D.).....	180
Table 6.7 Simple correlations between carcass characteristics, histological and biochemical characteristics of the <i>M. longissimus thoracis et lumborum</i> of electrically stimulated carcasses of indigenous South African goats.....	181
Table 6.8 The effect of electrical stimulation on pH and temperature profiles (means \pm S.D) of the <i>M. semimembranosus</i> of South African indigenous goats.....	183

List of Tables

	Page
Table 6.9	Effect of electrical stimulation on the chevon quality properties (means \pm S.D.) that were determined on the <i>M. semimembranosus</i> muscle of South African indigenous goats..... 184
Table 6.10	Simple correlations between carcass characteristics, histological characteristics, shear force and the colorimetric co-ordinates of the <i>M. semimembranosus</i> of electrically stimulated carcasses of indigenous South African goats..... 186
Table 6.11	Effects of ageing on sarcomere and myofibrillar fragment lengths (μm), cooking losses (%), shear force (N) and colour of chevon from electrically stimulated and non-stimulated carcasses of South African indigenous goat (<i>P</i> -values)..... 187
Table 7.1	The occurrence, mean concentration (mean \pm S.D. mg/g), range of concentration and proportions (mean \pm S.D. percentage) of fatty acids in the <i>M. longissimus lumborum</i> of South African indigenous goats..... 200
Table 7.2	Effect of sex on the concentration (mg/g) and proportions (%) of fatty acids in the <i>M. longissimus lumborum</i> of South African indigenous goats..... 201
Table 7.3	Effect of age on the fatty acid concentration (mean \pm S.D. mg/g) in the <i>M. longissimus lumborum</i> of South African indigenous goats..... 202
Table 7.4	Effect of age on the fatty acid proportions (mean \pm S.D %) in the <i>M. longissimus lumborum</i> of South African indigenous goats..... 203
Table 7.5	Effect of pre-slaughter conditioning on the fatty acid concentration (mean \pm S.D. mg/g) in the <i>M. longissimus lumborum</i> of South African indigenous goats..... 205
Table 7.6	Effect of pre-slaughter conditioning on the fatty acid proportions (mean \pm S.D. percentage) in the <i>M. longissimus lumborum</i> of South African indigenous goats..... 206

List of Tables

	Page
Table 7.7	Interaction effects of age and sex, sex and pre-slaughter conditioning and conditioning and age on fatty acid concentration of the <i>M. longissimus lumborum</i> muscle of South African indigenous goats..... 207
Table 7.8	Interaction effects of age and sex, sex and pre-slaughter conditioning and conditioning and age on fatty acid proportions of the <i>M. longissimus lumborum</i> muscle of South African indigenous goats..... 208
Table 7.9	Amino acid composition (mean \pm S.D. g/100g) of <i>M. longissimus lumborum</i> muscle of kids, young goats and does..... 209
Table 7.10	Essential amino acid concentration in chevon (mean \pm S.D. g/100g) compared to dietary requirements of adult consumers.....213
Table 8.1	Slaughter weight, carcass, histological, histochemical, metabolic and proteolytic characteristics of the 2-to-6 teeth castrate and female South African indigenous goats that were used in sensory evaluations (Means \pm S.D.)..... 216
Table 8.2	Slaughter weight, carcass, histological, histochemical, metabolic and proteolytic characteristics of South African indigenous goat kids and does that were used in the sensory evaluations (means \pm S.D.)..... 218
Table 8.3	Cooking losses (%) from the chevon and mutton samples that were employed in the sensory evaluations..... 219
Table 8.4	<i>P</i> -values for the analysis of variance for the effects of consumer population category gender, age and level of education on ratings of aroma, flavour, tenderness and on overall acceptability in the first series of evaluations..... 220
Table 8.5	Distribution of ratings for intended frequency of consumption with consumer population groups, gender, age and level of education for series I of sensory evaluations.....222

List of Tables

	Page
Table 8.6	<i>P</i> -values for the analysis of variance for the effects of consumer population category gender, age and level of education on ratings of aroma, flavour, tenderness and overall acceptability in the second series of samples..... 224
Table 8.7	Distribution of ratings for intended frequency of consumption with consumer population groups, gender, age and level of education for series I of sensory evaluations.....226
Table 8.8	Maximum likelihood analysis for effect of consumer gender, age, population category and level of education on meat preferences.....227
Table 8.9	Classification of preferences for chevon from 2-to-6 teethed castrated and female goats and mutton from sheep of similar age using discriminant variables..... 232
Table 8.10	Classification of preferences for chevon from milk teethed male kids and old does and mutton from 2-to-6 teethed sheep using discriminant variables..... 232

List of Figures

LIST OF FIGURES

	Page
Figure 1.1	Distribution of goats by manner of exit from smallholder flocks (Simela et al., 2000b).....3
Figure 1.2	i) Positive and ii) negative perceptions of chevon by South African consumers (USAID/South Africa and ARC-ANAPI, 1998a).....6
Figure 1.3	South African consumers' behaviour towards various types of meat (USAID/South Africa and ARC-ANAPI, 1998a).....7
Figure 2.1	Diagrammatic representation of relative metabolic types of i) ovine and ii) bovine muscles (Adapted from Monin, 1981).....10
Figure 2.2	Effect of electrical stimulation on the rate of pH decline (Adapted from Geesink, Mareko, Morton and Bickerstaffe, 2001).....16
Figure 2.3	Relationship between meat pH, tenderness and colour (Adapted from Wythes and Ramsay, 1979).....18
Figure 2.4	Post mortem changes in u-calpain, m-calpain and calpastatin in the <i>longissimus</i> muscle of lamb (adapted from Bickerstaffe, 1996).....22
Figure 2.5	Sarcomere length (SL, μm) and shear force (SF, kg) of lamb <i>longissimus thoracis et lumborum</i> at specific times post-mortem (Wheeler and Koohmaraie, 1994).....40
Figure 3.1	Diagram showing the joining lines for the goat carcasses (Casey, 1982).....58
Figure 3.2	Illustrations of fields of (i) <i>M. longissimus lumborum</i> and (ii) <i>M. semimembranosus</i> prepared for sarcomere length determination as viewed under the visual image analyser (100 x magnification).....59
Figure 3.3	An illustration of a field of myofibrillar fragments as viewed under the visual image analyser at a magnification of 40x (<i>M. longissimus lumborum</i> aged for 96 hours).....60
Figure 3.4	Illustrations of fields of (i) <i>M. longissimus thoracis</i> and (ii) <i>M. semimembranosus</i> muscles prepared for myofibre typing as viewed under the VIA (10x magnification).....62

List of Figures

	Page
Figure 4.1 The interaction effects of pre-slaughter conditioning and sex on i) dressing out percentage, ii) chilling losses percentage, and iii) chest depth (cm).....	79
Figure 4.2 The interaction effects of age and sex on i) dressing out percentage and ii) chest depth (cm).....	80
Figure 4.3 Pre-slaughter conditioning and sex interaction effects on (i) neck weight (g), (ii) fore limb lean %, and (iii) dorsal trunk lean (%).	96
Figure 4.4 Pre-slaughter conditioning and age interaction effects on (i) neck weight (g), (ii) dorsal trunk weight (%), (iii) dorsal trunk (%), and (iv) fore limb lean (%).	97
Figure 5.1 Effect of sex on pH and temperature (°C) profiles of the <i>M. longissimus thoracis</i> of goat South African indigenous goats.....	105
Figure 5.2 Effect of age on pH and temperature (°C) profiles of the <i>M. longissimus thoracis</i> of South African indigenous goats.....	107
Figure 5.3 Effect of pre-slaughter conditioning on pH and temperature (°C) profiles of the <i>M. longissimus thoracis</i> of South African indigenous goats.....	108
Figure 5.4 Pre-slaughter conditioning and sex interaction effects on i) red, ii) intermediate and iii) white myofibre areas.....	116
Figure 5.5 Age and sex interaction effects on i) red, ii) intermediate and iii) white myofibre proportions (%).	117
Figure 5.6 Sex and pre-slaughter conditioning interaction effects on i) calpastatin activity (U/g sample) and ii) calpastatin specific activity (U/mg extractable protein).....	118
Figure 5.7 Sex and pre-slaughter conditioning interaction effects on immediate post-mortem concentrations of i) creatine phosphate (µmol/g) and ii) ATP (µmol/g).....	120
Figure 5.8 Effect of sex on pH and temperature (°C) profiles the <i>M. semimembranosus</i> of South African indigenous goats.....	128

List of Figures

	Page
Figure 5.9	Effect of age on pH and temperature (°C) profile of the <i>M. semimembranosus</i> of South African indigenous goats..... 129
Figure 5.10	Effect of pre-slaughter conditioning on pH and temperature (°C) profile of the <i>M. semimembranosus</i> of South African indigenous goats..... 130
Figure 5.11	i) Age and sex and ii) pre-slaughter conditioning age interaction effects on the 96-hour sarcomere lengths (µm) of the <i>M. semimembranosus</i>138
Figure 5.12	The i) sex and pre-slaughter conditioning, and ii) age and pre-slaughter conditioning interaction effects on the 96-hour shear force values (N) of the <i>M. semimembranosus</i> 139
Figure 5.13	Sarcocyst infection in muscle prepared for myofibrillar length determination and viewed under a visual image analyser (40x magnification)..... 159
Figure 5.14	Relationship between shear force (N) and 24-hour sarcomere length (µm) of goat <i>M. semimembranosus</i> with pH ₃ <6.1 (i, ii); 6.1 to 6.3 (iii, iv) and >6.3 (v, vi)..... 163
Figure 5.15	Effect of ultimate pH and ageing on the shear force (N) of the <i>M. semimembranosus</i> of goats..... 165
Figure 6.1	The effect of electrical stimulation on pH and temperature (°C) profiles of the <i>M. longissimus thoracis et lumborum</i> of South African indigenous goats 178
Figure 6.2	The effect of electrical stimulation on pH and temperature profiles of the <i>M. semimembranosus</i> of South African indigenous goats..... 183
Figure 6.3	Effect of ageing and electrical stimulation on shear force (N) and colour co-ordinate values of the <i>M. semimembranosus</i> of South African indigenous goats..... 188
Figure 6.4	Relationship between 24-hour shear force (N) and sarcomere length (µm) of <i>M. semimembranosus</i> of electrically stimulated (○) and non-stimulated (△) carcasses of South African indigenous goats190
Figure 6.5	Relationship between 24-hour shear force (N) and 3-hour pH of <i>M. semimembranosus</i> of electrically stimulated (○) and non-stimulated (△) carcasses of South African indigenous goats.....192

List of Figures

	Page
Figure 8.1 The effect of consumer i) gender, ii) age and iii) level of education on the ratings of sensory attributes of meat samples employed in series I of sensory evaluations.....	221
Figure 8.2 The effect of consumer i) population category, ii) gender, iii) age and iv) level of education on the ratings of sensory attributes of meat samples employed in series II.....	225
Figure 8.3 Acceptability of chevon from 2-to 6 teethed castrates and female goats compared to mutton from sheep of similar age.....	228
Figure 8.4 Acceptability of chevon from milk-teethed male kids and old does compared to mutton from 2-to-6 teethed females.....	229
Figure 8.5 Consumer preference for chevon from 2-to-6 teethed female and castrated goats compared to mutton from sheep of similar age.....	231
Figure 8.6 Consumer preference for chevon from milk teethed male kids and old does compared to mutton from 2-to-6 teethed sheep.....	231