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Effects of AminoGut and Diet Formulation Approach on Growth Performance and Economic Return in Nursery Pigs

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Effects of AminoGut and Diet Formulation Approach on Growth Performance and Economic Return in Nursery Pigs

Abstract

Diets containing animal protein sources have higher levels of glutamine than diets based on plant protein sources. Therefore, the objective of this study was to determine the effects of AminoGut (Ajinomoto Heartland, Inc., Chicago, IL) and protein source (animal vs. plant proteins) on growth performance and economic return in nursery pigs from 12 to 60 lb. AminoGut is a product that contains both glutamine and glutamate. A total of 1,134 pigs (337 × 1050; PIC, Hendersonville, TN, initially 11.6 ± 0.18 lb BW) were used in a 52-d trial. At the beginning of the experiment, pigs were weighed in pens, and pens were ranked by average BW and randomly assigned dietary treatments in a randomized complete block design based on BW. The treatment structure was a 2 × 3 factorial with 2 protein sources (animal vs. plant) and 3 AminoGut durations (0, 10, and 24 d). The experiment was divided into Phases 1 (d 0 to 10), 2 (d 10 to 24), and 3 (d 24 to 52). Pigs were fed a common diet during Phase 3. AminoGut was added at 0.8 and 0.6% in Phases 1 and 2, respectively. From d 0 to 10, pigs fed animal protein-based diet had marginally ($P = 0.074$) greater ADG and improved F/G ($P = 0.035$) compared to pigs fed plant-based diet. No evidence for differences was observed in pigs fed AminoGut in this phase ($P > 0.188$). From d 10 to 24, pigs fed AminoGut had improved ADG (linear, $P < 0.022$) and F/G (linear, $P = 0.004$). No evidence for differences was observed between protein sources in this phase. From d 24 to 52, pigs that had been previously fed AminoGut for 10 d had marginally improved F/G (quadratic, $P = 0.057$) compared to pigs not previously fed AminoGut or previously fed AminoGut for 24 d. No evidence for differences was observed between protein sources in this common phase. For the combined performance from Phases 1 and 2 (d 0 to 24), pigs fed AminoGut had improved ADG (linear, $P < 0.021$), F/G (linear, $P = 0.004$), and BW (quadratic, $P = 0.028$) compared to pigs not fed AminoGut. No evidence for differences was observed between pigs fed different protein sources. For the overall performance (d 0 to 52), no statistical evidence for differences between pigs fed protein source or different AminoGut duration was observed. In conclusion, feeding AminoGut for 10 d post-weaning marginally improved growth performance until d 24 but there was no carry over effect when a common diet was fed from d 24 to 52. Further research should evaluate the supplementation of glutamine and glutamate throughout the nursery period and at greater inclusion levels.

Keywords

glutamate, glutamine, growth, nursery pig, protein source

Cover Page Footnote

The authors thank Ajinomoto Heartland Inc., Chicago, IL, for providing feed-grade amino acids and for partial financial support. Appreciation is expressed to New Horizon Farms for use of pigs and facilities and to Allan Morris, Marty Heintz, and Craig Steck for technical assistance.

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K-STATE Research and Extension

Swine Day 2016

Effects of AminoGut and Diet Formulation Approach on Growth Performance and Economic Return in Nursery Pigs [1,2]

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Summary

Diets containing animal protein sources have higher levels of glutamine than diets based on plant protein sources. Therefore, the objective of this study was to determine the effects of AminoGut (Ajinomoto Heartland, Inc., Chicago, IL) and protein source (animal vs. plant proteins) on growth performance and economic return in nursery pigs from 12 to 60 lb. AminoGut is a product that contains both glutamine and glutamate. A total of 1,134 pigs (337 × 1050; PIC, Hendersonville, TN, initially 11.6 ± 0.18 lb BW) were used in a 52-d trial. At the beginning of the experiment, pigs were weighed in pens, and pens were ranked by average BW and randomly assigned dietary treatments in a randomized complete block design based on BW. The treatment structure was a 2 × 3 factorial with 2 protein sources (animal vs. plant) and 3 AminoGut durations (0, 10, and 24 d). The experiment was divided into Phases 1 (d 0 to 10), 2 (d 10 to 24), and 3 (d 24 to 52). Pigs were fed a common diet during Phase 3. AminoGut was added at 0.8 and 0.6% in Phases 1 and 2, respectively. From d 0 to 10, pigs fed animal protein-based diet had marginally ($P = 0.074$) greater ADG and improved F/G ($P = 0.035$) compared to pigs fed plant-based diet. No evidence for differences was observed in pigs fed AminoGut in this phase ($P > 0.188$). From d 10 to 24, pigs fed AminoGut had improved ADG (linear, $P < 0.022$) and F/G (linear, $P = 0.004$). No evidence for differences was observed between protein sources in this phase. From d 24 to 52, pigs that had been previously fed AminoGut for 10 d had marginally improved F/G (quadratic, $P = 0.057$) compared to pigs not previously fed AminoGut or previously fed AminoGut for 24 d. No evidence for differences was observed between protein sources in this common phase. For the combined performance from Phases 1 and 2 (d 0 to 24), pigs fed AminoGut had improved ADG (linear, $P < 0.021$), F/G (linear, $P = 0.004$), and BW (quadratic, $P = 0.028$) compared to pigs not fed AminoGut. No evidence for differences was observed between pigs fed different protein sources. For the overall performance

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(d 0 to 52), no statistical evidence for differences between pigs fed protein source or different AminoGut duration was observed. In conclusion, feeding AminoGut for 10 d post-weaning marginally improved growth performance until d 24 but there was no carry over effect when a common diet was fed from d 24 to 52. Further research should evaluate the supplementation of glutamine and glutamate throughout the nursery period and at greater inclusion levels.

Key words: glutamate, glutamine, growth, nursery pig, protein source

Introduction

Glutamine is considered a non-essential amino acid for young pigs and is important for optimum health and function of the enterocytes in the small intestine. Glutamate is an important compound in cellular metabolism and is an energy source for the enterocytes in the intestine. Dietary glutamate may be limiting in newly-weaned pigs due to rapid turnover and replacement of mucosal cells. These are the most abundant amino acids in milk. AminoGut (Ajinomoto Heartland, Inc., Chicago, IL) is a product that contains both glutamine and glutamate. There may be a benefit of glutamine and glutamate supplementation in newly-weaned pigs on jejunal atrophy and growth performance (Wu et al., 1996;[5] Rezaei et al., 2012;[6] Cabrera et al., 2013[7]). Additionally, dietary animal protein sources have greater glutamine content compared to plant protein sources. Therefore, the objective of this study was to determine the effects of AminoGut and protein source on growth performance and economic return in nursery pigs from 12 to 60 lb.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. This study was conducted at a commercial research nursery barn in southwestern Minnesota. The facility was totally enclosed, environmentally controlled, and mechanically ventilated. Pens had completely slatted flooring and deep pits for manure storage. Each pen (12 × 7.5 ft) was equipped with a 6-hole stainless steel, dry self-feeder (SDI Industries, Alexandria, SD) and a pan waterer for ad libitum access to feed and water.

A total of 1,134 pigs (PIC 337 × 1050; initial BW of 11.6 ± 0.18 lb) were used in a 52-d growth trial. There were 7 pens per treatment and 27 pigs per pen. Daily feed additions to each pen were accomplished through a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of providing and measuring feed amounts for individual pens. This system is capable of feeding each individual pen any of the individual diets as well as a blend of 2 diets.

[5] Wu, G., M. Sa, and K. Da. 1996. Dietary glutamine supplementation prevents jejunal atrophy in weaned pigs. J. Nutr. 126:2578–2584.

[6] Rezaei, R., D. A. Knabe, C. D. Tekwe, S. Dahanayaka, M. D. Ficken, S. E. Fielder, S. J. Eide, S. L. Lovering, and G. Wu. 2012. Dietary supplementation with monosodium glutamate is safe and improves growth performance in postweaning pigs. Amino Acids 44:911–923.

[7] Cabrera, R. A., Usry, J. L., Arrellano, C., Nogueira, E. T., Kutschenko, M., Moeser, A. J., and Odle, J. 2013. Effects of creep feeding and supplemental glutamine or glutamine plus glutamate (AminoGut) on pre-and post-weaning growth performance and intestinal health of piglets. J. Anim. Sci. Biot., 4:1-13.

Pens were randomly assigned within weight blocks to dietary treatments. Dietary treatments (Table 1) were arranged as a 2 × 3 factorial with 2 diet formulation approaches (animal or plant protein) and 3 feeding durations of AminoGut (0, 10, or 24 d). The AminoGut inclusion rate was 0.8% from d 0 to 10 and 0.6% from d 10 to 24. From d 24 to 52, pigs were fed a common diet. Pig BW and feed disappearance were measured on d 0, 10, 24, and 52 to calculate ADG, ADFI, and F/G.

Diet samples were taken from 6 feeders per dietary treatment 3 d after the beginning and 3 d before the end of the experiment and stored at -4°F until analyzed. Total amino acids and CP analyses were conducted on composite samples from each dietary treatment (Ajinomoto Heartland, Inc). Diet samples were also submitted for analysis of DM, crude fiber, ADF, NDF, ash, ether extract, Ca, and P (Ward Laboratories, Inc Kearney, NE).

For the economic evaluation, total feed cost per pig, cost per lb of gain, revenue, and income over feed cost (IOFC) were calculated on a pen basis. The total feed cost per pig was calculated by multiplying the ADFI by diet cost and the number of days it was fed. Cost per lb of gain was calculated by dividing the total feed cost per pig by overall pounds gained. Revenue per pig was calculated by multiplying the ADG times the total days in the trial times an assumed live price of $54.00 per cwt. To calculate IOFC, total feed cost was subtracted from pig revenue. For all economic evaluations, price of ingredients were: corn at $3.60/bu ($129/ton), DDGS at $180/ton, soybean meal at $354/ton, L-tryptophan at $6.00/lb, L-valine at $7.50/lb, and AminoGut at $2.34/lb.

Responses measured at the pen level were analyzed using a linear mixed model. The model included the fixed effect of treatment and initial pig BW as a random effect. Pen was the experimental unit. Linear and quadratic contrasts were built to evaluate the dose response to feeding AminoGut for different durations. Statistical models were fitted using the GLIMMIX procedure in SAS (SAS Institute Inc., Cary, NC). Results were considered significant at $P \leq 0.05$ and marginally significant at $P \leq 0.10$.

Results and Discussion

The analyzed total amino acids, DM, CP, crude fiber, Ca, P, fat and ash contents of experimental diets (Table 2) were reasonably consistent with formulated estimates.

There were no interactions observed between protein source and AminoGut duration with the exception of BW at d 10, which was marginally heavier ($P = 0.093$) for pigs fed animal protein-based diet with 24 d of AminoGut duration (Table 3) compared with pigs fed vegetable-based diet with 24 d of AminoGut duration.

From d 0 to 10, pigs fed the animal protein-based diet had marginally ($P = 0.074$) greater ADG and improved F/G ($P = 0.035$) compared to pigs fed the plant-based diet. No evidence for differences was observed among pigs fed AminoGut in this phase ($P > 0.188$). From d 10 to 24, pigs fed AminoGut had improved ADG (linear, $P < 0.022$) and F/G (linear, $P = 0.004$). No evidence for differences was observed between protein sources in this phase. From d 24 to 52, pigs that had been previously fed AminoGut for 10 d had marginally improved F/G (quadratic, $P = 0.057$) compared to pigs not previ-

ously fed AminoGut or previously fed AminoGut for 24 d. No evidence for differences was observed between protein sources in this common phase.

For the combined performance from Phases I and II (d 0 to 24), pigs fed AminoGut had improved ADG (linear, $P < 0.021$), F/G (linear, $P = 0.004$), and BW (quadratic, $P = 0.028$) compared to pigs not fed AminoGut. No evidence for differences was observed between pigs fed different protein sources. For the overall performance (d 0 to 52), no statistical evidence for differences between pigs fed either animal- or plant-based protein source or different AminoGut durations was observed

Feed cost per pig was greater ($P < 0.001$) in pigs fed animal protein source compared to plant protein source. Additionally, feed cost per pig increased (linear, $P = 0.002$) with increasing AminoGut duration. Feed cost per lb of gain increased (quadratic, $P = 0.020$) with increasing duration of AminoGut supplementation and also increased ($P < 0.001$) in pigs fed animal protein compared to plant protein. No evidence for differences was observed in total revenue per pig or IOFC.

In conclusion, feeding AminoGut for 10 d post-weaning marginally improved growth performance until d 24 but there was no carry over effect when a common diet was fed from d 24 to 52. Further research should evaluate the supplementation of glutamine and glutamate throughout the nursery period and at greater inclusion levels.

Table 1. Diet composition (as-fed)[1]

	Phase 1		Phase 2		
Protein source:	Plant	Animal	Plant	Animal	Common
Ingredient					
Corn	37.92	39.00	46.12	47.15	54.70
Soybean meal (46% CP)	18.05	17.95	25.09	25.06	28.82
Bovine blood plasma	---	4.00	---	---	---
DDGS[2]	5.00	5.00	7.50	7.50	10.00
Fish meal	---	2.50	---	5.00	---
HP 300 (Hamlet Protein)	6.50	---	5.00	---	---
Spray-dried whey	25.00	25.00	9.00	9.00	---
Corn oil	3.00	3.00	3.00	3.00	3.00
Monocalcium phosphate	0.95	0.50	1.03	0.45	1.00
Limestone	0.95	0.90	1.03	0.75	1.10
Salt	0.30	0.30	0.35	0.35	0.35
L-Lys HCL	0.545	0.350	0.500	0.425	0.450
DL-Met	---	---	0.190	0.150	0.130
Methionine hydroxy analog	0.271	0.177	---	---	---
L-Thr	0.190	0.110	0.180	0.160	0.150
L-Trp	0.036	0.013	0.021	0.029	0.021
L-Val	0.110	0.025	0.250	0.035	---
Choline chloride, 60%	0.035	0.035	---	---	---
Zinc oxide	0.400	0.400	0.250	0.250	
Vitamin E, 20,000 IU	0.050	0.050	---	---	---
AminoGut[3]	---	---	---	---	---
Trace mineral premix[4]	0.100	0.100	0.100	0.100	0.100
Vitamin premix[5]	0.125	0.125	0.125	0.125	0.125
Aureo–90[6]	0.445	0.445	0.445	0.445	---
TBCC[7]	---	---	---	---	0.025
Phytase[8]	0.025	0.025	0.025	0.025	0.025
Total	100	100	100	100	100

continued

Table 1. Diet composition (as-fed)[1]

	Phase 1		Phase 2		
Protein source:	Plant	Animal	Plant	Animal	Common
Standardized ileal digestible (SID) AA, %					
Lys	1.40	1.40	1.34	1.34	1.27
Ile:Lys	55	55	57	57	59
Leu:Lys	110	118	119	120	130
Met:Lys	36	32	36	36	34
Met and Cys:Lys	56	56	56	56	56
Thr:Lys	62	62	62	62	62
Trp:Lys	18.5	18.5	18.5	18.5	18.5
Val:Lys	66	66	66	66	66
Total Lys, %	1.54	1.56	1.50	1.51	1.43
ME, kcal/lb	1,568	1,576	1,568	1,576	1,559
NE NRC, kcal/lb	1,182	1,188	1,167	1,176	1,157
SID Lys:ME, g/Mcal	4.05	4.04	3.88	3.85	3.70
CP, %	20.5	21.3	21.7	22.0	21.6
Ca, %	0.75	0.75	0.68	0.68	0.68
P, %	0.69	0.66	0.63	0.62	0.62
Available P, %	0.59	0.59	0.36	0.36	0.33
Stand. Dig. P with phytase, %	0.60	0.60	0.49	0.49	0.46
Ca:P	1.09	1.12	0.40	0.39	0.38

[1] Corn, dried distillers grains with solubles (DDGS), and soybean meal were analyzed for CP and total amino acid concentrations and NRC (2012) SID digestibility values were used in the diet formulation.
[2] Dried distillers grains with solubles.
[3] AminoGut (Ajinomoto Heartland, Inc., Chicago, IL) is a product that contains both glutamine and glutamate. AminoGut was included at 0.80% and 0.60% in Phases 1 and 2, respectively, at the expense of corn.
[4] Provided per lb of diet: 33 ppm Mn from manganese oxide, 110 ppm Fe from iron sulfate, 110 ppm Zn from zinc oxide, 16.5 ppm Cu from copper sulfate, 0.33 ppm I from ethylenediamin dihydroiodide, and 0.30 ppm Se from sodium selenite.
[5] Provided per lb of diet: 4,000 IU vitamin A; 625 IU vitamin D_3; 20 IU vitamin E; 2.0 mg vitamin K; 12.5 mg pantothenic acid; 22.5 mg niacin; and 3.5 mg riboflavin and 15 μg vitamin B12.
[6] Aureo-90 (Zoetis, New York City, NY) provided 800 g/ton of chlortetracycline.
[7] TBCC (Intellibond C; Micronutrients Inc., Indianapolis, IN) provided 145 ppm of tribasic copper chloride.
[8] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN) provided 568 phytase units (FTU) per lb of diet.

Table 2. Chemical analysis of diets (as-fed)[1,2]

	Phase 1				Phase 2			
Protein source:	Plant		Animal		Plant		Animal	
AminoGut:	0.00%	0.80%	0.00%	0.80%	0.00%	0.60%	0.00%	0.60%
Proximate analysis, %								
DM	92.64 (87.65)	93.18 (86.94)	92.63 (88.02)	92.87 (87.31)	91.28 (86.45)	91.92 (85.92)	91.63 (86.98)	92.06 (86.45)
CP	19.3 (20.5)	20.1 (21.3)	20.3 (21.3)	21.2 (22.1)	20.7 (21.7)	21.9 (22.2)	21.6 (22)	23.2 (22.5)
CF	1.9 (2.1)	1.5 (2.1)	1.5 (1.9)	1.6 (1.9)	1.8 (2.7)	1.8 (2.7)	1.9 (2.6)	2 (2.6)
ADF	2.2 (2.6)	2.9 (2.6)	2.2 (2.7)	2.5 (2.7)	3.1 (3.6)	3.3 (3.5)	3.1 (3.6)	3.6 (3.6)
NDF	7.5 (6.5)	7.5 (6.4)	7.9 (6.6)	7.5 (6.5)	9.4 (8.5)	10.7 (8.5)	9.9 (8.6)	8.7 (8.6)
Ca	1.01 (0.75)	0.86 (0.75)	1.04 (0.75)	0.94 (0.75)	0.90 (0.68)	0.84 (0.68)	0.89 (0.68)	0.94 (0.68)
P	0.63 (0.69)	0.62 (0.68)	0.62 (0.66)	0.59 (0.66)	0.66 (0.63)	0.7 (0.63)	0.68 (0.62)	0.69 (0.62)
Fat	5.7 (5.3)	5.9 (5.3)	6.1 (5.5)	6.1 (5.5)	5.4 (5.7)	5.5 (5.7)	6 (6.1)	6 (6.1)
Ash	6.68 (4.27)	6.2 (4.26)	6.22 (4.59)	6.06 (4.58)	5.63 (3.63)	5.83 (3.62)	5.72 (4.1)	6.12 (4.09)
Amino acids, %								
Lysine	1.40 (1.54)	1.43 (1.54)	1.53 (1.56)	1.58 (1.56)	1.32 (1.50)	1.37 (1.50)	1.46 (1.51)	1.47 (1.51)
Isoleucine	0.82 (0.86)	0.84 (0.86)	0.87 (0.88)	0.86 (0.88)	0.83 (0.88)	0.80 (0.88)	0.81 (0.89)	0.81 (0.89)
Leucine	1.71 (1.72)	1.73 (1.72)	1.79 (1.88)	1.77 (1.87)	1.60 (1.82)	1.56 (1.81)	1.70 (1.85)	1.70 (1.84)
Methionine[3]	0.28 (0.52)	0.27 (0.52)	0.31 (0.53)	0.30 (0.53)	0.44 (0.53)	0.48 (0.53)	0.49 (0.48)	0.50 (0.48)
Met and Cys[3]	0.57 (0.86)	0.57 (0.86)	0.66 (0.86)	0.66 (0.86)	0.75 (0.87)	0.81 (0.87)	0.83 (0.89)	0.85 (0.89)
Threonine	0.96 (1.00)	0.93 (0.99)	0.95 (1.02)	0.94 (1.02)	0.95 (0.97)	0.91 (0.96)	0.99 (0.97)	0.97 (0.97)
Tryptophan	0.27 (0.29)	0.28 (0.29)	0.28 (0.29)	0.27 (0.29)	0.26 (0.28)	0.26 (0.28)	0.28 (0.28)	0.27 (0.28)
Valine	0.95 (1.05)	0.96 (1.04)	1.00 (1.08)	0.99 (1.08)	0.97 (1.03)	0.94 (1.03)	0.97 (1.04)	0.99 (1.04)
Histidine	0.50 (0.50)	0.50 (0.50)	0.53 (0.55)	0.51 (0.55)	0.45 (0.56)	0.44 (0.56)	0.48 (0.56)	0.48 (0.56)
Phenylalanine	0.95 (0.92)	0.95 (0.92)	1.00 (0.97)	0.99 (0.97)	0.86 (1.03)	0.85 (1.02)	0.90 (1.01)	0.88 (1.01)

[1] Diet samples were taken from 6 feeders per dietary treatment 3 d after the beginning of the trial and 3 d prior to the end of the trial and stored at -20°C, then CP and amino acid analysis was conducted on composite samples by Ajinomoto Heartland, Inc. (Chicago, IL). Samples of the diets were also submitted to Ward Laboratories, Inc. (Kearney, NE) for analysis of DM, crude fiber, Ca, P, ash, and crude fat.

[2] Values in parentheses indicate those calculated from diet formulation and are based on values from NRC (2012).

[3] Difference between analyzed and formulated value is due to the utilization of methionine hydroxyl analog in diet formulation not being recovered during chemical analysis.

Table 3. Effects of AminoGut and diet formulation approach (plant or animal protein) on growth performance and economics of nursery pigs[1,2]

								Probability, $P <$				
								AminoGut duration, d			AminoGut × Protein source	
Protein source:	Vegetable			Animal						Protein		
AminoGut duration, d:	0	10	24	0	10	24	SEM	Linear	Quadratic	source	Linear	Quadratic
d 0 to 10												
ADG, lb	0.19	0.17	0.18	0.19	0.19	0.21	0.012	0.392	0.188	0.074	0.204	0.855
ADFI, lb	0.39	0.39	0.38	0.38	0.38	0.39	0.008	0.853	0.804	0.379	0.237	0.648
F/G	2.13	2.37	2.16	2.06	2.02	1.87	0.139	0.557	0.232	0.035	0.437	0.439
d 10 to 24												
ADG, lb	0.73	0.77	0.80	0.75	0.79	0.79	0.022	0.022	0.553	0.503	0.331	0.653
ADFI, lb	1.00	1.00	1.04	1.03	1.04	1.03	0.019	0.197	0.844	0.166	0.294	0.364
F/G	1.37	1.31	1.30	1.37	1.32	1.32	0.020	0.004	0.150	0.526	0.713	0.841
d 0 to 24												
ADG, lb	0.50	0.52	0.54	0.51	0.54	0.54	0.014	0.021	0.913	0.236	0.789	0.727
ADFI, lb	0.74	0.74	0.76	0.75	0.76	0.76	0.012	0.219	0.841	0.290	0.626	0.549
F/G	1.49	1.44	1.42	1.47	1.42	1.40	0.024	0.004	0.625	0.360	0.963	0.941
d 24 to 52												
ADG, lb	1.19	1.23	1.21	1.22	1.24	1.22	0.017	0.552	0.101	0.188	0.456	0.558
ADFI, lb	1.80	1.85	1.84	1.85	1.86	1.87	0.022	0.147	0.511	0.125	0.457	0.373
F/G	1.51	1.50	1.53	1.52	1.50	1.53	0.011	0.168	0.057	0.835	0.888	0.651

continued

Table 3. Effects of AminoGut and diet formulation approach (plant or animal protein) on growth performance and economics of nursery pigs[1,2]

								Probability, $P <$				
Protein source:	Vegetable			Animal				AminoGut duration, d		Protein source	AminoGut × Protein source	
AminoGut duration, d:	0	10	24	0	10	24	SEM	Linear	Quadratic		Linear	Quadratic
d 0 to 52												
ADG, lb	0.87	0.90	0.90	0.89	0.91	0.91	0.015	0.154	0.247	0.194	0.578	0.853
ADFI, lb	1.30	1.34	1.34	1.34	1.35	1.35	0.015	0.141	0.547	0.147	0.474	0.632
F/G	1.51	1.49	1.49	1.50	1.48	1.49	0.013	0.469	0.181	0.703	0.932	0.755
BW, lb												
d 0	11.6	11.6	11.6	11.6	11.5	11.6	0.18	0.725	0.636	0.566	0.414	0.314
d 10	13.5	13.3	13.4	13.5	13.5	13.8	0.20	0.516	0.211	0.060	0.093	0.864
d 24	23.8	24.1	24.8	24.2	24.7	24.9	0.42	0.028	0.848	0.191	0.739	0.580
d 52	57.2	58.5	58.8	58.5	59.3	59.1	0.84	0.149	0.430	0.185	0.552	0.987
Economics, $												
Feed cost/pig	10.47	10.73	11.00	11.18	11.30	11.56	0.130	0.002	0.770	0.001	0.536	0.771
Feed cost/lb gain[3]	0.232	0.230	0.236	0.241	0.239	0.246	0.002	0.056	0.020	0.001	0.880	0.918
Total revenue/pig[4]	24.35	25.23	25.16	25.05	25.58	25.31	0.41	0.154	0.247	0.194	0.578	0.853
IOFC[5]	13.88	14.50	14.16	13.87	14.27	13.86	0.308	0.662	0.102	0.475	0.637	0.904

[1] A total of 1,134 pigs (PIC 337 × 1050, initially 11.6 lb BW) were used in a 52-d growth trial with 27 pigs per pen and 7 pens per treatment.
[2] Corn was valued at $3.60/bu ($129/ton), DDGS at $180/ton, soybean meal at $354/ton, and AminoGut at $2.34/lb.
[3] Feed cost/lb gain = total feed cost divided by total gain per pig. Cost per ton used is not considering processing costs.
[4] One lb of live gain was considered to be worth $0.68. Total revenue/pig = total gain/pig × $0.54.
[5] Income over feed cost = total revenue/pig – feed cost/pig.

Table 4. Main effects of AminoGut duration and diet formulation approach (plant vs. animal proteins) on growth performance and economics in nursery pigs[1,2]

	Protein source			Probability,	AminoGut duration, d				Probability,
Item	Plant	Animal	SEM	*P* <	0	10	24	SEM	*P* <
d 0 to 10									
ADG, lb	0.18[x]	0.20[y]	0.01	0.074	0.19	0.18	0.20	0.01	0.291
ADFI, lb	0.39	0.38	0.01	0.379	0.38	0.38	0.38	0.01	0.953
F/G	2.22[a]	1.98[b]	0.09	0.032	2.09	2.19	2.02	0.10	0.400
d 10 to 24									
ADG, lb	0.76	0.78	0.01	0.497	0.74[x]	0.78[y]	0.79[y]	0.02	0.056
ADFI, lb	1.01	1.03	0.01	0.166	1.01	1.02	1.04	0.01	0.421
F/G	1.33	1.34	0.01	0.515	1.37[a]	1.31b	1.31b	0.01	0.005
d 0 to 24									
ADG, lb	0.52	0.53	0.01	0.225	0.51[x]	0.53[xy]	0.54[y]	0.01	0.059
ADFI, lb	0.75	0.76	0.01	0.280	0.75	0.75	0.76	0.01	0.438
F/G	1.45	1.43	0.01	0.347	1.48[a]	1.43b	1.41[b]	0.02	0.011
d 24 to 52									
ADG, lb	1.21	1.23	0.01	0.180	1.21	1.23	1.21	0.01	0.204
ADFI, lb	1.83	1.86	0.01	0.122	1.82	1.85	1.86	0.02	0.273
F/G	1.51	1.52	0.01	0.830	1.51[xy]	1.50[x]	1.53[y]	0.01	0.057
d 0 to 52									
ADG, lb	0.89	0.90	0.01	0.182	0.88	0.90	0.90	0.01	0.172
ADFI, lb	1.33	1.35	0.01	0.138	1.32	1.34	1.35	0.01	0.265
F/G	1.50	1.49	0.01	0.696	1.50	1.48	1.49	0.01	0.295
BW, lb									
d 0	11.6	11.6	0.17	0.565	11.6	11.6	11.6	0.17	0.837
d 10	13.4[x]	13.6[y]	0.17	0.063	13.5	13.4	13.6	0.18	0.379
d 24	24.2	24.6	0.30	0.179	24.0[x]	24.4[xy]	24.9[y]	0.33	0.074
d 52	58.1	59.0	0.58	0.173	57.8	58.9	58.9	0.65	0.240
Economics, $									
Feed cost/pig	10.73[a]	11.45[b]	0.075	0.024	10.83[x]	11.02[x]	11.28y	0.091	0.078
Feed cost/lb gain[3]	0.233	0.242	0.001	0.445	0.237	0.234	0.241	0.002	0.183
Total revenue/pig[4]	24.91	25.35	0.244	0.194	24.70	25.40	25.29	0.292	0.188
IOFC[5]	14.18	14.00	0.181	0.820	13.87	14.38	14.00	0.217	0.216

[1] A total of 1,134 pigs (PIC 337 × 1050, initially 11.6 lb BW) were used in a 52-d growth trial with 27 pigs per pen and 7 pens per treatment.
[2] Corn was valued at $3.60/bu ($129/ton), DDGS at $180/ton, soybean meal at $354/ton, and AminoGut at $2.34/lb.
[3] Feed cost/lb gain = total feed cost divided by total gain per pig. Cost per ton used not considering processing costs.
[4] One lb of live gain was considered to be worth $0.68. Total revenue/pig = total gain/pig × $0.54.
[5] Income over feed cost = total revenue/pig – feed cost/pig.
[a, b] Within rows and within each factor (protein source or AminoGut duration), means with different superscript differ ($P < 0.05$).
[x, y,z] Within rows and within each factor (protein source or AminoGut duration), means with different superscript differ ($P < 0.10$).