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Evaluation of High Standardized Ileal Digestible Tryptophan:Lysine Ratios with Ractopamine HCl on Growth and Carcass Performance of Pigs from 240 to 295 lb[1]

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Summary

A total of 935 pigs (PIC 1050 × 337, initially 237.2 lb BW) were used in a 22-d trial to determine the effects of feeding high levels of standardized ileal digestible (SID) Trp:Lys ratio in diets with ractopamine HCl (RAC, Paylean, Elanco Animal Health, Greenfield, IN) on growth and carcass performance of finishing pigs. Pens of 23 or 24 pigs were allotted by BW and randomly assigned to 1 of 5 dietary treatments with 8 replications per treatment. The dietary treatments included 5 SID Trp:Lys ratios (20, 22, 24, 26, and 28% of Lys). All diets were formulated to 0.90% SID Lys and contained 10 ppm ractopamine. At d 22, pigs were transported to a packing plant for processing and carcass data collection. For overall growth performance, increasing SID Trp:Lys increased (linear, $P < 0.05$) ADFI and SID Trp g/kg gain. However, there was no evidence for treatment differences for ADG or F/G. For carcass characteristics, there was no evidence for treatment differences for HCW, carcass yield, backfat loin depth, lean, carcass ADG, or carcass feed efficiency. In summary, increasing SID Trp:Lys increased ADFI and SID Trp g/kg gain, however, there was no evidence for treatment differences for other growth or carcass parameters measured.

Introduction

Tryptophan (Trp) is generally considered the second or third limiting amino acid in corn-soybean meal-based diets fed to growing and finishing swine.[4] Although considerable research has been conducted to determine the optimum Trp requirement for swine, there are important discrepancies between studies.[5] The NRC[6] SID Trp:Lys ratio

[1] Appreciation is expressed to New Horizons Farms (Pipestone, MN) for providing animals and research facilities, and to Marty Heintz for technical assistance.

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[3] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[4] Burgoon, K. G., D. A. Knabe, and E. J. Gregg. 1992. Digestible tryptophan requirements of starting, growing, and finishing swine. J. Anim. Sci. 70:2493-2500.

[5] Susenbeth, A. 2006. Optimum tryptophan: lysine ratio in diets for growing pigs: analysis of literature data. Livest. Sci. 101:32–45.

[6] NRC. 2012. Nutrient Requirements of Swine. 11th ed. Natl. Acad. Press, Washington, DC.

requirement estimate for pigs above 165 lb is 17.7% of Lys. Zhang[7] et al. suggested an ideal SID Trp:Lys ratio ranged from 19.7 to 23.6% for finishing pigs depending on the response variable. Gonçalves[8] et al. reported that increasing SID Trp: Lys ratio to 24.5% in finishing pigs fed ractopamine HCl (RAC) during summer months improved ADG by 0.15 and 0.08 lb/d in comparison with ratios of 18 and 21%, respectively. These results were later supported by the findings of Soto[9] et al., where Trp:Lys ratios of 24 and 28% improved ADG by 0.11 and 0.09 lb/d, respectively, compared with pigs fed a Trp:Lys ratio of 20% ratio when diets contained RAC. With a limited number of ratios to determine the maximum performance response, the objective of this experiment is to evaluate the effects of feeding higher levels of SID Trp:Lys than used in our earlier study in diets containing RAC on growth and carcass performance of pigs from 240 to 295 lb.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at a commercial research-finishing site in southwest Minnesota. The barn was naturally ventilated and double-curtain-sided. Each pen was equipped with a 5-hole stainless steel feeder and bowl waterer for ad libitum access to feed and water. Feed additions to each individual pen were made and recorded by a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN).

In April 2017, a total of 935 pigs (PIC 1050 × 337, initially 237.2 lb BW) were used in a 22-d trial. There were 23 or 24 mixed-gender pigs per pen at a floor space of 7.4 ft^2 per pig, and 8 replications per treatment. Pigs were allotted based on initial BW and assigned to 1 of 5 treatments in a completely randomized block design. The dietary treatments included 5 SID Trp:Lys ratios (20, 22, 24, 26, and 28% of Lys, Table 1). All diets were formulated with 0.90% SID Lys and contained 10 ppm ractopamine. Prior to the trial, from 200 to 240 lb, these pigs were fed a corn-soybean meal-dried distillers grains with solubles-based diet that contained 13.0% CP, 0.70% SID Lys, 20% SID Trp:Lys ratio, and 1,150 kcal NE/lb.

Pigs were weighed on d 0, 9, and 22, to determine ADG, ADFI, and F/G. Prior to marketing, pigs were individually tattooed with a pen ID number to allow for carcass measurements to be recorded on a pen basis. On d 22, final pen weights were taken, and pigs were sent to a commercial packing plant (JBS Swift and Company, Worthington, MN) for processing and carcass data collection. Carcass measurements taken at the plant included HCW, loin depth, backfat, and percentage lean.

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 until they were

[7] Zhang, G. J., Q. L. Song, C. Y. Xie, L. C. Chu, P. A. Thacker, J. K. Htoo, and S. Y. Qiao. 2012. Estimation of the ideal standardized ileal digestible tryptophan to lysine ratio for growing pigs fed low crude protein diets supplemented with crystalline amino acids. Livest. Sci. 149:260–266.

[8] Gonçalves, M. A. D. 2015. Effects of standardized ileal digestible tryptophan:lysine ratio on growth performance of finishing gilts under commercial conditions. PhD diss., Kansas State University, Manhattan, KS.

[9] J. A. Soto, M. D. Tokach, K. J. Touchette, S. S. Dritz, J. C. Woodworth, J. M. DeRouchey, and R. D. Goodband. 2017. Evaluation of Standardized Ileal Digestible Tryptophan:Lysine Ratio on Growth Performance and Carcass Characteristics of Finishing Pigs Fed with or without Ractopamine HCl. *Kansas Agricultural Experiment Station Research Reports*: Vol. 3: Iss. 7.

homogenized, subsampled, and submitted for total AA analysis (except Trp; method 994.12;[10]) and Trp (method 994.13;[10]) by Ajinomoto Heartland, Inc. (Chicago, IL). Samples of the diets were also submitted to Cumberland Valley Analytical Service (Hagerstown, MD) for analysis of DM, CP, Ca, P, ether extract, and ash.

Data were analyzed using the GLIMMIX procedure of SAS version 9.4 (SAS Institute, Inc., Cary, NC) in a randomized complete block design with pen serving as the experimental unit and initial BW serving as the blocking factor. Dietary treatments were the fixed effect and block served as the random effect in the analysis. Preplanned linear and quadratic orthogonal contrast were built using coefficients for equally spaced treatment and used to determine the main effects of increasing SID Trp. Hot carcass weight served as a covariate for the analysis of backfat, loin depth, and lean percentage. Results from the experiment were considered significant at $P < 0.05$ and a marginally significant between $P > 0.05$ and $P \leq 0.10$.

Results

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

For overall growth performance (d 0 to 22), increasing SID Trp:Lys ratio increased (linear, $P < 0.05$) ADFI and SID Trp g/kg gain. However, there was no evidence for treatment differences for ADG or F/G. Similarly, for carcass characteristics, there was no evidence for treatment differences for HCW, carcass yield, backfat loin depth, lean, carcass ADG, or carcass feed efficiency.

In summary, increasing SID Trp:Lys did not provide any benefits in overall growth or carcass performance. The ADFI results of this study are consistent with the findings of Gonçalves et al.,[8] where ADFI was 0.07 lb/d higher in finishing gilts fed 24.5% SID Trp:Lys ratio compared with pigs fed 21% SID Trp:Lys ratio in diets containing RAC. Consequently, ADG was 0.08 lb/d higher in their experiment. Furthermore, Soto et al.[9] observed improvements in growth, where ADG was 50 g/d higher in finishing pigs fed 24.0% SID Trp:Lys ratio compared with pigs fed 20% SID Trp:Lys ratio in diets containing RAC. Conversely, ADG did not improve with increasing Trp:Lys in the current study. Tryptophan is involved in the regulation of behavioral and physiological processes such as susceptibility to stress and feed intake.[11,12] In addition, extended supplementation of Trp may be required to observe performance improvements.[13] Further research is necessary to determine why inconsistencies are observed when feeding high SID Trp:Lys ratios to finishing pigs as well as to identify the greatest opportunities to yield economic benefits.

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[10] AOAC International. 2012. Official Methods of Analysis of AOAC Int. 19rd ed. Assoc. Off. Anal. Chem., Gaithersburg, MD.

[11] Adeola O., Ball R. 1992. Hypothalamic neurotransmitter concentrations and meat quality in stressed pigs offered excess dietary tryptophan and tyrosine. J. Anim. Sci. 70:1888–94.

[12] Li Y., Kerr B., Kidd M., Gonyou H. 2006. Use of supplementary tryptophan to modify the behavior of pigs. J Anim. Sci. 84:212–20.

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

	Standardized ileal digestible Trp:Lys ratio, %				
Ingredient, %	20	22	24	26	28
Corn	74.88	74.85	74.82	74.83	74.85
Soybean meal (46.5% CP)	21.74	21.74	21.74	21.74	21.74
Choice white grease	1.10	1.10	1.10	1.08	1.05
Limestone	0.95	0.96	0.97	0.96	0.95
Monocalcium P (21% P)	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
L-Lys-HCl	0.25	0.25	0.25	0.25	0.25
DL-Met	0.11	0.11	0.11	0.11	0.11
L-Thr	0.12	0.12	0.12	0.12	0.12
L-Trp	0.03	0.04	0.06	0.08	0.10
L-Val	0.02	0.02	0.02	0.02	0.02
Ractopamine[2]	0.05	0.05	0.05	0.05	0.05
Phytase[3]	0.02	0.02	0.02	0.02	0.02
Vitamin and trace minerals	0.15	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Standardized ileal digestible amino acids, %					
Lys	0.90	0.90	0.90	0.90	0.90
Ile:Lys	63	63	63	63	63
Leu:Lys	136	136	136	136	136
Met:Lys	37	37	37	37	37
Met and Cys:Lys	62	62	62	62	62
Thr:Lys	67	67	67	67	67
Trp:Lys	20.0	22.0	24.0	26.0	28.0
Val:Lys	71	71	71	71	71
His:Lys	40	40	40	40	40
SID Lys: NE, g/Mcal	3.53	3.53	3.53	3.53	3.53
NE NRC, kcal/lb	1,157	1,157	1,157	1,157	1,157
CP, %	16.0	16.0	16.0	16.0	16.0
Ca, %	0.50	0.50	0.50	0.50	0.50
P, %	0.40	0.40	0.40	0.40	0.40
Available P, %	0.24	0.24	0.24	0.24	0.24
Standardized digestible P, %	0.29	0.29	0.29	0.29	0.29

[1] Diets were fed from d 218 to 285 lb.

[2] Paylean (Elanco Animal Health, Greenfield, IN) provided the final diet with 10 ppm of ractopamine.

[3] Optiphos 2000 (Enzyvia LLC, Sheridan, IN) provided 136.5 FTU per pound of diet.

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

	SID Trp:Lys, %				
Item, %	20	22	24	26	28
DM	86.6	86.6	86.7	86.6	86.6
CP	16.0	15.8	15.4	15.0	15.8
Ca	0.73	0.50	0.63	0.58	0.63
P	0.38	0.37	0.41	0.35	0.36
Fat	3.6	3.4	4.1	3.3	3.7
Ash	2.9	3.3	3.3	3.0	3.7
Amino acids, %					
Lys	0.96	0.96	0.95	0.94	0.91
Ile	0.69	0.69	0.67	0.69	0.66
Leu	1.41	1.41	1.40	1.43	1.39
Met	0.33	0.33	0.33	0.34	0.32
Met and Cys	0.60	0.60	0.60	0.61	0.59
Thr	0.68	0.66	0.66	0.67	0.64
Trp	0.19	0.19	0.21	0.21	0.20
Val	0.78	0.78	0.77	0.77	0.75
His	0.40	0.40	0.39	0.39	0.39
Phe	0.78	0.79	0.77	0.78	0.76
Free Trp	0.03	0.05	0.07	0.09	0.07

[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. Amino acid analysis was conducted on composite samples by Ajinomoto Heartland, Inc. (Chicago, IL). Samples of the diets were also submitted to Cumberland Valley Analytical Service (Hagerstown, MD) for analysis of DM, CP, Ca, P, ether extract, and ash.

Table 3. The effects of feeding high standardized ileal digestible (SID) tryptophan to lysine ratio on growth performance, carcass characteristics, and economics of finishing pigs[1]

	SID Trp:Lys, %						Probability, *P* <	
Item	20	22	24	26	28	SEM	Linear	Quadratic
BW, lb								
d 0	237.2	237.2	237.2	237.2	237.3	2.03	0.822	0.927
d 22	290.4	292.6	290.2	293.3	292.6	1.99	0.247	0.955
d 0 to 20								
ADG, lb	2.42	2.50	2.41	2.54	2.48	0.056	0.340	0.733
ADFI, lb	6.30	6.42	6.38	6.52	6.62	0.084	0.007	0.675
F/G	2.61	2.57	2.65	2.57	2.66	0.047	0.477	0.564
SID Trp g/kg gain	5.2	5.6	6.4	6.7	7.4	0.11	<0.001	0.495
NE Caloric efficiency[2]	3,079	3,033	3,129	3,033	3,140	55.3	0.464	0.561
Carcass characteristics								
HCW, lb	216.4	217.8	216.3	218.1	217.4	1.60	0.550	0.839
Carcass yield, %	74.5	74.4	74.6	74.4	74.3	0.21	0.451	0.671
Backfat,[3] in.	0.60	0.57	0.60	0.59	0.60	0.010	0.797	0.421
Loin depth,[3] in.	2.76	2.78	2.73	2.82	2.74	0.124	0.988	0.866
Lean,[3] %	57.9	58.5	57.9	58.4	57.9	1.01	0.938	0.791
Carcass performance								
Carcass ADG,[4] lb	1.80	1.86	1.80	1.89	1.84	0.042	0.391	0.683
Carcass G:F[5]	0.286	0.290	0.282	0.290	0.279	0.005	0.392	0.489

[1] A total of 935 pigs (PIC 1050 × 337) were used with 23 or 24 pigs per pen and 8 replications per treatment.

[2] Caloric efficiency is expressed as kcal/lb of gain.

[3] Adjusted using HCW as a covariate.

[4] Carcass average daily gain = overall ADG × carcass yield.

[5] Carcass G:F = overall average feed intake:carcass average daily gain.