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Abstract
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EFFECTS OF EXOTIC SOYBEAN GENOTYPE ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, AND CARCASS TRAITS IN FINISHING PIGS [1]

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Summary

Compared to a corn-soybean meal control, added-fat from tallow, soybean oil, and dry-extruded whole soybeans (DEWS) improved ADG, F/G, and digestibility of DM and N. Feeding tallow increased belly firmness but also increased backfat thickness compared to diets with soy oil and DEWS. Comparisons among soybean genotypes indicated that high oleic acid soybeans supported greater growth performance than soybeans with high palmitic acid content. However, soybean genotype had no effect on carcass or meat quality measurements.

(Key Words: Extrusion, Soybeans, Carcass, Finishing Pigs.)

Introduction

Genetic modification of soybeans offers the opportunity to change nutritional (such as amino acids) and chemical (such as fatty acids) compositions. These changes could have direct effects on carcass characteristics in pigs, because finishing pigs fed extruded soybeans yield pork with an increased unsaturated:saturated fatty acid ratio. Therefore, we designed an experiment to determine the effects of soybean genotypes with modified fatty acid composition on growth performance, nutrient digestibility, and carcass traits in finishing pigs.

Procedures

A total of 70 crossbred pigs (average initial BW of 145 lb) was used in a 47-d growth assay. The pigs were blocked by weight and allotted to pens (two pigs/pen and five pens/trt) based on sex and ancestry. The pigs were housed in an environmentally controlled building with a totally slatted floor. Each pen had a nipple waterer and a self-feeder to provide the pigs with ad libitum access to feed and water. Treatments were: 1) control, no added fat; 2) tallow; 3) soy oil; 4) mill run soybeans; 5) low linoleic acid soybeans; 6) high palmitic acid soybeans; and 7) high oleic acid soybeans. The mill run soybeans were purchased at the Manhattan Coop elevator. The low linoleic acid (3.4 vs 8.0% in commercial soybeans) and high palmitic acid (19 vs 10% in commercial soybeans) soybeans were grown at KSU, and the high oleic acid soybeans (85 vs 25% in commercial soybeans) were supplied courtesy of Dupont Quality Grains.

To prepare the soybeans for use in our diets, they were coarsely-rolled and then extruded in an Insta-Pro® dry-extruder. The target barrel temperature was 300°F. However, only 280°F was achieved. After extrusion, the dry-extruded whole soybeans (DEWS) were cooled and bagged for subsequent use in corn-based diets.

For d 0 to 25, the control diet (no added fat) was formulated to .9% lysine, .65% Ca,

[1]Appreciation is extended to the Kansas State Board of Agriculture and the Kansas Soybean Commission for funding this project and to Troy Lohroman and Dupont Quality Grains for the high oleic acid soybeans.

[2]Department of Agronomy.

and .55% P. The other diets were formulated to a lys:DE ratio of 3.6 g/Mcal with a dietary crude fat of 8.4%. The control diet for d 25 to 47 was formulated to .75% lysine. The other Phase II diets were formulated to a lys:DE ratio of 2.8 g/Mcal with a dietary crude fat of 7.3%.

Pig and feeder weights were taken at d 0, 25, and 47 of the growth assay. Feces samples were collected on d 46, dried, and ground for laboratory analyses. The pigs were killed in a commercial slaughter plant, and last rib backfat thickness and chilled carcass wt were recorded. Finally, belly firmness was evaluated by scoring from 1 (soft) to 3 (hard), and samples of loin muscle and fat were collected. Loin muscle and fat characteristics (loin area, water holding capacity, cooking loss, shear force of loin tissue, and backfat firmness) were evaluated according to standard procedures recommended in the 1991 NPPC Handbook.

Growth and carcass data were analyzed as a randomized complete block design using the GLM procedure of SAS. Pen was the experiment unit, and orthogonal comparisons were used to separate treatment means. Contrasts were: 1) no-added-fat control vs others; 2) tallow vs soy oil & DEWS; 3) soy oil vs DEWS; 4 mill run DEWS vs modified DEWS; 5) unsaturated (low linoleic acid) DEWS vs saturated (high palmitic and high oleic acid) DEWS; and 6) high palmitic acid DEWS vs high linoleic acid DEWS.

Results and Discussion

Urease activity of the soybean preparations was below .4, and protein dispersible index ranged from 18 to 28% (Table 2). Trypsin inhibitor activity ranged from 7 to 18 mg/g. These laboratory measurements were greater than suggested values (i.e., .02 to .2 for urease activity and <4 mg/g for TI activity). Thus, the processing temperature of 280°F was less than desirable.

Results for growth performance of the pigs (Table 3) show that added fat (as tallow, soy oil, and DEWS) improved overall ADG (P<.08) and F/G (P<.01) and digestibilities of DM and N (P<.01). Pigs fed tallow were more efficient (P<.04) than pigs fed the various forms of soy oil (as free oil or DEWS) for d 0 to 25. However, the effect was not present for d 25 to 47 or overall, and the soy oil treatments tended to have greater digestibility of N (P<.09) than tallow diets.

Pigs fed soy oil had greater (P<.02) ADG (for d 0 to 25) and greater digestibilities of DM and N (P<.03) than pigs fed DEWS. These responses probably were related to the low processing temperature of 280°F achieved while processing the DEWS. However, even with the relatively high residual TI activity in the DEWS (8 to 18 mg/g), overall ADG and F/G were not different (P>.15) for pigs fed soy oil vs DEWS.

Comparisons among the DEWS sources suggested few difference, except that growth performance of pigs fed high oleic acid soybeans was consistently superior to growth performance of pigs fed soybeans with high palmitic acid content. However, this effect could be related to a difference in TI content of the end products (7 mg/g for high oleic acid DEWS and 12 mg/g for high palmitic acid DEWS) and not necessarily to a difference in fatty acid composition.

In terms of carcass traits, pigs fed tallow had increased belly firmness score (P<.07) but also increased backfat thickness (P<.02). However, tallow did not improve fat firmness when determined with an Instron Press (P>.15). No differences occurred among pigs fed the various soybean genotypes for belly firmness, loin muscle characteristics, or backfat characteristics (P>.15).

In conclusions, adding fat (as tallow, soy oil, or DEWS) to corn-based diets improved ADG and F/G. Tallow (our most saturated fat source) increased belly firmness score but not fat firmness when measured on an Instron Press. Finally, comparisons among DEW mill-run soybeans and soybeans with modified fatty acid composition suggested few effects on carcass fat and meat characteristics.

Table 1. Compositions of Basal Diets

	Day 0 to 25[a]							Day 25 to 47[b]						
Ingredients, %	Control	Tallow	Soy oil	Mill run	Low lino	High palm	High oleic	Control	Tallow	Soy oil	Mil run	Low lino	High palm	High oleic
Corn	74.85	64.74	64.74	64.74	64.74	64.74	64.74	80.03	72.19	72.19	72.19	72.19	72.19	72.19
Soybean meal	22.56	22.1	22.1	-	-	-	-	17.29	14.86	14.86	-	-	-	-
Extruded soy	-	-	-	29.88	29.93	32.65	30.98	-	-	-	22.99	23.03	25.12	23.83
Soy oil	-	-	5.9	-	-	-	-	-	-	5.4	-	-	-	-
Tallow	-	5.9	-	-	-	-		-	5.4	-	-	-	-	
Starch	-	4.4	4.36	2.61	2.56	-	1.58	-	4.56	4.56	2.03	2.00	-	1.23
Lysine HCL	.043	.13	.13	.12	.12	.04	.09	.038	.005	.005	.095	.094	.034	.071
DL-methionine	-	.04	.037	.044	.044	.016	.033	-	.04	.037	--	--	.016	.033
Monocalcium phosphate	.84	1.06	1.06	.89	.89	.82	.86	.71	.92	.92	.75	.75	.69	.73
Limestone	1.01	.95	.95	1.0	1.00	1.02	1.01	.99	.94	.94	.98	.98	1.00	.99
Salt	.35	.36	.36	.36	.36	.36	.36	.35	.36	.36	.36	.36	.36	.36
Trace minerals	.10	.103	.103	.103	.103	.103	.103	.103	.103	.103	.103	.103	.103	.103
Vitamin premix	.125	.129	.129	.129	.129	.129	.129	.125	.129	.129	.129	.129	.129	.129
Chromic oxide[c]	--	--	--	--	--	--	--	.25	.25	.25	.25	.25	.25	.25
Antibiotics[d]	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125

[a]The control diet for d 0 to 25 was formulated to .9% lysine, .65% Ca, and .55% P, and the other diets to a lys: DE ratio of 3.6 g/Mcal (crude fat was 8.4%).

[b]The control diet for d 25 to 47 was formulated to .75% lysine, .6% Ca, and .5% P, and the other diets to a lys: DE ratio of 2.8 g/Mcal (crude fat was 7.3%).

[c]As a indigestible marker.

[d]Supplied 50 g/ton of tylosin.

Table 2. Processing Characteristics of Soybeans Varieties

Genotype	Mill Run	Low Linoleic	High Palmitic	High Oleic
GEI, kWh/ton[a]	92.9	89.5	89.3	91.8
SEI, kWh/ton[b]	66.5	62.0	53.0	65.2
PR, ton/hr[c]	.56	.57	58.6	.55
Temperature, °F	281	279	280	282
TI of raw beans, mg/g[d]	22.0	34.6	20.3	17.4
TI of extruded beans, mg/g[d]	10.5	12.7	11.8	6.9
Urease, DpH[e]	.23	.12	.16	.39
PDI, %[f]	27.1	26.4	23.4	18.1

[a]Gross energy input.
[b]Specific energy input.
[c]Production rate.
[d]Trypsin inhibitor activity.
[e]Urease activity.
[f]Protein dispersible index.

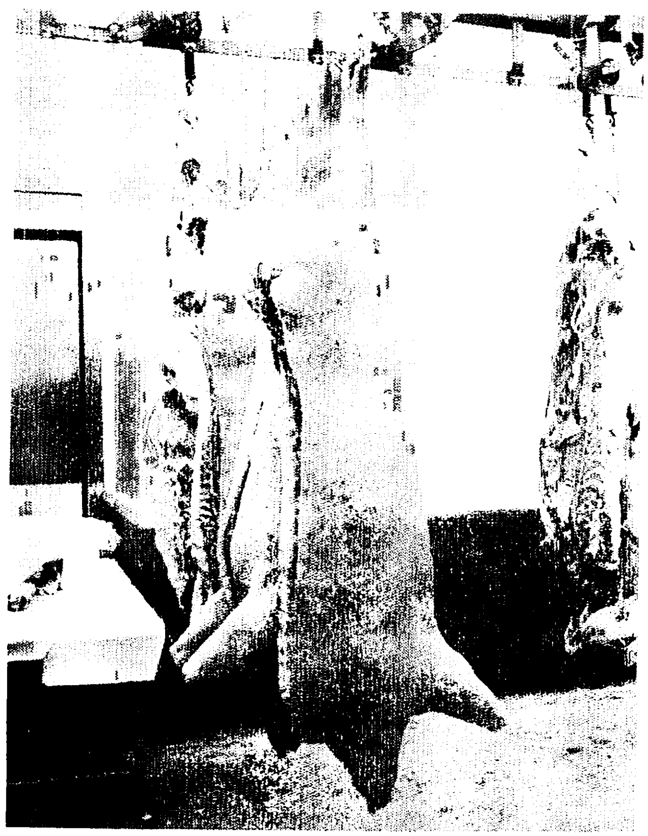

Table 3. Effect of Soybean Genotype on Growth Performance and Nutrient Digestibility in Finishing Pigs[a]

Items	Control	Tallow	Soy Oil	Mill Run	Low Lino	High Palm	High Oleic	SE	Contrast[b] 1	2	3	4	5	6
d 0 to 25														
ADG, lb	2.07	2.47	2.49	2.38	2.14	2.24	2.17	.09	.02	.06	.02	.07	--	--[c]
ADFI, lb	6.16	5.91	6.25	6.13	5.39	6.03	5.52	.20	--	--	.04	.05	.12	.09
F/G	2.98	2.39	2.51	2.58	2.51	2.67	2.56	.03	.001	.04	--	--	--	--
d 25 to 47														
ADG, lb	1.71	1.92	1.76	1.69	1.84	1.84	2.00	.17	--	--	--	--	--	.09
ADFI, lb	7.11	6.96	6.79	6.53	6.63	7.43	6.76	.28	--	--	--	--	--	.10
F/G	4.15	3.64	3.88	3.91	3.57	4.64	3.41	.05	--	--	--	--	--	.01
Overall (d 0 to 47)														
ADG, lb	1.90	2.21	2.15	2.05	2.00	1.94	2.09	.08	.06	.07	--	--	--	--
ADFI, lb	6.58	6.38	6.49	6.32	5.94	6.66	6.08	.20	--	--	--	--	.09	.05
F/G	3.46	2.88	3.02	3.08	2.97	3.40	2.92	.03	.01	--	--	--	--	.005
Apparent nutrient digestibility, %														
DM	82.8	86.4	89.9	86.0	86.5	88.9	87.2	.7	.001	.11	.01	.05	.07	.09
N	79.8	81.8	86.6	81.6	81.7	85.1	85.2	1.0	.01	.09	.03	.08	.02	--

[a]A total of 70 finishing pigs was used (two pigs/pen and five pens/trt) with an avg initial BW of 145 lb.
[b]Contrasts were: 1) no added fat control vs others; 2) tallow vs soy oil & DEWS; 3) soy oil vs DEWS; 4 mill run DEWS vs modified DEWS; 5) unsaturated (low linoleic acid) DEWS vs saturated (high palmitic and high oleic acid) DEWS; and 6) high palmitic acid DEWS vs high linoleic acid DEWS.
[c]Dashes indicate P>.15.

Table 4. Effects of Soybean Genotype on Carcass Traits in Finishing Pigs[a]

Items	Control	Tallow	Oil	Mill Run	Low Lino	High Palm	High Oleic	SE	Contrasts [b] 1	2	3	4	5	6
Dressing, %	76.1	75.9	75.7	75.8	74.1	75.1	76.1	.8	--[g]	--	--	--	.06	--
Belly firmness [c]	1.8	1.8	1.5	1.3	1.5	1.2	1.6	.3	.12	.07	--	--	--	--
Loin Muscle														
Area, in²	7.5	7.8	7.8	7.8	7.6	7.9	8.3	.3	--	--	--	--	--	--
Water holding capacity, g [d]	.38	.40	.48	.36	.37	.25	.34	.1	--	--	.08	--	--	--
Cooking loss, %	24.7	24.0	25.6	25.6	24.8	24.7	25.3	2.0	--	--	--	--	--	--
Tenderness, lb [e]	1.9	2.1	2.1	2.3	2.1	2.3	2.5	.1	.04	--	--	--	--	--
Backfat														
Thickness, in	1.18	1.22	1.14	1.10	1.06	1.18	1.10	.03	--	.04	--	--	--	--
Firmness, lb [f]	120.3	106.7	109.4	113.1	109.4	116.7	122.6	11.4	--	--	--	--	--	--

[a]A total of 70 finishing pigs was used (two pigs/pen and five pens/trt) with an avg initial BW of 145 lb.

[b]Contrasts were: 1) no fat control vs others; 2) tallow vs soy oil & DEWS; 3) soy oil vs DEWS; 4) mill run DEWS vs modified DEWS; 5) unsaturated (low linoleic acid) DEWS vs saturated (high palmitic and high oleic acid) DEWS; and 6) high palmitic acid vs high linoleic acid DEWS.

[c]Belly firmness scored from 1(soft) to 3 (hard).

[d]Water holding capacity was grams of water loss from a cubic inch of muscle tissue during 24 hrs in a closed container.

[e]Warner-Bratzler method, Universal Instron Testing Machine.

[f]Compression test, Universal Instron Press Testing Machine.

[g]Dashes indicate P>.15.