EFFECT OF PROTEIN SOURCE ON RESPONSE OF NURSERY PIGS TO CRYSTALLINE AMINO ACID SUPPLEMENTATION[1]

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Story in Brief

A total of 48 pigs averaging 21 d of age and 13.9 lb were penned in groups of four (3 pens per treatment) and fed one of four dietary treatments to determine if protein source in the basal diet affected response to crystalline amino acid addition. Treatments were arranged as a 2 x 2 factorial and contained 1.4% digestible lysine. Each of two basal diets differing in protein source was supplemented with either whey protein concentrate or a mixture of crystalline amino acids to meet ideal protein requirements. Other protein sources present in basal diet 1 included 1.5% spray-dried blood meal, 3.5% spray-dried plasma protein, 6.57% select menhaden fish meal, and 2.67% soy protein concentrate. Protein sources in basal diet 2 included 5% wheat gluten, 1.6% spray-dried blood meal, 6.63% spry-dried plasma protein, 5% select menhaden fish meal, and .20% soybean meal (48%). Average daily gain and feed intake were greater for pigs fed whey protein concentrate than for pigs fed diets supplemented with crystalline amino acids from d 0 to 7, d 7 to 14, and d 0 to 14. However, these differences were greater from d 0 to 7 for pigs fed basal diet 1. Pigs fed whey protein concentrate during the initial two weeks of the study had greater growth rate and feed intake from d 14 to 28, however, G/F during this phase was greater for pigs fed diets containing crystalline amino acids than those fed crystalline amino acids. Average daily gain, ADFI, and G/F from d 28 to 42 were not affected by the diets fed during the initial phase of the experiment. However, ADG and ADFI for the entire 42-d experiment was greater for pigs fed whey protein concentrate than for those fed crystalline amino acids. This study suggests that pig response to the replacement of amino acids in whey protein concentrate with crystalline amino acids may be affected by the protein source in the basal diet.

(Key Words: Swine, Protein Source, Amino Acids.)

Introduction

A previous study conducted to determine the potential for the use of cystalline amino acids in the diets of phase 1 nursery pigs resulted in poor average daily gain and gain:feed when crystalline amino acids were used to achieve the same dietary lysine level as diets formulated with whey protein concentrate as the protein source. This is contrary to reports obtained from a similar study conducted at Kansas State University (Owen et al., 1995) which resulted in acceptable performance when diets containing wheat gluten were supplemented with crystalline amino acids.

A possible explanation for the inconsistent performance observed in the previous experiments is that the protein source used in the basal diet may affect the response to crystalline amino acid supplementation. In addition, crystalline amino acid diets may have been deficient in nonessential nitrogen needed for the synthesis of dispensable amino acids. Wang and Fuller (1989) suggested that the essential amino acid nitrogen:total nitrogen ratio should be maintained at 45:55. Another explanation is that the diets used in the previous study contained excessive amounts of methionine since the dietary requirement for the sulfur-containing amino acids (methionine and cystine) were met exclusively by addition of methionine. Chung and Baker (1992a) found that 50% of the sulfur amino acid requirement of 10- to 20-kg pigs can be supplied by cystine. Therefore, the specific objectives of this study were: 1) to compare the performance of pigs fed different basal diets supplemented with crystalline amino acids and 2) to determine if adjusting the essential amino acid:crude protein ratio to .50 improves the utilization of diets containing large amounts of crystalline amino acids, and if addition of each sulfur-containing amino acid to meet the ratio requirement results in improved pig performance compared to addition of only methionine.

Materials and Methods

A total of 48 pigs averaging 21 d of age and 13.9 lb were blocked by weight and stratified by litter and sex into 4 subgroups per block with 4 pigs/pen. Pens within each block were randomly assigned to one of four dietary treatments (Table 1) resulting in three pens/treatment. Dietary treatments were arranged as a 2 x 2 factorial consisting of two basal diets (Diets 1 and 2) and two lysine sources (Natural and Crystalline).

The factorially arranged treatments were formulated to contain 1.60% total lysine and consisted of 1) Diet 1 with whey protein concentrate as the amino acid source; 2) Diet 1 with the whey protein concentrate component replaced by a mixture of crystalline amino acids; 3) Diet 2 (similar to Diet 1 but with 5% wheat gluten, .20% soybean meal, and 6.6% plasma protein added at the expense of corn, fishmeal, and soy protein concentrate) with whey protein concentrate as the amino acid source; 4) Diet 2 with the whey protein concentrate component replaced by a crystalline amino acid mixture. Glutamic acid was added to each diet as needed to adjust the essential amino acid:crude protein ratio to .50 and methionine and cystine were added separately to meet ideal protein ratios according to Chung and Baker (1992b).

Treatment diets were fed for the first 14 d (Phase 1) postweaning, after which all pigs were fed common Phase 2 (d 14 to 28) and Phase 3 (d 28 to 42) diets to monitor any carryover effects from the treatments fed during Phase 1. Pig weight and feed intake were recorded weekly and ADG, ADFI, and G/F were calculated. Blood samples were obtained on d 14 of the study and serum was analyzed for blood urea nitrogen concentration. Pigs were housed in an environmentally controlled nursery with elevated pens (4□11"x 5") and woven wire flooring. Access to feed and water were available ad libitum from a 4-hole feeder and a nipple waterer. Temperature was maintained initially at 86° F and was decreased by 2° F weekly. until the temperature reached 78° F.

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 procedures of SAS (1988). The effects of basal diet, lysine source, and basal diet x lysine source interaction were evaluated.

Results and Discussion

From d 0 to 7, growth rate and feed intakes of pigs fed diets containing only natural sources of amino acids were greater ($P<.01$) than for those fed diets containing crystalline amino acids (Table 2). Pigs fed Diet 1 with only natural sources of amino acids utilized feed more efficiently than those fed Diet 1 with crystalline amino acids; however pigs fed Diet 2 with only natural sources of amino acids had similar G/F to those fed Diet 2 with crystalline amino acids (interaction, $P<.09$). Pigs fed only natural amino acids had greater average daily gain than those fed crystalline amino acids, however, these differences were much greater for pigs fed Diet 1 than for those fed Diet 2 during d 7 to 14 (interaction, $P<.04$) and during d 0 to 14 (interaction, $P<.09$). Feed intake was less during d 7 to 14 ($P<.05$) and during d 0 to 14 ($P<.01$) for pigs fed crystalline amino acids than those fed amino acids from natural sources. Gain:feed ratios during d 0 to 14 tended to be greater for pigs fed Diet 1 with amino acids from natural sources than for those fed Diet 1 with crystalline amino acids, although no differences were found in gain:feed ratios of pigs fed Diet 2 with only natural amino acids and pigs fed Diet 2 with crystalline lysine (interaction, $P<.08$). Blood urea nitrogen concentrations on d 14 were lower ($P<.01$) for pigs fed Diet 1 than for those fed Diet 2 and greater ($P<.01$) for pigs fed diets containing only natural amino acids than for those fed diets containing crystalline amino acids.

From d 14 to 28, feed intake of pigs previously fed diets containing only natural sources of amino acids was greater ($P<.05$) than for pigs fed diets containing crystalline amino acids. Gain:feed ratios, however, were greater ($P<.05$) for pigs fed diets containing crystalline amino acids than for those fed diets containing only natural sources of amino acids. Average daily gain, ADFI, and G/F from d 28 to 42 were not affected by the diets fed during the initial two weeks of the study. However, for the entire 42 d experiment, average daily gain and feed intake of pigs previously fed diets containing natural amino acid sources were greater ($P<.05$) than for pigs fed crystalline amino acids.

In the present study, diets formulated with crystalline amino acids failed to result in satisfactory pig performance when compared to diets formulated with whey protein concentrate. Glutamic acid supplementation to achieve an essential amino acid:crude protein ratio of .50 did not improve the response of pigs fed crystalline amino acid supplemented diets. These results were similar to those observed in a previous study (Davis, 1997) where crystalline amino acid supplemented diets with essential amino acid:crude protein ratios of .58 were fed. Roth et al (1994) found that although alanine, aspartic acid, glycine, and serine were completely dispensable in the growing pig, arginine, glutamic acid, and proline must be provided in minute amounts in the diet. In the present study, it is possible that crude protein levels were lowered enough in diets supplemented with crystalline amino acids that these amino acids may have been limiting. Similarly, substituting the sulfur amino acids separately to meet ideal protein ratios did not alter the response to crystalline amino acid addition observed in the previous study. In conclusion, substitution of a natural dietary protein source with crystalline amino acids did not produce satisfactory pig performance and response is dependent on protein source in the basal diet. Additionally glutamic acid supplementation and separate addition of methionine and cystine did not improve the poor response to crystalline amino acid supplementation observed in a previous study (Davis et al., 1996)

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Table 1. Composition of experimental diets[a].

	Basal Diet 1		Basal Diet 2		Phase 2	Phase 3
Ingredient,%	Natural	Crystalline	Natural	Crystalline	1.35	1.15
Corn, ground	34.31	32.15	33.00	37.67	55.075	68.975
Lactose	3.29	4.65	10.00	10.00	10.00	-
Whey, dehyd.	20.00	20.00	20.00	20.00	-	-
SBM, 48% CP	-	-	.20	.20	22.25	27.50
Soy oil	4.00	4.00	5.00	5.00	2.50	-

Steam-rolled oats	10.00	10.00	-	-	-	-
AP-301[b]	1.50	1.50	1.60	1.60	2.00	-
Fish meal	6.57	6.57	5.00	5.00	5.00	-
Soy prot. conc.	2.67	2.67	-	-	-	-
AP-920[c]	3.50	3.50	6.63	6.63	-	-
Micro curb	-	-	-	-	.10	-
Lysine, HCl	-	.55	-	.59	.15	.15
WPC[d] 77% CP	9.60	-	10.26	-	-	-
Wheat Gluten			5.00	5.00		
Ethoxiquin	.03	.03	-	-	.03	-
Isoleucine	-	.30	-	.27	-	-
Threonine	-	.29	-	.20	.05	-
Valine	-	.12	-	-	-	-
Tryptophan	-	.10	-	.05	-	-
DL-Methionine	.06	.22	.03	.12	.12	-
Cystine	-	.17	-	.11		
Glutamic acid	1.22	3.35	-	1.56	-	-
Neoterramycin	1.00	1.00	1.00	1.00	-	-
CuSO4	.07	.07	-	-	.05	.08
Ca carbonate	-	-	-	-	.27	.60
Vit. min. premix[e]	.38	.38	.40	.40	.25	.25
Dicalcium phos.	1.20	1.39	1.50	1.70	1.43	1.90
Cornstarch	-	3.20	-	2.52	-	-

Sucrose	-	3.19	-	-	-	-
Salt	.20	.20	-	-	.30	.42
Flavor	.10	.10	-	-	-	-
Zinc oxide	.30	.30	.38	.38	.30	-
Tylan40-Sulfa	-	-	-	-	.125	.125

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] Whey protein concentrate, Land O□Lakes, Fort Dodge, IA.

eVitamins and minerals meet or exceed the NRC (1988) requirements.

Table 2. Effect of diet and lysine source (Natural or Crystalline) on weanling pig performance and blood urea nitrogen (BUN)

	Basal Diet 1		Basal Diet 2		P Value			
Item	Natural	Crystalline	Natural	Crystalline	Diet	Source	Diet x Source	SEM
d 0 to 7								
ADG, lb	.73	.41	.67	.43	.709	.0005	.433	.03
ADFI, lb	.66	.49	.69	.44	.826	.0011	.319	.04
Gain:feed	1.10	.83	.97	.97	.881	.055	.083	.05
d 7 to 14								
ADG, lb	.96	.66	.81	.72	.345	.002	.035	.05

ADFI, lb	1.18	.90	1.06	.88	.414	.029	.544	.07
Gain:feed	.81	.73	.76	.81	.772	.809	.293	.06
d 0 to 14								
ADG, lb	.84	.53	.74	.57	.438	.0004	.084	.03
ADFI, lb	.92	.69	.88	.66	.424	.0030	.897	.06
Gain:feed	.92	.76	.84	.86	.783	.120	.076	.04
d 14 to 28								
ADG, lb	1.28	1.21	1.35	1.26	.166	.082	.928	.05
ADFI. lb	1.86	1.62	1.91	1.73	.220	.012	.593	.08
Gain:feed	.69	.75	.71	.73	.767	.011	.153	.05
d 0 to 42								
ADG, lb	1.14	1.02	1.19	1.05	.395	.024	.841	.03
ADFI, lb	1.77	1.57	1.82	1.64	.327	.013	.858	.09
Gain:feed	.65	.65	.65	.64	..753	.502	.499	.03
BUN, mg/dl	6.57	1.75	11.35	4.69	.0008	.0001	.188	.34

[a] Data are means of 3 pens/treatment with 6 pigs/pen.
