CHAPTER 4

RESULTS AND DISCUSSION

4.1 LONG-CHAIN FATTY ACIDS IN THE CARCASS FAT OF THE AFRICAN BUFFALO (*SYNCERUS CAFFER*)[1]

The most abundant fatty acids present in depot fat of African buffalo, in proportions higher than 10% of the total fatty acids present, were C18:1, C18:0, C16:0 and C13:0. The ranking order, differing between depots and sometimes also within a specific depot, depending on the age gender and habitat.

Table 4-1 Long-chain fatty acid composition (Mean±SD; w/w %) of the subcutaneous (SCF), M. Longissimus dorsi (LD), perirenal (PRF), pericardial (PCF), and omental (OMF) fat in the African buffalo.

(w/w %)	SCF (n = 36)	LD (n = 35)	PRF (n = 36)	PCF (n = 17)	OMF (n = 30)
C13:0	41.68^{A}±24.68	51.76^{A}±18.08	14.14^{B}±12.38	10.50^{B}±7.73	14.88^{B}±5.84
C14:0	3.13±1.20	2.10±1.48	28.03±26.12	3.29±1.64	15.68±22.86
C15:0	$0.61^{A,B}$±0.47	0.32^{B}±0.09	1.29^{A}±0.84	$0.52^{A,B}$±0.18	$1.10^{A,B}$±0.69
C16:0	11.91^{A}±5.14	$12.00^{A,C}$±4.06	19.54^{B}±7.84	$19.26^{B,C}$±7.36	19.27^{B}±5.92
C16:1	2.42^{A}±1.30	2.22^{A}±0.69	3.86^{B}±1.27	$3.10^{A,B}$±1.42	3.00^{A}±1.43
C17:0	1.22±0.80	1.03±0.47	2.11±0.16	2.11±0.50	2.20±0.04
C18:0	$14.30^{A,C}$±9.482	10.18^{A}±5.04	$17.86^{B,C}$±8.29	24.91^{B}±10.03	$19.65^{B,C}$±8.39
C18:1	$23.51^{A,C}$±10.33	19.28^{C}±7.47	28.69^{B}±8.42	$29.94^{A,B}$±3.85	$27.64^{A,B}$±6.00
C18:2	$1.94^{A,B}$±0.70	1.78^{B}±0.59	2.40^{A}±0.86	$2.17^{A,B}$±0.56	2.88^{A}±1.10
C18:3	$1.21^{A,B}$±0.68	0.83^{B}±0.35	1.74^{A}±0.37	1.76^{A}±0.90	$1.36^{A,B}$±0.62

$^{A, B, C}$ Means in the same row bearing different superscripts, differ (P<0.01)

C13:0 was present in the highest proportions in subcutaneous fat (SCF) and *M. Longissimus dorsi* (LD), followed by C18:1, C18:0 and C16:0 in SCF and C18:1, C16:0 and C18:0 in LD (Table 4-1). In all internal fat depots, the proportion of C18:1 was the highest in the pericardial (PCF) and omental fat (OMF), followed by C18:0, C16:0 and C13:0 and C16:0, C18:0 and C13:0 in the perirenal fat (PRF) (Table 4-1).

[1] Results presented at IX International Symposium on Ruminant Physiology, 1999 (Steenkamp *et al.*, 1999a).

Figure 4-1 Comparison of the long-chain fatty acid composition of different fat depots in the African buffalo.

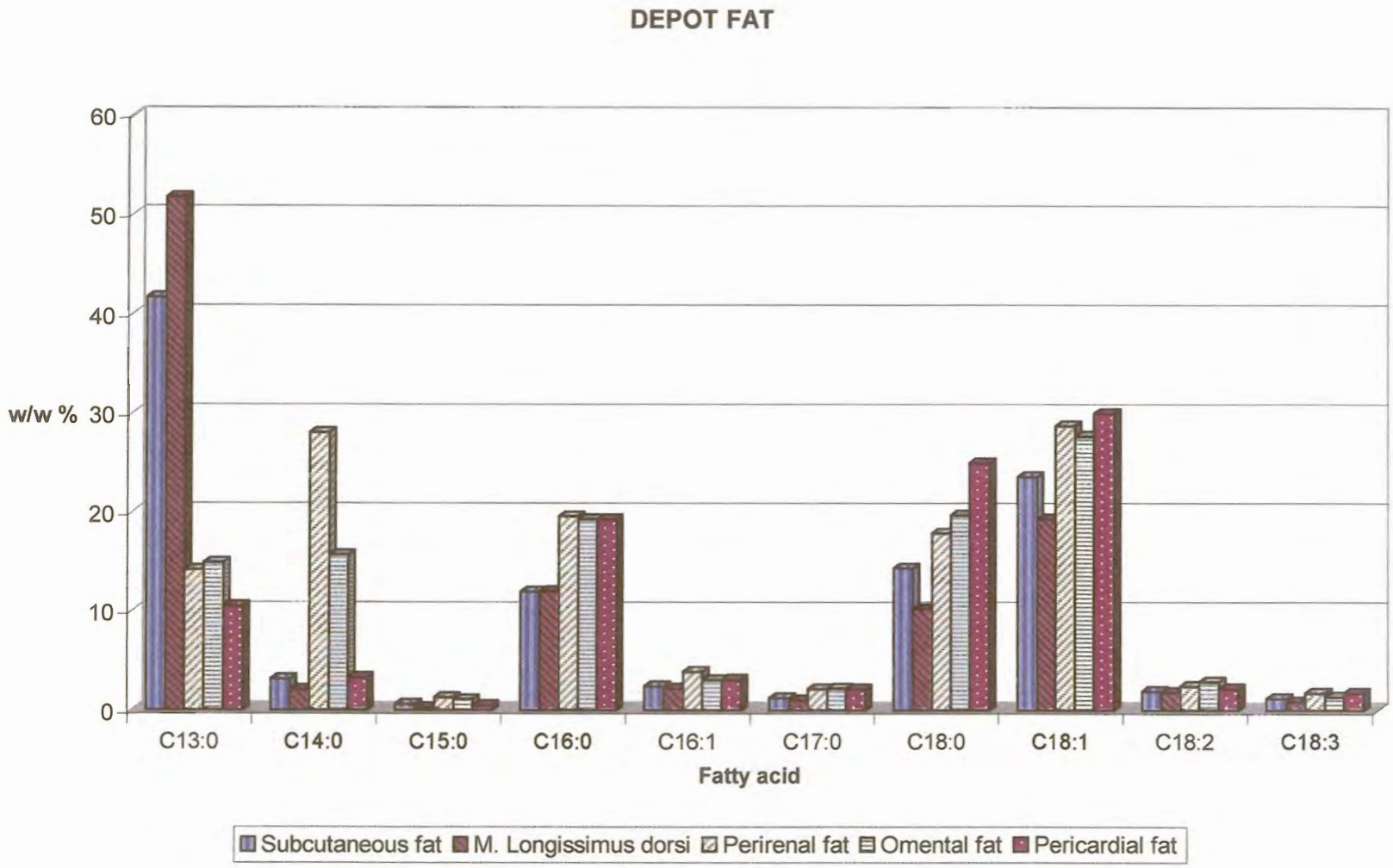
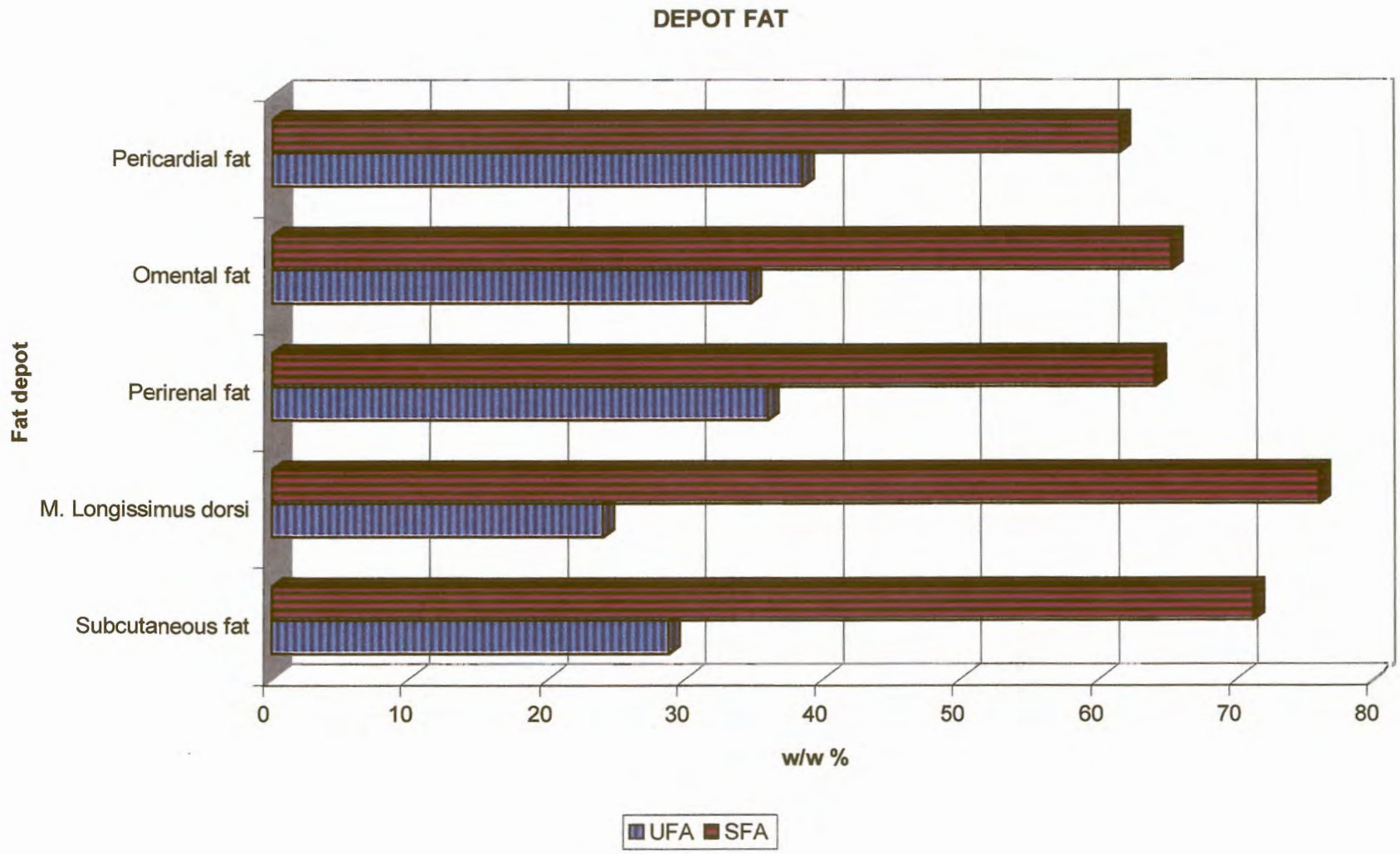


Figure 4-2 Differences between the proportions of total saturated and unsaturated long-chain fatty acids of different fat depots in the African buffalo.



C14:1 and C15:1 were detected in all fat depots, but in proportions lower than 1%. A small proportion of C20:1 (<1%) was detected only in LD, and C20:0 (<1%) only in the PRF and PCF. These are therefore not shown in Table 4-1.

In the literature, C13:0 is not usually listed in fatty acid profiles of ruminants and if listed (Link *et al.*, 1970; Kurbanov *et al.*, 1975) the proportion is generally lower than 1%. Possible reasons for the absence of C13:0 from previous reports may be that it was not present in the fatty acid standard as reference, due to very low proportions present, or the absence of C13:0 from the samples. Although it was difficult to separate C13:0 and C14:0, it was decided to include C13:0 in the report because of the prominent peak in all chromatograms (see results and Figure 2-3). The inclusion of C13:0 resulted in higher saturation levels of depot fat and relatively lower proportions of the other fatty acids, with the result that the proportions of fatty acids in fat depots from buffalo, can not accurately be compared to data from other ruminants (see Section 5.5 Critical Evaluation).

Highly significant differences ($P<0.01$) were found between the proportions of C13:0 in different depots. SCF and LD contained significantly higher proportions of C13:0 compared to PRF, PCF and OMF, indicated in Table 4-1. This corresponds with results of fat-tailed Karakul sheep reported by Kurbanov *et al.*, (1975) (internal fat: 0.27%; tail fat: 0.53%), although they found much lower proportions of C13:0.

PRF and OMF contained numerically higher proportions of C14:0 than the other fat depots (SCF, LD and PCF), although the differences were not statistically significant. This may be due to the problems encountered with the separation of C13:0 and C14:0, resulting in high standard deviations for C13:0 and C14:0 in PRF and OMF. Casey and van Niekerk (1985) also reported significantly lower proportions of C14:0 in SCF than in PRF in goats.

Table 4-2 Relative proportions (Mean±SD; w/w %) of the total saturated (SFA) and unsaturated (UFA) long-chain fatty acid content of the carcass fat in the African buffalo.

(w/w %)	UFA	SFA
Subcutaneous fat (SCF)	$28.77^{A,C}$±12.06	$71.15^{A,C}$±12.04
***M. Longissimus dorsi* (LD)**	23.97^{A}±8.63	75.94^{A}±8.63
Perirenal Fat (PRF)	35.96^{B}±11.00	64.04^{B}±11.01
Pericardial fat (PCF)	38.50^{B}±4.54	61.47^{B}±4.53
Omental fat (OMF)	$34.68^{B,C}$±7.29	$65.24^{B,C}$±7.22

$^{A, B, C}$ Means in the same column bearing different superscripts differ (P < 0.01)

The SFA and UFA content of the internal fat depots (PRF, OMF, PCF) did not differ significantly (P<0.01) (Table 4-2). The dominant fatty acids within the internal fat depots were C18:1, C18:0, C16:0 and C13:0 (Table 4-1). C16:1 differed significantly (P<0.01) between the PRF and OMF. The relative proportion of C16:1 in the PRF fat was higher (3.856±1.274%) than in omental fat (3.001±1.428%). The proportions of C16:1 in PCF (3.103±1.424%) did not differ significantly from either PRF or OMF. The proportions of C20:0 was less than 1% for all internal depots analysed.

SFA and UFA content of SCF and fat from the LD (Table 4-2) did not differ significantly (P<0.01) although the proportion of fatty acids in LD appeared to be more saturated compared to the SCF. The dominant fatty acids within SCF and LD were C13:0, C18:1, C18:0 and C16:0 respectively. No significant differences were found between the fatty acid composition of SCF and LD except for C18:1 being significantly lower in LD compared to SCF. This is in contrast to previous research where differences were found between individual fatty acids in SCF and LD (Zembayashi and Nishimura, 1996; Eichhorn *et al.*, 1985).

No significant difference was found between the proportions of SFA and UFA of SCF and OMF (P<0.01). OMF contained significantly higher proportions of C16:0 and lower proportions of C13:0 than SCF.

Table 4-2 Relative proportions (Mean±SD; w/w %) of the total saturated (SFA) and unsaturated (UFA) long-chain fatty acid content of the carcass fat in the African buffalo.

(w/w %)	UFA	SFA
Subcutaneous fat (SCF)	$28.77^{A,C}$±12.06	$71.15^{A,C}$±12.04
***M. Longissimus dorsi* (LD)**	23.97^{A}±8.63	75.94^{A}±8.63
Perirenal Fat (PRF)	35.96^{B}±11.00	64.04^{B}±11.01
Pericardial fat (PCF)	38.50^{B}±4.54	61.47^{B}±4.53
Omental fat (OMF)	$34.68^{B,C}$±7.29	$65.24^{B,C}$±7.22

$^{A, B, C}$ Means in the same column bearing different superscripts differ (P < 0.01)

The SFA and UFA content of the internal fat depots (PRF, OMF, PCF) did not differ significantly (P<0.01) (Table 4-2). The dominant fatty acids within the internal fat depots were C18:1, C18:0, C16:0 and C13:0 (Table 4-1). C16:1 differed significantly (P<0.01) between the PRF and OMF. The relative proportion of C16:1 in the PRF fat was higher (3.856±1.274%) than in omental fat (3.001±1.428%). The proportions of C16:1 in PCF (3.103±1.424%) did not differ significantly from either PRF or OMF. The proportions of C20:0 was less than 1% for all internal depots analysed.

SFA and UFA content of SCF and fat from the LD (Table 4-2) did not differ significantly (P<0.01) although the proportion of fatty acids in LD appeared to be more saturated compared to the SCF. The dominant fatty acids within SCF and LD were C13:0, C18:1, C18:0 and C16:0 respectively. No significant differences were found between the fatty acid composition of SCF and LD except for C18:1 being significantly lower in LD compared to SCF. This is in contrast to previous research where differences were found between individual fatty acids in SCF and LD (Zembayashi and Nishimura, 1996; Eichhorn *et al.*, 1985).

No significant difference was found between the proportions of SFA and UFA of SCF and OMF (P<0.01). OMF contained significantly higher proportions of C16:0 and lower proportions of C13:0 than SCF.

PCF contained significantly higher (P<0.01) proportions of C18:0 and C16:0 than SCF (Table 4-1). SCF was significantly (P<0.01) more saturated than PCF and PRF (Table 4-2). This is an unusual finding, as SCF are known to be more unsaturated than fat from internal fat depots of other ruminant species (Casey and van Niekerk, 1985; Webb *et al.*, 1998; Banskalieva, 1996). Animals were culled just after the dry season. The present results suggest that animals were in a poor body condition and that adipose reserves were mobilised to meet energy requirements for maintenance and other physiological conditions like lactation and growth during the dry season.

Significant differences (P<0.01) in the proportions of UFA and SFA were found between SCF and PRF depots (Table 4-1). This finding is in contrast with results obtained in a similar study on beef cattle (Webb *et al.*, 1998). SCF and PRF differed significantly (P<0.01) for the proportions of C13:0, C16:0, C16:1, C17:0 and C18:1 (Table 4-1). The PRF contained significantly higher proportions of C16:0, C16:1, C17:0 and C18:1 (P<0.01) than SCF (Table 4-1) and lower proportions of C13:0.

The fatty acid content of the LD differed significantly (P<0.01) from PRF (Table 4-2). LD was significantly more saturated than PRF. This is mainly due to the significantly higher proportions of C13:0 found in LD than in PRF. PRF, on the other hand, contained higher proportions of C15:0; C16:0, C16:1, C18:0, C18:1, C18:2 and C18:3 than LD.

LD contained significantly more saturated fat than PCF (Table 4-2). Significant (P<0.01) differences were found in the proportions of C13:0, C18:0, C18:1 and C18:3. The proportions of C13:0 were generally higher (P<0.01) and C18:0, C18:1 and C18:3 lower in LD than in PCF (Table 4-1).

Highly significant differences (P<0.01) were found between the proportions of C13:0 in LD and OMF (Table 4-1). LD contained higher proportions of C13:0 than OMF resulting in

significantly higher proportions of total saturated fatty acids in LD than in OMF ($P<0.01$) (Table 4-2). The relative proportions of the other fatty acids did not differ significantly between the different depots.

4.2 INFLUENCE OF AGE[2]

4.2.1 *Subcutaneous fat*

The relative proportions of individual fatty acids in the subcutaneous fat of buffalo were influenced by age, but these differences did not significantly affect the overall proportion of saturated fatty acids. The proportion of C14:0 decreased significantly ($P<0.01$) from 6.896±6.622% in the A age (animals younger than 2 years of age) to 1.425±0.649% in the C age (animals older than 6 years of age).

A small, but significant ($P<0.05$) decrease with age was detected for the proportion of C18:3. The relative proportions of C18:0 ($P<0.001$) and C18:1 ($P<0.05$) were significantly lower in the A than the B or C ages.

Previous research (Banskalieva, 1996; Huerta-Leidenz *et al.*, 1996, Malau-Aduli *et al.*, 1997) on ruminants, suggest similar results for the proportions of C14:0, C18:1 and C18:3. For C18:0, contrasting results were reported. Banskalieva (1996) reported that C18:0 increase with age in sheep, while others (Huerta-Leidenz *et al.*, 1996; Malau-Aduli *et al.*, 1997) reported that C18:0 decrease with age in cattle. The reason for this may be that there are other, more important factors that influence the proportions of C18:0 e.g. energy balance of the animal (Vernon, 1981; Adrouni and Khachadurian, 1968) and diet (Casey and van Niekerk, 1985; Christie, 1981b; Banskalieva, 1996; Rumsey *et al.*, 1972; Wood *et al.*, 1991; Westerling and Hedrick, 1979). Saturated long-chain fatty acids are increasingly desaturated to unsaturated fatty acids with age (Banskalieva, 1996; Webb

[2] Results presented at IX International Symposium on Ruminant Physiology, 1999 (Steenkamp *et al.*, 1999b).

and Casey, 1995; Westerling and Hedrick, 1979; Zembayashi and Nishimura, 1996). Long-chain fatty acids are preferentially mobilised for physiological functioning compared to fatty acids of shorter chain length (Vernon, 1981). This may explain the decrease in the proportion of C13:0, although statistically insignificant, (Figure 4-3) and the relative increase of C18:0 and C18:1. Embleton and Leat, 1972 (as quoted by Christie, 1981b) reported that C18:0 and C16:0 increase linearly with age. Similar results were obtained in the present study, but C16:0 was not influenced to the same extend (Figure 4-3). This may be because the proportion of C16:0 is influenced by the energy balance of the animals and is a sensitive indicator of the mobilisation and synthesis of fatty acids (Vernon, 1981).

Table 4-3 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition (Mean±SD; w/w %) of subcutaneous fat (SCF) in the African buffalo.

Age (w/w %)	A (< 2 years of age) (n = 12)	B (2 to 6 years of age) (n = 12)	C (> 6 years of age) (n = 12)
C13:0	39.97±24.87	43.97±24.09	27.41±20.70
C14:0	6.90^{A}±6.62	3.13±1.47	1.43^{B}±0.65
C14:1	6.87±0.18	0.73±0.09	0.67±0.27
C15:0	1.00±0.33	0.61±0.52	0.37±0.21
C15:1	0.22±0.04	0.20±0.05	0.17±0.12
C16:0	14.91±6.89	12.58±5.18	12.18±3.17
C16:1	3.35±1.64	2.59±1.66	2.30±0.64
C17:0	1.12±0.38	0.84±0.63	1.39±0.57
C18:0	9.76^{A}±4.48	12.06^{B}±7.04	21.14^{B}±8.72
C18:1	22.33^{a}±8.61	22.51^{b}±9.71	31.07^{b}±8.84
C18:2	1.96±0.87	2.09±0.67	2.27±0.31
C18:3	1.66^{a}±0.49	1.09^{b}±0.59	1.15±0.40
UFA	28.50±11.51	28.18±11.95	36.65±10.00
SFA	71.50±11.51	71.62±11.74	63.30±10.04

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

Figure 4-3 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition of subcutaneous fat in the African buffalo.

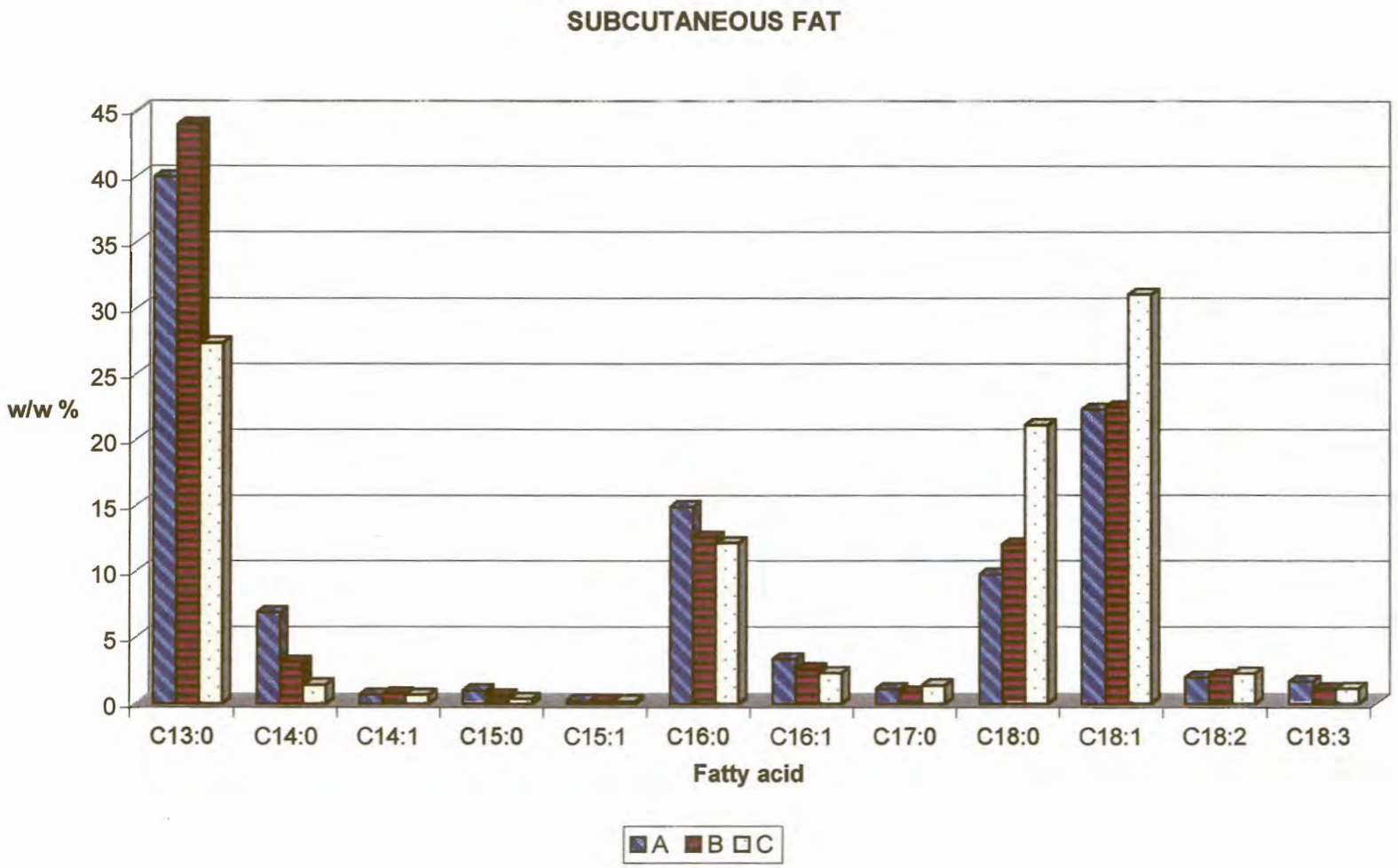
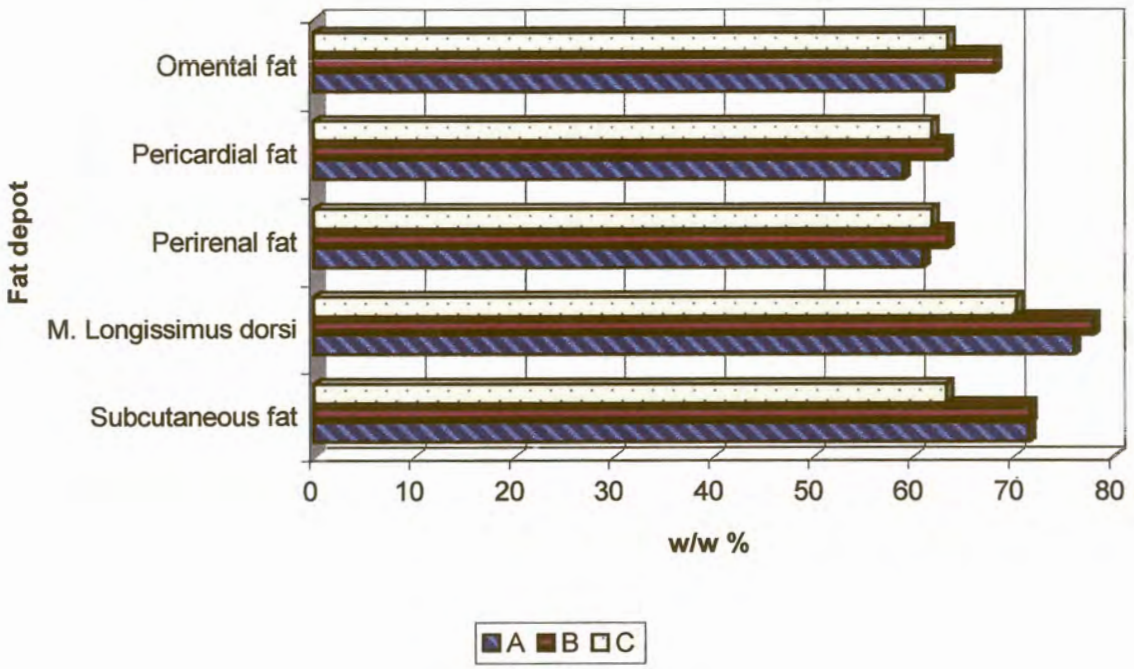
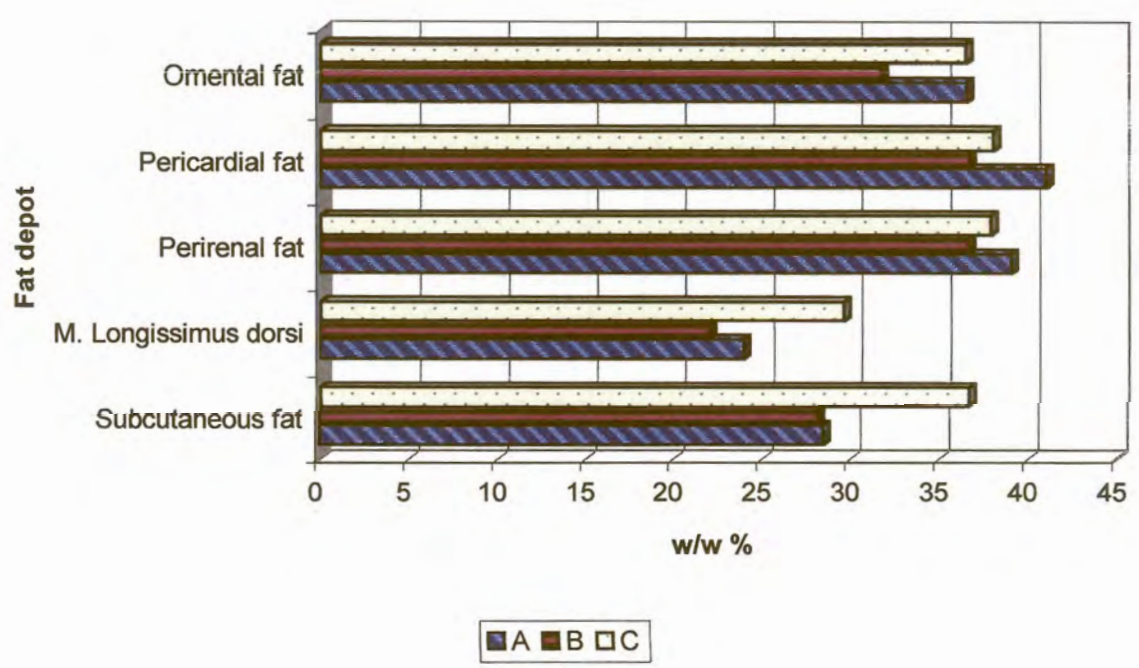


Figure 4-4 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the proportions of (a) total saturated and (b) total unsaturated long-chain fatty acids of different fat depots in the African buffalo.

a) SATURATED FATTY ACIDS



b) UNSATURATED FATTY ACIDS



4.2.2 *M. Longissimus dorsi*

The most abundant fatty acids in LD at all ages were C13:0, followed by C18:1, C16:0 and C18:0 (Figure 4-5). The proportions of total saturated fatty acids in LD changed with age (Table 4-4 and Figure 4-4). This is in agreement with previous results that reported the proportions of unsaturated fatty acids of carcass lipids (subcutaneous and intramuscular) to increase with age (or carcass fatness) (Zembayashi and Nishimura, 1996).

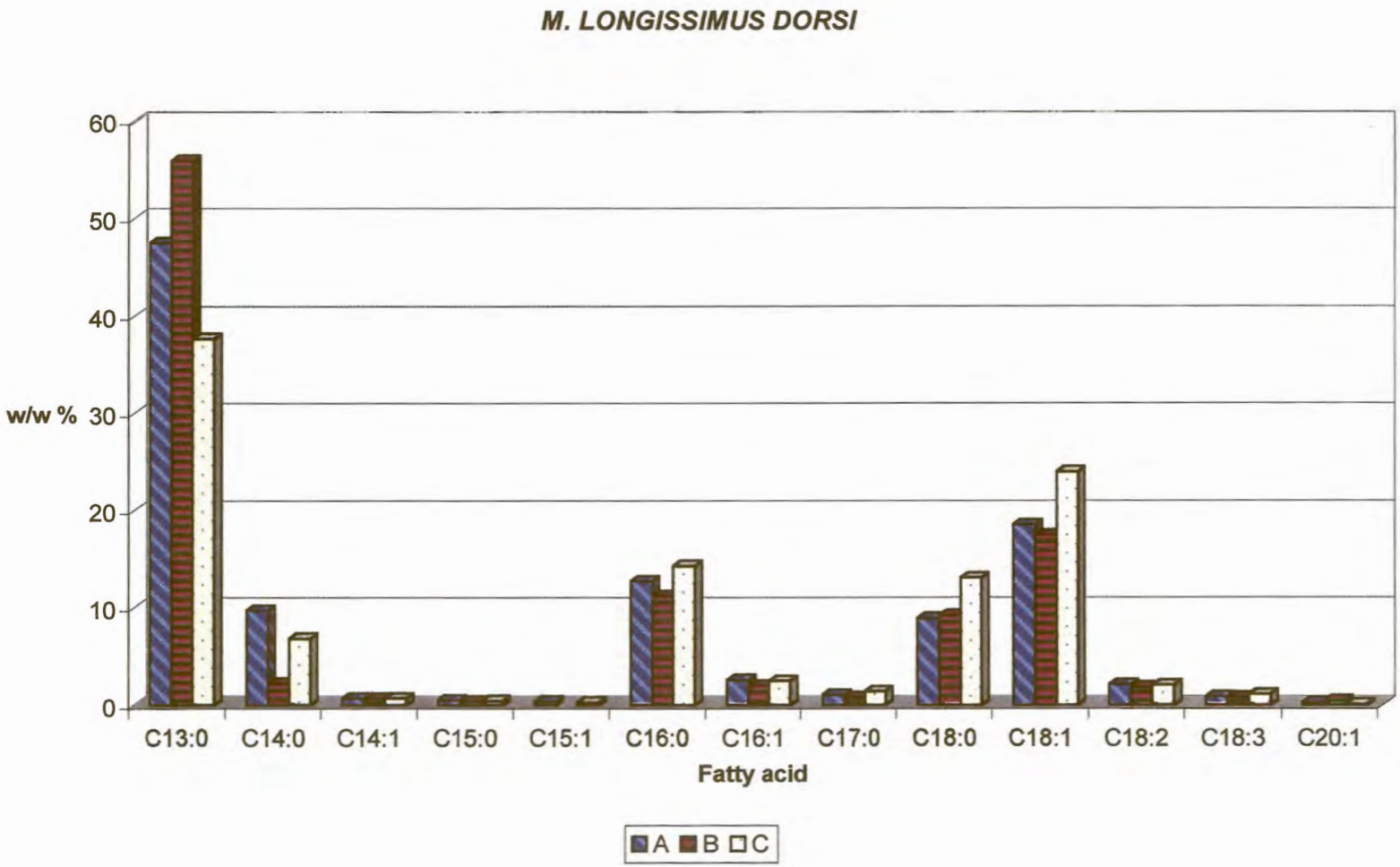
Table 4-4 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition (Mean±SD; w/w %) of M. Longissimus dorsi (LD) in the African buffalo.

Age (w/w %)	A (< 2 years of age) (n = 12)	B (2 to 6 years of age) (n = 11)	C (> 6 years of age) (n = 12)
C13:0	47.50±15.83	55.89^{A}±13.00	37.68^{B}±21.98
C14:0	9.67±17.79	2.23±1.45	6.82±11.43
C14:1	0.70±00.32	0.71	0.72±0.18
C15:0	0.527±0.40	0.40±0.12	0.45±0.14
C15:1	0.37		0.28±0.20
C16:0	12.68±3.97	11.16±3.09	14.24±6.04
C16:1	2.56±0.46	2.00±1.00	2.47±1.11
C17:0	1.06±0.70	0.84±0.37	1.42±0.17
C18:0	8.88^{a}±5.16	9.18±3.11	13.04^{b}±6.15
C18:1	18.53±5.72	17.47^{a}±4.78	23.92^{b}±10.05
C18:2	2.13±1.23	1.85±0.59	2.07±0.81
C18:3	0.89±0.53	0.79±0.35	1.13±0.22
C20:1	0.31±0.21	0.43±0.26	0.11±0.02
UFA	23.90±7.19	21.98^{a}±6.25	29.62^{b}±11.99
SFA	75.99±7.23	77.90^{a}±6.22	70.35^{b}±12.02

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

More recent research (Webb *et al.*, 1998) indicate that the monounsaturated fatty acids increase, and that the polyunsaturated fatty acids, mainly part of the polar lipids, decrease with fatness. Animals older than 6 years (C age) had significantly more unsaturated fat (Figure 4-4b) than younger animals (P<0.05) as seen in Table 4-4.

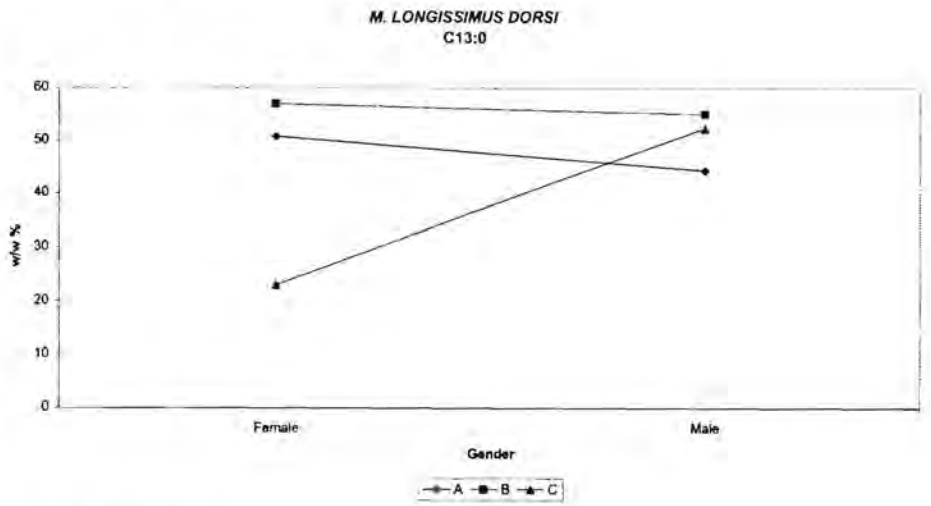
Figure 4-5 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition of M. Longissimus dorsi in the African buffalo.



Significant interactions were found between age and gender for the proportions of C13:0, C18:0 and C18:1 and the total proportion of saturated fatty acids in LD (Addendum II). In male buffalo, the proportion of C13:0 increased with age (Figure 4-6), while C18:0 remained fairly constant (Figure 4-7) and C18:1 decreased slightly with age (Figure 4-8).

Figure 4-6 The effect of a) gender (male and femlae) and b) age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the proportion of C13:0 in M. Longissimus dorsi of the African buffalo (P<0.05).

a) Effect of gender



b) Effect of age

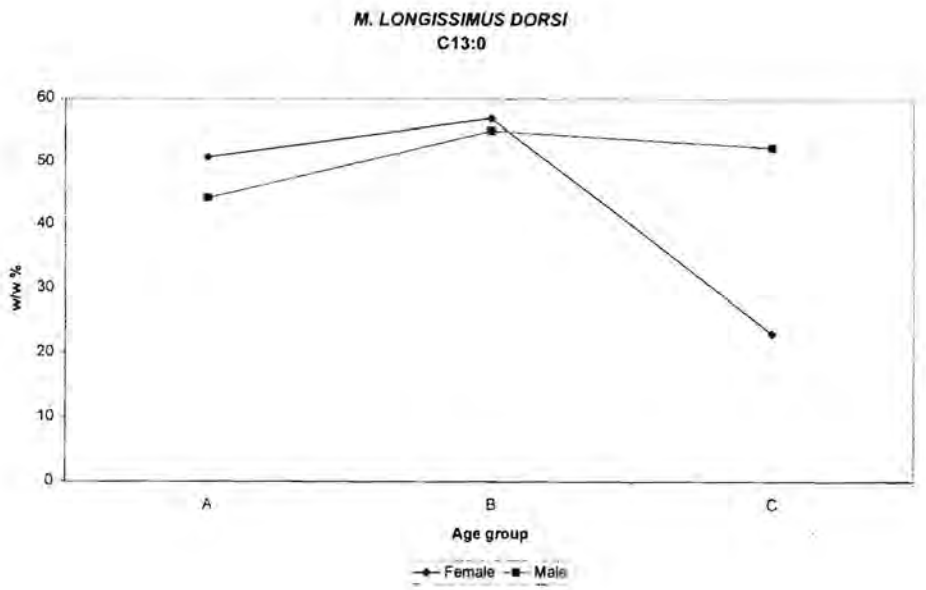
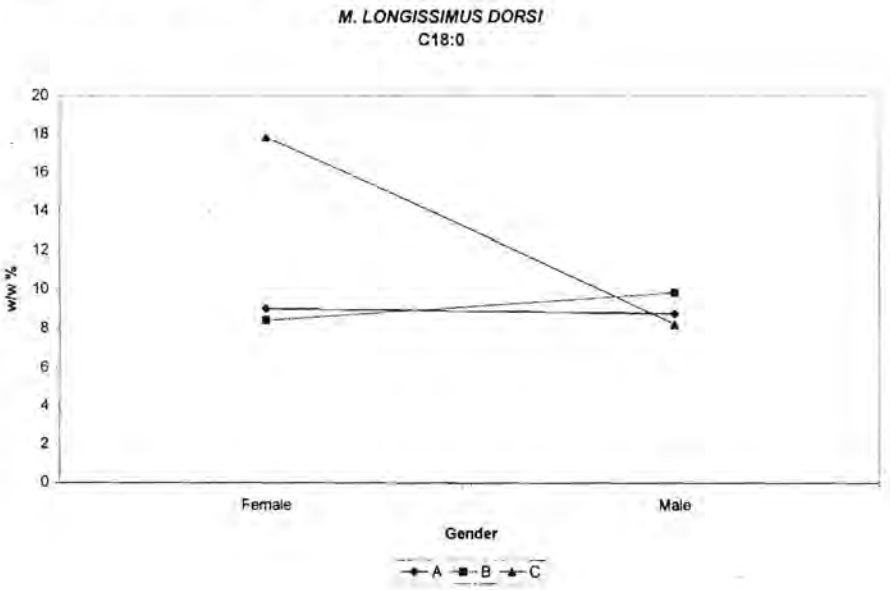
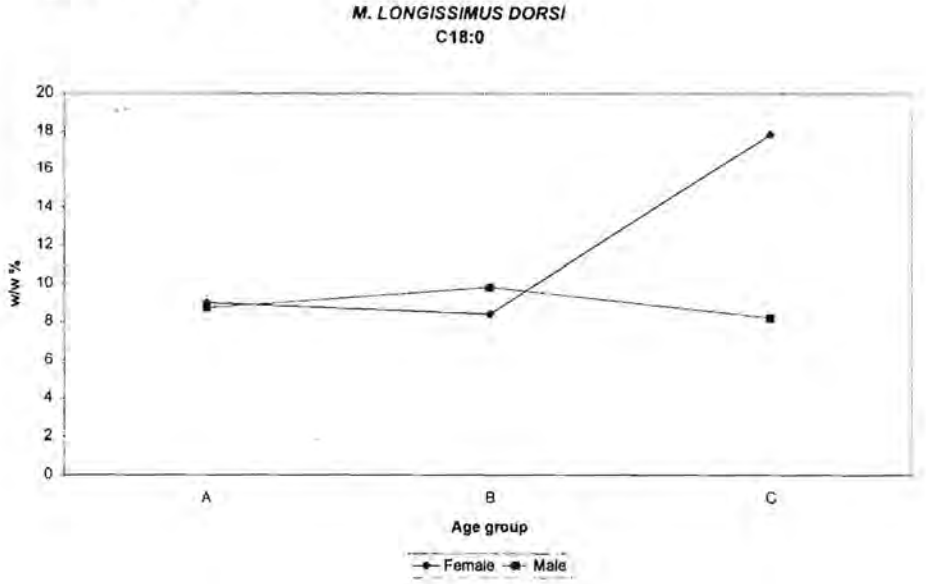


Figure 4-7 The effect of a) gender (male and female) and b) age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the proportion of C18:0 in M. Longissimus dorsi of the African buffalo (P<0.05).

a) Effect of gender



b) Effect of age

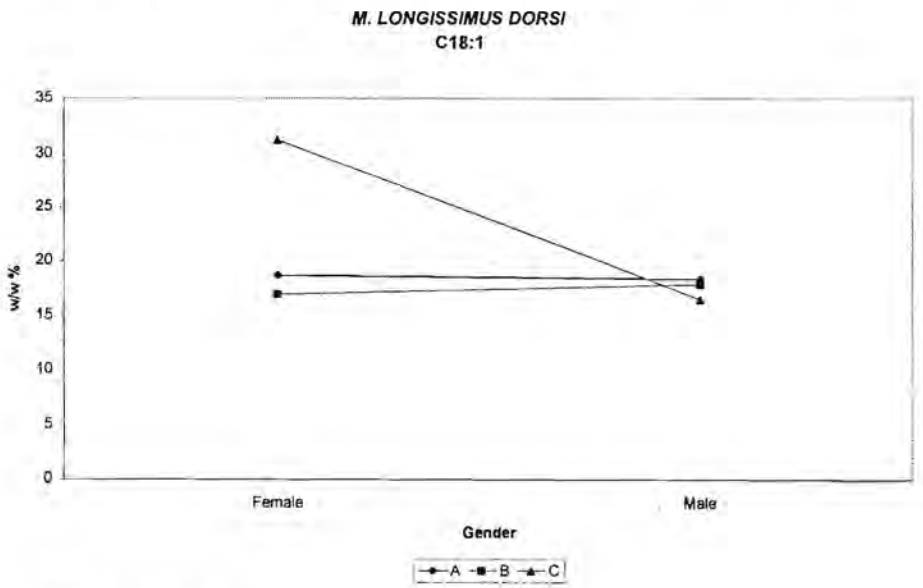


The relative proportions of fatty acids did not differ significantly between male and female buffalo within the A and B age groups. By contrast, female buffalo in the C age group, contained significantly higher proportions of C18:0 and C18:1 but lower proportions of C13:0, resulting in significantly higher proportions of UFA (P<0.05). The relative proportions of total saturated fatty acids in male buffalo increased slightly with age (Figure 4-9). Nürnberg *et al.*, 1996 (as quoted by Nürnberg *et al.*, 1998) found that saturated fatty

acids in lamb muscle increase with age. The current finding that adult (age C) females have more unsaturated fatty acids, may be due to physiological conditions, because most of the animals in the C age were either pregnant and/or lactating.

Figure 4-8 The effect of a) gender (male and female) and b) age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the proportion of C18:1 in M. Longissimus dorsi of the African buffalo (P<0.05).

a) Effect of gender



b) Effect of age

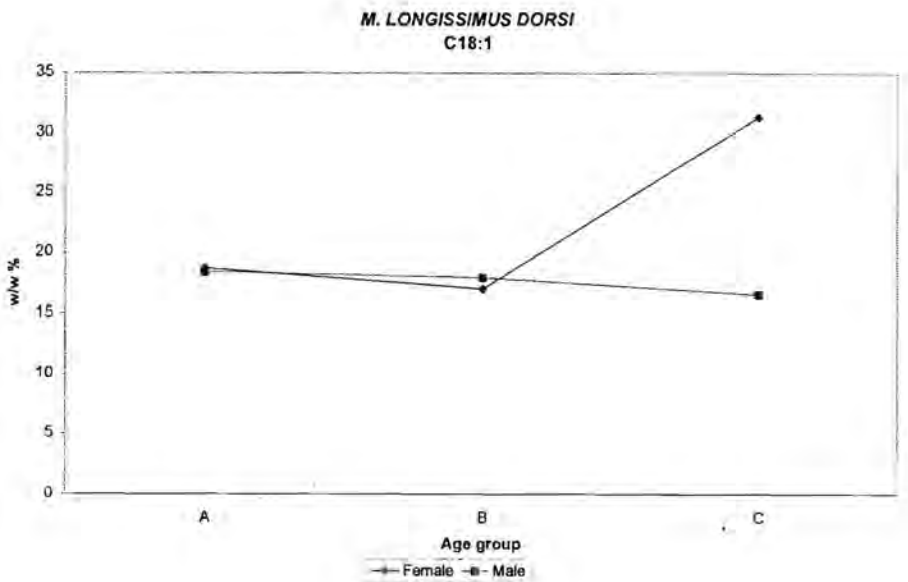
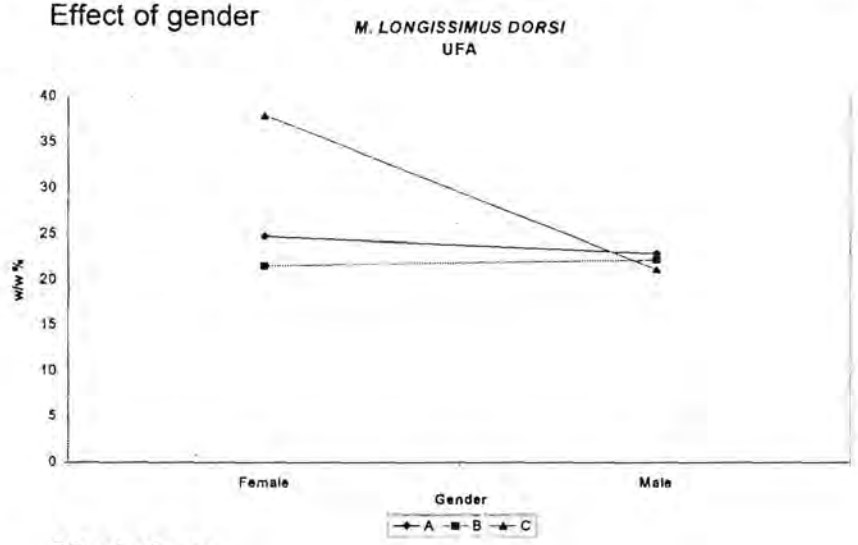
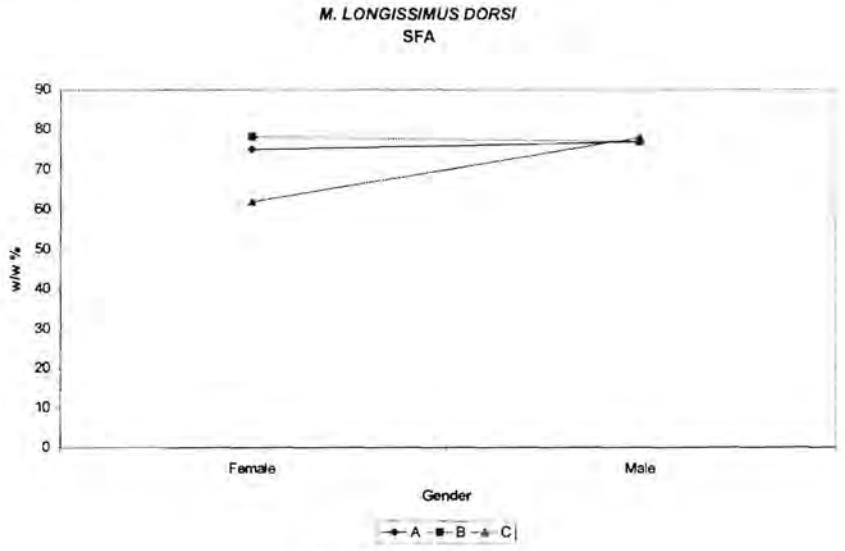


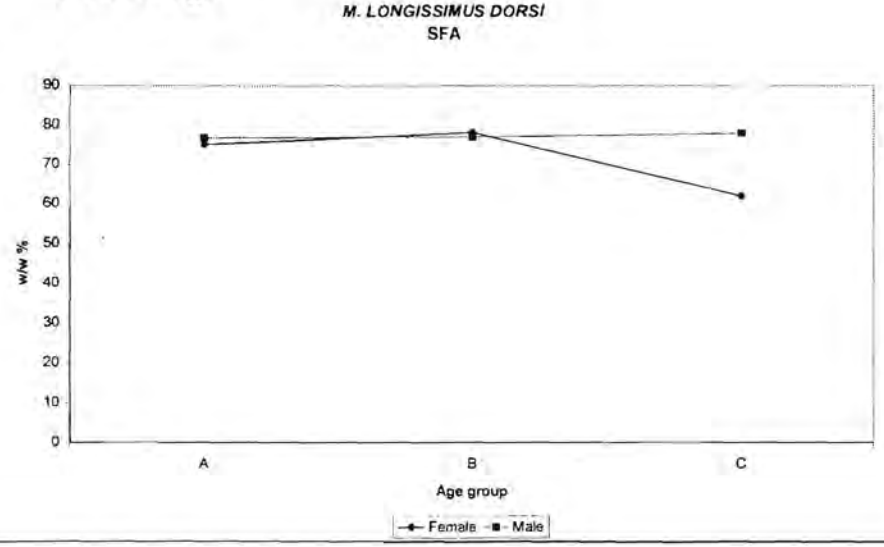
Figure 4-9 The effect of a) gender (male and female) and b) age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the saturation level of M. Longissimus dorsi in the African buffalo (P<0.05).

a) Effect of gender





b) Effect of age



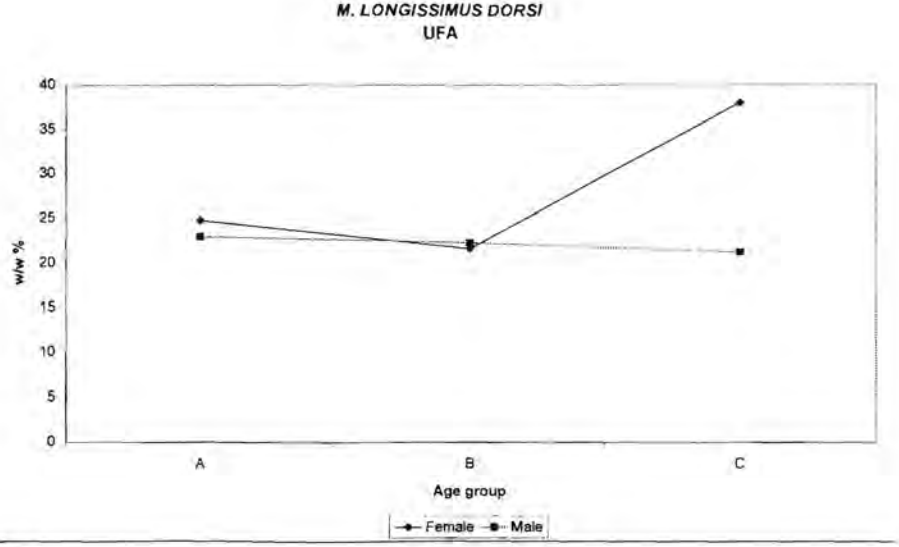
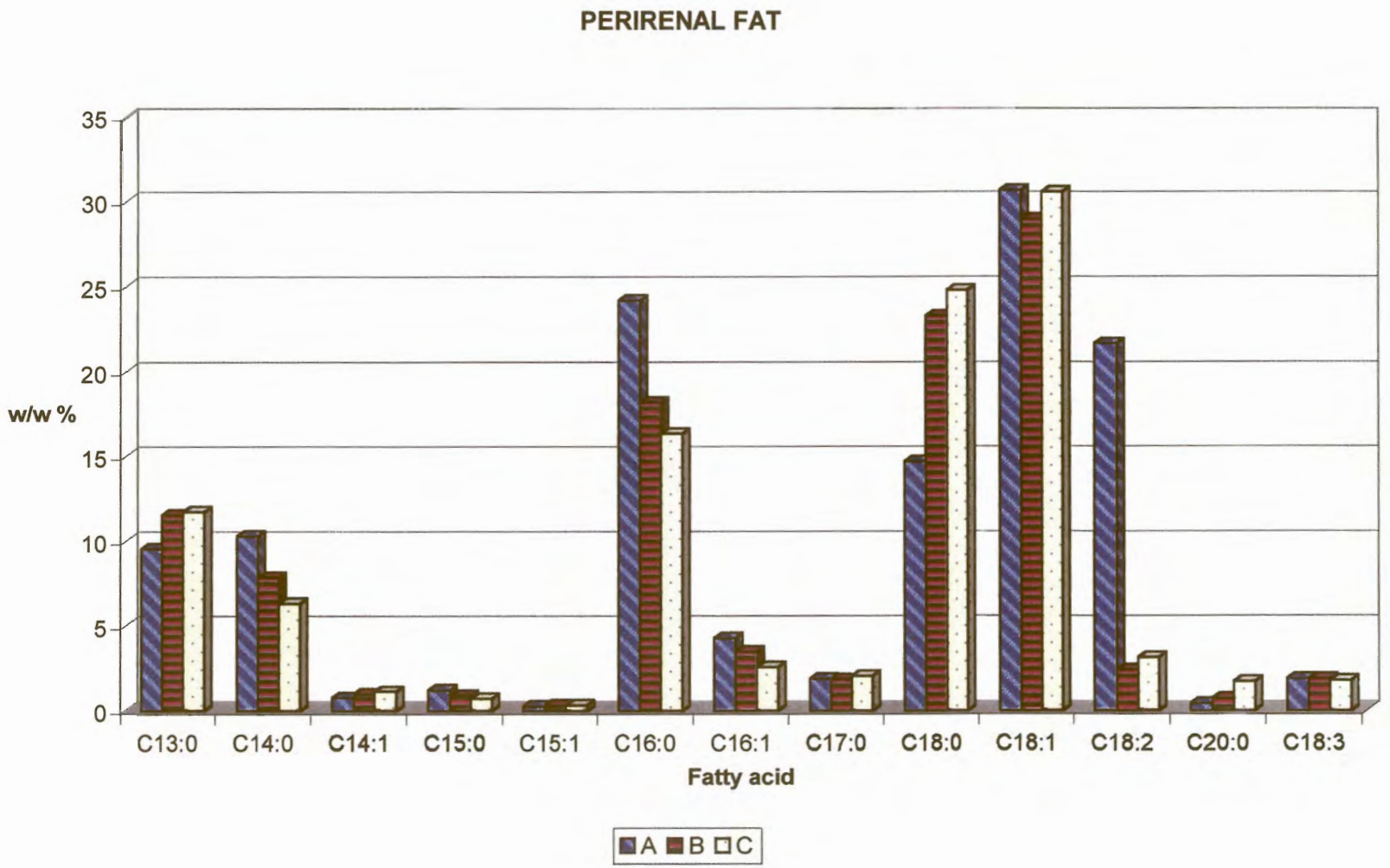


Figure 4-10 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition of perirenal fat in the African buffalo.



4.2.3 *Internal fat*

In perirenal fat (PRF) of buffalo calves, C18:1 was the most abundant fatty acid, followed by C16:0, C18:0 and C13:0 (Figure 4-11). In subadult buffalo (B age group), C18:0 was the most abundant long-chain fatty acid, followed by C18:1 and in adult animals (C age group), C18:1 was the most abundant followed by C18:0 (Table 4-5). C16:0 and C13:0 were the other two important fatty acids (Table 4-5). The level of saturation of the perirenal fat did not change with age, but differences were noted between specific fatty acids (Table 4-5). The relative proportions of C15:0, C16:0 and C16:1 were significantly higher ($P<0.01$) in the A age group than the C group, while the proportions of C18:0 increased significantly ($P<0.01$) with age (Figure 4-10). Banskalieva (1996) also reported similar changes in C14:0, C16:0 and C18:0 with age. The proportions of C20:0 in PRF and PCF were generally lower than 1%.

Table 4-5 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition (Mean±SD; w/w %) of perirenal fat (PRF) in the African buffalo.

Age (w/w %)	A (< 2 years of age) (n = 12)	B (2 to 6 years of age) (n = 12)	C (> 6 years of age) (n = 12)
C13:0	9.560±7.672	11.541±9.725	11.751±12.031
C14:0	10.313±14.139	7.842±12.707	6.321±8.909
C14:1	0.774±0.266	0.984±0.192	1.134±0.268
C15:0	1.204^{A}±0.513	0.884±0.256	0.734^{B}±0.185
C15:1	0.265±0.039	0.324±0.026	0.320±0.071
C16:0	24.191^{A}±7.002	$18.202^{A,B}$±6.646	16.345^{B}±4.333
C16:1	4.248^{a}±1.748	3.468±1.087	2.548^{b}±0.780
C17:0	1.862±0.279	1.850±0.257	2.019±0.545
C18:0	14.697^{A}±5.132	23.284^{A}±8.930	24.785^{B}±6.610
C18:1	30.686±7.659	28.976±7.542	30.578±4.703
C18:2	2.167±0.543	2.390±0.719	3.102±1.998
C20:0	0.421	0.737±0.246	1.705±1.099
C18:3	1.859±0.462	1.868±0.390	1.777±0.732
UFA	39.014±9.894	36.611±9.866	37.892±6.133
SFA	60.986±9.894	63.381±9.870	61.916±6.137

^{a,b} Means in the same row bearing different superscripts differ ($P<0.05$)
^{A,B} Means in the same row bearing different superscripts differ ($P<0.01$)

The three most abundant fatty acids within PCF and OMF were C18:1, C18:0 and C16:0 (Table 4-6 and Table 4-7). C13:0 also comprised a significant portion of OMF (Table 4-7).

This may be because dietary fatty acids are reflected in the omental fat (Bas *et al.*, 1992). The proportion of total saturated fatty acids in omental and pericardial fat did not change with age (Figure 4-4, Table 4-6 and Table 4-7), but differences were noted between the proportions of specific fatty acids (Table 4-6 and Figure 4-11; Table 4-7 and Figure 4-12).

Table 4-6 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition (Mean±SD; w/w %) of pericardial fat (PCF) in the African buffalo.

Age (w/w %)	A (< 2 years of age) (n = 5)	B (2 to 6 years of age) (n = 5)	C (> 6 years of age) (n = 7)
C13:0	7.937±3.747	12.092±9.880	11.204±8.753
C14:0	4.798±2.714	3.578±2.063	4.217±5.895
C14:1	0.811±0.216	1.065±0.048	0.095±0.173
C15:0	1.403^{A}±0.753	1.186±0.670	0.643^{B}±0.331
C15:1	0.304±0.035	0.230±0.086	0.289±0.090
C16:0	23.921^{a}±8.558	20.701±8.386	14.904^{b}±2.596
C16:1	3.687^{A}±1.289	3.466±1.831	2.461^{B}±0.381
C17:0	2.021±0.313	1.921±0.508	2.013±0.263
C18:0	19.151±10.078	25.023±8.934	28.943±10.022
C18:1	32.091±4.380	28.740±2.961	29.271±3.911
C18:2	2.269±0.791	2.152±0.610	3.261±3.033
C20:0	0.869	0.766	0.808±0.240
C18:3	2.205±1.018	1.414±0.613	2.728±3.136
UFA	40.981±5.332	36.649±5.020	38.038±3.214
SFA	59.001±5.306	63.316±5.014	61.914±3.324

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

Table 4-7 The effect of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition (Mean±SD; w/w %) of omental fat (OMF) in the African buffalo.

Age (w/w %)	A (< 2 years of age) (n = 10)	B (2 to 6 years of age) (n = 9)	C (> 6 years of age) (n = 11)
C13:0	15.598±15.923	17.346±7.597	15.257±6.880
C14:0	8.799±10.024	10.729±17.067	5.417±7.887
C14:1	0.815±0.171	0.955±0.186	0.870±0.324
C15:0	1.071^{A}±0.514	0.827±0.231	0.607^{B}±0.223
C15:1	0.316±0.032	0.312±0.034	0.345±0.081
C16:0	22.441^{a}±5.648	16.561^{b}±6.538	18.052±2.972
C16:1	3.144±0.978	2.370±1.440	2.653±1.081
C17:0	1.811±0.212	1.790±0.354	1.748±0.394
C18:0	15.221±4.556	21.873±7.829	23.265±7.281
C18:1	28.845±6.702	24.991±5.858	29.270±3.140
C18:2	2.364±0.594	3.564±1.611	3.387±1.100
C18:3	1.610^{a}±0.617	1.021^{b}±0.456	1.049±0.409
UFA	36.512±7.773	31.721±7.876	36.452±4.011
SFA	63.453±7.795	68.148±7.783	63.532±4.015

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

Figure 4-11 The influence of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition of pericardial fat in the African buffalo.

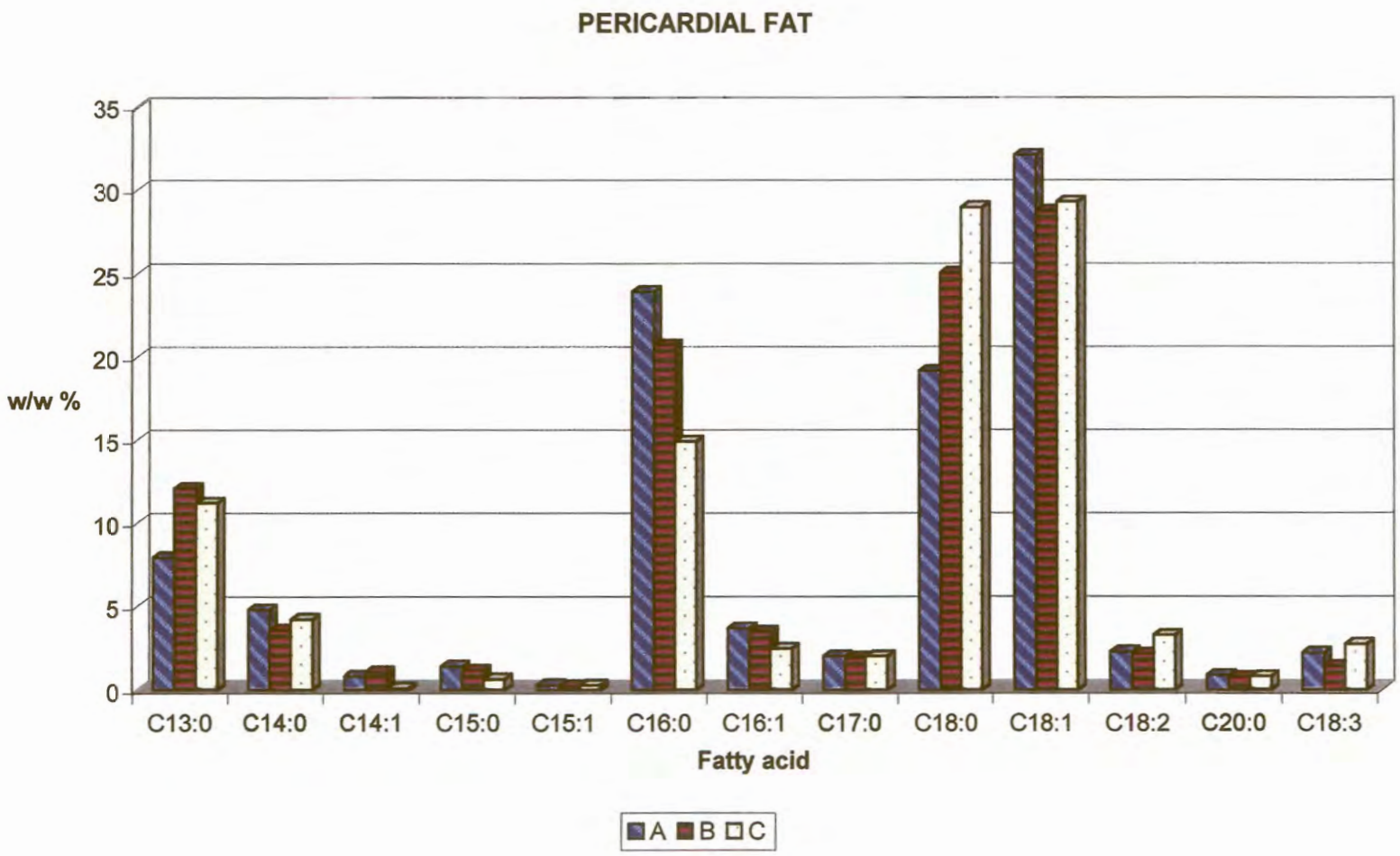
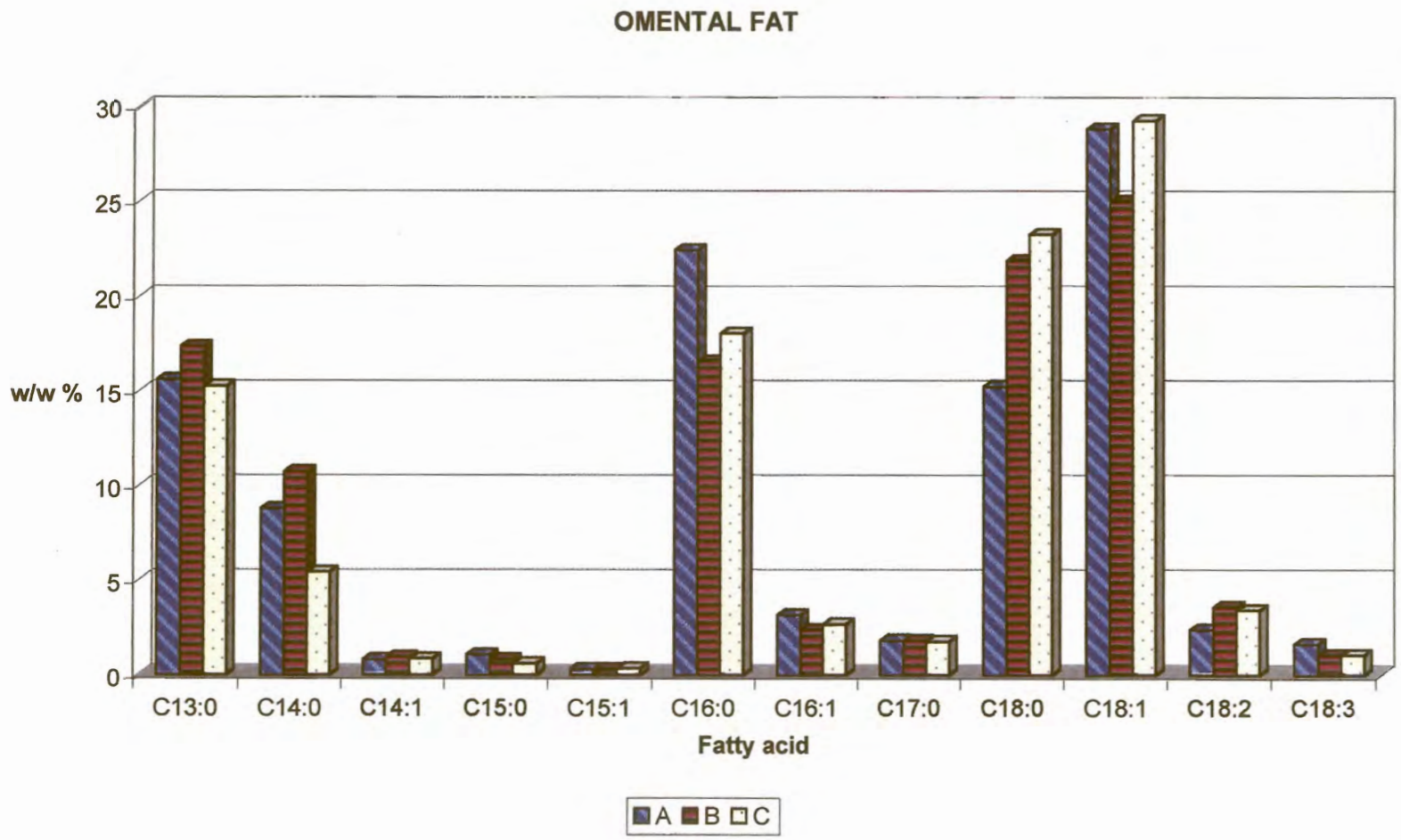


Figure 4-12 The influence of age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) on the long-chain fatty acid composition of omental fat in the African buffalo.



Within both depots, OMF and PCF, C15:0 ($P<0.01$) and C16:0 ($P<0.05$) decreased significantly (Table 4-6 and Table 4-7) with age. The proportions of C18:0 increased as the animal grew older (Table 4-7), although it was statistically insignificant ($P>0.05$). In PCF, the proportions of C16:1 decreased significantly after 6 years of age ($P<0.01$) (Figure 4-11). The proportions of the other fatty acids detected in the PCF and OMF remained relatively constant. Changes in the fatty acid composition of PCF and OMF with age were similar compared to those detected in PRF.

4.3 INFLUENCE OF GENDER[3]

The most abundant fatty acids in the subcutaneous fat, present in proportions higher than 10%, include C18:1, C13:0, C18:0 and C16:0 in females[4] and C13:0, C18:1, C16:0 and C18:0 in males[5] (Figure 4-14).

Significant differences ($P<0.05$) were found in the proportions of C13:0, C16:0, C17:0, C18:0, C18:1 and SFA, between males and females. The proportions of C13:0 were significantly higher ($P<0.01$) in male buffalo (46.10±22.97%) than in female buffalo (28.13±21.45%) (Table 4-8 and Figure 4-14), while the proportions of C16:0, C17:0, C18:0 and C18:1 were significantly ($P<0.05$) higher in females than in males. The proportion of C16:1 was numerically higher in females than in males, but these differences were not statistically significant (Table 4-8). Zembayashi *et al.* (1995) and Westerling and Hedrick, (1979) also reported higher proportions of C16:0 and C18:0 in heifers compared to steers. Although Nürnberg *et al.* (1998) reported higher proportions of C16:0, C17:0 and C18:0 and more saturated fat in females (in sheep, cattle and pigs), subcutaneous fat of male buffalo was significantly ($P<0.05$) more saturated (SFA =

[3] Results presented at IX International Symposium on Ruminant Physiology, 1999 (Steenkamp *et al.*, 1999b).
[4] Female animals or females will be used whenever no differentiation is made between calves and juveniles, subadult and adult cows. Calves and juveniles, subadult cows and adult cows will be referred to in specific cases.
[5] Male animals or males will be used whenever no differentiation is made between young and old bulls. Bull calves or juveniles, subadult bulls and adult bulls will be referred to in specific cases.

72.95±11.37%) compared to female buffalo (SFA = 64.66±10.33%) (Figure 4-15). The current results are also more pronounced due to the high proportions of C13:0 observed in males in this study (Table 4-8).

Table 4-8 The influenced of gender (male and female) on the long-chain fatty acid composition (Mean±SD; w/w %) of subcutaneous fat (SCF) in the African buffalo.

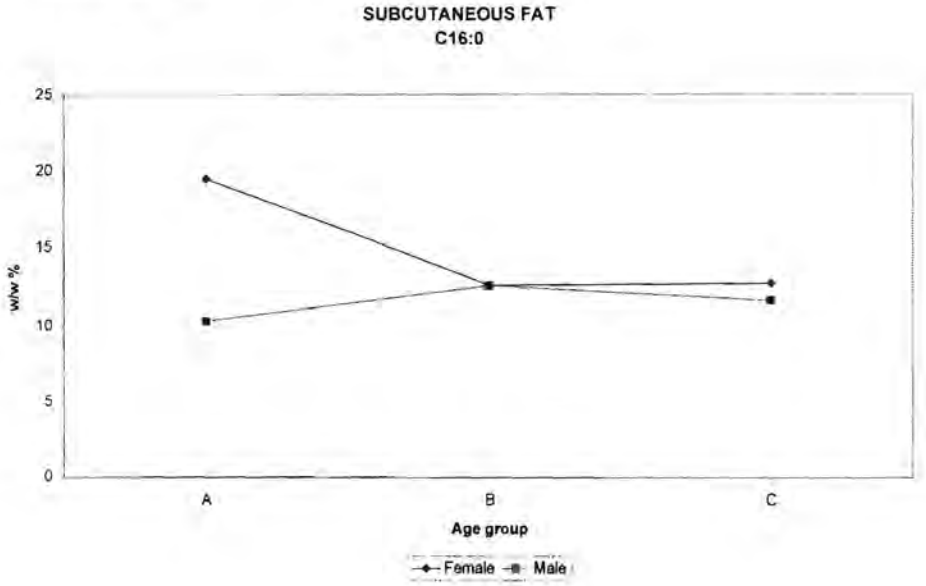
(w/w %)	Female (n = 18)	Male (n = 18)
C13:0	28.128^{A}±21.446	46.100^{B}±22.966
C14:0	3.233±3.031	5.560±6.614
C14:1	0.693±0.193	0.665±0.236
C15:0	0.667±0.477	0.620±0.428
C15:1	0.209±0.073	0.167±0.041
C16:0	14.931^{a}±5.482	11.516^{b}±4.630
C16:1	3.054±1.537	2.331±1.167
C17:0	1.382^{a}±0.551	0.873^{b}±0.530
C18:0	17.234^{A}±8.840	11.412^{B}±7.019
C18:1	28.345^{a}±9.010	22.264^{b}±9.697
C18:2	2.199±0.398	2.020±0.828
C18:3	1.464±0.479	1.032±0.572
UFA	35.221^{a}±10.448	27.003^{b}±11.426
SFA	64.661^{a}±10.328	72.950^{b}±11.369

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

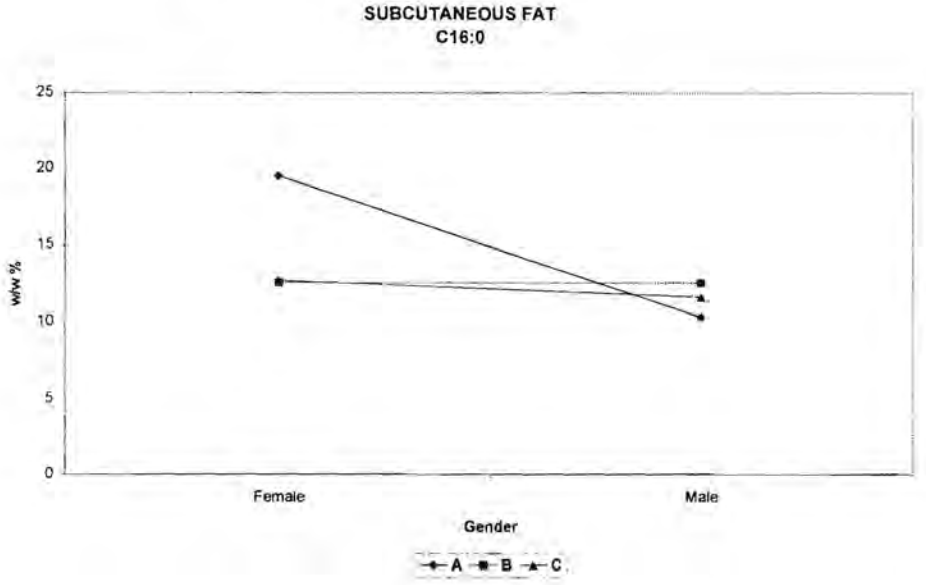
In the subcutaneous fat of buffalo, the relative proportion of C16:0 was significantly influenced by the interaction of age and gender (Figure 4-13). Within the A age group (juveniles and calves), female animals contained higher levels of C16:0 compared to young male buffalo (Figure 4-13). By contrast, there was little difference in the proportions of C16:0 (Figure 4-13) between gender in older animals (P<0.05). In males, the proportions of C16:0 appeared to be fairly constant between the different age groups. Female buffalo of the B and C age groups appeared not to be different from males of the same age (Addendum I) but female calves of the A age contained significantly higher proportions of C16:0 (Figure 4-13).

Figure 4-13 The effect of a) age (A = animals younger than 2 years of age; B = animals from 2 to 6 years of age; C = animals older than 6 years of age) and b) gender (male and female) on the proportion of C16:0 in subcutaneous fat of the African buffalo (P<0.05).

a) Effect of age



b) Effect of gender



In the LD of females, C14:1 and C15:1 were present in proportions lower than 1%, but these two fatty acids were not detected in males (Figure 4-14). High proportions of C13:0 were present in both genders, followed by C18:1, C16:0 and C18:0 (Figure 4-16).

Figure 4-14 The effect of gender (male and female) on the long-chaon fatty acid composition of subcutaneous fat in the African buffalo

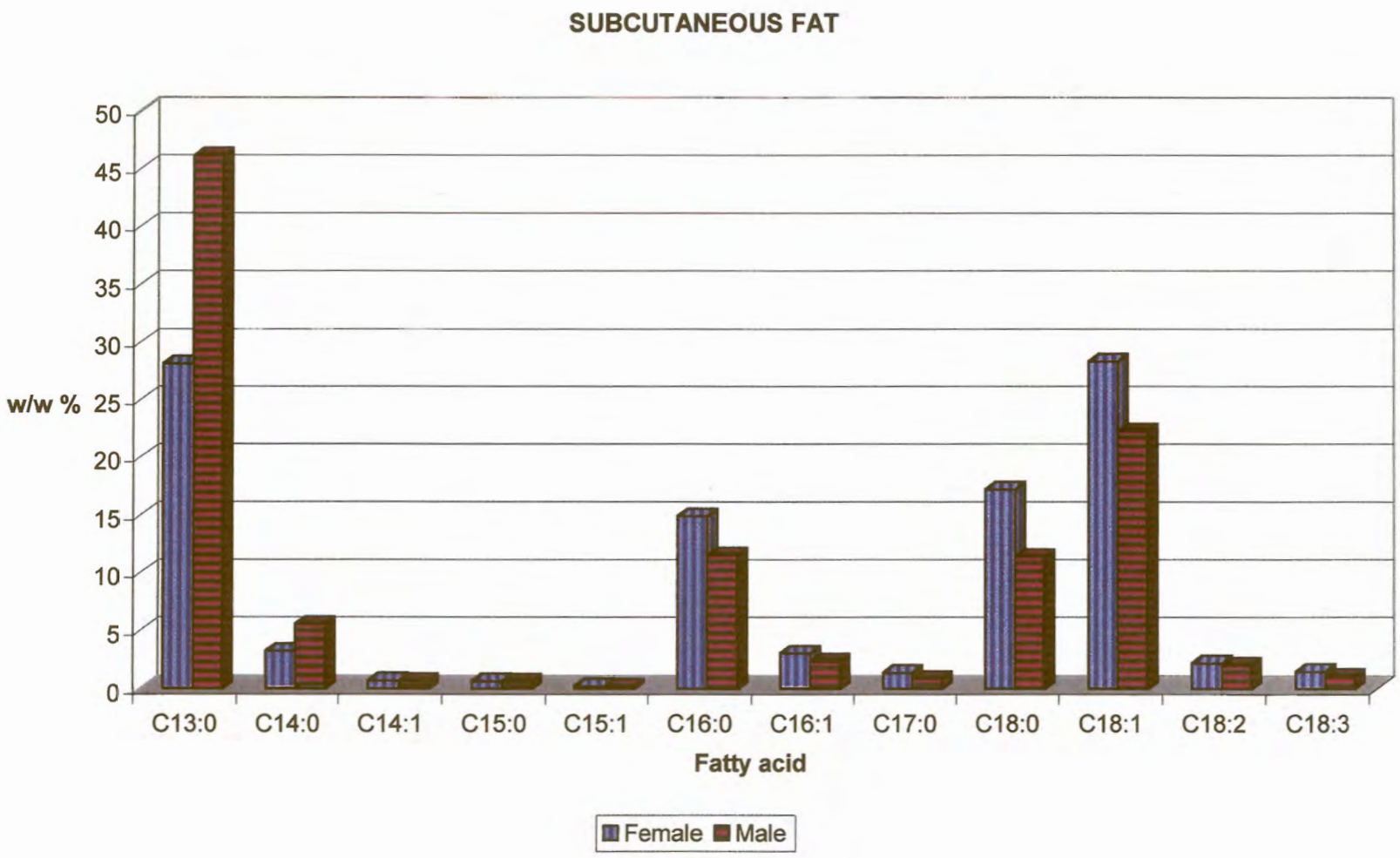


Figure 4-15 Illustration of the effect of gender (male and female) on the proportions of (a) total saturated and (b) total unsaturated long-chain fatty acids in fat depots of the African buffalo.

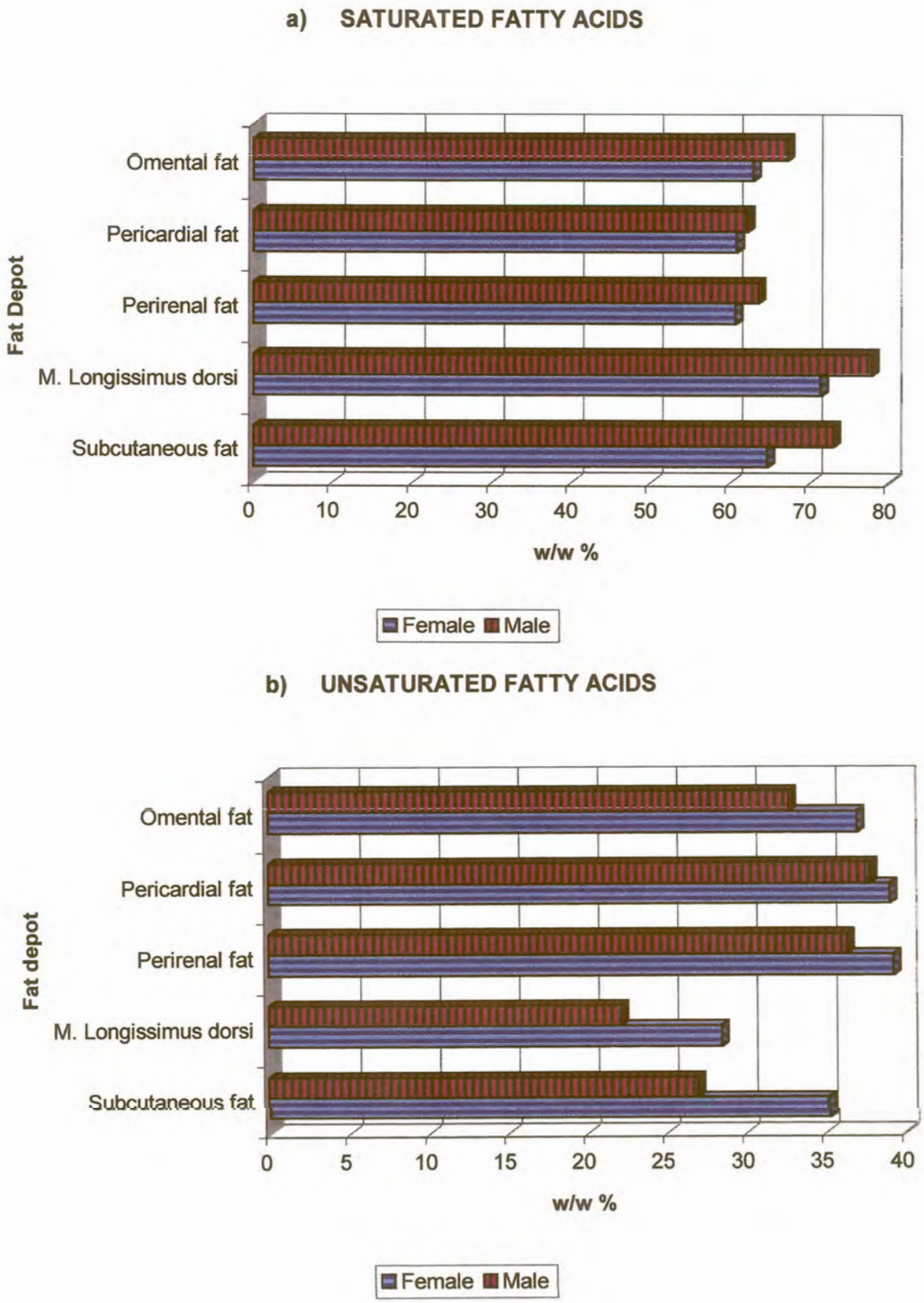


Figure 4-16 The effect of gender (male and female) on the long-chain fatty acid composition of M. Longissimus dorsi in the African buffalo.

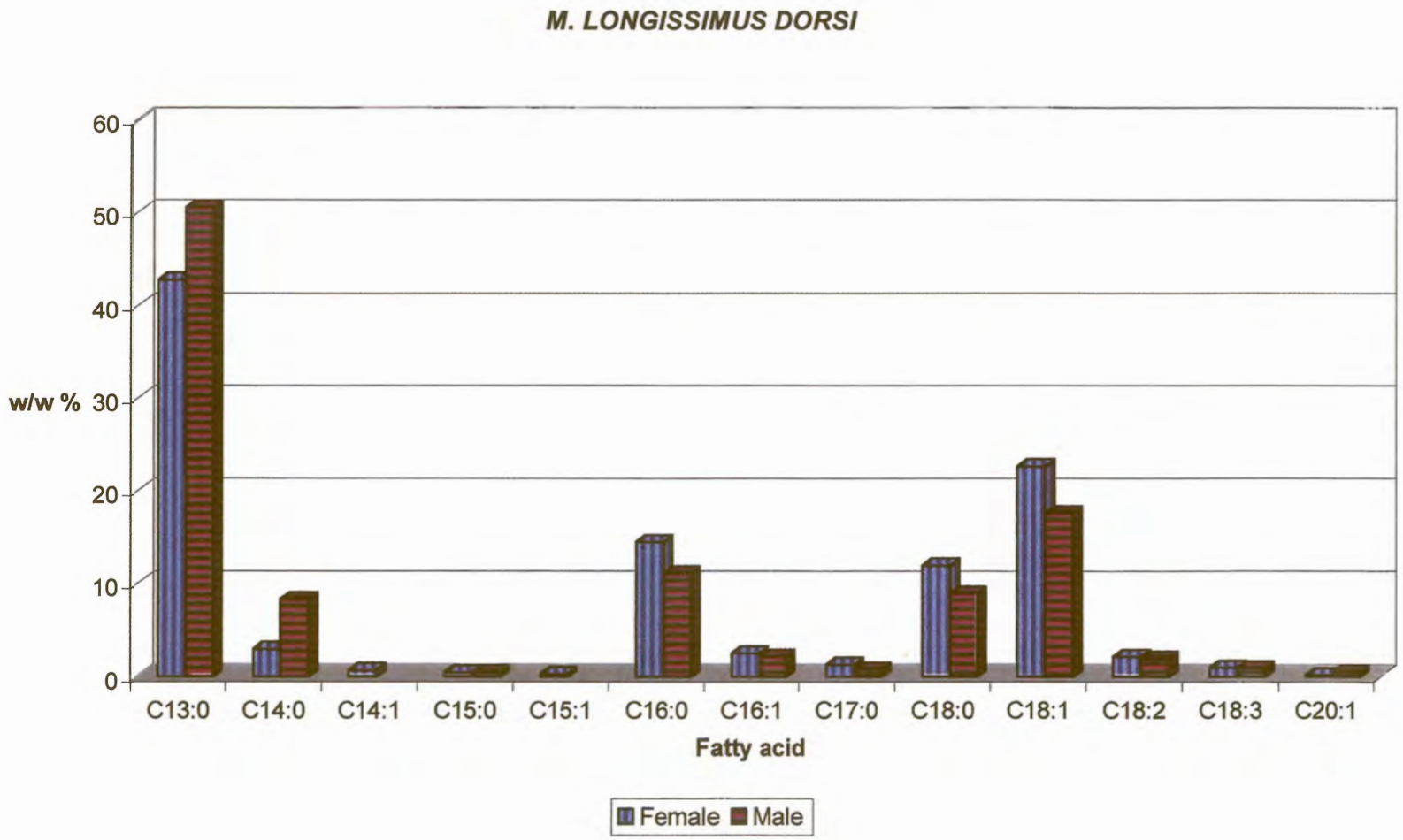


Table 4-9 The effect of gender (male and female) on the long-chain fatty acid composition (Mean±SD; w/w %) of M. Longissimus dorsi (LD) in the African buffalo.

(w/w %)	Female (n = 17)	Male (n = 18)
C13:0	42.791±21.163	50.527±15.309
C14:0	2.953±1.136	8.304±15.0.842
C15:0	0.462±0.256	0.446±0.093
C16:0	14.478[a]±4.739	11.088[b]±3.949
C16:1	2.516±0.703	2.155±1.076
C17:0	1.307±0.451	0.790±0.194
C18:0	11.956±6.305	8.927±3.567
C18:1	22.637[a]±7.840	17.593[b]±6.747
C18:2	2.135±1.100	1.921±0.686
C18:3	0.991±0.485	0.903±0.268
UFA	28.513[a]±9.210	22.181[b]±8.407
SFA	71.387[a]±9.218	77.736[b]±8.395

[a,b] Means in the same row bearing different superscripts differ (P<0.05)

The proportion of saturated fatty acids in muscle was significantly influenced by gender (Figure 4-15a). The muscle of females contained a higher proportion (P<0.05) of unsaturated fatty acids (28.51±9.21%) than males (22.18±8.41%) (Table 4-9 and Figure 4-15b). This is mainly due to significantly higher (P<0.05) proportions of C18:1 and numerically lower proportions of C13:0 (Figure 4-16). The proportions of C16:0 were significantly higher in female than in males (P<0.05; Table 4-9).

Table 4-10 The effect of gender (male and female) on the long-chain fatty acid composition (Mean±SD; w/w %) of perirenal fat (PRF) in the African buffalo.

(w/w %)	Female (n = 18)	Male (n = 18)
C13:0	9.734±9.595	12.167±9.990
C14:0	6.286±7.014	10.031±15.307
C14:1	0.931±0.259	1.037±0.281
C15:0	1.069±0.505	0.849±0.225
C15:1	0.307±0.053	0.294±0.055
C16:0	20.867±6.988	18.292±6.622
C16:1	3.685±1.566	3.043±1.180
C17:0	1.897±0.442	1.927±0.323
C18:0	21.037±6.438	20.807±9.862
C18:1	31.028±4.088	29.132±8.470
C18:2	2.225±0.343	2.784±1.637
C20:0	1.323±1.092	0.842±0.292
C18:3	1.907±0.575	1.749±0.461
UFA	39.298±5.650	36.380±10.783
SFA	60.699±10.805	63.490±10.805

Gender did not have any significant influences on the fatty acid composition of the perirenal fat of buffalo (Table 4-10 and Figure 4-17) although some numerical differences were found. In the pericardial fat, only the proportions of C15:0 and C16:0 were significantly ($P<0.05$) influenced by gender (Table 4-11). Both fatty acids were significantly higher in males than in females. Numerical differences were noted for the proportions of C18:0 (Figure 4-18), but these differences were not significant ($P<0.05$) and did not significantly influence the proportions of saturated fatty acids in PCF.

Table 4-11 The effect of gender (male and female) on the long-chain fatty acid composition (Mean±SD; w/w %) of pericardial fat (PCF) in the African buffalo.

(w/w %)	Female (n = 9)	Male (n = 8)
C13:0	12.868±8.373	7.845±6.410
C14:0	2.572±2.233	5.906±4.996
C14:1	0.877±0.173	1.094±0.049
C15:0	0.722^{a}±0.376	1.417^{b}±0.712
C15:1	0.274±0.065	0.321±0.067
C16:0	15.882^{a}±6.470	23.063^{b}±6.691
C16:1	2.950±1.081	3.306±1.525
C17:0	1.961±0.406	2.016±0.271
C18:0	27.336±11.352	22.181±8.146
C18:1	29.843±4.835	30.058±2.668
C18:2	2.948±2.775	2.300±0.233
C20:0	0.903±0.122	0.628±0.180
C18:3	2.787±2.708	1.521±0.509
UFA	39.082±5.264	37.835±3.808
SFA	60.860±5.232	62.155±3.822

^{a,b} Means in the same row bearing different superscripts differ ($P<0.05$)

No statistical differences were found between the proportions of saturated and unsaturated fatty acids in the omental fat of the African buffalo (Figure 15). Individual fatty acids were affected by the gender (Table 4-12). C15:0, C15:1, C17:0 and C18:0 were significantly higher ($P<0.05$) in females than in males (Table 4-12 and Figure 4-19) and the proportions of C18:3 were significantly ($P<0.01$) higher in females than in males. The omental fat of female buffalo contained significantly lower proportions of C15:0 ($P<0.01$) and C16:0 ($P<0.05$) than males (Table 4-12 and Figure 4-18).

Table 4-12 The effect of gender (male and female) on the long-chain fatty acid composition (Mean±SD; w/w %) of omental fat (OMF) in the African buffalo.

(w/w %)	Female (n = 16)	Male (n = 14)
C13:0	13.130±8.258	19.275±12.201
C14:0	4.989±6.603	11.963±15.543
C14:1	0.922±0.214	0.741±0.188
C15:0	1.043^{a}±0.449	0.650^{b}±0.294
C15:1	0.330^{a}±0.032	0.267^{b}±0.018
C16:0	20.048±5.226	17.948±5.925
C16:1	2.903±1.120	2.591±1.195
C17:0	1.918^{a}±0.299	1.558^{b}±0.202
C18:0	22.374^{a}±7.525	17.643^{b}±6.605
C18:1	29.633±3.815	25.800±6.534
C18:2	2.618±1.080	3.650±1.204
C18:3	1.471^{A}±0.591	0.943^{B}±0.360
UFA	37.042±4.741	32.779±8.184
SFA	62.919±4.759	67.143±8.115

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

The proportion of C15:0 present in the omental fat of the African buffalo was significantly (P<0.01) influenced by area and gender (Addendum VIII). In MD and MLS, with similar vegetation types (Figure 2-4), the proportion for C15:0 was lower in males than in females. A higher proportion of C15:0 was observed in males than in females in MH where the vegetation appeared to be different from MLS and MD (Figure 2-4). The shift observed in the proportions of C15:0 between gender may be the consequence of the shift in C13:0 due to the ingestion of riverine vegetation (e.g. the common reed) which is more prevalent in MD and MLS or the mobilisation of C16:0 to yield energy (Table 4-12).

Figure 4-17 The effect of gender (male and female) on the long-chain fatty acid composition of perirenal fat in the African buffalo.

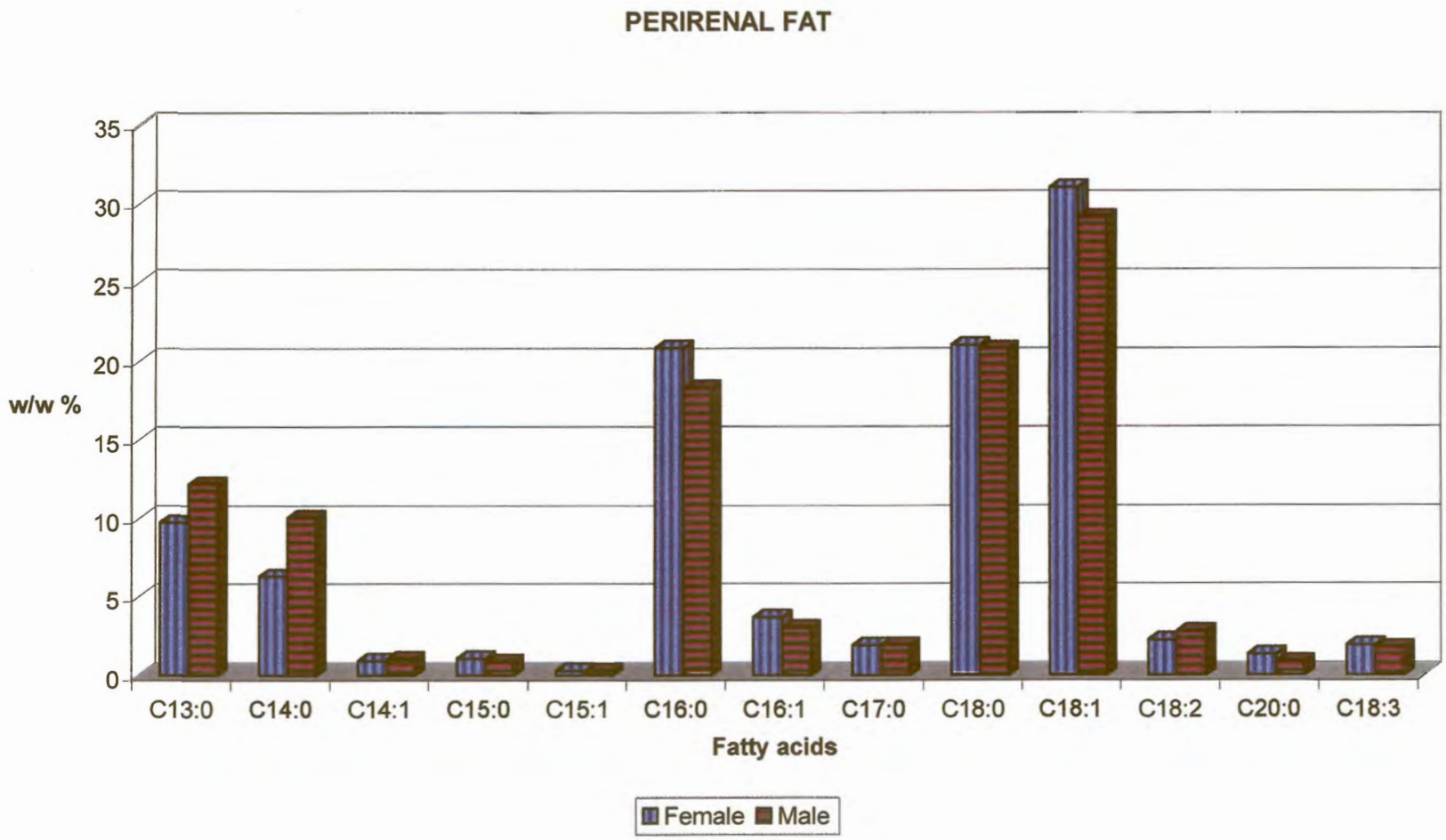


Figure 4-18 The effect of gender (male and female) on the long-chain fatty acid composition of pericardial fat in the African buffalo.

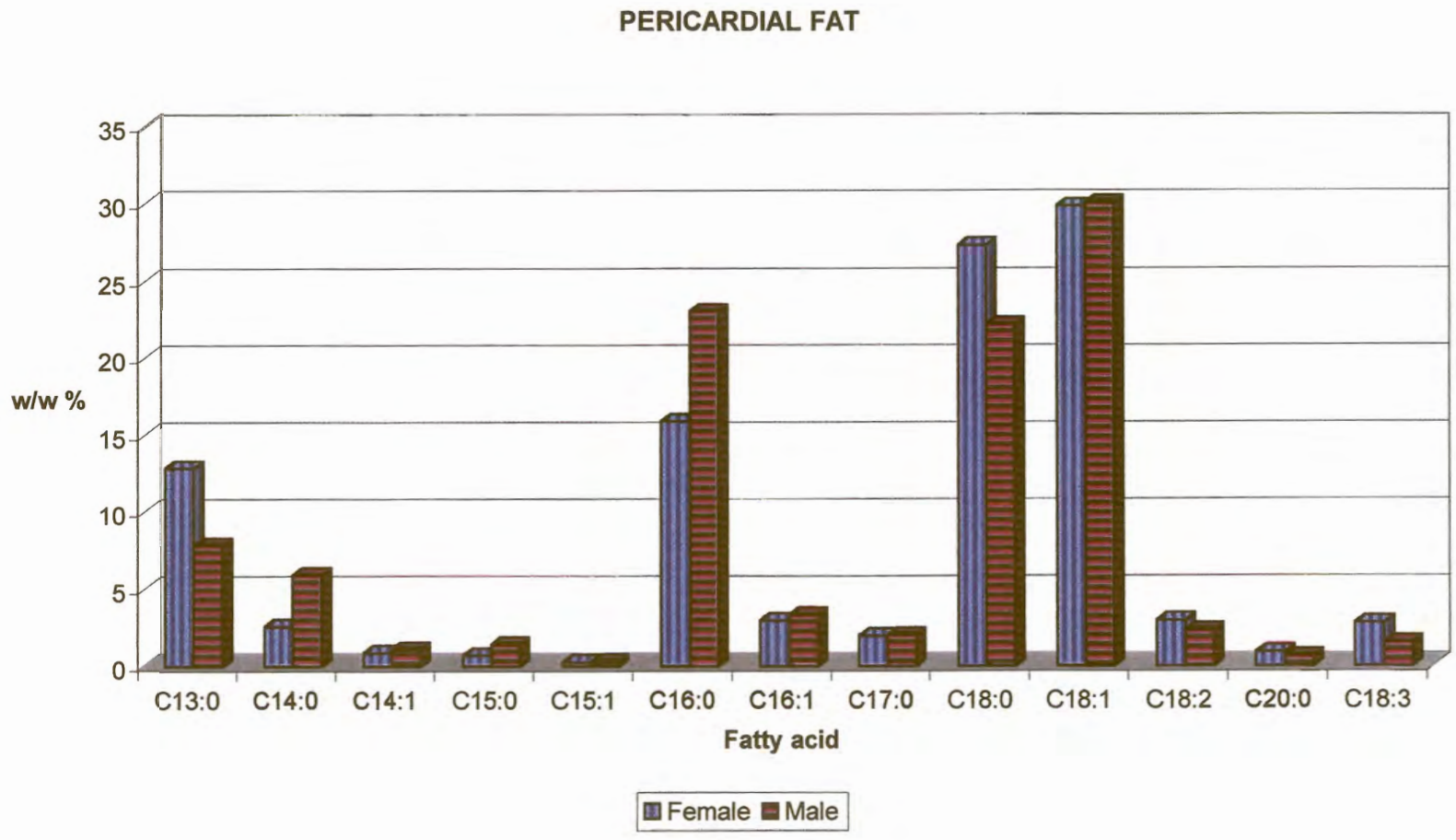
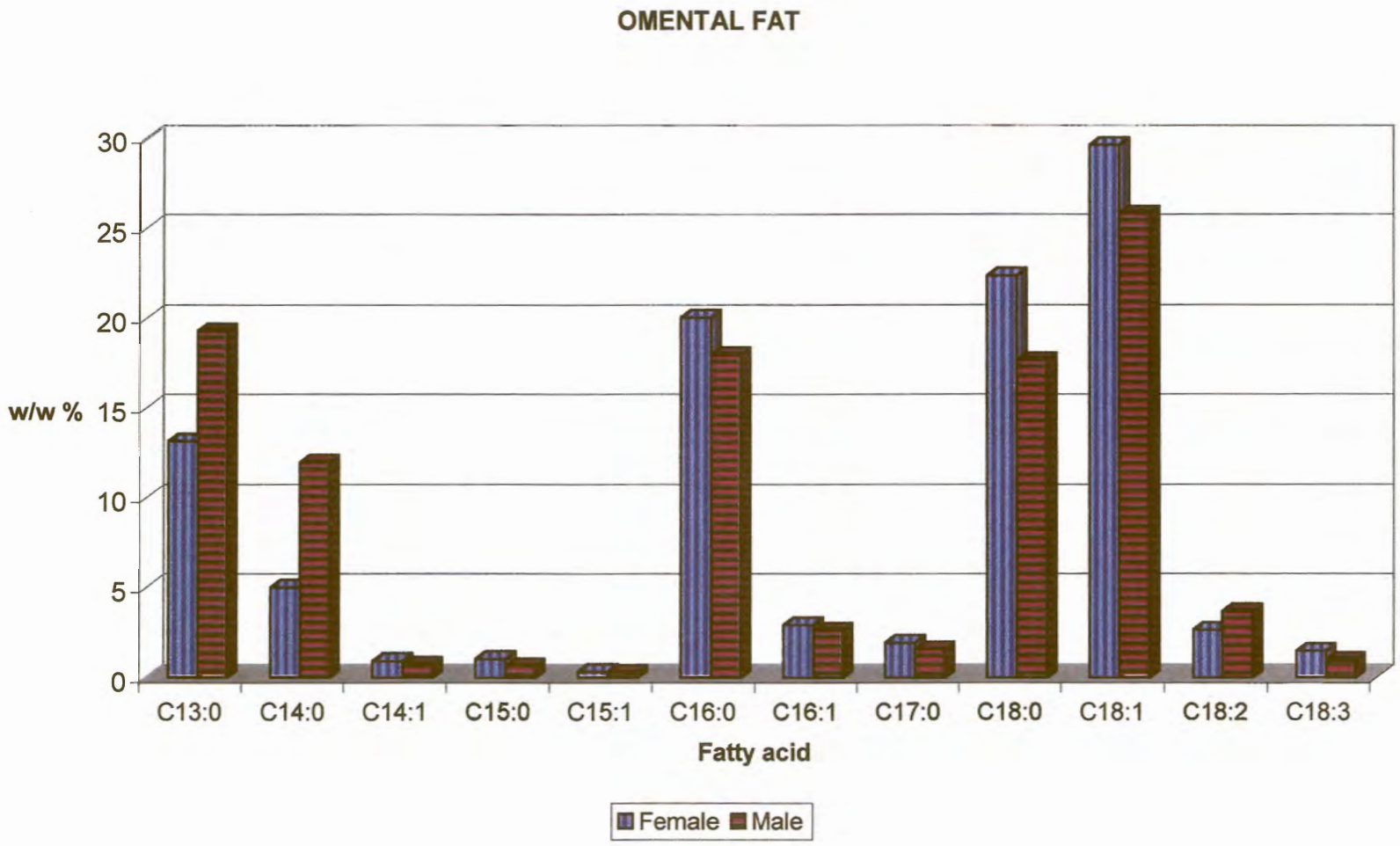


Figure 4-19 The effect of gender (male and female) on the long-chain fatty acid composition of omental fat in the African buffalo.



4.4 INFLUENCE OF AREA[6]

The home range areas of the buffalo differed in ecology as discussed in Chapter 2. In summary, Mpanamana dam (MD) is mainly Marula savannah, Mtandanyathi (MH), Mopane/Bushwillow woodlands and Mashatudrif (MLS), thorn thickets. There is more overlapping in the vegetation types of MD and MLS than with MH. Some plant species were encountered in al three areas but to a different extend depending on the geology of the area. More overlapping were found in the southern region (MD and MLS) than with the central region (MH) of the KNP. Although some species occurs in all of the areas, it does not necessarily mean that it was utilised to the same extend by the different herds, as buffalo tend to balance their diet by utilisation of different species available (Prins, 1991).

4.4.1 *Subcutaneous fat*

The most abundant fatty acids in the subcutaneous fat of buffalo from the southern region (MLS and MD) were C13:0, followed by C18:1 in both regions (Figure 4-22). C16:0 was third most abundant in MLS, followed by C18:0, whereas the proportion of C18:0 was higher than C16:0 in MD (Figure 4-22). Buffalo from MH contained the highest proportion of C18:1 subcutaneously, followed by C13:0, C18:0 and C16:0.

A higher proportion of unsaturated fatty acids was observed in animals from the Mopane/Bushwillow woodlands (MH) than animals from the thorn thickets (MLS), while that of animals from the Marula savannah (MD) was intermediate (Figure 4-23b).

Statistically significant differences ($P<0.05$) were observed between the different areas for the proportions of C13:0, C14:0, C15:1, C16:0, C16:1, C17:0 and C18:0 (Table 4-13). Animals from MLS contained significantly higher proportions of C13:0 compared to those

[6] Results presented at IX International Symposium on Ruminant Physiology, 1999 (Steenkamp *et al.*, 1999b).

from the other two areas (P<0.01) (Table 4-13), explaining the significantly higher proportion of saturated fatty acids in SCF of these animals (Figure 4-23a).

Table 4-13 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition (Mean±SD; w/w %) in the subcutaneous fat (SCF) of the African buffalo.

(w/w %)	MH (n = 10)	MLS (n = 13)	MD (n = 13)
C13:0	20.686^{A}±11.545	51.329^{B}±23.027	35.537±23.755
C14:0	5.425^{a}±7.210	5.094±3.734	2.385^{b}±1.186
C14:1	0.647±0.229	0.587±0.201	0.765±0.161
C15:0	0.763±0.463	0.551±0.428	0.616±0.504
C15:1	0.179^{a}±0.074	0.220±0.086	0.221^{b}±0.066
C16:0	16.70^{a}±5.369	10.637^{b}±4.642	13.13^{b}±4.604
C16:1	3.683^{a}±1.523	1.976^{b}±0.747	2.592±1.384
C17:0	1.614^{a}±0.352	$0.782^{a,b}$±0.516	1.246^{b}±0.575
C18:0	18.412^{a}±9.063	10.063^{b}±6.700	15.438±8.030
C18:1	30.134±6.504	20.210±10.259	26.684±9.452
C18:2	2.231±0.423	1.852±0.725	2.312±0.689
C18:3	1.328±0.426	1.171±0.741	1.380±0.493
UFA	37.806^{a}±6.362	24.669^{b}±11.848	32.407±11.635
SFA	62.152^{a}±6.414	75.175^{b}±11.750	67.554±11.587

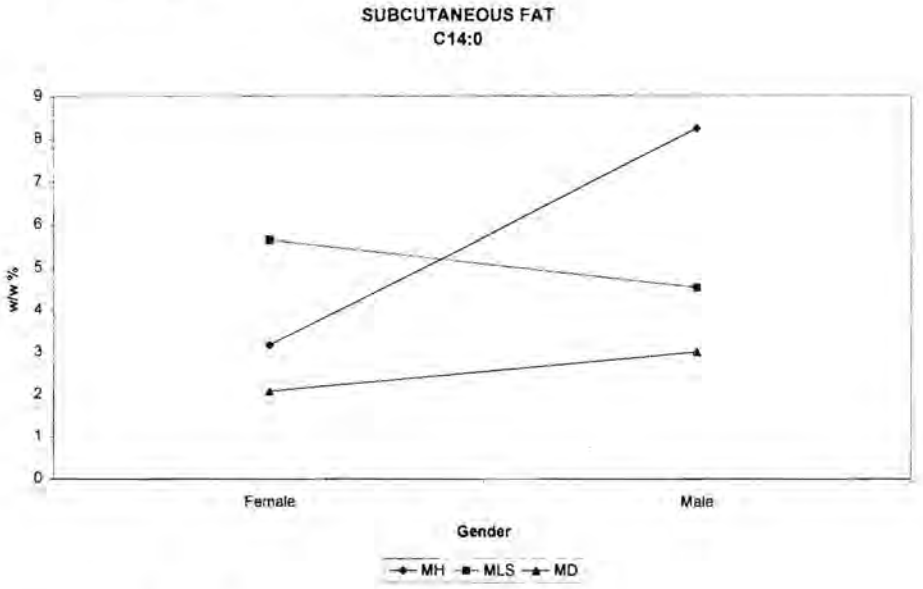
^{a,b} Means in the same row bearing different superscripts differ (P<0.05)
^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

MH contained significantly higher (P<0.05) proportions of C14:0 and C17:0 and lower proportions of C15:1 than MD, but neither differed from MLS (Table 4-13). MH contained significantly higher (P<0.05) proportions of C16:0, C16:1 and C18:0 than MLS with the proportions found in MD intermediate and not significantly different form either MH or MLS (Table 4-13).

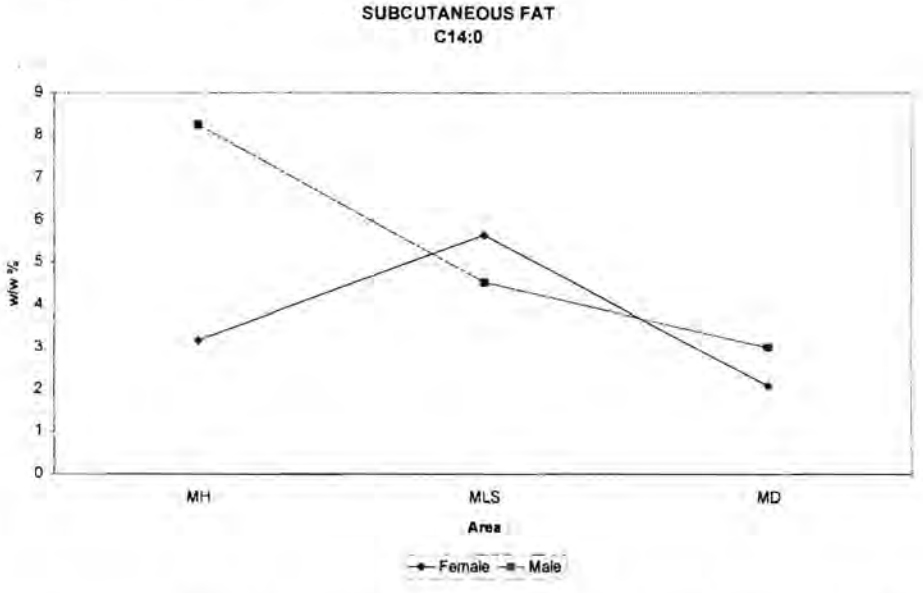
The significant higher proportion of C14:0 found in MH is due to higher proportions noted in male buffalo from MH (Figure 4-20) than in females from the same area. The proportions noted in males and females in the other two areas appeared to be fairly constant with males from MLS having slightly less C14:0 than females and males from MD had slightly more C14:0 than females from the same area.

Figure 4-20 The effect of a) gender (male and female) and b) area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the proportion of C14:0 in subcutaneous fat of the African buffalo (P<0.05).

a) Effect of gender



b) Effect of area

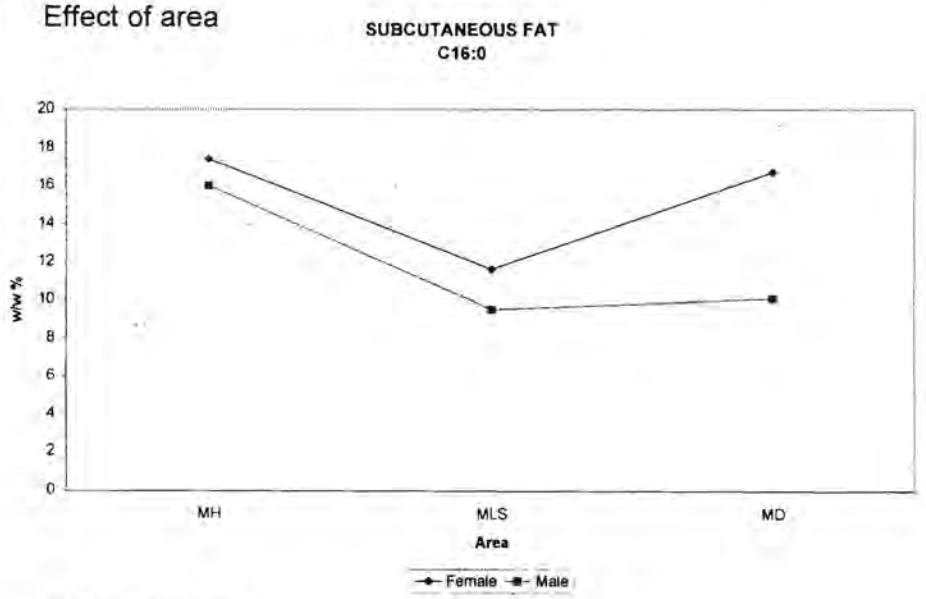


The proportion of C16:0 in SCF was significantly different between the male and female buffalo in the different areas and in particular for buffalo from MD (Figure 4-21). In all three areas, the proportion of C16:0 in SCF of females was higher than for males (as reported earlier in this chapter). Differences were not as significant in MH and MLS as in MD where the proportion of C16:0 was much higher for females than for males (Figure 4-

21). The relatively high proportion of C16:0 in SCF of buffalo sampled at MH and females sampled at MD, may reflect the better condition of these animals, while the low proportions of C16:0 of animals from MLS and males from MD indicate that the energy reserves of these animals were mobilised for energy. C16:0 is reportedly the first fatty acid to be mobilised from adipose tissue stores during periods of restricted energy intake (Vernon, 1981; Adrouni and Khachadurian, 1968).

Figure 4-21 The effect of a) area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) and b) gender (male and female) on the proportion of C16:0 present in subcutaneous fat of the African buffalo (P<0.05).

a) Effect of area



b) Effect of gender

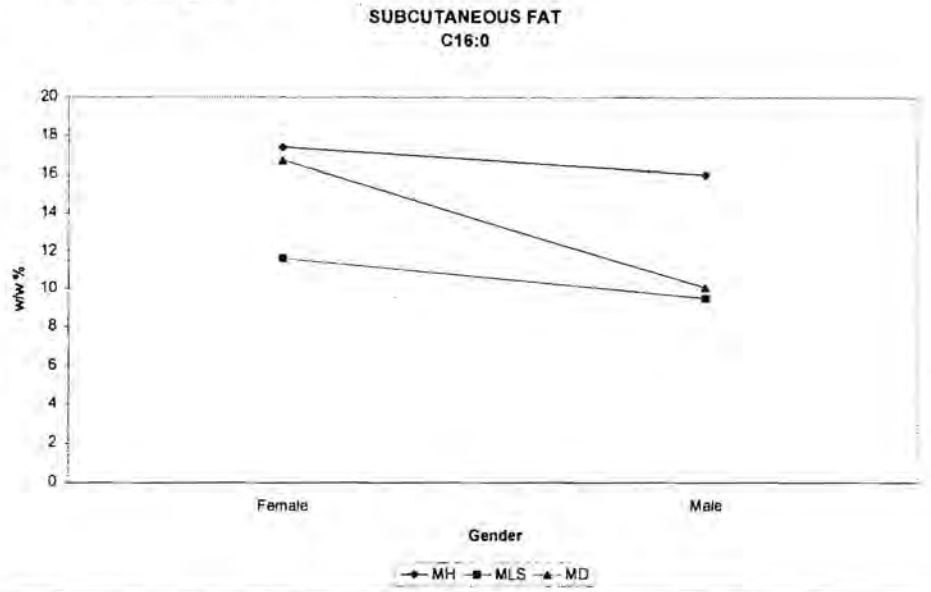


Figure 4-22 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition of subcutaneous fat in the African buffalo.

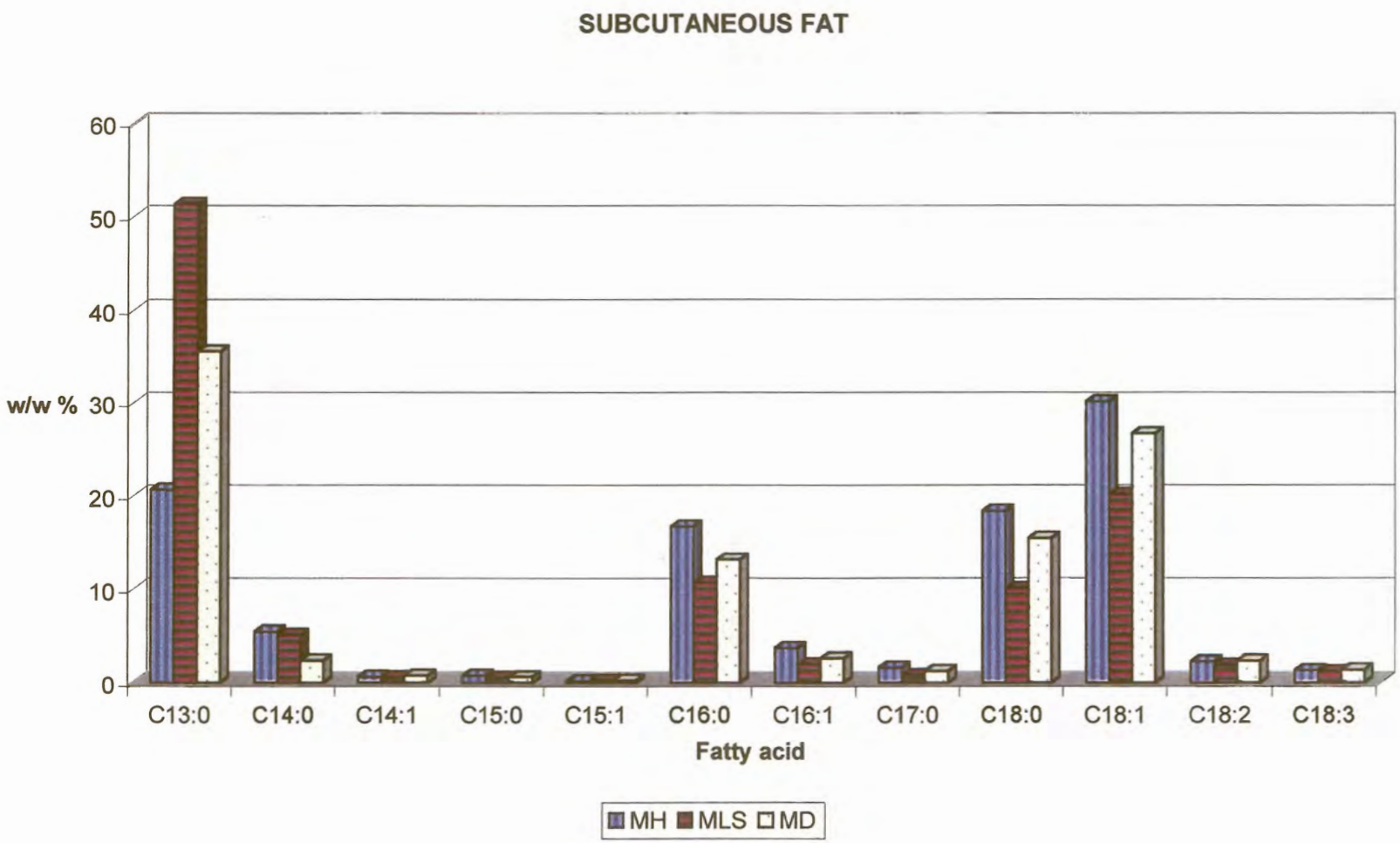
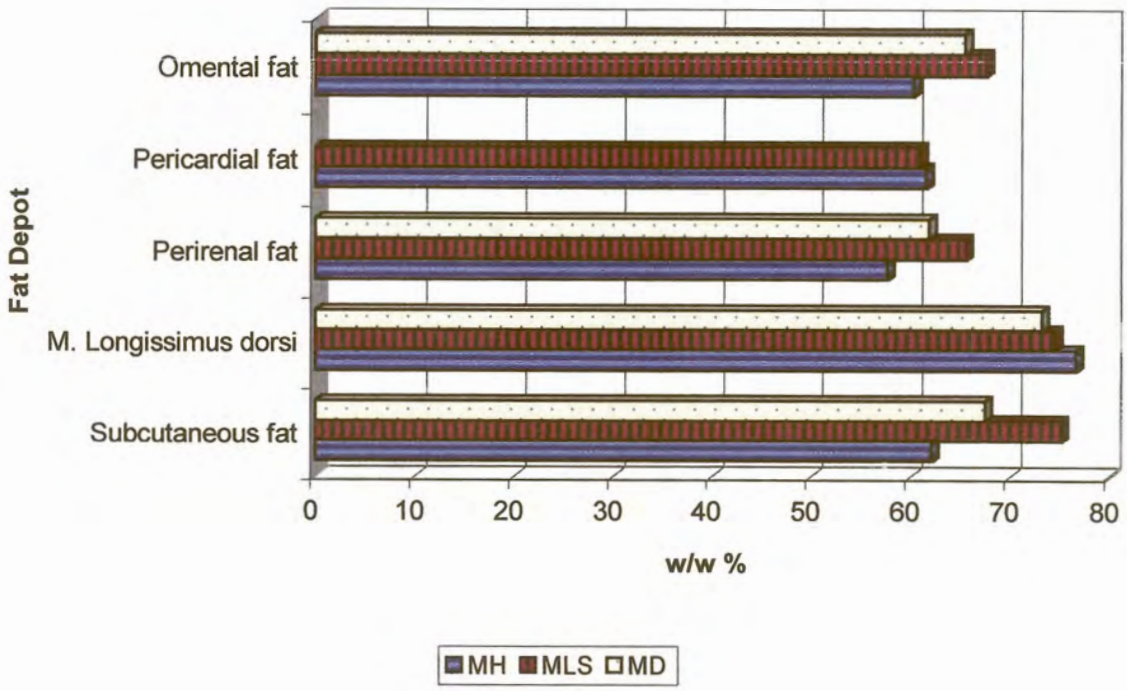


Figure 4-23 Illustration of the effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the proportions of (a) total saturated and (b) total unsaturated long-chain fatty acids of depot fat in the African buffalo.

a) SATURATED FATTY ACIDS



b) UNSATURATED FATTY ACIDS

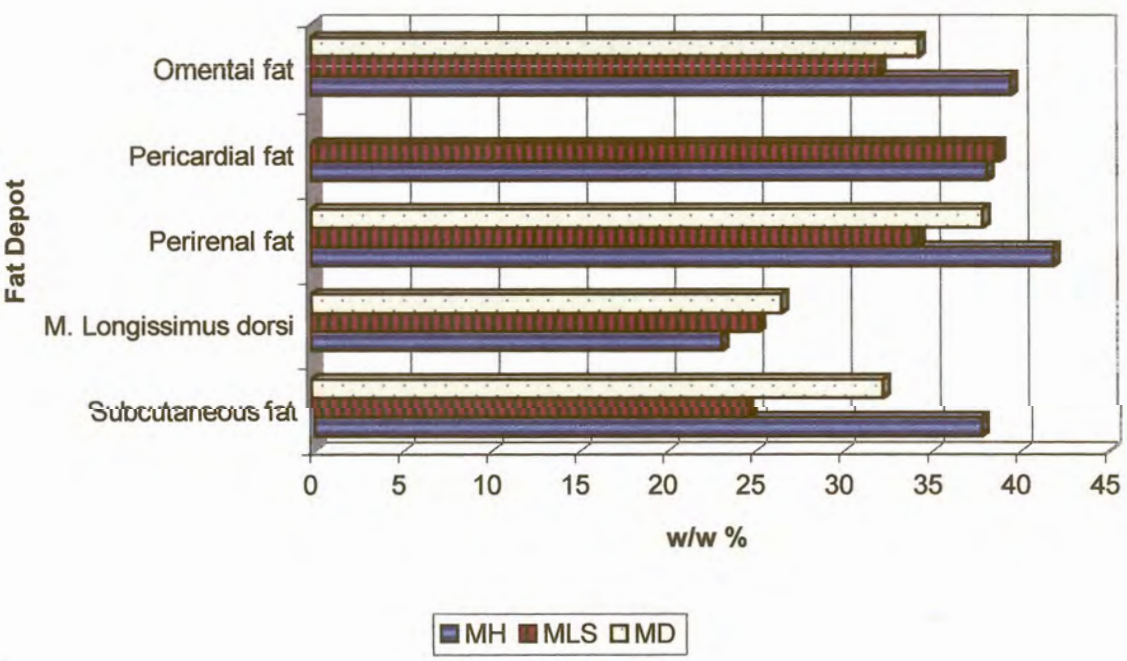
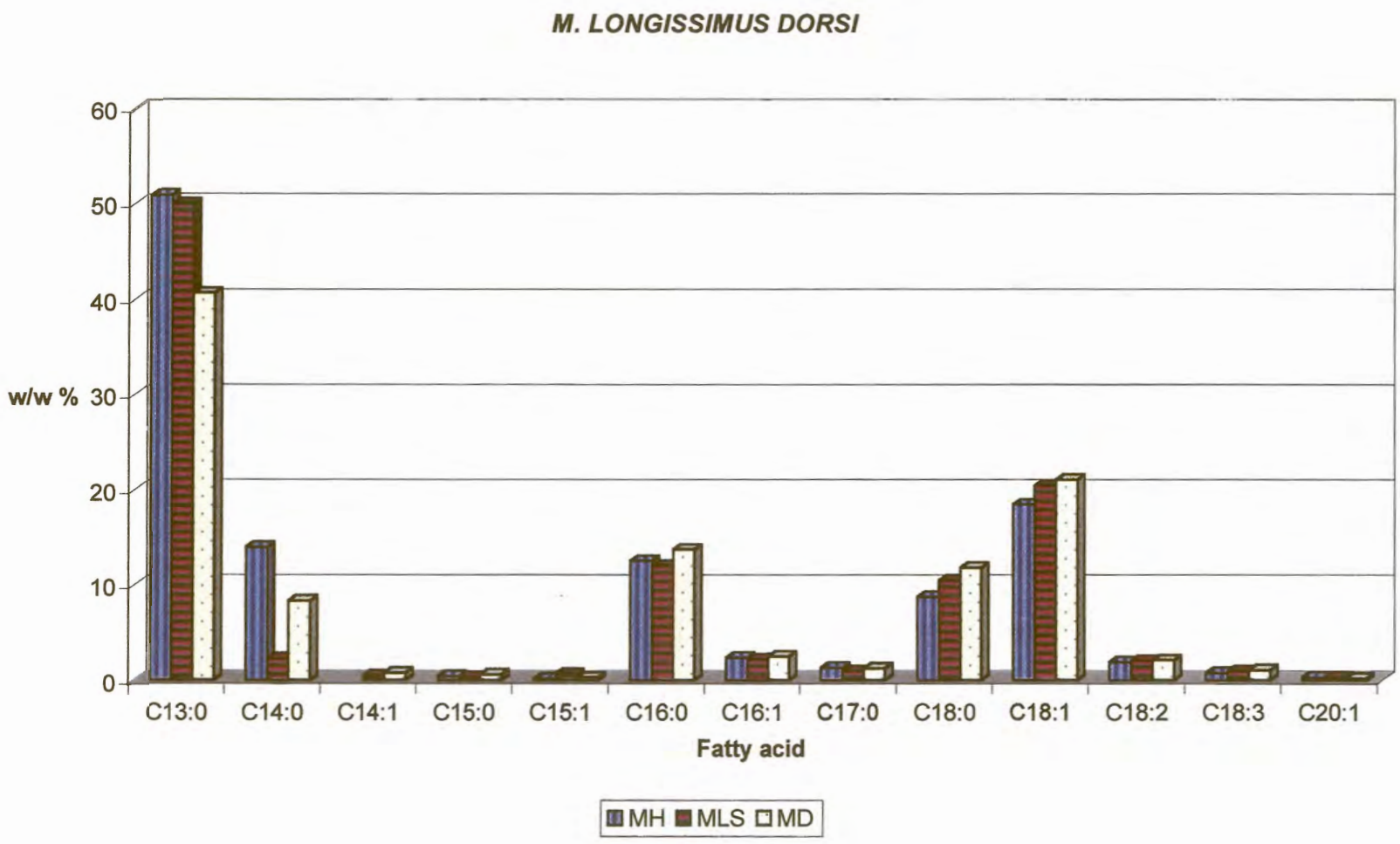


Figure 4-24 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition of M. Longissimus dorsi in the African buffalo.



4.4.2 *M. Longissimus dorsi*

The only statistically significant difference in LD between areas was in the proportion of C15:1 (Table 4-14). The area in which the herds grazed had other effects on the composition of the *M. Longissimus dorsi,* although some minor differences (Figure 4-24). The proportions of C13:0 and C14:0 were numerically different between different areas, but these could be due to problems in the separation of the peaks as explained earlier in this chapter as well as Chapter 3.

Table 4-14 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition (Mean±SD; w/w %) of M. Longissimus dorsi (LD) in the African buffalo.

(w/w %)	MH (n = 10)	MLS (n = 12)	MD (n = 13)
C13:0	50.893±18.189	49.962±16.424	40.651±20.310
C14:0	13.925±18.204	2.263±1.181	8.309±15.973
C14:1		0.476	0.769±0.145
C15:0	0.423±061	0.324±0.082	0.610±0.281
C15:1	0.161^{A}±0.001	0.637^{B}	0.275±0.085
C16:0	12.482±4.967	11.949±3.078	13.653±5.624
C16:1	2.360±0.748	2.194±0.954	2.474±1.017
C17:0	1.288±0.146	0.956±0.493	1.252±0.494
C18:0	8.678±5.108	10.379±4.458	11.739±5.896
C18:1	18.410±8.205	20.359±7.053	21.007±8.098
C18:2	1.913±1.431	2.042±0.499	2.096±0.730
C18:3	0.790±0.289	0.957±0.378	1.077±0.461
C20:1	0.306±0.302	0.328±0.250	0.182±0.157
UFA	23.270±9.438	25.371±8.550	26.680±10.154
SFA	76.614±9.402	74.547±8.570	73.240±10.175

^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

4.4.3 *Internal fat depots*

The internal fat depots were relatively stable and with no significant differences between areas. In the perirenal fat (PRF), C18:1 was numerically the most abundant fatty acid present in samples from all areas, followed by C16:0, C18:0 and C13:0 in samples from MH and MLS and C18:0 C16:0 and C13:0 in samples from MD (Figure 4-26). Only C13:0 was significantly influenced (P<0.05) by area namely higher proportions in buffalo from MLS, compared to buffalo from MH (Table 4-15).

Table 4-15 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition (Mean±SD; w/w %) of perirenal fat (PRF) in the African buffalo.

(w/w %)	MH (n = 10)	MLS (n = 13)	MD (n = 13)
C13:0	6.435[a]±2.732	16.857[b]±12.973	8.518±6.415
C14:0	5.640±4.629	11.066±17.645	7.190±8.325
C14:1	1.022±0.283	0.931±0.193	0.966±0.317
C15:0	0.830±0.195	1.164±0.636	0.913±0.218
C15:1	0.289±0.053	0.302±0.046	0.314±0.063
C16:0	22.722±5.359	17.904±8.254	18.838±5.893
C16:1	3.895±2.031	3.546±1.151	2.836±0.835
C17:0	2.195±0.153	1.953±0.335	1.743±0.411
C18:0	20.974±7.668	17.244±8.925	24.968±6.532
C18:1	32.797±3.389	27.862±9.675	30.208±3.781
C18:2	2.639±0.817	2.140±0.567	2.752±1.787
C20:0	1.156	2.181±1.200	0.705±0.300
C18:3	1.752±0.371	1.622±0.456	2.114±0.627
UFA	42.000±3.924	34.412±12.241	38.065±5.266
SFA	57.770±3.654	65.581±12.246	61.935±5.266

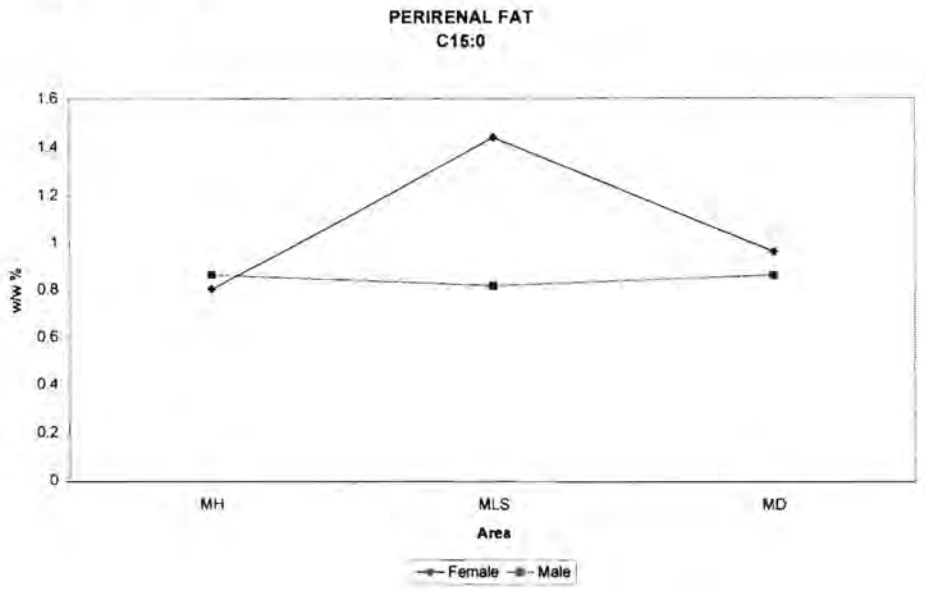
[a,b] Means in the same row bearing different superscripts differ (P<0.05)

In PRF, the proportion of C15:0 was reasonably constant in males sampled in different areas (Figure 4-25a), while it varied in females between the different areas. The most significant difference between gender was found in MLS where females had higher proportions of C15:0. In MH and MD, the differences between males and females were small and the relative proportion of C15:0 appeared to be about the same. This may be due to differences in diet because the proportion of C15:0 in females from MD was higher than males from the same areas, while the proportion of C15:0 was lower in females than in males from MH (Figure 4-25b).

The pericardial fat from buffalo at Mpanamana dam was not collected. The only significant difference (P<0.01) in the fatty acid composition of the pericardial fat between the areas collected, was for the proportion of C16:1 (Table 4-16). Area differences did not significantly influence the rest of the fatty acids present in PRF. Animals from MH had higher proportions (3.685±1.976%) of C16:1 than animals from MLS (2.825±0.633%) (P<0.01) (Table 4-16).

Figure 4-25 The effect a) area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) and b) gender on the proportion of C15:0 in perirenal fat of the African buffalo (P<0.01).

a) Effect of area



b) Effect of gender

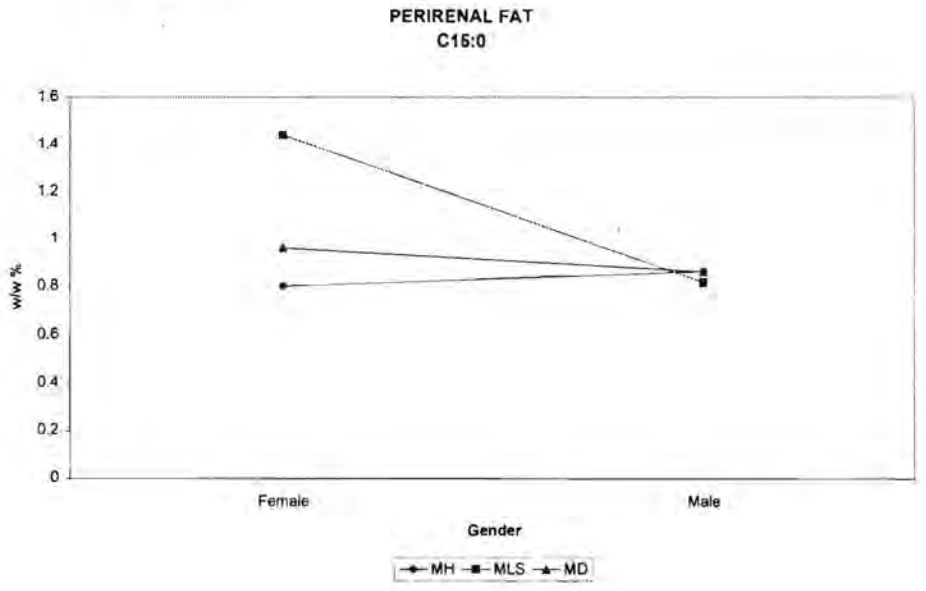


Figure 4-26 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition of perirenal fat in the African buffalo.

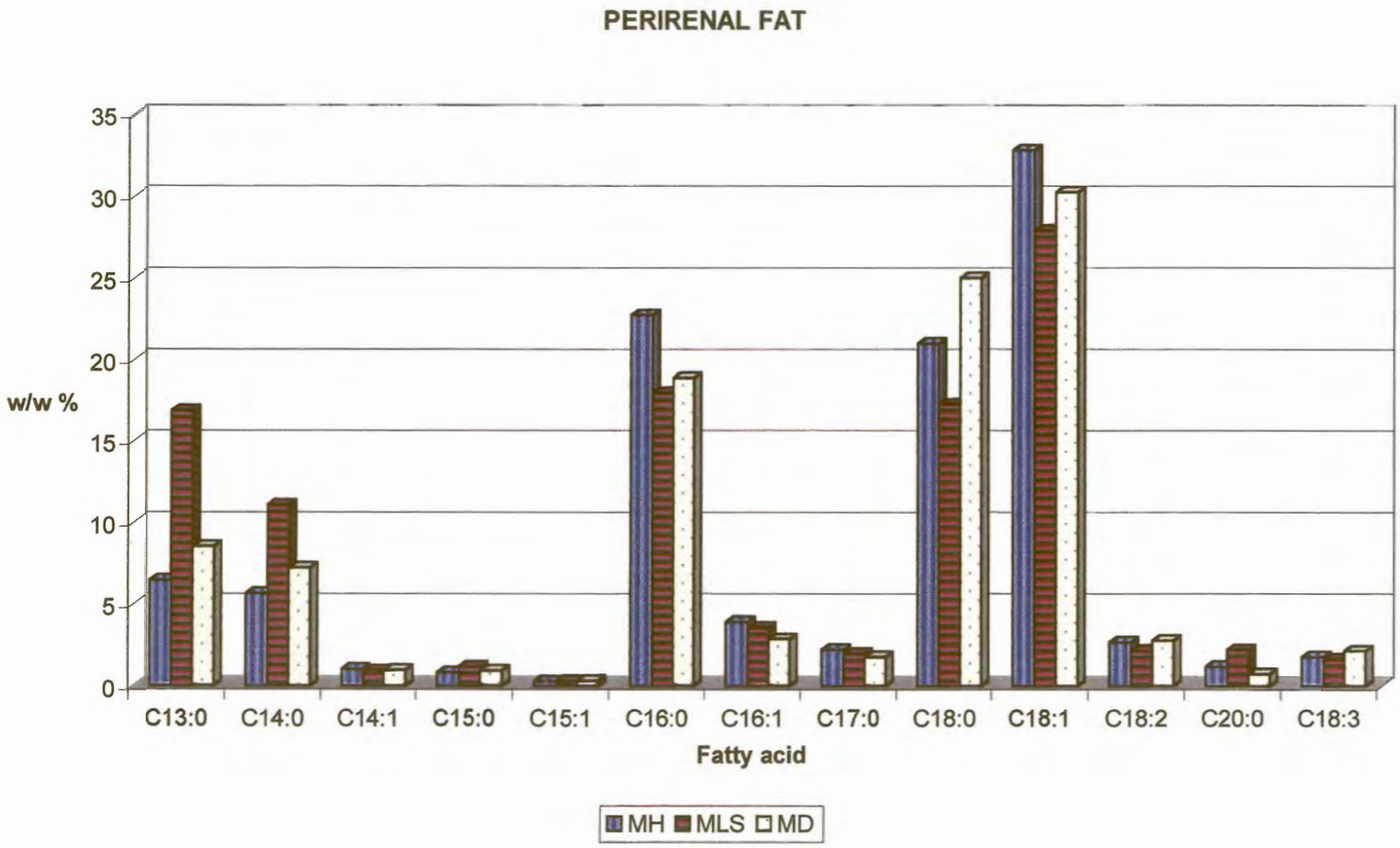


Table 4-16 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition (Mean±SD; w/w %) of pericardial fat (PCF) in the African buffalo.

(w/w %)	MH (n = 7)	MLS (n = 10)
C13:0	7.107±4.074	13.133±8.814
C14:0	3.562±2.888	3.240±1.947
C14:1	0.894±0.192	0.990±0.168
C15:0	0.884±0.647	1.213±0.721
C15:1	0.250±0.299	0.318±0.062
C16:0	20.668±8.843	18.704±7.090
C16:1	3.685^{A}±1.976	2.825^{B}±0.633
C17:0	2.124±0.216	1.932±0.387
C18:0	27.451±12.727	23.529±9.057
C18:1	30.038±1.875	30.090±4.890
C18:2	2.009±0.205	3.047±2.570
C18:3	1.620±0.449	2.556±2.627
UFA	38.304±2.699	38.947±5.576
SFA	61.626±2.733	61.035±5.551

^{A,B} Means in the same row bearing different superscripts differ (P<0.01)

Table 4-17 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition (Mean±SD; w/w %) of omental fat (OMF) in the African buffalo.

(w/w %)	MH (n = 9)	MLS (n = 13)	MD (n = 8)
C13:0	10.760±6.340	20.753±13.238	14.162±5.950
C14:0	4.836±3.119	12.039±16.213	5.917±9.354
C14:1	0.843±0.208	0.922±0.256	0.872±0.252
C15:0	0.846±0.340	1.052±0.643	0.796±0.222
C15:1	0.308±0.038	0.319±0.018	0.341±0.062
C16:0	22.034±5.211	17.414±6.031	18.419±4.265
C16:1	3.208±1.296	2.747±1.183	2.197±0.621
C17:0	1.860±0.358	1.795±0.314	1.687±0.299
C18:0	20.593±7.933	16.869^{a}±7.340	25.043^{b}±3.790
C18:1	31.564±2.772	25.671±6.989	27.193±2.563
C18:2	2.978±1.304	2.840±1.132	3.657±1.299
C18:3	1.474±0.636	1.056±0.493	1.350±0.574
UFA	39.630±3.033	32.250±8.487	34.458±4.003
SFA	60.342±3.048	67.655±8.429	65.514±4.026

^{a,b} Means in the same row bearing different superscripts differ (P<0.05)

C18:1 was the most abundant fatty acid present in OMF in all three areas, followed by C16:0, C18:0 and C13:0 in MH; C13:0, C16:0 and C18:0 in MLS; C18:0, C16:0 and C13:0 in MD (Table 4-17). The area did not affect the total proportions of SFA and UFA in the OMF. Animals sampled in MLS appeared to have a higher proportion of saturated fatty acids (67.655±8.429%) than those from MD (65.514±4.026%) and MH (60.342±3.048%), but these differences were only numerical and not significant (Table 4-17). C18:0 differed

between the areas with MD containing significantly (P<0.05) higher proportions of C18:0 than MLS. MH was intermediate, but not significantly different from the other areas. The proportion of C18:1 was numerically, but not statistically higher in MH than in MLS with MD intermediate. Although numerical differences were found for the proportions of C13:0 and C16:0 these were not significant (Figure 4-29).

Although the mean proportions of C16:0 in OMF of buffalo did not differ significantly between either area or gender, the interaction between area and gender for C16:0 was significant (P<0.05). The proportions of C16:0 in OMF of females remained fairly constant between the different areas (Figure 4-27). In both MH and MD, slightly lower proportions of C16:0 were noted for females than for males, while in MLS significantly higher proportions of C16:0 were noted for females than for males (Figure 4-27).

Figure 4-27 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) and gender (male and female) on the proportion of C16:0 in omental fat of the African buffalo (P<0.05).

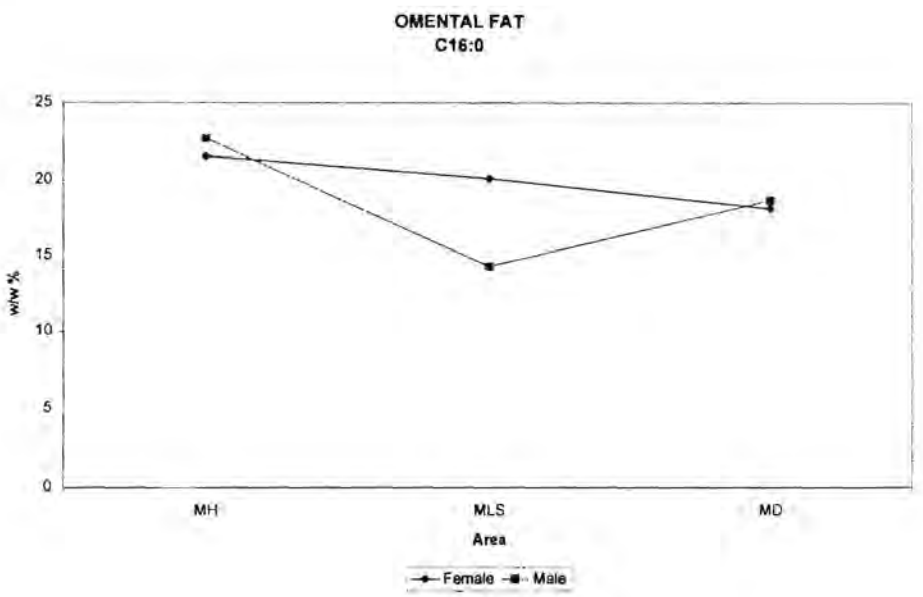


Figure 4-28 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition of pericardial fat in the African buffalo.

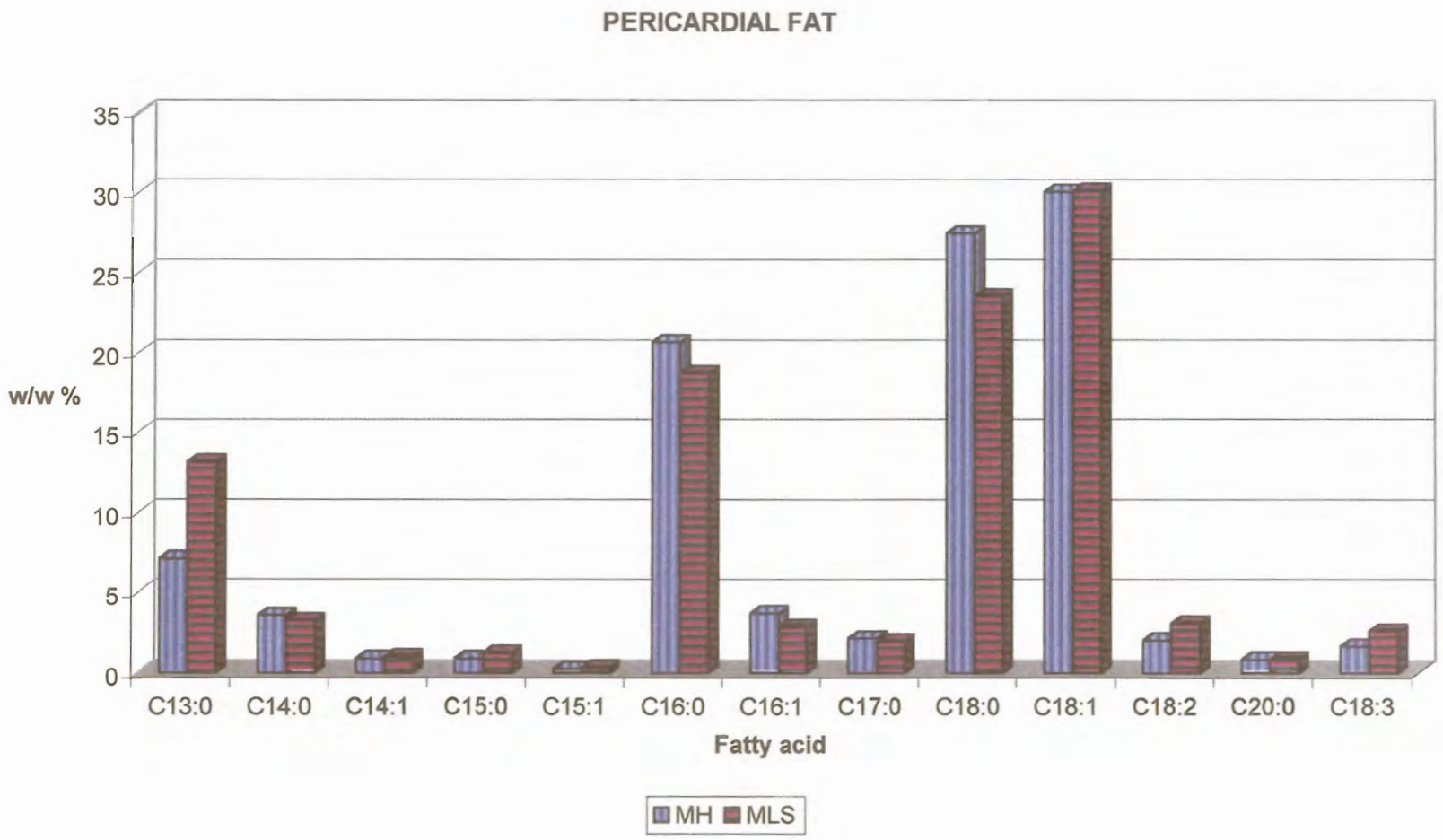
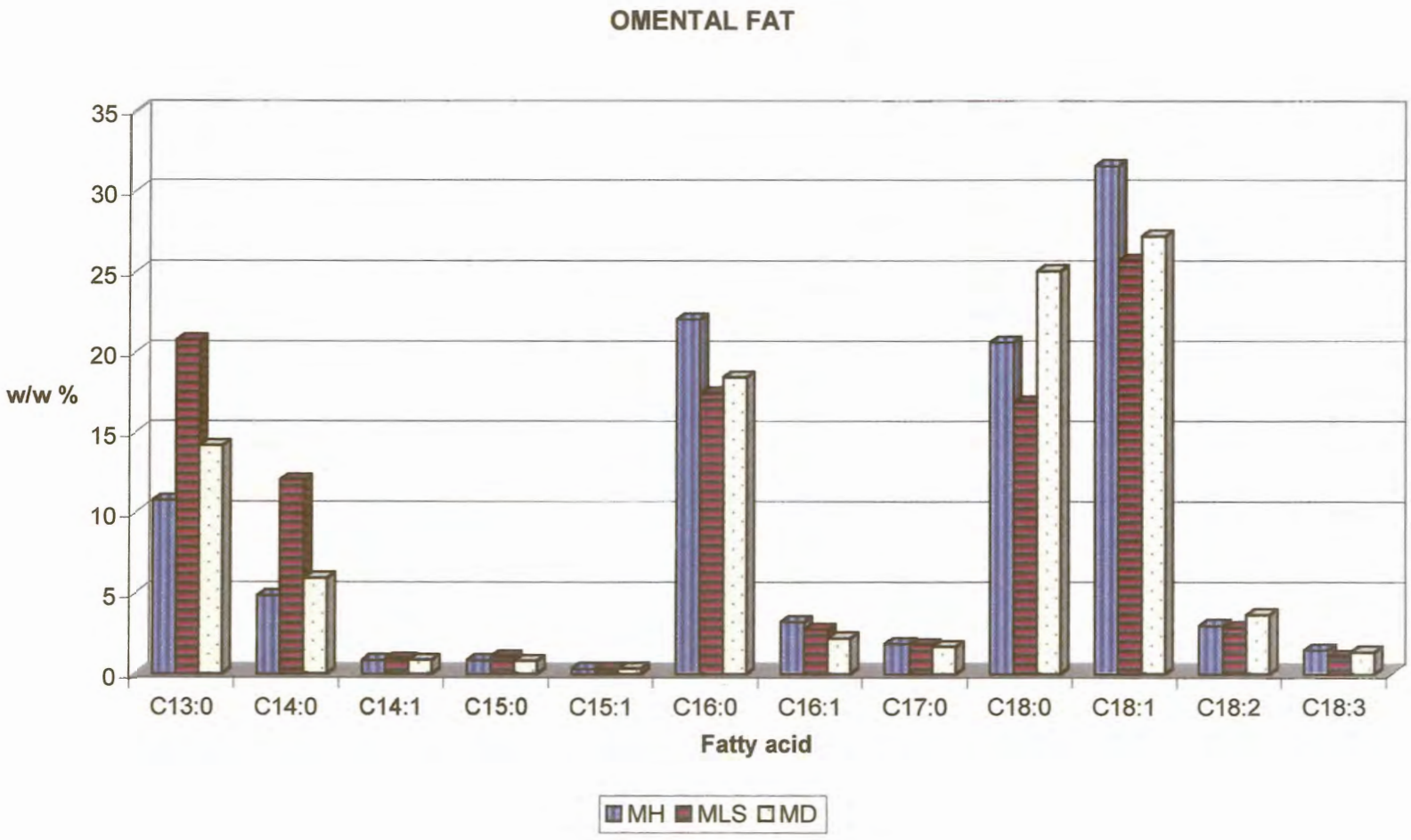


Figure 4-29 The effect of area (MH = Mtandanyathi at Houtboschrand; MLS = Mashatudrif at Lower Sabie; MD = Mpanamana dam at Crocodile Bridge) on the long-chain fatty acid composition of omental fat in the African buffalo.



Addendum I *Interaction effects of age and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of subcutaneous fat in the African buffalo.*

	A		B		C		P
	Female (n = 6)	Male (n = 6)	Female (n = 6)	Male (n = 6)	Female (n = 6)	Male (n = 6)	
C13:0	24.172±6.047	55.772±26.916	42.876±27.614	45.054±22.618	17.336±18.578	37.473±18.823	0.155
C14:0	5.249±3.701	9.368±9.754	2.548±1.271	3.569±1.630	1.225±0.663	1.925±0.264	0.051
C14:1	0.757±0.054	0.415	0.742±0.117	0.698	0.620±0.283	0.883	0.039
C15:0	1.001±0.366	0.977	0.628±0.598	0.595±0.490	0.372±0.235	0.363	0.410
C15:1	0.228±0.046	0.196	0.225±0.029	0.138	0.172±0.115		
C16:0	19.490±3.410	10.336±6.520	12.585±6.168	12.576±4.588	12.719±3.886	11.636±2.508	0.037
C16:1	4.033±1.444	2.333±1.506	2.561±1.970	2.623±1.464	2.568±0.586	2.036±0.612	0.377
C17:0	1.374±0.191	0.728±0.125	0.939±0.602	0.666±0.768	1.830±0.182	1.025±0.510	0.243
C18:0	12.994±3.167	6.532±3.002	12.783±7.381	11.343±7.308	25.926±8.072	16.361±6.863	0.195
C18:1	28.054±3.921	16.611±8.322	22.757±10.844	22.267±9.478	34.224±7.999	27.916±9.163	0.327
C18:2	2.163±0.461	1.713±1.223	1.988±0.359	2.177±0.886	2.453±0.246	2.118±0.281	0.695
C18:3	1.756±0.380	1.469±0.730	1.249±0.542	0.857±0.664	1.370±0.402	0.879±0.172	0.882
UFA	36.575±4.781	20.430±10.596	28.584±13.280	27.777±11.731	40.505±9.130	32.803±10.052	0.236
SFA	63.426±4.780	79.570±10.597	71.149±13.034	72.082±11.529	59.409±9.190	67.199±10.052	0.241

Addendum II *Interaction effects of age and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of M. Longissimus dorsi in the African buffalo.*

	A		B		C		P
	Female (n = 6)	**Male (n = 6)**	**Female (n = 5)**	**Male (n = 6)**	**Female (n = 6)**	**Male (n = 6)**	
C13:0	50.778±21.150	44.215±8.825	56.952±11.785	55.013±14.985	23.003±11.304	52.354±20.455	0.026
C14:0	3.766±0.317	11.632±20.597	4.474	1.782±1.050	2.167±0.717	11.464±15.713	0.816
C14:1	0.700±0.316		0.712		0.720±0.177		
C15:0	0.551±0.491	0.456	0.357±0.098	0.545	0.472±0.156	0.392±0.102	0.764
C15:1	0.369				0.283±0.201		
C16:0	13.399±4.610	11.961±3.486	11.444±3.352	10.914±3.157	18.085±3.926	10.388±5.418	0.109
C16:1	2.618±0.532	2.483±0.406	2.240±0.930	1.795±1.090	2.645±0.706	2.258±1.533	0.978
C17:0	1.851	0.664±0.170	0.763±0.603	0.916±0.140	1.416±0.166		0.076
C18:0	9.016±6.880	8.742±3.328	8.415±1.833	9.814±3.941	17.845±3.556	8.225±3.882	0.011
C18:1	18.692±5.885	18.376±6.105	16.956±3.510	17.889±5.943	31.317±3.295	16.513±8.942	0.017
C18:2	2.320±1.732	1.948±0.480	1.670±0.295	2.005±0.758	2.338±0.703	1.810±0.880	0.716
C18:3	0.884±0.689	0.903±0.229	0.867±0.436	0.718±0.274	1.202±0.207	1.056±0.216	0.998
C20:10	0.139±0.144	0.472±0.066	0.429±0.256		0.107±0.024		
UFA	24.808±7.735	22.996±7.212	21.603±5.081	22.287±7.568	37.978±4.382	21.261±11.364	0.046
SFA	75.125±7.788	76.847±7.254	78.225±5.172	77.062±7.464	61.951±4.417	78.515±11.364	0.046

Addendum III *Interaction effects of age and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of perirenal fat in the African buffalo.*

	A		B		C		P
	Female (n = 6)	**Male (n = 6)**	**Female (n = 6)**	**Male (n = 6)**	**Female (n = 6)**	**Male (n = 6)**	
C13:0	5.669±1.025	13.452±9.596	7.255±2.947	15.827±12.462	16.278±14.989	7.223±6.674	0.056
C14:0	5.086±1.984	15.541±19.243	5.109±3.384	10.575±18.051	8.664±11.904	3.978±4.443	0.434
C14:1	0.846±0.311	0.629±0.021	0.902±0.185	1.148±0.028	1.103±0.332	1.157±0.261	0.217
C15:0	1.359±0.665	1.018±0.165	0.921±0.266	0.809±0.271	0.784±0.253	0.705±0.158	0.097
C15:1	0.276±0.045	0.247±0.024	0.329±0.028	0.310±0.013	0.317±0.093	0.322±0.066	0.484
C16:0	27.505±4.372	20.876±7.899	19.660±4.814	16.745±8.301	15.437±5.806	17.254±2.369	0.576
C16:1	5.028±1.904	3.311±1.049	3.487±0.544	3.440±1.746	2.542±0.794	2.555±0.841	0.423
C17:0	1.950±0.172	1.797±0.351	1.935±0.245	1.723±0.250	1.800±0.801	2.194±0.161	0.225
C18:0	16.301±5.141	13.092±5.032	24.813±5.422	21.755±11.850	21.995±6.321	27.575±6.124	0.188
C18:1	33.006±2.719	28.366±10.429	31.417±1.644	26.535±10.399	28.661±5.928	32.496±2.165	0.226
C18:2	2.257±0.262	2.077±0.750	2.057±0.315	2.723±0.880	2.428±0.442	3.552±2.542	0.553
C20:0	0.421		0.674±0.266	0.831±0.267	2.273±1.055	0.854±0.428	0.124
C18:3	1.950±0.309	1.750±6.225	1.770±0.425	2.064±0.262	2.050±1.061	1.559±0.308	0.213
UFA	43.035±2.803	34.996±12.988	39.962±2.478	33.260±13.456	34.898±7.350	40.887±2.684	0.138
SFA	56.965±2.803	65.007±12.988	60.031±2.481	66.733±13.462	65.103±7.350	58.730±2.115	0.126

Addendum IV *Interaction effects of age and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of omental fat in the African buffalo.*

	A		B		C		P
	Female (n = 6)	**Male (n = 4)**	**Female (n = 4)**	**Male (n = 5)**	**Female (n = 6)**	**Male (n = 5)**	
C13:0	9.552±3.408	24.669±23.626	19.429±11.296	15.680±3.452	12.508±8.297	18.555±2.710	0.417
C14:0	4.818±1.213	16.762±15.988	1.916±0.845	17.780±21.028	7.208±10.742	3.267±0.836	0.226
C14:1	0.832±0.185	0.726	1.066±0.082	0.844±0.218	0.977±0.297	0.548	0.895
C15:0	1.288±0.418	0.637±0.443	0.990±0.117	0.664±0.199	0.589±0.269	0.661	0.351
C15:1	0.326±0.018	0.254	0.328±0.025	0.279	0.345±0.081		
C16:0	25.128±2.644	18.411±6.925	16.382±4.115	16.705±8.528	17.412±3.838	18.821±1.523	0.441
C16:1	3.639±0.895	2.402±0.554	2.288±0.686	2.432±1.956	2.474±1.194	2.869±1.015	0.192
C17:0	1.879±0.191	1.640±0.206	1.846±0.400	1.679±0.328	2.040±0.345	1.456±0.130	0.468
C18:0	16.739±3.677	12.943±5.311	25.664±5.884	18.840±8.412	25.816±8.637	20.205±4.219	0.156
C18:1	32.068±3.976	24.011±7.515	27.525±0.729	22.963±7.529	28.605±3.951	30.068±1.917	0.404
C18:2	2.130±0.183	2.715±0.854	3.220±2.026	3.839±1.377	2.703±0.646	4.208±0.978	0.462
C18:3	1.925±0.482	0.980±0.224	1.219±0.539	0.873±0.393	1.078±0.385	1.000±0.533	0.527
UFA	40.781±3.697	30.108±8.206	34.073±2.539	29.839±10.453	35.283±4.729	37.855±2.786	0.317
SFA	59.160±3.701	69.892±8.206	65.905±2.550	69.942±10.354	64.688±4.744	62.145±2.786	0.310

Addendum V *Interaction effects of area and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of subcutaneous fat in the African buffalo.*

	MH		MLS		MD		P
	Female (n = 5)	Male (n = 5)	Female (n = 7)	Male (n = 6)	Female (n = 6)	Male (n = 7)	
C13:0	16.203±7.965	25.169±13.646	46.264±23.535	57.238±23.025	16.908±9.730	51.504±20.131	0.074
C14:0	3.170±2.458	8.245±10.559	5.656±5.674	4.532±1.307	2.075±1.020	3.007±1.467	0.018
C14:1	0.645±0.223	0.649±0.331	0.587±0.202		0.781±0.181	0.698	
C15:0	0.696±0.499	0.876±0.470	0.617±0.442	0.218	0.687±0.589	0.437±0.220	0.175
C15:1	0.175±0.082	0.196	0.220±0.086		0.238±0.058	0.138	
C16:0	17.408±6.672	15.992±4.369	11.620±4.962	9.491±4.387	16.731±3.414	10.055±2.947	0.045
C16:1	4.199±1.55	3.168±1.467	1.875±0.825	2.151±0.634	3.476±1.345	1.835±0.936	0.105
C17:0	1.899±0.088	1.424±0.330	0.972±0.521	0.400±0.239	1.667±0.284	0.825±0.470	0.322
C18:0	19.997±11.280	16.826±7.162	12.047±7.908	7.748±4.557	20.983±5.168	10.686±7.043	0.289
C18:1	32.866±6.899	27.402±5.377	20.949±8.744	19.348±12.617	33.206±4.559	21.095±9.077	0.162
C18:2	2.357±0.479	2.104±0.365	2.063±0.414	1.606±0.960	2.237±0.236	2.362±0.903	0.717
C18:3	1.591±0.354	1.064±0.331	1.195±0.645	1.122±1.073	1.626±0.290	0.888±0.466	0.309
UFA	41.575±5.037	34.037±5.493	26.143±10.433	22.949±14.132	40.518±5.550	25.455±11.086	0.170
SFA	58.341±5.108	65.963±5.493	73.629±10.235	76.978±14.085	59.466±5.580	74.487±11.004	0.176

Addendum VI *Interaction effects of area and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of M. Longissimus dorsi in the African buffalo.*

	MH		MLS		MD		P
	Female (n = 5)	Male (n = 5)	Female (n = 6)	Male (n = 6)	Female (n = 6)	Male (n = 7)	
C13:0	44.344±17.592	57.442±18.102	50.292±18.841	49.632±15.432	33.996±25.843	46.356±13.644	0.536
C14:0		13.925±18.204	2.537±1.286	2.126±1.226	3.266±1.085	11.671±20.607	0.436
C14:1			0.476		0.769±0.145		
C15:0	0.407±0.076	0.456	0.325±0.091	0.320	0.662±0.345	0.505±0.057	0.594
C15:1	0.161±0.001		0.637		0.275±0.085		
C16:0	15.236±3.742	9.728±4.749	11.585±2.693	12.313±3.643	16.739±6.054	11.008±3.877	0.113
C16:1	2.453±0.445	2.244±1.094	2.168±0.666	2.220±1.248	2.918±0.798	2.030±1.080	0.470
C17:0	1.288±0.146		1.059±0.668	0.801±0.023	1.567±0.246	0.779±0.334	0.714
C18:0	10.793±6.009	6.517±3.379	10.613±6.177	10.146±2.687	14.267±7.087	9.571±3.973	0.342
C18:1	23.155±7.465	13.665±6.282	20.185±7.890	20.532±6.863	24.658±8.803	17.878±6.468	0.196
C18:2	2.460±1.868	1.366±0.609	1.900±0.491	2.184±0.508	2.099±0.816	2.092±0.716	0.388
C18:3	0.798±0.338	0.783±0.275	0.914±0.428	1.056±0.269	1.292±0.617	0.923±0.264	0.389
C20:1	0.092	0.519	0.328±0.250		0.122±0.090	0.425	0.797
UFA	28.931±7.376	17.609±8.119	25.278±9.186	25.464±8.741	31.401±10.989	22.633±8.011	0.217
SFA	71.051±7.395	82.178±8.173	74.558±9.228	74.536±8.741	68.496±10.991	77.306±8.037	0.239

Addendum VII *Interaction effects of area and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of perirenal fat in the African buffalo.*

	MH		MLS		MD		P
	Female (n = 5)	Male (n = 5)	Female (n = 7)	Male (n = 6)	Female (n = 6)	Male (n = 7)	
C13:0	6.011±1.110	6.858±3.887	15.810±13.593	18.080±13.374	5.748±2.389	10.892±7.956	0.885
C14:0	3.703±2.419	7.577±5.742	4.225±1.976	19.047±24.505	10.845±10.970	4.057±3.678	0.102
C14:1	0.916±0.245	1.286±0.214	0.984±0.098	0.879±0.274	0.915±0.366	1.030±0.282	0.361
C15:0	0.803±0.195	0.864±0.218	1.440±0.732	0.818±0.279	0.963±0.210	0.863±0.238	0.004
C15:1	0.263±0.028	0.354±0.049	0.319±0.044	0.275±0.043	0.349±0.055	0.279±0.056	0.072
C16:0	24.070±5.934	21.373±4.986	20.649±7.461	14.700±8.593	18.452±7.329	19.169±4.941	0.258
C16:1	4.346±2.303	3.444±1.863	3.906±1.281	2.914±0.546	2.877±0.911	2.794±0.835	0.729
C17:0	2.185±0.113	2.205±0.213	2.079±0.160	1.827±0.440	1.632±0.536	1.855±0.235	0.229
C18:0	20.120±6.687	21.479±9.295	18.707±7.384	15.536±10.921	24.527±4.078	24.845±8.451	0.640
C18:1	34.337±3.190	31.257±3.121	30.262±3.008	25.064±14.013	29.165±4.679	31.102±2.884	0.336
C18:2	2.409±0.295	2.869±1.133	2.095±0.200	2.178±0.779	2.180±0.444	3.242±2.369	0.661
C20:0		1.156	2.181±1.200		0.680±0.369	0.738±0.249	
C18:3	1.722±0.450	1.782±0.323	1.592±0.144	1.660±0.723	2.325±0.686	1.796±0.414	0.179
UFA	43.993±2.603	40.007±4.235	37.451±5.768	30.868±17.079	37.541±5.715	38.514±5.266	0.480
SFA	56.007±2.603	59.533±3.936	62.543±5.773	69.125±17.085	62.459±5.715	61.486±5.266	0.492

Addendum VIII *Interaction effects of area and gender on the long-chain fatty acid composition (Mean±SD; w/w %) of omental fat in the African buffalo.*

	MH		MLS		MD		P
	Female (n = 5)	Male (n = 4)	Female (n = 7)	Male (n = 6)	Female (n = 4)	Male (n = 4)	
C13:0	8.379±3.833	13.738±8.144	16.708±9.543	25.472±16.177	12.806±8.465	15.518±2.461	0.771
C14:0	3.880±1.561	6.032±4.389	3.434±1.971	24.086±20.150	9.094±13.296	2.740±0.686	0.049
C14:1	0.866±0.223	0.726	0.922±0.256		1.063±0.163	0.745±0.230	
C15:0	0.788±0.345	1.138	1.385±0.491	0.386±0.122	0.997±0.155	0.663±0.141	0.001
C15:1	0.321±0.027	0.254	0.319±0.018		0.372±0.042	0.279	
C16:0	21.520±5.064	22.677±6.101	20.082±5.111	14.301±5.861	18.148±6.459	18.689±0.722	0.044
C16:1	3.060±1.449	3.394±1.264	2.962±1.126	2.446±1.324	2.503±0.684	1.968±0.609	0.444
C17:0	2.089±0.226	1.554±0248	1.846±0.311	1.494	1.835±0.363	1.576±0.229	0.747
C18:0	23.260±9.686	17.260±4.006	20.537±7.707	12.591±4.148	24.481±4.911	25.605±2.925	0.150
C18:1	32.122±3.458	30.868±1.841	29.619±3.261	21.064±7.563	26.549±3.545	27.837±1.284	0.055
C18:2	2.274±0.463	3.858±1.547	2.379±0.686	3.378±1.366	3.464±1.822	3.850±0.719	0.388
C18:3	1.679±0.621	0.961±0.378	1.210±0.569	0.786±0.098	1.865±0.226	1.092±0.517	0.884
UFA	40.258±3.651	38.844±2.296	36.747±3.980	27.004±9.620	33.540±5.399	35.376±2.448	0.088
SFA	59.691±3.666	61.156±2.296	63.234±3.988	72.813±9.599	66.404±5.452	64.625±2.448	0.101

CHAPTER 5

CONCLUSIONS

5.1 DEPOT FAT

It can be concluded that SCF and LD of buffalo are more saturated than PRF, PCF and OMF. The dominant fatty acids present in depot fat of buffalo are C18:1, C18:0, C16:0 and C13:0. C13:0 were found to be the most abundant fatty acid in the external fat depots (SCF and LD) and C18:1 in the internal fat depots (PCF, PRF and OMF). Individual fatty acids differed between internal and external fat depots. No significant differences were found between the relative proportions of fatty acids in the internal fat depots.

SCF and LD were found to have similar fatty acid profiles, without any significant differences between the two depots.

The present results indicate a depletion of energy reserves for maintenance, growth and lactation, as a result of nutritional stress, during the dry season. During the winter months, animals were in a poor nutritional status where fat reserves were mobilised for physiological functions.

Buffalo fat and muscle contain high proportions of saturated fatty acids, mainly due to the high proportions of C13: present in LD and SCF. The proportions of C18:1 and C18:0 were higher than those of C16:0. High proportions of C16:0 in the human diet is associated with increased levels of LDL, the "bad" cholesterol (Mattson and Grundy, 1985, McNamara, 1991). The influence of high proportions of C13:0 on human lipoproteins, are unknown. Although the total UFA were proportionally low, the relative proportions of C18:1 and C18:0 were high, both being associated with reduced levels of

LDL in blood (McNamara, 1991). The indications that C16:0 and C18:0 were the main fatty acids mobilised in buffalo when in negative energy balance, may implicate the total fat content of buffalo meat to be very low and that the influence due to the intake of saturated fat, are negligible in the human diet.

5.2 INFLUENCE OF AGE

Age differences were noted for specific fatty acids, but the proportions of total saturated and unsaturated fatty acids in the internal and external fat depots were not significantly influenced except for LD where the proportion of saturated fatty acids decreased with age. The lack of an increase in the proportion of C16:0 is probably due to the mobilisation of C16:0 for the maintenance of a constant physiological state in the animal. Not all animals in the A age group reached puberty yet, and therefore they have not reached the stage of higher fat deposition in subcutaneous adipose tissues (Vernon, 1991).

Within SCF and LD, the proportions of C18:0 and C18:1 increased with age. Similarly, the proportions of C13:0 in LD, and C14:0 and C18:3 in SCF decreased with age. Within the internal fat depots (PRF, PCF and OMF) C15:0 and C16:0 decreased, while the proportion of C18:0 increased, although only significant in PRF.

Although the change in saturation level of SCF was not significant, adult buffalo of the C age appeared to have more unsaturated fat than animals in the A age. This is in agreement with previous research suggesting that saturated fatty acids are desaturated to unsaturated fatty acids with age (Banskalieva, 1996; Webb and Casey, 1995; Westerling and Hedrick, 1979; Zembayashi and Nishimura, 1996).

5.3 INFLUENCE OF GENDER

The fatty acid composition of SCF and LD was significantly influenced by gender. Not only was individual fatty acids affected, but also the proportions of total SFA present within these depots. Similarities were observed within SCF and LD for gender. Male buffalo had significantly more saturated fatty acids than females. In both depots, this appeared to be due to the higher proportions of C13:0 for males, although the difference were only significant for SCF.

Cramer and Marcello (1964) (as quoted by Webb, 1992) reported that females had larger amounts of fatty acids with 16 or more carbons and lower proportions of fatty acids with 16 or less carbons than males. Similar results were obtained in the present study where the proportions of C16:0, C16:1, C17:0, C18:0, C18:1, C18:2 and C18:3 were either significantly, or numerically higher in SCF and LD of females than observed in males.

The internal fat depots were, as expected, not significantly influenced by gender, except for C15:0 and C16:0 in PCF, and C15:0, C15:1, C17:0, C18:0 and C18:3 in OMF. These differences might be due to dietary differences between gender.

Although the reason for the difference in the domposition of pericardial fat between male and female buffalo is unclear, it appears that buffalo tend to deposit more fat pericardially than perirenally.

5.4 INFLUENCE OF AREA

The fatty acid profiles of buffalo sampled in different areas differed significantly. Internal fat depots appeared to be more stable compared to the external depots, which were more susceptible to environmental influences.

Significant differences ($P<0.05$) were found in the total unsaturated fatty acid (UFA) content of the subcutaneous fat of buffalo sampled in the different areas. The area and therefore the diet of the animals significantly influenced the fatty acid composition of the subcutaneous fat of buffalo. These differences are probably due to different veld-types and possibly different plant species selected by buffalo in the different areas.

A higher proportion of unsaturated fatty acids was observed in animals from the Mopane/Bushwillow woodlands (MH) than animals from the thorn thickets (MLS), while that of animals from the Marula savannah (MD) was intermediate. This may indicate that animals from MLS were in poorer condition than MD, with animals from MH in the best condition. Although no data was available on the conditions of the animals or the veld condition, animals from MLS were visually observed to be leaner (de Vos, personal communication).

It can be concluded that male buffalo, especially from MD, were in poorer body condition that females, although all animals appeared to be in a poor condition due to the depletion of stores of C16:0, C18:0 and C18:1, resulting consequently in a relative increase in proportions of especially C13:0 and other fatty acids within the depot fat of buffalo.

Due to the mobilisation of C16:0, C18:0 and C18:1 in animals from MLS, the proportion of C13:0 was relatively higher in these samples. The concentration of C13:0 may have remained constant, but the proportions, relative to the other fatty acids, increased due to the depletion of adipose tissue reserves. This may indicate that C13:0 is not easily mobilised from adipose tissue stores after deposition from the diet (without being modified).

The present results indicate that animals were in a poor nutritional status during the winter months, where fat reserves were mobilised for physiological functions. Parasitic infections and diseases in buffalo may also result in decreased productivity and poor condition of buffalo (Young and van den Heever, 1969). The original datasheet indicated that 6 buffalo were infected with TB. This type of work need to be repeated in different seasons to quantify the effect of season and fatty acid profiles as well as correlations with the condition scores of buffalo.

5.5 CRITICAL EVALUATION

Fatty acid mobilisation is part of a complex system, especially in free ranging buffalo where it is significantly influenced by environmental and dietary variations.

Results obtained in this study did not always agree with that reported for domestic ruminant species. This is probably due to the fact that animals were exposed to a harsh environment with significant fluctuating environmental conditions (e.g. feed quality and quantity, temperature etc).

The proportions of C13:0 observed in especially SCF and LD of buffalo, were unexpectedly high and caused concern. The first reaction was to ignore it, because it has never been reported to be a significant fatty acid in animal tissue.

The prominent peak of C13:0 could have been residues due to the addition of BHT during the extraction method. Therefore, similar samples were prepared with and without the addition of BHT but without any difference in the C13:0 peak. The standard was injected in-between samples and all relevant peaks occurred at the correct retention times, which rules out any deficiency of the column. Sample extraction and preservation were changed

(see Chapter 3) without any change in the peak of C13:0, the only difference being a better separation of the peaks of C13:0 and C14:0.

Before and after analysis of the buffalo samples, adipose tissue samples from steers and sheep were analysed, using the same extraction methods. C13:0 were not present to the same extend in these samples compared to buffalo samples. The lower proportions of C13:0 in PCF, OMF and PRF than in SCF and LD indicated that it could not be ignored.

In the present study, the peak has been identified and reported as C13:0, but the possibility that it may be wrong, can not be ignored. In future studies, other extraction methods need to be used and samples will need to be referred to other laboratories for confirmation of results.

Odd-numbered and branched-chain fatty acids can be synthesised *de novo* by certain rumen microbes (Christie, 1981a) and are deposited in adipose tissue without further metabolism. It can also be present in the diet. The rumen microbial population vary between species, breeds and even individual animals within herds (Noble, 1981) and is also influenced by the diet of the animal.

The proportion of C13:0 was influenced by the area and gender, suggesting that it could have been due to a specific plant pecies present in all areas, and consumed by all animals. It may be something like the common reed, *Phragmites austalis*, found not only in the riverine areas of KNP, but all over the world (Marks *et al.*, 1993). It is suspected that reeds are grazed during the dry winter months when herds utilise the riverine areas more readily (Funston *et al.*, 1994). Fatty acid profiles of reeds are not available. Fatty acid analyses of the common reed need to be included in future studies.

Before C13:0 are condemned as 'impossible to be present in ruminant fat in the proportions reported', it is important to note that the body condition of the animals, appeared to be poor and mainly due to the fact that the proportions of C16:0, a fatty acid known to be mobilised extensively during periods of negative energy balance, were very low in especially LD and SCF. Concentrations of the different fatty acids were not calculated, but might have given a completely different view and probably a better explanation for the observed results.

Since C16:0, C18:0 and C18:1 are mobilised for maintenance during growth and lactation, they are proportionally decreased as compared to C13:0, although the concentration of C13:0 probably remained constant in SCF and LD. The proportions of C13:0 in the internal depots (PRF, PCF and OMF) remained relatively uninfluenced by age or gender, with only PRF being influenced by area. This implicated that either the animals from MLS were in a poorer condition (PRF were also in the process of being mobilised) or there was more C13:0 in the diet of these animals.

Future research may involve rumen microorganisms and ruminal fermentation of dietary fatty acids in buffalo, plasma concentrations of fatty acids, seasonal variation in the long-chain fatty acid composition (the diet of buffalo are reported to be changing throughout the year). A research project was recently conducted in the KNP to study the correlations between body condition and composition of free-ranging buffalo and the incidence of TB. This research will also provide valuable information and could be combined with the present results to provide excellent baseline data for future projects on the African buffalo.