Effects of High Oil Corn and Duration of Conjugated Linoleic Acid (CLA) Supplementation on Pig Growth, Pork Quality and Carcass Composition

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Introduction

The swine industry has selected to increase percent lean in response to consumer demand for lean pork products. Unfortunately, selection to increase leanness has also resulted in poorer carcass quality, including lower color, firmness and marbling evaluations as well as decreased fat firmness. The pork industry must find a method to produce lean pork without sacrificing pork quality.

One quality problem associated with high-percent lean pigs is soft, unsliceable bellies. This problem is of major concern in the highly mechanized pork processing industry. Dietary supplementation with conjugated linoleic acid (CLA) has been shown to increase belly firmness of lean pigs. It has also been demonstrated that CLA can improve feed efficiency and act as a repartitioning agent by decreasing subcutaneous fat and increasing lean.

High oil corn (HOC) presents an interesting alternative ingredient to pork producers. HOC is utilized as a feedstuff to provide a high-energy diet comparable to conventional corn supplemented with animal fat. The use of HOC eliminates costs associated with supplementing with animal fat and thereby increases the amount of pork produced per acre of corn. To date, there have been no studies that have examined the effects of HOC and CLA on the growth, carcass composition and pork quality of high-lean pigs. This trial evaluated the effects of CLA and high oil corn on pig growth, carcass composition, and pork quality characteristics.

Materials and Methods

High-lean gilts (n=224) were randomly assigned in a 4 x 3 factorial arrangement of treatments based on corn type and duration of CLA supplementation. Pigs underwent segregated early weaning procedures followed by housing in two wings of the SEW grow-finish building for the remainder of the trial. The west wing is curtain sided with inside insulated panel doors that close during the winter. The east wing is environmentally controlled. Pigs in both wings were provided over 12 ft^2 per pig. Treatment groups were equally represented in both wings of the building. At 56 lb live weight, pigs were randomly allotted to one of four standard corn-soybean meal-based diets, which were fed on an ad libitum basis until slaughter at 256 lb. The four diets were: high oil corn (HOC), Optimum® high oleic, high oil corn (HOHOC), conventional corn (CONV), and conventional corn supplemented with choice white grease (CWG). The HOC, HOHOC and CWG diets were formulated to have equivalent lysine:calorie ratios. CLA treatments included no CLA (1% sunflower oil; SFO), finishing with 1.0% CLA oil from 195-256 lb (CLA1), and finishing with 1.0% CLA oil from 144-256 lb (CLA2). CLA oil contained 60% positional and geometric isomers of conjugated linoleic acid. Individual pig weights and pen feed intake were recorded every two weeks throughout the trial.

Upon reaching a slaughter weight of 256 lb, pigs were transported to the Purdue University Meat Laboratory for slaughter, tissue collection and carcass evaluation. Standardized carcass measurements and pork quality evaluations were obtained at 24 hours postmortem. The carcasses were ribbed at the 10-11th rib interface, and pork color, firmness and marbling scores were subjectively evaluated on a 1 to 5 scale according to established NPPC guidelines (NPPC, 1991). A loin sample was taken from the 10th rib to be evaluated for color by Hunter Colorimeter analysis of L*, a* and b* scores. Carcass data were used to calculate the percentage of fat-free lean.

Postmortem pH levels were measured from loin samples from at or near the last rib, and these samples were then used to assess the drip loss. Samples were weighed and suspended in a plastic tube to prevent contact with the released exudate. Drip loss was calculated as the percentage of weight lost by the sample over a 24-hour period. The portion of the belly anterior to the 10th rib was then removed from the carcass and subjectively evaluated for firmness by placing it on a 1 cm wide metal bar and determining the angle that it bent over the bar. A score of 3 was assigned to the firmest bellies which maintained a flop angle of greater than 120^o. A firmness score of 1 was designated for the softest bellies, which yielded a flop angle of less than 60^o. Any intermediate bellies were recorded as a firmness score of 2.

Results

CLA supplementation decreased feed consumption (P<.05) with no adverse effects on overall growth or feed conversion (Table 1). HOHOC resulted in an increase in feed consumption during the second measured phase (144-195 lb) of growth (P<.05), the third phase (195-256 lb) of growth (P<.01), and overall growth (P<.01), while CWG decreased consumption in all of these growth phases (Table 2). The CWG also increased feed efficiency from 56-144 lb, from 144-195 lb, and overall (P<.05). An effect of wing was observed for average daily gain (P<.05) and feed consumption (P<.05) in all growth phases.

Pork quality scores tended to increase as CLA duration increased (Table 3). Marbling scores increased greatly (P<.05), as did firmness scores (P<.01). The subjective color scores increased with increasing CLA duration (P<.10), but the L*, a* and b* scores did not reflect this trend. Loin eye area and percent fat-free lean tended to increase and 10th rib fat depth tended to decrease as the duration of CLA supplementation increased, but the results were not statistically significant (P>.10). CLA supplementation demonstrated a drastic improvement in belly firmness (P<.01). CLA decreased the thickness of the outer fat layer (P<.05), but did not affect the inner or middle layers or the overall 10th rib fat depth. Last rib fat depth, and backfat thickness at the last rib and last lumbar vertebrae were unaffected by CLA supplementation.

The type of corn fed significantly affected belly firmness (Table 4). Gilts fed the HOHOC diet possessed much firmer bellies than the other dietary treatments (P<.05). The HOC diet increased ultimate pH (P<.01). The type of corn fed did not affect any other carcass composition or pork quality traits. There were no significant corn x CLA interactions.

Discussion

This study demonstrated a large effect of CLA supplementation on increased belly firmness. Genetically lean pigs often have very soft fat. This is because lean pigs must rely on dietary sources of fat rather than de novo synthesis. De novo synthesis yields more saturated fat, which is much firmer than unsaturated fat. Feeding a higher percentage of dietary fat usually decreases de novo synthesis, because the pig is acquiring adequate fatty acids from dietary sources. Under these conditions, the pig will deposit the same type of fat as consumed from its diet. Therefore, the pigs will deposit soft, unsaturated fat when consuming unsaturated animal fats which are commonly used in swine diets. CLA alters this process in some way, as CLA is a polyunsaturated fatty acid and the pig deposits saturated fatty acids when supplemented with dietary CLA.

CLA also resulted in an increase in pork quality of genetically lean pigs. There tended to be an increase in pork quality and carcass composition measurements such as loin eye area, fat depth, subjective color and marbling as the duration of CLA supplementation increased.

The building wing played a large role in pig growth, with the west wing yielding .29 lb/day higher ADG and .40 lb/day higher feed consumption than the east wing. Pigs reared in the west wing had a higher percent fat-free lean (56.0 vs. 54.8%), with less 10th rib backfat depth (.54 vs. .61 inch) and larger loin eye area (7.67 vs. 7.38 in^2) than pigs reared in the east wing. The lean growth rate is approximately 18% higher for pigs reared in the west wing than the east wing. This is likely due to the poorer air quality in the east wing. The east wing of the building is totally enclosed, whereas the west wing has automatic curtains (Schinckel et al., 1997). During the spring, summer and fall months, the air quality and growth performance is noticeably better in the west wing than the east wing. The stresses induced by poorer air quality affected lean growth more than fat growth. Social and heat stressors have also in some cases reduced growth, feed intake, and percent lean.

Implications

As the swine industry continues to select for leanness, the quality of pork worsens. This relationship has been realized by the industry, but no practical solutions have been discovered. This trial demonstrated that dietary supplementation of CLA is a potential solution to this problem. CLA improved fresh pork quality and belly firmness. This will enable the producer to more efficiently produce a higher quality product for the consumer. CLA has the potential to increase profitability for not only the producer, but the processor as well. The pork processing industry will benefit by the increased belly firmness, because it will increase the sliceability of lean bellies.

This study also demonstrated that HOC has a negative effect on belly firmness, but that HOHOC showed an increase in firmness. This is a potential benefit of HOHOC; however, the feed efficiency of the HOHOC treatment group was not as high as the CWG treatment due to the increased consumption of the HOHOC group. Even though the HOC has a negative effect on belly firmness, it has a positive effect on pork quality by increasing ultimate pH. There exist many potential benefits for the producer by implementing HOC into swine diets, but it may need to be weighed by the costs. The effects of both HOC and CLA to the swine industry merit further investigation in order to precisely determine their role in pork production.

References

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Table 1. Effect of CLA duration and building wing on growth performance.

	Duration of CLA					Building Wing			
	SFO	CLA1	CLA2	SE[1]	Sig[2]	East	West	SE[1]	Sig[2]
ADG (lb/day)									
56-144 lb	--	--	--	--	--	1.77	2.03	.02	***
144-195 lb	1.96	--	1.91	.03	ns	1.93	2.04	.03	***
195-256 lb	1.86	1.92	1.89	.06	ns	1.76	2.03	.05	***
Overall	1.91	1.93	1.89	.03	ns	1.76	2.05	.03	***
Feed Consumption (lb/day)									
56-144 lb	--	--	--	--	--	3.90	4.31	.04	***
144-195 lb	5.61	--	5.37	.07	*	5.33	5.65	.07	**
195-256 lb	5.98	5.95	5.66	.08	*	5.70	6.02	.09	+
Overall	5.10	5.01	4.89	.05	*	4.79	5.20	.06	***
Feed:Gain									
56-144 lb	--	--	--	--	--	2.16	2.13	.02	ns
144-195 lb	2.90	--	2.85	.05	ns	2.93	2.81	.05	+
195-256 lb	3.19	3.16	3.11	.12	ns	2.96	3.35	.14	ns
Overall	2.69	2.60	2.63	.05	ns	2.53	2.75	.06	+

[1] Standard error.
[2] Significance: ns = not significant, P>.10; + P<.10; * P<.05; ** P<.01; *** P<.001.

Table 2. Effect of corn type on growth performance.

	Type of Corn					
	HOHOC	CONV	CWG	HOC	SE[1]	Sig[2]
ADG (lb/day)						
56-144 lb	1.89	1.89	1.92	1.91	.02	ns
144-195 lb	1.98	1.85	1.97	1.93	.05	ns
195-256 lb	2.02	1.78	1.94	1.93	.07	+
Overall	1.95	1.84	1.94	1.90	.03	+
Feed Consumption (lb/day)						
56-144 lb	4.17	4.15	4.02	4.07	.05	ns
144-195 lb	5.63	5.62	5.24	5.49	.10	*
195-256 lb	6.14	5.78	5.65	5.88	.10	**
Overall	5.11	5.03	4.84	5.00	.05	**
Feed:Gain						
56-144 lb	2.19	2.17	2.09	2.13	.02	*
144-195 lb	2.85	3.01	2.72	2.91	.07	*
195-256 lb	3.08	3.44	2.96	3.13	.14	+
Overall	2.62	2.77	2.53	2.64	.05	*

[1] Standard error.
[2] Significance: ns = not significant, P>.10; + P<.10; * P<.05; ** P<.01; *** P<.001.

Table 3. Effect of CLA duration and building wing on carcass measurements and pork quality evaluations.

	Duration of CLA					Building Wing			
	SFO	CLA1	CLA2	SE[1]	Sig[2]	East	West	SE[2]	Sig[2]
Carcass Composition									
Carcass Length (in.)	32.6	32.4	32.4	.11	ns	32.7	32.3	.09	**
Belly Firmness	1.58	2.12	2.21	.06	***	2.09	1.85	.06	**
% Fat Free Lean	55.08	55.43	55.80	.33	ns	54.8	56.02	.25	**
Fat Thickness									
Last Rib Backfat (in.)	1.10	1.08	1.10	.02	ns	1.12	1.07	.02	*
Last Lumbar Backfat (in.)	.67	.65	.62	.02	ns	.67	.62	.02	*
Last Rib Fat Depth (in.)	.56	.56	.59	.02	ns	.55	.59	.02	ns
Outer Layer Fat Thickness (in.)	.27	.26	.24	.01	*	.28	.23	.01	***
Middle Layer Fat Thickness (in.)	.22	.22	.21	.01	ns	.22	.21	.01	ns
Inner Layer Fat Thickness (in.)	.10	.11	.11	.01	ns	.11	.10	.005	ns
10th Rib Fat Depth (in.)	.59	.58	.56	.02	ns	.61	.54	.02	***
Loin Quality									
Loin Eye Area (in^2)	7.42	7.51	7.65	.11	ns	7.38	7.67	.09	*
L*	58.42	59.00	58.55	.40	ns	58.80	58.60	.34	ns
a*	9.72	9.70	9.82	.18	ns	9.60	9.90	.20	ns
b*	14.07	14.00	13.76	.22	ns	14.20	13.70	.20	ns
Color	2.29	2.37	2.42	.04	+	2.35	2.36	.04	ns
Marbling	1.36	1.45	1.52	.05	*	1.46	1.43	.04	ns
Firmness	2.07	2.26	2.23	.04	**	2.21	2.16	.04	ns
24-hour Postmortem pH	5.57	5.59	5.57	.01	ns	5.56	5.59	.01	ns
24-hour Postmortem Drip Loss %	5.26	5.60	5.35	.26	ns	4.39	6.42	.22	***

[1] Standard error.
[2] Significance: ns = not significant, P>.10; + P<.10; * P<.05; ** P<.01; *** P<.001.

Table 4. Effect of corn type on carcass measurements and pork quality evaluations.

	Type of Corn					
	HOHOC	CONV	CWG	HOC	SE[1]	Sig[2]
Carcass Composition						
Carcass Length (in.)	32.39	32.35	32.44	32.71	.13	ns
Belly Firmness	2.13	2.03	1.95	1.78	.08	*
% Fat Free Lean	55.23	55.14	55.81	55.56	.38	ns
Fat Thickness						
Last Rib Backfat (in.)	1.11	1.06	1.10	1.10	.03	ns
Last Lumbar Backfat (in.)	.66	.63	.67	.63	.02	ns
Last Rib Fat Depth (in.)	.56	.55	.61	.56	.02	ns
Outer Layer Fat Thickness (in.)	.26	.25	.25	.26	.01	ns
Middle Layer Fat Thickness (in.)	.22	.21	.22	.22	.01	ns
Inner Layer Fat Thickness (in.)	.10	.11	.11	.10	.01	ns
10th Rib Fat Depth (in.)	.59	.57	.58	.57	.02	ns
Loin Quality						
Loin Eye Area (in^2)	7.45	7.43	7.74	7.50	.13	ns
L*	58.73	58.40	58.77	58.73	.45	ns
a*	9.91	9.99	9.55	9.54	.22	ns
b*	13.70	14.27	13.96	13.83	.26	ns
Color	2.37	2.37	2.40	2.30	.05	ns
Marbling	1.41	1.51	1.44	1.42	.05	ns
Firmness	2.18	2.16	2.24	2.18	.05	ns
24-hour Postmortem pH	5.59	5.54	5.57	5.61	.01	**
24-hour Postmortem Drip Loss %	5.70	5.61	5.43	4.87	.30	ns

[1] Standard error.
[2] Significance: ns = not significant, P>.05; * P<.05; ** P<.01; *** P<.001.