DETERMINATION OF THE LYSINE REQUIREMENT IN SEGREGATED EARLY WEANED PIGS

J.S. Chung[1] , B.Z. de Rodas[2], C.V. Maxwell[3] and M.E. Davis[1]

Story in Brief

Two growth trials involving 140 weanling pigs were conducted to determine the dietary lysine requirement to maximize growth performance in segregated early-weaned pigs. Pigs were housed in an environmentally controlled off-site nursery. In Experiment 1, 60 pigs (14±2 days of age and 9.3 lb BW) penned in groups of three (5 pens per treatment) were used to evaluate four dietary lysine levels (1.30, 1.45, 1.60, and 1.75%). In Experiment 2, 80 pigs (14±2 days of age and 9.9 lb BW) penned in groups of four (4 pens per treatment) were used to evaluate five dietary lysine levels (1.30, 1.45, 1.60, 1.75, and 1.90%). Corn starch and sucrose were replaced by whey protein concentrate to increase lysine levels. Lactose content of all diets was 24%. Experimental diets were fed from day 0 to 14 postweaning, and then all pigs were fed a common transition diet (1.40% lysine) from day 14 to 28 and a Phase 2 diet (1.35% lysine) from day 28 to 42. Pigs in Experiment 2 were bled on day 14, 28 and 42 postweaning to determine urea N concentration. In Experiment 1 increasing dietary lysine improved average daily gain and gain:feed from day 0 to 7, and 0 to 14 postweaning linearly, (maximized at 1.75% dietary lysine). In Experiment 2 ADG and gain:feed increased with increasing dietary lysine during day 0 to 7, 0 to 14 and 0 to 42 postweaning. Both response criteria were maximized at 1.90% lysine. Concentration of blood urea nitrogen increased with increased dietary lysine. These results suggest that segregated early weaned pigs require at least 1.75% of total dietary lysine to optimize growth performance during day 0 to 14 postweaning.

(Key Words: Early-Weaned Pig, Lysine, Growth Performance.)

Introduction

This trial is the first step of a multi-phase study with the overall objective to determine the potential for substituting synthetic amino acids for dietary protein in segregated-early weaned (SEW) nursery diets. Recent trends in the swine industry have been toward earlier weaning with many systems routinely weaning pigs as early as 10 days of age in a segregated early weaning system and as early as 15 days of age in a traditional production system. Research at Iowa State University and Kansas State University with segregated early

[1]Graduate Student [2]Research Associate [3]Professor

weaned pigs suggests that the lysine requirement is much higher than levels recommended by NRC (1988). Furthermore, levels typically used in the industry are much higher than previously recommended. In typical feed formulations that utilize natural feed ingredients, there is usually an excess of many dispensable and indispensable amino acids. These excess amino acids have been suggested to depress animal performance, although no evidence for this is available for SEW pigs. In SEW diets the substitution of amino acids for protein offers the potential for improving performance as well as decreasing the inclusion level of expensive protein sources. Therefore, studies concerning the potential for replacing amino acids available at feed grade prices (lysine, methionine, threonine and tryptophan) in the diet of pigs weaned as early as 12 days of age are needed. First, the lysine requirement for segregated early-weaned pigs needs to be determined in our system. Therefore, the objective of this initial study was to determine the lysine requirement for segregated early-weaned pigs fed a high nutrient dense diet using whey protein concentrate as the source of amino acids.

Materials and Methods

Two trials involving a total of 140 weanling pigs were conducted to evaluate the dietary lysine requirement to maximize growth performance in segregated early-weaned pigs. In Experiment 1 a total of 60 pigs (14±2 days of age and 9.3 lb average initial body weight) were sorted by weight, and divided into five groups (blocks). Weight groups contained 12 pigs each. Pigs within each weight group were allotted into four equal subgroups (three pigs per pen) with stratification based on sex and litter. The pens within each of the five weight groups were randomly assigned to four dietary treatments (5 pens/treatment). Four dietary levels of lysine were used to estimate the lysine requirement of segregated early-weaned pigs. The four lysine levels were: 1.30, 1.45, 1.60, and 1.75% (Table 1). In Experiment 2 a total of 80 pigs (14±2 days of age and 9.9 lb) were sorted by weight and divided into four weight groups (blocks). Weight groups contained 20 pigs each. Pigs within each weight group were allotted into five equal subgroups (four pigs per pen) with stratification based on sex and litter. The pens within each of the four weight groups were randomly assigned to five dietary treatments (4 pens per treatment). Five dietary levels of lysine were used to determine the lysine requirement of segregated early-weaned pigs. The five lysine levels were: 1.30, 1.45, 1.60, 1.75, and 1.90% (Table 2). The different lysine levels in both trials were obtained by replacing corn starch and sucrose with whey protein concentrate. Lactose levels were maintained at 24% in all diets. Pigs in both trials were fed a common transition diet (1.40% lysine; Table 1) from day 14 to 28 and a common Phase 2 diet (1.35% lysine) from day 28 to 42 postweaning.

Pigs were housed in an environmentally controlled off-site nursery in pens with woven wire flooring. The initial temperature of 88°F was subsequently decreased 2°F per week. Pigs in each pen had ad libitum access to one nipple waterer and a three-hole feeder. Pig body weight and feed intake were determined weekly to evaluate average daily gain (ADG), average daily feed intake (ADFI), and gain:feed. Blood samples were taken via anterior vena cava puncture on d 14, 28 and 42 of the trial and serum was analyzed for urea N concentration using TheRoche® Reagent for BUN[1].

Performance data were analyzed according to a randomized complete block design with pen as the experimental unit and blocks based on initial BW. Analysis of variance was performed using the GLM procedures of SAS (1988), and orthogonal polynomials were evaluated. Blood urea nitrogen data were analyzed by split plot analysis of variance with treatment as the main plot and sampling day as a sub plot and all appropriate interactions.

Results and Discussion

In Experiment 1 from day 0 to 7 and 0 to 14 postweaning, ADG and gain:feed were improved linearly ($P<.01$) as dietary lysine increased (Table 3). Feed intake, however, was not affected by dietary lysine level. Pigs fed 1.75% dietary lysine grew 39% and 17% faster and gained 33% and 30% more per lb of feed than pigs fed 1.30% lysine during day 0 to 7 and 0 to 14 postweaning, respectively. From d 0 to 42 postweaning, gain:feed was improved linearly ($P<.01$), but ADG and ADFI were not affected ($P>.1$) by treatment.

In Experiment 2 from day 0 to 7 and 0 to 14 postweaning, ADG and gain:feed increased linearly ($P<.006$) as dietary lysine level increased (Table 4). Pigs fed 1.90% lysine grew 44% and 42% faster and gained 35% and 36% more per lb of feed than pigs fed 1.30% lysine during day 0 to 7 and 0 to 14 postweaning, respectively. Feed intake was not affected ($P>.46$) by dietary lysine levels. During the overall 42-day experimental period, a linear increase ($P<.006$) in ADG and gain:feed was observed with increasing dietary lysine in the diet. Pigs fed 1.90% lysine had 16% greater gains and gain:feed than those fed 1.30% lysine.

Research estimating the lysine requirement in segregated early weaning pigs is limited. The lysine requirement recommended by NRC (1988) for the 11 to 22 lb pig is 1.15%. However, Stahly et al. (1994) suggested that segregated early weaned pigs need much higher lysine requirements than levels recommended by NRC (1988) and indicated that feed efficiency was optimized by dietary lysine levels of 1.8% for high lean growth strains. Owen et al. (1994) reported that ADG from day 0 to 7 postweaning was maximized in pigs

[1]The Roche; Somerville, NJ

fed between 1.65 and 1.80% dietary lysine with the lowest gain:feed for pigs fed 1.95% lysine diet. In our studies, ADG and gain:feed during day 0 to 7 and 0 to 14 postweaning were maximized in pigs fed 1.75% lysine for Experiment 1 and 1.90% lysine for Experiment 2. Concentrations of blood urea nitrogen were also increased (linearly, $P<.01$) with increasing dietary lysine in the diet (Table 4). These results are in agreement with those reported by Owen et al. (1995) who found that plasma urea N increased with increasing dietary lysine from 1.40 to 1.80%. In general, the results of the present study suggest that segregated early-weaned pigs require at least 1.75% of total lysine to optimize growth performance during day 0 to 14 postweaning when whey protein concentrate serve as the lysine source.

Literature Cited

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Table 1. Composition of experimental diets (Experiment 1)[a]

	SEW diets, lysine %				Transit.	Phase 2
Ingredient, %	1.30	1.45	1.60	1.75	diet	diet
Corn, ground	28.37	28.37	28.37	28.37	48.79	55.08
Lactose	13.56	13.10	12.65	12.20	-	-
Soybean meal, 48%	12.00	12.00	12.00	12.00	20.00	-
Steam-rolled oats	-	-	-	-	12.75	22.25
Fish meal	10.00	10.00	10.00	10.00	-	-
WPC, 77%[b]	8.00	8.00	8.00	8.00	8.00	5.00
Corn starch	-	3.20	6.40	9.61	-	-
Sucrose	3.99	2.67	1.32	-	-	-
Dried skim milk	5.00	5.00	5.00	5.00	-	-
AP-301[c]	-	-	-	-	1.50	2.00
AP-920[d]	5.00	5.00	5.00	5.00	2.50	-
Egg protein	4.00	4.00	4.00	4.00	-	-
Soy oil	3.00	3.00	3.00	3.00	4.00	2.50
Calcium carbonate	-	-	-	-	.15	.27
Dical	1.07	1.00	.95	.85	.60	1.43
Lysine, HCl	.10	.10	.10	.10	-	.15
Threonine	.01	-	-	-	-	.05
Methionine	.09	.07	.07	.06	.10	.12
Neoterramycin[e]	1.00	1.00	1.00	1.00	1.00	-
Ethoxiquin	.03	.03	.03	.03	.03	.03
Flavor	.10	.10	.10	.10	-	-
Salt	-	-	-	-	.20	.30
Tylan 40-Sulfa[f]	-	-	-	-	-	.13
$CUSO_4$	-	-	-	-	-	.05
Zinc oxide	.30	.30	.30	.30	-	.30
Mico curb	-	-	-	-	-	.10
Vit. TM premix[g]	.38	.38	.38	.38	.38	.25
Biotin supplement	.001	.001	.001	.001	-	-

[a] As fed basis. Diets were formulated to contain 90% Ca and .79% P in SEW phase; 1.40% lysine, .85% Ca, and .75% P in transition phase; 1.35% lysine, .8% Ca, and .7% P in Phase 2, and to exceed the NRC (1988) standards for all nutrients.

[b] Whey protein concentrate, 77% CP.

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

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

[e] Contained 10 g of neomycin and 5 g of oxytetracline per lb.

[f] Contained 40 g tylosin and 40 g of sulfamethazine per lb.

[g] Vitamins and minerals met or exceeded the NRC (1988) requirements.

Table 2. Composition of experimental diets (Experiment 2)[a]

	SEW diet				
	Lysine, %				
Ingredient, %	1.30	1.45	1.60	1.75	1.90
Corn, ground	23.00	23.00	23.00	23.00	23.00
Lactose	6.81	6.35	5.90	5.45	5.02
Whey	21.96	21.96	21.96	21.96	21.96
Soybean meal, 48%	-	-	-	-	-
Steam-rolled oats	10.00	10.00	10.00	10.00	10.00
Fish meal	8.00	8.00	8.00	8.00	8.00
Whey protein conc.,77%	-	3.19	6.38	9.57	12.60
Corn starch	5.27	3.93	2.60	1.26	-
Sucrose	5.26	3.92	2.59	1.26	-
Dried skim milk	5.00	5.00	5.00	5.00	5.00
AP-920[b]	5.00	5.00	5.00	5.00	5.00
Egg protein	4.00	4.00	4.00	4.00	4.00
Soy oil	3.00	3.00	3.00	3.00	3.00
Calcium carbonate	.02	-	-	-	-
Dical	.80	.77	.71	.64	.57
Methionine	.07	.07	.05	.05	.04
Neoterramycin[c]	1.00	1.00	1.00	1.00	1.00
Ethoxiquin	.03	.03	.03	.03	.03
Flavor	.10	.10	.10	.10	.10
zinc oxide	.30	.30	.30	.30	.30
Vit. TM premix[d]	.38	.38	.38	.38	.38
Biotin supplement	.001	.001	.001	.001	.001

[a] As fed basis. Diets were formulated to contain .92% Ca and .8% P.
[b] Plasma protein source, American Protein Corp., Ames, IA.
[c] Contained 10 of neomycin and 5 g of oxytetracline per lb.
[d] Vitamins and minerals met or exceeded the NRC (1988) requirements.

Table 3. The effect of increasing dietary lysine on growth performance of segregated early weaned pigs (Experiment 1)[a].

	Lysine, %				
Item	1.30	1.45	1.60	1.75	SEM
Day 0 to 7					
ADG, lb[b]	.36	.44	.47	.50	.034
ADFI, lb	.43	.47	.47	.47	.033
Gain:feed[b]	.83	.94	.99	1.10	.031
Day 0 to 14					
ADG, lb[b]	.63	.72	.71	.74	.023
ADFI, lb	.79	.78	.73	.73	.029
Gain:feed[b]	.81	.92	.97	1.05	.02
Day 0 to 42					
ADG, lb	1.12	1.12	1.15	1.14	.018
ADFI, lb	1.53	1.50	1.59	1.52	.029
Gain:feed[b]	.75	.78	.78	.82	.007

[a] Data are means of 5 pens of 3 pigs each. Pigs averaged 9.3 lb and 57 lb at initiation and termination, respectively.

[b] Linear effect of increasing dietary lysine ($P<.01$).

Table 4. The effect of increasing dietary lysine on growth performance and blood urea N of segregated early-weaned pigs (Experiment 2)[a]

	Lysine, %					
Item	1.30	1.45	1.60	1.75	1.90	SEM
Day 0 to 7						
ADG, lb[b]	.41	.43	.53	.59	.59	.037
ADFI, lb	.44	.45	.46	.50	.47	.027
Gain:feed[b]	.92	.94	1.16	1.17	1.26	.05
Day 0 to 14						
ADG, lb[b]	.57	.66	.77	.78	.81	.040
ADFI, lb	.70	.75	.79	.76	.73	.038
Gain:feed[b]	.85	.90	1.03	1.07	1.16	.03
Day 0 to 42						
ADG, lb[b]	1.00	1.05	1.11	1.14	1.16	.039
ADFI, lb	1.36	1.42	1.44	1.48	1.46	.054
Gain:feed[b]	.76	.77	.83	.84	.88	.01
Blood Urea N, mg/dl						
Day 14	7.34	6.89	10.24	10.95	10.37	.89
Day 28	6.42	7.01	6.51	7.10	7.66	.92
Day 42	7.09	7.37	8.10	8.93	9.00	1.05
Overall[c]	6.95	7.09	8.29	8.99	9.01	.62

[a] Data are means of 4 pens of 4 pigs each. Pigs averaged 9.9 lb and 56 lb at initiation and termination, respectively.

[b] Linear effect of increasing dietary lysine (P<.006).

[c] Linear effect of increasing dietary lysine (P<.01).