# EFFECTS OF INCREASING EXTRUDED SOY-PROTEIN CONCENTRATE ON GROWTH PERFORMANCE OF NURSERY PIGS[1]

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## Summary

Two hundred and forty barrows and gilts (initially 13.0 lb and 18 ± 2 d of age at weaning) were blocked by initial weight and were allotted randomly to one of five dietary treatments. There were eight replications (pens) per treatment, with six pigs per pen. Pigs were fed experimental diets from d 0 to 14 after weaning that included a control diet containing 40% soybean meal and diets containing 7.1, 14.3, 21.4, or 28.6% extruded soy-protein concentrate. From d 14 to 28, all pigs were fed a similar diet to determine if any carry-over effects existed from the treatment diets.

From d 0 to 14, ADG and ADFI increased (quadratic, P<0.06) as extruded soy protein concentrate increased from 7.1 to 21.4%, and then decreased similar to control values when 28.6% extruded soy-protein concentrate was fed. Feed efficiency improved (linear, P<0.01) with increasing rates of extruded soy-protein concentrate in the diet. Overall (d 0 to 28), there were no differences observed for ADG or ADFI, but F/G improved (linear, P<0.01) as extruded soy-protein concentrate increased in the diet. These results indicate that an inclusion rate up to 21.4% of extruded soy-protein concentrate was optimal for nursery-pig performance during the first two weeks post-weaning.

(Key Words: Growth, Extruded Soy Protein Concentrate, Pigs, Weanling Pigs.)

## Introduction

Commercial diets for early weaned pigs currently contain relatively low concentrations of soybean meal. It has been suggested that the transient hypersensitivity response to beta-conglycinin and conglycinin contained in soybean meal limits its inclusion in starter diets. A greater inclusion of soy proteins may be possible without negatively affecting pig performance because soy proteins are produced by different processing methods than those for soybean meal. Therefore, further-processed soy proteins such as extruded soy-protein concentrates may be alternatives to animal-based protein sources. Soy-protein concentrates are produced from defatted soy flakes. Soluble carbohydrates, primarily sucrose, raffinose, and stachyose, are removed from the defatted flakes. In previous trials (Swine Day 2003 Report of Progress), we have observed that pigs fed greater than 14% extruded soy-protein concentrate in diets immediately after weaning had decreased ADG compared with that of pigs fed soybean meal. It seemed that high rates of extruded soy-protein concentrate (28%) as a complete replacement for soybean meal negatively affected feed intake. There-

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fore, this experiment was designed to follow up our previous studies and to determine the optimal concentration of extruded soy-protein concentrate (Profine E) in nursery-pig diets.

## Procedures

Two hundred and forty barrows and gilts (Line 327 sire × C42 dams; PIC; initially 13.0 lb and 18 ± 2 d of age at weaning) were blocked by initial weight and were allotted randomly to one of five dietary treatments. There were eight replications (pens) per treatment, with six pigs per pen. The experiment was conducted at the Kansas State University Swine Teaching and Research Center. Each pen (5 × 4 ft) had slatted metal flooring and contained a stainless steel self-feeder and one nipple waterer to allow ad libitum consumption of feed and water.

Pigs were fed experimental diets from d 0 to 14 after weaning that included a control diet containing 40% SBM and diets containing 7.1, 14.3, 21.4, or 28.6% extruded soy-protein concentrate (Profine E; Table 1). From d 14 to 28, all pigs were fed the same phase 2 diet formulated to contain 1.5% total lysine (Table 1). Diets were formulated to meet or exceed the nutrient requirements of pigs. Pigs and feeders were weighed every 7 d to determine ADG, ADFI, and feed efficiency (F/G).

Data were analyzed as a randomized complete-block design with pen as the experimental unit. Pigs were blocked based on weaning weight, and analysis of variance was performed by using the PROC MIXED procedure of SAS. Linear and quadratic polynomial contrasts were performed to determine the effects of increasing extruded soy-protein concentrate.

## Results

From d 0 to 14 post-weaning, an increase in ADG (quadratic, $P<0.06$) and ADFI (quadratic, $P < 0.04$) was observed as extruded soy protein concentrate increased to 21.4% of the diet (Table 2). But both ADG and ADFI decreased to control values when pigs were fed 28.6% extruded soy-protein concentrate. Feed efficiency improved (linear, $P<0.01$) as extruded soy-protein concentrate increased to 28.6%.

From d 14 to 28 post-weaning, when all pigs were fed the same phase 2 diet, there were no differences in ADG, ADFI, or F/G. Overall (d 0 to 28), there were no differences observed for ADG or ADFI. Feed efficiency improved (linear, $P<0.01$) as extruded soy-protein concentrate increased to 28.6% of the diet.

Conclusions from this study, combined with the findings in the Swine Day 2003 Report of Progress, indicate that nursery pigs can be fed as much as to 21.4% extruded soy protein concentrate post-weaning to maximize growth rate. Higher dietary rates have resulted in improved feed efficiency, but consistently reduced nursery-pig growth rate.

**Table 1. Diet Composition (As-fed Basis)**

| | | Extruded Soy-Protein Concentrate, % | | | | |
|---|---|---|---|---|---|---|
| Ingredient, % | 40% SBM | 7.1 | 14.3 | 21.4 | 28.6 | Phase 2 |
| Corn | 32.96 | 35.92 | 38.91 | 41.87 | 44.34 | 51.17 |
| Soybean meal, 46.5% CP | 40.00 | 29.90 | 19.75 | 9.65 | --- | 27.30 |
| Soy oil | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 3.00 |
| Extruded soy protein concentrate[a] | --- | 7.14 | 14.28 | 21.42 | 28.55 | --- |
| Spray dried whey | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 10.00 |
| Monocalcium phosphate, 21% P | 1.38 | 1.39 | 1.40 | 1.41 | 1.45 | 0.90 |
| Limestone | 0.93 | 0.93 | 0.94 | 0.95 | 0.98 | 0.60 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Vitamin premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Trace mineral premix | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Medication[b] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Zinc oxide | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.25 |
| L-lysine HCl | 0.05 | 0.04 | 0.04 | 0.03 | 0.01 | 0.30 |
| DL-methionine | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.15 |
| L-threonine | --- | --- | --- | --- | --- | 0.13 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.00 |
| | | | | | | |
| Calculated Analysis: | | | | | | |
| Total lysine, % | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.50 |
| Isoleucine:lysine ratio, % | 72 | 73 | 74 | 75 | 77 | 61 |
| Leucine:lysine ratio, % | 133 | 135 | 137 | 139 | 142 | 121 |
| Methionine:lysine ratio, % | 30 | 30 | 30 | 30 | 30 | 34 |
| Met & Cys:lysine ratio, % | 57 | 57 | 57 | 58 | 57 | 58 |
| Threonine:lysine ratio, % | 65 | 66 | 67 | 68 | 70 | 65 |
| Tryptophan:lysine ratio, % | 21 | 20 | 20 | 19 | 19 | 17 |
| Valine:lysine ratio, % | 77 | 78 | 80 | 81 | 83 | 68 |
| ME, kcal/lb | 1,513 | 1,513 | 1,513 | 1,513 | 1,513 | 1,545 |
| CP, % | 23.8 | 24.0 | 24.2 | 24.4 | 24.7 | 21.1 |
| Ca, % | 0.90 | 0.90 | 0.89 | 0.89 | 0.90 | 0.81 |
| P, % | 0.80 | 0.80 | 0.80 | 0.79 | 0.80 | 0.73 |
| Lysine:calorie ratio, g/mcal | 4.53 | 4.53 | 4.53 | 4.53 | 4.53 | 4.40 |

[a]Profine E.
[b]Provided 55 mg/kg carbadox per ton of complete feed.

**Table 2. Effect of Increasing Extruded Soy-Protein Concentrate on Growth Performance of Weanling Pigs[a]**

| | | Extruded Soy-Protein Concentrate, % | | | | | Probability (P<) | |
|---|---|---|---|---|---|---|---|---|
| Item | 40% SBM | 7.1 | 14.3 | 21.4 | 28.6 | SED | Linear | Quadratic |
| Day 0 to 14 | | | | | | | | |
| ADG, lb | .72 | .74 | .78 | .78 | .72 | 0.03 | 0.81 | 0.06 |
| ADFI, lb | .80 | .83 | .83 | .85 | .73 | 0.51 | 0.33 | 0.04 |
| F/G | 1.09 | 1.11 | 1.04 | 1.08 | 1.00 | 0.02 | 0.01 | 0.28 |
| Day 14 to 28[b] | | | | | | | | |
| ADG, lb | 1.39 | 1.36 | 1.35 | 1.36 | 1.39 | 0.03 | 0.93 | 0.15 |
| ADFI, lb | 1.87 | 1.81 | 1.83 | 1.87 | 1.82 | 0.50 | 0.76 | 0.74 |
| F/G | 1.33 | 1.33 | 1.35 | 1.36 | 1.30 | 0.02 | 0.74 | 0.25 |
| Day 0 to 28 | | | | | | | | |
| ADG, lb | 1.06 | 1.05 | 1.06 | 1.07 | 1.06 | 0.27 | 0.83 | 0.77 |
| ADFI, lb | 1.33 | 1.32 | 1.33 | 1.36 | 1.28 | 0.46 | 0.44 | 0.30 |
| F/G | 1.20 | 1.20 | 1.18 | 1.20 | 1.14 | 0.01 | 0.01 | 0.15 |

[a]A total of 240 pigs (average BW of 13.0 lb), with six pigs per pen and eight pens per treatment with experimental diets fed for 14 d.
[b]All pigs were fed a common phase 2 diet from d 14 to 28.