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## Determining the effects of tryptophan:lysine ratios in diets containing 30% dried distillers grains with solubles on growth performance of 157- to 285-lb pigs

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# Determining the effects of tryptophan:lysine ratios in diets containing 30% dried distillers grains with solubles on growth performance of 157- to 285-lb pigs

## Abstract

A total of 2,298 pigs (half gilts and half barrows, PIC TR4  $\bar{A}$ — 1050; initially 157 lb) were used in a 52-d study to determine the effects of increasing tryptophan:lysine ratios in diets containing 30% dried distillers grains with solubles (DDGS) on the 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 within gender; each pen contained 23 pigs and each treatment had 16 to 17 replications. Treatments were arranged as a 2  $\bar{A}$ — 6 factorial with main effects of gender (gilts or barrows) and standardized ileal digestible (SID) tryptophan:lysine ratio (2 positive control diets with no DDGS containing SID tryptophan:lysine ratios of 17 or 21% of lysine and 4 diets containing 30% DDGS with SID tryptophan:lysine ratios of 15, 17, 19, or 21% lysine). Overall (d 0 to 52), no gender  $\bar{A}$ — treatment interactions were measured. Pigs fed 30% DDGS had poorer ADG, ADFI, and F/G ( $P < 0.01$ ,  $P = 0.04$ , and  $P = 0.01$ , respectively) compared with those fed the corn-soybean meal diet. In pigs fed diets without DDGS, those fed the 17% SID tryptophan:lysine ratio tended to have better F/G ( $P = 0.09$ ) compared with pigs fed the 20% SID tryptophan:lysine ratio. Increasing SID tryptophan:lysine ratio from 15 to 21% in diets containing 30% DDGS had no effect on ADG, ADFI, or F/G. For carcass characteristics, feeding 30% DDGS reduced HCW, loin depth, and lean percentage ( $P < 0.01$ ,  $P < 0.01$ , and  $P = 0.04$ , respectively). For carcass traits, in pigs fed diets without DDGS, those fed the 21% SID tryptophan:lysine ratio had decreased backfat ( $P = 0.04$ ) and greater lean percentage ( $P = 0.04$ ) compared with pigs fed 17% SID tryptophan:lysine ratio. Increasing the SID tryptophan:lysine ratio from 15 to 21% in the 30% DDGS diets increased (linear,  $P < 0.01$ ) percentage carcass yield and had a tendency (linear,  $P = 0.07$ ) to increase HCW. These results suggest an opportunity to improve carcass traits and carcass value by increasing the SID tryptophan:lysine ratio for late finishing pigs that are fed high levels of DDGS.; Swine Day, Manhattan, KS, November 17, 2011

## Keywords

Swine Day, 2011; Kansas Agricultural Experiment Station contribution; no. 12-064-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1056; Swine; amino acid ratio; DDGS; Lysine; Tryptophan; Finishing pig

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# Determining the Effects of Tryptophan:Lysine Ratios in Diets Containing 30% Dried Distillers Grains with Solubles on Growth Performance of 157- to 285-lb Pigs<sup>1</sup>

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## Summary

A total of 2,298 pigs (half gilts and half barrows, PIC TR4 × 1050; initially 157 lb) were used in a 52-d study to determine the effects of increasing tryptophan:lysine ratios in diets containing 30% dried distillers grains with solubles (DDGS) on the 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 within gender; each pen contained 23 pigs and each treatment had 16 to 17 replications. Treatments were arranged as a 2 × 6 factorial with main effects of gender (gilts or barrows) and standardized ileal digestible (SID) tryptophan:lysine ratio (2 positive control diets with no DDGS containing SID tryptophan:lysine ratios of 17 or 21% of lysine and 4 diets containing 30% DDGS with SID tryptophan:lysine ratios of 15, 17, 19, or 21% lysine).

Overall (d 0 to 52), no gender × treatment interactions were measured. Pigs fed 30% DDGS had poorer ADG, ADFI, and F/G ( $P < 0.01$ ,  $P = 0.04$ , and  $P = 0.01$ , respectively) compared with those fed the corn-soybean meal diet. In pigs fed diets without DDGS, those fed the 17% SID tryptophan:lysine ratio tended to have better F/G ( $P = 0.09$ ) compared with pigs fed the 20% SID tryptophan:lysine ratio. Increasing SID tryptophan:lysine ratio from 15 to 21% in diets containing 30% DDGS had no effect on ADG, ADFI, or F/G. For carcass characteristics, feeding 30% DDGS reduced HCW, loin depth, and lean percentage ( $P < 0.01$ ,  $P < 0.01$ , and  $P = 0.04$ , respectively). For carcass traits, in pigs fed diets without DDGS, those fed the 21% SID tryptophan:lysine ratio had decreased backfat ( $P = 0.04$ ) and greater lean percentage ( $P = 0.04$ ) compared with pigs fed 17% SID tryptophan:lysine ratio. Increasing the SID tryptophan:lysine ratio from 15 to 21% in the 30% DDGS diets increased (linear,  $P < 0.01$ ) percentage carcass yield and had a tendency (linear,  $P = 0.07$ ) to increase HCW. These results suggest an opportunity to improve carcass traits and carcass value by increasing the SID tryptophan:lysine ratio for late finishing pigs that are fed high levels of DDGS.

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

<sup>1</sup> Appreciation is expressed to The Hanor Company and Ajinomoto Heartland LLC, Chicago, IL, for use of pigs and facilities and providing the synthetic amino acids used in diet formulation.

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## Introduction

Dried distillers grains with solubles have been widely used in swine feed in the United States. Tryptophan is the second limiting amino acid after lysine in diets containing high levels of DDGS. A previous study (Barnes et al., 2010<sup>5</sup>) at Kansas State University found a linear increase in ADG and ADFI as SID tryptophan:lysine ratio increased from 14 to 18% of lysine in 160- to 265-lb pigs fed 30% DDGS. This suggested that the optimal SID tryptophan:lysine ratio in late finishing pigs was greater than 18% of lysine.

Therefore, our objective was to validate the results of Barnes et al. (2010) and use a greater range of tryptophan:lysine ratios in 150- to 275-lb pigs fed diet containing 30% DDGS.

## Procedures

The study was conducted at a commercial research-finishing barn in western Illinois. The barns were tunnel-ventilated and double-curtain-sided. Pens had completely slatted flooring and shallow pits for manure storage. Each pen was equipped with a 4-hole stainless steel dry self-feeder and a swinging nipple waterer for ad libitum access to feed and water. Daily feed additions to each pen were accomplished through an automated feeding system capable of providing and measuring feed amounts for individual pens.

A total of 2,298 pigs (half gilts and half barrows, PIC TR4 × 1050) with an initial BW of 157 lb were used in this study; each pen contained 23 pigs and each treatment comprised 16 to 17 pens. Pens of pigs were allotted to 1 of 6 dietary treatments in a completely randomized design within gender while balancing for initial BW. Treatments were arranged as a 2 × 6 factorial with main effects of gender (gilts or barrows) and level of SID tryptophan:lysine ratio (2 positive control diets with no DDGS containing SID tryptophan:lysine ratios of 17 or 21% and 4 diets contained 30% DDGS with SID tryptophan:lysine ratios of 15, 17, 19, or 21% lysine). Soybean meal replaced crystalline lysine and threonine to increase the SID tryptophan:lysine ratios from 15 to 21% (Tables 1, 2, and 3). All diets were fed in meal form and treatments were fed in 3 phases, d 0 to 21 (157 to 210 lb), d 21 to 42 (210 to 250 lb), and d 42 to 52 (250 lb to market; Tables 1 to 3). During the last phase, the DDGS level was lowered to 20%. Pens of pigs were weighed and feed disappearance was recorded at d 21, 42, and 52 to determine ADG, ADFI, and F/G. At the end of the experiment, pigs were individually tattooed by pen number to allow for carcass data collection at the packing plant and data retrieval by pen. Pigs were transported to Triumph Foods LLC (St. Joseph, MO) for processing. Standard carcass criteria of loin and backfat depth, HCW, percentage lean, and percentage carcass yield were collected.

The experimental data were analyzed by The Hanor Company (Franklin, KY) using the GLM 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, percentage lean, and fat-free lean index (FFLI) were adjusted to a common carcass weight using HCW as a covariate. Data were analyzed for the main effect of level of DDGS by comparing the corn-soybean meal diets containing 17 and 20% SID tryptophan:lysine ratio with the 30% DDGS

<sup>5</sup> Barnes et al., Swine Day 2010, Report of Progress 1038, pp. 156-165.

diets containing 17 and 20% SID tryptophan:lysine ratio. Data also were analyzed to determine the influence of increasing SID tryptophan:lysine ratio in diets without DDGS (17 vs. 20% SID tryptophan:lysine ratio), linear and quadratic effect of SID tryptophan:lysine ratio in diet containing 30% DDGS, and any interactions between tryptophan level and gender.

## Results and Discussion

For the overall period (d 0 to 52), no gender  $\times$  treatment interactions were observed. Pigs fed 30% DDGS had poorer ADG, ADFI, and F/G ( $P < 0.01$ ,  $P = 0.04$ , and  $P = 0.01$ , respectively; Table 4) compared with those fed the corn-soybean meal diet. In pigs fed diets without DDGS, those fed the 17% SID tryptophan:lysine ratio tended to have better F/G ( $P = 0.09$ ) compared with pigs fed 20% SID tryptophan :lysine ratio. Increasing SID tryptophan:lysine ratio from 15 to 21% in diets containing 30% DDGS had no effect ( $P > 0.26$ ) on ADG, ADFI, or F/G.

For carcass characteristics, feeding 30% DDGS reduced HCW, loin depth, and lean percentage ( $P < 0.01$ ,  $P < 0.01$ , and  $P = 0.04$ , respectively; Table 4). When considering carcass traits of pigs fed corn-soybean meal diets, pigs fed 21% SID tryptophan:lysine ratio had decreased backfat ( $P = 0.04$ ) with greater lean percentage ( $P = 0.04$ ) compared with pigs fed the 17% SID tryptophan:lysine ratio. Increasing the SID tryptophan:lysine ratio from 15 to 21% in the 30% DDGS diets increased (linear,  $P < 0.01$ ) percentage carcass yield and had a tendency (linear,  $P = 0.07$ ) to increase HCW.

In contrast to a previous trial (Barns et al., 2010) at K-State that indicated a linear improvement in ADG, ADFI, and F/G when increasing SID tryptophan:lysine ratio from 15.0 to 19.5% in diets containing 30% DDGS, increasing dietary SID tryptophan:lysine level did not influence pig growth performance in this experiment; however, improvements in carcass yield percentage in this experiment with increasing SID tryptophan:lysine ratio agree with a recent K-State study where increasing tryptophan:lysine ratio also improved carcass yield percentage in diets containing high levels of DDGS (see “Determining the Effects of Tryptophan:Lysine Ratio in Diets Containing Dried Distillers Grains with Solubles on Growth Performance of Finishing Pigs,” pp. 168). In conclusion, these results suggest an opportunity to improve carcass traits and carcass value by increasing the SID tryptophan:lysine ratio in late finishing pigs that are fed high levels of DDGS.

**Table 1. Composition of diets (Phase 1, 157 to 210 lb; as-fed basis)<sup>1</sup>**

Ingredient, %	DDGS, % <sup>2</sup>	Phase 1					
		0	30			0	
		17	15	17	19	21	21
	SID trp:lys, %						
Corn	80.50	59.54	56.21	52.77	49.44	73.79	
Soybean meal (47.5% CP)	16.70	8.43	11.58	14.83	17.98	23.09	
DDGS	---	30.00	30.00	30.00	30.00	---	
Choice white grease	0.53	---	0.32	0.64	0.95	1.21	
Limestone	0.78	1.14	1.11	1.08	1.05	0.72	
Monocalcium P (21% P)	0.68	---	---	---	---	0.65	
Salt	0.40	0.40	0.40	0.40	0.40	0.40	
Vitamin/mineral premix	0.10	0.10	0.10	0.10	0.10	0.10	
L-Lysine HCl	0.26	0.38	0.29	0.18	0.09	0.06	
L-Threonine	0.08	0.02	0.01	0.01	---	---	
DL-Methionine	0.01	---	---	---	---	---	
Total	100	100	100	100	100	100	
Calculated analysis							
Standardized ileal digestible (SID) amino acids, %							
Lysine	0.82	0.82	0.82	0.82	0.82	0.82	
Isoleucine:lysine	62	67	74	80	86	74	
Met & Cys:lysine	56	76	79	82	86	61	
Threonine:lysine	65	65	69	74	78	66	
Tryptophan:lysine	17	15	17	19	21	21	
Valine:lysine	72	85	91	97	103	84	
Total lysine, %	0.90	0.94	0.95	0.95	0.96	0.92	
Modified ME, kcal/lb <sup>3</sup>	1,480	1,481	1,481	1,480	1,480	1,480	
SID lysine:ME, g/Mcal	2.52	2.52	2.52	2.52	2.52	2.52	
CP, %	14.9	17.4	18.6	19.7	20.9	17.2	
Ca, %	0.60	0.60	0.60	0.60	0.60	0.60	
P, %	0.57	0.52	0.53	0.55	0.56	0.59	
Available P, %	0.30	0.30	0.31	0.31	0.31	0.30	
SID lysine <sup>4</sup>	0.83	0.80	0.81	0.81	0.81	0.83	
SID tryptophan:lysine, % <sup>4</sup>	17.0	15.6	17.6	19.8	21.7	21.0	
ME, kcal/lb <sup>5</sup>	1,530	1,526	1,532	1,538	1,544	1,543	

<sup>1</sup>Phase 1 experimental diets were fed from d 0 to 21 (157- to 210-lb BW).

<sup>2</sup>Dried distillers grains with solubles.

<sup>3</sup>Modified ME was calculated by The Hanor Company.

<sup>4</sup>SID lysine, SID tryptophan:lysine (%), and ME (kcal/lb) were calculated using NRC values.

<sup>5</sup>All energy levels used to calculate ME were based on NRC values except DDGS, where the energy value of corn was used.

**Table 2. Composition of diets (Phase 2, 210 to 250 lb; as-fed basis)<sup>1</sup>**

Ingredient, %	DDGS, % <sup>2</sup>	Phase 2				
		0	30			0
		SID trp:lys, % 17	15	17	19	21
Corn	83.85	62.41	59.45	56.40	53.43	77.96
Soybean meal (47.5% CP)	13.43	5.53	8.31	11.17	13.95	19.04
DDGS	---	30.00	30.00	30.00	30.00	---
Choice white grease	0.60	0.11	0.41	0.71	1.00	1.19
Limestone	0.83	1.12	1.09	1.06	1.04	0.79
Monocalcium P (21% P)	0.51	---	---	---	---	0.48
Salt	0.40	0.40	0.40	0.40	0.40	0.40
Vitamin/mineral premix	0.10	0.10	0.10	0.10	0.10	0.10
L-Lysine	0.23	0.34	0.26	0.17	0.09	0.06
L-Threonine	0.65	---	---	---	---	---
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
Calculated analysis						
Standardized ileal digestible (SID) amino acids, %						
Lysine	0.72	0.72	0.72	0.72	0.72	0.72
Isoleucine:lysine	63	70	77	83	89	76
Met & Cys:lysine	58	83	86	89	93	65
Threonine:lysine	66	66	71	77	82	67
Tryptophan:lysine	17	15	17	19	21	21
Valine:lysine	75	91	97	103	109	87
Total lysine, %	0.80	0.84	0.84	0.85	0.85	0.81
Modified ME, kcal/lb <sup>3</sup>	1,490	1,490	1,490	1,490	1,490	1,490
SID lysine:ME, g/Mcal	2.20	2.20	2.20	2.20	2.20	2.20
CP, %	13.6	16.3	17.3	18.3	19.3	15.6
Ca, %	0.58	0.58	0.58	0.58	0.58	0.58
P, %	0.52	0.51	0.52	0.53	0.54	0.53
Available P, %	0.26	0.30	0.30	0.31	0.31	0.26
SID lysine <sup>4</sup>	0.72	0.69	0.70	0.70	0.71	0.73
SID tryptophan:lysine, % <sup>4</sup>	16.9	15.7	17.7	19.8	21.8	21.0
ME, kcal/lb <sup>5</sup>	1,534	1,529	1,535	1,540	1,546	1,545

<sup>1</sup> Phase 2 experimental diets were fed from d 21 to 42 (210- to 250-lb BW).

<sup>2</sup> Dried distillers grains with solubles.

<sup>3</sup> Modified ME was calculated by The Hanor Company.

<sup>4</sup> SID lysine, SID tryptophan:lysine (%), and ME (kcal/lb) were calculated using NRC (1998) values.

<sup>5</sup> All energy levels used to calculate ME were based on NRC values except DDGS, where the energy value of corn was used.

**Table 3. Composition of diets (Phase 3, 250 to market; as-fed basis)<sup>1</sup>**

Ingredient, %	DDGS, % <sup>2</sup>	Phase 3					0
		0	30			0	
		17	15	17	19	21	
	SID trp:lys,%						
Corn	86.02	72.58	69.92	67.18	64.53	80.67	
Soybean meal (47.5% CP)	11.42	5.44	7.97	10.59	13.13	16.54	
DDGS	---	20.00	20.00	20.00	20.00	---	
Choice white grease	0.45	---	0.25	0.50	0.75	0.95	
Limestone	0.84	1.09	1.08	1.06	1.04	0.81	
Monocalcium P (21% P)	0.52	0.07	0.05	0.02	---	0.49	
Salt	0.40	0.40	0.40	0.40	0.40	0.40	
Vitamin/mineral premix with phytase	0.10	0.10	0.10	0.10	0.10	0.10	
L-Lysine HCl	0.22	0.31	0.23	0.15	0.08	0.06	
L-Threonine	0.05	0.02	---	---	---	---	
Total	100	100	100	100	100	100	
Calculated analysis							
Standardized ileal digestible (SID) amino acids, %							
Lysine	0.66	0.66	0.66	0.66	0.66	0.66	
Isoleucine:lysine	64	68	74	80	86	77	
Met & Cys:lysine	61	78	81	85	88	68	
Threonine:lysine	66	66	70	75	79	69	
Tryptophan:lysine	17	15	17	19	21	21	
Valine:lysine	77	87	93	99	105	89	
Total lysine, %	0.73	0.76	0.76	0.77	0.77	0.74	
Modified ME, kcal/lb <sup>3</sup>	1,491	1,491	1,490	1,490	1,490	1,490	
SID lysine:ME, g/Mcal	2.01	2.01	2.01	2.01	2.01	2.01	
CP, %	12.8	14.3	15.2	16.2	17.1	14.6	
Ca, %	0.58	0.58	0.58	0.58	0.58	0.58	
P, %	0.51	0.48	0.48	0.49	0.50	0.53	
Available P, %	0.26	0.26	0.26	0.26	0.26	0.26	
SID lysine <sup>4</sup>	0.66	0.64	0.64	0.65	0.65	0.67	
SID tryptophan:lysine, % <sup>4</sup>	16.9	15.4	17.5	19.6	21.5	20.9	
ME, kcal/lb <sup>5</sup>	1,531	1,526	1,531	1,536	1,541	1,540	

<sup>1</sup>Phase 3 experimental diets were fed from d 42 to market (250 lb BW to market).

<sup>2</sup>Dried distillers grains with solubles.

<sup>3</sup>Modified ME was calculated by The Hanor Company.

<sup>4</sup>SID lysine, SID tryptophan:lysine (%), and ME (kcal/lb) were calculated using NRC (1988) values.

<sup>5</sup>All energy levels used to calculate ME were based on NRC values except DDGS, where the energy value of corn was used.



**Table 4. Effects of standardized ileal digestible (SID) tryptophan:lysine ratios in diets containing 30% dried distillers grains with solubles (DDGS) on growth performance of 157- to 285-lb pigs<sup>1</sup>**

	DDGS, %	0		30				SEM	DDGS <sup>2</sup>	Probability, <i>P</i> < 17 vs. 21% trp:lys in corn-soy	Tryptophan	
		SID trp:lys,%	17	21	15	17	19				21	Linear
Replications <sup>3</sup>			17	17	17	16	16	17				
Initial wt, lb		157.1	157.3	157.3	157.2	157.2	157.4	3.0	0.96	0.97	0.98	0.96
Final wt, lb		280.0	278.3	274.6	272.5	276.7	273.6	2.6	0.02	0.65	0.92	0.85
Avg. days from d 42 to harvest <sup>4</sup>		18.9	17.9	18.9	18.8	18.4	19.2	0.3	0.08	0.04	0.87	0.17
d 0 to 52												
ADG, lb		1.97	2.02	1.90	1.88	1.97	1.89	0.02	<0.01	0.12	0.52	0.27
ADFI, lb		6.42	6.40	6.33	6.24	6.43	6.22	0.08	0.04	0.88	0.72	0.50
F/G		3.26	3.17	3.34	3.33	3.27	3.30	0.04	0.01	0.09	0.26	0.63
HCW, lb		206.0	205.8	202.0	200.9	204.3	203.1	0.90	<0.01	0.89	0.07	0.98
Yield, %		73.8	73.9	73.2	73.4	73.8	74.4	0.31	0.99	0.80	<0.01	0.42
Backfat, in.		21.4	20.8	21.3	21.1	20.9	21.2	0.20	1.00	0.04	0.69	0.24
Loin depth, in.		59.8	60.4	59.6	59.1	59.8	59.2	0.30	<0.01	0.15	0.79	0.73
Lean, %		52.1	52.4	52.1	52.1	52.2	52.0	0.11	0.04	0.04	0.70	0.44

<sup>1</sup> A total of 2,298 pigs (gilts and barrows, PIC TR4 × 1050; initially 157 lb) were used in a 52-d late finishing trial with 23 pigs per pen and 16 to 17 pens per treatment.

<sup>2</sup> Main effect of level of DDGS was analyzed by comparing between 17 and 20% SID tryptophan:lysine ratio in corn-soybean meal diet with 17 and 20% SID tryptophan:lysine ratio in 30% DDGS diet.

<sup>3</sup> Replications are numbers of pens for each treatment.

<sup>4</sup> Average days from d 42 to harvest was calculated as total pig days from d 42 to harvest divided by total head count at the d 42.