CHAPTER 7

7 THE FATTY ACID AND AMINO ACID COMPOSITION OF CHEVON

7.1 INTRODUCTION

Several studies have indicated that chevon has a salubrious fatty acid profile and therefore suggested that the meat is ideal for the health conscious consumers (Hogg et al., 1992; Mahgoub, Khan, Al-Maqbaly, Al-Sabahi, Annamalai and Al-Sakry, 2002). In addition to their salient role in nutrition, fatty acids also influence flavour and keeping quality of meat. For example, it has been shown that high concentrations of α-linolenic acid (C18:3) such as occurs in meat from ruminants raised on forages (Enser et al., 1998) confer a grassy flavour that is not acceptable in some consumer circles but may be the main attraction in others (Sanudo, Enser, Campo, Nute, Maria, Sierra and Wood, 2000). High linoleic acid (C18:2) concentration is associated with grain-based diets and less intense meat flavour (Enser et al., 1998). Unsaturated fatty acids (UFA) are key to the keeping quality of meat. The higher the proportion of UFA, the more prone the meat is to oxidation and spoilage. The basic fatty acid profile of chevon is therefore an indication of not only the potential nutritive value of the meat but also its organoleptic and storage-related properties. According to Banskalieva, Sahlu and Goetsch (2000), data on the fatty acid composition of chevon is still scanty, fragmentary and based on different muscles and fat depots, making it difficult to compare results from various studies. This chapter will therefore add to the pool of information on chevon fat quality. The findings are based on the *M. longissimus*, which is generally accepted as the standard muscle for meat quality analysis.

Few studies are concerned with the biological value of meat possibly because of the fact that the composition of muscle protein is genetically determined and therefore would not be expected to be readily subject to the conditions during growth of the animal. On the other hand, the influence of growth, diet and sex on the proportions of muscles may well be translated into differences in protein, and hence amino acid composition of the muscle (Gilka, Jelínek, Janková, Knesel, Krejčí, Mašek and Dočekalová, 1989).

In many instances, reports on the nutritive quality of chevon are presented as stand alone studies without the complementary meat quality evaluation or vice versa. This is often the case because comprehensive studies are expensive and time consuming. This chapter serves to give some indication of the fatty acid composition of the goats as well as the amino acid profile in order to present a more comprehensive profile of the quality of chevon from South African indigenous goats.

7.2 RESULTS

7.2.1 Fatty Acid Composition

Fatty acid concentrations and percentages in the LL of the South African indigenous goats are shown in Table 7.1. Not all fatty acids were detectable in all the LL samples. The most prevalent fatty acids were palmitic acid (C16:0), the C18 series and myristic acid (C14:0) which occurred in upwards of 93% of the samples. Eicosenoic (C20:1) and lauric (C12:0) acids were the least ubiquitous, occurring in 32% and 24% of the samples, respectively.

The most abundant fatty acids were oleic acid (C18:1), linoleic acid (C18:2) and C16:0, respectively. The three made up 74.4% of the total fatty acid content of the LL samples. Myristic acid, C20:1 and C12:0 were the least abundant, each constituting less than 1% of the total weight of the fatty acids. Using the experimental fatty acid profile, 98.5% of the fatty acids were identified.

Sex, age and pre-slaughter conditioning effects were tested only for the fatty acids occurring in more than 70% of the samples. Sex had no significant effect (P>0.05) on fatty acid concentrations, ratios and proportions (Table 7.2). Age of the goats tended to affect concentrations of C18:0 (P=0.060) and arachidic acid (C20:0) (P=0.065), and the UFA/SFA (P=0.057) and PUFA/SFA (P=0.081) ratios (Table 7.3) only. Stearic acid (C18:0) tended to be most abundant in full-mouthed goats and least concentrated in LL of kids. Arachidic acid tended to increase with the age of the goats from a mean of 1.17mg/g in milk-teethed kids to about twice as much in the 8-teeth group. The UFA/SFA ratio tended to be low in the 4-to-6 teeth group and PUFA/SFA ratio tended to be high amongst the milk-teethed kids. The proportions of the fatty acids did not significantly differ across the age groups (P>0.05) (Table 7.4). However, the SFA percentage tended to be lower in the milk-teethed kids than the older goats (P=0.062).

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Table 7.1 The occurrence, mean concentration (mean ± S.D. mg/g), range of concentration and proportions (mean ± S.D. percentage) of fatty acids in the *M.* l*ongissimus lumborum* of South African indigenous goats

Fatty acid	Occurrence (No of samples)	Concentration (mg/g)			% by weight of total fatty acids
		Mean ± S.D.	Min	Max	Mean ± S.D.
C12:0 Lauric	19	0.09 ± 0.24	0.00	1.09	0.23 ± 0.73
C14:0 Myristic	76	0.27 ± 0.31	0.01	2.61	0.69 ± 0.97
C16:0 Palmitic	78	7.99 ± 3.12	2.84	17.58	16.65 ± 3.64
C16:1 Palmitoleic	71	2.57 ± 1.36	0.57	7.87	5.14 ± 1.68
C17:0 Margaric	54	1.40 ± 0.84	0.07	3.56	2.90 ± 1.35
C17:1 Heptadecenoic	54	0.88 ± 0.52	0.05	2.06	1.98 ± 1.34
C18:0 Stearic	78	4.86 ± 2.06	1.62	10.52	10.01 ± 1.91
C18:1 Oleic	78	20.89 ± 7.89	7.65	45.04	43.13 ± 4.44
C18:2 Linoleic	78	8.16 ± 3.34	1.88	20.20	17.62 ± 5.45
C18:3 Linolenic	73	0.49 ± 1.74	0.03	14.91	0.70 ± 0.81
C20:0 Arachidic	41	2.19 ± 1.26	0.07	4.74	4.74 ± 2.38
C20:1 Eicosenoic	25	0.08 ± 0.05	0.01	0.22	0.22 ± 0.17
UNID	41	0.47 ± 0.64	0.00	2.51	1.06 ± 1.47
SFA	78	15.26 ± 5.98	5.84	32.55	31.88 ± 6.79
UFA	78	32.48 ± 11.15	10.83	73.18	67.53 ± 6.60
MUFA	78	23.84 ± 9.06	7.72	53.61	49.18 ± 5.61
PUFA	78	8.65 ± 3.62	2.12	20.82	18.35 ± 5.74
Total Fatty acids	78	48.00 ± 15.79	19.66	100.69	
UFA/SFA	78	2.26 ± 0.66	0.44	5.22	
PUFA/SFA	78	0.65 ± 0.43	0.10	3.56	

NB: Saturated fatty acids (SFA); unsaturated fatty acids (UFA); monounsaturated fatty acids (MUFA); polyunsaturated fatty acids (PUFA)

Table 7.2 Effect of sex on the concentration (mg/g) and proportions (%) of fatty acids in the *M. longissimus lumborum* of South African indigenous goats

Fatty acid	*P*-values of sex main effects	
	Fatty acid concentration (mg/g)	Fatty acid proportions (%)
C14:0 Myristic	0.4553	0.4878
C16:0 Palmitic	0.4174	0.2467
C16:1 Palmitoleic	0.7511	0.9286
C18:0 Stearic	0.5246	0.9262
C18:1 Oleic	0.4283	0.4531
C18:2 Linoleic	0.5619	0.4009
C18:3 Linolenic	0.4459	0.2488
C20:0 Arachidic	0.3860	0.4555
Total	0.2695	
Saturated fatty acids	0.2878	0.6489
Unsaturated fatty acids	0.5168	0.4976
Monounsaturated fatty acids	0.5226	0.4410
Polyunsaturated fatty acids	0.6043	0.5695
UFA/SFA	0.7461	
PUFA/SFA	0.7313	

NB: Saturated fatty acids (SFA); unsaturated fatty acids (UFA); polyunsaturated fatty acids (PUFA)

Table 7.3 Effect of age on the fatty acid concentration (mean ± S.D. mg/g) in the *M. longissimus lumborum* of South African indigenous goats

Fatty acid	Fatty acid concentration (mg/g) per age class				*P*-values
	0 teeth	2 teeth	4 to 6 teeth	8 teeth	
C14:0	0.46 ± 0.69	0.24 ± 0.17	0.29 ± 0.17	0.17 ± 0.10	0.9562
C16:0	6.18 ± 1.80	7.87 ± 7.74	7.33 ± 3.18	9.96 ± 3.09	0.3302
C16:1	2.17 ± 1.15	2.34 ± 1.07	2.40 ± 1.39	3.30 ± 1.67	0.5346
C18:0	3.52 ± 1.47	4.82 ± 1.99	4.45 ± 1.91	6.20 ± 1.98	0.0603
C18:1	16.18 ± 5.03	21.96 ± 7.74	17.69 ± 7.64	25.47 ± 7.28	0.1571
C18:2	8.18 ± 2.99	8.47 ± 3.97	6.62 ± 2.00	9.25 ± 3.27	0.6674
C18:3	1.71 ± 4.39	0.21 ± 0.15	0.30 ± 0.31	0.33 ± 0.43	0.3617
C20:0	1.17 ± 0.88	2.02 ± 1.16	2.09 ± 1.17	3.30 ± 1.17	0.0648
Total	38.55 ± 10.08	48.74 ± 16.25	42.36 ± 14.74	57.75 ± 15.08	0.1966
SFA	11.30 ± 3.25	14.73 ± 5.88	15.09 ± 6.28	18.69 ± 5.63	0.2118
UFA	27.15 ± 7.79	33.70 ± 11.07	26.90 ± 10.30	38.88 ± 11.08	0.1877
MUFA	18.57 ± 6.18	25.02 ± 8.41	19.98 ± 8.95	29.28 ± 8.61	0.1217
PUFA	9.81 ± 4.44	8.68 ± 3.96	6.92 ± 2.02	9.59 ± 3.36	0.4325
UFA/SFA	2.47 ± 0.54	2.37 ± 0.50	1.92 ± 0.62	2.18 ± 0.53	0.0567
PUFA/SFA	0.82 ± 0.33	0.63 ± 0.25	0.53 ± 0.25	0.57 ± 0.25	0.0844

NB: Myristic acid (C14:0); palmitic acid (C16:0); palmitoleic acid (C16:1); stearic acid (C18:0); oleic acid (C18:1); linoleic acid (C18:2); linolenic acid (C18:3); arachidic acid (C20:0); saturated fatty acids (SFA); unsaturated fatty acids (UFA); monounsaturated fatty acids (MUFA); polyunsaturated fatty acids (PUFA)

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Table 7.4 Effect of age on the fatty acid proportions (mean ± S.D %) in the *M. longissimus lumborum* of South African indigenous goats

Fatty acid	% of total weight of fatty acids per age class				*P*-values
	0 teeth	2 teeth	4 to 6 teeth	8 teeth	
C14:0	1.32 ± 2.08	0.57 ± 0.52	0.77 ± 0.61	0.34 ± 0.28	0.4878
C16:0	15.52 ± 3.29	15.09 ± 4.54	17.40 ± 6.11	17.10 ± 2.84	0.7280
C16:1	5.08 ± 1.62	4.89 ± 1.50	5.06 ± 1.87	5.52 ± 1.88	0.9721
C18:0	8.74 ± 2.56	9.81 ± 1.62	10.30 ± 1.98	10.61 ± 1.73	0.1333
C18:1	40.25 ± 6.41	44.82 ± 3.32	40.94 ± 6.17	43.80 ± 3.03	0.6457
C18:2	20.81 ± 6.43	17.49 ± 5.18	16.44 ± 5.05	16.40 ± 4.62	0.8355
C18:3	1.07 ± 1.00	0.49 ± 0.43	0.86 ± 1.09	0.62 ± 0.76	0.5373
C20:0	2.77 ± 1.71	4.51 ± 2.25	4.92 ± 2.63	5.84 ± 1.76	0.3750
SFA	28.48 ± 5.96	30.14 ± 4.59	35.67 ± 9.74	32.24 ± 5.80	0.0624
UFA	67.32 ± 8.82	69.32 ± 4.51	63.28 ± 9.12	67.36 ± 5.57	0.2768
MUFA	45.97 ± 7.54	51.31 ± 3.91	45.98 ± 7.94	50.32 ± 3.87	0.4680
PUFA	21.94 ± 6.63	18.00 ± 5.23	17.30 ± 5.56	17.04 ± 4.96	0.3064

NB: Myristic acid (C14:0); palmitic acid (C16:0); palmitoleic acid (C16:1); stearic acid (C18:0); oleic acid (C18:1); linoleic acid (C18:2); linolenic acid (C18:3); arachidic acid (C20:0); saturated fatty acids (SFA); unsaturated fatty acids (UFA); monounsaturated fatty acids (MUFA); polyunsaturated fatty acids (PUFA)

The main source of variation in both fatty acid concentration and proportions was pre-slaughter conditioning (Tables 7.5 and 7.6). Pre-slaughter conditioned goats tended to have higher concentration of C18:1 (P=0.060), and hence UFA (P=0.060) and MUFA (P=0.056). As a result, the UFA/SFA ratio of the pre-slaughter conditioned goats was 1.6 times higher than that of the non-conditioned goats (P=0.030).

Proportionally, the pre-slaughter conditioned goats had significantly less C14:0 and combined SFA than the non-conditioned ones (P<0.01). Conversely the pre-slaughter conditioned goats had a significantly higher proportion of C18:1 (P=0.0004), and hence a higher proportion of MUFA (P=0.0004) than the non-conditioned goats.

The first order interaction effects of sex and age class, sex and pre-slaughter conditioning and, age class and pre-slaughter conditioning on the fatty acid concentrations (Table 7.7) and percentages (Table 7.8) were all not significant (P>0.05).

7.2.2 Amino Acid Composition

The amino acid composition of the kids (milk-teeth), young castrated males (2-to-4 teeth), young females (2-to-4 teeth) and does (8-teeth) were mostly similar (Table 7.9). Only alanine and tyrosine 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. The most abundant amino acid was glutamic acid, which averaged 13.65g/100g. Following glutamic acid were lysine, aspartic acid and leucine whose concentrations averaged 8.01g/100g, 7.88 g/100g and 7.08g/100g, respectively. Arginine, alanine and threonine averaged 5.65 g/100g, 4.95 g/100g and 4.70g/100g, respectively. Valine (4.07g/100g), isoleucine (3.92g/100g), glycine (3.87g/100g), serine (3.86g/100g) and phenylalanine (3.54g/100g) were all in a similar range of concentrations. Methionine (2.25g/100g), cysteine (0.93g/100g) and tryptophan (0.89g/100g) were the least concentrated amino acids.

Table 7.5 Effect of pre-slaughter conditioning on the fatty acid concentration (mean ± S.D. mg/g) in the *M. longissimus lumborum* of South African indigenous goats

Fatty acid	Mean concentration per pre-slaughter conditioning group		*P*-values
	Non-conditioned	Conditioned	
C14:0 Myristic	0.34 ± 0.38	0.16 ± 0.10	0.3491
C16:0 Palmitic	7.25 ± 2.99	9.09 ± 3.03	0.2306
C16:1 Palmitoleic	2.33 ± 1.24	2.87 ± 1.47	0.3247
C18:0 Stearic	4.49 ± 1.97	5.43 ± 2.09	0.4772
C18:1 Oleic	17.96 ± 6.72	25.32 ± 7.52	0.0602
C18:2 Linoleic	7.04 ± 1.93	9.87 ± 4.25	0.2685
C18:3 Linolenic	0.66 ± 0.29	0.24 ± 0.33	0.9335
C20:0 Arachidic	2.24 ± 1.27	1.86 ± 1.24	0.3631
Total	42.76 ± 13.51	55.47 ± 16.67	0.7782
Saturated fatty acids	14.65 ± 6.00	16.19 ± 5.91	0.9898
Unsaturated fatty acids	27.88 ± 8.74	39.00 ± 11.57	0.0597
Monounsaturated fatty acids	20.49 ± 7.90	28.90 ± 8.43	0.0560
Polyunsaturated fatty acids	7.70 ± 2.73	10.09 ± 4.31	0.3303
UFA/SFA	2.73 ± 2.05	4.31 ± 2.50	0.0304
PUFA/SFA	0.59 ± 0.29	0.66 ± 0.26	0.7782

NB: Saturated fatty acids (SFA); unsaturated fatty acids (UFA); polyunsaturated fatty acids (PUFA)

Table 7.6 Effect of pre-slaughter conditioning on the fatty acid proportions (mean ± S.D. percentage) in the *M. longissimus lumborum* of South African indigenous goats

Fatty acid	Mean % of total weight of fatty acids per pre-slaughter conditioning group: Non-conditioned	Conditioned	*P*-values
C14:0 Myristic	0.92 ± 1.16	0.31 ± 0.23	0.0021
C16:0 Palmitic	16.68 ± 4.60	15.49 ± 4.38	0.3950
C16:1 Palmitoleic	5.04 ± 1.62	5.21 ± 1.83	0.6703
C18:0 Stearic	10.14 ± 2.11	9.69 ± 1.70	0.4448
C18:1 Oleic	41.05 ± 5.17	45.76 ± 2.78	0.0004
C18:2 Linoleic	17.30 ± 5.55	17.75 ± 5.09	0.6857
C18:3 Linolenic	0.87 ± 0.90	0.44 ±0.57	0.7748
C20:0 Arachidic	4.94 ± 2.41	3.25 ± 1.64	0.7499
Saturated fatty acids	33.54 ± 7.83	29.03 ± 3.23	0.0211
Unsaturated fatty acids	64.94 ± 7.72	70.52 ± 4.32	0.1015
Monounsaturated fatty acids	46.71 ± 6.59	52.35 ± 3.23	0.0004
Polyunsaturated fatty acids	18.23 ± 5.95	18.17 ± 5.18	0.6331

Table 7.7 Interaction effects of age and sex, sex and pre-slaughter conditioning and conditioning and age on fatty acid concentration of the *M. longissimus lumborum* muscle of South African indigenous goats

Fatty acid	*P*-values of first order interactions		
	Age(sex)[1]	Sex*conditioning	Conditioning(age)[2]
C14:0 Myristic	0.3323	0.4926	0.7215
C16:0 Palmitic	0.7983	0.6102	0.8459
C16:1 Palmitoleic	0.6782	0.6039	0.9065
C18:0 Stearic	0.6498	0.4070	0.7073
C18:1 Oleic	0.5264	0.3450	0.8564
C18:2 Linoleic	0.1414	0.4695	0.1335
C18:3 Linolenic	0.4502	0.5885	0.8123
C20:0 Arachidic	0.2124	-	-
Total	0.5475	0.2695	0.9073
Saturated fatty acids	0.6183	0.1986	0.8082
Unsaturated fatty acids	0.4103	0.3767	0.7468
Monounsaturated fatty acids	0.5097	0.4037	0.8430
Polyunsaturated fatty acids	0.4018	0.5504	0.1741
UFA/SFA	0.0936	0.2560	0.5906
PUFA/SFA	0.1050	0.4366	0.1351

NB: 1- sex effects were nested in age effects (refer to § 3.3.2)

2- Age effects were nested in conditioning effects (refer to § 3.3.2)

Significant interaction effects ($P<0.05$) are in bold face

NB: Saturated fatty acids (SFA); unsaturated fatty acids (UFA); polyunsaturated fatty acids (PUFA)

Table 7.8 Interaction effects of age and sex, sex and pre-slaughter conditioning and conditioning and age on fatty acid proportions of the *M. longissimus lumborum* muscle of South African indigenous goats

	P-values of first order interactions		
Fatty acid	Age(sex)[1]	Sex*conditioning	Conditioning(age)[2]
C14:0 Myristic	0.2698	0.1020	0.2422
C16:0 Palmitic	0.2552	0.1832	0.4583
C16:1 Palmitoleic	0.6988	0.9745	0.9862
C18:0 Stearic	0.3938	0.8968	0.4998
C18:1 Oleic	0.5666	0.9333	0.2132
C18:2 Linoleic	0.2688	0.5630	0.3545
C18:3 Linolenic	0.6544	0.2552	0.8089
C20:0 Arachidic	0.4091	-	-
Saturated fatty acids	0.1589	0.1677	0.4656
Unsaturated fatty acids	0.1425	0.1552	0.3452
Monounsaturated fatty acids	0.6920	0.4137	0.1279
Polyunsaturated fatty acids	0.3938	0.5376	0.3261

NB: 1- sex effects were nested in age effects (refer to § 3.3.2)

2- Age effects were nested in conditioning effects (refer to § 3.3.2)

Significant interaction effects ($P<0.05$) are in bold face

NB: Saturated fatty acids (SFA); unsaturated fatty acids (UFA); polyunsaturated fatty acids (PUFA)

Table 7.9 Amino acid composition (mean ± S.D. g/100g) of *M. longissimus lumborum* muscle of South African indigenous goat kids, young goats and does

Amino acid	amino acid concentration (g/100g)				*P*-value
	Kids	Female	Castrates	Does	
Histidine	2.26 ± 0.14	2.44 ± 0.13	2.48 ± 0.24	2.55 ± 0.20	0.3110
Threonine	4.64 ± 0.14	4.67 ± 0.12	4.67 ± 0.15	4.82 ± 0.18	0.5510
Valine	3.97 ± 0.12	4.02 ± 0.16	4.06 ± 0.21	4.24 ± 0.11	0.1871
Methionine	2.22 ± 0.07	2.23 ± 0.07	2.29 ± 0.10	2.25 ± 0.04	0.6870
Isoleucine	3.93 ± 0.11	3.82 ± 0.16	3.86 ± 0.20	4.07 ± 0.17	0.3192
Leucine	7.03 ± 0.22	6.83 ± 0.33	7.10 ± 0.11	7.34 ± 0.31	0.2376
Phenylalanine	3.63 ± 0.16	3.50 ± 0.15	3.43 ± 0.07	3.61 ± 0.11	0.3611
Lysine	8.36 ± 0.31	8.11 ± 0.26	7.52 ± 0.34	8.04 ± 0.24	0.1079
Tryptophan	0.99 ± 0.07	1.00 ± 0.03	0.79 ± 0.15	0.77 ± 0.28	0.3379
Cysteine	0.92 ± 0.01	0.94 ± 0.02	0.92 ± 0.03	0.93 ± 0.01	0.4415
Aspartic acid	7.65 ± 0.05	7.73 ± 0.30	8.01 ± 0.12	8.13 ± 0.17	0.0824
Glutamic acid	13.43 ± 0.10	13.25 ± 0.29	13.80 ± 0.42	14.14 ± 0.40	0.0627
Serine	3.76 ± 0.02	3.79 ± 0.17	3.89 ± 0.03	3.99 ± 0.10	0.1290
Glycine	3.76 ± 0.26	3.91 ± 0.40	3.93 ± 0.19	3.88 ± 0.14	0.7538
Arginine	5.53 ± 0.16	5.44 ± 0.09	5.67 ± 0.15	5.95 ± 0.27	0.0973
Alanine	4.83 ± 0.07^{ab}	4.82 ± 0.05^{a}	5.03 ± 0.03^{ab}	5.10 ± 0.05^{b}	0.0290
Proline	3.15 ± 0.12	3.27 ± 0.22	3.32 ± 0.08	3.34 ± 0.17	0.3613
Tyrosine	3.07 ± 0.08^{ab}	3.01 ± 0.15^{a}	3.24 ± 0.07^{ab}	3.27 ± 0.11^{b}	0.0396

CHAPTER 7

7.3 DISCUSSION

7.3.1 Fatty Acid Composition

The proportion of identified fatty acids in this study was high. This implies that the standards profile employed in the analysis included most of the fatty acids that occurred in the intramuscular fat of the caprine LL muscle.

A comparison of the present results to Banskalieva's et al. (2000) compilation, Mahgoub et al. (2002) and Tshabalala et al. (2003) shows that South African indigenous goats had similar proportions of the major fatty acids to most of the earlier studies. The proportions of C16:0 and C18:0 tended to be on the lower side of the reported ranges of 15% to 31% and 12% to 20%, respectively. Oleic acid was within the reported range of 28% to 48%. On the contrary, C18:2 was above the 4% to 15% range and C18:3 on the lower end of the 0.17% to 3.15% range. Such high concentration of C18:2 have been reported for ostrich intramuscular fat, whose C18 series comprise about 10% C18:0, 30% C18:1, 16%, C18:2 and less than 2% C18:3 (Hoffman and Fisher, 2001; Girolami, Marsico, D'Andrea, Braghieri, Napolitano and Cifuni, 2003).

Chevon and ostrich are both lean red meats, which typically have relatively high phospholipid content (Enser et al., 1998) and, muscle phospholipids have high concentration of C18:2. For example, some reported values of C18:2 in phospholipids were about 11% of total fatty acids in forage-fed beef and 20% in grain-fed beef (Marmer et al., 1984; Larick and Turner, 1989; Webb, DeSmet, Van Nevel, Martens and Demeyer, 1998). Corresponding values reported for reindeer were 21% and 28%, respectively (Wiklund, Pickova, Sampels and Lundström, 2001b) while the levels in neutral lipids were less than 2% for both beef and venison.

Although the concentration of C18:2 usually increases with feeding of grain-based diets, the proportion was not changed by pre-slaughter conditioning in this study. However the proportion of C14:0 was three times lower in the pre-slaughter conditioned goats. Similarly, C12:0 percentages suggest that the content of this fatty acid was highly influenced by pre-slaughter conditioning. The fatty acid averaged 0.62% in non-conditioned goats and only 0.05% in the pre-slaughter conditioned group. (Statistical analyses were not performed on C12:0 because it was detected in only 19 of the 78 samples). Oleic acid and MUFA increased significantly with pre-slaughter conditioning. Such dietary effects on C14:0 and MUFA have been reported previously for fattened sheep (Casey, van Niekerk and Spreeth, 1988) and for goats (Johnson et al., 1995). The dietary effects are a seemingly advantageous change in fatty acid profile to a more healthful one since the fatty acids that decrease (C12:0 and C14:0) are considered highly hypercholesterolaemic (Lichtenstein et al., 1998) while those that increase are at least neutral in that effect (Voet and Voet, 1990).

There are several considerations in the balance of fatty acids for beneficial effects to meat consumers. One is the PUFA/SFA ratio, which, in the present study, fell above the minimum of 0.45 that is recommended for British consumers (Enser et al., 1998). Another consideration is the proportion of what are termed desirable fatty acids, which are C18:0 and all unsaturated fatty acids (Banskalieva et al., 2000). In this study the desirable fatty acids constituted 77.5% of the LL muscle fatty acids. This value is within the range of 61 to 80% in the studies reviewed by Banskalieva et al. (2000) and higher than the 67.45% from Mahgoub et al. (2002) and the 66.4% of Tshabalala et al. (2003). Corresponding values that have been reported for beef and lamb/mutton range between 63% and 71% (Banskalieva et al., 2000).

In recent years interest has been in the n-3 and n-6 PUFA isomers and their proportions within human diets. The ratio of the n-6/n-3 fatty acids in lipids depends on the concentrations of their respective precursor fatty acids, C18:2 and C18:3. The average C18:2/C18:3 ratio is the present study was 16.6, a high value that is in the range associated with grain-based diets (Enser et al., 1998). According to Enser (2001), grain feeding has shifted the n-6/n-3 ratio from about two in ruminants on forages to between 7 and 20 in ruminants on grain-based diets. Therefore, while grain feeding has the desirable effect of reducing SFA that are implicated in coronary heart disease and enhancing the production of the neutral UFA, it has the adverse effect of raising the n-6 PUFA. High n-6 PUFA content is undesirable because these fatty acids yield eicosanoids with more powerful thrombotic tendencies than n-3 PUFA derivatives, which would predispose consumers to coronary diseases (Enser, 2001).

Reported results of the effects of sex on fatty acid composition have been variable. Johnson et al. (1995) reported lower muscle lipid content, PUFA percentage and a higher PUFA/SFA ratio for intact males compared to females. In concord with these findings, intact males in Mahgoub et al.

(2002) had higher concentration of C18:2, C18:3, C15:0 but lower concentration of C17:0, C16:0, C18:0 and C18:1 than females. No age effects were observed in this study. However, where sex and/or age effects occur on fatty acid percentages, they are usually attributed to differences in the degree of fatness between males and females and/or the different age groups rather than direct effects on the fatty acid proportions as such (Mahgoub et al., 2002). Females tend to be fatter than intact males, and hence to have a lower phospholipid to triacylglycerides ratio than the leaner males, and consequently, proportionately less PUFA. Similarly, as fatness increases with age, differences observed in fatty acid profile post-weaning tend to be reflective of increased fatness.

The oxidative stability of meat depends on the balance between oxidative substrates, such as PUFA, pro-oxidants and anti-oxidants (Morrisey et al., 1998). The high PUFA and MUFA content of chevon may compromise its shelf life.

7.3.2 Amino Acids

Compared to the amino acid profiles of lamb, ostrich, beef and chicken (Gilka et al., 1989; Sales and Hayes, 1996 and Lawrie, 1998), goat amino acid proportions tended to be lower.

According to Schweigert (1987), the amino acid composition of a protein remains remarkably constant independent of cut. There is nevertheless, a contention that it is feasible that differences in amino acids may occur between muscle locations, breeds and animals of different ages (Lawrie, 1998) as well as with different diets and muscle proportions (Gilka et al., 1989). In Gilka et al. (1989) tyrosine was the amino acid most influenced by monensin and lasalocid supplementation. Alanine was among several amino acids that varied with muscle type in ostrich, which included valine, leucine, methionine and glycine (Sales and Hayes, 1996). In the present study there is a suggestion of age effects on the concentration of tyrosine and alanine but the impact of the variation on the nutritive value of the muscle is unlikely to be substantial, more so that they are both non essential amino acids. On the whole, the present results suggest that there is negligible variation within the amino acid profile of caprine LL muscle.

On a whole meat basis however, the amino acid composition may be affected considerably by the fat content. This was aptly demonstrated by Sheridan et al. (2003) wherein Boer goats with

20.2% intramuscular fat had greater concentrations of eleven (namely; aspartic acid, threonine, glutamic acid, proline, valine, methionine, isoleucine, leucine, tyrosine, phenylalanine and lysine) out of 18 amino acids that were profiled than Mutton Merino lambs with an intramuscular fat content of 36.8%.

The essential amino acid profile of chevon would adequately meet the dietary amino acid requirements of adult consumers that were proposed by Pellet and Young (1990). The estimated dietary requirements and concentrations obtained in the present study compare well (Table 7.10).

Table 7.10 Essential amino acid concentration in chevon from South African indigenous goats (mean ± S.D. g/100g) compared to dietary requirements of adult consumers

	Concentration (g/100g)	
Amino acid	Chevon†	dietary requirements of adults‡
Alanine	4.94 ± 0.13	3.8
Leucine	7.07 ± 0.29	6.5
Lysine	8.01 ± 0.40	5.0
Methionine & cysteine	3.18 ± 0.08	2.5
Phenylalanine & tyrosine	4.43 ± 0.26	6.5
Threonine	4.70 ± 0.15	2.5
Tryptophan	0.89 ± 0.18	1.0
Valine	4.07 ± 0.14	3.5

† Overall means from present study

‡ Pellet and Young (1990).

7.4 SUMMARY

Chevon from South African indigenous goats was found to have high concentration of PUFA, particularly C18:2, which were similar to values reported for ostrich. Consequently the PUFA/SFA ratio was high and typical of grain-fed ruminants. High C18:2/C18:3 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. However, pre-slaughter conditioning resulted in lower concentration of C14:0 and total SFA, and increased concentration of C18:1 and hence MUFA but did not affect the PUFA content.

The amino acid proportions suggest that within the caprine LL muscle there is no variation in the amino acid profile. Chevon would adequately meet consumer dietary amino acid requirements of adult consumers.