EFFECT OF IDEAL PROTEIN DIET FORMULATION ON PIG PERFORMANCE DURING PHASE 2 OF THE NURSERY PERIOD

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Story in Brief

The effect of diet formulation based upon ideal protein calculated requirements was studied utilizing 71 early weaned pigs averaging 22.5 days of age. All pigs were fed a common Phase 1 diet containing 1.50% lysine and 19.66% crude protein for the first 10 days following weaning. During Phase 2, pigs (average initial weight of 19.9 lb) were fed one of the following diets: 1) the control diet (Treatment 1), which produced optimum performance in an earlier trial and contained 1.40% lysine from natural protein sources; 2) as Treatment 1 plus .13% synthetic methionine (Treatment 2); 3) a reduced protein diet (1.29% lysine from natural protein sources) plus .14% added L-lysine HCL (making it equivalent to 1.40% total lysine) with .04% threonine added (Treatment 3); 4) as Treatment 3 but with synthetic methionine added to meet the calculated ideal amino acid requirements. Average daily gain and average daily feed intake were similar among treatments. Treatment 4 had a 10.8% greater gain:feed than Treatment 1 in the total 4-wk experiment. During wk 2 both treatments that were deficient in methionine (Treatments 1 and 3) had poorer gain:feed than Treatment 4 which met the ideal amino acid requirements. During wk 3, the two diets in which natural lysine composed all of the 1.40% total lysine requirement (Treatments 1 and 2) had lower gain:feed than the 1.29% natural lysine diets with added lysine-HCL (Treatments 3 and 4). This study indicates that formulating diets to meet ideal protein calculated ratios will result in a small improvement in gain and a significant improvement in efficiency in the 20 to 44 lb pig.

(Key Words: Pig, Ideal Protein, Amino Acids, Methionine.)

Introduction

In typical feed formulations that utilize natural feed ingredients there is usually an excess of many dispensable and indispensable amino acids. This oversupply of amino acids is not only wasteful, because the animal does not have the potential to convert the extra amino acids into body proteins, but has been suggested to depress performance (Kerr, 1988). Properly balanced diets have been shown to have a large impact on feed intake, growth rate, and carcass composition. Similarly, excesses of amino acids have been shown to be

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detrimental to animal performance (Edmonds et al., 1987). In 1981 the ARC (1981) proposed an ideal protein for growing swine in which indispensable amino acids were listed as ratios to (percentage of) lysine. The concept suggests that once requirements are determined for lysine, other amino acids would be required in proportions dictated by ratios in the ideal protein. Chung and Baker (1992) developed an ideal protein amino acid pattern for the 20 to 44 lb pig and compared performance of pigs fed the ideal protein pattern with performance of pigs fed several suggested patterns. Patterns tested were the Illinois final amino acid pattern (Chung and Baker, 1991), the Wang and Fuller ideal amino acid pattern (Wang and Fuller, 1989), the Illinois ideal amino acid pattern (IIP, Chung and Baker, 1992), and the 1988 National Research Council (NRC, 1988) amino acid requirement pattern for 22 lb pigs. Although the ideal protein concept suggests that performance should be enhanced in pigs fed diets based upon the ideal amino acid composition, this has not been demonstrated in practical swine diets. This study was conducted to determine the effect of diet formulation of practical swine diets based on the Chung and Baker (1992) ideal protein composition. The 1.40% total lysine diet from natural protein sources that optimized gain, feed intake, and feed efficiency during Phase 2 of the nursery period (Rose et al., 1994) was used as the control diet. Calculations, based upon the Chung and Baker (1992) IIP pattern of indispensable amino acids, indicate that methionine was deficient in this diet, therefore methionine was added to the 1.40% lysine diet to determine if performance was enhanced by methionine addition. In addition, protein level was then reduced in the control diet by changing the ratio of corn to soybean meal (to the point where the fourth limiting amino acid requirement, isoleucine, was met) and lysine and threonine or lysine, threonine and methionine was supplemented. Therefore specific objectives of this study were to 1) determine if methionine is limiting in a 1.40% lysine diet which produced optimum performance (Rose et al., 1994); and 2) determine if reduced protein diets formulated to meet the Chung and Baker (1992) ideal indispensable amino acid pattern utilizing crystalline amino acids will improve performance in Phase 2 nursery diets.

Materials and Methods

A total of 71 Yorkshire, Hampshire and Crossbred (Yorkshire x Hampshire) pigs were used in this 28-day study to determine the effect of ideal protein diet formulation on performance. The pigs were weaned at an average of 22.5 days of age (ranging from 19 to 25 days) and averaged 13.4 lb body weight. Pigs were stratified by litter, weight and sex (boars and gilts) into 12 pens with six pigs in a pen. Pens were randomly allotted to one of four treatments (3 pens/treatment). The experiment was conducted as a completely randomized design in which pen was the experimental unit. All pigs were fed a common Phase 1 diet containing 1.50% lysine and 19.66% crude protein for

the first ten days following weaning. During Phase 2 (average initial weight of 19.9 lb) pigs were fed one of the following diets: 1) The control diet (Treatment 1, Tables 1 and 2) which produced optimum performance in previous studies (Rose et al., 1994) and contained 1.40% lysine from natural protein sources; 2) as Treatment 1 plus .13% synthetic methionine was added to meet the methionine requirement based upon the IIP ratio of indispensable amino acids by Chung and Baker (1992, Treatment 2); 3) a reduced protein diet (1.29% lysine from natural protein sources) plus .14% added L-lysine HCL (making it equivalent to 1.40% total lysine) with .04% threonine added to meet the ideal protein requirement based upon the IIP ratio of indispensable amino acids (Treatment 3); and 4) as Treatment 3 plus .16% methionine added to meet the calculated ideal amino acid requirements (IIP) for all amino acids. The Treatment 3 ration is adequate in all indispensable amino acids when compared to the IIP ratios except for a .16% deficiency in methionine. All four diets contained .90% calcium and .75% phosphorus which exceeds current NRC (1988) requirements. Pigs were allowed ad libitum access to diets and water throughout the experiment.

Pigs were housed in an environmentally controlled nursery in elevated pens with woven wire floors, nipple waterers and open front self-feeders. The environmental temperature was initially 86°F, with a 2°F reduction in temperature each week until the temperature reached 78°F. Interim gain and efficiency of gain estimates were obtained weekly. The trial was analyzed as a 2 x 2 factoral experiment to evaluate the efficacy of added methionine and/or protein.

Results and Discussion

Average daily gain was not affected by adding synthetic methionine or reducing crude protein (Table 2). Average daily feed intake was only affected in wk 3 when pigs fed the reduced protein diets consumed less ($P<.05$) than those fed the higher protein diet. Pigs fed the diets with added methionine during wk 2 ($P<.04$), 3 ($P<.10$), and 4 ($P<.06$) utilized feed more efficiently than those fed diets calculated to be deficient in methionine. In the overall 28-day trial, pigs fed diets with added methionine to meet the IIP designated ratios gained weight more efficiently ($P<.03$) when compared to those fed diets calculated to be deficient in methionine. In addition, those fed the reduced protein diets with added synthetic amino acids utilized feed more efficiently ($P<.08$) than those fed the slightly higher protein diet.

The suggestion that excess amino acids contribute to pollution in the environment through the release of excess nitrogen in the form of nitrates and may depress animal performance has resulted in research to determine the efficacy of low-protein, amino acid-supplemented diets for swine. This has led to the conclusion that minimum levels of amino acids must be present for maximum growth and proper ratios of amino acids must be present for

Table 1. Composition of experimental diets used to determine the effect of ideal protein formulation on pig performance[a]

	Phase 1 diet	Phase 2 diet			
		Treatment			
Ingredient		1	2	3	4
AP300		2.75	2.75	2.75	2.75
AP820	5.00				
Whey, dehydrated	20.00	5.00	5.00	5.00	5.00
Dried skim milk	10.00				
SBM,44%		27.75	27.75	23.80	23.80
Corn, ground	38.67	58.50	58.37	62.20	62.04
Oats, steam rolled	10.00				
Soybean oil	4.00				
Pro-88	5.00				
Fishmeal, menhaden	5.00	3.00	3.00	3.00	3.00
Lysine, HCL	.28			.14	.14
DL-Methionine	.02		.13		.16
Threonine				.04	.04
Mecadox-10	.25				
Tylan 40		.125	.125	.125	.125
Turbozyme-160	.20				
Flavor, berry	.10				
Salt		.40	.40	.40	.40
Copper sulfate	.08	.075	.075	.075	.075
Calcium carbonate		.47	.47	.45	.45
Dicalcium phosphate	.90	1.55	1.55	1.64	1.64
Vitamin TM PMX [b]	.38	.38	.38	.38	.38
Special premix	.12				
Calculated composition					
Lysine	1.50	1.40	1.40	1.40	1.40
Crude protein	19.66	22.16	22.28	20.85	20.99
Calcium	.90	.90	.90	.90	.90
Phosphorus	.79	.75	.75	.75	.75
M.E. (Kcal/lb)	1582.46	1474.66	1472.64	1476.19	1473.70
Tryptophan	.26	.30	.30	.28	.28
Threonine	.93	.92	.92	.91	.91
Met & Cyst	.76	.71	.84	.68	.84

[a] As fed basis.
[b] See Rose et al., 1994.

Table 2. Effect of diet formulation based on ideal protein composition on average daily gain, average daily feed intake and feed efficiency[a].

Item	Treatments 1	2	3	4	SEM
No. of pigs	17	18	18	18	—
Average daily gain					
Week 1	.71	.78	.82	.73	.18
Week 2	1.21	1.29	1.18	1.43	.23
Week 3	1.50	1.46	1.52	1.50	.08
Week 4	1.37	1.48	1.50	1.52	.15
Overall (wk 1-4)	1.19	1.26	1.25	1.30	.11
ADFI					
Week 1	1.25	1.20	1.27	1.29	.11
Week 2	1.70	1.69	1.68	1.67	.17
Week 3[b]	2.48	2.29	2.26	2.22	.11
Week 4	2.47	2.50	2.56	2.50	.16
Overall (wk 1-4)	1.96	1.92	1.94	1.92	.11
G:F					
Week 1	.566	.655	.650	.560	.0550
Week 2	.710	.762	.700	.855	.042
Week 3[c]	.621	.640	.671[d]	.680[d]	.0075
Week 4[c]	.522	.596	.586	.611	.0160
Overall (wk 1-4)[e]	.610	.655	.646	.676[d]	.0141

[a] Least squares means.
[b] Protein effect, P<.05.
[c] Methionine effect, P<.1.
[d] Means with a superscript differ from Treatment 1 (P < .05).
[e] Methionine effect, P<.05.

maximum feed efficiency. This study suggests that the formulation of practical Phase 2 (22 to 44 lb) nursery diets may not affect gain, but significantly (10.8% overall for the four week trial) improve feed efficiency.

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