CHARACTERIZING THE FEEDING VALUE OF EXTRUDED-EXPELLED SOYBEAN MEAL WITH OR WITHOUT ADDED FAT IN A COMMERCIAL SWINE PRODUCTION FACILITY[1,2]

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Summary

A total of 1,200 gilts was used to evaluate the effects of replacing conventionally processed soybean meal with extruded-expelled soybean meal on finishing pig growth performance. Dietary treatments were arranged in a 2 × 3 factorial with two sources of soybean meal (solvent-extracted or extruded-expelled) and three levels of added fat (none, 3.4, and 7% in Phase 1 than decreasing in subsequent phases). Energy levels were adjusted such that the higher energy in extruded-expelled soybean meal (with or without added fat) was equal to that provided by solvent-extracted soybean meal with added fat. From 54 to 135 lb, pigs fed extruded-expelled soybean meal had improved ADG and F/G compared to those fed solvent-extracted soybean meal. Increasing added fat in either extruded-expelled- or solvent-extracted soybean meal-based diets linearly improved ADG and F/G. From 135 to 270 lb, pigs fed extruded-expelled soybean meal and(or) increasing added fat had decreased feed intake. For the overall growing-finishing period, ADG was unaffected by increasing energy density. However, ADFI was decreased and F/G improved as energy density of the diet was increased either with extruded-expelled soybean meal and(or) added fat. Carcass leanness was not affected by dietary treatment. These results indicate that increasing the energy density of the diet by using extruded-expelled soybean meal and(or) added fat improves feed efficiency in finishing pigs reared in a commercial environment.

(Key Words: Soybean Meal, Processing, Fat, Growth, Finishing Pigs.)

Introduction

The ileal amino acid digestibility and metabolizable energy (ME) of extruded-expelled soybean meal were established in a previous KSU study. As expected because of the higher fat content, the extruded-expelled soybean meal had a higher ME content compared to conventional soybean meal.

Recent research at KSU indicated a linear improvement in feed efficiency through the growing and finishing phases with increasing additions of fat (0 to 6% choice white grease) in diets. However, the improvements in ADG were not the same throughout the finishing phase. During the growing phase (80 to 130 lb) when the pigs were in an energy dependant phase of growth, increasing added dietary fat linearly increased growth rate. Each 1% added fat improved ADG approximately 2%. During the late finishing phase (210 to 260 lb), added fat had no effect on ADG, but F/G continued to be improved. Thus, the economic value of added dietary fat for improv-

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ing ADG is greater during the growing phase.

The linear improvements suggest that when economical, the highest level of added dietary fat should be fed. Added dietary fat levels in corn-soybean meal based diets usually are limited to 6% for feed manufacturing and handling reasons. Thus, extruded-expelled soybean meal may provide an increase in energy density above that of a diet with 6% added fat. In addition, use of extruded-expelled soybean meal can result in higher energy density for diets during the growing phase, when the value of the energy density is greater for ADG improvements.

Therefore, the main objective of this study was to verify the feeding value of extruded-expelled soybean meal in a growth trial conducted under commercial conditions. A second objective was to determine if extruded-expelled soybean meal can provide added dietary energy in addition to maximum levels of added dietary fat.

Procedures

A total of 1,200 gilts (PIC C22 × 337), initially 54 lb, was housed in a commercial research facility in southwestern Minnesota. The barn was a 48-pen curtain-sided, total-slatted finishing barn with 7.2 sq ft provided per pig and each pen initially stocked with 25 pigs. Eight pens per treatment were arranged in a 2 × 3 factorial with two soybean sources and three levels of increasing energy density as the main effects. The control diet was corn and solvent-extracted soybean meal-based and contained no added fat. In the next dietary treatment, the solvent-extracted soybean meal was replaced by extruded-expelled soybean meal. We then added fat (3.4 to 1.5% based on phase) to the solvent-extracted soybean meal-based diet to equal the energy content of the extruded-expelled soybean meal diet. This amount of added fat then was added to the extruded-expelled-soybean meal-based diet, and a solvent-extracted soybean meal diet with added fat (7 to 3.1%) was formulated to equal the energy content of the extruded-expelled soybean meal diet with added fat. The last dietary treatment consisted of extruded-expelled soybean meal with 7 to 3.1% added fat, the same amount added to the solvent-extracted soybean meal diet. So, the diet containing solvent-extracted soybean meal with the medium level of added fat was formulated to equal the ME level of the extruded-expelled soybean meal diet with no added fat. In addition, the diet containing solvent-extracted soybean meal with the high level of added fat was formulated to equal the ME level of the extruded-expelled soybean meal diet with the medium levels of fat.

All pigs were phase-fed four diets from 54 to 270 lb (Tables 1 through 4). Diets were formulated to the same digestible lysine to energy ratio within each phase. Because the lysine content of each diet was decreased as the pigs became heavier, the amount of extruded-expelled soybean meal was decreased. This decreased the amount of extra ME it provided relative to diets containing solvent-extracted soybean meal. Therefore, the amount of added fat to equalize energy density between solvent-extracted and extruded-expelled soybean meals decreased in each successive phase. Each phase was fed for approximately 28 d. All diets were formulated using NRC (1998) nutrient values for solvent-extracted soybean meal. Metabolizable energy and digestible amino acid values estimated in a previous KSU study were used for the extruded-expelled soybean meal.

Pigs were weighed and feed disappearance was determined every 14 days. The ADG, ADFI, and F/G were determined for the performance data. At market time, pigs were tattooed by pen for treatment identification and sent to Swift in Worthington, MN, where carcass characteristics (loin depth, fat depth, hot carcass weight, dressing percentage, lean yield, and fat-free lean index, FFLI) were measured.

Results and Discussion

From d 0 to 54, (54 to 135 lb), a source × fat interaction ($P<.05$) was observed for ADG (Table 5). In the diets without added fat, pigs fed solvent-extracted soybean meal had greater ADG than those fed extruded-expelled soybean meal. However, when medium and high levels of fat were added, pigs fed extruded-expelled soybean meal had greater ADG than those fed solvent-extracted soybean meal. Replacing solvent-extracted soybean meal with extruded-expelled soybean meal had no effect on ADFI but tended (P<.06) to improve feed efficiency. Increasing added fat decreased (linear, P<.03) ADFI and F/G.

From d 54 to 126, ADG was not affected (P>.12) by either extruded-expelled soybean meal or added fat. However, ADFI decreased with the addition of extruded-expelled soybean meal (P<.02) or increasing added fat (linear, P<.01). Feed efficiency was not affected (P>.18) by dietary treatment.

For the overall experiment, ADG was not affected (P>.32) by either extruded-expelled soybean meal or added fat. However, increasing the dietary energy content by either replacing solvent-extracted soybean meal with extruded-expelled soybean meal and(or) increasing added fat decreased ADFI (P<.06, and linear, P<.03, respectively) and improved F/G (P<.02, and linear P<.01, respectively). No differences were observed in the carcass data among the dietary treatments.

The results of this experiment agree with previous research evaluating increasing dietary energy density in pigs reared in commercial environments. Growing pigs are in an energy-dependent stage. Therefore, increasing energy density of the diet either by using extruded-expelled soybean meal and(or) adding fat increases ADG and improves F/G. In late finishing, when the pig's energy intake begins to exceed that necessary for maximum protein deposition, increasing dietary energy density does not affect ADG, but can reduce ADFI and improve F/G.

Furthermore, results indicate that extruded-expelled soybean meal and solvent-extracted soybean meal affect ADG, ADFI, and F/G similarly when formulated to the same energy level. When more than 6% fat is added, feed manufacturing and handling characteristics become problems. Therefore, higher energy levels could be obtained by using extruded-expelled soybean meal with 6% added fat.

Table 1. Diet Compositions during Phase 1 (60 to 90 lb)

	Fat Level:	None		Medium		High	
	Source:	SMB[1]	EE Soy[2]	SBM	EE Soy	SBM	EE Soy
Ingredients, %	ME Level:	1,503	1,571	1,571	1,643	1,643	1,721
Corn		69.22	69.99	63.59	64.59	57.77	58.78
Soybean meal, 46.5%		28.05	0.00	30.16	0.00	32.30	0.00
EE soy w/o hulls		0.00	26.92	0.00	28.85	0.00	30.94
Choice white grease		0.00	0.00	3.40	3.40	7.00	7.00
Monocalcium P, 21% P		1.05	1.33	1.10	1.39	1.16	1.48
Limestone		1.00	1.00	1.00	1.00	1.00	1.00
Salt		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix		0.08	0.08	0.08	0.08	0.08	0.08
Trace mineral premix		0.15	0.15	0.15	0.15	0.15	0.15
Lysine HCl		0.15	0.15	0.15	0.15	0.15	0.15
DL-methionine		0.00	0.03	0.02	0.04	0.04	0.07
Total		100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis							
Apparent digestible lysine, %		0.96	1.00	1.00	1.05	1.05	1.10
Protein, %		18.90	19.50	19.40	20.10	19.90	20.60
ME, kcal/lb		1503	1571	1571	1643	1643	1721
Dig. lysine:cal ratio, g/mcal		2.89	2.89	2.89	2.89	2.89	2.89
Calcium, %		0.69	0.74	0.71	0.75	0.72	0.78
Phosphorus, %		0.61	0.66	0.62	0.67	0.63	0.69
Available phosphorus, %		0.29	0.31	0.30	0.32	0.32	0.33

Table 2. Diet Compositions during Phase 2 (90 to 135 lb)

	Energy Level:	None		Medium		High	
	Source:	SMB[1]	EE Soy[2]	SBM	EE Soy	SBM	EE Soy
Ingredients, %	ME Level:	1,506	1,565	1,565	1,628	1,628	1,694
Corn		72.48	73.79	67.98	69.40	63.14	64.81
Soybean meal, 46.5%		24.89	0.00	26.49	0.00	28.23	0.00
EE soy w/o hulls		0.00	23.35	0.00	24.83	0.00	26.28
Choice white grease		0.00	0.00	2.90	2.90	6.00	6.00
Monocalcium P, 21% P		1.00	1.18	1.00	1.23	1.00	1.25
Limestone		0.90	0.95	0.90	0.90	0.90	0.90
Salt		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix		0.08	0.08	0.08	0.08	0.08	0.08
Trace mineral premix		0.15	0.15	0.15	0.15	0.15	0.15
Lysine HCl		0.15	0.15	0.15	0.15	0.15	0.15
DL-methionine		0.00	0.00	0.00	0.01	0.00	0.03
Total		100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis							
Apparent digestible lysine, %		0.88	0.91	0.91	0.94	0.95	0.97
Protein, %		17.70	18.10	18.10	18.40	18.50	18.80
ME, kcal/lb		1506	1565	1565	1628	1628	1694
Dig. lysine:cal ratio, g/mcal		2.65	2.63	2.65	2.62	2.65	2.61
Calcium, %		0.63	0.68	0.64	0.67	0.64	0.68
Phosphorus, %		0.58	0.61	0.58	0.62	0.58	0.63
Available phosphorus, %		0.28	0.28	0.28	0.28	0.28	0.29

[1]SBM = solvent-extracted soybean meal, 46.5% crude protein.
[2]EE Soy = extruded-expelled soybean meal without hulls.

Table 3. Diet Compositions during Phase 3 (135 to 190 lb)

	Energy Level:	None		Medium		High	
	Source:	SMB[1]	EE Soy[2]	SBM	EE Soy	SBM	EE Soy
Ingredients, %	ME Level:	1,512	1,553	1,553	1,596	1,596	1,641
Corn		80.54	81.64	77.67	78.88	74.72	76.01
Soybean meal, 46.5%		17.15	0.00	18.02	0.00	18.93	0.00
EE soy w/o hulls		0.00	15.92	0.00	16.66	0.00	17.43
Choice white grease		0.00	0.00	2.00	2.00	4.10	4.10
Monocalcium P, 21% P		0.75	0.88	0.75	0.90	0.75	0.90
Limestone		0.90	0.90	0.90	0.90	0.90	0.90
Salt		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix		0.06	0.06	0.06	0.06	0.06	0.06
Trace mineral premix		0.10	0.10	0.10	0.10	0.10	0.10
Lysine HCl		0.15	0.15	0.15	0.15	0.15	0.15
Total		100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis							
Apparent digestible lysine, %		0.70	0.71	0.71	0.73	0.73	0.74
Protein, %		14.80	15.00	15.00	15.10	15.10	15.30
ME, kcal/lb		1512	1553	1553	1596	1596	1641
Dig. lysine:cal ratio, g/mcal		2.09	2.07	2.08	2.06	2.08	2.06
Calcium, %		0.56	0.58	0.57	0.59	0.57	0.59
Phosphorus, %		0.50	0.52	0.50	0.52	0.50	0.52
Available phosphorus, %		0.22	0.22	0.22	0.22	0.22	0.22

Table 4. Diet Compositions during Phase 4 (190 to 260 lb)

	Energy Level:	None		Medium		High	
	Source:	SMB[1]	EE Soy[2]	SBM	EE Soy	SBM	EE Soy
Ingredients, %	ME Level:	1,515	1,546	1,545	1,578	1,578	1,611
Corn		84.82	85.68	82.76	83.79	80.62	81.66
Soybean meal, 46.5%		12.97	0.00	13.53	0.00	14.07	0.00
EE soy w/o hulls		0.00	11.97	0.00	12.42	0.00	12.93
Choice white grease		0.00	0.00	1.50	1.50	3.10	3.10
Monocalcium P, 21% P		0.70	0.78	0.70	0.78	0.70	0.80
Limestone		0.85	0.85	0.85	0.85	0.85	0.85
Salt		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix		0.06	0.06	0.06	0.06	0.06	0.06
Trace mineral premix		0.10	0.10	0.10	0.10	0.10	0.10
Lysine HCl		0.15	0.15	0.15	0.15	0.15	0.15
Total		100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis							
Apparent digestible lysine, %		0.60	0.60	0.61	0.61	0.62	0.62
Protein, %		13.20	13.30	13.30	13.40	13.40	13.50
ME, kcal/lb		1,515	1,546	1,545	1,578	1,578	1,611
Dig. lysine:cal ratio, g/mcal		1.79	1.77	1.78	1.76	1.77	1.76
Calcium, %		0.52	0.53	0.52	0.53	0.52	0.54
Phosphorus, %		0.47	0.49	0.47	0.48	0.47	0.49
Available phosphorus, %		0.20	0.20	0.20	0.20	0.20	0.20

[1]SBM = solvent-extracted soybean meal, 46.5% crude protein.

[2]EE Soy = extruded-expelled soybean meal without hulls.

Table 5. Characterizing the Feeding Value of Express Soy in a Commercial Swine Production Facility[1]

	Treatments													
Fat Level:	None		Medium		High									
Source:	SBM[2]	EE Soy[3]	SBM	EE Soy	SBM	EE Soy					Fat		ME	
Item ME Level:	1,509	1,559	1,559	1,611	1,611	1,667	SEM	Source	Fat	Source$\times$Fat	Linear	Quad	Linear	Quad
Phase 1 & 2 (d 0 to 54)														
ADG	1.56	1.53	1.56	1.68	1.63	1.67	.026	.06	.001	.02	.0003	.23	.001	.63
ADFI	3.38	3.29	3.24	3.33	3.23	3.18	.059	.75	.10	.26	.03	.81	.03	.80
F/G	2.17	2.15	2.07	1.98	1.97	1.91	.038	.07	.0001	.60	.0001	.44	.0001	.91
Phase 3 & 4 (d 54 to 126)														
ADG	1.71	1.71	1.72	1.61	1.66	1.66	.032	.18	.25	.14	.12	.53	.11	.81
ADFI	5.30	5.05	5.20	4.82	4.88	4.92	.100	.03	.04	.11	.01	.74	.004	.17
F/G	3.10	2.95	3.02	3.00	2.94	2.97	.052	.28	.37	.25	.18	.71	.09	.22
Overall (d 0 to 126)														
ADG	1.64	1.63	1.65	1.64	1.65	1.66	.020	.81	.61	.80	.32	.94	.46	.66
ADFI	4.45	4.28	4.33	4.18	4.16	4.15	.070	.05	.02	.44	.01	.91	.002	.28
F/G	2.71	2.62	2.62	2.55	2.52	2.50	.031	.02	.0001	.52	.0001	.91	.0001	.32
Final wt.	270	269	272	266	271	273	2.70	.55	.47	.31	.36	.42	.50	.40
Packing Plant Data w/o HCW Covariate														
Live wt.	270	268	273	267	271	275	2.64	.48	.25	.21	.13	.54	.28	.27
HCW	205	202	208	201	206	208	1.85	.13	.15	.09	.07	.47	.38	.16
Yield, %	75.9	75.5	76.0	75.6	76.0	75.6	.003	.14	.95	.99	.77	.87	.56	.99
Back fat, in.	.665	.675	.700	.663	.683	.699	.015	.75	.36	.14	.15	.94	.19	.91
Loin depth, in.	2.36	2.26	2.30	2.28	2.25	2.31	.036	.52	.70	.15	.42	.78	.31	.07
Lean, %	55.8	55.3	55.0	55.5	55.1	55.1	.254	.98	.25	.20	.10	.87	.10	.49
FFLI	50.6	50.4	50.2	50.5	50.4	50.2	.162	.75	.60	.37	.34	.71	.23	.60
Packing Plant Data w/ HCW Covariate														
Yield, %	75.9	75.5	76.0	75.6	76.0	75.6	.003	.17	.96	.99	.83	.86	.48	.85
Back fat, in.	.665	.686	.693	.677	.681	.689	.014	.71	.73	.38	.51	.67	.32	.51
Loin depth, in.	2.36	2.30	2.27	2.32	2.25	2.27	.031	.82	.14	.20	.05	.89	.11	.21
Lean, %	55.8	55.3	55.1	55.4	55.2	55.1	.263	.78	.41	.27	.20	.78	.15	.31
FFLI	50.6	50.3	50.3	50.4	50.4	50.3	.169	.66	.69	.45	.46	.67	.28	.49

[1]A total of 1,200 PIC gilts with an average initial wt. of 54 lb were used in the experiment. The values represent the mean of eight pens per treatment and 25 pigs per pen. [2]SBM = solvent-extracted soybean meal. [3]EE Soy = extruder-expelled soybean meal without hulls.