Dietary Conjugated Linoleic Acid Can Decrease Backfat in Pigs Housed under Commercial Conditions

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ABSTRACT : Conjugated linoleic acids (CLA) have been shown to decrease body fat content of individually-housed pigs but little is known about the responses under commercial conditions. Two studies were conducted to evaluate the effect of CLA under commercial conditions using contemporary genotypes. The experimental designs were similar between the two sites. Briefly, the studies were 2×2 factorial designs with the respective factors being sex (boar and gilt) and supplemental dietary CLA (0 and 4 g/kg). The studies involved 16-20 pens of pigs with 4-5 pens of each sex×CLA group. The first study was conducted with 144 pigs in 16 pens consuming a pelleted feed for 6 weeks at Bunge Meat Industries, Corowa, NSW. In the second study, 160 pigs were obtained from a commercial source and put into 20 pens in simulated commercial conditions and fed a mash diet for 7 weeks at Medina Research Station, WA. In Study 2 some aspects of meat quality were also investigated. Data from Study 1 showed that, although CLA had no significant effect upon feed intake and daily gain, the small changes in both resulted in a reduction in (-0.10 g/g, p=0.10) feed conversion ratio (FCR). While there was no significant effect of CLA on ultrasonic backfat depths, there was a significant decrease in carcass P2 (-1.0 mm, p=0.014) and estimated carcass fat (-7 g/kg, p=0.049). In the study conducted at Medina CLA had no significant effect upon feed intake, feed:gain or most measures of back fat. The exception was that dietary CLA decreased the rate of accumulation of fat at the shoulder, particularly in gilts, resulting in a significantly lower amount of shoulder fat at slaughter (-1.3 mm, p=0.044). CLA tended to increase dressing percentage although this was not significant (+0.5%, p=0.14). Meat from CLA treated pigs tended to be darker (p=0.12) and had a higher ultimate pH (p=0.06). These data suggest that under commercial conditions dietary CLA can improve growth performance and decrease P2 in pigs of an improved genotype, particularly gilts. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 7 : 1011-1017)***

Key Words : Growth, Meat Quality, Sex, CLA, Pig

INTRODUCTION

Conjugated linoleic acid (CLA) is a collective term describing a mixture of positional and geometric conjugated diene isomers of linoleic acid. Scientists at the University of Wisconsin demonstrated that a lipid fraction isolated from cooked ground beef had anticarcinogenic activity (Ha et al., 1987), and since that time the anticarcinogenic activity of CLA has been demonstrated in a wide range of animal models (Banni and Martin, 1998; Belury, 1995; Ip et al., 1999). The interest in CLA has grown because it possesses several additional biological proper relating to health. Dietary supplement of CLA reduced the catabolic effects of immune stimulation in mice, rats and chickens without adversely affecting immune function (Miller et al., 1994). Furthermore, CLA has been shown to be anti-atherogenic in the hamster (Nicolosi et al., 1997) and anti-diabetic in the Zucker diabetic fatty acid fa/fa rat (Houseknecht et al., 1998).

One of the biological effects of CLA relates to fat accretion and nutrient partitioning. CLA has been shown to increase liveweight gain and to improve feed efficiency in rats, mice and chickens (Chin et al., 1994; Park et al., 1997) and decrease carcass fat content in mice (West et al., 1998). Recent results suggest similar growth responses to CLA may occur in pigs since dietary supplementation of CLA reduced fat deposition and improved feed conversion efficiency (Ostrowska et al., 1999), reduced back fat thickness (Thiel et al., 1998) and reduced the fat content of commercial meat cuts (Dugan et al., 1999). However, effects of CLA on growth performance and backfat thickness have not been reported for commercial pigs housed under industry conditions. Therefore, our objective was to examine the effect of a moderate dose of supplemental CLA on growth performance, backfat thickness and meat quality in male and female pigs housed under commercial conditions. To do this we conducted two studies in different geographical locations, with differing basal dietary ingredients and different sources of pigs.

MATERIALS AND METHODS

Two studies were conducted to evaluate the effect of CLA under commercial conditions. The experimental designs were similar between the two sites. Briefly, the studies were 2×2 factorial designs with the respective

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Received October 16, 2001; Accepted February 15, 2002

factors being sex (boar and gilt) and supplemental dietary CLA {0 and 4 g/kg (Natural Lipids Ltd., Hovdebygda, Norway)}. The studies involved 16-20 pens of pigs with 4-5 pens of each sex CLA group. The first study was conducted with 144 Large White × Landrace pigs weighing approximately 64.8±6.3 kg (mean±SD) in 16 pens consuming a pelleted feed for 6 weeks at Bunge Meat Industries (BMI), Corowa, NSW. For the second study, 160 Large White × Landrace pigs weighing approximately 61.6±5.9 kg were obtained from a commercial source and were placed into 20 pens in simulated commercial conditions (ie. group housed) and fed a mash diet for 7 weeks at Medina Research Station, WA. In both studies pigs were weighed and feed intake was measured on a per pen basis weekly from commencement of the study. Diet compositions are given in table 1. Diets were formulated by the respective nutritionists on each farm and were formulated to the specifications generally used for these classes of pigs using the ideal protein concept (Baker et al., 2000). The conditioning time for the press that produced the pelleted feed at BMI was approximately 8 to 10 seconds, at a temperature of between 85 to 88°C while the exit temperature was approximately 88°C. Preliminary studies showed that there was negligible loss of CLA under these conditions (D. Cadogan, personal communication). All procedures were approved by the Victorian Institute of Animal Science animal ethics committee as well as by the respective animal ethics committees at each experimental site.

In Study 1 backfat was determined ultrasonically (US) over the P2 region at the beginning and end of the study. After slaughter, fat depths were measured at the P2 site and over the hind leg with an intrascope on the cold carcass. Fat depth over the leg was measured at a point 5 cm from the tail and 2 cm from the mid-line above the second to last lumbar vertebrae. Carcass weight and dressing percentage were determined with the head on for Study 1. In addition, backfat at the P2 site was measured on the slaughter chain using a Hennessy grading probe (Hennessy Grading Systems Ltd, Auckland, New Zealand).

In Study 2, backfat was determined ultrasonically over the P2 region and along the midline over the shoulder, middle and tail at the beginning and end of the study. Carcass weight and dressing percentage were determined with the head off for Study 2. The pH of the *Longissimus thoracis* (LT) muscle between the 12th and 13th rib was determined at 24 h (pH_u) post-slaughter using a portable pH/temperature meter (Jenco Electronic Ltd, Model 6009) fitted with a polypropylene spear-type gel electrode (Ionode IJ42S, Brisbane, QLD) and a temperature probe. In addition, samples of loin muscle were obtained from the carcass 24 h after slaughter to determine drip loss and colour. Drip loss from the LT muscle was measured using the suspension method (Honikel 1987) with samples removed at 24 h post-slaughter being standardised to 20 mm in thickness. Surface lightness (L^*) of the LT muscle was measured with a Minolta Chromameter CR-100, using D_{65} lighting, a 2° standard observer and a measuring aperture of 8 mm, standardised to a white tile. Pigs were classified as pale soft exudative (PSE) if the LT muscle had drip loss values >5% and surface lightness L* values>50, or dark firm and dry (DFD) if the LT muscle had pH_u values>6.0, drip loss values <1% and surface lightness L*<45 (Warner et al., 1993).

Dietary fatty acids were extracted into chloroform: methanol and after saponification and methylation the individual fatty acids were analysed by GLC. The CLA isomers in the diet, the CLA-55 and a similar batch of tallow to that used in Study 2 were analysed by HPLC separation of the free fatty acids (Ostrowska et al., 2000).

Data for each farm were analysed separately by ANOVA suitable for a 2×2 factorial design using pen as the experimental unit.

RESULTS

Diets were formulated to contain 4.0 g/kg of a commercial mix of CLA containing 55% total CLA isomers or 2.2 g added CLA/kg diet. As can be seen from tables 2 and 3, the amount of CLA recovered in the diets was less than expected. For example, in Study 1 only 1.1 g/kg additional CLA was measured whereas in Study 2, an additional 1.3 g/kg of CLA was measured. Analyses of the commercial CLA mix showed that it contained the anticipated CLA content and isomeric distribution (table 1). There was very little CLA in the Study 1 control diet whereas there was a considerable amount in the Study 2 control diets (table 3). Possible sources of CLA include tallow and meat and bone meal. Stocks of these ingredients were exhausted by the time the relatively high basal CLA levels were discovered and hence the CLA content of the ingredients could not be measured. However, tallow and meat and bone meal from the Study 2 supplier was analysed for CLA. While there was considerable amounts of CLA in the tallow and meat and bone meal, the CLA content of the samples assayed suggest that tallow and meat and bone meal could only explain approximately 10%, each respectively, of the relatively high basal CLA levels (table 3).

In Study 1 there were no significant interactions between sex and CLA for any measures (table 4). While CLA had no significant effect upon feed intake and daily gain, the small changes in both tended to reduce (2.90 vs 2.78, p=0.10) feed conversion ratio (FCR). Also, although there was no significant effect of sex on feed intake and daily gain, the

Table 1. Ingredient composition (%) of the diets used in Study 1 (NSW) and Study 2 (WA)

	Study 1		Study 2 - CLA		Study 2 + CLA	
	-CLA	+CLA	Male	Female	Male	Female
Wheat	47.65	47.65				
Barley	15.0	15.0	48.58	50.88	48.58	50.88
Lupin kernals	15.0	15.0				
Lupins whole			26.21	24.89	26.21	24.89
Millrun[A]	10.0	10.0	15.0	15.0	15.0	15.0
Canola meal	6.03	6.03				
Meatmeal	1.5	1.5				
Meat and bone meal			6.17	6.15	6.17	6.15
Water	1.0	1.0				
Tallow	1.2	0.8	3.08	2.21	2.68	1.81
CLA-55		0.4			0.4	0.4
Salt	0.2	0.2	0.2	0.2	0.2	0.2
Limestone	1.13	1.13	0.50	0.52	0.50	0.50
Dicalcium phosphate	0.8	0.8				
Lysine-HCl	0.13	0.13	0.11	0.038	0.11	0.038
DL-methionine	0.0167	0.0167	0.046	0.025	0.046	0.025
Vitamin mineral premix	0.133	0.133	0.1	0.1	0.1	0.1
Lindox[B]	0.1	0.1				
Estimated content						
Digestible energy (MJ/kg)	13.6	13.6	13.5	13.3	13.5	13.3
Protein	16.5	16.5	18.5	18.2	18.5	18.2
Available lysine (g/MJ DE)	0.47	0.47	0.52	0.48	0.52	0.48
Total fat	4.18	4.18	6.75	5.87	6.75	5.87

[A] By product of wheat processing containing pollard and bran.
[B] Contains 10% active oliquindox antibiotic.

small differences in both resulted in male pigs having a lower FCR than female pigs (2.75 vs 2.93, p=0.009). While there was no significant effect of CLA on ultrasonic backfat depths, there was a significant decrease in carcass P2 measured on the slaughter chain (12.5 vs 11.4 mm, p=0.014) and estimated carcass fat (16.7 vs 16.0%, p=0.049). All measures of backfat were lower for male than for female pigs. Dressing percentage was not affected by dietary CLA but was significantly lower for female than for male pigs.

In Study 2 there were no significant interactions between sex and CLA for any of the measures (table 5). CLA had no significant effect upon feed intake, daily gain or FCR. Although male pigs grew more quickly and tended to eat less than female pigs there were no significant differences. In general dietary CLA had little effect upon any of the measures of backfat. The exception was that dietary CLA decreased the rate of accumulation of fat at the shoulder over the duration of the study (8.8 vs 7.1 mm, p=0.044) and as a consequence, shoulder fat tended to be decreased in pigs fed diets containing supplemental CLA (24.9 vs 23.6 mm, p=0.087). Most measures of backfat were lower in male than in female pigs. Dressing percentage tended to be higher in pigs fed supplemental dietary CLA (67.4 vs 67.9%, p=0.14) and was higher in female than in male pigs (68.2 vs 67.1%, p<0.001). Meat from CLA treated pigs tended to be darker (p=0.12) and had a higher ultimate pH (p=0.060). There was no significant effect of sex on meat colour but meat from male pigs had a higher ultimate pH than that from female pigs (5.45 vs 5.37, p<0.001).

DISCUSSION

Data from Study 1 demonstrate that a moderate rate of inclusion of CLA in the diet can improve growth performance and reduce backfat at the P2 region under commercial conditions in finisher pigs. While the responses were not spectacular, under most pricing grids currently used in Australia, the benefits may be sufficient to justify CLA inclusion. However, the data from Study 2 conducted under simulated commercial conditions were less encouraging. While there was a significant reduction in backfat at one site (the shoulder), this was unfortunately not a site that is used in current pricing grids and so would not result in any economic returns to the producer. Previously, we have shown that in individually housed female pigs with a high P2 back fat (ca. 24 mm), dietary CLA can cause a

Table 2. Fatty acid composition (g/kg) of the diets used in Study 1 (NSW) and Study 2 (WA)

	Study 1		Study 2 - CLA		Study 2 + CLA	
	-CLA	+CLA	Male	Female	Male	Female
Lauric acid 12:0	0.03	0.02	0.49	0.09	0.09	0.07
Tridecanoic acid 13:0	0.00	0.00	0.49	0.00	0.00	0.00
Tridecanoleic acid 13:1	0.15	0.06	0.14	0.00	0.20	0.00
Myristic acid 14:0	0.61	0.45	1.05	1.00	1.03	1.02
Myristoleic acid 14:1	0.02	0.04	0.15	0.06	0.08	0.03
Pentadecanoic acid 15:0	0.04	0.04	0.00	0.05	0.12	0.09
Palmitic acid 16:0	8.95	8.05	15.26	15.73	14.12	18.36
Palitoleic acid 16:1	0.25	0.25	0.22	0.48	0.45	0.41
Heptadecanoic acid 17:0	1.70	1.56	2.45	3.26	2.35	3.28
Stearic acid 18:0	12.71	15.24	21.78	21.92	21.50	23.71
Oleic acid 18:1	6.96	6.80	9.25	9.43	7.77	8.01
Linoleic acid 18:2	15.56	13.01	15.85	15.55	12.12	11.91
Linolenic acid 18:3	1.71	1.77	1.43	1.65	1.44	1.53
Total CLA	0.19	1.28	0.62	0.51	1.91	1.82
Arachidic acid 20:0	0.16	0.43	0.47	0.28	0.14	0.50
Erucic acid 22:1	0.22	0.20	0.28	0.34	0.39	0.38

Table 3. Conjugated linoleic acid isomer composition (g/kg) of the diets and selected ingredients used in Study 1 (NSW) and Study 2 (WA)

	Study 1		Study 2 - CLA		Study 2 + CLA		Tallow[a]	Meat and bone meal[a]	CLA-55
	-CLA	+CLA	Male	Female	Male	Female			
t,t-11,13	ND	0.013	0.024	0.015	0.021	0.022	0.117	0.069	2.4
t,t-10,12	ND	0.041	0.011	0.015	0.061	0.058	0.075	ND	11.4
t,t-9,11	ND	0.199	0.131	0.080	0.078	0.073	0.289	0.071	11.9
t,t-8,10	ND	0.015	ND	ND	0.021	0.027	0.086	0.017	2.5
c,t/t,c-11,13	0.041	0.199	0.042	0.055	0.296	0.284	0.223	0.044	104.0
c,t/t,c-10,12	0.044	0.207	0.066	0.083	0.558	0.526	0.082	0.014	176.7
c,t/t,c-9,11	0.048	0.314	0.188	0.139	0.476	0.450	0.188	0.439	142.9
c,t/t,c-8,10	0.020	0.159	0.066	0.043	0.241	0.226	0.092	ND	84.2
c,c-11,13	ND	0.027	0.023	0.011	0.025	0.015	0.024	ND	5.1
c,c-10,12	ND	ND	ND	ND	0.053	0.049	0.014	ND	15.7
c,c-9,11	ND	0.033	0.051	0.030	0.050	0.047	0.028	ND	12.8
c,c-8,10	ND	0.029	ND	0.012	0.011	0.020	0.002	ND	4.3
Other	0.036	0.044	0.019	0.026	0.015	0.025	ND	0.026	ND
Total	0.190	1.280	0.620	0.510	1.906	1.822	1.220	0.680	573.9

[A] Same source of material as used in Study 2 but not exact same batch.

dose dependent reduction in backfat and chemically determined fat as well as decreased FCR (Ostrowska et al., 1999). At the highest dose of CLA used (10 g/kg of CLA-55) there was a 25% (6 mm) reduction in backfat and a 31% (86 g/d) reduction in fat deposition. Other studies have also indicated that dietary CLA supplementation of growing pigs results in less fat at slaughter as estimated by dissection of wholesale loin cuts (Dugan et al., 1999) or back fat thickness (Thiel et al., 1998). For example, at five times the anticipated dose of CLA investigated in this study (20 g/kg of CLA-55), Dugan and co-workers (Dugan et al., 1997) reported a 27% reduction ($p=0.01$) in subcutaneous fat per kilogram of total cuts in gilts. While we, (Ostrowska et al., 1999) and others (Dugan et al., 1997; Thiel et al., 1998) have observed small improvements in FCR in pigs supplemented with dietary CLA, others did not observe any improvements where a novel source of CLA produced during the Kraft (sulfate) paper process (modified tall oil) was used (O'Quinn et al., 2000).

The reason for the relative lack of an effect of CLA in Study 2 is unknown but may in part be due to the fact that there was already a substantial amount of CLA in the basal diet. The source of this CLA is unknown but given our knowledge of CLA biochemistry it is likely to be of ruminant origin. An indication that the CLA in the control diets is of ruminant origin is that the major CLA isomer

Table 4. Effect of sex and CLA (4 g/kg) on performance of finisher pigs in Study 1[A]

CLA level, C	-CLA		+CLA		sed	Significance		
Sex, S	Male	Female	Male	Female		S	C	C×S
Rate of gain, g/d	919	913	969	889	39.7	0.15	0.66	0.22
Feed intake, g/d	2,603	2,685	2,580	2,583	76.5	0.27	0.45	0.48
FCR, g/g	2.84	2.95	2.66	2.91	0.08	0.009	0.10	0.25
US P_2, mm[B]	9.1	11.7	9.0	11.1	0.60	<0.001	0.43	0.53
Δ US P_2, mm[B,C]	2.2	3.8	2.5	2.9	0.62	0.050	0.50	0.18
Leg fat, mm[B]	11.6	17.4	11.8	16.4	1.06	<0.001	0.62	0.45
Δ Leg fat, mm[B,C]	2.5	5.1	2.9	3.6	1.08	0.053	0.48	0.25
Carcass P_2, mm	11.8	13.1	11.0	11.9	0.48	0.006	0.014	0.57
Estimated fat, %[D]	13.8	19.6	13.4	18.6	0.46	<0.001	0.049	0.34
Dressing, %	76.8	78.6	76.7	79.0	0.34	<0.001	0.54	0.23

[A] Data are for a 6 week treatment period from 112 days of age (65 kg). Study involved 144 pigs in 16 pens and ANOVA were performed with pen as the experimental unit.
[B] US=Ultrasonic fat depth.
[C] Δ=Change in fat depth over the study.
[D] Estimated using a proprietary algorithm based on fat depths and carcass weight (B. Luxford, personal communication).

Table 5. Effect of sex and CLA (4 g/kg) on performance of finisher pigs in Study 2[A]

CLA level, C	-CLA		+CLA		sed	Significance		
Sex, S	Male	Female	Male	Female		S	C	C×S
Rate of gain, g/d	1007	964	991	952	24.5	0.020	0.41	0.90
Feed intake, g/d	2991	3125	2976	3152	113.6	0.071	0.94	0.80
FCR, g/g	2.79	2.92	2.82	2.93	0.158	0.29	0.87	0.87
US P_2, mm	15.2	16.1	14.6	17.0	0.69	<0.001	0.82	0.13
US tail fat, mm[B]	13.6	14.2	13.9	15.2	0.79	0.074	0.25	0.50
Δ US tail fat, mm[B,C]	4.4	5.6	5.5	5.6	0.73	0.19	0.24	0.29
US Middle fat, mm[B]	9.3	10.3	9.4	10.6	0.54	0.004	0.54	0.80
Δ US Middle fat,mm[B]	2.4	3.7	3.0	3.4	0.48	0.015	0.72	0.24
US shoulder fat, mm[2,3]	24.7	25.0	23.3	23.9	0.92	0.50	0.087	0.73
ΔUS shoulder fat, mm[B,C]	8.8	8.7	8.0	6.1	1.14	0.21	0.044	0.31
Dressing, %	66.9	67.9	67.2	68.5	0.43	<0.001	0.14	0.57
Drip loss, %	6.25	5.56	5.70	6.02	0.59	0.65	0.91	0.23
Colour L	54.7	55.4	53.8	54.4	0.84	0.26	0.12	0.95
Colour a	9.6	10.1	10.0	9.9	0.29	0.34	0.62	0.11
Colour b	0.63	0.45	0.33	0.36	0.24	0.67	0.24	0.54
Ultimate pH	5.43	5.36	5.47	5.38	0.023	<0.001	0.060	0.55

[A] Data are for a 6 week treatment period from 62 kg. Study involved 160 pigs in 20 pens and ANOVA were performed with pen as the experimental unit.
[B] US=ultrasonic fat depth.
[C] Δ=change in fat depth over the study.

present in the control diets is the c 9, t 11 which is also the major isomer found in ruminant fat (Pariza et al., 2001). The most likely source of CLA is tallow or meat and bone meal although analyses of theses ingredients suggest that the levels of CLA were not high enough to be the major source. However, since we did not obtain samples of the exact lots of tallow and meat and bone meal used, this cannot be totally discounted. Also, while it is possible that some of the CLA was inadvertently mixed in with the control diets this does not appear likely since the CLA profiles of the control diets are markedly different from that of the supplemental CLA-55. Another concern is the relatively low recovery of CLA added to the diets which indicates that there may be a mixing problem with including CLA in the diet. However, the internal consistency between the male and female diets in Study 2 suggests that this was not the case. Very recently, there has been evidence that the CLA fatty acids, while stable in the triglyceride form, are relatively unstable in the free fatty acid form (Yang et al., 2000). These authors found that CLA oxidized rapidly with

more than 80% of total CLA being degraded within 110 h in air at 50 degrees C. The c,c-CLA isomers were most unstable followed by the c,t-CLA isomers while in contrast, the t,t-CLA isomers were relatively stable under the same experimental conditions (Yang et al., 2000). Previously, whenever CLA has been mixed in our feed mill and most other times when we have analysed other commercial mixes, recoveries have been very good. In these cases CLA containing diets have been mixed every 2 weeks and subsamples taken and stored refrigerated. In the present studies, CLA containing diets were mixed in one single batch per study and stored at ambient temperatures. Also, commercial mixes of CLA are highly viscous and do tend to stick to mixing vessels and apparatus. Under controlled research conditions we have mixed the CLA with additional dietary oil to aid in uniform mixing of the diets. However, this was not done in the present studies and in future attention should be paid to mixing of CLA.

Dietary CLA had some subtle effects on meat quality. Meat from CLA supplemented pigs tended to be darker and had a higher ultimate muscle pH than meat from pigs fed the unsupplemented diets. While, this was not reflected in any differences in drip loss or proportion of pigs exhibiting pale soft and exudative meat (data not shown) these responses could be interpreted as improvements in pork that was exhibiting high drip loss, was pale in colour and had a low ultimate pH (<5.6). Dugan et al. (1999) found that there was no effect of 20 g/kg of CLA on drip loss or subjective LT scores for structure or colour. However, objective colour measurements indicated LT from CLA-fed pigs had slightly higher colour saturation values. Also, dietary CLA supplementation did not affect any measured palatability characteristics such as initial and overall tenderness, juiciness, flavour desirability, flavour intensity, amount of connective tissue or overall palatability (Dugan et al., 1999). Previously, we have shown no discernible effects of dietary CLA on meat quality parameters such as colour, ultimate pH, drip and cooking loss and tenderness (shear force) of individually-housed gilts (Dunshea and Ostrowska, 1999). O'Quinn et al. (2000) similarly reported that there were no effects of CLA on colour, marbling, drip loss or firmness.

The effects of sex on growth performance were similar to those previously reported. In general male pigs grew more rapidly and more efficiently and had less backfat than female pigs. However, the differences between the sexes were not as large as generally encountered in individually-housed pigs (Campbell and Taverner, 1988; Dunshea et al., 1993, 1998; Weatherup et al., 1998). The pigs used in the present study were well advanced in puberty and entire males of this age normally display an increasing amount of sexual behaviours and related aggression (Cronin et al., 2001). It would be anticipated that these effects would be exacerbated in group-housed boars and it is possible this is the reason for only small differences in performance between entire male and female pigs.

In Study 2, meat from entire males had a higher ultimate pH than from females. Consistent with these data, meat from entire males had a higher ultimate pH than from castrates, with individually-housed boars having a higher pH than group-housed boars (Dunshea et al., 2000). These data suggest animal mixing occurring during transport or in lairage had a pronounced effect on the meat quality and could result in DFD meat, particularly in boars. Fighting and aggression, due to mixing of unfamiliar boars pre-slaughter has been related to a reduction in meat quality, particularly increased incidence and severity of dry, firm, dark pork (Sather et al., 1995; D'Souza et al., 1999). Fighting-induced physical activity in response to aggressive interactions in pigs depletes muscle glycogen prior to slaughter, which in turn limits muscle pH decline post-slaughter resulting in high ultimate pH, higher L* values (darker colour), reduced drip loss and DFD meat (Ferdandez et al., 1994; D'Souza et al., 1999). The influence of sex on meat quality in Study 2 and Dunshea et al. (2000) is in contrast with the study by Weatherup et al. (1998) who reported that gender did not have a significant effect on meat quality parameters. However, Beattie et al. (1999) while similarly reporting no effect of sex on meat quality, reported that 100 kg entire male carcasses had lower L* values (darker meat) compared to 100 kg gilt carcasses.

In conclusion, CLA can improve growth performance, carcass composition and improve meat quality under some commercial conditions but the responses were variable. In general, CLA seems to be more effective in female pigs. Some Australian diets may already contain appreciable amounts of CLA, with some of the CLA coming from tallow, meat meal and meat and bone meal that are routinely used in pig diets.

ACKNOWLEDGEMENTS

The authors are appreciative of the funding provided by the Pig Research and Development Corporation. The authors also wish to thank Daria Jerome from Conlinco for supply of CLA and John Black for helpful discussions.

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