# EFFECT OF INCREASING DIETARY LYSINE LEVEL WITH ADDITION OF WHEY PROTEIN CONCENTRATE ON PIG PERFORMANCE DURING PHASE 1 OF THE NURSERY PERIOD

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## Story in Brief

Pigs weaned at 16 to 24 days (average age and weight of 20 ± 3 days and 13.2 lb) were fed four dietary levels of lysine from whey protein concentrate to determine the lysine requirement of nursery pigs during Phase 1 (d 0 to 14 postweaning). Two trials involving 12 pens of 6 pigs each were performed using a total of 144 pigs. The four diets were formulated by substituting whey protein concentrate for cornstarch and sucrose to attain the desired levels of 1.15%, 1.30%, 1.45%, and 1.60% lysine. Each trial was conducted for six weeks. The four experimental diets were fed for the first two weeks postweaning. All pigs were fed a common Phase 2 diet (1.35% lysine) from d 14 to 28 and Phase 3 diet (1.15% lysine) from d 28 to 42 to monitor any carryover effect from Phase 1 diets. Average daily gain, average daily feed intake, and gain:feed were determined weekly. Average daily gain and gain:feed ratio increased linearly with increasing lysine level during Phase 1 and over the entire six weeks of the study. Average daily feed intake did not differ in any phase of the trial. The results of this study demonstrate that pig performance improves as dietary lysine level increases when whey protein concentrate is used as the lysine source. Average daily gain and gain:feed responses indicate that the lysine requirement for maximum performance of conventionally weaned pigs during the first two weeks postweaning is at least 1.60% of the diet.

(Key Words: Pigs, Lysine, Performance.)

## Introduction

With current environmental concern over nitrogen excretion from modern swine facilities, interest has surfaced in the use of synthetic amino acids in the formulation of swine diets. This would result in a reduction of nitrogen excretion by decreasing the amount of excess amino acids that occur when balancing for the most limiting amino acid. Synthetic amino acids also have the potential to decrease the cost of rations by decreasing the amount of protein ingredient in the diet. The greatest potential for their use is in the formulation

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of nursery rations since many of the protein sources in these diets are expensive.

Before benefits from the use of synthetic amino acids can be realized, the lysine requirement for the 10 to 20 lb postweaning pig must be determined. This experiment is the first in a series to determine the potential for the use of synthetic amino acids in swine diets. Many studies have been conducted to determine the lysine requirement of pigs in the postweaning stage of production (Lewis et al., 1981; Aherne and Nielson, 1983; Martinez and Knabe, 1990), though agreement upon the optimum level of lysine has not been reached. Current research at Kansas State University with segregated early weaned pigs has determined that the lysine requirement may be much higher than the level recommended by the NRC (1988). This leads to the conclusion that the recommended NRC (1988) level needs to be reevaluated. Therefore, the objective of this experiment was to determine the lysine requirement of 10 to 20 lb conventionally weaned pigs using whey protein concentrate as the amino acid source.

## Materials and Methods

Two trials involving a total of 144 pigs (72 in each of the two trials) averaging 13.2 lb and 20 ± 3 days of age were conducted to determine the effect of increasing dietary lysine on pig growth performance during Phase 1 of the nursery period. Pigs were allotted into three groups (blocks) based on initial body weight. Pigs within each weight group were divided into four equal subgroups (six pigs per subgroup) per trial, with distribution of pigs based on litter and sex. Dietary treatments were then randomly assigned to pens (three pens per diet per trial). Experimental diets were formulated by substituting whey protein concentrate for cornstarch and sucrose to obtain lysine levels of 1.15%, 1.30%, 1.45%, and 1.60% in the diet (Table 1). Methionine was added to meet ideal protein ratios according to Chung and Baker (1992) in relation to lysine level. Lactose, calcium, and phosphorus levels were maintained constant at 18%, .93%, and .80%, respectively. The four experimental diets were fed during Phase 1, after which common Phase 2 and Phase 3 diets were fed each for two weeks to all pigs to monitor any carryover effect of diets fed during Phase 1.

Pigs were housed in elevated pens (4'11" x 5') with woven wire flooring in an environmentally controlled nursery. Temperature was maintained initially at 86°F and decreased by 2°F weekly. Feed and water was available ad libitum from one nipple waterer and a 4-hole feeder. Weight gain and feed intake were recorded weekly and average daily gain, average daily feed intake, and gain:feed were calculated (Table 2).

Data were analyzed as a randomized complete block design with pen as the experimental unit. Blocks were based on initial body weight. Analysis of variance was performed using the General Linear Models procedure of SAS (1985). Orthogonal polynomials were used to test for linear, quadratic, and cubic effects.

## Results and Discussion

Average daily gain increased linearly (P<.002) during d 0 to 7, d 7 to 14, and d 0 to 14. Average daily gain was 42% greater from d 0 to 7, 33% greater from d 7 to 14, and 36% greater during Phase 1 for pigs fed the highest lysine level (1.60%) when compared with those fed the lowest dietary level of lysine (1.15%). For the overall 42 d trial, average daily gain increased linearly (P<.002) with increasing level of dietary lysine. Pigs fed the 1.60% lysine level in Phase 1 grew 11% faster compared with those fed the 1.15% lysine diet. No carryover effect from Phase 1 treatment was observed on average daily gain during the weeks of Phase 2 and Phase 3 feedings.

Gain:feed improved linearly (P<.002) with increasing lysine level during week 1, week 2, and the entire 42 d trial. There was a 36%, 33%, and 35% increase from d 0 to 7, d 7 to 14, and d 0 to 14 in pigs fed 1.60% lysine as compared with those fed 1.15%. Gain:feed improved 13% in the overall 42 d trial when pigs were fed 1.60% lysine compared with those fed 1.15%. Gain:feed improved 13% in the overall 42 d trial when pigs were fed 1.60% lysine compared with 1.15%.

Similar to this experiment, other studies conducted to determine the lysine requirement of the postweaned pig have observed increases in average daily gain and gain:feed with lysine addition to the diet (Lewis et al., 1981; Aherne and Nielson, 1983; Martinez and Knabe, 1990; and Owen et al., 1994). Yet they differ in the level of lysine where optimum performance is observed. Most found growth rate and gain:feed were optimal at 1.15-1.25% of the diet. The experiment by Owen et al. (1994) recommended 1.70% lysine in the diet for segregated early weaned pigs, which more closely resembles the findings of this experiment.

Average daily feed intake was not affected (P>.10) by dietary lysine level during any phase of the trial, nor during the overall 42 d experiment. This is similar to studies conducted by Aherne and Nielson (1983) and Owen et al. (1994) who found no effect on average daily feed intake with increasing lysine level. In contrast, Lewis et al. (1981) observed a tendency for average daily feed intake to increase with addition of lysine, while Martinez and Knabe (1990) found a significant increase with increasing lysine level.

In conclusion, the results from this experiment indicate that an increase in lysine level from the addition of dietary whey protein concentrate improves pig

performance during d 0 to 14 of the nursery period. Maximum performance was observed at the 1.60% lysine level. Further studies are needed to determine if the increase in performance is due solely to the lysine level of the diet or partially from the use of whey protein concentrate as the lysine source of the diet. Also, additional research is necessary to determine the potential for the substitution of synthetic lysine for a portion of the protein ingredients used in this study.

## Literature Cited


Aherne, F. X. and H. E. Nielson. 1983. Can. J. Anim. Sci. 63:221.
Chung, T. K. and D. H. Baker. 1992. J. Anim. Sci. 70:3102.
Lewis, A. J. et al. 1981. J. Anim. Sci. 51:361.
Martinez, G. M. and D. A. Knabe. 1990. J. Anim. Sci. 68:2748.
NRC. 1988 (9th Ed.). National Academy Press, Washington, DC.
Owen et al. 1994. KSU Swine Day 1994. pp. 49-52.
SAS. 1985. SAS User's Guide: Statistics. SAS Inst., Inc., Cary, NC.

**Table 1. Composition of experimental diets.**[a]

| | Phase 1 | | | | Phase 2 | Phase 3 |
|---|---|---|---|---|---|---|
| **Ingredient,%** | 1.15 | 1.30 | 1.45 | 1.60 | 1.35 | 1.15 |
| Corn, ground | 35.55 | 35.55 | 35.55 | 35.55 | 55.075 | 68.97 |
| Lactose | 4.65 | 4.20 | 3.74 | 3.30 | 10.00 | - |
| Whey, dehyd | 20.00 | 20.00 | 20.00 | 20.00 | - | - |
| SBM, 48% CP | - | - | - | - | 22.25 | 27.50 |
| Soy oil | 4.00 | 4.00 | 4.00 | 4.00 | - | - |
| Steam-rolled oats | 10.00 | 10.00 | 10.00 | 10.00 | - | - |
| AP-301[b] | 1.50 | 1.50 | 1.50 | 1.50 | 2.00 | - |
| Fish meal | 6.57 | 6.57 | 6.57 | 6.57 | 5.00 | - |
| Soy prot conc | 2.67 | 2.67 | 2.67 | 2.67 | - | - |
| AP-920[c] | 3.50 | 3.50 | 3.50 | 3.50 | - | - |
| Micro curb | - | - | - | - | .10 | - |
| Lysine, HCl | - | - | - | - | .10 | .15 |
| WPC, 77% CP | - | 3.19 | 6.38 | 9.55 | - | - |
| Ethoxiquin | .03 | .03 | .03 | .03 | .03 | - |
| DL-Methionine | .09 | .10 | .08 | .09 | .12 | - |
| Neoterramycin | 1.00 | 1.00 | 1.00 | 1.00 | - | - |
| $CuSO_4$ | .07 | .07 | .07 | .07 | .05 | .08 |
| Ca carbonate | - | - | - | - | .27 | .60 |
| Vit. min. premix[d] | .38 | .38 | .38 | .38 | .25 | .25 |
| Dicalcium phos | 1.39 | 1.34 | 1.25 | 1.19 | 1.43 | 1.90 |
| Cornstarch | 4.00 | 2.65 | 1.34 | - | - | - |
| Sucrose | 4.00 | 2.65 | 1.34 | - | - | - |
| Salt | .20 | .20 | .20 | .20 | .30 | .42 |
| Flavor | .10 | .10 | .10 | .10 | - | - |
| Zinc oxide | .30 | .30 | .30 | .30 | .30 | - |
| Threonine | - | - | - | - | .05 | - |
| Tylan40-Sulfa | - | - | - | - | .125 | .125 |
| **Calculated composition** | | | | | | |
| Crude protein | 17.25 | 19.72 | 22.16 | 24.61 | 20.62 | 19.32 |
| Calcium | .92 | .92 | .92 | .92 | .80 | .82 |
| Phosphorus | .81 | .81 | .81 | .81 | .70 | .71 |
| Lactose | 18.00 | 18.00 | 18.00 | 18.00 | 9.90 | - |

[a] Diets were formulated on an as fed basis and to meet or exceed the NRC (1988) standards for all nutrients.

[b] Blood meal source, American Protein Corp., Ames, IA.

[c] Plasma protein source, American Protein Corp., Ames, IA.

[d] Vitamins and minerals meet or exceed the NRC (1988) requirements.

**Table 2. Performance of pigs fed increasing levels of dietary lysine from whey protein concentrate during Phase 1.**

| | Lysine level, % | | | | |
|---|---|---|---|---|---|
| **Item** | 1.15 | 1.30 | 1.45 | 1.60 | SEM |
| d 0 to 7 | | | | | |
| ADG, lb[b] | .46 | .49 | .54 | .65 | .04 |
| ADFI, lb | .53 | .51 | .51 | .55 | .03 |
| Gain:feed[b] | .87 | .96 | 1.04 | 1.18 | .04 |
| d 7 to 14 | | | | | |
| ADG, lb[b] | .76 | .87 | .95 | 1.01 | .03 |
| ADFI, lb | 1.10 | 1.13 | 1.14 | 1.11 | .04 |
| Gain:feed[b] | .69 | .77 | .83 | .92 | .03 |
| d 0 to 14 | | | | | |
| ADG, lb[b] | .61 | .68 | .74 | .83 | .03 |
| ADFI, lb | .81 | .82 | .83 | .83 | .04 |
| Gain:feed[b] | .78 | .87 | .93 | 1.05 | .02 |
| d 14 to 28 | | | | | |
| ADG, lb | 1.07 | 1.05 | 1.08 | 1.07 | .03 |
| ADFI. lb | 1.55 | 1.55 | 1.61 | 1.53 | .08 |
| Gain:feed | .69 | .68 | .67 | .69 | .03 |
| d 28 to 42 | | | | | |
| ADG, lb | 1.25 | 1.31 | 1.33 | 1.35 | .04 |
| ADFI,lb | 2.31 | 2.42 | 2.54 | 2.49 | .08 |
| Gain:feed | .55 | .54 | .52 | .54 | .02 |
| d 0 to 42 | | | | | |
| ADG, lb[b] | .98 | 1.01 | 1.05 | 1.08 | .02 |
| ADFI, lb | 1.56 | 1.60 | 1.66 | 1.62 | .05 |
| Gain:feed[b] | .67 | .70 | .71 | .76 | .01 |

[a] Data are means of 6 pens of 6 pigs each.

[b] Linear effect of increasing dietary lysine ($P<.002$).