Determining the Effects of Tryptophan:Lysine Ratio in Diets Containing Dried Distillers Grains with Solubles on Growth Performance of Finishing Pigs[1]

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Summary

A total of 1,235 pigs (PIC 1050 × 337; initially 149 lb) were used in a 71-d study to determine the effects of tryptophan:lysine ratio in diets containing 0, 20, or 40% dried distillers grains with solubles (DDGS) on growth performance of finishing pigs raised in a commercial environment. Pens of pigs were balanced by initial weight and randomly allotted to 1 of 6 dietary treatments in a completely randomized design with 26 to 28 pigs per pen and 7 to 8 replications per treatment. Treatments were arranged as a 2 × 3 factorial with main effects of standardized ileal digestible (SID) tryptophan:lysine ratio (16.5 or 20% of lysine) and DDGS (0, 20, or 40%). Overall (d 0 to d 71), no differences occurred in growth performance due to SID tryptophan:lysine ratio. Increasing DDGS resulted in poorer F/G (linear, $P = 0.02$), but did not influence other growth performance criteria. For carcass characteristics, increasing the SID tryptophan:lysine ratio increased ($P = 0.02$) carcass yield percentage with the greatest improvement in yield observed when diets contained high levels (20 and 40%) of DDGS (tryptophan × DDGS interaction, $P = 0.07$). Pigs fed high levels of DDGS had reduced loin depth (linear, $P = 0.02$); however, the lowest loin depth was at 40% DDGS for 16.5% SID tryptophan:lysine ratio and at 20% DDGS for 20% SID tryptophan:lysine ratio resulting in a tryptophan × DDGS interaction (quadratic, $P = 0.02$). A tendency of tryptophan × DDGS interaction (linear, $P = 0.08$) was observed for lean percentage, with lean percentage decreasing as DDGS increased in diets containing the 16.5% SID tryptophan:lysine ratio and no change in lean percentage as DDGS increased in diets containing the 20% SID tryptophan:lysine ratio. The tendency of interactions for yield and lean percentage indicate an advantage to increasing the SID tryptophan:lysine ratio in diets with high levels of DDGS, but no effects on growth performance were observed due to SID tryptophan:lysine ratio.

Key words: amino acid ratio, DDGS, lysine, tryptophan, finishing pig

Introduction

Dried distillers grains with solubles (DDGS) have been widely used in swine diets in the United States. Tryptophan is the second limiting amino acid after lysine in diets containing high level of DDGS. A previous study (Barnes et al., 2010[4]) observed a

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[4] Barnes et al., Swine Day 2010, Report of Progress 1038, pp. 156-165.

linear increase in ADG and ADFI ($P < 0.001$) as SID tryptophan:lysine ratio increased through 18% of lysine in pigs fed 30% DDGS. This suggests that the optimal SID tryptophan:lysine ratio in finishing pigs may be greater than 18%. In their study, the response of pigs less than 160 lb tended to indicate optimal ADG and ADFI at a 16.5% SID tryptophan:lysine ratio.

Thus, the objective of this experiment was to determine if the optimal SID tryptophan:lysine ratio for finishing pigs from 150 to 300 lb is influenced by the DDGS level (0, 20, or 40%) in the diet.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment.

The study was conducted at the commercial research-finishing barn in southwestern Minnesota. The barns were naturally ventilated and double-curtain-sided. Pens had completely slatted flooring and deep pits for manure storage. Each pen was equipped with a 5-hole stainless steel dry self-feeder and a cup waterer for ad libitum access to feed and water. 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.

A total of 1,235 pigs (PIC 1050 × 337) with an initial BW of 149 lb were used in a 71-d study. A similar number of barrows and gilts were placed in each pen, with 26 to 28 pigs per pen and 7 to 8 pens per treatment. Pens of pigs were allotted to 1 of 6 dietary treatments in a completely randomized design while balancing for BW. Treatments were arranged as a 2 × 3 factorial with main effects of SID tryptophan:lysine ratio (16.5 or 20% of lysine) and DDGS (0, 20, or 40%). Pigs were fed a common diet containing a 17.3% SID tryptophan:lysine ratio from approximately 100 to 149 lb BW (Table 1). Dried distillers grains with solubles and lysine sulfate were added at the expense of corn and soybean meal to increase the DDGS level in the diet while maintaining the SID tryptophan:lysine ratio at 16.5%. Soybean meal replaced crystalline lysine and threonine to increase the SID tryptophan:lysine ratio from 16.5 to 20% (Tables 1 to 3). All diets were fed in meal form and treatments were fed in 3 phases, from 150 to 195 lb, 195 to 240 lb, and 240 lb to market (Tables 1, 2, and 3). In the last phase, DDGS levels for the 20 and 40% diets were lowered to 10 and 20%, respectively, to reduce the impact on carcass fat quality. Diets in this phase also contained 9 g/ton of Ractopamine HCl (Paylean; Elanco Animal Health, Greenfield, IN).

Pens of pigs were weighed and feed disappearance was recorded at d 22, 44, and 71 to determine ADG, ADFI, and F/G. On d 44 of the experiment, the 4 heaviest pigs (2 barrows and 2 gilts, determined visually) per pen were weighed and sold according to the farm's normal marketing procedure. At the end of the trial (d 71), pigs were individually tattooed by pen number to allow for carcass data collection. Pigs were transported to JBS Swift and Company (Worthington, MN) for processing and carcass data collection. Hot carcass weights were measured immediately after evisceration, and standard carcass criteria of percentage yield, HCW, percentage lean, backfat depth, and

loin depth were collected. Percentage of yield was calculated by dividing live weight at the plant with carcass weight at the plant as reported by the processor.

The experimental data were analyzed using the MIXED procedure of SAS (SAS institute, Inc., Cary, NC). Pen was the experimental unit for all data and significance and tendencies were set at $P < 0.05$ and $P < 0.10$, respectively. Analysis of backfat depth, loin depth, and percentage lean were adjusted to a common carcass weight. Data were analyzed for the main effects of SID tryptophan:lysine ratio, linear and quadratic effect of DDGS, and any interactions between SID tryptophan:lysine ratio and DDGS. Results were considered significant at $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

Results and Discussion

For the overall period (d 0 to 71), no differences were measured in growth performance among pigs fed a SID tryptophan:lysine ratio of either 16.5 or 20% of lysine (Table 4). Increasing DDGS resulted in poorer F/G (linear, $P = 0.02$) but did not influence other growth performance criteria. Also, a tendency (linear, $P = 0.07$) for an interaction was observed for ADFI with the greatest ADFI at 40% DDGS for 16.5% SID tryptophan:lysine ratio and at 20% DDGS for 20% SID tryptophan:lysine ratio.

For carcass characteristics, increasing the SID tryptophan:lysine ratio increased ($P = 0.02$) carcass yield, with the greatest improvement in yield observed when diets contained high levels of DDGS (tryptophan:lysine ratio × DDGS interaction, $P = 0.07$), but other carcass characteristics were not affected by increasing the SID tryptophan:lysine ratio. Pigs fed high levels of DDGS had reduced loin depth (linear, $P = 0.02$); however, the lowest loin depth was at 40% DDGS for 16.5% SID tryptophan:lysine and at 20% DDGS for 20% SID tryptophan:lysine, resulting in a tryptophan:lysine ratio × DDGS interaction (quadratic, $P = 0.02$). Level of DDGS did not influence other carcass criteria. A tendency for a tryptophan:lysine ratio × DDGS interaction (linear, $P = 0.08$) was observed for lean percentage, with lean percentage decreasing as DDGS were added to diets containing 16.5% SID tryptophan:lysine; no changes in lean percentage occurred as DDGS were added to diets containing 20% SID tryptophan:lysine ratio. Other carcass values were not influenced by SID tryptophan:lysine ratio or DDGS (Table 4).

In conclusion, the tendency of interactions for yield and lean percentage indicate some advantage to increasing the SID tryptophan:lysine ratio in diets with high levels of DDGS compared with no advantage to increasing the ratio in the control diet; however, increasing the SID tryptophan:lysine ratio from 16.5 to 20% did not improve growth performance or carcass value. Because a previous study at Kansas State University (Barnes et al., 2010[5]) showed improvements in ADG, ADFI, and income over feed cost when increasing SID tryptophan:lysine through 18%, more studies on tryptophan:lysine ratio in high-DDGS diets should be conducted to determine the appropriate SID tryptophan:lysine ratio in diets containing high levels of DDGS.

[5] Barnes et al., Swine Day 2010, Report of Progress 1038, pp. 156-165.

Table 1. Composition of Phase 1 diets (as-fed basis)[1]

			Standardized ileal digestible (SID) tryptophan:lysine, %					
			16.5			20		
Item	Common diet[1]	DDGS, %[2]	0	20	40	0	20	40
Ingredient								
Corn	53.60		82.70	66.40	50.00	77.90	61.60	45.20
Soybean meal, 46.5% CP	14.40		15.10	11.50	7.80	20.30	16.60	12.90
DDGS	30.00		---	20.00	40.00	---	20.00	40.00
Monocalcium P, 21% P	---		0.35	---	---	0.33	---	---
Limestone	1.15		0.95	1.15	1.18	0.93	1.10	1.13
Salt	0.35		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	---		0.09	0.09	0.09	0.09	0.09	0.09
L-Threonine	---		0.08	0.02	---	---	---	---
L-Lysine sulfate	0.50		0.42	0.49	0.56	0.16	0.23	0.30
Phytase[3]	0.01		0.01	0.01	0.01	0.01	0.01	0.01
Total	100		100	100	100	100	100	100
Calculated analysis								
SID amino acids, %								
Lysine	0.90		0.79	0.79	0.79	0.79	0.79	0.79
Isoleucine:lysine	71		62	68	73	73	79	84
Leucine:lysine	195		158	191	224	174	207	240
Methionine:lysine	34		28	33	39	31	36	42
Met & Cys:lysine	70		57	68	79	63	74	85
Threonine:lysine	65		65	65	69	65	71	78
Tryptophan:lysine	17.3		16.5	16.5	16.5	20.0	20.0	20.0
Valine:lysine	86		74	83	93	85	94	103
Phenylalanine:lysine	91		77	88	98	89	100	110
Tyrosine:lysine	67		55	63	72	64	72	81
Total lysine, %	1.06		0.88	0.92	0.96	0.90	0.93	0.97
ME, kcal/lb	1,527		1,523	1,526	1,527	1,522	1,525	1,526
SID lysine:ME, g/Mcal	2.67		2.35	2.35	2.35	2.35	2.35	2.35
CP, %	19.8		14.4	16.8	19.2	16.2	18.6	21.0
Ca, %	0.51		0.50	0.50	0.50	0.50	0.50	0.50
P, %	0.46		0.41	0.41	0.48	0.43	0.43	0.50
Available P, %	0.31		0.23	0.26	0.35	0.23	0.26	0.36

[1] Common diet was fed from 100 to 149 lb of pig body weight; Phase 1 diet was an experimental diet fed from 149 to 195 lb.
[2] Dried distillers grains with solubles from Vera-Sun (Aurora, SD).
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN).

Table 3. Composition of Phase 3 diets (as-fed basis)[1]

	Standardized ileal digestible (SID) tryptophan:lysine ratio, %					
	16.5			20		
Item DDGS, %[2]	0	20	40	0	20	40
Ingredient						
Corn	85.50	69.20	52.80	81.20	65.00	48.40
Soybean meal, 46.5% CP	12.30	8.70	5.10	16.90	13.20	9.70
DDGS	---	20.00	40.00	---	20.00	40.00
Monocalcium P, 21% P	0.35	---	---	0.35	---	---
Limestone	0.98	1.18	1.20	0.93	1.13	1.15
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.09	0.09	0.09	0.09	0.09	0.09
DL-Methionine	0.05	---	---	---	---	---
L-Threonine	0.05	---	---	---	---	---
L-Lysine sulfate	0.38	0.45	0.52	0.15	0.22	0.29
Phytase[3]	0.01	0.01	0.01	0.01	0.01	0.01
Ractopamine HCl, 9 g/lb[4]	0.05	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100	100
Calculated analysis						
SID amino acids, %						
Lysine	0.92	0.92	0.92	0.92	0.92	0.92
Isoleucine:lysine	61	63	66	72	74	76
Leucine:lysine	146	160	174	161	176	190
Methionine:lysine	31	28	31	29	31	34
Met & Cys:lysine	58	58	63	59	64	69
Threonine:lysine	65	65	65	65	66	69
Tryptophan:lysine	16.5	16.6	16.5	20.0	20.0	20.0
Valine:lysine	71	75	79	82	86	90
Phenylalanine:lysine	74	79	83	86	90	95
Tyrosine:lysine	53	57	60	62	66	70
Total lysine, %	1.02	1.04	1.06	1.04	1.06	1.08
ME, kcal/lb	1,523	1,525	1,525	1,521	1,524	1,524
SID lysine:ME, g/Mcal	2.74	2.74	2.74	2.74	2.74	2.74
CP, %	16.0	17.2	18.4	18.0	19.2	20.4
Ca, %	0.50	0.50	0.50	0.50	0.50	0.50
P, %	0.42	0.39	0.42	0.44	0.41	0.45
Available P, %	0.23	0.21	0.26	0.23	0.22	0.27

[1] Phase 3 diet was fed from 240 lb until market (approximately 300 lb).
[2] Dried distillers grains with solubles from Vera-Sun (Aurora, SD).
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN).
[4] Ractopamine HCl (Paylean; Elanco Animal Health, Greenfield, IN) at 9.0 g/ton was added.

Table 4. Effects of tryptophan:lysine ratio in diets containing increasing dried distillers grains with solubles (DDGS) on growth performance of finishing pigs[1]

	Standardized ileal digestible (SID) tryptophan:lysine ratio, %								Probability, P <				
	16.5			20					Trp	DDGS		Trp × DDGS	
DDGS, %	0	20	40	0	20	40	SEM	TRT	level	Linear	Quadratic	Linear	Quadratic
Replications[2]	8	7	8	8	7	8							
Initial wt, lb	149.6	149.0	149.3	149.2	149.6	149.0	3.05	1.00	1.00	0.93	0.98	1.00	0.86
Final wt, lb	299.7	301.3	299.0	302.6	304.2	300.8	3.24	0.89	0.35	0.70	0.45	0.86	0.93
d 0 to 71													
ADG , lb	2.18	2.21	2.18	2.23	2.23	2.18	0.021	0.30	0.23	0.27	0.14	0.30	0.80
ADFI, lb	6.46	6.64	6.74	6.67	6.75	6.63	0.089	0.25	0.36	0.20	0.37	0.07	0.70
F/G	2.97	3.00	3.10	3.00	3.03	3.04	0.035	0.17	0.93	0.02	0.79	0.21	0.51
Carcass weight, lb	229.3	229.8	225.1	231.0	230.7	229.5	2.710	0.70	0.32	0.29	0.55	0.63	0.66
Yield, %	77.6	76.5	76.8	77.2	78.2	78.0	0.408	0.05	0.02	0.96	0.85	0.07	0.10
Backfat, in.	0.70	0.72	0.71	0.73	0.74	0.68	0.017	0.24	0.54	0.26	0.13	0.09	0.78
Loin depth, in.	2.86	2.89	2.78	2.91	2.82	2.86	0.030	0.04	0.39	0.02	0.98	0.62	0.02
Lean, %	56.8	55.8	55.8	56.4	56.0	56.7	0.362	0.24	0.40	0.37	0.13	0.08	0.99
Carcass values													
Price, $/cwt	91.84	92.18	92.12	91.34	92.19	92.62	0.906	0.95	1.00	0.39	0.81	0.58	1.00
Premium, $/cwt	2.69	2.73	2.55	2.62	2.60	3.06	0.220	0.65	0.59	0.51	0.75	0.20	0.39
Sort loss, $/cwt	-5.02	-4.72	-4.60	-5.46	-4.58	-4.60	0.76	0.96	0.88	0.41	0.70	0.78	0.79

[1] A total of 1,235 pigs (PIC 1050 × 337, initially 149 lb) were used in a 71-d growing-finishing trial with 26 to 28 pigs per pen and 7 to 8 pens per treatment.
[2] Replications are numbers of pens for each treatment.