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Effects of Standardized Ileal Digestible Tryptophan:Lysine Ratio on Growth and Carcass Performance of Finishing Pigs Fed Ractopamine HCl[1]

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Summary

Recent research has reported that increasing standardized ileal digestible (SID) Trp:Lys ratio above 20% in finishing pigs fed ractopamine HCl (RAC) resulted in improved growth and carcass performance, however, this response has been inconsistent. Therefore, the objective of this study was to evaluate the effects of feeding high SID Trp:Lys ratios with RAC on growth and carcass performance. A total of 1,791 finishing pigs (PIC 1050 × 337, initially 245.1 lb BW) were used in a 27-d study to evaluate the effects of feeding high SID Trp:Lys ratios on growth and carcass performance of pigs fed ractopamine HCl (RAC, Paylean, Elanco Animal Health, Greenfield, IN). Pens of 25 or 26 pigs were allotted by initial body weight (BW) and randomly assigned to 1 of 5 dietary treatments with 14 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 27, pigs were transported to a commercial packing plant (JBS Swift and Company, Worthington, MN) for processing and carcass data collection. For overall growth performance, increasing SID Trp:Lys ratio increased (linear; P = <0.0001) SID Trp intake and Trp g/kg of gain; however, there was no evidence of a treatment difference (P > 0.10) for average daily gain (ADG) or feed efficiency (F/G). For carcass characteristics, increasing SID Trp:Lys decreased (linear; P = 0.002) carcass yield and tended to decrease (P = 0.078) lean percentage. There was no evidence of treatment differences (P > 0.10) for hot carcass weight, loin depth, carcass ADG, or carcass feed efficiency. The results from this study showed that grams per day of SID Trp intake ranged from 5.5 to 7.5. Greater feed intakes observed in this study resulted in increased Trp g/d of intake and could potentially be a reason why no evidence for treatment differences was observed. In summary, increasing SID

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Trp:Lys ratios above 20% (approximately 5.4 g SID Trp intake per day) in pigs fed RAC did not improve growth or carcass performance.

Introduction

The NRC[4] requirement estimate for Trp for pigs greater than 165 lb is 17.7% of Lys. Gonçalves[5] observed that increasing SID Trp:Lys ratio to 23.5% in finishing pigs fed ractopamine HCl (RAC) during summer months optimized the ADG. Soto[6] also observed an improvement in ADG when finishing pigs were fed Trp:Lys ratios of 24 and 28% compared with pigs fed a Trp:Lys ratio of 20% when diets contained RAC. However, more recent research has observed inconsistencies to the response of increasing ratios of SID Trp:Lys in pigs fed diets containing RAC. Soto[7] observed that increasing SID Trp:Lys from 20 to 28% showed no evidence for a difference in growth or carcass growth performance in pigs fed RAC. Therefore, the objective of this study was to further evaluate the effects of high SID Trp:Lys ratios with RAC on growth and carcass performance of finishing pigs.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol for 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 feed system (FeedPro; ComDel Innovation, Wilmar, MN).

A total of 1,791 finishing pigs (PIC 1050 × 337, initially 245.1 lb BW) were used in a 27-d study. There were 25 or 26 pigs per pen at a floor space allowance of 6.78 ft.^{2} per pig, and 14 replications per treatment. Pigs were allotted based on initial BW and assigned to 1 of 5 dietary treatments in a completely randomized block design. The dietary treatments included increasing SID Trp concentrations of 20, 22, 24, 26, or 28% of SID Lys (Table 1). All diets were corn-soybean meal-based and were formulated to 0.90% SID Lys. All diets contained 10 ppm ractopamine.

Pigs were weighed on d 0, 6, and 27 to determine ADG, average daily feed intake (ADFI), and F/G. At the first marketing event (d 6), the 2 heaviest pigs per pen were selected and marketed following the routine farm protocol with no carcass data collected on these pigs. At the conclusion of the trial (d 27), final pen weights were taken, and the remaining animals were tattooed with a corresponding pen number

[4] NRC. 2012. Nutrient Requirements of Swine. 11th ed. Natl. Acad. Press, Washington, D.C.

[5] Gonçalves, M.A.D., M.D. Tokach, N.M. Bello, K.J. Touchette, R.D. Goodband, J.M. DeRouchey, J.C. Woodworth, and S.S. Dritz. 2018. Dose–response evaluation of the standardized ileal digestible tryptophan: lysine ratio to maximize growth performance of growing-finishing gilts under commercial conditions. Anim 12:1380-1387. doi:10.1017/S1751731117002968.

[6] Soto, J.A., 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. Kans. Ag. Exp. Stat. Res. Rep. 3:1-7. doi:10.4148/ 2378-5977.7488.

[7] Soto, J. A. 2018. Effects of low crude protein, amino acid fortified diets and neutral detergent fiber on finishing pig performance. Ph.D. Diss. Kansas State Univ., Manhattan.

and were transported 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 depth, 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 submitted for total amino acid (AA) analysis (except Trp; AOAC method 994.12[8]) and free Trp (AOAC method 994.13[9]) by Ajinomoto Heartland, Inc. (Chicago, IL). Samples of the diets were also analyzed for dry matter (DM), crude protein (CP), calcium (Ca), and phosphorus (P; Ward Laboratories, Inc., Kearney, NE; Table 2).

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 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 and initial BW as a covariate. Preplanned linear and quadratic contrasts were used to determine the effects of increasing SID Trp. Hot carcass weight served as a covariate for the analysis of backfat depth, loin depth, and lean percentage. Results were considered significant at $P < 0.05$ and marginally significant between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

Results of analyzed nutrients and total AA content of experimental diets (Table 2) showed calcium levels that were higher than expected from formulated values. This was consistent across all experimental diets. Phosphorus and crude protein levels were reasonably consistent with formulated values. Total AA content values for free Trp analyzed as expected as the analyzed values increased in a step-wise manner with increasing SID Trp:Lys.

For overall growth performance (d 0 to 27), increasing SID Trp:Lys increased (linear, $P = <0.0001$) SID Trp g/d intake and SID Trp g kg/of gain; however, there was no evidence of treatment differences ($P > 0.10$) for ADG, ADFI, F/G, or caloric efficiency (Table 3). Increasing SID Trp:Lys decreased ($P = 0.002$) carcass yield and tended to increase ($P = 0.078$) backfat depth. Lean percentage tended to decrease ($P = 0.0980$) with increasing SID Trp:Lys ratio. There was no evidence of treatment differences ($P > 0.10$) for HCW, loin depth, carcass ADG, or carcass feed efficiency.

In summary, there was no evidence for effects of increasing SID Trp:Lys ratio to improve overall growth or carcass performance. These results disagree with the observations of Gonçalves[5] and Soto.[6] The discrepancies in the results of the former studies could potentially be due to the high g/d of Trp intake observed in this study. Gonçalves[5] tested SID Trp:Lys ratios from 14.5% to 24.5% and observed SID Trp intake per day ranged from 2.3 to 4.4 grams, respectively. Soto[6] tested SID Trp:Lys ratios of 20, 24, and 28% and observed SID Trp intake per day ranged from 4.4 to 6.0 grams. The current study tested SID Trp:Lys ratios from 20% to 28% and observed grams of SID Trp intake ranged from 5.5 to 7.5 grams. This indicates that in the studies conducted by Gonçalves[5] and Soto[6] the SID Trp intake requirement was not being met

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

at the lower levels tested, and increasing the SID Lys:Trp resulted in a performance response. In the current study, the requirement for SID Trp intake was being met at the lowest level tested and resulted in no evidence of difference in growth performance with increasing SID Trp:Lys. The results of the current study would agree with observations from Soto.[7] These researchers tested SID Trp:Lys ratios from 20% to 28% and observed grams of SID Trp intake ranged from 5.1 to 7.6. The grams per day of SID Trp intake observed in Soto[7] were comparable to the observations in the current study. The results of the current study and Soto[5] show that greater feed intakes resulting in increased intake of Trp g/d could potentially be a reason why no evidence for treatment differences are observed. Therefore, increasing SID Trp:Lys ratios above 20% (approximately 5.4 g SID Trp intake per day) in pigs fed RAC did not improve growth or carcass performance.

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

Ingredient, %	Basal diet
Corn	75.30
Soybean meal, 47% crude protein	21.40
Beef tallow	1.00
Limestone	0.95
Monocalcium phosphate (21% P)	0.25
Salt	0.50
L-lysine-HCl	0.25
DL-methionine	0.05
L-threonine	0.09
L-tryptophan[2]	---
Ractopamine[3]	0.05
Phytase[4]	0.02
Vitamin and trace minerals	0.15
Total	100.00
Calculated analysis	
Standardized ileal digestible (SID) AA, %	
Lysine	0.90
Methionine:lysine	32
Methionine and cysteine:lysine	59
Threonine:lysine	65
Tryptophan:lysine	20
Valine:lysine	72
Histidine:lysine	44
SID Lysine:net energy, g/Mcal	3.54
Net energy, kcal/lb	1,138
Crude protein, %	16.8
Calcium, %	0.50
Phosphorus, %	0.40
STTD P[5], %	0.36

[1]A total of 1,791 pigs (PIC 1050 × 337; initially 245.1 lb BW) were used with 25 or 26 pigs per pen and 14 replications per treatment.
[2]L-tryptophan was added at 0.31, 0.68, 1.05, 1.42, and 1.78 lb to achieve SID Trp:Lys ratios of 20, 22, 24, 26, and 28.
[3]Paylean (Elanco Animal Health, Greenfield, IN) provided the final diet with 10 ppm of ractopamine.
[4]Optiphos 2000 (Huevepharma, Inc., Sofia, Bulgaria) provided 136.5 FTU per lb of diet with an estimated release of 0.10% STTD P.
[5]Standardized total tract digestible phosphorus.

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

	Standardized ileal digestible Trp:Lys ratio, %				
Item, %	20	22	24	26	28
Dry matter	88.7	88.5	88.8	88.4	88.3
Crude protein	16.1	16.4	16.2	16.0	16.5
Calcium	0.64	0.60	0.60	0.57	0.60
Phosphorus	0.37	0.38	0.37	0.36	0.39
Amino acids, %					
Lysine	0.98	1.08	0.98	0.94	0.94
Isoleucine	0.61	0.67	0.63	0.62	0.61
Leucine	1.35	1.44	1.34	1.32	1.26
Methionine	0.35	0.36	0.33	0.31	0.31
Methionine and cysteine	0.59	0.62	0.57	0.55	0.54
Threonine	0.67	0.69	0.67	0.64	0.63
Tryptophan	0.19	0.20	0.21	0.23	0.22
Valine	0.71	0.77	0.72	0.70	0.68
Histidine	0.40	0.43	0.39	0.38	0.36
Phenylalanine	0.82	0.88	0.81	0.78	0.74
Free tryptophan	0.03	0.04	0.05	0.06	0.08

[1]Diet samples were taken from 6 feeders per dietary treatment 3 d after 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 diet were also submitted to Ward Laboratories, Inc. (Kearney, NE) for analysis of dry matter, crude protein, calcium, and phosphorus.

Table 3. Effects of standardized ileal digestible (SID) tryptophan:lysine ratio on growth performance and carcass characteristics of finishing pigs fed ractopamine HCl[1]

	SID Trp:Lys, %						Probability, *P* =	
Item[2]	20	22	24	26	28	SEM	Linear	Quadratic
BW, lb								
d 0	244.4	244.6	245.4	245.2	245.8	4.47	0.053	0.890
d 27[3]	299.1	298.4	301.2	297.6	302.5	1.62	0.208	0.404
d 0 to 27								
ADG, lb[3]	2.16	2.06	2.21	2.04	2.23	0.060	0.521	0.199
ADFI, lb[3]	5.90	5.80	6.01	5.74	5.92	0.071	0.978	0.753
F/G[3]	2.75	2.83	2.73	2.86	2.66	0.067	0.464	0.192
SID Trp intake, g/d[3]	5.4	5.8	6.5	6.8	7.5	0.08	<0.0001	0.681
SID Trp, g/kg gain[3]	5.5	6.2	6.7	7.4	7.5	0.13	<0.0001	0.079
Caloric efficiency, kcal/lb of gain[3]	3,132	3,219	3,108	3,254	3,206	75.8	0.464	0.192
Carcass characteristics								
HCW, lb	222.6	221.4	222.3	221.0	222.1	3.27	0.892	0.835
Carcass yield, %	74.7	74.4	73.8	74.3	73.2	0.40	0.002	0.770
Backfat,[4] in.	0.61	0.60	0.62	0.61	0.63	0.011	0.078	0.648
Loin depth,[4] in.	2.88	2.91	2.89	2.89	2.88	0.017	0.805	0.532
Lean,[4] %	58.3	58.4	58.0	58.2	57.8	0.19	0.098	0.547
Carcass performance								
Carcass ADG,[5] lb	1.61	1.53	1.63	1.51	1.63	0.042	0.838	0.176
Carcass F/G[6]	3.68	3.80	3.71	3.85	3.64	0.096	0.898	0.169

[1]A total of 1,791 pigs (PIC 1050 × 337) were used with 25 or 26 pigs per pen and 14 replications per treatment.
[2]BW = body weight. ADG = average daily gain. ADFI = average daily feed intake. F/G = feed efficiency.
[3]Adjusted using initial BW as a covariate.
[4]Adjusted using HCW as a covariate.
[5]Carcass average daily gain = overall ADG × carcass yield.
[6]Carcass F/G = overall ADFI/carcass ADG.