HIGH QUALITY PROTEIN VS CRYSTALLINE AMINO ACIDS AS AN AMINO ACID SOURCE FOR SEGREGATED EARLY WEANED PIGS

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Story in Brief

A total of 80 pigs (14± 2 d of age and 4.7 kg BW) were used to evaluate the efficacy of whey protein concentrate (WPC) or a mixture of crystalline amino acids (CAA) at two lysine levels on performance and blood urea N of segregated early weaned pigs. Pigs were housed in an off-site nursery with 4 pigs per pen and 4 pens per treatment and were assigned to five dietary treatments arranged as a 2x2 factorial with a negative control (1.12% digestible lysine and no WPC). The factorially arranged treatments consisted of two lysine levels (1.40 and 1.68% digestible lysine) with WPC as a source of amino acids or the the WPC component replaced by an ideal mixture of CAA. Experimental diets were fed from d 0 to 14 postweaning, then all pigs were fed common diets. From d 0 to 14, pigs fed the negative control diet had lower gains and gain:feed than those fed WPC or CAA. Pigs fed WPC grew faster than pigs fed CAA. Gain:feed increased with increasing lysine level in the WPC diets and decreased with increasing lysine level in the CAA diets. For the entire 42-d experiment, pigs fed WPC grew faster and were more efficient than pigs fed the negative control, and pigs fed WPC were more efficient than pigs fed CAA. There was an increase in blood urea N concentrations (d 14) with increasing lysine levels in the WPC diets, but a decrease in blood urea N with increasing lysine levels in the CAA diets. These data indicate that adding CAA to the diet of segregated early weaned pigs improved performance when compared to pigs fed a low protein negative control diet, but did not produce equivalent performance when compared to pigs fed WPC.

(Key Words: Early-Weaned Pig, Protein Source, Amino Acids.)

Introduction

Previous research at Oklahoma State University to determine the lysine requirements of segregated early weaned pigs fed a high nutrient dense diet with whey protein concentrate (WPC) as the supplemental source of amino acids resulted in a linear increase in growth performance with increasing lysine levels in the diet from 1.30 to 1.90 % in .15% increments of total lysine (Chung et al., 1996). However, the question remains whether this improvement in performance was due to the lysine concentration of whey protein concentrate or was due to component(s) other than lysine present in whey protein concentrate. Cinq-Mars et al. (1986) reported that the inclusion of whey protein up to 33.7% (of the dry matter) in corn-soybean meal diets for early weaned pigs (3 to 4 weeks of age) resulted in improved gain and efficiency of gain. Mahan (1992) indicated that the inclusion of high-quality dried whey in the diet of weanling pigs resulted in improved performance and suggested that the lactose component of dried whey, not protein was the primary component that improved postweaning performance. Therefore, the objective of this study was to evaluate the efficacy of WPC and a mixture of crystalline amino acids (CAA) at two lysine levels on performance and blood urea N (BUN) of segregated early weaned pigs (SEW).

Materials and Methods

A total of 80 weanling pigs (14± 2 d of age and 4.7 kg) 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). Treatments were arranged as a 2 x 2 factorial with a negative control. The negative control was formulated to contained 1.12% digestible lysine and no whey protein concentrate. The factorially arranged treatments consisted of two dietary lysine levels (1.40 and 1.68% digestible lysine) with WPC as a source of amino acids or the WPC component replaced by an ideal mixture of CAA (Chung and Baker, 1992).

From d 0 to 14 postweaning, all diets contained 8% select menhaden fish meal, 5% dried skim milk, 5% spray-dried plasma protein, 4% egg protein, and 22% dried whey (Table 1). The lysine levels were achieved by increasing the amount of whey protein concentrate or crystalline amino acids at the expense of corn starch and sucrose. Lactose content of all diets was 24%. All pigs were fed a common transition diet (1.40% total lysine; Table 2) from d 14 to 28 and a common phase 2 diet (1.35% total lysine) from d 28 to 42 postweaning.

Pigs were housed in an environmentally controlled off-site nursery in pens with woven wire flooring. The initial temperature of 31°C was subsequently decreased 1°C 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 feed efficiency (G:F). Blood samples were taken via anterior vena cava puncture on day 14 of the trial and serum was analyzed for urea N concentration.

Data were analyzed as 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). A comparison of the negative control versus the average of the diets containing WPC and the negative control versus the average of the diets containing a mixture of CAA were made. Also, the effects of lysine source, lysine level, and the lysine source x lysine level interaction were evaluated.

Results and Discussion

From d 0 to 14 postweaning, pigs fed the control diet had lower ($P<.01$) ADG and G:F than the average of pigs receiving WPC, and lower ADG and G:F ($P<.09$ and $P<.01$, respectively) than the average of pigs receiving the CAA diets (Table 3). Pigs given the diets containing WPC had greater gains ($P<.05$) than those receiving the diets containing CAA. Gain:feed increased with increasing lysine level in the WPC diets, but decreased with increasing lysine level in the CAA diets (interaction, P<.05). Average daily feed intake was not significantly affected by dietary treatments.

From d 14 to 28, performance was similar among pigs previously fed the varying levels of dietary protein and lysine. From d 28 to 42, ADG of pigs previously fed 1.40% digestible lysine was greater (P<.06) than for pigs previously fed 1.68% digestible lysine. For the entire 42-day experiment ADG and G:F of pigs fed diets containing WPC during the initial 2 weeks of the study were greater (P<.05 and P<.01, respectively) than for pigs fed the control diet. Pigs fed the WPC diets had greater (P<.05) G:F than pigs fed the CAA diets. Pigs fed the control diet had lower (P<.01) BUN than the average of pigs fed the WPC diets and higher (P<.01) BUN than the average of pigs fed the CAA diets. There was an increase in BUN concentrations when lysine levels increased in the WPC diets, but a decrease in BUN when lysine levels increased in the CAA diets (interaction, P<.05)

Research estimating the lysine requirement in segregated early weaned (SEW) pigs is limited. The lysine requirement recommended by NRC (1988) for the 5 to 10 kg pig is 1.15%. However, Stahly et al. (1994) suggested that segregated early weaned pigs need much higher lysine levels than those recommended by NRC (1988) and indicated that feed efficiency was optimized by dietary lysine levels of 1.80% for high lean growth pigs. Chung et al. (1996) also indicated that ADG and gain:feed of SEW pigs increased linearly as total lysine level increased from 1.30 to 1.90% when WPC serve as the lysine source. In the present study, however, gain:feed during the first 14 d postweaning increased with increasing lysine levels in pigs fed WPC based diets, but decreased with increasing lysine levels in pigs fed CAA diets. These results are contrary to the findings of Owen et al. (1995) who reported that ADG and feed efficiency of SEW pigs improved during the first two weeks postweaning when L-lysine HCl was used to obtained 1.80% total lysine. Stables and Carr (1979), on the other hand, reported that feed refusals were more common with addition of L-lysine HCl and/or DL-methionine to corn-meat and bone meal diets fed to growing pigs, but this depression in feed intake was alleviated with the addition of tryptophan. Fickler et al. (1994) reported a 24% decrease in growth rate of 10-kg pigs fed a chemically defined diet containing essential amino acids as recomended by Chung and Baker (1992) and a complete mixture of nonessential amino acids when compared to pigs fed the control diet containing grains, soybean meal, fish meal and skim milk as the source of amino acids.

Although, there has been some success with small additions of CAA to replace limited amounts of natural protein sources, there have been reductions in performance associated with higher levels of substitutions. In our study, additions of CAA to the diet of SEW pigs improved performance when compared to pigs fed the low protein negative control diet, but depressed performance when compared to pigs fed the higher lysine WPC diets. In general, the results of the present study indicate that adding CAA to the diet of SEW pigs improved performance when compared to pigs fed a low protein negative control diet, but did not produce equivalent performance when compared to pigs fed WPC.

Literature Cited

Cinq-Mars, D. et al. 1986. J. Anim. Sci. 63:145.

Chung, J.S. et al. 1996. Okla. Agr. Exp. Sta. P-951:258.

Chung, T. K. and D. H. Baker. 1992. J. Anim. Sci. 70:3102.

Fickler, J. et al. 1994. J. Anim. Physiol. and Anim. Nutr. 72:207.

Mahan, D. C. 1992. J. Anim. Sci. 70:2182.

NRC. 1988. National Academy Press, Washington, DC.

Owen, K.Q. et al. 1995. J. Anim. Sci. 73:68 (Suppl. 1).

SAS. 1988. SAS/STAT® User□s Guide (Release 6.03) SAS Inst. Inc., Cary, NC.

Stables, N. J. and Carr. 1979. J. Agri. Res. 19:311.

Stahly, T.S. et al. 1994. J. Anim. Sci. 72, suppl. 1:165.

Table 1. Diet composition (%), as fed basis.

		Segregated early weaned diets[a]				
	Lys source	Control	WPC[b]		CAA[b]	
Item	Dig. Lys, %[c]	1.12	1.40	1.68	1.40	1.68
Yellow corn		23.00	23.00	23.00	23.00	23.00
Lactose		6.80	5.90	5.02	6.80	6.80
Dehydrated whey		21.96	21.96	21.96	21.96	21.96
Steam-rolled oats		10.00	10.00	10.00	10.00	10.00

Menhaden fish meal	8.00	8.00	8.00	8.00	8.00
WPC, 77% CP[b]	-	6.36	12.62	-	-
Corn starch	5.28	2.62	-	4.79	4.03
Sucrose	5.28	2.62	-	4.78	4.02
Dried skim milk	5.00	5.00	5.00	5.00	5.00
AP-920[d]	5.00	5.00	5.00	5.00	5.00
Egg protein	4.00	4.00	4.00	4.00	4.00
Soybean oil	3.00	3.00	3.00	3.00	3.00
Calcium carbonate	.02	-	-	.02	.03
Dicalcium phosphate	.80	.71	.57	.82	.79
Lysine.HCl	-	-		.35	.71
Threonine	-	-	-	.18	.36
Tryptophan	.01	-	-	.06	.11
Methionine	.04	.02	.02	.20	.36
Tyrosine	-	-	-	-	.05
Phenylalanine	-	-	-	-	.07
Valine	-	-	-	.05	.24
Leucine	-	-	-	-	.21
Isoleucine	-	-	-	.16	.33
Histidine	-	-	-	.02	.12
Neoterramycin[e]	1.00	1.00	1.00	1.00	1.00
Ethoxiquin	.03	.03	.03	.03	.03
Berry flavor	.10	.10	.10	.10	.10

Zinc oxide	.30	.30	.30	.30	.30
Vitamin-min. premix[f]	.38	.38	.38	.38	.38
Biotin supplement	.001	.001	.001	.001	.001
[a]Diets were formulated to contain .90% Ca and .79% P and to exceed the NRC (1988) standards for all nutrients.					
[b]WPC: whey protein concentrate; CAA: crystalline amino acid mixture.					
[c]Dig. Lys: digestible lysine.					
[d]Plasma protein source, American Protein Corp., Ames, IA.					
[e]Contained 22.04 g of Neomycin and 11.02 g of Oxytetracycline per kg.					
[f]Vitamins and minerals met or exceeded the NRC (1988) requirements.					

Table 2. Composition of transition and phase 2 diets[a].

	Diets	
Ingredient, %	Transition	Phase 2
Yellow corn	48.79	55.075
Lactose	-	10.00
Dehydrated whey	20.00	-
Soybean meal, 48% CP	12.75	22.25
Menhaden fish meal	8.00	5.00
AP-920[b]	2.50	-

AP-301[b]	1.50	2.00
Soybean oil	4.00	2.50
Calcium carbonate	.15	.27
Dicalcium phosphate	.60	1.43
Lysine.HCl	-	.15
Threonine	-	.05
Methionine	.10	.12
Neoterramycin[c]	1.00	-
Ethoxiquin	.03	.03
Sodium chloride	.20	.30
Tylan 40-sulfa[d]	-	.125
Cooper sulfate.5H_2O	-	.05
Zinc oxide	-	.30
Micro curb	-	.10
Vit. TM premix[e]	.38	.25

[a]As fed basis. Diets were formulated to contain 1.40% lysine, .85% Ca and .75% P in transition phase; 1.35% lysine, .80% Ca, and .70% P in phase 2, and to exceed the NRC (1988) standards for all nutrients.

[b]AP-920: spray-dried plasma protein; AP-301: spray-dried blood meal; American Protein Corp., Ames, IA.

[c]Contained 22.04 g of Neomycin and 11.02 g of Oxytetracycline per kg.

[d]Contained 88.18 g of Tylosin and 88.18 g of Sulfamethaszine per kg.

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

Table 3. Effect of lysine source and level on performance and blood urea N of segregated early weaned pigs[a].

	Lys source	Control		WPC[b]			CAA[b]		
Item	Dig. Lys, %[b]	1.12		1.40	1.68		1.40	1.68	SEM
d 0 to 14									
ADG, g[cfi]		207		279	287		262	226	16
ADFI, g		285		305	284		296	259	20
G:F[dfh]		.72		.92	1.01		.90	.87	.02
d 14 to 28									
ADG, g		469		501	501		481	494	20
ADFI, g		612		636	617		627	659	34
G:F		.76		.78	.82		.77	.75	.02
d 28 to 42									
ADG, g[e]		560		670	604		657	593	31
ADFI, g		836		887	839		908	901	59
G:F		.76		.78	.74		.73	.68	.05
d 0 to 42									

ADG, g[g]		425		484	464		467	438	15
ADFI, g		578		609	580		610	606	34
G:F[cf]		.75		.83	.86		.80	.77	.02
BUN, mg/dl[bdfh]		7.8		9.2	11.3		3.3	2.4	.7
aData are means of 4 pens of 4 pigs each. Pigs averaged 4.7 and 23.9 kg at initiation and termination, respectively.									
bWPC: whey protein concentrate; CAA: crystalline amino acids; BUN:blood urea nitrogen; Dig: digestible.									
cWPC vs CAA (P<.05).									
dLysine source x lysine level interaction (P<.05).									
eLysine level effect (P<.06).									
fControl vs WPC (P<.01).									
gControl vs WPC (P<.05).									
hControl vs CAA (P<.01).									
iControl vs CAA (P<.09).									

1997 Research Report