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EFFECT OF DIETARY FAT SOURCE, LEVEL, AND FEEDING INTERVAL ON PORK FATTY ACID COMPOSITION

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Introduction

As the pork industry strives for efficient production of increasingly leaner pigs reduction in fat quality can occur that may adversely effect further processing, tissue separation and storage stability. Combining extreme leanness in the pig with diets composed of cereal grains and supplemented with fat, often high in poly-unsaturated fatty acids (PUFA), in order to maximize grow-finish performance and efficiency can result in soft fat composition. These pork production techniques do help to realize consumer demands for reduced total carcass fat and saturated fatty acids, but this is opposite from the optimal physical qualities of fat for further processing. Consistency and composition of pork fat are quality concerns because thin bellies and soft fat produce more mis-cuts and a higher percentage yield of lower quality product.

Materials and Methods

Two trials were conducted. In the first study market gilts (n = 294) from PIC 406 sires by PIC C22 dams were delivered to the North Carolina Swine Evaluation Station at 62 kg. Pigs were fed one of four diets varying in polyunsaturated fatty acid (PUFA) content for 4, 6 or 8 weeks prior to slaughter. All diets contained 5 % added fat, comprised of 100, 66.7, 33.3 or 0 % soy oil (Cargill Inc., Fayetteville, NC) with an iodine value of 132. The balance was provided by a fully hydrogenated animal fat (Patrick Cudahy, Cudahy, WI) with an iodine value ~ 0. Animals were fed the 100% soy oil diet for 3 weeks prior to allotment to a 4 X 3 factorial design, blocked by initial weight. At allotment pigs averaged 80 kg.

In the second study barrows (n = 147) and gilts (n = 147)from PIC 406 sires by PIC C22 females averaging 80 kg in weight were randomly assigned to one of seven dietary treatments and blocked by initial weight. Pigs were housed three per pen with fourteen pens per dietary treatment. Dietary treatments varied in percentage dietary fat and dietary fat type for 6 weeks prior to slaughter. Diets contained 0, 2.5, or 5% dietary fat comprised of 100, 50 or 0% beef tallow (T) with iodine value of 41. The balance was provided by animal-vegetable (AV) blended fat with an iodine value of 97.5.

Results and Discussion

Trial 1. In the first study as soy oil was replaced with saturated animal fat, growth rate was unaffected, but feed intake and feed:gain increased linearly ($P \leq .05$, Table 1).

Table 1. Effects of dietary fat composition on growth performance from Trial 1

Diet, % Soy oil:	100	66.7	33.3	0	Pooled SEM
Weeks 0-2					
ADG, kg	.92	.94	.89	.90	.02
ADFI, kg [a]	2.49	2.67	2.67	2.73	.04
FCR [a]	2.75	2.86	3.05	3.07	.05
Weeks 3-4					
ADG, kg	.92	.87	.88	.97	.03
ADFI, kg [a]	2.77	3.04	3.07	3.20	.06
FCR [a]	3.01	3.53	3.54	3.75	.09
Weeks 5-6					
ADG, kg	.83	.83	.78	.79	.03
ADFI, kg [a]	3.00	3.15	3.33	3.42	.06
FCR [a]	3.63	3.95	4.32	4.48	.17
Weeks 7-8					
ADG, kg	.87	.99	.93	.99	.06
ADFI, kg [a]	3.09	3.23	3.36	3.73	.10
FCR [b]	3.59	3.34	3.81	3.91	.25

[a] Linear effect of diet, $P \leq .0001$
[b] Linear effect of diet, $P \leq .1$

These data suggest that the saturated animal fat was not well digested. No effects of dietary fat composition were detected on final live weight, carcass weight, dressing percentage, fat or loin depth, lean percentage, pH, loin color, belly color or drip loss. As the PUFA content of the diet was reduced, there was a linear decrease ($P \leq .05$) in C18:2 content and IV of carcass fat (Table 2).

Table 2. Effects of dietary fat composition on backfat fatty acid profile, iodine value, fat firmness, fat melting point, and stick test from Trial 1.

Time	Four Weeks				Six weeks</p				Eight Weeks				Pooled
Diet, % soy oil:	100	66.7	33.3	0	100	66.7	33.3	0	100	66.7	33.3	0	SEM
C16:1 [a,b,c,d]	2.42	2.49	2.40	2.43	2.16	2.28	2.47	2.70	2.44	2.59	2.66	3.21	.10
C18:0 [a,b,d]	8.26	8.5	8.34	7.89	7.28	7.88	8.23	8.45	6.94	7.54	8.67	8.37	.30
C18:1 [a,b,c,d]	38.7	39.0	39.4	38.9	36.9	38.7	39.2	40.8	38.4	39.6	39.9	42.9	.4
C18:2 [a,b,d]	26.3	25.9	25.9	26.4	29.8	27.4	24.1	21.9	27.9	25.2	23.5	18.6	.7
C20:1	.67	.80	.80	.79	.85	.83	.71	.69	.81	.91	.82	.67	.05
Iodine Value [a,b,d]	85.4	82.9	95.3	86.0	90.0	87.4	82.0	79.6	88.1	84.5	80.2	75.9	1.1

[a] Linear diet effect, $P \leq .05$

[b] Linear time effect, $P \leq .05$ (confounded with animal weight and slaughter day)

[c] Quadratic time effect, $P \leq .05$

[d] Diet by time interaction, $P \leq .05$

Both parameters also decreased linearly over time ($P \leq .05$). The maximum rate of decline (2% C18:2 per week and 2.5 IV units per week) was exhibited by gilts fed the diet containing 0 % soy oil (diet x time interaction, $P \leq .05$). Conversely, C16:1, C:18:0 and C18:1 increased as the PUFA content of the diet was decreased. The monounsaturates increased quadratically (positive) with time; whereas C18:0 decreased linearly with time. In each case, the rate of change was greatest for the diet containing 0 soy oil (diet x time interaction, $P \leq .05$). No effects on C20:1 content or stick test were detected ($P > .1$). Analysis of fatty acid composition of backfat biopsy samples indicated that C18:2 concentration remained unchanged during the three-week pretest period, averaging about 25%; however, two weeks after allotment to the experimental diets, a small decrease in C18:2 concentration was detected in gilts fed the diet containing 0 % soy oil. The collective time course of changes in C18:2 concentration throughout the experiment is illustrated in Figure 1.

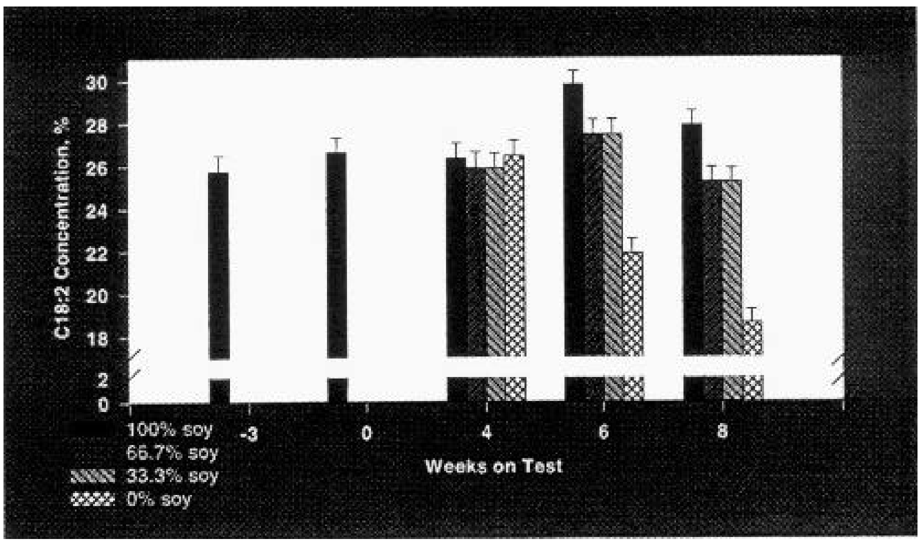

Figure 1. Effects of Dietary Fat and Time Course on C18:2 Content of Backfat

Trial 2. In the second study as the level of dietary fat was decreased feed:gain and feed intake increased linearly ($P \leq .05$, Table 3).

Table 3. Effects of dietary fat level and type on growth performance in Trial 2.

Sex	Female								Castrate							Pooled
Diet	Cntrl	2.5AV	2.5B	2.5T	5AV	5B	5T		Cntrl	2.5AV	2.5B	2.5T	5AV	5B	5T	SEM
ADG, kg[b]	2.13	2.02	2.05	2.08	2.13	2.13	2.08		2.06	2.43	1.98	2.16	2.24	2.31	2.25	.10
ADFI,kg[a,b]	6.72	6.79	7.02	6.70	6.19	6.46	5.91		7.30	8.02	7.07	6.92	7.09	7.50	7.07	.29
FCR[c]	3.17	3.39	3.43	3.32	2.80	3.04	2.89		3.78	3.37	3.57	3.23	3.21	3.29	3.20	.14

[a] Linear effect of percentage dietary fat, $P \leq .05$
[b] Gender, $P \leq .05$
[c] Gender by percentage dietary fat interaction, $P \leq .05$

Table 4. Effects of dietary fat level and type on backfat fatty acid profile, iodine value and stick test in Trial 2.

Sex	Female							Castrate							Pooled
Diet	Cntrl	2.5AV	2.5B	2.5T	5AV	5B	5T	Cntrl	2.5AV	2.5B	2.5T	5AV	5B	5T	SEM
C16:1, % [a,b]	2.96	2.81	2.81	2.88	2.61	2.76	2.96	2.99	2.75	2.75	2.97	2.77	2.80	2.83	.09
C18:0, %	9.67	9.72	9.37	9.68	9.18	9.44	9.94	9.64	9.82	10.12	9.02	9.32	10.00	9.81	.37
C18:1, % [b,e]	41.1	40.9	42.3	42.2	40.7	41.2	42.8	42.1	40.3	41.0	41.6	40.6	41.8	42.3	.5
C18:2, % [d]	19.1	20.3	19.4	18.3	22.0	20.1	17.4	17.9	19.4	19.3	19.3	20.4	18.7	17.5	.8
C20:1, %	.48	.61	.57	.63	.61	.55	.53	.59	.67	.66	.51	.54	.57	.57	.05
Iodine Value [c,d]	74.9	76.8	76.5	74.5	7.6	76.6	73.4	73.6	74.7	75.	75.7	76.7	74.7	73.0	1.2

[a] Linear effect of percentage dietary fat, P ≤ .05

[b] Linear effect of dietary fat type, P ≤ .05

[c] Gender, P ≤ .05

[d] Percentage dietary fat by dietary fat type interaction, P ≤ .05

[e] Gender by percentage dietary fat interaction, P ≤ .05

Gilts fed 0% dietary fat were more efficient than gilts feed 2.5% dietary fat, whereas the efficiency of barrows improved linearly with increased dietary fat (gender by percentage dietary fat interaction ($P \leq .05$). No effects of dietary fat level or type were detected on carcass weight and drip loss. A negative quadratic effect ($P \leq .05$) of dietary fat type on fat depth was observed, being lower (22) for diets containing 100 or 0% tallow as compared to diets containing 50% tallow (23.6).

As the level of tallow increased in the diet there was a linear decrease ($P \leq .05$) in C18:2 content and IV of carcass fat (Table 4).

Conversely, the monunsaturates, C16:1 and C18:1, increased linearly as the level of tallow in the diet was increased. However, C16:1 decreased linearly as the percentage of dietary fat in the diet increased. Linoleic Acid (C18:2) showed a percentage dietary fat by dietary fat type interaction as depicted in Figure 2.

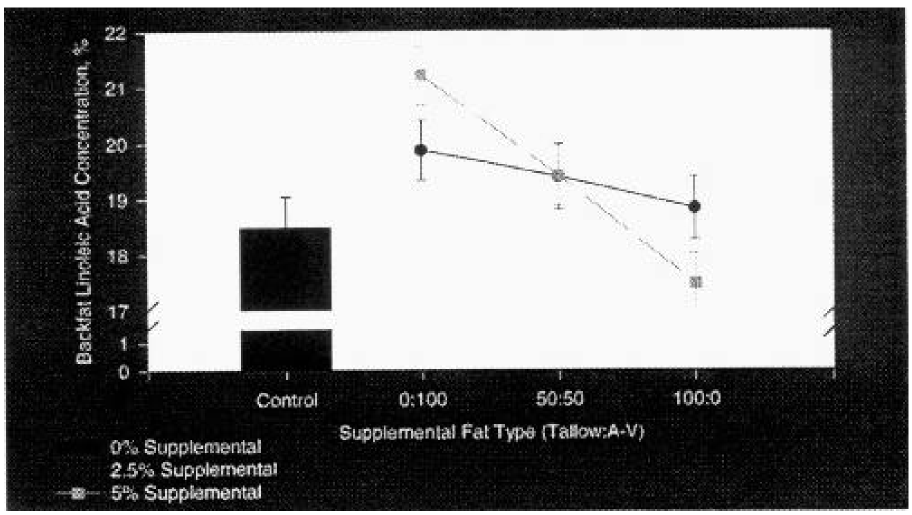

Figure 2. Effects of Dietary Fat Level and Dietary Fat Composition on C18:2 Content

As the level of dietary tallow increased a greater reduction in C18:2 and iodine value was observed in diets with 5% dietary fat as compare to diets with 2.5% dietary fat. Diet 5T, 100% tallow supplemented to the diet at 5% caused a significantly ($P \leq .05$) greater reduction in C18:2 and iodine value than diets 2.5AV, 2.5TAV, 5AV, and 5TAV. In contrast diet 5AV, 100% a-v blend supplemented to the diet at 5% produced a significantly higher ($P \leq .05$) C18:2 content and IV of carcass fat than diets Cntrl, 2.5TAV, 2.5T, 5TAV, and 5T.

Summary

Reduction of dietary fat level and the reduction of dietrary PUFA content had the desired effects of lowering the C18:2 content and IV of pork fat as expected. Furthermore, although dietary PUFA content affected carcass fatty acid composition, no major effects on measured carcass characteristics were detected. Based on these findings, the prefereed feeding program during the late finishing period would consist of feeding a saturated fat that is highly digestible for a period of at least six weeks. Future research should utilize saturated fat of higher digestibility and should include additional assessment of the effects on other pork-processing characteristics.