Body Composition and Sensory Characteristics of Pork from CLA-Fed Pigs

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Summary and Implications

Conjugated linoleic acid (CLA) improved carcass characteristics of pork by decreasing backfat and increasing fat hardness (firmness). CLA also improved the color of pork loin chops and patties both initially and over retail storage time. Combined, these carcass composition and sensory characteristic improvements could provide processors and consumers a more desirable product. The increase in fat hardness should provide processors with bellies that have improved sliceability and consumers with bacon that holds its shape when cooked.

Introduction

Conjugated linoleic acid is a group of naturally occurring isomers of linoleic acid containing a conjugated double bond that has been shown to inhibit cancer in laboratory animals (1,2). While studying anticarcinogenic effects in laboratory animals, researchers noticed that some improved production efficiency and carcass composition occurred (3).

The purpose of this portion of the study was to investigate the ability of CLA to improve body composition and sensory characteristics in pork.

Materials and Methods

Eight replications of five littermate barrows with an average initial weight of 26.3 kg each, were allotted at random to individual pens in this study. Within replication, dietary treatments containing 0, .12, .25, .50 or 1.0% CLA were assigned at random. Ultrasound was used to determine backfat thickness and loin eye area at approximately 52, 68, 91 and 114 kg of body weight. Pigs were harvested at an average weight of 116 kg.

Post-slaughter, the carcasses were chilled for 24 hours at (-2 - 0°C). Loin eye area was measured at the 10^{th}-11^{th} rib interface to the nearest tenth of a square inch with a plastic grid. Backfat measurements were made to the nearest 0.1 of an inch at the first, tenth, and last rib and the last lumbar. Total loin dissection, and primal to wholesale-ready cut measurements also were taken. The wholesale loin from the right side of each pig was dissected into its component parts (lean, subcutaneous fat, intermuscular fat, bone and trim), and weight of each was recorded in pounds. Each primal cut from the left side of the carcass (ham, loin, picnic, butt, and belly) was then trimmed to .64 cm external fat wholesale ready product. Weights of component parts were measured in pounds. In addition, belly hardness (firmness) was determined by placing the center of the belly over a bar and measuring the distance in inches between the ham and shoulder end, both lean side up and lean side down.

Loin chops were cut from the left side of each carcass. Two chops (2.54 cm in thickness) were cut for Hunter color and Warner-Bratzler shear analysis. Both chops were measured at three locations (dorsal, central, and ventral) with a 1.27 cm appeture and D65 light source for Hunter color determinations. Hunter L*, a*, and b* values were recorded. The scale for each is as follows; L* (100 =pure white, 0=pure black), a* (+ = red, - = green) and b* (+ = yellow, - = green). These chops were then cooked to 70°C internal temperature and allowed to cool for 24 hours to 2°C for Warner-Bratzler analysis. Warner-Bratzler determination was made with an Instron universal testing machine (model 4502) controlled by a Model 4500 computer assist module (Instron, Canton, MA). Peak shear force values were recorded as kg/2.54 cm diameter core.

Samples of loin tissue were taken for pH_{24} and water holding capacity. pH was measured with a Fischer (Accumet 985) pH meter on a 10 g homogenized sample. Water holding capacity was determined by using the Carver press method.

Three chops each 2.54 cm in thickness were cut, vacuum-packaged, and frozen at day 1 postmortem for subsequent sensory panel analysis. Chops were thawed in a refrigerator (3°C) for 26 hours before cooking. Two chops from each animal were broiled in a conventional household oven. Temperature was monitored by inserting a probe (Omega Engineering, Stamford, CT) into the geometric center of each chop. The chops were turned at 40°C, removed from the oven at 68°C, and allowed to stand until the internal temperature registered 70°C. The chops were cut into 1.27 cm cubes and cubes were served to 10 panelists trained to evaluate initial juiciness, tenderness, sustained juiciness, overall tenderness, and pork flavor. An eight point category scale was used to indicate the degree of each attribute (4).

A preliminary study using picnic shoulders from two repetitions were trimmed to .32 cm exterior fat and ground into 70/30 fresh pork patties. Two patties per treatment / rep. combination were placed in a styrofoam tray, with fresh overwrap and held fresh for 1,3,7, or 14 days prior to freezing. Frozen pork patties were thawed in a refrigerator (3°C) for 18 hours. The raw patties were cooked in preheated household electric skillets set at 163°C. The patties were cooked to an end point temperature of 70°C, taken in the center of the patty by using probes (Omega Engineering, Stamford, CT). Each patty was cut into eight wedges and the wedges from the two patties in each treatment were mixed. Panelists were asked to evaluate the magnitude of differences in the treated patties relative to the labeled control. The seven point scale was labeled from none to very large, with appropriate intermediate terms.

Results and Discussion

In Table 1, data indicate tenth rib backfat from CLA treated pork carcasses had significantly less fat (16%) than did controls (P<.05). No other backfat measurements (first rib, last rib, last lumbar) exhibited a difference between treatments. Ultrasound results for tenth rib backfat of live animals confirmed tenth rib carcass results. Ultrasound loin eye area (LEA) results showed a linear increase with increased concentration of CLA in the diet. This result was not supported by actual LEA measurements, which found no statistical difference between controls and treatments.

The results of loin dissection shown in Table 2, indicated that weights for initial loin (P<.04), subcutaneous fat (P<.03), and intermuscular fat (P<.005) showed a quadratic relationship. In addition, bone weight increased linearly (P<.03) with increasing amounts of CLA. (5) also described increases in initial loin weight, subcutaneous fat and intermuscular fat in pigs fed .50% CLA. Combined with data from (5) our loin dissection study demonstrated that CLA-fed pigs have more lean and less subcutaneous and intermuscular fat than did controls (5.1, 8.9, and 8.5%,respectively).

Within individual, wholesale ready cuts, initial (raw) cut weight of CLA treated cuts was increased over controls for ham (P<.02), picnic(P<.03), and belly (P<.004) as shown in Table 3. Finished (trimmed) cut weight for CLA cuts increased over controls for butt (P<.05) and belly (P<.006). The most obvious difference observed during this portion of the experiment was the hardness (firmness) of fat. This was especially noted in bellies from the treated groups. When belly hardness was measured lean side up a linear (P<.01) difference was observed. A similar linear relationship was observed (P<.05) when bellies were measured lean side down. This greater distance observed between belly edges during this test provides a potential improvement in sliceability and yield of bacon. Although trimmed bellies from CLA fed pigs were heavier, there was no difference in trim weight. Therefore, more bacon can be produced with better sliceabilty and no additional trim production.

There were no measurable differences between control and treatment loin chops at day 1 postmortem for Warner-Bratzler shear (WBS), pH_{24}, or water holding capacity. These objective results were supported by subjective color, firmness, and marbling scores that indicated no difference in quality attributes of loin chops between controls and treatments. Loin chops were all acceptable based on the NPPC standards for color, firmness, and marbling as shown in Table 4.

Hunter L*,a*, and b* values for day 1 chops indicated that there were no differences between controls and treatments for L* and b* values; however, the a* values shown in Table 5, increased as the amount of CLA added to the diet increased (P<.01). This increased a* value shows that loin chops were increasingly more red with increasing amounts of CLA.

Sensory panel results shown in Table 6, indicate no significant differences between treatments and controls except in initial juiciness and sustained juiciness. For these two categories, chops from controls were described as more juicy than were the .12% CLA fed pigs. Panelists did not describe any other sensory differences between controls and treatments, and results indicate that all samples were within the normal range for acceptability and palatability of commercial pork chops.

The preliminary amount of information provided by the patty subsample study suggests several areas for future research. Patties tended to have higher L* and a* values with CLA addition up to .50%. There seemed to be an increase in L* and a decrease in a* values in patties from pigs fed above .50%. This darker, more red color exhibited at day 7 indicates that product with .50% CLA treated pigs held its color and would have the most consumer appeal. Cook loss data tended to indicate that the higher the CLA added, the lower the cook loss. No differences in sensory panel results were found between control and treated patties.

References

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Table 1. Ultrasound and measured tenth rib backfat and loin eye area results from CLA fed growing-finishing pigs.

Item	Added CLA%					SEM
	0.0	.12	.25	.50	1.0	
Ultrasound backfat, cm	2.44	2.15	2.16	2.28	2.37	
Measured backfat, cm	2.86a	2.34b	2.34b	2.61	2.57	.16
Ultrasound loin eye area, cm^2	42.6b	43.7b	45.6c	45.4c	47.2ac	
Measured loin eye area, cm^2	41.2	43.9b	42.0	40.1	39.3a	1.4

Values with different letters within a row indicate significant differences (P<.05).

Table 2. Least squares means, standard error, and P values of loin dissection from growing-finishing pigs fed CLA.

Component	%CLA added	LSM	SEM	P
Initial loin, kg				
	0.0	11.26	.31	.04z
	.12	10.89	.31	
	.25	10.68	.31	
	.50	11.54	.34	
	1.0	11.89	.31	
Intermuscular fat, kg				
	0.0	.25d	.02	.005z
	.12	.15bc	.02	
	.25	.20bd	.02	
	.50	.22d	.03	
	1.0	.27ad	.02	
Subcutaneous fat, kg				
	0.0	2.86	.19	.03z
	.12	2.37	.19	
	.25	2.39	.19	
	.50	2.62	.20	
	1.0	2.84	.19	
Bone, kg				
	0.0	1.56	.06	.03y
	.12	1.56	.06	
	.25	1.46b	.06	
	.50	1.73a	.07	
	1.0	1.71a	.06	
Finished loin, kg				
	0.0	3.88	.13	.08y
	.12	4.00	.13	
	.25	4.04	.13	
	.50	4.07	.14	
	1.0	4.24	.13	

a,b,c,d Indicate significant differences within a column (P<.05).
y Linear relationships.
z Quadratic relationships.

Table 3. Least squares means, standard error, and linear P values for primal cuts trimmed to wholesale ready product from growing finishing pigs fed CLA.

Primal Cut weight, kg	%CLA	LSM	SEM	P	Wholesale Cut weight, kg	%CLA	LSM	SEM	P
Initial Ham					Finished Ham				
	0.0	10.08[a]	.28	.02		0.0	7.56	.25	.07
	.12	10.18	.28			.12	7.73	.25	
	.25	10.33	.28			.25	7.88	.25	
	.50	10.55	.30			.50	7.99	.28	
	1.0	10.94b	.28			1.0	8.02	.25	
Initial Loin					Finished Loin				
	0.0	11.71	.38	.54		0.0	8.06	.29	.08
	.12	11.57	.38			.12	8.31	.29	
	.25	11.64	.38			.25	8.67	.29	
	.50	11.57	.41			.50	8.57	.32	
	1.0	12.09	.38			1.0	8.77	.29	
Initial Picnic					Finished Picnic				
	0.0	4.65a	.14	.03		0.0	2.64	.12	.03
	.12	4.81	.14			.12	2.79	.12	
	.25	4.76	.14			.25	2.82	.12	
	.50	4.94	.15			.50	2.78	.13	
	1.0	5.12b	.14			1.0	2.85	.12	
Initial Butt					Finished Butt				
	0.0	4.49	.15	.23		0.0	2.46	.10	.05
	.12	4.53	.15			.12	2.34a	.10	
	.25	4.54	.15			.25	2.44	.10	
	.50	4.49	.16			.50	2.52	.11	
	1.0	4.79	.15			1.0	2.69b	.10	
Initial Belly					Finished Belly				
	0.0	7.96a	.24	.004		0.0	5.20a	.20	.006
	.12	8.02a	.24			.12	4.90a	.20	
	.25	8.53	.24			.25	5.16a	.20	
	.50	8.36	.26			.50	5.39	.22	
	1.0	8.99b	.24			1.0	5.91b	.20	

Values with different letters within a column category indicate significant differences.

Table 4. Subjective color, firmness and marbling values of pork loin chops at 1 day post slaughter from pigs fed CLA[z]

% CLA added	Color	SEM	Firmness	SEM	Marbling	SEM
0.0	2.07	.23	2.62	.28	2.59	.23
.12	2.19	.23	2.74b	.28	2.59	.23
.25	2.24	.23	2.37	.27	2.74	.23
.50	2.48	.25	2.30	.30	2.87	.25
1.0	1.85	.25	1.89a	.29	2.32	.24

[a,b] Values with different letters within a column indicate significant differences (p<.05)
[z] NPPC standards used

Table 5. Hunter L*, a* and b* values for pork loin chops at day 1 post slaughter from pigs fed CLA

% CLA added	L*	SEM	a*	SEM	b*	SEM
0.0	53.40	1.73	.80b	.57	11.33	.56
.12	52.03		.94b		10.63	
.25	54.43		1.60		11.43	
.50	53.80		1.54		11.03	
1.0	54.83		2.95a		11.52	

Values with different letters within a column indicate significant differences (p<.05)

Table 6. Sensory panel values for day 1 pork loin chops from pigs fed CLA

% CLA	Initial Juiciness	SEM	Sustain. Juiciness	SEM	Initial Tender	SEM	Overall Tender	SEM	Pork Flavor	SEM
0.0	4.63a	.21	4.58	.19	4.54	.21	4.86	.20	4.64	.18
.12	3.96bc	.21	3.98	.19	4.46	.21	4.60	.20	4.39	.18
.25	4.19c	.21	4.42	.19	4.82	.21	5.01	.20	4.35	.18
.50	4.18c	.21	4.22	.19	4.51	.21	4.66	.20	4.47	.18
1.0	4.25c	.23	4.30	.21	4.80	.23	5.05	.22	4.56	.20

Values with different letters within a column are significantly different (p<.05)