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Effects of Adding Fiber Sources to Low Crude Protein, Amino Acid Supplemented Diets on Nitrogen Excretion, Performance, and Carcass Traits of Finishing Pigs

J.A. Shriver, S.D. Carter, B.W. Senne and L.A. Pettey

Story in Brief

Two experiments were conducted to evaluate the effects of adding fiber sources to low crude protein, amino acid supplemented diets on nitrogen excretion, growth performance, and carcass traits of finishing pigs. In Exp. 1, six sets of four littermate barrows, initially weighing 80 lb, were allotted to one of four dietary treatments to determine nitrogen balance. Dietary treatments were: 1) fortified corn-soybean meal control, 2) as 1 with crude protein lowered by four percentage units and supplemented with lysine, threonine, methionine, tryptophan, isoleucine, and valine (LPAA), 3) as 2 plus 10% soybean hulls (SBH), and 4) as 2 with 10% dried beet pulp (DBP). Total nitrogen excretion was reduced by 49% in pigs fed the LPAA diet, but it was not affected by fiber addition. However, addition of SBH or DBP to the LPAA diet shifted nitrogen excretion from the urine to the feces. In Exp. 2, 72 pigs, initially weighing 78 lb, were blocked by BW, sex, and litter and allotted randomly to three dietary treatments. The three dietary treatments used were similar to those used in Exp. 1, with a control diet, a LPAA diet, and a LPAA diet with 10% SBH. Growth performance, lean gain, and most carcass traits were not affected by treatment. However, pigs fed the LPAA diet had slightly smaller longissimus muscle area and an increase in 10th rib fat depth. The addition of SBH to the LPAA diet reduced 10th rib fat to that of the control pigs. These data suggest that reducing crude protein by four percentage units decreased nitrogen excretion without influencing growth performance. Fiber addition to a LPAA diet had little effect on nitrogen balance or growth performance.

Key Words: Pigs, Amino Acids, Fiber, Carcass Traits

Introduction

Nitrogen excretion is currently a major pollution concern in the swine industry. Excess nitrogen in the diet of finishing pigs is excreted primarily as urinary nitrogen. It has been reported that reducing dietary protein by four percentage units with addition of lysine, methionine, threonine, and tryptophan results in a marked reduction in urinary nitrogen excretion from growing-finishing pigs (Carter et al., 1996). Urinary nitrogen is composed primarily of urea nitrogen, which is associated with ammonia emission from the slurry. Feeding soybean hulls or beet pulp to finishing pigs reduces slurry ph and ammonia emissions (Cahn et al., 1998). Furthermore, including fermentable carbohydrates, such as soybean hulls or beet pulp (van Soest, 1967), in the diet will shift nitrogen excretion from the urine to the feces (Morgan and Whittemore, 1988). Therefore, an experiment was conducted to evaluate the effects of fiber addition to low crude protein, amino acid supplemented diets on nitrogen balance, growth performance, and carcass traits of

finishing pigs.

Materials and Methods

In Exp. 1, six sets of four littermate barrows, initially weighing 80 lb, were allotted randomly based on BW, sex, and litter, to one of four dietary treatments. Dietary treatments were: 1) fortified corn-soybean meal based diet serving as the control, 2) as Diet 1 with crude protein lowered by four percentage units with the addition of L-lysine HCL, DL-methionine, L-threonine, L-tryptophan L-isoleucine, and L-valine (LPAA), 3) as Diet 2 plus 10% soybean hulls (11.4% CP, SBH), and 4) as Diet 2 plus 10% dried beet pulp (8.6% CP, DBP) (Table 1). Soybean hulls and beet pulp were added to Diets 3 and 4 at the expense of corn and soybean meal. Crystalline amino acids were added to Diets 2 through 4 to achieve an ideal ratio to digestible lysine (Chung and Baker, 1991). Pigs were housed in metabolism chambers (2.5 x 3 ft) to allow for the total, but separate, collection of urine, feces, and refused feed.

Pigs were fed dietary treatments for a 9-d adjustment period, followed by a 5-d total collection period of feces, urine, and feed refusals. Chromic oxide was fed on d 0 and d 5 of the collection period to be used as a marker for the beginning and end of the collection period. Pigs had ad libitum access to feed and water, and pigs and feeders were weighed on d 0 and 5 to monitor average daily gain (ADG), average daily feed intake (ADFI), and feed:gain (F:G). Feed, feces, and urine were collected daily to be analyzed for nitrogen content by Kjeldahl methodology.

In Exp. 2, 72 pigs, initially weighing 78 lb, were blocked by weight, sex, and genotype and allotted randomly to three dietary treatments in a randomized complete block design. There were six pen replicates per treatment of four pigs per pen. Dietary treatments were similar to those used in Exp. 1, with a control diet, a LPAA diet, and a LPAA diet with 10% SBH. Pigs were fed diets in three dietary phases. Phase 1 diets (78 to 130 lb) were formulated to .95% lysine, Phase 2 (131 to 180 lb) diets contained .80% lysine, and Phase 3 (181 to 240 lb) diets contained .65% total lysine. Dietary crude protein of the control diet was 18, 16, and 14% for the three phases, respectively. Dietary crude protein of Diets 2 through 4 was reduced by four percentage units in each phase. All other nutrients met or exceeded NRC (1998) standards. Pigs were allowed ad libitum access to feed and water throughout the test period. Pigs and feeders were weighed at 2-wk intervals for the determination of ADG, ADFI, and F:G.

Pigs were bled by jugular venipuncture at the end of each dietary phase. Blood was centrifuged and plasma harvested for plasma urea nitrogen analyses. Plasma urea nitrogen was determined by colorimetric procedures. When pigs reached approximately 240 lb, they were transported to a commercial packing plant and were humanely killed

(electrocution followed by exsanguination). Following scalding, scraping, and evisceration, the carcasses were weighed and chilled for 24 h. Standard carcass measures including backfat and longissimus muscle area at the 10th rib were collected. Dressing percentage was calculated by dividing hot carcass weight by live weight. Carcass lean (lb) and fat-free lean percentage were calculated using hot carcass weight, 10th rib backfat and longissimus muscle area (NPPC, 1991).

Data were analyzed as a randomized complete block design using analysis of variance procedures as described by Steel and Torrie (1997). Pen served as the experimental unit.

Results and Discussion

Experiment 1. Pigs fed the LPAA diet tended (P=.18) to have lower dry matter excretion than pigs fed the control diet (Table 2). Dry matter excretion tended (P=.10) to be higher with the addition of SBH to the LPAA diet; however this effect was less pronounced for pigs fed the DBP diet. Lowering CP and adding AA reduced (P<.01) N intake, and it reduced (P<.01) nitrogen excretion by 49% (Table 2). These effects were not affected (P>.10) by the addition of fiber source to the LPAA diet. Even though the control pigs absorbed more N, the amount of N retained was not affected (P>.10) by diet. However, addition of SBH or DBP to the LPAA diet resulted in a shift in N excretion from the urine to the feces. Pigs fed the control diet excreted 73% of total N as urinary N, while pigs fed the LPAA, SBH, and DBP excreted 65%, 61%, and 60% as urinary N respectively (Figure 1). This response is consistent with previous work (Morgan and Whittemore, 1988). Urinary urea N was reduced (P<.01) in pigs fed the LPAA diet, and a further reduction (P<.10) was observed when fiber was added to the LPAA diet. Urinary urea N is a substrate for urease, which is found in the feces. Reducing urinary urea N has been shown to reduce ammonia emission from the slurry (Cahn et al., 1998). Pigs fed the LPAA diet with soybean hulls did show a reduction of ammonia in the slurry (data not shown).

Experiment 2. No effects of dietary treatment on growth performance or carcass characteristics were observed, with the exception of average backfat (Table 3). Pigs fed the LPAA diet had increased backfat (P<.01); however, SBH addition to the LPAA diet tended to decrease (P<.10) average backfat and 10th rib fat. Longissimus muscle area and fat-free lean gain were not affected (P>.10) by treatment, although pigs fed the LPAA diet tended (P=.12) to have slightly smaller LMA.

As expected, plasma urea nitrogen concentrations were reduced (P<.01) markedly by lowering crude protein and adding amino acids. Addition of soybean hulls to the LPAA diet led to a slight reduction in plasma urea nitrogen (PUN) (Table 3). The reduction in PUN in pigs fed the low

protein, amino acid diet is indicative of a reduction in excess amino acids in these diets, agreeing with the reduction in urinary urea nitrogen in Exp. 1.

Implications

Reducing crude protein concentration of the diet of growing-finishing pigs with amino acid supplementation can markedly reduce nitrogen excretion. Furthermore, these results suggest that fiber addition to a LPAA diet will shift nitrogen excretion from the urine to the feces and reduce urinary urea nitrogen. Finally, the addition of a low cost feedstuff, such as soybean hulls, to a low protein, amino acid supplemented diet did not affect growth performance or carcass traits.

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Figure 1. Proportion of total N excretion attributed to urine and feces.

Table 1. Composition of diets in Exp. 1 (as fed basis).

	Diet[a]			
Ingredients, %	Control	LPAA	SBH	DBP
Corn, dent grain	71.12	72.22	71.56	71.63
SBM, dehulled	25.94	14.40	14.42	14.41
Soybean hulls	--	--	10.00	--
Beet pulp	--	--	--	10.00
Corn starch	--	10.00	--	--
Soybean oil	1.00	1.00	1.00	1.00
Dicalcium phosphate	1.23	1.58	1.55	1.57
Salt	.25	.25	.25	.25
Vit/TM premix	.25	.25	.25	.25
Antibiotic	.20	.20	.20	.20
L-lysine HCl	--	.29	.35	.32
L-threonine	--	.15	.17	.16
DL-methionine	--	.12	.12	.11
L-tryptophan	--	.04	.05	.04
L-isoleucine	--	.02	.04	.03
L-valine	--	--	.04	.02
Calculated Analysis				
Crude Protein, %	15.00	11.00	11.00	11.00
Lysine, %	.96	.96	.96	.96
Digestible AA, %				
Lysine	.78	.82	.80	.78
Threonine	.51	.55	.54	.53
Methionine + Cystine	.51	.54	.52	.50
Tryptophan	.16	.16	.16	.15

[a]Control = fortified corn-soybean meal diet; LPAA = low protein, amino acid supplemented diet; SBH = LPAA + 10% soybean hulls; DBP = LPAA + 10% dried beet pulp.

Table 2. Effects of reducing crude protein with amino acid supplementation and fiber addition on nitrogen balance, Exp. 1[a].

	Diet[b]				
Item	Control	LPAA	SBH	DBP	SE
DM excretion, g/d	7.8	6.2	9.6	7.8	1.0
Apparent N balance, g/d					

N intake[c]	58.4	43.8	46.3	45.6	1.5
Fecal N excretion	6.1	4.4	5.6	5.4	.85
Urinary N excretion[c]	16.9	9.5	8.7	8.1	1.2
Total N excretion[c]	23.1	13.9	14.3	13.5	1.4
Absorbed N[c]	52.2	39.1	40.8	41.0	1.8
Retained N[c]	35.3	31.1	32.2	32.9	1.9
Apparent N balance, %					
Absorption, % of int.	89.4	89.9	88.1	88.4	.83
Retention, % of int.[c]	60.5	71.2	69.3	70.7	.02
Retention, % of abs.[c]	67.7	79.1	78.5	79.8	.01

[a]Least squares means for six individually-penned pigs per treatment.

[b]Control = fortified corn-soybean meal diet; LPAA = low protein, amino acid supplemented diet; SBH = LPAA + 10% soybean hulls; DBP = LPAA + 10% dried beet pulp.

[c]LPAA vs Control, P<.10.

Table 3. Growth performance and carcass traits in Exp. 2[a].

	Diet[b]			
	Control	LPAA	SBH	SE
Performance				
ADG, lb	1.69	1.72	1.72	.06
ADFI, lb	4.68	4.85	4.88	.14
F:G	2.80	2.76	2.89	.12
Plasma urea N, mg/dl				
Phase I[d]	10.14	4.76	4.35	.53
Phase II[d]	8.51	4.40	4.07	.63
Phase III[d]	8.23	4.38	3.51	.82
Carcass traits[c]				
Dressing %	75.3	75.5	74.1	.29
Avg. backfat, in[d,e]	1.17	1.29	1.12	.03
10th rib BF, in	.873	.884	.798	.04
LMA, in	6.82	6.47	6.41	.16
Fat-free lean, %	50.4	49.7	50.2	.54
Fat-free lean, g/d	337.8	331.1	329.6	7.41

[a] Least squares means for six pens/trt of four pigs/pen.

[b]Control = fortified corn-soybean meal diet; LPAA = low protein, amino acid supplemented diet; SBH = LPAA + 10% soybean hulls; DBP = LPAA + 10%

dried beet pulp.

[c]Hot carcass weight used as covariate for carcass traits.

[d]LPAA vs Control, P<.10.

[e]SBH vs LPAA, P<.10.

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