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# Effect of replacing milk products with a soybean protein isolate milk replacer in diets for nursery pigs


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# EFFECT OF REPLACING MILK PRODUCTS WITH A SOYBEAN PROTEIN ISOLATE MILK REPLACER IN DIETS FOR NURSERY PIGS

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## Summary

One hundred eighty pigs (21 d of age and averaging 14.5 lb) were used to determine if a milk replacer containing soybean protein isolate can replace dried skim milk and dried whey in a high nutrient density starter diet. Pigs received pelleted feeds that were: 1) corn-soybean meal control; 2) a high nutrient density diet (HNDD) containing 20% dried skim milk and 20% dried whey; 3 and 4) diet 2 with milk replacer substituted for 50% and 100% of the milk products; 5) corn-milk replacer; 6) corn-milk products. Average daily gain (ADG), average daily feed intake (ADFI), feed conversion (F/G), and fecal scores were determined on d 7, 14, and 35 of the experiment. Apparent digestibilities of nitrogen and dry matter were determined on d 14. On d 7, pigs fed the corn-soybean meal control had the poorest performance. Feed efficiency was better for pigs fed the corn-milk replacer and corn-milk products diets than for pigs fed the HNDD's. At d 14, ADFI was less for pigs fed the corn-milk replacer and corn-milk products diets than for pigs given the HNDD's. Digestibilities of nitrogen and dry matter were greater for all diets vs the control, and there was decreased incidence of diarrhea as the level of milk replacer increased in the diet. At d 35, ADG was greatest for pigs given the HNDD's and ADFI was lower for pigs fed the corn-milk replacer and corn-milk products diets. Our results indicate that milk replacers containing a high quality soybean protein isolate can be substituted for milk products in HNDD's with no reduction in pig performance.

(Key Words: Soybean Protein Isolate, Dried Skim Milk, Dried Whey, Nursery Pigs.)

## Introduction

It has become commonplace for producers to wean their pigs at early ages, often at 3 wk of age. Early weaning has resulted in the use of diets high in milk products, especially dried skim milk and dried whey, to increase the nutrient density of those diets and to better match the diet to the pigs' digestive capabilities. Although performance of pigs fed these high milk-products diets is greater than performance of pigs fed simple corn-soybean meal diets, the milk-products diets are also more expensive. Thus, other feed ingredients need to be investigated as replacements for all or part of the dried skim milk and whey in high nutrient density diets (HNDD's). One such product[1], a milk replacer using a soybean protein isolate as the major protein component, is presently receiving attention. Soybean protein isolate is produced by separating the large storage proteins of the soybean from the soluble and insoluble carbohydrates, lipids, and smaller proteins (including the trypsin inhibitors). This leaves a high quality, soybean protein isolate that is approximately 90% crude protein. An experiment was

[1]Nurish 2000™, Protein Technologies International, Checkerboard Square, St. Louis, MO.

conducted to investigate the effect of substituting this milk replacer for dried skim milk and dried whey in HNDD's for weanling pigs.

## Experimental Procedures

A total of 180 crossbred pigs weaned at 21 d of age, were used in a 5-wk growth assay. Initial weights ranged from 11 to 18 lb. Pigs were housed (six per pen) in an environmentally controlled nursery equipped with 4 ft × 5 ft pens and woven wire flooring. Each pen had a self-feeder and nipple waterer, so feed and water could be supplied ad libitum.

Pigs were fed the Phase 1 diets (Table 1) from weaning to d 14 and were switched to the Phase 2 diets (Table 2) for the remainder of the experiment. Phase 1 treatments were: 1) corn-soybean meal control; 2) a high nutrient density diet (HNDD) containing 20% dried skim milk and 20% dried whey; 3) diet 2 with the milk replacer substituted for 50% of the milk products; 4) diet 2 with the milk replacer substituted for 100% of the milk products; 5) corn-milk replacer; 6) corn-milk products. All of the Phase 1 diets contained .25% chromic oxide, as an indigestible marker for determination of apparent digestibilities of nitrogen and dry matter. Phase 2 treatments were the same as Phase 1, except that diets were formulated to 1.20% lysine and did not contain dried skim milk (with the exception of the corn-milk products diet).

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 (F/G). On d 12 and 13 of the experiment, fecal samples were collected from all of the pigs, pooled within pen, dried, and analyzed for dry matter, nitrogen, and chromium content.

Each pen of pigs was observed daily at approximately 0800 h and given a fecal score. Scores were based on the following scale; 0 = all pigs with normal feces to 6 = six 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

Nutrient contents of dried skim milk, dried whey, and the milk replacer are given in Table 3. The nutrient profile of the milk replacer was very similar to that of dried skim milk. The milk replacer contained approximately 1/3 soybean protein isolate and 2/3 dried whey, which provided the lactose.

During the first week (d 0 to 7), pigs fed the corn-soybean meal control diet had poorer F/G ($P<.001$) than pigs fed the other treatments (Table 4). Feed/gain was improved ($P<.10$) for pigs fed the corn-milk replacer and corn-milk products diets vs the HNDD's. Feed/gain responded in a quadratic manner to level of milk replacer substitution ($P<.08$), with the 50% substitution having the best F/G. There were no treatment differences for ADG and ADFI during d 0 to 7 ($P>.10$).

**Table 1. Composition of Diets (Phase 1)**

| Ingredient, % | Corn-soybean meal | HNDD | HNDD + milk replacer 50% | HNDD + milk replacer 100% | Corn-milk replacer | Corn-milk products |
|---|---|---|---|---|---|---|
| Corn | 40.72 | 24.43 | 26.97 | 33.58 | 31.81 | 13.04 |
| Soybean meal (48%) | 42.30 | 21.30 | 17.00 | 9.50 | -- | -- |
| Dried skim milk | -- | 20.00 | 10.00 | -- | -- | 45.00 |
| Dried whey | -- | 20.00 | 10.00 | -- | -- | 30.00 |
| Milk replacer | -- | -- | 20.00 | 40.00 | 50.70 | -- |
| Soy oil/CWG[a] | 12.00 | 11.00 | 13.00 | 14.00 | 15.00 | 10.00 |
| Monocalcium phosphate | 1.98 | 1.15 | 1.05 | .98 | .73 | .40 |
| Limestone | 1.09 | .52 | .48 | .44 | .26 | -- |
| L-lysine HCL | .11 | .10 | -- | -- | .06 | .06 |
| Copper sulfate | .10 | .10 | .10 | .10 | .10 | .10 |
| Vitamins, minerals, antibiotic | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Totals | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated analysis[b] | | | | | | |
| Crude protein, % | 23.98 | 21.73 | 22.21 | 21.50 | 20.50 | 20.08 |
| Lysine:DE, g lys/Kcal DE | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 | 3.80 |
| Lactose, % | -- | 25.00 | 22.50 | 20.00 | 25.35 | 45.15 |

[a]50:50 blend of soybean oil and choice white grease.
[b]All diets formulated to contain 1.5% lysine, .9% Ca, and .8% P.

At d 14, control pigs consumed more feed (P<.08) and converted feed less efficiently (P<.01) than the other pigs. Feed/gain was better (P<.09) for pigs fed the corn-milk replacer and corn-milk products diets than for pigs fed the HNDD's, but ADFI was less for pigs fed the corn-milk replacer and corn-milk products diets. Average daily feed intake responded in a quadratic manner to level of milk replacer substitution in the HNDD's (P<.02),with pigs fed the 50% substitution diet having the lowest feed intakes.

For the entire experimental period (d 0 to 35), pigs given the HNDD's gained faster (P<.001), but were less efficient (P<.05) than pigs given the corn-milk replacer and corn-milk products diets. That difference is due to the decreased ADFI for pigs fed the corn-milk replacer and corn-milk products diets compared to pigs fed the HNDD's (P<.001).

Diarrhea scores are given in Table 5. At d 7 and 35, pigs fed the corn-milk replacer diets had lower incidence of diarrhea than pigs fed the corn-milk products diets (P<.10). Also,

**Table 2. Composition of Diets (Phase 2)**

| Ingredient, % | Corn-soybean meal | HNDD | HNDD + milk replacer 50% | HNDD + milk replacer 100% | Corn-milk replacer | Corn-milk products |
|---|---|---|---|---|---|---|
| Corn | 57.54 | 43.09 | 49.77 | 56.85 | 54.20 | 31.75 |
| Soybean meal (48%) | 34.00 | 28.00 | 22.50 | 15.50 | -- | -- |
| Dried skim milk | -- | -- | -- | -- | -- | 32.00 |
| Dried whey | -- | 20.00 | 10.00 | -- | -- | 30.00 |
| Milk replacer | -- | -- | 10.00 | 20.00 | 38.00 | -- |
| Soy oil/CWG[a] | 4.00 | 5.00 | 4.00 | 4.00 | 5.00 | 4.00 |
| Monocalcium phosphate | 1.55 | 1.18 | 1.11 | 1.06 | .65 | .27 |
| Limestone | 1.08 | .86 | .81 | .76 | .45 | .20 |
| Salt | .30 | .30 | .30 | .30 | .20 | .20 |
| L-lysine HCL | .03 | .07 | .01 | .03 | -- | .08 |
| Copper sulfate | .10 | .10 | .10 | .10 | .10 | .10 |
| Vitamins, minerals, antibiotic | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Totals | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated analysis[b] | | | | | | |
| Crude protein, % | 21.38 | 19.90 | 19.98 | 19.37 | 17.95 | 17.34 |
| Lysine:DE, g lys/Kcal DE | 3.40 | 3.40 | 3.40 | 3.40 | 3.40 | 3.40 |
| Lactose, % | -- | 14.80 | 12.40 | 10.00 | 19.00 | 38.52 |

[a]50:50 blend of soybean oil and choice white grease.
[b]All diets formulated to contain 1.2% lysine, .8% Ca, and .7% P.

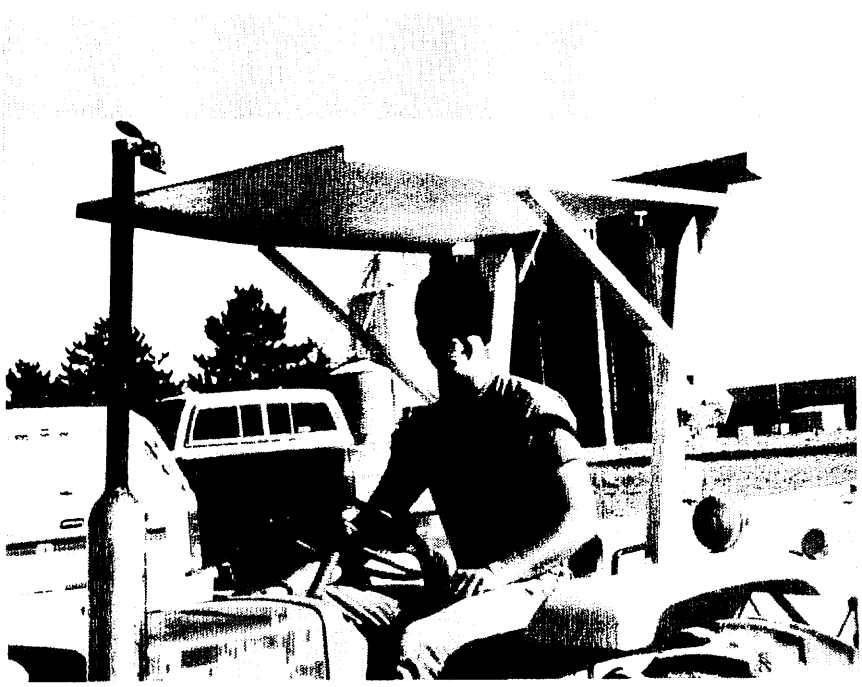
**Table 3. Nutrient Content of Dried Skim Milk, Dried Whey, and Milk Replacer**

| Nutrient | Dried skim milk | Dried whey | Milk replacer |
|---|---|---|---|
| Crude protein, % | 33.30 | 13.30 | 35.10 |
| Lysine, % | 2.54 | .94 | 2.80 |
| Threonine, % | 1.57 | .89 | 1.50 |
| Tryptophan, % | .43 | .18 | .50 |
| Ether extract, % | 1.10 | .80 | 2.00 |
| Fiber, % | .20 | .20 | .20 |
| DE, Kcal/g | 3.84 | 3.21 | 3.55 |
| Lactose, % | 51.00 | 74.00 | 50.00 |
| Calcium, % | 1.28 | .86 | 1.30 |
| Phosphorus, % | 1.02 | .76 | 1.11 |

there was a decrease in the incidence of diarrhea at d 14 and d 35 as the milk replacer was substituted for milk products in the HNDD's ($P<.05$). So, it does not appear that the milk replacer containing soybean protein isolate, when used at the levels tested in this experiment, will cause more diarrhea than milk products.

Apparent digestibilities of nitrogen and dry matter are given in Table 6. At d 14 of the experiment, the corn-soybean meal diet had lower digestibilities for nitrogen and dry matter than the other diet treatments ($P<.05$). Nitrogen ($P<.05$) and dry matter ($P<.09$) digestibilities of the HNDD's were lower than those of the corn-milk replacer and corn-milk products diets. It should be noted that the corn-milk replacer and corn-milk products diets contained the same ingredients as the HNDD's, except for soybean meal. Dry matter digestibility of the corn-milk replacer diet was lower than that of the corn-milk products diets ($P<.07$). That difference may have been due to the differences in corn content of the diets (31.8% for the corn-milk replacer diet and 13.0% for the corn-milk products diet).

When compared to a simple corn-soybean meal diet, diets containing milk products and the milk replacer were clearly of greater nutritional value for the weanling pig. The corn-milk replacer and corn-milk products diets (those without soybean meal) were utilized best by the pigs from d 0 to 7 postweaning and were the most digestible at d 14. Finally, using the milk replacer in substitution for the dried skim milk and whey in the HNDD's did not reduce performance of the weanling pigs.



Joe Carpenter, breeding barn manager.

Table 4. Effects of a Soybean Isolate Milk Replacer on Pig Performance[a]

| Item | Corn-soybean meal | HNDD | HNDD + milk replacer 50% | HNDD + milk replacer 100% | Corn-milk replacer | Corn-milk products | CV |
|---|---|---|---|---|---|---|---|
| Day 0 to 7 | | | | | | | |
| ADG, lb[b] | .64 | .75 | .69 | .72 | .72 | .70 | 15.7 |
| ADFI, lb[c] | .59 | .60 | .53 | .59 | .55 | .52 | 13.4 |
| F/G[d] | .92 | .80 | .75 | .82 | .76 | .73 | 7.4 |
| Day 0 to 14 | | | | | | | |
| ADG, lb[e] | .84 | .87 | .83 | .91 | .85 | .82 | 10.2 |
| ADFI, lb[f] | .83 | .83 | .75 | .84 | .76 | .72 | 7.4 |
| F/G[g] | .99 | .96 | .90 | .92 | .89 | .88 | 5.7 |
| Day 0 to 35 | | | | | | | |
| ADG, lb[h] | 1.04 | 1.07 | 1.07 | 1.09 | .96 | .88 | 8.9 |
| ADFI, lb[i] | 1.51 | 1.53 | 1.47 | 1.52 | 1.34 | 1.18 | 8.2 |
| F/G[j] | 1.45 | 1.43 | 1.38 | 1.39 | 1.39 | 1.33 | 3.7 |

[a]Six pigs per pen, five pens per treatment, avg initial wt of 14.5 lb.
[b]No treatment effect (P>.10).
[c]No treatment effect (P>.10).
[d]Control vs others (P<.001); HNDD's vs corn-milk replacer and corn-milk products (P<.10); quadratic effect of milk replacer substitution (P<.08).
[e]No treatment effect (P>.10).
[f]Control vs others (P<.08); HNDD's vs corn-milk replacer and corn-milk products (P<.01); quadratic effect of milk replacer substitution (P<.02).
[g]Control vs others (P<.006); HNDD's vs corn-milk replacer and corn-milk products (P<.09).
[h]HNDD's vs corn-milk replacer and corn-milk products (P<.001).
[i]Control vs others (P<.09); HNDD's vs corn-milk replacer and corn-milk products (P<.001); corn-milk replacer vs corn-milk products (P<.05).
[j]Control vs others (P<.03); HNDD's vs corn-milk replacer and corn-milk products (P<.05); corn-milk replacer vs corn-milk products (P<.10).

**Table 5. Effects of a Soybean Isolate Milk Replacer on the Incidence of Diarrhea[a]**

| Item | Corn-soybean meal | HNDD | HNDD + milk replacer 50% | HNDD + milk replacer 100% | Corn-milk replacer | Corn-milk products | CV |
|---|---|---|---|---|---|---|---|
| Day 7 score[b] | .1 | .3 | .3 | .6 | .1 | .5 | 24.0 |
| Day 14 score[c] | 1.5 | 1.9 | 1.6 | 1.0 | 1.1 | 1.0 | 23.1 |
| Day 35 score[d] | .5 | .9 | .7 | .4 | .3 | .9 | 23.2 |

[a]On a scale of 0 = no pigs with diarrhea, to 6 = 6 pigs with diarrhea.
[b]Corn-milk replacer vs corn-milk products (P<.10).
[c]Linear effect of milk replacer substitution (P<.05).
[d]Linear effect of milk replacer substitution (P<.05); corn-milk replacer vs corn-milk products (P<.05).

**Table 6. Effects of a Soybean Isolate Milk Replacer on Apparent Digestibility of Nitrogen and Dry Matter[a]**

| Item | Corn-soybean meal | HNDD | HNDD + milk replacer 50% | HNDD + milk replacer 100% | Corn-milk replacer | Corn-milk products | CV |
|---|---|---|---|---|---|---|---|
| Apparent nitrogen digestibility, %[b] | 81.7 | 82.7 | 84.6 | 84.0 | 85.5 | 87.2 | 3.5 |
| Apparent dry matter digestibility, %[c] | 82.4 | 83.7 | 86.2 | 84.6 | 85.2 | 88.7 | 3.3 |

[a]Determined on d 14 of the experiment using the indirect ratio method.
[b]Control vs others (P<.05); HNDD's vs corn-milk replacer and corn-milk products (P<.05).
[c]Control vs others (P<.03); HNDD's vs corn-milk replacer and corn-milk products (P<.09); corn-milk replacer vs corn-milk products (P<.07).