EFFECTS OF LOW-PROTEIN, AMINO ACID-FORTIFIED DIETS, FORMULATED ON A NET ENERGY BASIS, ON THE GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF FINISHING PIGS [1]

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Summary

Two hundred eighty-eight gilts were used to determine the effects of corn-soybean meal or low-protein, amino acid-fortified diets, formulated on a net energy (NE) basis on growth performance and carcass characteristics. Pigs fed high NE grew faster from 105 to 165 lb. However, pigs fed diets with intact protein grew faster and more efficiently during the finishing period and for the entire trial than those fed low protein, amino acid-fortified diets. Carcass data revealed that pigs consuming high NE were fatter and had lower percentage lean than pigs consuming low NE. Additionally, longissimus muscle area tended to be greater in pigs fed diets containing intact protein than pigs fed low protein, amino acid-supplemented diets. Based on these results, pigs fed low protein, amino acid-fortified diets had poorer ADG, feed efficiency, and carcass leanness than those fed diets with intact protein, regardless of NE.

(Key Words: Growing-Finishing Pigs, Net Energy.)

Introduction

Recent decreases in prices have increased the interest in replacing soybean meal with synthetic amino acids. However, research has shown that pigs fed low protein, amino acid-fortified diets generally have poorer carcass characteristics than those fed intact protein (soybean meal). None of the previous research has examined the role of energy, specifically net energy (NE), in low protein, amino acid-fortified diets. Soybean meal has a lower NE value than synthetic amino acids and corn. Therefore, replacing soybean meal with synthetic amino acids and corn would result in diets with a greater NE content. With this in mind, the objective of this experiment was to determine the effects of low protein, amino acid-fortified diets, formulated on an NE basis, on growth performance and carcass characteristics of growing-finishing pigs.

Procedures

Two-hundred eighty-eight crossbred gilts (PIC L326 × C22, initially 106 lb) were used. Diets were fed in two phases: growing (105 to 165 lb) and finishing (165 to 245). They were formulated to contain .75 and .55 % apparent digestible lysine, respectively (Table 1). All diets were corn-soybean meal based and were fed in a meal form. Treatments were arranged in a 2 × 2 factorial. Main effects included NE level and protein source. The low NE growing and finishing diets contained 1.14 and 1.17 Mcal NE/lb, respectively; and the high NE growing and finishing diets contained 1.17 and 1.20 Mcal NE/lb, respectively. Protein was provided from soybean meal in the intact protein diets, and crystalline amino acids were used in the amino acid-fortified diets. Low protein, amino acid-fortified diets were formulated to meet true and apparent digestible amino acid requirements using the Illinois ideal amino acid ratio. Soybean oil (1.20 to 2.6%) was added to the corn-soybean meal diets to

[1]The authors thank Nutri-Quest Inc. and BioKyowa Inc., Chesterfield, MO for providing the amino acids used for this project.

provide identical NE concentrations as the low protein, amino acid-fortified diets. Pigs were blocked by weight and ancestry and allotted to one of the four dietary treatments.

The pigs were housed in a modified open-front finishing barn with 6 ft × 16 ft partially slatted pens. Each pen had nine pigs and contained a single two-hole feeder and a nipple waterer to allow ad libitum access to feed and water. Drip coolers were activated when temperatures exceeded 80°F, cycling on 3 out of every 15 min. This trial was conducted in two stages of four replicates. The first four replicates were fed from May to July, and the second four from June to August. Pigs and feeders were weighed every 14 d to calculate ADG, ADFI, and F/G. Pigs were scanned ultrasonically to determine body composition when their mean pen weight reached 250 lb. Additionally, 184 pigs were slaughtered at a commercial packing facility to collect carcass data.

The data from this trial were analyzed with the GLM procedure of SAS. The statistical model included main and interactive effects of NE and protein source. Live weight, at the time of ultrasound scanning was used as a covariate in the statistical analysis of tenth rib fat depth, longissimus muscle area, and lean percentage. Additionally, hot carcass weight was used as a covariate in the analysis of skinned fat depth, loin depth, lean percentage, and carcass yield.

Results and Discussion

No protein source by NE concentration interactions were detected for any of the criteria evaluated in this trial. During the growing phase (105 to 165 lb), pigs fed diets containing 1.17 Mcal NE/lb grew faster than pigs provided the diets containing 1.14 Mcal NE/lb ($P < .10$). The increase in ADG was primarily due to increased energy intake, both NE and metobolizable energy (ME), of those pigs ($P < .05$). Pigs fed low protein, amino acid-fortified diets consumed more feed and were less efficient than pigs consuming the intact protein diets ($P < .10$ and .05, respectively).

From 165 to 245 lb, pigs fed intact protein diets had increased ADG and ME intakes and improved F/G ($P < .01$). The NE concentration did not affect growth or feed intake. However, as expected, pigs fed high NE diets consumed more NE and ME ($P < .01$ and 06, respectively) from 165 to 235 lb.

Over the entire experiment, pigs fed diets containing intact protein grew faster and more efficiently than pigs fed low protein, amino acid-fortified diets ($P < .001$). This was primarily due to the improved performance during the finishing period. Pigs fed the diets formulated to contain high NE consumed more feed during the entire feeding trial than pigs fed the low NE diet ($P < .05$).

Real-time ultrasound revealed that pigs fed low protein, amino acid-fortified diets had greater 10th rib fat depths and, therefore, had lower lean percentage ($P < .10$) than pig fed diets with intact protein. When pigs were slaughtered, pigs fed diets with intact protein had less 10th rib, skinned fat depth and percentage lean than pigs fed the low protein, amino acid-fortified diets ($P < .05$ and .10, respectively).

Based upon the results of this experiment, providing more energy in diets for growing-finishing pigs can improve growth during the growing period and increase fat depth of the carcass. More importantly, providing protein from synthetic sources impairs growth and decreases feed utilization, especially in the finishing phase of production. The marked decrease in feed utilization needs to be evaluated against any savings in diet cost that may be achieved by adding synthetic amino acids to growing-finishing swine diets.

Table 1. Compositions of Growing Diets

Item	Net Energy: Low, Protein Source: Intact	Low: Synthetic	High, Protein Source: Intact	High: Synthetic
		%		
Corn	71.32	82.73	69.90	81.20
SBM, 46.5% CP	24.57	13.82	24.67	14.02
Soybean oil	1.32	—	2.63	1.32
Monocalcium phosphate, 21% P	.91	1.09	.92	1.10
Limestone	1.04	1.02	1.04	1.01
Salt	.35	.35	.35	.35
Vitamin premix	.20	.20	.20	.20
Trace mineral premix	.15	.15	.15	.15
Antibiotic	.13	.13	.13	.13
L-Lysine	—	.32	—	.32
DL-Methionine	.02	.10	.02	.10
L-Threonine	—	.08	—	.08
L-Tryptophan	—	.02	—	.02
Calculated Analysis				
ME, Mcal/lb	1.53	1.50	1.55	1.53
NE, Mcal/lb	1.14	1.14	1.17	1.17
CP, %	17.64	13.72	17.57	13.68
Ca, %	.65	.65	.65	.65
P, %	.55	.55	.55	.55
Calculated Total Amino Acids, %				
Lysine	.93	.88	.92	.88
Threonine	.68	.60	.68	.60
Tryptophan	.20	.17	.20	.17
Isoleucine	.76	.56	.76	.56
Methionine	.31	.34	.61	.34
Methionine + cystine	.62	.60	.62	.60
Calculated Digestible Amino Acids, %				
Lysine	.75	.75	.75	.75
Threonine	.52	.47	.51	.47
Tryptophan	.15	.13	.15	.13
Isoleucine	.62	.45	.62	.45
Methionine	.27	.31	.27	.31
Methionine + cystine	.49	.49	.49	.49

Table 2. Compositions of Finishing Diets

	Net Energy			
	Low Protein Source		High Protein Source	
Item	Intact	Synthetic	Intact	Synthetic
		%		
Corn	80.36	90.90	79.09	89.52
SBM, 46.5% CP	16.02	6.15	16.11	6.33
Soybean oil	1.20	—	2.37	1.20
Monocalcium phosphate, 21% P	.81	.98	.83	.99
Limestone	.88	.86	.87	.85
Salt	.35	.35	.35	.35
Vitamin premix	.15	.15	.15	.15
Trace mineral premix	.10	.10	.10	.10
Antibiotic	.13	.13	.13	.13
L-Lysine	—	.29	—	.29
DL-Methionine	—	.03	—	.03
L-Threonine	—	.05	—	.05
L-Tryptophan	—	.02	—	.02
Calculated Analysis				
ME, Mcal/lb	1.53	1.51	1.55	1.53
NE, Mcal/lb	1.17	1.17	1.20	1.20
CP, %	14.44	10.79	14.37	10.76
Ca, %	.55	.55	.55	.55
P, %	.50	.50	.50	.50
Calculated Total Amino Acids, %				
Lysine	.69	.65	.69	.65
Threonine	.55	.45	.55	.45
Tryptophan	.16	.13	.16	.13
Isoleucine	.60	.42	.60	.42
Methionine	.25	.23	.25	.23
Methionine + cystine	.52	.46	.52	.45
Calculated Digestible Amino Acids, %				
Lysine	.55	.55	.55	.55
Threonine	.41	.34	.41	.34
Tryptophan	.11	.09	.11	.09
Isoleucine	.48	.33	.48	.33
Methionine	.22	.21	.22	.21
Methionine + cystine	.41	.36	.41	.36

Table 3. Effects of Net Energy and Protein Source on Finishing Pig Growth Performance and Carcass Characteristics[a]

	Net Energy							
	Low		High					
	Protein Source		Protein Source			Effects		
Item	Intact	Synthetic	Intact	Synthetic	Net Energy	Protein	Interaction	CV
Growing (105 to 165 lb)								
ADG, lb	1.96	1.90	2.03	1.98	.0482	.1537	.8631	5.3
ADFI, lb	4.84	5.01	4.97	5.11	.1420	.0530	.8876	4.4
F/G	2.47	2.64	2.45	2.58	.1465	.0001	.4540	2.8
ME intake, Mcal/d	7.39	7.53	7.70	7.81	.0221	.2954	.8917	4.5
NE intake, Mcal/d	5.52	5.73	5.83	6.01	.0043	.0553	.9097	4.5
Total lysine intake, g/d	20.32	20.07	20.85	20.49	.1547	.3567	.8719	4.5
Digestible lysine intake, g/d	16.48	17.09	16.92	17.42	.1420	.0533	.8876	4.4
Finishing (165 to 245 lb)								
ADG, lb	1.84	1.57	1.89	1.58	.3270	.0001	.6223	5.3
ADFI, lb	5.40	5.18	5.37	5.34	.3440	.0721	.1660	3.5
F/G	2.96	3.40	2.86	3.42	.6083	.0001	.4214	6.7
ME intake, Mcal/d	8.27	7.83	8.32	8.18	.0584	.0093	.1698	3.6
NE intake, Mcal/d	6.31	6.05	6.42	6.39	.0108	.0768	.1759	3.6
Total lysine intake, g/d	16.93	15.32	16.82	15.79	.4110	.0001	.1861	3.7
Digestible lysine intake, g/d	13.48	12.92	13.39	13.32	.3440	.0721	.1660	3.5
Overall								
ADG, lb	1.89	1.71	1.94	1.75	.0444	.0001	.7920	3.7
ADFI, lb	5.15	5.11	5.19	5.24	.0311	.9481	.2433	2.1
F/G	2.73	3.01	2.66	3.00	.3797	.0001	.6444	4.1
Ultrasound Data[b]								
Live weight, lb	248.7	235.5	254.5	240.3	.0121	.0001	.7896	2.2
10th rib fat depth, in	.75	.80	.78	.87	.0577	.0931	.4477	7.7
Loin muscle area, in^2	6.10	6.01	5.89	5.99	.4169	.9967	.4614	5.8
Lean percentage	52.97	52.22	52.06	51.51	.0547	.3068	.7769	1.8
Packing Plant Data[c]								
Live weight, lb	248.2	236.7	255.1	241.0	.0215	.0001	.5847	2.6
Hot carcass weight, lb	159.9	151.4	165.2	156.0	.0053	.0001	.8019	2.8
Skinned fat depth, in	.56	.59	.56	.62	.3300	.0263	.2049	5.6
Loin depth, in	2.12	2.08	2.06	2.10	.6174	.9386	.2999	4.9
Lean percentage	56.66	56.14	56.56	55.72	.3727	.0829	.5010	1.2
Carcass yield, %	64.30	64.27	64.30	64.83	.2342	.4126	.1554	.8

[a]Means derived from 288 gilts (PIC 326 × C22, initially 105 lb) housed at 9 pigs per pen with eight replicate pens per treatment.
[b]Live weight was used as a covariate to analyze 10th rib fat depth, loin muscle area, and lean percentage.
[c]One-hundred eighty-four gilts were slaughtered at a commercial packing plant to collect commercial carcass data. Hot carcass weight was used as a covariate to analyze skinned fat depth, loin depth, lean percentage, and carcass yield.