The Effects of Conjugated Linoleic Acid (CLA) and Feed Intake on Lean Pig Growth and Carcass Composition

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Introduction

The challenge to the pork industry is to produce lean pigs without compromising pork quality. The leanest genotypes of pigs have poorer muscle quality (lower color scores, lower percent intramuscular fat, greater drip loss) and poorer fat quality (soft, unsliceable bellies) in comparison to genotypes with average leanness. Conjugated linoleic acid (CLA) refers to a group of linoleic acid isomers that have several biological effects. Scientists at the *1st Annual CLA Forum* reported that pigs fed CLA had less backfat, less carcass fat, more carcass lean, improved feed conversion and firmer carcasses. Feeding CLA resulted in decreased feed intake while growth rate was unchanged, thus improving feed efficiency. The studies thereafter (Table 1) have consistently shown that CLA decreases backfat and increases fat firmness, but have been inconclusive in determining the effects of CLA on growth traits. This trial was designed to differentiate between the effects of CLA and the effects of lower feed intake on pig growth and carcass composition of a *lean* genotype of pigs.

Materials and Methods

At 165 lb live weight, 30 lean-genotype gilts, Large White x [Landrace x (Duroc-Large White)], were randomly assigned to one of three dietary treatments. The diets consisted of conventional corn-soybean meal diets supplemented with either 1.0% CLA-60 ad libitum (CLA), 1.0% sunflower oil ad libitum (SFO), or 1.0% sunflower oil restricted to the feed intake level of the CLA-fed group (RSFO). Feed intake of the CLA pigs was determined weekly and fit to a quadratic equation as a function of live weight. This equation was used to determine the daily feed intake for the RSFO pigs. Such a design allowed us to differentiate between the effects of CLA and the effects of lower feed intake on changes in growth and carcass composition.

Individual live weights and feed intake were obtained weekly for seven weeks. Ultrasonic 10th rib backfat and loin eye area images were collected weekly and used to model lean growth and individual backfat layer growth. At the conclusion of the trial, pigs were transported to the Purdue Meat Laboratory for slaughter, tissue collection and carcass evaluation. At exsanguination, outer, middle and inner layer backfat, belly fat and loin were collected and snap frozen in liquid nitrogen until assayed for lipid and fatty acid composition. At 24 hours postmortem, standard carcass measurements such as backfat depths, loin eye area, and subjective loin eye quality (color, firmness/wetness and marbling) were taken. Standardized loin slices were obtained for drip loss and for chemical analyses of fat and CLA. Bellies were removed from the carcasses and subjectively graded for firmness.

Results and Discussion

Growth Traits

CLA-fed pigs demonstrated lower average daily gain (ADG). CLA pigs also tended to have lower average daily feed intake (ADFI) and to be less feed efficient (FE), although our results were not significant for these traits (Table 2). RSFO-fed pigs performed poorly in terms of ADG, ADFI and FE, which suggests that the effects of CLA on the growth of pigs may be due to the effect of CLA on feed intake.

Carcass Composition

Neither the CLA nor RSFO treatments had an effect on dressing percentage, ultimate (24-hour) pH, loin eye area, or subjective evaluations of loin color, firmness or marbling. Analysis of percent intramuscular fat remains in progress and will be reported in the future. Both the CLA and RSFO treatments demonstrated a tendency, although not statistically significant, to improve drip loss and decrease kidney fat. Additionally, the CLA-fed pigs tended to have less backfat, while the RSFO pigs tended to have more (Table 2). Although these differences in backfat were not significant, they demonstrate that the effects of CLA on backfat thickness are not simply due to changes in feed intake.

Belly Firmness

CLA dramatically increased the firmness of bellies, while the RSFO treatment had a detrimental effect on belly firmness (Table 2). Approximately 50% of the SFO bellies for this genotype of pigs were questionable in terms of being firm enough to slice, while even the thinnest CLA-fed bellies were acceptably firm. This further demonstrates that the effects of CLA are not simply due to changes in feed intake. In future trials we will better quantify differences in belly firmness in an effort to better define this effect. The question of *how* CLA improves belly firmness remains to be answered. We are currently determining the fatty acid profiles of the bellies from this trial and will include the results in future reports.

Fatty Acid Composition

Analysis of the fatty acid composition of loins is reported in Table 3. CLA-fed pigs deposited more CLA in their loins, and deposited an amount which is similar to what they were fed (0.6%). The loins of CLA-fed pigs contained more saturated fatty acids and less unsaturated fatty acids, which resulted in a higher saturates:unsaturates ratio. CLA-fed pigs tended to have less mono- and poly-unsaturated fatty acids, but the results were not significantly different. Thus, the feeding of a poly-*unsaturated* fatty acid resulted in an increase in the amount of *saturated* fats. This result differs from our previous experiences in which the feeding of unsaturates have decreased the saturate:unsaturate ratio and resulted in a decrease in fat firmness. CLA may be affecting the regulation of genes that determine fatty acid composition. We will determine the effects of CLA on such genes in future trials.

Value of Research to the Swine Industry

CLA is naturally present in beef, lamb and turkey at much higher levels than it is in pork, and has received considerable attention as a protective agent against both cancer and heart disease. Thus, CLA is likely to become a selling point for other meat industries – an advantage which may be neutralized, as this trial has demonstrated a method of creating CLA-enriched pork. In addition to the marketing advantages of CLA-enriched or “heart-healthy” pork, CLA has the potential to directly increase profitability to both producers and processors. Published studies conducted on laboratory animals and preliminary reports on swine trials indicate that feeding CLA-supplemented diets may provide a means by which feed intake and backfat can be decreased and percent lean can be increased without affecting growth rate. As pork-processing plants become increasingly mechanized, CLA may provide a nutritional solution to carcass fat and belly firmness problems that may enhance the overall value of extremely lean carcasses.

Future Objectives

Future trials must not only determine the effects of CLA on growth, composition and quality, but also seek to further understand the underlying biology that controls such traits. Because the effects of CLA will likely vary across genotypes, learning how CLA affects growth and gene expression will enable us to better determine at what level and for what duration CLA should be used by producers. Knowledge of how CLA affects the biology of the pig will allow us to select for components of fat growth and to identify genes which have major effects on pig growth and development.

Table 1. Summary of trials investigating the effects of CLA on pig growth and carcass composition*.

	Wisconsin	Iowa State	Kansas St.	Lacombe	Purdue
% dietary CLA	0.5 %	0.5 %	0.5 %	2.0 %	0.6 %
Duration of CLA	50-286 lb	55-255 lb	90-230 lb	135-235 lb	165-265 lb
# pigs	24 barrows	40 barrows	36 barrows	108 b & g	30 gilts
Avg. daily gain	Not sig.	↑ 3.4 %	↓ 5.8 %	Not sig.	↓ 10.2 %
Feed intake	Not sig.	Not sig.	Not sig.	Not sig.	Not sig.
Feed efficiency	↑ 4.6 %	↑ 5.1 %	Not sig.	Not sig.	Not sig.
10th rib backfat	↓ 27.0 %	↓ 10.3 %	Not sig.	↓ 6.8 %	Not sig.
% lean	↑ 5.0 %			↑ 2.3 %	
Belly quality	↑ firmness	↑ firmness	↑ firmness		↑ firmness

*Not sig. = not significant, P>.05.

Table 2. Effects of diet and feed intake on growth and carcass traits.

	Diet				
Trait	CLA	SFO	RSFO	SE	Sig.*
Start Weight (lb)	167.75	164.10	164.40	5.82	Not sig.
Slaughter Weight (lb)	262.40	269.35	250.40	6.94	Not sig.
Average Daily Gain (lb)	1.93	2.15	1.76	0.06	P<.01
Average Daily Feed Intake (lb)	7.65	8.09	7.01	0.38	Not sig.
Feed:Gain	3.98	3.76	4.01	0.19	Not sig.
Dressing Percentage (%)	73.71	73.82	74.29	0.61	Not sig.
Ultimate pH (24-hour)	5.47	5.41	5.47	0.03	Not sig.
Drip Loss (%)	5.07	5.46	4.44	0.53	Not sig.
Carcass Length (in.)	33.37	32.96	33.37	0.31	Not sig.
First Rib Backfat (in.)	1.36	1.45	1.51	0.08	Not sig.
Last Rib Backfat (in.)	0.91	0.97	0.96	0.06	Not sig.
Last Lumbar Backfat (in.)	0.66	0.71	0.75	0.06	Not sig.
10th Rib Fat Depth (in.)	0.75	0.82	0.89	0.06	Not sig.
Loin Color**	2.55	2.54	2.27	0.15	Not sig.
Loin Firmness**	2.36	2.33	1.86	0.17	Not sig.
Loin Marbling**	1.40	1.38	1.17	0.15	Not sig.
Loin Eye Area (sq.in.)	6.84	6.97	6.86	0.21	Not sig.
Kidney Fat (lb)	3.01	3.32	3.07	0.22	Not sig.
Belly Firmness***	2.91	2.43	2.07	0.13	P<.01

*Not sig. = not significant, P>.05.
**NPPC Scoring System.
Color: 1 = pale, pinkish gray; 5 = dark, purplish red.
Firmness: 1 = very soft and very watery; 5 = very firm and dry.
Marbling: 1 = devoid to practically devoid; 5 = moderately abundant or greater.
***1 = soft, unsliceable; 3 = very firm.

Table 3. Effects of diet on the fatty acid composition of intramuscular fat.

Trait	Diet			SE	Sig.*
	CLA	SFO	RSFO		
% Total Conjugated Linoleic Acid (CLA)	0.55	0.09	0.09	0.03	P<.01
% Total Saturated Fatty Acids (SFA)	39.77	36.04	36.73	0.74	P<.01
% Total Unsaturated Fatty Acids (UFA)	60.23	63.96	63.27	0.74	P<.01
SFA : UFA	0.66	0.56	0.58	0.02	P<.01
% Total Mono-Unsat. Fatty Acids (MUFA)	51.62	53.27	52.78	0.95	Not sig.
% Total Poly-Unsat. Fatty Acids (PUFA)	8.60	10.69	10.49	0.99	Not sig.

*Not sig. = not significant, P>.05.