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Effect of replacing dried skim milk with specially processed soy products on digestibility of nutrients and growth performance of nursery pigs

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Abstract

One hundred twenty-eight pigs (21 d of age and 11.7 lb) were used to determine the effects of feeding specially processed soy products and lactose versus dried skim milk on growth performance and nutrient digestibility. For d 0-14, pigs received pelleted diets that were: 1) corn-soybean meal-whey control; 2) a high nutrient density diet (HNDD) containing 20% dried skim milk and 20% dried whey; 3 and 4) the HNDD with soy protein isolate replacing 50% and 100% of the protein supplied by dried skim milk; 5 and 6) the HNDD with soy protein concentrate replacing 50% and 100% of the protein supplied by dried skim milk; 7 and 8) the HNDD with modified soy flour replacing 50% and 100% of the protein supplied by dried skim milk. For d 14-35, all pigs were fed a common diet. Average daily gain (ADG), average daily feed intake (ADFI), feed:gain ratio (F/G), and fecal scores were determined for d 7, 14, and 35 of the experiment. Apparent digestibilities of N and DM were determined from fecal samples collected on d 13. For d 0 to 7, pigs fed the HNDD had the best F/G, pigs fed the corn-soybean meal-whey control had the poorest F/G, and pigs fed diets with the specially processed soy products were intermediate in feed efficiency. Pigs fed the soy isolate had improved feed efficiency and less incidence of diarrhea compared to pigs fed the soy concentrate. For d 0 to 14, pigs fed the corn-soybean meal-whey control had the poorest performance and DM digestibility. When dried skim milk was replaced with the specially processed soy products, F/G was worse, but digestibility of N and DM were not decreased, especially at the 50% level of replacement. Pigs fed the soy isolate had performance more similar to pigs fed the HNDD than pigs fed the soy concentrate or modified soy flour. From d 0 to 35, ADG and ADFI were greater for pigs fed diets with soy products replacing the protein from dried skim milk than pigs given the HNDD. However, pigs fed the HNDD gained more efficiently. Our data indicate that replacing the protein from dried skim milk with the specially processed soy products tested in this experiment resulted in slight depressions in performance early in the nursery phase (ie., d 0 to 14). However, as the processing techniques became more elaborate (ie., isolate> concentrate> modified soy flour), utilization of the products was improved.; Swine Day, Manhattan, KS, November 15, 1990

Keywords

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EFFECT OF REPLACING DRIED SKIM MILK WITH SPECIALLY PROCESSED SOY PRODUCTS ON DIGESTIBILITY OF NUTRIENTS AND GROWTH PERFORMANCE OF NURSERY PIGS

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Summary

One hundred twenty-eight pigs (21 d of age and 11.7 lb) were used to determine the effects of feeding specially processed soy products and lactose versus dried skim milk on growth performance and nutrient digestibility. For d 0-14, pigs received pelleted diets that were: 1) corn-soybean meal-whey control; 2) a high nutrient density diet (HNDD) containing 20% dried skim milk and 20% dried whey; 3 and 4) the HNDD with soy protein isolate[2] replacing 50% and 100% of the protein supplied by dried skim milk; 5 and 6) the HNDD with soy protein concentrate[3] replacing 50% and 100% of the protein supplied by dried skim milk; 7 and 8) the HNDD with modified soy flour[4] replacing 50% and 100% of the protein supplied by dried skim milk. For d 14-35, all pigs were fed a common diet. Average daily gain (ADG), average daily feed intake (ADFI), feed:gain ratio (F/G), and fecal scores were determined for d 7, 14, and 35 of the experiment. Apparent digestibilities of N and DM were determined from fecal samples collected on d 13. For d 0 to 7, pigs fed the HNDD had the best F/G, pigs fed the corn-soybean meal-whey control had the poorest F/G, and pigs fed diets with the specially processed soy products were intermediate in feed efficiency. Pigs fed the soy isolate had improved feed efficiency and less incidence of diarrhea compared to pigs fed the soy concentrate. For d 0 to 14, pigs fed the corn-soybean meal-whey control had the poorest performance and DM digestibility. When dried skim milk was replaced with the specially processed soy products, F/G was worse, but digestibility of N and DM were not decreased, especially at the 50% level of replacement. Pigs fed the soy isolate had performance more similar to pigs fed the HNDD than pigs fed the soy concentrate or modified soy flour. From d 0 to 35, ADG and ADFI were greater for pigs fed diets with soy products replacing the protein from dried skim milk than pigs given the HNDD. However, pigs fed the HNDD gained more efficiently. Our data indicate that replacing the protein from dried skim milk with the specially processed soy products tested in this experiment resulted in slight depressions in performance early in the nursery phase (i.e., d 0 to 14). However, as the processing techniques became more elaborate (i.e., isolate> concentrate> modified soy flour), utilization of the products was improved.

(Key words: Starter, Performance, Soybean, SBM, DSM.)

Introduction

Early weaning has resulted in the use of diets high in milk products, especially dried skim milk and dried whey, to increase the nutrient quality and to better match those diets to

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[2]Ardex F, [3]Pig Pro 70, [4]Pig Pro 50, ADM Protein Specialties, Archer Daniels Midland Co., Decatur, IL.

the pigs' digestive capabilities. Although performance of pigs fed these high milk-product diets is greater than performance of pigs fed simple corn-soybean meal diets, the milk-product diets are more expensive. Thus, other feed ingredients need to be investigated as possible replacements for all or part of the milk products in high nutrient density diets (HNDD). Three potential replacement products are soy protein isolate, soy protein concentrate, and modified soy flour. Soy protein isolates are produced by using precipitation techniques to separate the large storage proteins of defatted soy flakes from the soluble and insoluble carbohydrates and smaller whey proteins. This leaves a high quality soy product that is approximately 90% crude protein. Soy protein concentrates are produced by extracting (usually with ethanol and/or water) the soluble carbohydrates from the defatted soy flakes, leaving a product of about 70% crude protein. Modified soy flour is produced by fine grinding dehulled soybean meal and then further processing it by methods such as toasting or extrusion that serve to deactivate the growth inhibitors and cause structural changes to the soybean proteins. An experiment was conducted to determine the effects of using these specially processed soy products to replace the protein from dried skim milk in diets for weanling pigs.

Procedures

One hundred twenty-eight crossbred pigs were weaned at 21 d of age (avg wt=11.7 lb) and used in a 5-wk growth assay to determine the effects of feeding specially processed soy products and lactose in place of dried skim milk in diets for newly weaned pigs. Pigs were housed (two barrows and two gilts per pen) in an environmentally controlled nursery equipped with 4 × 5 ft pens and woven wire flooring. Each pen had a self-feeder and nipple waterer so feed and water could be consumed ad libitum.

Pigs were fed the Phase 1 diets (Table 1) from weaning to d 14. Phase 1 treatments were: 1) corn-soybean meal-whey control; 2) a high nutrient density diet (HNDD) containing 20% dried skim milk and 20% dried whey; 3 and 4) the HNDD with soy protein isolate replacing 50% and 100% of the protein supplied by dried skim milk; 5 and 6) the HNDD with soy protein concentrate replacing 50% and 100% of the protein supplied by dried skim milk; 7 and 8) the HNDD with modified soy flour replacing 50% and 100% of the protein supplied by dried skim milk. All Phase 1 diets contained .25% chromic oxide as an

Table 1. Diet Composition.

Ingredient, %	Corn-soy-whey	HNDD[a]
Corn	37.82	31.34
Soybean meal(48%)	33.20	20.60
Soy replacements	—	—
Dried skim milk	—	20.00
Dried whey	20.00	20.00
Lactose	—	—
Soy oil	5.00	5.00
Lysine-HCl	.23	.11
Vit/Min/Antibio.	3.50	2.70
Chromic oxide	.25	.25
Total	100.00	100.00
Calculated composition[b]		
Lactose, %	14.80	25.00
g Lys/Mcal DE	4.20	4.10

[a]Soy isolate, soy concentrate or modified soy flour were used to replace 50% and 100% of the protein from dried skim milk in the HNDD. Lactose was added so that all HNDD's contained 25% lactose.
[b]Formulated to provide 22% crude protein, 1.5% lysine, .9% Ca, and .8% P.

indigestible marker for determination of apparent digestibilities of N and DM. A common diet was fed to all pigs during Phase 2 (from d 14 to 35), based on corn-soybean meal with 20% dried whey, formulated to contain 1.25% lysine, .9% Ca, and .8% P.

Pigs and feeders were weighed on d 7, 14, and 35 of the experiment to determine average daily gain (ADG), average daily feed intake (ADFI), and feed:gain ratio (F/G). On d 13 of the experiment, fecal samples were collected from all of the pigs by rectal massage; pooled within pen; dried; and analyzed for N, DM, and Cr content. Apparent digestibilities of N and DM were calculated using the indirect ratio method.

Each pen of pigs was observed at approximately 8:00 a.m. and given a fecal score. Scores were assigned using the scale 1 = all pigs with normal feces to 5 = all pigs with diarrhea. Scores for d 7, 14, and 35 were calculated by averaging the scores for d 5, 6, and 7; d 12, 13, and 14; and d 33, 34, and 35, respectively. The pooled scores were transformed (square root transformation) prior to statistical analysis.

Results and Discussion

Growth data, digestibility data, and fecal scores are given in Table 2. From d 0 to 7 of the experiment, pigs fed the HNDD had the best F/G ($P<.05$). Pigs fed the corn-soybean meal-whey control were the least efficient ($P<.02$), and pigs fed the diets with soy products replacing the protein from dried skim milk were intermediate in efficiency of feed utilization. Pigs fed the soy isolate had improved F/G ($P<.01$) and less incidence of diarrhea ($P<.02$) compared to pigs fed the soy concentrate. Pigs fed the diets with soy isolate or soy concentrate ate more feed and had greater ADG as the level of soy products was increased from 50 to 100% replacement, whereas pigs given the modified soy flour ate less feed and had decreased ADG as the level of soy flour was increased in the diets ($P<.02$). Pigs fed diets with soy isolate had lower incidence of diarrhea ($P<.02$) than pigs fed soy concentrate.

From d 0 to 14 of the experiment, pigs given the corn-soy-whey control gained slower than pigs fed the other diets ($P<.11$). Also, ADG increased as the level of soy isolate or soy concentrate was increased in the diet, but ADG decreased ($P<.11$) as the level of modified soy flour was increased. Feed intake was affected by concentration of soybean product, with increased ADFI as more isolate and concentrate were added to the diets, but reduced ADFI as the inclusion rate of modified soy flour was increased ($P<.09$). Pigs fed the corn-soy-whey control diet had greater F/G ($P<.02$) than pigs fed the other treatments, and F/G was less ($P<.02$) for pigs fed the HNDD than for those fed diets with dried skim milk replaced by the soy products. Dry matter digestibilities were lower for pigs fed the control diet than for those fed the HNDD's ($P<.04$), and the diets containing modified soy flour had lower DM digestibility than diets with soy isolate or soy concentrate ($P<.09$). Nitrogen digestibilities followed a similar trend to DM digestibilities; however, the differences were not statistically significant ($P>.18$). On d 14 of the experiment, there was a reduction in the incidence of diarrhea as the level of soy isolate or soy concentrate was increased in the diet, but an increase in the incidence of diarrhea as the level of modified soy flour was increased in the diet ($P<.08$).

Overall (d 0 to 35), pigs fed diets with the specially processed soy products from d 0 to 14 consumed more feed ($P<.001$) and gained faster ($P<.03$) than those fed the HNDD.

There was an increase in ADG as the concentration of the soy product replacements was increased (P<.07), and pigs given isolate or concentrate gained faster than those given modified soy flour (P<.05). Pigs given the HNDD were more efficient than pigs given the other treatments (P<.08). At d 35, there were no treatment effects (P>.18) on the incidence of diarrhea, which could be expected because all pigs received the same dietary treatment for the last 21 d of the experiment.

When compared to a simple corn-soybean meal-whey diet, HNDDs containing skim milk and(or) the soy products plus lactose were of greater nutritional value to the weanling pig for the first 14 d postweaning. The diets containing soy isolate and concentrate were highly digestible, and diets with soy isolate tended to cause less diarrhea than diets containing soy concentrate or modified soy flour. For the soy products, as the complexity of the processing methods increased (i.e., soy isolate> soy concentrate> modified soy flour), nutritional value tended to be improved. However, during the early nursery phase, HNDD's with the soy products replacing the protein from dried skim milk were of slightly less nutritional value than the HNDD with dried skim milk.

Table 2. Effects of Soybean Products on Performance and Nutrient Digestibility in Nursery Pigs

Item	Corn-soy whey	HNDD	Soy isolate 50%	Soy isolate 100%	Soy concentrate 50%	Soy concentrate 100%	Modified soy flour 50%	Modified soy flour 100%	CV
d 0 to 7									
ADG, lb[a]	.47	.55	.49	.54	.42	.49	.55	.43	15.6
ADFI, lb[b]	.48	.44	.40	.45	.40	.49	.48	.39	15.5
F/G[c]	1.03	.80	.83	.85	.94	1.00	.86	.90	10.5
d 0 to 14									
ADG, lb[d]	.50	.60	.56	.56	.54	.55	.58	.50	11.4
ADFI, lb[e]	.62	.60	.62	.63	.59	.63	.65	.58	11.3
F/G[f]	1.24	1.02	1.11	1.13	1.10	1.15	1.12	1.15	8.4
d 0 to 35									
ADG, lb[g]	.93	.82	.88	.96	.89	.93	.85	.87	6.7
ADFI, lb[h]	1.26	1.05	1.16	1.27	1.21	1.28	1.16	1.18	6.1
F/G[i]	1.35	1.28	1.32	1.32	1.36	1.37	1.36	1.35	5.4
Digestibility, %									
N[j]	76.4	80.5	81.9	79.5	79.4	78.4	76.5	78.3	5.2
DM[k]	81.6	84.7	86.8	84.0	85.0	85.8	82.5	84.1	3.2
Fecal Scores[l]									
d 7[m]	1.9	1.9	1.8	1.7	2.3	2.1	2.0	2.1	11.0
d 14[n]	3.7	3.1	3.5	3.1	3.5	3.3	3.0	3.8	12.1
d 35[o]	2.7	1.9	2.5	2.3	2.2	1.9	2.4	2.5	15.3

[a]Linear X Soy isolate & Soy concentrate vs Modified soy flour (P<.01).
[b]Linear X Soy isolate & Soy concentrate vs Modified soy flour (P<.02).
[c]Control vs others (P<.02), HNDD vs replacements (P<.05), Soy isolate vs Soy concentrate (P<.01).
[d]Control vs others (P<.11), Linear X Soy isolate & Soy concentrate vs Modified soy flour (P<.11).
[e]Linear X Soy isolate & Soy concentrate vs Modified soy flour (P<.09).
[f]Control vs others (P<.02), HNDD vs replacements (P<.02).
[g]HNDD vs replacements (P<.03), Linear effect of replacements (P<.07), Soy isolate & Soy concentrate vs Modified soy flour (P<.05).
[h]Control vs others (P<.07), HNDD vs replacements (P<.001), Linear effect of replacements (P<.04), Soy isolate & Soy concentrate vs Modified soy flour (P<.06).
[i]HNDD vs replacements (P<.08).
[j]No treatment effect (P>.18).
[k]Control vs others (P<.04), Soy isolate & Soy concentrate vs Modified soy flour (P<.09).
[l]Scale: 1= all pigs with normal feces to 5= all pigs with diarrhea.
[m]Soy isolate vs Soy concentrate (P<.02).
[n]Linear X Soy isolate & Soy concentrate vs Modified soy flour (P<.08).
[o]No treatment effect (P>.18).