Evaluation of the Effects of Dietary Fat, Conjugated Linoleic Acid, and Ractopamine on the Fatty Acid Profiles of Fat and Muscle Tissue of Lean Gilts

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Introduction

Feeding diets containing conjugated linoleic acid (CLA) has been shown to increase feed efficiency, carcass leanness (Dugan et al., 1997), and belly firmness (Eggert et al., 2001). Additionally, feeding CLA increases the saturated fatty acid content of bellies and loins of finishing pigs (Eggert et al., 2001), which may be the mechanism by which CLA enhances belly firmness. Adding rendered animal fats to diets has long been known to enhance the feed efficiency of growing and finishing pigs, and it is a well known phenomenon that the fatty acid composition of the pig's fat tissues reflects the fatty acid composition of the diet consumed. Adding ractopamine to finishing swine diets leads to an increase in growth performance, carcass lean, and carcass yield (Herr et al., 2001). However, there is little data as to the effects of ractopamine on the fatty acid profiles of pigs. The objective of this study was to determine the interactive and combined effects of CLA, dietary fat, and ractopamine on the fatty acid profiles of tisues from genetically lean gilts. The performance and carcass data from this experiment were previously presented (Weber et al., 2001).

Materials and Methods

Gilts (n = 180; Newsham XL sires x Newsham parent females; initial BW = 130 lb) were randomly assigned to a 2 x 2 x 3 factorial arrangement consisting of dietary CLA, ractopamine, and fat treatments. The CLA treatment consisted of a 1% commercially available CLA product containing 60% CLA isomers (0.6% CLA) or 1% soybean oil. Ractopamine levels were either 0 or 9 g/ton. Dietary fat treatments consisted of : 1) diets containing 0% added fat; 2) diets containing 5% choice white grease (CWG); or 3) diets containing 5% beef tallow (BT). The CLA and fat treatments were initiated at 130 lb BW, 4 wk prior to the ractopamine treatments. The ractopamine treatments were imposed when the gilts reached an average BW of 188 lb and lasted for the final 4 wk of the experiment, at which time carcass data and tissue samples were collected.

At the time of slaughter, sections of loin muscle, belly tissue, and inner and outer backfat were collected from a subset of the pigs (n = 72; 6 pigs/treatment). The fatty acid content and iodine values (IV) of the tissues were determined as previously described (Bligh and Dyer, 1959; Eggert et al., 2001). The data were analyzed using ANOVA (Proc GLM; SAS Institute; Cary, NC) to test the significance of the main effects and all interactions. There were no significant interactions ($P > 0.05$), and therefore, the data are presented as main effects.

Results

The effects of the dietary treatments on fatty acid profiles are presented in Tables 1 through 4. Dietary CLA caused ($P < 0.05$) the lipids contained in the carcass fat and muscle tissue to become more saturated. The addition of 5% animal fat decreased ($P < 0.05$) the abundance of saturated fatty acids in the bellies and in both layers of backfat. Ractopamine decreased ($P < 0.05$) the abundance of total lipids in the loin muscle, and increased ($P < 0.05$) the content of total unsaturated fatty acids and the IV of inner-layer backfat.

Discussion

The increased abundance of saturated fatty acids in carcass tissues of pigs fed CLA may partially explain the increased belly firmness noted in pigs fed CLA (Eggert et al., 2001; Weber et al., 2001). The addition of 5% animal fat, either as CWG or BT, had relatively smaller effects on the fatty acid profiles of porcine tissues than did CLA. These data also indicate that CWG and BT are equivalent in their ability to alter the fatty acid content of pig carcasses. It is interesting that dietary fat actually decreased the abundance of saturated fatty acids in bellies and backfat. It is plausible that the addition of dietary fat to pig diets decreases the activity of lipogenic enzymes in the pig, and hence, decreases *de novo* fatty acid synthesis. The products of *de novo* fatty acid synthesis are made up primarily of saturated fatty acids (i.e., palmitate). However, this potential mechanism needs to be explored in more detail. Dietary ractopamine had very little impact on the type of fatty acids found in pig tissues. However, ractopamine did decrease intramuscular lipid percentage. Taken together, these data indicate that CLA has a far greater impact on the fatty acid profiles of porcine tissues than does dietary animal fat or ractopamine.

Implications

The results of this study indicate that CLA may be a very valuable nutritional “tool” used to increase the saturation of fatty acids in porcine tissues.

Literature Cited

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Table 1. Effects of dietary treatment on fatty acid profiles of bellies

	CLA[a]		Added fat type			Ractopamine	
Item	**0%**	**0.6%**	**0%**	**CWG[a]**	**BT[a]**	**0 g/ton**	**9 g/ton**
Total CLA [a], %	0.35[x]	2.12[y]	1.27	1.12	1.31	1.17	1.30
Total SFA[a], %	39.06[x]	46.49[y]	45.03[x]	41.64[y]	41.51[y]	43.37	42.08
Total MUFA[a],%	48.27[x]	40.14[y]	42.91	45.01	44.69	44.10	44.32
Total PUFA[a], %	12.66	12.74	12.05[x]	13.28[y]	12.76[y]	12.41	12.99
Total UFA[a], %	60.92[x]	52.88[y]	54.96[x]	58.29[y]	57.45[y]	56.50	57.30
Iodine value	63.02[x]	56.12[y]	57.36[x]	61.24[y]	60.11[y]	58.99	60.15

[a]CLA = conjugated linoleic acid; CWG = 5% choice white grease; BT = 5% beef tallow; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; UFA = unsaturated fatty acids.

[x,y]Means within a factor with different superscripts are significantly different ($P < 0.05$).

Table 2. Effects of dietary treatment on fatty acid profiles of outer-layer backfat

	CLA[a]		Added fat type			Ractopamine	
Item	**0%**	**0.6%**	**0%**	**CWG[a]**	**BT[a]**	**0 g/ton**	**9 g/ton**
Total CLA[a], %	0.34[x]	2.82[y]	1.61	1.40	1.74	1.52	1.64
Total SFA[a], %	35.88[x]	43.07[y]	41.73[x]	37.76[y]	38.93[y]	39.80	39.14
Total MUFA[a],%	47.48[x]	41.40[y]	42.03[x]	45.14[y]	46.17[y]	44.21	44.68
Total PUFA[a], %	16.57	16.66	16.36	16.81	16.67	16.07	17.16
Total UFA[a], %	64.05[x]	58.06[y]	58.38[x]	61.95[y]	62.84[y]	60.23	61.83
Iodine value	69.50[x]	64.24[y]	64.34[x]	67.75[y]	68.53[y]	65.72	68.02

[a]CLA = conjugated linoleic acid; CWG = 5% choice white grease; BT = 5% beef tallow; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; UFA = unsaturated fatty acids.

[x,y]Means within a factor with different superscripts are significantly different ($P < 0.05$).

Table 3. Effects of dietary treatment on fatty acid profiles of inner-layer backfat

	CLA[a]		Added fat type			Ractopamine	
Item	**0%**	**0.6%**	**0%**	**CWG[a]**	**BT[a]**	**0 g/ton**	**9 g/ton**
Total CLA [a], %	0.45[x]	3.22[y]	1.89	1.73	1.88	1.76	1.91
Total SFA[a], %	37.64[x]	44.12[y]	44.09[x]	39.10[y]	39.46[y]	41.77	40.00
Total MUFA[a],%	46.48[x]	39.02[y]	39.88[x]	44.23[y]	44.15[y]	42.47	43.03
Total PUFA[a], %	16.04	16.93	16.23	16.67	16.56	15.95	17.02
Total UFA[a], %	62.52[x]	55.95[y]	56.11[x]	60.90[y]	60.70[y]	58.42[x]	60.05[y]
Iodine value	67.56[x]	62.54[y]	62.14[x]	66.55[y]	66.46[y]	63.80[x]	66.24[y]

[a]CLA = conjugated linoleic acid; CWG = 5% choice white grease; BT = 5% beef tallow; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; UFA = unsaturated fatty acids.
[x,y]Means within a factor with different superscripts are significantly different ($P < 0.05$).

Table 4. Effects of dietary treatment on fatty acid profiles and lipid abundance of the loin muscle

	CLA[a]		Added fat type			Ractopamine	
Item	**0%**	**0.6%**	**0%**	**CWG[a]**	**BT[a]**	**0 g**	**9 g**
Total CLA[a], %	0.07[x]	1.24[y]	0.67	0.75	0.55	0.63	0.68
Total SFA[a], %	38.42[x]	44.63[y]	42.56	41.65	40.38	41.53	41.52
Total MUFA[a],%	42.80	40.56	41.88	41.39	41.60	41.56	41.68
Total PUFA[a], %	18.91[x]	14.53[y]	15.61	16.54	18.03	16.89	16.56
Total UFA[a], %	61.59[x]	55.10[y]	57.48	57.93	59.3	58.46	58.24
Iodine value	65.18[x]	57.90[y]	60.15	61.01	63.47	61.47	61.61
Total lipid, %	2.15	2.22	2.05	2.24	2.25	2.44[x]	1.93[y]

[a]CLA = conjugated linoleic acid; CWG = 5% choice white grease; BT = 5% beef tallow; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; UFA = unsaturated fatty acids.
[x,y]Means within a factor with different superscripts are significantly different ($P < 0.05$).