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EFFECTS OF EXPANDED WHOLE SOYBEANS ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY IN NURSERY PIGS

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Summary

As expected, ADG, ADFI, F/G, and digestibility of DM and N were improved in nursery pigs when cone pressure was increased during dry and moist expanding of whole soybeans. These response were quadratic for the most part, such that 1,000 psi was optimal with dry expanding and 700 to 800 psi was optimal with moist expanding.

(Key Words: Expander, Soybeans, Nursery Pigs.)

Introduction

In just the past years, expander processing has become popular for preparing complete poultry feeds. During expanding, heat changes the physical/chemical structure of starch and protein, making them more tacky. These tacky particles then can be pushed together to make extremely durable pellets. It seemed logical that the same shear heat and shear that improve pellet durability could also serve to inactivate the antinutritional factors in whole soybean seeds. Two experiments were designed to determine the effects of cone pressure (with or without steam preconditioning) during expansion of whole soybeans on growth performance and nutrient digestibility in nursery pigs.

Procedures

In Exp.1, a total of 150 crossbred pigs was weaned at 21 d and fed a commercial starter diet (Table 1) for 1 wk. At the close of the 1-wk acclimation period, the pigs were blocked by weight and allotted to 25 pens by sex and ancestry (5 pens/trt and 6 pigs/pen) for a 25-d growth assay.

No cone pressure or pressures of 400, 800, 1,000, and 1,200 psi were used during dry expansion (Model OE15.2, Amandus-Kahl, Hamburg, Germany) of whole soybeans. The expanded beans were ground to 550 microns before use in corn-based diets. For d 7 to 21, the diets had 1.05% lysine, .90% Ca, and .80% P, and for d 21 to 32, the diets had .86% lysine, .8% Ca, and .7% P. The lysine concentration was 90% of NRC (1988) recommendation to accentuate differences in growth performance. All other nutrients were in excess of NRC suggestions.

The pigs were housed in an environmentally controlled building with wire-meshed floor. A nipple waterer and a self-feeder provided the pigs with ad libitum access to feed and water. Pigs and feeders were weighed at d 0, 14, and 25. Feces were collected at d 24; dried; and ground for analyses of DM, N, GE, and Cr.

In Exp. 2, a total of 180 crossbred pigs was weaned at 21 d and fed the commercial starter diet for 1 wk. Then they were blocked by weight and allotted to 30 pens by sex and ancestry (6 pens/trt and 6 pigs/pen) for a 24-d growth assay. Soybean treatments were expanding with no cone pressure or pressures of 400, 600, 700, and 800 psi after steam conditioning to 180°F (California Pellet

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Mill® conditioner) for 10 seconds. The pigs were housed and managed as in Exp. 1.

For both experiments, the growth and digestibility data were analyzed as a randomized completed block design using the GLM procedure of SAS. Pen was the experiment unit, and polynomial regression was used to characterize the slope of the response curve as related to increasing cone pressure.

Results and Discussion

With both dry and moist expanding, processing energy inputs increased and production rate decreased with increased cone pressures (Table 2). Also, trypsin inhibitor, protein dispersible index, and urease activity were decreased. Previous work has suggested that properly heated soybean products will have a protein dispersible index of 25%, urease activity of .02 to .2, and trypsin inhibitor activity of less than 4 mg/g. With our dry and moist expanding, 1,000 and 700 to 800 psi, respectively, were needed to achieve the targeted laboratory values.

When the soy preparations were fed to pigs (Exp. 1), increasing cone pressure from 0 to 1,200 psi (with dry expanding) improved ADG, ADFI, and F/G and digestibilities of DM, N, and GE (P<.001) (Table 3). However, cubic effect of the cone pressure indicated that when cone pressure increased above 1000 psi, the growth performance fluctuated. Within this range, the optimal response was achieved at 1,000 psi (quadratic effect, P<.03).

For moist expanding (Exp. 2), ADG, ADFI, and F/G and digestibilities of DM and N were improved (P<.001) when cone pressure was increased from 0 to 800 psi (Table 4). However, most of the response was achieved with 600 psi, and the response plateaued at 700 to 800 psi (quadratic effect, P<.001).

In conclusion, expander processing can be used to prepare full-fat soy products. Furthermore, the cone pressure needed to achieve optimal nutritional value can be reduced with moist processing.

Table 1. Compositions of Basal Diets for Experiments 1 and 2[a]

Ingredient, %	d 0 to 7	d 7 to21	d 21 to 32
Corn	35.82	51.81	61.05
SBM (47.5% CP)	24.45	---	---
Whole soybeans [b]	---	31.60	29.35
Dried whey	20.00	10.00	5.00
Porcine plasma	6.00	1.00	---
Fish meal	1.00	1.00	---
Blood meal	1.00	---	---
Lactose	5.00	---	---
Soy oil	2.00	---	---
Dicalcium phosphate	1.38	---	---
Monocalcium phosphate	---	1.62	1.49
Limestone	.80	.98	1.04
Salt	.20	.30	.35
Threonine	.04	---	---
Lysine HCl	.20	---	---
DL-methionine	.32	.03	.004
Vitamin premix	.25	.25	.25
Trace mineral premix	.15	.15	.15
Antibiotics [c]	1.00	1.00	1.00
Zinc oxide	.39	.25	---
Copper sulfate	---	---	.07
Chromic oxide [d]	---	---	.25

[a]Diets for d 0 to 7 were formulated to 1.7% lysine, .9% Ca, and .8% P. Diets for d 7 to 21 were formulated to 1.05% lysine .9% Ca, and .8% P. Diets for d 21 to 32 were formulated to .86% lysine .8% Ca, and .7% P. [b]The expanded whole soybeans were ground to a particle size of 550 microns before use in the diets. [c]Apramycin (150 g/ton) for d 0 to 21and carbadox (50 g/ton) for d 21 to 32. [d]Used as an indigestible marker.

Table 2. Processing Characteristics of Expanded Soybeans

	Cone Pressure, psi						
Item	0	400	600	700	800	1000	1200
Dry expanding (Exp.1)							
GEI, kwh/ton [a]	20.9	32.8	--	--	54.4	88.2	118.9
SEI, kwh/ton [b]	.7	10.1	--	--	34.4	48.9	72.7
PR, ton/hr [b]	2.47	2.29	--	--	2.47	1.81	1.07
Temperature, °F [d]	82.0	112.3	--	--	190.1	236.5	312.6
TI, mg/g [e]	26.4	26.6	--	--	24.8	4.6	0.4
Urease, ΔpH [f]	2.24	2.24	--	--	2.24	0.18	0.02
PDI, % [g]	86.1	83.9	--	--	61.0	14.0	9.0
Moist expanding (Exp.2)							
GEI, kwh/ton	19.2	37.2	38.7	43.3	47.3	--	--
SEI, kwh/ton	.7	14.8	19.9	23.2	27.0	--	--
PR, ton/hr	1.35	1.11	1.32	1.24	1.20	--	--
Temperature, °F	182.0	227.4	273.7	254.4	266.4	--	--
TI, mg/g	29.0	13.2	3.2	3.2	2.3	--	--
Urease, ΔpH	2.15	1.97	1.22	1.15	0.08	--	--
PDI, %	74.2	47.8	30.8	21.8	12.0	--	--

[a]Gross energy input.
[b]Specific energy input.
[c]Production rate.
[d]Estimated by equation: T (°F) = condition temp + 3.2 × (Specific energy input).
[e]Trypsin inhibitor activity.
[f]Urease activity.
[g]Protein dispersible index.

Table 3. Effects of Dry-Expanded Whole Soybeans on Growth Performance and Nutrient Digestibility in Nursery Pigs (Exp. 1)[a]

	Cone Pressure, psi						Contrast [b]			
Item	0	400	800	1,000	1,200	SE	Lin	Quad	Cub	Quart
d 7 to 21										
ADG, lb	.24	.19	.26	.69	.65	.05	.005	.001	.001	.03
ADFI, lb	1.58	.92	.94	1.31	1.30	.04	--	.001	.001	.005
F/G	4.33	4.76	3.64	1.89	2.00	.09	.01	.001	.001	--
Overall										
ADG, lb	.36	.31	.43	.93	.83	.02	.001	.001	.001	.001
ADFI, lb	1.28	1.25	1.24	1.76	1.72	.05	.001	.001	.003	.001
F/G	3.62	3.62	2.89	1.88	2.07	.02	.001	.001	.001	.001
Apparent digestibility, %										
DM	76.3	72.4	75.1	79.1	80.0	1.0	.001	.02	.02	--
N	63.6	50.0	57.9	75.2	74.4	2.0	.001	.001	.001	--
GE	75.9.	71.7	75.3	79.8	80.3	1.0	.001	.03	.01	--

[a]A total of 150 nursery pigs was used (6 pigs/pen and 5 pens/trt) with an avg weight of 17 lb.
[b]Dashes indicate P>.15.

Table 4. Effects of Moist-Expanded Whole Soybeans on Growth Performance and Nutrient Digestibility in Nursery Pigs (Exp. 2)[a]

	Cone Pressure, psi						Contrast [b]			
Item	0	400	600	700	800	SE	Lin	Quad	Cub	Quart
d 7 to 19										
ADG, lb	.32	.61	.73	.84	.92	.04	.001	.01	--	--
ADFI, lb	.97	1.10	1.33	1.46	1.48	.07	.001	--	--	--
F/G	3.04	1.60	1.84	1.74	1.65	.12	.01	.06	.04	--
Overall										
ADG, lb	.37	.63	.87	.88	.99	.03	.001	.001	--	--
ADFI, lb	1.19	1.37	1.63	1.72	1.8	.06	.001	.09	--	--
F/G	3.26	2.17	1.89	1.95	1.82	.01	.001	.001	.001	--
Apparent digestibility, %										
DM	78.8	80.7	81.9	82.2	80.3	.6	.001	.02	--	--
N	62.3	70.6	75.5	76.0	76.3	1	.001	.001	--	--

[a]A total of 180 nursery pigs was used (6 pigs/pen and 6 pens/trt) with an avg wt of 17 lb.
[b]Dashes indicate P>.15.