Effects of Conjugated Linoleic Acid (CLA) on Swine Performance and Body Composition

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Summary and Implications

Market animals fed conjugated linoleic acid (CLA) could be leaner, have less fat and more muscle, and an increased rate of gain and improved feed efficiency. Improvement of these three production variables–improved lean, rate of gain, and feed efficiency–would offer significant economic advantages in swine production. Moreover, consumers would have available a leaner, more healthful meat product because consumption of the product could potentially help prevent obesity, cancer, and heart disease. Coupling both production efficiencies and the consumption of a more healthful meat product would mean significant enhancement economically for the pork industry. This project taken in total offers economic incentives to produce lean meat animals at the farm level and a more healthful product for consumption.

Introduction

This is a project underway to determine the effects of feeding conjugated linoleic acid (CLA) to swine on body composition, content of CLA in meat, and palatability. A full report of results will be made in next year's report.

CLA in the diets of lab animals has been shown to improve feed efficiency, rate of gain, and body composition. Based on these observations, feeding CLA in swine rations would seemingly improve feed efficiency, rate of gain, and body composition. Improvement of these three production variables would make pork production more profitable. Furthermore, human consumption of fortified CLA pork meat products offers potential health benefits against obesity, cancer, and heart disease.

This investigation of the effects of CLA in swine rations and in pork meat products offers potential swine production and human health advantages. Basic work indicates CLA has anticarcinogenic and antiatherogenic activity. Some applied research has been done on the CLA content of dairy products and beef products. Lab animal feed efficiency, weight gain, and body composition also have been studied. Further study by using swine would seemingly prove valuable for (1) improved production efficiencies and carcass composition by feeding CLA to swine and (2) positive human health attributes by consuming pork meat products fortified with CLA.

CLA is a collective term that refers to a mixture of positional and geometric isomers of linoleic acid. Linoleic acid is an 18-carbon, unsaturated fatty acid with two double bonds in positions 9 and 12, respectively, and both of these are in the cis configuration. CLA has both positional changes of the double bonds and geometric changes, i.e., the double bonds can be in the cis or trans configuration. Nine different isomers of CLA have been identified (c9, c11; c9, t11; t9, c11; t9, t11; c10, c12; c10, t12; t10, c12; t10, t12; c11, c13).

The total CLA content in foods varies widely. With a few exceptions, the c9, t11-isomer is the predominant form. This is particularly true in meat, cheese, and other dairy products. Meat from ruminants generally contains more CLA than meat from non-ruminants. Cheese and other dairy products also are good sources of CLA, whereas seafoods and vegetable oils are not. It is of interest to note that the c9, t11-isomer accounts for less than 50% of the total CLA in vegetable oils, in contrast to the 80 to 90% range found in meat and dairy products.

The objectives of this project will be to determine the effects of; (1) feeding CLA on feed efficiency, increased body weight gain, and decreased body fat; (2) feeding CLA to pigs on deposition of CLA in their tissues, particularly skeletal and adipose tissues; (3) feeding CLA as a percent of total diet and CLA concentration deposited in muscle and adipose tissue to determine a dose-dependent relationship; and (4) CLA on palatability and shelf life. Theoretically, this positive relationship would increase the amount of CLA available in the human diet by the consumption of fortified food products such as CLA pork meat products.

Materials and Methods

Eight replications of five littermate barrows with an average initial weight 26.3 kg. each were allotted at random to individual pens. Within replication, dietary treatments containing 0, .12, .25, .5, or 1.0% CLA were assigned at random. The source of CLA contained 65% CLA and was added to the diets at concentrations of .20, .42, .83, or 1.67% to provide the desired concentration of CLA. The CLA was substituted for corn. The diets were initially formulated to contain 18.7% crude protein and 1% lysine (Table 1). Diets were reformulated at about 3-week intervals (six formulations) to reduce crude protein and lysine content to 12.3% and .55%, respectively, in the final finishing stage. Room temperature was maintained at about 65°F to 70°F. Pigs were allowed ad libitum access to feed and water. Pigs were weighed and feed disappearance was determined at 14-day intervals.

Blood samples were obtained four times for determination of prostaglandin status ($PGE_{2\alpha}$ and PGE_2), immune function (cell surface staining and phagocytosis), electrolytes, liver function, CK, glucose, total cholesterol, HDL cholesterol, total lipids, and total proteins and urea nitrogen. Ultrasound was used to determine backfat thickness and loin eye area at approximately 68, 91, and 114 kg of body weight. Pigs were slaughtered at an average weight of 116 kg. Carcass composition was determined by wholesale loin dissection. Gas chromatography will be used to determine CLA content in intermuscular fat, intramuscular fat, and phospholipid of selected muscles from each animal. Palatability and shelf life of chops and ground pork will be assessed by sensory methodology. Results were analyzed statistically with the GLM procedure of SAS with the pig as the experimental unit.

Results and Discussion

Pigs were fed for an average of 93 days and were an average weight of 116 kg at slaughter. Average daily gain increased linearly (Table 2, P<.01) as the level of CLA increased in the diet. Average daily feed intake was not affected by the concentration of CLA in the diet. With no effect on feed intake and a linear increase in growth rate, there was also a linear improvement in gain to feed ratio. Backfat measured by ultrasound was not affected by the concentration of CLA in the diet. However, there was a linear increase in loin eye (P<.01) as the concentration of CLA in the diet increased as measured by ultrasound.

Table 1. Diet composition.

Ingredient	%
Corn, ground	70.13
Soybean meal, dehulled	27.13
Dicalcium phosphate	1.28
Calcium Carbonate	.86
Salt	.25
Vitamin premix[a]	.20
Mineral premix[b]	.05
Antimicrobialc	.10

[a]Contributed the following per pound of diet: 1,010 IU of vitamin A, 250 IU of vitamin D_3, 5 μg of vitamin B_{12}, 1.5 mg of riboflavin, 4.0 mg of d-pantothenic acid, and 7.5 mg. of niacin.
[b]Contribuited the following per pound of diet: 45 mg of Zn, 22.7 g of Fe, 2.5 mg of Cu, 12.5 mg of Mn, and .34 mg of I.
[c]Contributed 40 mg of tylosin per pound of diet.

Table 2. Effect of conjugated linolenic acid (CLA) on growing-finishing pig performance and composition.

	Added CLA, %				
Item	0	.12	.25	.5	1.0
ADG[a], lb	2.07	2.05	2.10	2.14	2.24
ADFI, lb	5.90	5.58	4.62	5.79	5.79
Gain/feed[a]	.352	.367	.373	.370	.384
Backfat, in.	.96	.85	.85	.90	.93
LEAa, in.^{2}	6.60	6.77	7.07	7.03	7.32

[a]Linear effect of CLA (P<.01).

Table 3. Effect of conjugated linolenic acid on growing-finishing pig performance

	Level of conjugated linolenic acid					
Week	0	.125	.25	.5	1.0	0
			Body Weight, kg			
0	26.2	27.2	26.7	27.2	26.4	26.7
2	38.6	37.6	37.8	38.5	38.2	38.0
4	52.3	53.2	53.3	53.5	54.5	50.4
7	68.7	69.4	70.0	70.5	72.2	68.0
8	79.6	79.5	79.9	81.8	84.3	79.1
10	92.3	93.2	92.6	95.7	97.3	93.3
12	104.0	105.8	105.8	108.0	111.2	105.2
Final	114.1	114.1	115.8	118.4	121.6	112.7
			ADG, kg			
0–2	.887	.738	.790	.809	.840	.808
2–4	.979	1.116	1.105	1.072	1.161	.888
4–7	.965	.952	.982	.999	1.047	1.037
7–8	.996	.818	.898	1.032	1.098	1.009
8–10	.904	.981	.913	.991	.923	1.014
10–12	.836	.898	.943	.882	1.024	.850

0–4	.933	.928	.948	.940	1.001	.848
0–7	.945	.936	.961	.962	1.018	.919
0–8	.955	.933	.948	.976	1.033	.937
0–10	.944	.942	.941	.979	1.012	.923
0–12	.926	.935	.941	.963	1.014	.935
0–Final	.942	.930	.953	.974	1.019	.942
			ADFI, kg			
0–2	1.813	1.661	1.635	1.628	1.625	1.776
2–4	2.194	2.257	2.292	2.217	2.379	2.148
4–7	2.587	3.389	2.497	2.476	2.614	2.580
7–8	3.007	2.750	2.639	2.863	3.006	2.851
8–10	2.821	2.764	2.762	2.899	2.779	2.945
10–12	3.234	3.053	3.030	3.055	3.179	3.135
0–4	2.004	1.959	1.964	1.923	1.999	1.962
0–7	2.224	2.122	2.165	2.132	2.231	2.195
0–8	2.378	2.245	2.258	2.275	2.384	2.324
0–10	2.466	2.349	2.359	2.400	2.463	2.448
0–12	2.595	2.466	2.471	2.509	2.582	2.563
0–Final	2.683	2.538	2.556	2.633	2.634	2.572
			Gain/feed			
0–2	.492	.451	.484	.499	.516	.456
2–4	.446	.494	.484	.485	.490	.414
4–7	.373	.400	.393	.402	.401	.402
7–8	.332	.333	.323	.362	.369	.355
8–10	.320	.355	.335	.345	.331	.347
10–12	.258	.292	.312	.289	.323	.265
0–4	.467	.475	.484	.491	.500	.433
0–7	.425	.443	.445	.452	.457	.419
0–8	.402	.417	.421	.430	.434	.404
0–10	.438	.402	.401	.409	.411	.390
0–12	.358	.379	.382	.385	.393	.366
0–Final	.352	.367	.373	.370	.384	.367
			Feed/gain			
0–2	2.045	2.250	2.075	2.016	1.949	2.199
2–4	2.254	2.028	2.085	2.086	2.056	2.424
4–7	2.691	2.511	2.556	2.498	2.504	2.499
7–8	3.019	3.079	4.731	2.793	2.786	2.836
8–10	3.150	2.830	3.076	2.975	3.085	2.915
10–12	4.194	3.468	3.225	3.538	3.127	4.028
0–4	2.149	2.111	2.072	2.048	2.000	2.315
0–7	2.360	2.263	2.252	2.216	2.194	2.389
0–8	2.490	2.402	2.381	2.330	2.312	2.479
0–10	2.613	2.489	2.505	2.451	2.445	2.568
0–12	2.806	2.637	2.624	2.605	2.555	2.738
0–Final	2.853	2.728	2.684	2.711	2.615	2.729
			Backfat, cm			
4	1.44	1.33	1.39	1.43	1.41	1.32
6	1.83	1.62	1.64	1.67	1.77	

9.5	2.11	1.84	1.91	1.96	2.04	
Final	2.44	2.15	2.16	2.28	2.37	
			Loin eye area, cm^2			
4	22.8	23.2	22.0	23.4	24.2	21.5
6	29.5	29.7	28.3	30.1	29.6	
9.5	33.9	36.3	35.6	35.1	38.0	
Final	42.6	43.7	45.6	45.4	47.2	