THE OMEGA 3 CONTENT OF LEAN RED MEAT

Final Report
to
Meat & Livestock Australia

Project CMHN.016

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Final Report to Meat & Livestock Australia

Project Number CMHN.016

Project Title The Omega 3 Content of Lean Red Meat

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Objectives

Objectives

Part A:

To provide a full report for beef omega 3 fatty acid and other major fatty acid concentrations from grass (pasture) and short-grain fed animals.

Samples from C3 grass fed, C4 grass fed and short grain fed beef cattle (Bos Indicus and Bos Taurus in the domestic class and Bos indicus and Bos taurus in the Jap ox class).

The aim of the research was:

1. To define the omega 3 fatty acid, saturated fatty acid content and trans fatty acid content of beef.
2. To determine if there was there a difference in omega 3 fatty acid content, saturated fatty acid content and trans fatty acid content between feeding regime (grass versus grain feeding).
3. To determine whether breed type influenced the different fatty acids in beef.
4. To determine whether the omega 3 fatty acid content of beef met the FSANZ requirements to be considered as a source or a good source of these fatty acids.

Part A involved only the analysis of two cuts per animal since preliminary studies showed that rump and striploin had different omega 3 contents.

Part B:

To provide a full report for the beef omega 3 fatty acid and other major fatty acid concentrations from grass (C3 pasture), short-grain fed and long-grain fed animals (all Bos Taurus genotype).

Samples from C3 grass fed were sourced from northern and central New South Wales and the short grain fed and long grain fed beef cattle were sourced from feedlots in southern Queensland.

The aims of Part B were the same as in Part A, except that three cuts per animal were analysed in order to obtain a more representative sampling of the meat sold for consumption.

Studies

Objectives

To provide a full report for the beef omega 3 fatty acid content and other major fatty acid concentration from grass (pasture) and short-grain fed animals.

Methods

As described in the studies in Appendix 1.

Samples

PART A

Samples from C3 grass fed, C4 grass fed and Short grain fed beef cattle (Bos Indicus, Jap ox). In each case 15 animals and two cuts per animal were analysed (rump and striploin).

Class	Genotype	C3	C4	Short fed
Domestic	**Bos Taurus**	**1 Bankisia beef** Diff. Pro. complete		**5 Warwick Meats** Diff. Pro. Complete
	Bos indicus	**2 ACC** Diff. Pro. Complete		**6 Stanbroke** Diff. Pro. Complete
Jap Ox	**Bos Taurus**			**7 IMTP** Diff. Pro. Complete
	Bos Indicus	**3 Brigalow** Diff. Pro. complete	**4 Stanbroke** Diff. Pad complete	**8 Stanbroke** Comm. Pro. Complete

PART B

Samples were obtained Mr Shane Blakely from C3 grass fed, short grain fed and long grain-fed beef cattle In each case, there were 18 animals per feed-type and three cuts per animal were analysed (rump, blade and striploin).

Samples from C3 grass fed were sourced from northern and central New South Wales and the short grain fed and long grain fed beef cattle were sourced from feedlots in southern Queensland. All animals were Bos Taurus genotype.

Omega 3 Fatty Acid Content of Lean Red Meat
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Key findings:

1. In general, rump across all animals or feed types had more omega 3 FA, omega 6 FA, trans 18:1 FA, saturated and monounsaturated FA and CLA than striploin.
2. Grass-fed cattle had more omega 3 FA (short and long chain omega 3) than short grain-fed across all animal types; this finding was especially true for rump (significantly higher total n-3 FA for grass fed than grain fed), but less obvious for strip loin (no consistent significant difference between grass fed and grain fed, though the highest value for n-3 FA in striploin was in C3 grass fed and the lowest in domestic short grain fed).
3. For rump and striploin, there were no major or significant differences in omega 3 FA between C3 and C4 grasses.
4. The C4 grass fed animals had the highest CLA value in rump (not striploin), however this probably reflected the fact that this group for rump had the highest total FA content.
5. For rump and striploin, there were no significant differences between Bos indicus and Bos taurus values for domestic C3 fed, there were few significant difference for domestic short grain fed (total n-6 FA and trans FA), while the short grain fed Jap ox had significantly higher FA values for most FA classes except CLA.
6. Moisture: For rump, the values ranged from 73 to 75%, while for striploin the values ranged from 73 to 74%. There were no consistent differences between species or feed type.
7. RUMP & STRIPLOIN - Total LCPn-3 values ranged from 40 to 118 mg/100g lean beef. This should allow lean beef to be counted as a 'source of long chain omega 3 fatty acids' as per ANZFA. However, beef and lamb have quite a high level of DPA (docosapentaenoic acid n-3) which ANZFA **do NOT count** in their category for LCPn-3. DPA levels are approximately 33 to 66 mg/100g for rump and 23 to 42 mg/100 g for striploin. Only grass fed rump EPA+DHA would consistently reach the ANZFA target of >30 mg/100g, independent of breed, but not always for short grain-fed (3/4 were). For striploin, only 3 of 8 groups exceeded the 30 mg/100 g value (the three were C3 grass-fed).
8. RUMP - Long chain omega 3 (LCPn-3, 20:5, 22:5 & 22:6) in grass-fed in range 110-118 mg/100 g lean rump; in short grain-fed the values were significantly lower at 62 – 86 mg/100 g lean rump. These values, especially for the grass-fed are in the range for values for some white fish.
9. RUMP - Alpha-linolenic acid (ALA) values for grass-fed 60-88mg/100g lean rump; in short grain-fed values were significantly lower at 16-32 mg/100g lean rump.
10. RUMP – CLA in grass fed animals showed a trend (non significant) to be higher than in short grain fed.
11. RUMP – trans 18:1 in grass fed animals showed a trend (non-significant) to be lower than in short grain fed animals.
12. RUMP EPA + DHA values in grass fed (51-55 mg/100g) were significantly higher than short grain fed animals (28-35 mg/100g).
13. STRIPLOIN - Long chain omega 3 (LCPn-3) in grass-fed in range 61-75 mg/100 g lean striploin; in short grain-fed the values are 40-62 mg/100 g lean striploin (some significant differences).
14. STRIPLOIN - Alpha-linolenic acid (ALA) values for grass-fed 32-58 mg/100g lean striploin; in short grain-fed values were significantly lower at 11-19 mg/100g lean striploin.
15. STRIPLOIN – CLA in grass fed animals showed no significant difference from the short grain fed animals.
16. STRIPLOIN – trans 18:1 in grass fed animals showed a trend (mostly significant) to be lower than in short grain fed animals.

17. STRIPLOIN EPA + DHA values in grass fed (26-34 mg/100g) were not significantly different to the short grain fed animals (17-26 mg/100g).
18. More research is required on DPA to show it should be "counted" as a LCPn-3.

Summary Tables

Table 1. Total saturated, monounsaturated, omega-3, omega-6, C18:1 trans fatty acid, CLA concentration, and moisture content of Rump[1]

Variable	C3		C4		Short grain			
	Domestic		JAP	JAP	Domestic		JAP	
	Taurus	Indicus	Indicus	Indicus	Taurus	Indicus	Taurus	Indicus
Total SFA	1500^{a}	1298^{a}	1335^{a}	2564^{b}	1114^{a}	1036^{a}	2110^{b}	1394^{a}
Total MUFA	1574^{b}	1315^{ab}	1420^{ab}	3229^{d}	953^{a}	989^{ab}	2349^{c}	1492^{ab}
Total n-3 FA	175^{cd}	165^{c}	206^{d}	202^{d}	92^{a}	78^{a}	114^{b}	95^{a}
Total n-6FA	316^{ab}	268^{a}	320^{ab}	347^{b}	352^{b}	259^{a}	467^{c}	367^{b}
Total trans 18:1	67^{ab}	50^{a}	79^{ab}	161^{bc}	166^{bc}	101^{ab}	227^{c}	127^{b}
Total CLA	26^{b}	18^{b}	30^{b}	63^{c}	9^{a}	13^{a}	26^{b}	17^{ab}
Moisture	74.5^{c}	73.5^{b}	74.1^{bc}	72.6^{a}	74.2^{bc}	74.6^{c}	73.1^{ab}	73.5^{b}

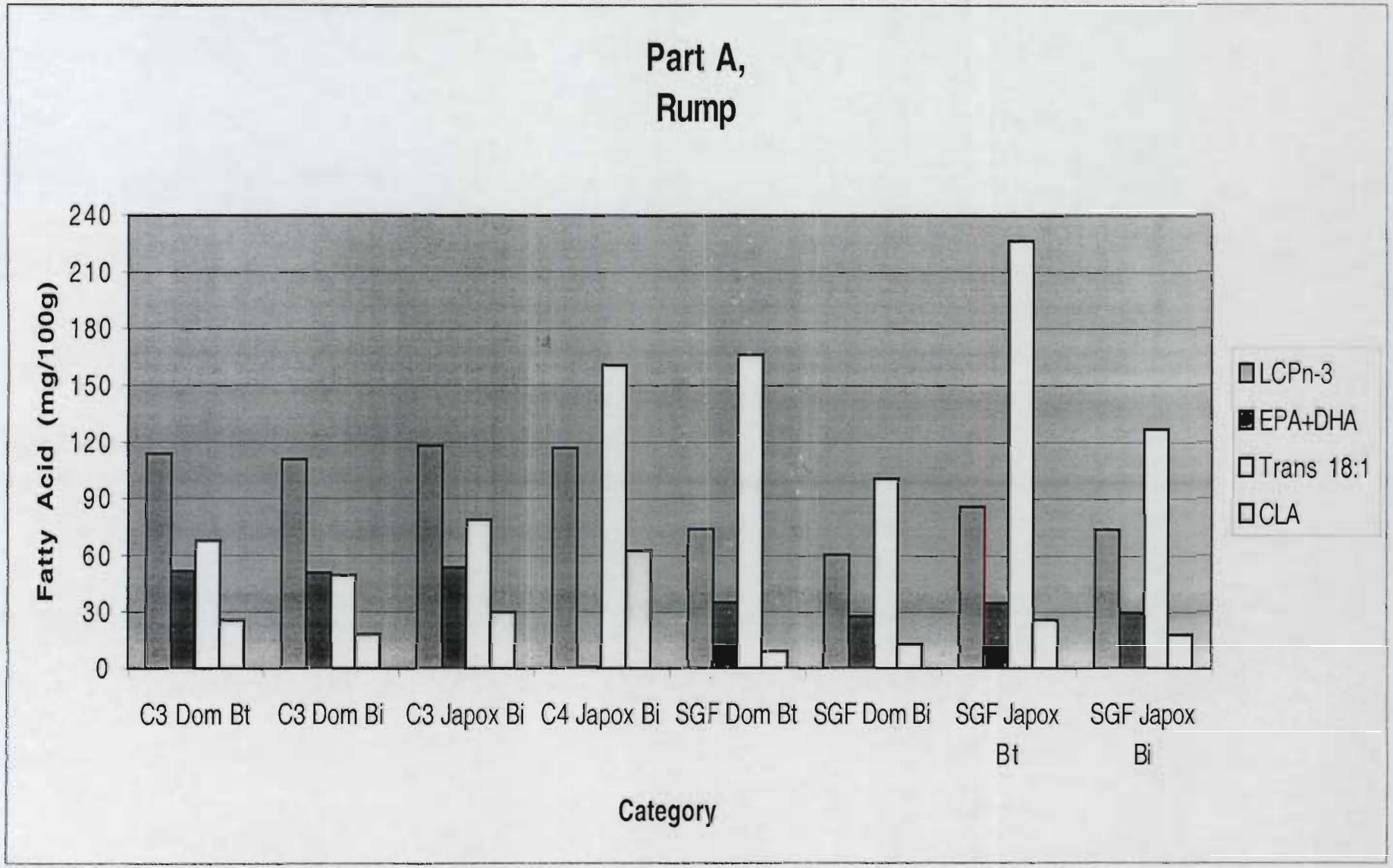
[1]Values are expressed in mg/100 g of meat sample and an average of 15 observations (analysed in duplicate). For moisture, values expressed as g/100g meat.
[a,b,c,d]Within a row, means without a common superscript letter differ (P < 0.05).

Table 2. Total saturated, monounsaturated, omega-3, omega-6, C18:1 trans fatty acid, CLA concentration, and moisture content of Strip Loin[1]

Variable	C3		C4		Short grain			
	Domestic		JAP	JAP	Domestic		JAP	
	Taurus	Indicus	Indicus	Indicus	Taurus	Indicus	Taurus	Indicus
Total SFA	1112^{ab}	917^{ab}	1230^{b}	1150^{ab}	974^{ab}	873^{a}	1670^{c}	1186^{ab}
Total MUFA	1084^{ab}	871^{ab}	1246^{b}	1217^{b}	822^{ab}	755^{a}	1704^{c}	1120^{ab}
Total n-3 FA	114^{c}	101^{bc}	132^{d}	93^{bc}	64^{ab}	50^{a}	80^{b}	63^{ab}
Total n-6FA	195^{ab}	153^{a}	205^{b}	149^{a}	221^{b}	150^{a}	295^{c}	236^{b}
Total trans 18:1	45^{ab}	30^{a}	59^{ab}	52^{ab}	150^{c}	87^{b}	189^{c}	113^{b}
Total CLA	15^{ab}	11^{ab}	22^{b}	19^{b}	7^{a}	8^{a}	17^{ab}	12^{a}
Moisture	74.1^{d}	73.8^{cd}	73.2^{bc}	73.5^{bcd}	73.5^{bcd}	73.8^{cd}	72.5^{a}	73.0^{ab}

[1]Values are expressed in mg/100 g of meat sample and an average of 15 observations(analysed in duplicate). For moisture, values expressed as g/100g meat.
[a,b,c,d]Within a row, means without a common superscript letter differ (P < 0.05).

Figure 1. Fatty Acid content of rump from different beef categories (feed type and species)



Feeding regimes affect fatty acid composition in Australian beef cattle

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Background - There is growing evidence that red meat contributes significantly to the intake of omega 3 long chain PUFA in western diets. The type of feeding regime used in animal production, can influence the lipids in red meat due to the fatty acid composition of the feed. Pasture feed being relatively rich in α-linolenic acid (18 3n-3), while grain is relatively rich in linoleic acid (18:2n-6).
Objective - To determine the effect on beef fatty acid profile of varying length of grain feeding compared with grass feeding.
Design - Samples of rump, strip loin and blade cuts were obtained from eighteen cattle from each of three feeding regimes (pasture fed, short term grain feeding STGF, and long term grain feeding LTGF). All samples were analysed in triplicate as lean tissue only, using a standard chloroform – methanol extraction and capillary column gas-chromatograph fatty acid quantification.
Outcomes - Total fat, saturated and monounsaturated fatty acids were all significantly higher in the LTGF animals. The grass fed animals had high levels of omega 3 PUFA in all three cuts, with combined EPA + DHA reaching levels in blade and strip loin that would meet Australian Food Standards classification as a "source" of omega-3, with the rump cut reaching this level in the STGF group also. Rump from the grass fed animals was a relatively rich source of EPA + DHA and would qualify as a "good source" of omega 3.
Conclusions - This study was able to show that pasture feeding of Australian cattle maximises omega-3 PUFA content and minimizes trans 18:1 fatty acid levels relative to grain feeding. Furthermore, LTGF results in elevated total fat and saturated fat content relative to STGF or grass feeding in lean cuts of Australian beef.

Figure 2. Fatty Acid content of striploin from different beef categories (feed type and species)

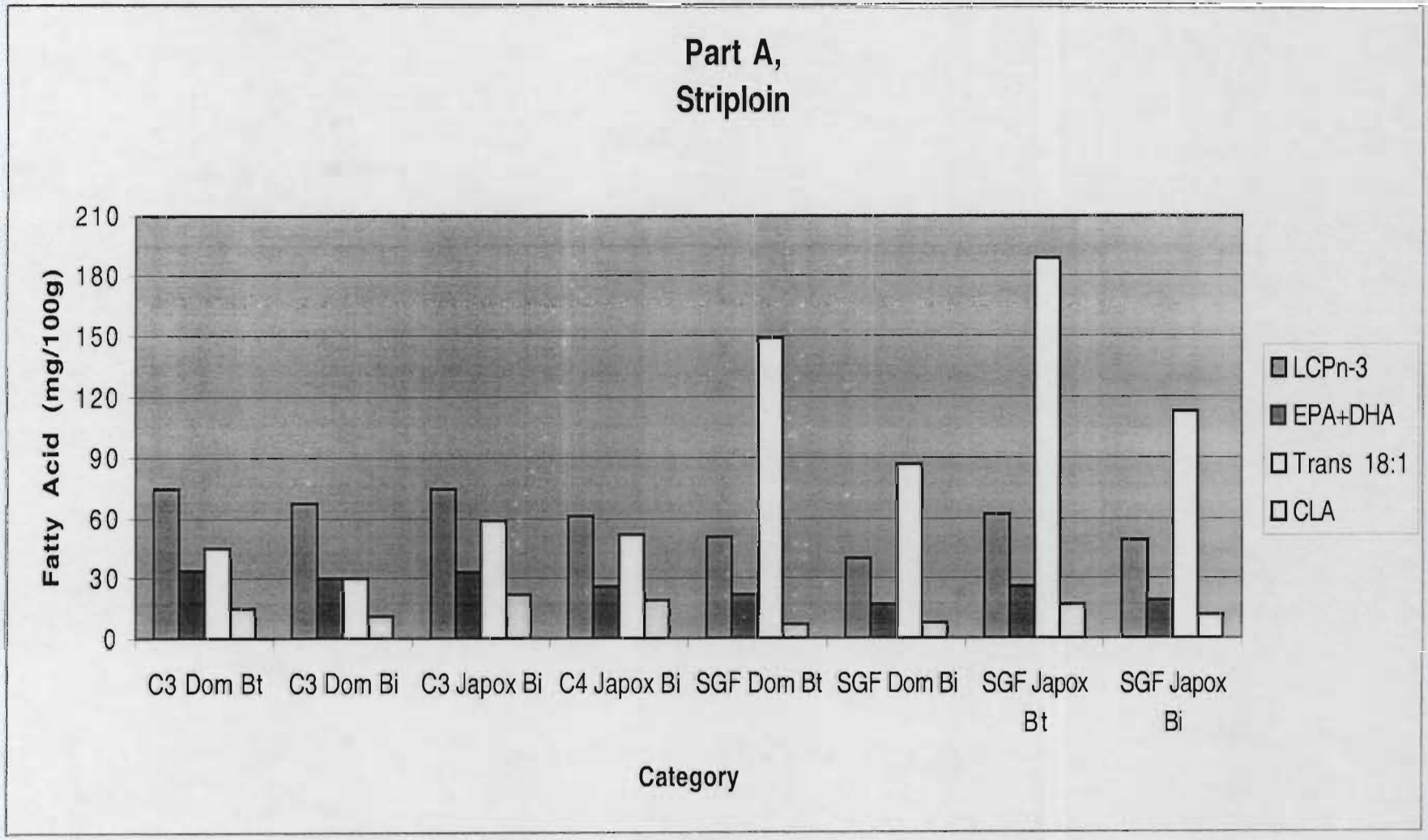


Table 3. Rump fatty acid concentration (mg/100g wet weight)[1]

	C3			C4	SHORT GRAIN-FED			
	DOMESTIC		JAPANESE	JAPANESE	DOMESTIC		JAPANESE	
	Taurus[2]	Indicus[2]	Indicus[2]	Indicus[2]	Taurus[2]	Indicus[2]	Taurus[2]	Indicus[2]
ALA 18:3n-3	60.73 ± 8.36 [c]	54.79 ± 12.17 [c]	88.42 ± 7.32 [d]	84.63 ± 3.73 [d]	18.41 ± 1.08 [a]	16.49 ± 1.62 [a]	31.18 ± 8.23 [ab]	20.97 ± 5.06 [a]
EPA 20:5n-3	43.70 ± 5.02 [b]	41.63 ± 5.46 [b]	46.18 ± 2.21 [b]	40.21 ± 3.94 [b]	27.72 ± 2.67 [a]	21.48 ± 2.45 [a]	27.41 ± 5.21 [a]	22.84 ± 4.43 [a]
DPA 22:5n-3	62.04 ± 5.01 [b]	60.02 ± 6.28 [b]	63.48 ± 3.68 [b]	66.16 ± 8.94 [b]	39.35 ± 2.39 [a]	33.48 ± 3.77 [a]	50.81 ± 7.01 [ab]	43.60 ± 8.91 [a]
DHA 22:6n-3	8.69 ± 1.42 [a]	9.31 ± 1.74 [a]	8.20 ± 1.24 [a]	10.76 ± 2.09 [a]	6.91 ± 0.95 [a]	6.51 ± 0.46 [a]	7.32 ±0.96 [a]	7.39 ± 1.85 [a]
EPA+DHA	52.39 ± 6.37 [b]	50.94 ± 6.76 [b]	54.37 ± 3.11 [b]	50.97 ± 5.80 [b]	34.63 ± 3.19 [a]	27.99 ± 2.82 [a]	34.73 ± 5.60 [a]	30.21 ± 6.07 [a]
Total n-3 LCPUFA	114.44 ± 11.30 [b]	110.96 ± 12.48 [b]	117.85 ± 6.39 [b]	117.13 ± 13.35 [b]	73.98 ± 5.35 [a]	61.48 ± 6.14 [a]	85.54 ± 12.50 [a]	73.81 ± 14.96 [a]
Total n-3 PUFA	175.17 ± 15.12 [cd]	165.83 ± 22.41 [c]	206.27 ± 9.21 [d]	201.77 ± 16.54 [d]	92.39 ± 6.20 [a]	77.71 ± 7.19 [a]	114.07 ± 18.68 [b]	94.78 ± 19.58 [a]
CLA 18:2	25.69 ± 7.88 [b]	18.47 ± 3.01 [b]	29.85 ± 3.34 [b]	63.25 ± 8.12 [c]	9.47 ± 2.10 [a]	13.17 ± 3.55 [a]	26.46 ± 9.93 [b]	17.76 ± 2.61 [ab]
18:1Trans	66.70 ± 16.07 [ab]	50.35 ± 7.64 [a]	78.53 ± 15.70 [ab]	160.74 ± 19.95 [bc]	166.26 ± 22.27 [bc]	100.91 ± 16.57 [ab]	227.16 ± 80.96 [c]	127.47 ± 48.02 [b]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n = 3 x 5 beasts x duplicate analyses

Table 4. Strip loin fatty acid concentration (mg/100g wet weight)[1]

	C3		C4		SHORT GRAIN-FED			
	DOMESTIC		JAPANESE	JAPANESE	DOMESTIC		JAPANESE	
	Taurus[2]	Indicus[2]	Indicus[2]	Indicus[2]	Taurus[2]	Indicus[2]	Taurus[2]	Indicus[2]
ALA 18:3n-3	39.36 ± 6.57 [b]	33.95 ± 5.56 [b]	57.53 ± 5.89 [c]	32.24 ± 7.23 [b]	13.69 ± 0.73 [a]	10.97 ± 0.64 [a]	19.29 ± 4.84 [a]	14.59 ± 4.29 [a]
EPA 20:5n-3	28.52 ± 3.37 [c]	24.42 ± 4.98b [c]	27.73 ± 1.74b [c]	21.38 ± 3.67 [b]	18.20 ± 2.53 [ab]	12.86 ± 0.91 [a]	20.18 ± 3.96 [b]	14.83 ± 4.01 [a]
DPA 22:5n-3	37.38 ± 8.10 [b]	41.08 ± 5.63 [b]	41.89 ± 1.12 [b]	34.86 ± 6.48 [b]	28.15 ± 1.85 [ab]	22.59 ± 1.09 [a]	36.27 ± 5.98 [b]	29.38 ± 7.70 [at
DHA 22:6n-3	5.11 ± 0.92 [a]	5.73 ± 1.81 [a]	4.92 ± 0.68 [a]	4.75 ± 0.42 [a]	4.19 ± 0.78 [a]	4.11 ± 0.29 [a]	5.68 ± 0.76 [a]	4.54 ± 1.50 [a]
EPA+DHA	33.63 ± 4.15 [b]	30.15 ± 6.71 [b]	32.65 ± 1.65 [b]	26.13 ± 4.09 [b]	22.39 ± 2.89 [ab]	16.98 ± 1.16 [a]	25.86 ± 4.61 [b]	19.37 ± 5.48 [at
Total n-3 LCPUFA	74.71 ± 9.54 [c]	67.53 ± 14.67 [b]	74.55 ± 2.74b [c]	61.00 ± 10.23 [b]	50.53 ± 4.47 [ab]	39.57 ± 1.62 [a]	62.13 ± 10.46 [b]	48.76 ± 13.17 [ab]
Total n-3 PUFA	114.06 ± 13.50 [c]	101.48 ± 18.83 [bc]	132.07 ± 6.70 [d]	93.24 ± 16.83 [bc]	64.22 ± 4.92 [ab]	50.54 ± 1.44 [a]	80.01 ± 14.21 [b]	63.35 ± 17.41 [ab]
CLA 18:2	15.45 ± 4.91 [ab]	11.45 ± 2.18 [ab]	22.11 ± 2.75 [b]	18.66 ± 8.81 [b]	7.34 ± 1.24 [a]	8.46 ± 1.43 [a]	16.99 ± 3.71 [ab]	12.12 ± 3.46 [a]
18:1Trans	44.74 ± 10.13 [ab]	30.05 ± 7.97 [a]	58.55 ± 9.02 [ab]	52.19 ± 25.37 [ab]	149.55 ± 26.98 [c]	87.47 ± 11.10 [b]	189.45 ± 26.51 [c]	113.10 ± 42.6[[b]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, $P<0.05$). [2] n = 3 x 5 beasts x duplicate analyses.

THE OMEGA 3 CONTENT OF LEAN RED MEAT
(Part B)

The aim of Part B was to compare the fatty acids in meat (rump, blade and striploin) from C3 grass-fed, short grain-fed and long grain-fed beef cattle.

Studies

Objectives

To provide a full report for the beef omega 3 fatty acid content and other major fatty acid concentration from grass (C3 pasture), short grain-fed and long grain-fed animals.

Methods

As described.

Samples

Samples were obtained Mr Shane Blakely from C3 grass fed, short grain fed and long grain-fed beef cattle In each case, there were 3 groups of 6 animals per feed-type and three cuts per animal were analysed (rump, blade and striploin).

Samples from C3 grass fed were sourced from northern and central New South Wales and the short grain fed and long grain fed beef cattle were sourced from feedlots in southern Queensland. All animals were of the Bos Taurus genotype.

Part B

Omega 3 Fatty Acid Content of Lean Red Meat
Project CMHN.016

Key findings:

1. Japanese ox, long grain-fed had the highest total fatty acid content for all three cuts. As a consequence, this beef had the highest saturated, monounsaturated, n-6 polyunsaturated and 18:1-trans fatty acid content for all three cuts examined, compared with domestic grass and short grain-fed beef.
2. Domestic, short grain-fed beef had the same total fatty acid, saturated, monounsaturated, n-6 polyunsaturated content as domestic grass-fed beef.
3. Domestic, short grain-fed beef had significantly lower long chain n-3 fatty acids and CLA and significantly higher levels of 18:1-trans fatty acid content for all three cuts compared with domestic grass fed beef.
4. Domestic grass-fed beef had the highest level of EPA plus DHA, long chain n-3 fatty acids and total n-3 fatty acids for all three cuts, compared with short grain-fed and long grain-fed beef.
5. Rump across all feed types had significantly more omega 3, omega 6, trans 18:1, saturated and monounsaturated fatty acids and CLA than blade and striploin. In some cases, striploin contained the lowest level of omega 3 fatty acids.
6. The total omega 3 fatty acid content ranged from 49 to 155 mg/100g lean meat (wet weight).
7. The long chain omega 3 content ranged from 38 to 105 mg/100g lean meat (wet weight).
8. EPA plus DHA ranged from 15 to 48 mg/100g lean meat (wet weight).
9. Grass-fed and short grain-fed cattle had less saturated, monounsaturated and trans-18:1 than long-grain fed animals for all three cuts of meat. There was a step-wise increase in trans-18:1 from C3 to short grain-fed to long grain-fed.

10. All cuts of meat and all feed types had more than 30 mg of long chain n-3 FA (EPA plus DPA plus DHA), Figure 3.

11. All feed types for rump had more than 30 mg of EPA plus DHA, however none of the strip loins exceeded 30 mg and only the C3 grass-fed for blade exceeded the 30 mg of EPA plus DHA, Figure 3.

Are there plausible explanations for the findings?

The highest fat content was found in Japanese ox. As animals age and with long-term grain feeding, there is an increase in fat accumulation in meat. As the fat content increases, so the components of total fat increase (that is, the typical triglyceride fatty acids). Therefore, saturated, monounsaturated and 18:1-trans fatty acid contents would be higher in this group of animals.

The domestic grass-fed animals had the highest omega 3 fatty acid content. This group of animals would be expected to have the highest dietary intake of omega 3 fatty acids from the grass. Typically, grass contains 60% omega 3 fatty acids (as alpha-linolenic acid) and 10-20% omega 6 fatty acids (as linoleic acid). In contrast, almost all grain is typically rich in omega 6 fatty acids and contains low levels of omega 3 fatty acids.

Grass-fed beef had a higher CLA level than short grain-fed beef.

The literature reveals that the major product of rumen hydrogenation of PUFA in grass (linolenic and linoleic acids) is *trans*-11 18:1 (vaccenic acid). Once this fatty acid is absorbed, it is the substrate for CLA production in adipose or mammary tissue via the action of the delta-9 desaturase. Cattle fed pasture have higher levels of *trans*-11-18:1 than concentrate-fed cattle and also higher levels of CLA (Griiniari and Bauman 1999, Advances in Conjugated Linoleic Acid Research Volume 1, pp 180-200, 1999, AOCS Press, Champaign IL). Furthermore, it has been found that *trans*-10 18:1 is a major *trans* fatty acid in US beef (basically grain-fed) compared with European beef where the major trans isomer is *trans*-11 18:1 (Griiniari and Bauman 1999). The trans-10 isomer is not an effective substrate for CLA production. The data obtained in this study show that the % CLA of total fatty acids in rump steak was 1.15% for

grass-fed, 0.55% for short grain-fed and 0.52% for long grain-fed, which is consistent with the literature cited here.

Grain-fed beef had a higher 18:1-trans fatty acid content than grass-fed beef.
In this study, all *trans* isomers of 18:1 are grouped together because this is the nature of collection of the data in the technology we are using. The concentration of *trans*-18:1 increases from grass-fed, through short grain-feeding to long grain-fed samples. The % *trans*-18:1 in rump steak shown in Table 5, was 2.3% for grass-fed, 5.1% for short grain-fed and 4.0% for long grain-fed, suggesting that grain feeding increases the proportion of all *trans*-18:1 isomers. The increased content of *trans*-18:1 is consistent with literature reports (for example, Marmer, Maxwell & Williams, J Anim Sci 59, 109-120, 1984) and is perhaps due to the increased intake of linoleic acid in grain feeding compared with grass feeding.

Comparison between Part A and Part B data
Figures 4 and 5 depict selected fatty acids in rump and strip loin from each of the two parts of this project. Fatty acids shown are LCP n-3, EPA+DHA, trans-18:1 and CLA.

The data in Figure 4 (for rump) shows that both part A and B found similar levels of these four fatty acids (groups). In particular, for EPA+DHA, the C3 domestic cattle had values of approx. 50 mg/100 g lean meat, while for the short grain-fed cattle the EPA+DHA values were approx. 30 mg/100 g lean meat.

The data in Figure 5 (for strip loin) shows that both part A and B found similar levels of these four fatty acids (groups). In particular, for EPA+DHA, the C3 domestic cattle had values of 65-75 mg/100 g lean meat, while for the short grain-fed cattle the EPA+DHA values were 15-20 mg/100 g lean meat.

Figure 3. Fatty Acid content of three cuts from three feeding systems

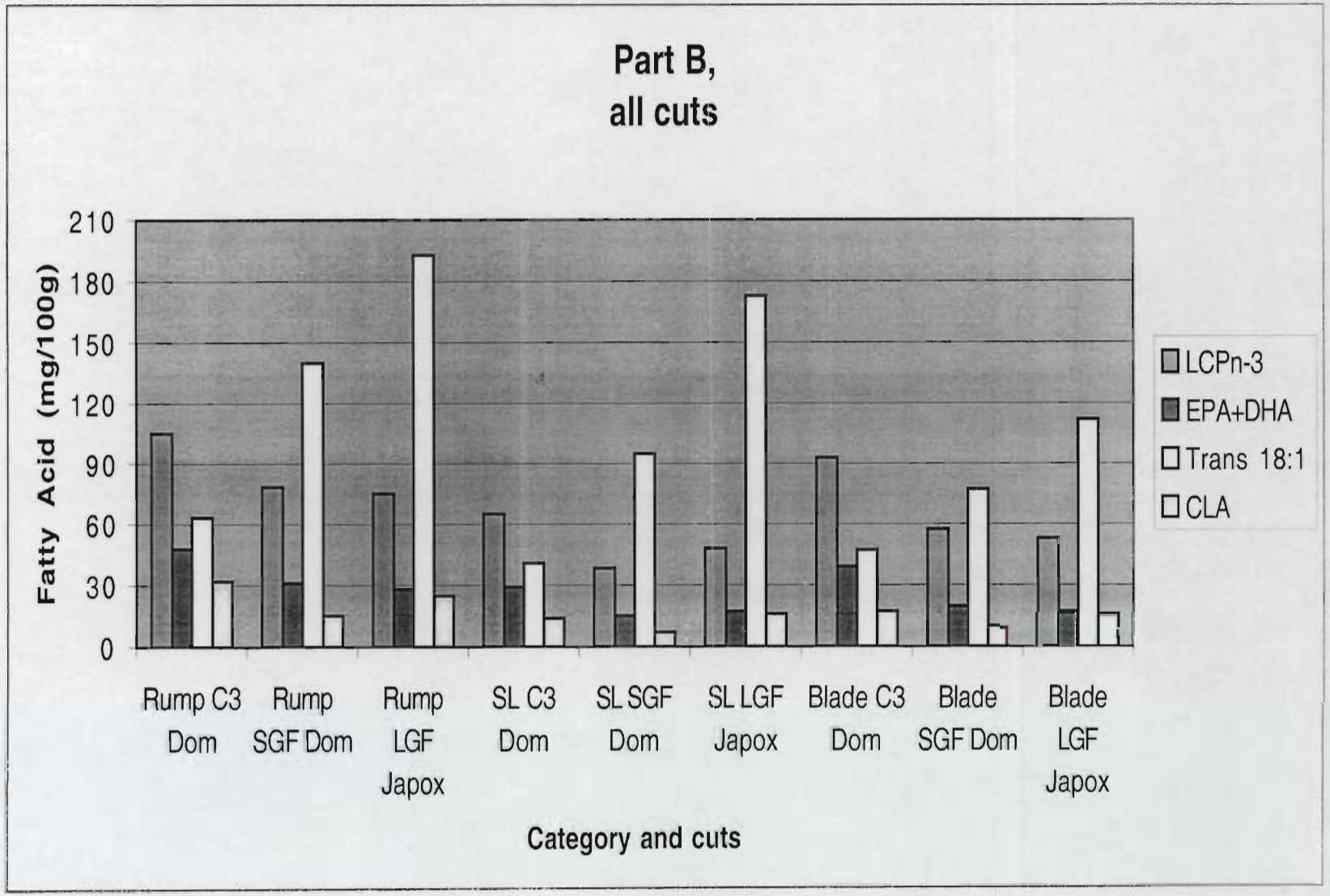


Figure 4. Fatty Acid content of Rump from Part A and Part B studies

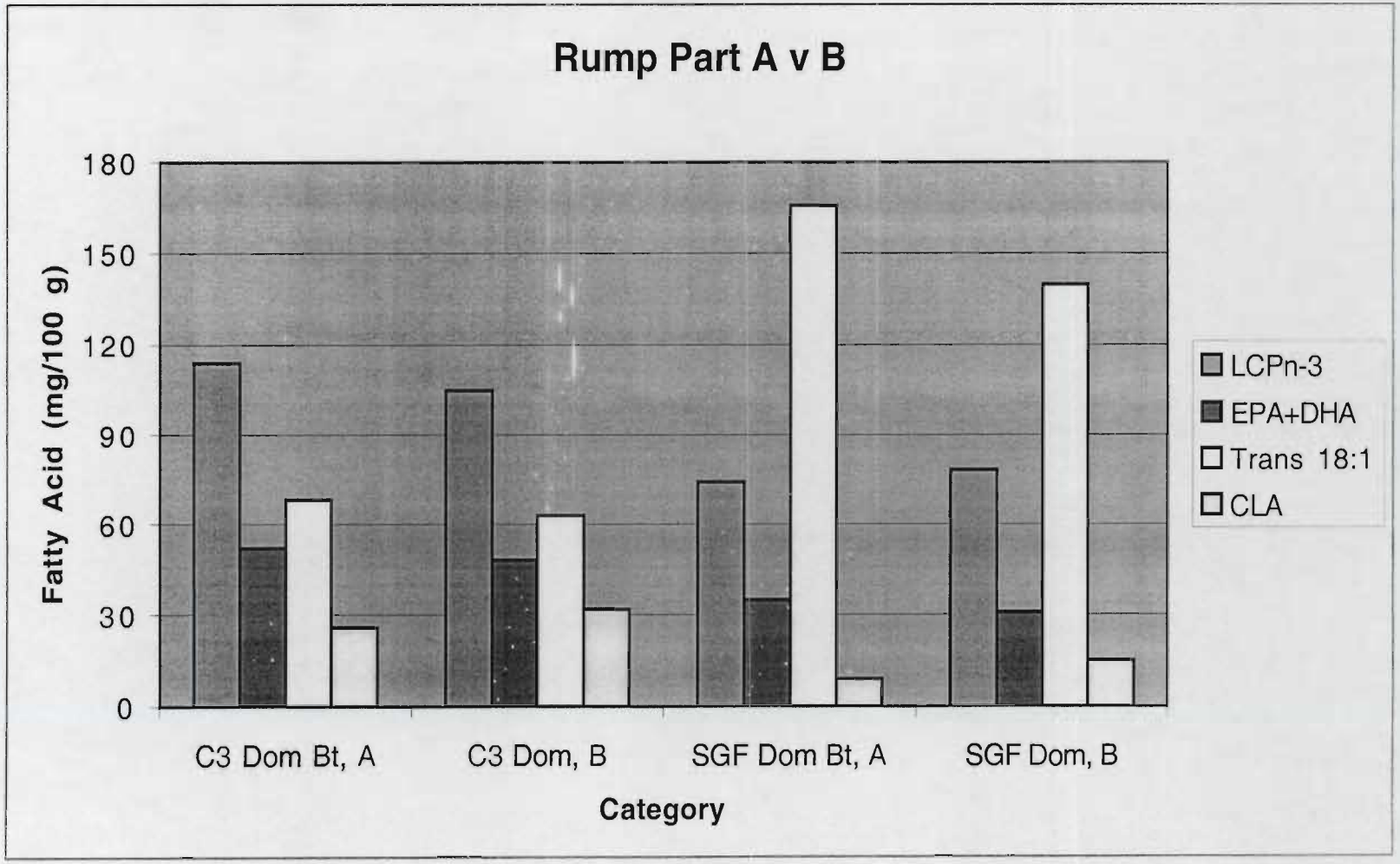
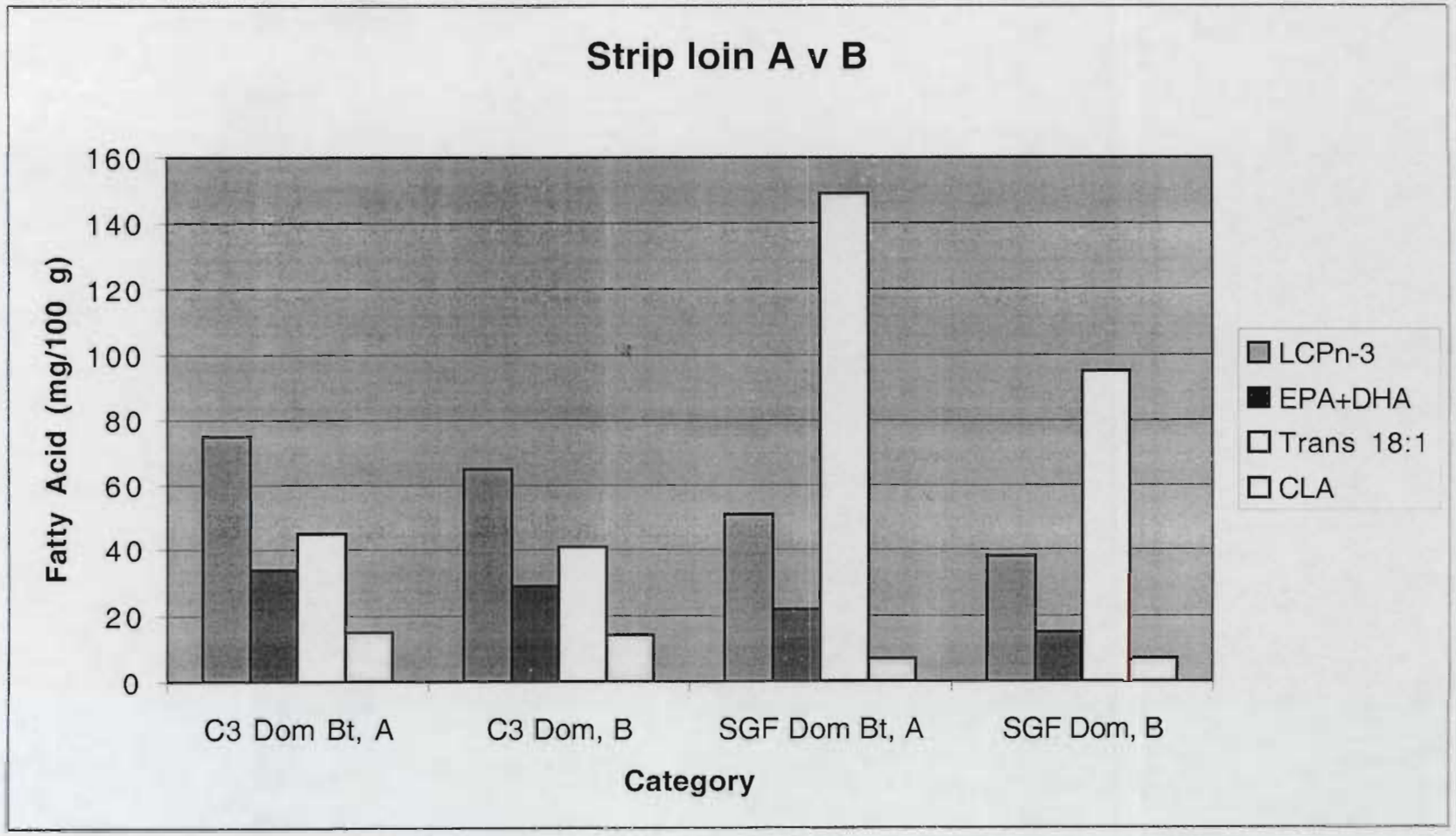


Figure 5. Fatty Acid content of Strip Loin from Part A and Part B studies



Part B

Summary Tables

Comparison between feeding systems for different cuts (Tables 5 to 10)

Table 5: Total saturated, monounsaturated, omega-3 and omega-6 fatty acid concentration in **Rump steaks** of cattle fed grass, short-term grain (80 days) and long-term grain (150- 200 days)

	Domestic C3 Grass	Domestic Short Grain	Japanese Ox Long Grain	S.E.M	P-value
Total SFA	1117[a]	1067[a]	1865[b]	162.7	0.001
Total MUFA	1185[a]	1218[a]	2463[b]	237.4	0.001
Total n-3 PUFA	155[b]	97[a]	97[a]	11.9	0.01
Total n-6 FA	334[a]	354[ab]	399[b]	25.6	0.04
18:1-trans	63[a]	140[b]	193[c]	19.7	0.001
CLA	32[b]	15[a]	25[ab]	6.5	0.05
Total FA	2792[a]	2736[a]	4824[b]	411	0.001
Moisture	73.9[b]	73.7[b]	71.6[a]	0.32	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 6: Total saturated, monounsaturated, omega-3 and omega-6 fatty acid concentration in **Strip Loin** of cattle fed grass, short-term grain (80 days) and long-term grain (150- 200 days)

	Domestic C3 grass	Domestic Short Grain	Japanese Ox Long Grain	S.E.M	P-value
Total SFA	900[a]	677[a]	1568[b]	167.8	0.001
Total MUFA	930[a]	639[a]	1729[b]	208.6	0.01
Total n-3 PUFA	98[b]	49[a]	63[a]	7.5	0.01
Total n-6 FA	192[a]	173[a]	254[b]	15.7	0.01
18:1-trans	41[a]	95[b]	173[c]	18.9	0.001
CLA	14[b]	7[a]	16[b]	2.3	0.01
Total FA	2120[a]	1538[a]	3614[b]	383	0.001
Moisture	73.6[b]	73.5[b]	71.2[a]	0.35	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 7: Total saturated, monounsaturated, omega-3 and omega-6 fatty acid concentration in **Blade** of cattle fed grass, short-term grain (80 days) and long-term grain (150- 200 days)

	Domestic C3 grass	Domestic Short Grain	Japanese Ox Long Grain	S.E.M	P-value
Total SFA	801[a]	644[a]	1172[b]	98.6	0.001
Total MUFA	943[a]	781[a]	1663[b]	156	0.01
Total n-3 PUFA	135[b]	70[a]	68[a]	8.9	0.001
Total n-6 FA	258	242	272	17.8	NS
18:1-trans	47[a]	77[b]	112[c]	13.1	0.001
CLA	17[b]	10[a]	16[b]	2.3	0.01
Total FA	2138[a]	1738[a]	3175[b]	265	0.001
Moisture	75.0[b]	74.8[b]	73.2[a]	0.25	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 8: Individual fatty acid concentration in **Rump steaks**
of cattle fed grass, short-term grain (80 days) and long-term grain (150- 200 days)

	Domestic C3 Grass	Domestic Short Grain	Japanese Ox Long Grain	S.E.M	P-value
ALA 18:3n-3	49[b]	17[a]	21[a]	5.1	0.001
EPA 20:5n-3	40[b]	23[a]	21[a]	3.2	0.001
DPA 22:5n-3	57[b]	47[a]	48[a]	4.4	0.05
DHA 22:6n-3	8	8	7	0.97	NS
EPA + DHA	48[b]	31[a]	28[a]	3.63	0.001
Total LCn-3 PUFA	105[b]	78[a]	75[a]	7.8	0.001
Total n-3 PUFA	155[b]	97[a]	97[a]	11.9	0.01
CLA	32[b]	15[a]	25[ab]	6.5	0.05
18:1-trans	63[a]	140[b]	193[c]	19.7	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 9: Individual fatty acid concentration in **Strip Loin**
of cattle fed grass, short-term grain (80 days) and long-term grain (150- 200 days)

	Domestic C3 Grass	Domestic Short Grain	Japanese Ox Long Grain	S.E.M	P-value
ALA 18:3n-3	32[b]	10[a]	15[a]	3.2	0.001
EPA 20:5n-3	25[b]	11[a]	13[a]	1.9	0.001
DPA 22:5n-3	37[c]	24[a]	32[b]	2.6	0.001
DHA 22:6n-3	4	4	4	0.44	NS
EPA + DHA	29[b]	15[a]	17[a]	2.2	0.001
Total LCn-3 PUFA	65[c]	38[a]	48[b]	4.7	0.001
Total n-3 PUFA	98[b]	49[a]	63[a]	7.5	0.01
CLA	14[b]	7[a]	16[b]	2.3	0.01
18:1-trans	41[a]	95[b]	173[c]	18.9	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 10: Individual fatty acid concentration in **Blade**
of cattle fed grass, short-term grain (80 days) and long-term grain (150- 200 days)

	Domestic C3 Grass	**Domestic Short Grain**	**Japanese Ox Long Grain**	**S.E.M**	**P-value**
ALA 18:3n-3	42^{b}	14^{a}	15^{a}	4.0	0.001
EPA 20:5n-3	32^{b}	15^{a}	12^{a}	2.3	0.01
DPA 22:5n-3	54^{b}	37^{a}	36^{a}	3.2	0.001
DHA 22:6n-3	7^{b}	5^{a}	4^{a}	0.48	0.01
EPA + DHA	39^{b}	20^{a}	17^{a}	2.5	0.001
Total LCn-3 PUFA	93^{b}	57^{a}	53^{a}	5.4	0.001
Total n-3 PUFA	135^{b}	70^{a}	68^{a}	8.9	0.001
CLA	17^{b}	10^{a}	16^{b}	2.3	0.01
18:1-trans	47^{a}	77^{b}	112^{c}	13.1	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
^{a,b,c}Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Comparison between Strip loin, rump and blade cuts (Tables 11 to 16)

Table 11: Total saturated, monounsaturated, omega-3 and omega-6 fatty acid concentration in **Strip loin, Rump, and Blade** cuts of cattle fed C_3 grass

	Strip Loin	Rump	Blade	S.E.M	P-value
Total SFA	901[ab]	1118[b]	801[a]	131.1	0.05
Total MUFA	930	1185	943	172.8	NS
Total n-3 PUFA	97.6[a]	154.7[b]	135.2[b]	13.4	0.001
Total n-6 FA	192[a]	334[c]	258[b]	18.7	0.001
18:1-trans	40.5[a]	63.3[b]	47.0[ab]	8.6	0.05
Total FA	2120[a]	2792[b]	2138[a]	312	0.05

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 12: Total saturated, monounsaturated, omega-3 and omega-6 fatty acid concentration in **Strip Loin, Rump** and **Blade** cuts of cattle fed short-term grain (80 days)

	Strip Loin	Rump	Blade	S.E.M	P-value
Total SFA	676[a]	1067[b]	644[a]	80.1	0.001
Total MUFA	639[a]	1218[b]	781[a]	113.3	0.001
Total n-3 PUFA	48.6[a]	96.8[c]	70.4[b]	6.1	0.001
Total n-6 FA	173[a]	354[c]	243[b]	18.3	0.001
18:1-trans	94.9[a]	139.5[b]	76.5[a]	17.3	0.01
Total FA	1538[a]	2736[b]	1738[a]	193	0.001

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 13: Total saturated, monounsaturated, omega-3 and omega-6 fatty acid concentration in **Strip loin, Rump** and **Blade** cuts of cattle fed long-term grain (150- 200 days)

	Strip Loin	Rump	Blade	S.E.M	P-value
Total SFA	1567[b]	1865[b]	1172[a]	201.8	0.01
Total MUFA	1729[a]	2463[b]	1663[a]	285.4	0.01
Total n-3 PUFA	63.3[a]	96.6[b]	67.8[a]	7.6	0.001
Total n-6 FA	254[a]	399[b]	272[a]	23.2	0.001
18:1-trans	172.9[b]	192.7[b]	111.6[a]	23.2	0.01
Total FA	3614[a]	4824[b]	3175[a]	501	0.01

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 14: Individual fatty acid (important) concentration in **Strip loin, Rump** and **Blade** cuts of cattle fed C_3 grass

	Strip Loin	Rump	Blade	S.E.M	P-value
ALA 18:3n-3	32.4[a]	49.8[b]	42.1[ab]	6.4	0.05
EPA 20:5n-3	24.5[a]	39.8[b]	32.0[a]	3.8	0.001
DPA 22:5n-3	36.5[a]	57.4[b]	54.0[b]	3.9	0.001
DHA 22:6n-3	4.2[a]	7.7[b]	7.1[b]	0.65	0.01
EPA + DHA	28.8[a]	47.5[c]	39.1[b]	4.0	0.001
Total LCn-3 PUFA	65.2[a]	104.9[b]	93.0[b]	7.6	0.001
Total n-3 PUFA	97.6[a]	154.7[b]	135.2[b]	13.4	0.001
CLA 18:2n-6	14.3[a]	31.5[b]	17.0[a]	6.4	0.05
18:1-trans	40.5[a]	63.3[b]	47.0[ab]	8.6	0.05

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 15: Individual fatty acid (important) concentration in **Strip Loin, Rump** and **Blade** cuts of cattle short-term grain (80 days)

	Strip Loin	Rump	Blade	S.E.M	P-value
ALA 18:3n-3	10.3[a]	18.6[c]	13.5[b]	1.7	0.001
EPA 20:5n-3	11.0[a]	23.3[b]	14.7[a]	2.5	0.001
DPA 22:5n-3	23.6[a]	46.9[c]	36.9[b]	3.2	0.001
DHA 22:6n-3	3.7[a]	7.9[c]	5.3[b]	0.72	0.001
EPA + DHA	14.8[a]	31.2[c]	20.0[b]	2.1	0.001
Total n-3 PUFA	48.6[a]	96.8[c]	70.4[b]	6.1	0.001
Total n-6 FA	173[a]	354[c]	243[b]	18.3	0.001
CLA 18:2n-6	6.8[a]	15.0[c]	9.6[b]	1.45	0.01
18:1-trans	94.9[a]	139.5[b]	76.5[a]	17.3	0.01

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).
S.E.M = Pooled standard error means are shown.

Table 16: Individual fatty acid (important) concentration in **Strip loin, Rump** and **Blade** cuts of cattle long-term grain (150- 200 days)

	Strip Loin	Rump	Blade	S.E.M	P-value
ALA 18:3n-3	14.9[a]	21.4[b]	15.1[a]	3.0	0.06
EPA 20:5n-3	13.1[a]	20.9[b]	13.2[a]	1.5	0.001
DPA 22:5n-3	31.6[a]	47.6[b]	36.2[a]	3.4	0.001
DHA 22:6n-3	3.7[a]	6.8[b]	4.2[a]	0.65	0.001
EPA + DHA	16.8[a]	27.7[b]	16.5[a]	2.0	0.001
Total LCn-3 PUFA	48.4[a]	75.3[b]	52.8[a]	5.3	0.001
Total n-3 PUFA	63.3[a]	96.6[b]	67.8[a]	7.6	0.001
CLA 18:2n-6	16.1[a]	25.2[b]	15.6[a]	3.1	0.01
18:1-trans	172.9[b]	192.7[b]	111.6[a]	23.2	0.01

Values are expressed in mg/100 g of muscle sample and an average of 18 observations (3 x 6 animals analysed in duplicate).

[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).

S.E.M = Pooled standard error means are shown.

Appendix

Table 1a. Rump fatty acid concentration (mg/100g wet weight) of C3 grass-fed, domestic Bos Taurus.

	011017BkB[2]	011030BkB[2]	011114BkB[2]
ALA 18:3n-3	48.08 ± 11.89 [a]	75.98 ± 72.21 [a]	58.15 ± 13.97 [a]
EPA 20:5n-3	35.68 ± 8.38 [a]	42.47 ± 3.64 [ab]	52.96 ± 8.91 [a]
DPA 22:5n-3	43.65 ± 10.62 [a]	70.54 ± 8.16 [a]	71.93 ± 13.54 [ab]
DHA 22:6n-3	6.92 ± 1.28 [a]	8.41 ± 0.83 [a]	10.75 ± 3.53 [a]
EPA+DHA	42.60 ± 9.62 [a]	50.88 ± 3.97 [ab]	63.71 ±. 12.32 [b]
Total n-3 LC PUFA	86.26 ± 19.65 [a]	121.42 ± 12.00 [b]	135.3 ± 25.76 [b]
Total n-3 PUFA	134.34 ± 30.0 [a]	197.40 ± 37.64 [b]	193.78 ± 22.30 [b]
CLA 18:2	22.80 ± 8.47 [a]	32.10 ± 18.43 [a]	22.17 ± 5.34 [a]
18:1Trans	53.60 ± 20.16 [a]	85.75 ± 38.28 [a]	60.75 ± 15.33 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses

Table 1b. Rump fatty acid concentration (mg/100g wet weight) of C3 grass-fed, domestic Bos Indicus.

	011018-1ACC[2]	011018-2ACC[2]	011018-3ACC[2]
ALA 18:3n-3	50.51 ± 18.52 [a]	7.63 ± 20.62 [a]	42.24 ± 13.52 [a]
EPA 20:5n-3	36.72 ± 8.95 [a]	51.09 ± 4.86 [b]	37.07 ± 8.65 [a]
DPA 22:5n-3	54.70 ± 8.48 [a]	75.45 ± 7.69 [b]	49.92 ± 8.95 [a]
DHA 22:6n-3	7.28 ± 2.88 [a]	11.54 ± 2.33 [a]	9.13 ± 3.34 [a]
EPA+DHA	44.00 ± 10.09 [a]	62.62 ± 6.10 [b]	46.20 ± 10.15 [a]
Total n-3 LCPUFA	98.69 ± 17.36 [a]	138.07 ± .33 [b]	96.12 ± 18.98 [a]
Total n-3 PUFA	149.43 ± 35.13 [a]	209.70 ± 22.2 [b]	138.36 ± 30.60 [a]
CLA 18:2	17.23 ± .22 [a]	20.28 ± 10.07 [a]	17.91 ± 4.58 [a]
18:1Trans	38.90 ± 13.12 [a]	55.79 ± 2.94 [a]	56.35 ± 9.88 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 1c. Rump fatty acid concentration (mg/100g wet weight) of C3 grass-fed, Japanese Bos Indicus.

	010816ROK[2]	010823ROK[2]	011019IMTP[2]
ALA 18:3n-3	46.27 ± 6.06 [a]	108.13 ± 20.43 [b]	110.86 ± 20.66 [b]
EPA 20:5n-3	31.36 ± 7.45 [a]	47.32 ± 5.1 [b]	59.84 ± 3.24 [c]
DPA 22:5n-3	43.41 ± 9.01 [a]	72.32 ± 5.28 [b]	74.72 ± 9.64 [b]
DHA 22:6n-3	6.58 ± 1.74 [a]	9.92 ± 3.19 [a]	8.09 ± 0.82 [a]
EPA+DHA	37.94 ± 9.05 [a]	57.25 ± 6.22 [b]	67.93 ± 3.38 [b]
Total n-3 LCPUFA	81.35 ± 17.93 [a]	129.5 ± 10.19 [b]	142.64 ± 12.54 [b]
Total n-3 PUFA	127.63 ± 23.30 [a]	237.69 ± 25.00 [b]	253.50 ± 31.0 [b]
CLA 18:2	23.49 ± 7.19 [a]	37.20 ± 7.87 [b]	28.87 ± 7.84 [ab]
18:1Trans	63.89 ± 23.76 [a]	83.48 ± 26.44 [a]	88.22 ± 27.18 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 1d. Rump fatty acid concentration (mg/100g wet weight) of C4 grass-fed, Japanese Bos Indicus.

	010808-2G[2]	010809-2G[2]	010810-2G[2]
ALA 18:3n-3	77.81 ± 28.85 [a]	82.01 ± 33.69 [a]	94.08 ± 17.74 [a]
EPA 20:5n-3	35.03 ± 5.74 [a]	37.13 ± 10.71 [a]	48.48 ± 9.79 [a]
DPA 22:5n-3	56.51 ± 13.42 [a]	60.88 ± 27.28 [a]	81.10 ± 6.50 [a]
DHA 22:6n-3	10.61 ± 2.10 [a]	8.66 ± 4.36 [a]	12.10 ± 4.37 [a]
EPA+DHA	45.65 ± 6.40 [a]	45.78 ± 14.72 [a]	61.48 ± 13.69 [a]
Total n-3 LC PUFA	102.16 ± 19.34 [a]	106.67 ± 41.80 [a]	142.58 ± 13.20 [a]
Total n-3 PUFA	179.97 ± 44.29 [a]	188.67 ± 72.49 [a]	236.66 ± 24.23 [a]
CLA 18:2	58.86 ± 36.06 [a]	62.83 ± 37.78 [a]	68.05 ± 13.23 [a]
18:1Trans	146.79 ± 73.45 [a]	162.67 ± 90.37 [a]	172.76 ± 43.38 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 1e. Rump fatty acid concentration (mg/100g wet weight) of short grain-fed, domestic Bos Taurus.

	010929W[2]	011004W[2]	011011W[2]
ALA 18:3n-3	15.54 ± 3.49 [a]	25.03 ± 2.04 [b]	14.68 ± 2.42 [a]
EPA 20:5n-3	22.35 ± 3.03 [a]	36.05 ± 2.87 [b]	24.76 ± 5.53 [a]
DPA 22:5n-3	41.66 ± 4.32 [a]	40.92 ± 4.15 [a]	35.46 ± 5.59 [a]
DHA 22:6n-3	6.53 ± 1.07 [ab]	8.29 ± 1.01 [b]	5.91± 1.15 [a]
EPA+DHA	28.88 ± 3.69 [a]	44.35 ± 3.18 [b]	30.67 ± 6.29 [a]
Total n-3 LC PUFA	70.54 ± 7.21 [ab]	85.27 ± 6.87 [b]	66.13 ± 11.79 [a]
Total n-3 PUFA	86.08 ± 10.09 [a]	110.29 ± 8.90 [b]	80.80 ± 14.00 [a]
CLA 18:2	8.42 ± 1.77 [a]	11.00 ± 3.42 [a]	9.00 ± 2.97 [a]
18:1Trans	206.81 ± 96.60 [a]	139.54 ± 53.18 [a]	152.44 ± 47.63 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 1f. Rump fatty acid concentration (mg/100g wet weight) of short grain-fed, domestic Bos Indicus.

	010807G[2]	010808-1G[2]	010810-1G[2]
ALA 18:3n-3	13.42 ± 3.40 [a]	17.08 ± 3.46 [a]	18.98 ± 3.80 [a]
EPA 20:5n-3	16.61 ± 2.26 [a]	20.12 ± 4.04 [a]	27.73 ± 3.40 [b]
DPA 22:5n-3	23.64 ± 3.05 [a]	34.22 ± 7.12 [b]	42.59 ± 4.04 [b]
DHA 22:6n-3	4.24 ± 0.61 [a]	7.23 ± 1.31 [b]	8.07 ± 1.19 [b]
EPA+DHA	20.85 ± 2.35 [a]	27.34 ± 4.83 [b]	35.80 ± 2.3 [c]
Total n-3 LC PUFA	44.48 ± 5.03 [a]	61.57 ± 10.75 [b]	78.39 ± .45 [c]
Total n-3 PUFA	57.90 ± 8.13 [a]	78.65 ± 14.17 [b]	96.57 ± 4.71 [c]
CLA 18:2	11.38 ± 8.72 [a]	12.54 ± 2.37 [a]	15.58 ± 5.69 [a]
18:1Trans	80.97 ± 40.82 [a]	114.96 ± 33.69 [a]	106.81 ± 40.52 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 1g. Rump fatty acid concentration (mg/100g wet weight) of short grain-fed, Japanese Bos Taurus.

	011012IMTP[2]	011025IMTP[2]	011112G[2]
ALA 18:3n-3	24.47 ± 5.43 [ab]	21.64 ± 3.76 [a]	47.41 ± 24.51 [b]
EPA 20:5n-3	32.41 ± 6.83 [a]	23.32 ± 4.14 [a]	26.50 ± 7.38 [a]
DPA 22:5n-3	51.56 ± 9.68 [ab]	39.32 ± 5.65 [a]	61.57 ± 9.27 [b]
DHA 22:6n-3	7.87 ± 1.01 [a]	6.81 ± 1.27 [a]	7.28 ± 0.96 [a]
EPA+DHA	40.28 ± 7.23 [a]	30.13 ± 5.16 [a]	33.78 ± 7.09 [a]
Total n-3 LC PUFA	91.83 ± 16.78 [ab]	69.44 ± 9.66 [a]	95.35 ± 16.17 [b]
Total n-3 PUFA	108.38 ± 21.11 [ab]	91.09 ± 10.69 [a]	142.76 ± 39.65 [b]
CLA 18:2	25.09 ± 14.26 [ab]	14.38 ± 5.81 [a]	39.92 ± 13.04 [b]
18:1Trans	109.14 ± 48.83 [a]	222.19 ± 116.57 [ab]	350.15 ± 137.03 [b]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 1h. Rump fatty acid concentration (mg/100g wet weight) of short grain-fed, Japanese Bos Indicus.

	010809-1G[2]	010906G[2]	010912G[2]
ALA 18:3n-3	13.65 ± 6.47 [a]	21.64 ± 12.52 [a]	27.64 ± 8.01 [a]
EPA 20:5n-3	18.70 ± 8.32 [a]	21.77 ± 8.42 [a]	28.05 ± 3.64 [a]
DPA 22:5n-3	32.05 ± 17.25 [a]	40.67 ± 16.51 [ab]	58.08 ± 3.90 [b]
DHA 22:6n-3	5.56 ± 2.15 [a]	6.62 ± 2.74 [ab]	9.93 ± 1.74 [b]
EPA+DHA	24.26 ± 10.43 [a]	28.39 ± 11.15 [a]	37.98 ± 1.94 [a]
Total n-3 LC PUFA	56.30 ± 27.62 [a]	69.06 ± 27.58 [ab]	96.06 ± 5.28 [b]
Total n-3 PUFA	69.95 ± 33.93 [a]	90.70 ± 39.52 [ab]	123.69 ± 12.58 [b]
CLA 18:2	12.77 ± 5.27 [a]	15.54 ± 10.93 [a]	24.96 ± 8.93 [a]
18:1Trans	135.93 ± 77.98 [a]	145.60 ± 89.04 [a]	100.88 ± 41.69 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2a. Strip loin fatty acid concentration (mg/100g wet weight) of C3 grass-fed, domestic Bos Taurus.

	011017BkB[2]	011030BkB[2]	011114BkB[2]
ALA 18:3n-3	25.69 ± 10.06 [a]	57.31 ± 13.08 [b]	35.08 ± 10.62 [a]
EPA 20:5n-3	17.22 ± 4.42 [a]	34.38 ± 4.96 [b]	33.94 ± 7.90 [b]
DPA 22:5n-3	24.01 ± 8.59 [a]	51.35 ± 5.42 [b]	47.87 ± 9.43 [b]
DHA 22:6n-3	3.30 ± 0.99 [a]	5.56 ± 1.32 [ab]	6.47 ± 2.55 [b]
EPA+DHA	20.52 ± 5.40 [a]	39.95 ± 5.43 [b]	40.42 ± 10.14 [b]
Total n-3 LC PUFA	44.53 ± 13.73 [a]	91.30 ± 10.56 [b]	88.28 ± 19.43 [b]
Total n-3 PUFA	70.22 ± 23.03 [a]	148.60 ± 18.85 [b]	123.37 ± 21.16 [b]
CLA 18:2	13.08 ± 6.70 [a]	20.60 ± 10.54 [a]	12.68 ± 1.74 [a]
18:1Trans	36.62 ± 14.57 [a]	60.01 ± 23.63 [a]	37.59 ± 3.71 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses

Table 2b. Strip loin fatty acid concentration (mg/100g wet weight) of C3 grass-fed, domestic Bos Indicus.

	011018-1ACC[2]	011018-2ACC[2]	011018-3ACC[2]
ALA 18:3n-3	30.24 ± 10.06 [a]	42.54 ± 4.12 [a]	29.05 ± 15.05 [a]
EPA 20:5n-3	17.53 ± 5.36 [a]	31.10 ± 8.5 [b]	24.62 ± 7.44 [ab]
DPA 22:5n-3	28.63 ± 13.17 [a]	47.78 ± 7.13 [b]	35.73 ± 10.91 [ab]
DHA 22:6n-3	3.39 ± 1.53 [a]	7.45 ± 2.27 [b]	6.36 ± 2.07 [ab]
EPA+DHA	20.92 ± 6.00 [a]	38.54 ± 10.73 [b]	30.98 ± 8.4 [ab]
Total n-3 LCPUFA	49.55 ± 19.17 [a]	86.32 ± 17.48 [b]	66.71 ± 19.26 [ab]
Total n-3 PUFA	79.80 ± 29.19 [a]	128.87 ± 15.65 [b]	95.77 ± 32.85 [ab]
CLA 18:2	13.23 ± 6.81 [a]	10.67 ± 1.55 [a]	10.45 ± 1.73 [a]
18:1Trans	25.58 ± 22.65 [a]	29.57 ± 5.07 [a]	34.99 ± 5.56 [a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2c. Strip loin fatty acid concentration (mg/100g wet weight) of C3 grass-fed, Japanese Bos Indicus.

	010816ROK[2]	010823ROK[2]	011019IMTP[2]
ALA 18:3n-3	31.35 ± 5.34[a]	74.72 ± 13.31[b]	66.50 ± 18.14[b]
EPA 20:5n-3	20.05 ± 3.88[a]	28.04 ± 3.46[ab]	35.11 ± 6.72[b]
DPA 22:5n-3	31.99 ± 7.56[a]	48.23 ± 3.60[b]	45.46 ± 9.35[b]
DHA 22:6n-3	4.29 ± 1.18[a]	5.75 ± 2.07[a]	4.72 ± 0.98[a]
EPA+DHA	87.69 ± 17.44[a]	156.75 ± 16.86[ab]	151.78 ± 33.89[b]
Total n-3 LCPUFA	56.33 ± 12.41[a]	82.02 ± 7.76[b]	85.29 ± 1.74[b]
Total n-3 PUFA	87.69 ± 17.44[a]	156.75 ± 16.86[b]	151.78 ± 33.89[b]
CLA 18:2	19.18 ± 6.92[a]	29.07 ± 3.55[b]	18.09 ± 5.98[a]
18:1Trans	48.85 ± 21.14[a]	70.73 ± 14.25[a]	56.09 ± 17.81[a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2d. Strip loin fatty acid concentration (mg/100g wet weight) of C4 grass-fed, Japanese Bos Indicus.

	010808-2G[2]	010809-2G[2]	010810-2G[2]
ALA 18:3n-3	28.24 ± 14.34[a]	27.68 ± 5.95[a]	40.81 ± 9.02[a]
EPA 20:5n-3	12.90 ± 3.85[a]	19.84 ± 6.50[a]	31.41 ± 6.89[b]
DPA 22:5n-3	22.78 ± 5.32[a]	28.84 ± 10.83[a]	52.97 ± 9.12[b]
DHA 22:6n-3	3.33 ± 0.82[a]	3.79 ± 1.45[a]	7.14 ± 1.47[b]
EPA+DHA	16.23 ± 4.40[a]	23.63 ± 7.82[a]	38.55 ± 7.90[b]
Total n-3 LC PUFA	39.01 ± 9.33[a]	52.46 ± 18.28[a]	91.52 ± 14.00[b]
Total n-3 PUFA	67.25 ± 22.93[a]	80.15 ± 22.30[a]	132.33 ± 22.54[b]
CLA 18:2	20.71 ± 18.00[a]	15.39 ± 6.11[a]	19.8 ± 10.82[a]
18:1Trans	66.34 ± 54.49[a]	39.82 ± 9.71[a]	50.40 ± 23.73[a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2e. Strip loin fatty acid concentration (mg/100g wet weight) of short grain-fed, domestic Bos Taurus.

	010929W[2]	011004W[2]	011011W[2]
ALA 18:3n-3	12.61 ± 3.22[b]	20.11 ± 2.00[c]	8.34 ± 0.32[a]
EPA 20:5n-3	15.64 ± 5.36[a]	25.94 ± 3.15[b]	13.01 ± 2.45[a]
DPA 22:5n-3	29.22 ± 6.90[b]	34.17 ± 3.18[b]	21.05 ± 1.33[a]
DHA 22:6n-3	3.16 ± 2.69[a]	6.21 ± 1.27[b]	3.20 ± 0.29[a]
EPA+DHA	18.80 ± 7.59[a]	32.15 ± 4.13[b]	16.21 ± 2.24[a]
Total n-3 LC PUFA	48.02 ± 14.28[a]	66.33 ± 6.91[b]	37.26 ± 2.84[a]
Total n-3 PUFA	60.64 ± 16.74[a]	86.43 ± 8.84[b]	45.60 ± 3.03[a]
CLA 18:2	6.47 ± 2.19[a]	9.50 ± 2.38[a]	6.04 ± 1.44[a]
18:1Trans	162.90 ± 48.77[a]	172.65 ± 107.96[a]	113.10 ± 35.56[a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2f. Strip loin fatty acid concentration (mg/100g wet weight) of short grain-fed, domestic Bos Indicus.

	010807G[2]	010808-1G[2]	010810-1G[2]
ALA 18:3n-3	7.87 ± 2.00[a]	9.91 ± 1.68[a]	15.13 ± 1.98[b]
EPA 20:5n-3	8.95 ± 2.03[a]	10.65 ± 2.35[a]	18.99 ± 2.39[b]
DPA 22:5n-3	14.57 ± 2.90[a]	19.88 ± 1.64[b]	33.31 ± 3.16[c]
DHA 22:6n-3	2.39 ± 0.55[a]	4.13 ± 1.39[ab]	5.83 ± 0.96[b]
EPA+DHA	11.34 ± 2.37[a]	14.78 ± 3.60[a]	24.82 ± 2.74[b]
Total n-3 LC PUFA	25.90 ± 5.07[a]	34.66 ± 4.83[a]	58.14 ± 5.62[b]
Total n-3 PUFA	33.77 ± 7.04[a]	44.57 ± 6.33[a]	73.27 ± 5.82[b]
CLA 18:2	6.61 ± 3.51[a]	8.43 ± 1.80[a]	10.34 ± 3.95[a]
18:1Trans	62.81 ± 27.02[a]	98.63 ± 15.28[a]	100.98 ± 40.08[a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2g. Strip loin fatty acid concentration (mg/100g wet weight) of short grain-fed, Japanese Bos Taurus.

	011012IMTP[2]	011025IMTP[2]	011112G[2]
ALA 18:3n-3	17.48 ± 2.66[a]	14.76 ± 2.21[a]	25.65 ± 13.52[a]
EPA 20:5n-3	21.73 ± 3.89[a]	18.51 ± 2.31[a]	20.29 ± 7.55[a]
DPA 22:5n-3	37.17 ± 5.85[a]	30.97 ± 4.84[a]	40.68 ± 9.49[a]
DHA 22:6n-3	5.51 ± 1.06[ab]	7.06 ± 1.88[b]	4.49 ± 0.98[a]
EPA+DHA	27.24 ± 4.50[a]	25.57 ± 3.26[a]	24.77 ± 7.91[a]
Total n-3 LC PUFA	64.41 ± 10.25[a]	56.54 ± 6.87[a]	65.46 ± 17.04[a]
Total n-3 PUFA	77.63 ± 10.40[a]	71.30 ± 8.57[a]	91.11 ± 29.71[a]
CLA 18:2	14.19 ± 2.48[a]	12.56 ± 3.37[a]	24.23 ± 7.90[b]
18:1Trans	87.44 ± 31.59[a]	208.85 ± 80.45[b]	272.06 ± 80.80[b]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 2h. Strip loin fatty acid concentration (mg/100g wet weight) of short grain-fed, Japanese Bos Indicus.

	010809-1G[2]	010906G[2]	010912G[2]
ALA 18:3n-3	9.19 ± 1.14[a]	17.85 ± 11.13[a]	16.73 ± 5.15[a]
EPA 20:5n-3	9.46 ± 1.62[a]	16.00 ± 7.19[ab]	19.03 ± 5.52[a]
DPA 22:5n-3	17.93 ± 1.97[a]	31.61 ± 13.10[ab]	38.60 ± 10.70[b]
DHA 22:6n-3	2.91 ± 0.77[a]	4.67 ± 2.09[a]	6.05 ± 2.32[a]
EPA+DHA	39.50 ± 5.04[a]	70.13 ± 33.37[ab]	80.41 ± 22.26[b]
Total n-3 LC PUFA	30.31 ± 4.02[a]	52.28 ± 22.29[ab]	63.68 ± 18.07[b]
Total n-3 PUFA	39.50 ± 5.04[a]	70.13 ± 33.37[ab]	80.41 ± 22.26[b]
CLA 18:2	10.53 ± 0.68[a]	12.00 ± 9.93[a]	13.83 ± 1.49[a]
18:1Trans	148.35 ± 68.50[a]	119.28 ± 74.83[a]	71.67 ± 17.38[a]

[1]Values are expressed as mean ± standard deviation. Different superscript letters indicate significant difference between mean values within the same row (Tukey HSD, P<0.05). [2] n=5 beasts x duplicate analyses.

Table 3a. Total saturated, monounsaturated, and omega-6 fatty acid concentration of Rump[1]

Variable	C3		C4		Short grain				SEM	Pvalue
	Domestic		JAP	JAP	Domestic		JAP			
	Taurus	Indicus	Indicus	Indicus	Taurus	Indicus	Taurus	Indicus		
Total SFA	1500^{a}	1298^{a}	1335^{a}	2564^{b}	1114^{a}	1036^{a}	2110^{b}	1394^{a}	243	0.001
Total MUFA	1574^{b}	1315^{ab}	1420^{ab}	3229^{d}	953^{a}	989^{ab}	2349^{c}	1492^{ab}	297	0.001
Total n-6FA	316^{ab}	268^{a}	320^{ab}	347^{b}	352^{b}	259^{a}	467^{c}	367^{b}	38.8	0.001

[1]Values are expressed in mg/100 g of meat sample and an average of 15 observations.
[a,b,c,d]Within a row, means without a common superscript letter differ ($P < 0.05$).

Table 3b. Total saturated, monounsaturated, omega-6 fatty acid concentration of Strip Loin[1]

Variable	C3		C4		Short grain				SEM	Pvalue
	Domestic		JAP	JAP	Domestic		JAP			
	Taurus	Indicus	Indicus	Indicus	Taurus	Indicus	Taurus	Indicus		
Total SFA	1112^{ab}	917^{ab}	1230^{b}	1150^{ab}	974^{ab}	873^{a}	1670^{c}	1186^{ab}	177	0.001
Total MUFA	1084^{ab}	871^{ab}	1246^{b}	1217^{b}	822^{ab}	755^{a}	1704^{c}	1120^{ab}	198	0.001
Total n-6FA	195^{ab}	153^{a}	205^{b}	149^{a}	221^{b}	150^{a}	295^{c}	236^{b}	24.5	0.001

[1]Values are expressed in mg/100 g of meat sample and an average of 15 observations.
[a,b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).

Preliminary Studies (1)

Objectives

1. To determine the number of samples to be analysed per 'treatment' (by repeat analysis of fresh samples of beef and lamb, collected by RMIT from retail outlets),
2. To determine which cuts should be sampled (forequarter, hindquarter or both), based on the provision by MLA of samples from 6 different grass-fed beef cattle.

Methods

1. Beef rump steak was purchased from a local supermarket, trimmed of visible fat and minced thoroughly. Ten samples of the rump mince were analysed for omega 3 fatty acids by the standard method and a streamlined method (streamlined to reduce the number of steps following extraction, using the standard method, otherwise all steps /procedures were identical. Rationale for the streamlined method was to save time and solvents).
2. Samples of blade, striploin and rump from 6 grass-fed beef animals were analysed in triplicate for the omega 3 content.

Results

Determination of the number of meat samples to be assayed for omega 3 fatty acids

- The omega 3 content of supermarket rump steak (fat-trimmed) is shown in Table 1. The coefficient of variation (CV) for the 10 rump samples ranged from 2 to 6% for the different omega 3 fatty acids. The streamlined method yielded results not significantly different to the standard method, with CV's in the same range of 2-6% (Table 1).
- Based on these data, we can be confident that we will be able to detect a difference of 5 mg omega 3 fatty acids/100g lean meat if we conduct future analyses of meat samples from 15 cattle per treatment (this is the number of samples for analysis, as noted in the agreement). Five mg equates to a difference in omega 3 content of approximately 10% (total omega 3 content in the beef samples analysed was in the range 38 to 59 mg/100g lean meat).

Determination of which cuts should be sampled

- The omega 3 fatty acid content was not significantly different between the blade and rump samples, however the values for striploin were significantly lower by approximately 31% (Table 2). As noted in Table 2, the standard deviations for total omega 3 fatty acids were relatively high (CVs of 6-15%) which indicates considerable variability between the six animals. This emphasises again the need to have a higher number of animals in each cell of the experiment (the budget allows for 15 animals, 2 sites, analyses in duplicate).

Recommendations

1. Beef analyses for omega 3 fatty acids should be conducted on two samples of meat per beast (rump and striploin) and with 15 animals to be sampled per treatment/cell. Rump preferred to blade for ease of preparation for mincing and also since it is a high quality cut.
2. All omega 3 fatty acid analyses will be conducted in duplicate.

Lamb analyses

Lamb samples will be analysed to determine the variability in the assay of omega 3 fatty acids as per the above studies in beef, and subsequent to this the cuts to be sampled will also be investigated once we have been provided with the appropriate samples.

Table 1. Determination of the omega 3 fatty acid content of lean beef (rump): Coefficient of variation of the *standard* and a *streamlined method*

Stream-lined method	Fatty acid (mg/100g meat)	Mean	SD	CV (%)
	18:3n-3	18.05	1.08	6.0
	20:5n-3	18.10	0.58	3.2
	22:5n-3	23.42	0.87	3.7
	22:6n-3	3.37	0.16	4.8
	Total n-3 FA	**62.94**	**2.48**	**3.9**
Standard Method				
	18:3n-3	17.19	1.03	
	20:5n-3	17.35	0.37	2.1
	22:5n-3	21.95	0.77	3.5
	22:6n-3	3.21	0.18	5.7
	Total n-3 FA	**59.71**	**2.27**	**3.8**

* Supermarket rump steak (trimmed, minced and frozen), n =10 analyses per method.

Table 2. Omega-3 fatty acid distribution in beef

Fatty acid (mg/100g)	Blade	Striploin	Rump
18:3n-3	20.43±2.65^{a}	12.23±1.98^{b}	18.35±3.70^{a}
20:5n-3	13.11±2.37^{a}	9.51±0.83^{b}	13.77±2.29^{a}
22:5n-3	20.10±1.91^{a}	14.40±1.61^{b}	18.76±3.00^{a}
22:6n-3	2.47±2.47^{a}	1.69±0.24^{b}	2.42±0.57^{a}
Total LC n-3 FA	35.68±3.27^{a}	25.60±2.00^{b}	34.95±5.00^{a}
Total n-3 FA	**56.11±3.73^{a}**	**37.83±3.82^{b}**	**53.29±8.36^{a}**
Total FA's (g/100g)	2.39±0.61^{a}	1.47±0.45^{b}	1.76±0.66^{ab}
Total fat (g/100g)	2.61±0.66^{a}	1.60±0.49^{b}	1.92±0.73^{ab}
Moisture (%)	24.2±1.0	24.8±1.0	24.3±0.9

Data shown as mean±SD for triplicate analysis of 6 samples per cut.

Preliminary Studies (2)

Objectives

1. To determine the moisture content variability in minced meat samples (beef and lamb) using the CEM automated meat moisture instrument
2. To determine the coefficient of variation in lamb omega 3 fatty acids using the method modified to determine beef omega 3 fatty acids (see Report #1).

Methods

1. Beef rump steak was purchased from Queen Victoria Market, trimmed of visible fat and minced thoroughly. Eleven samples of the rump mince were analysed for moisture using the CEM machine.
2. Lamb backstrap was purchased from Queen Victoria Market, trimmed of visible fat and minced thoroughly. Eleven samples of the lamb mince were analysed for moisture using the CEM machine.
3. Lamb backstrap was purchased from Queen Victoria Market or obtained from Mr David Quinnane (Damara lamb). The omega 3 fatty acids were analysed by the streamlined method discussed in report #1 (streamlined to reduce the number of steps following extraction, using the standard method, otherwise all steps /procedures were identical. Rationale for the streamlined method was to save time and solvents).

Results

Determination of the moisture content of beef and lamb

The moisture content was 74 and 71%, respectively, for beef and lamb. The coefficient of variation was very low (<1% in both cases) (Table 1).

Based on these data, we can be confident that determining moisture on duplicate samples will be sufficient to obtain an accurate moisture content.

Determination of the omega 3 content of lamb (minced)

The omega 3 fatty acid content was found to be 64-74mg/100 gram minced meat (Table 2). There was a higher CV than found previously for the analysis of beef using this method (report #1).

Based on these data, it was determined to modify the method for the analysis of the lamb, prior to conducting the full scale lamb analyses. Some early trials on modifications have resulted in improved CVs.

Arrival of first shipment of beef samples

The 1st batch of 90 beef samples (from 45 animals) arrived in mid-August. These have been minced, moisture content determined and extractions have started.

Decision on analysis of extra samples

As noted in email to MLA this week (10/9/01), samples have been supplied from groups of animals outside the agreed schedule (see Table 3). Shane Blakely has indicated he believes these additional 45 animals (3 extra groups) should be analysed. If

As noted in email to MLA (10/9/01), analysis of these additional samples will necessitate discussion of additional funding.

Lamb samples

As noted in email to MLA (4/9/01), Dr Dave Pethick from Perth has indicated he may be able to provide samples of lamb suitable for the determination of the omega 3 content.

Table 1. Moisture Contents

Lamb backstrap - ex Vic market Bag 1+2 of 3 (Constant Weight Mode: power 100%, interval time 15secs, differential weight 0.2mg)	
Sample weight (g)	**% Moisture**
3.3237	71.49
3.0677	71.4
3.6154	71.38
3.0396	71.45
3.0255	70.94
2.2036	70.41
2.7304	71.64
2.5109	71.68
2.7947	71.39
3.7923	71.76
2.9682	71.15
Average	**71.34**
Stdev	**0.39**
CV (%)	**0.5**

Rump - ex Vic market Bag 5 of 6 (Constant Weight Mode: power 100%, interval time 15secs, differential weight 0.2mg)	
Sample weight (g)	**% Moisture**
4.4031	74.02
3.1679	74.2
5.0606	74.45
4.0692	74.41
3.7354	73.97
3.7273	73.89
4.7797	73.67
3.8643	74.14
3.0562	74.29
4.7943	74.33
2.6419	73.33
Average	**74.06**
Stdev	**0.34**
CV (%)	**0.5**

Table 2. Lamb omega 3 content

Fatty acid	Sample #	Sample description	Amount (mg/100g meat)	Mean	Stdev	CV (%)
18:3n-3	55	Backstrap ex. Vic market	44.41	42.38	2.30	5
	56		44.34			
	57		39.99			
	58		44.5			
	59		39.71			
	60		41.31			
	64	Backstrap ex. Interstate	19.02	23.9	4.25	18
	65		26.89			
	66		19.66			
	67		25.63			
	68		22.43			
	69		29.77			
20:5n-3	55	Backstrap ex. Vic market	14.11	14.73	0.77	5
	56		16.13			
	57		14.55			
	58		14			
	59		14.63			
	60		14.98			
	64	Backstrap ex. Interstate	11.81	13.61	1.59	12
	65		14.4			
	66		13.05			
	67		13.64			
	68		12.49			
	69		16.29			
22:5n-3	55	Backstrap ex. Vic market	13.84	13.53	0.88	7
	56		13.77			
	57		12.43			
	58		14.99			
	59		13.16			
	60		13.02			
	64	Backstrap ex. Interstate	14.01	17.56	2.75	16
	65		19.78			
	66		15.1			
	67		18.75			
	68		16.72			
	69		21.03			
22:6n-3	55	Backstrap ex. Vic market	5.11	4.53	0.6	13
	56		4.25			
	57		4.1			
	58		5.45			
	59		4.04			
	60		4.22			
	64	Backstrap ex. Interstate	6.87	8.02	1.05	13
	65		9.09			
	66		6.86			
	67		8.46			
	68		7.65			
	69		9.17			

Table 3. Suggested beef sampling protocol from Mr Shane Blakely

Feeding regime	Class	Bos indicus	Bos taurus
C4 grassfed	Domestic (200-250 kg)	15 samples	15 samples
C3 grassfed	Domestic (200-250 kg)	Not applicable	15 samples
C4 grassfed	Jap ox (300-340 kg)	15 samples 3 kills Grantham (ex Frankfield)	15 samples
C3 grassfed	Jap ox (300-340 kg)	15 samples 2 kills AMH Rockhampton (ex Brigalow Beef)	15 samples
Short grainfed	Domestic (200-250 kg)	15 samples 3 kills Grantham (ex Bottletree & Mort&Co)	15 samples
Short grainfed	Jap ox (300-340 kg)	15 samples 2 kills Grantham (ex Bottletree)	Not applicable
Long grainfed	Jap ox (300-340 kg)	Not applicable	15 samples

Suggested additional samples:

15 samples	C3 Jap Bos indicus
15 samples	C3 Jap Bos taurus
15 samples	100 day Jap Bos indicus

Table 4. Sample Matrix, MLA Phase B study (origin of samples)

Class	C3	80d Grainfed	150/200d Grainfed
Domestic	021113 #145-168 Orange, NSW 021115 #169-192 Gracemere, QLD 021119 #193-216 Dalby, QLD	020725 #1-24 Grantham 020830 #49-72 Grantham 020828 #97-120 Bottletree feedlot	
Jap Ox			020725 #25-48 Grantham 020904 #73-96 Stockyard 021012 #121-144 Kerwee feedlot