Effects of Reduced Dietary CP and P on Nutrient Excretion of Finisher Pigs

M.B. Lachmann, S.D. Carter, T.A. Buhay, S.K. Jenkins, J.W. Bundy, and Z. Marable

Story in Brief

Approximately 80% of the feed consumed by a finisher pig occurs during the growing-finishing phase. Therefore, special attention needs to be placed on the amount of nutrients excreted during this phase. An experiment was conducted to determine the effects of reducing dietary crude protein (CP) by 2% units, and P by .1% unit on dry matter (DM), N, P, and mineral excretion during an entire finishing period. To achieve this objective, 48 Yorkshire barrows weighing 76 lb were used. Pigs were housed in an environmentally-controlled building with a shallow pit, pull-plug system as is commonly used in the High Plains region. The diets employed were a typical corn-soybean meal diet (control), and a low excretion diet (LED) with 2% units reduction in CP and .1% unit reduction in P. Pig weights and feed intake were recorded each week, and slurry samples were collected. Feed and slurry samples were analyzed for DM, N, P, Ca, K, Mg, Na, Fe, Zn, Cu and Mn. Dietary treatment did not affect pig growth performance. Daily and cumulative DM excretion was not affected by dietary treatment. However, the LED reduced daily N and P excretion by 21 and 23%, and cumulative N and P excretion by 20 and 24%, respectively, during the 106-d period. Ammonium N was reduced by 29%. However, very little effect on mineral excretion was observed. The reduction in dietary CP by 2% units and P by .1% unit reduced N and P excretion by .76 kg of N and .17 kg of P per finished pig.

Key Words: Nutrient Excretion, Nitrogen, Phosphorus, Finishing Pigs

Introduction

Intensive swine production operations have been associated with increased general concern about environmental pollution. Feeding nutrients in excess of pig requirements is a common practice in commercial operations, and nutrients fed in excess are excreted (Kornegay and Harper, 1997, Knowlton et al., 2004). Previous estimates of nutrient excretion of finishing pigs reported that 70% of N intake (Kornegay and Verstegen, 2001), 68% of P, and 50 to 95% of other minerals (Kornegay and Harper, 1997) are excreted. Reducing dietary protein with addition of crystalline AA is an effective means to decrease N excretion (Lachmann et al., 2006, Deng et al., 2007). Also, reducing dietary P by .1 % unit decreased P excretion between 21 and 25% (Cromwell et al., 1995, Harper et al., 1997, Lachmann et al., 2006). However, very little data are available for nutrient excretion using direct measurements with group-fed pigs. Therefore, the present experiment was conducted to determine the effects of reducing dietary CP by 2% units and P by .1% unit on DM, N, P, Ca, K, Mg, Na, Fe, Zn, Cu and Mn excretion during the finishing period.

Materials and Methods

A total of 48 Yorkshire barrows weighing 76 lb were housed in an environmentally-controlled building. The building had four identical rooms; each room contained an individual shallow pit, with a pull-plug system. Pigs were stratified by ancestry, blocked by body weight, and assigned to a dietary treatment. The two dietary treatments were a typical corn soybean meal diet

(control), and a low excretion diet (LED) with 2% units reduction in CP and .1% unit reduction in P. Both diets were formulated to be fed in three dietary phases based on true digestible lysine (.84, .71, and .59%, respectively). In order to achieve a 2% unit reduction in CP in the LED, soybean meal inclusion was reduced and crystalline AA were added on an ideal basis. Also, in the LED, dicalcium phosphate and limestone inclusion were reduced to achieve a .1% reduction in P while maintaining a Ca:tP ratio of 1.2:1. The diet composition is presented in Table 1.

Table 1. Composition of diets.

Phase	1 (76 - 122 lb)		2 (122 - 191 lb)		3 (191 - 238 lb)	
Diet	Control	LED	Control	LED	Control	LED
Ingredients, %						
Corn	68.98	74.67	74.44	80.18	83.37	89.01
Soybean meal, 48%	25.84	20.24	20.68	15.04	14.91	9.33
L-lysine	-	.17	-	.18	-	.17
L-threonine	-	.03	-	-	-	-
Soybean oil	3.00	3.00	3.00	3.00	-	-
Dicalcium phosphate	.68	.26	.52	.11	.33	-
Limestone	.95	.98	.82	.81	.84	.82
Salt	.25	.25	.25	.25	.25	.25
Vitamin mix	.15	.15	.15	.15	.15	.15
Trace mineral mix	.10	.10	.10	.10	.10	.10
Calculated composition, %						
CP	18.0	16.0	16.0	14.0	14.0	12.0
True dig. Lys	.84	.84	.71	.71	.59	.59
P	.50	.40	.45	.35	.40	.30

At the end of each week, pig weights, feed intake, slurry volume, pH, electrical conductivity (EC), and temperature were measured and slurry samples were collected. The finishing period ended when pigs reached a target weight of 238 lb. Feed and slurry samples were analyzed for DM, N, P, Ca, K, Mg, Na, Fe, Zn, Cu and Mn. Slurry volume and nutrient concentration were used to calculate nutrient excretion. The data were analyzed using a randomized complete block design. The model included the effects of diet, block, and the interaction. A room was used as the experimental unit, using 12 pigs per room and 2 rooms per treatment.

Results and Discussion

The average initial pig weight was 76 lb, and all pigs were fed to a target weight of 238 lb (P>.10). Pigs fed either control or LED had similar (P>.10) average daily gain (ADG), average daily feed intake (ADFI), feed:gain ratio (F:G), and duration of the finishing period (106-d) (Table 2).

Table 2. Pig growth performance of pigs fed control or LED for the 106-d period.

Diet	Control	LED	SE	P value
Initial Wt, lb	75.5	76.3	.46	>.10
Final Wt, lb	237.8	237.8	1.47	>.10
Duration of finishing period, d	104	108	2.48	>.10
ADG, lb/d	1.60	1.55	.06	>.10
ADFI, lb/d	4.60	4.40	.05	>.10
F:G	2.83	2.86	.01	>.10

Slurry DM concentration was similar (P>.10) for control and LED. Slurry N (10.3 vs 8.5%), NH4-N (6.0 vs 4.4%), and P (2.2 vs 1.7%) concentration tended (P<.10) to be reduced when the LED was fed. Slurry volume, temperature, EC and pH were similar (P>.10) for both treatments (Table 3).

Table 3. Slurry characteristics of pigs fed control or LED for the 106-d period

	Control	LED	SE	P value
Volume, gal/pig/d	2.84	3.22	.19	>.10
Temperature, oC	22.49	22.23	.13	>.10
EC, mS	4.58	3.58	.3	>.10
pH	7.04	7.02	.02	>.10
Nutrient concentration				
DM, %	1.9	2.1	.16	>.10
N, % DM basis	10.3	8.5	.41	<.10
NH4-N, % DM basis	6.0	4.4	.37	<.10
P, % DM basis	2.2	1.7	.03	<.10

Daily DM intake and excretion were similar (P>.10) for both diets. However, the reduction in dietary CP by 2% units tended (P<.10) to reduce daily N intake by 18%, and reduced (P<.05) daily N excretion by 21%. Also with the LED, ammonium N was reduced (P<.05) by 29%. When pigs were fed the control diet, daily N excretion was 32.3 g/pig, which is similar to 34.7 g/pig measured in a previous study (Lachmann et al., 2006) and very close to the value estimated by Carter et al. (2003) for an average finished pig (39.9 g/d N). The data is presented in Table 4.

The reduction in dietary P by .1% unit tended (P<.10) to reduce P intake for pigs fed the LED. The use of the LED reduced (P<.05) daily P excretion by 23% and tended (P<.10) to reduce total P excretion for the entire finishing period by 24% (Table 4). Daily P excretion with the control diet was 6.8 g/pig which is similar to that measured in a previous study (Lachmann et al., 2006).

Also, the changes in diet formulation to achieve the expected reductions in dietary CP and P levels in the LED diet tended (P<.10) to reduce daily K and Fe excretion, and reduced (P<.05) daily Mg and Mn excretion. The dietary treatments did not affect (P>.10) daily excretion of Ca, Na, Zn, and Cu (Table 4).

Table 4. Nutrient intake and excretion of pigs fed control or LED for the 106-d period.

	Control	LED	SE	P value
DM intake, kg/pig/d	1.85	1.77	.04	>.10
DM excretion, g/pig/d	303	296	14.7	>.10
N intake, g/pig/d	52.0	42.0	1.32	<.10
N excretion, g/pig/d	32.3	25.6	.90	<.05
P intake, g/pig/d	9.1	6.8	.22	<.10
P excretion, g/pig/d	6.8	5.1	.19	<.05
Macro-mineral excretion, g/pig/d:				
Ca	8.6	7.7	.1	>.10
K	15.0	12.0	.2	<.10
Mg	3.0	2.7	.01	<.01
Na	4.2	4.2	.2	>.10
Micro-mineral excretion, mg/pig/d:				
Fe	560	421	10.6	<.10
Zn	377	324	7.2	>.10
Cu	61	50	.1	>.10
Mn	113	96	2.4	<.05

The reduction in N excretion observed for pigs fed the LED is in agreement with previous reports from our lab (Lachmann et al., 2006) (Figure 1). Our results together suggest that a 10% reduction in N excretion should be expected for each percentage unit reduction in dietary CP. Similar results have been previously reported (Shriver et al., 2003). Also, in both experiments, the reduction in dietary P by .1% reduced P excretion by 24%. It is important to note that N and P excretion of pigs fed the control diet in both experiments was similar.

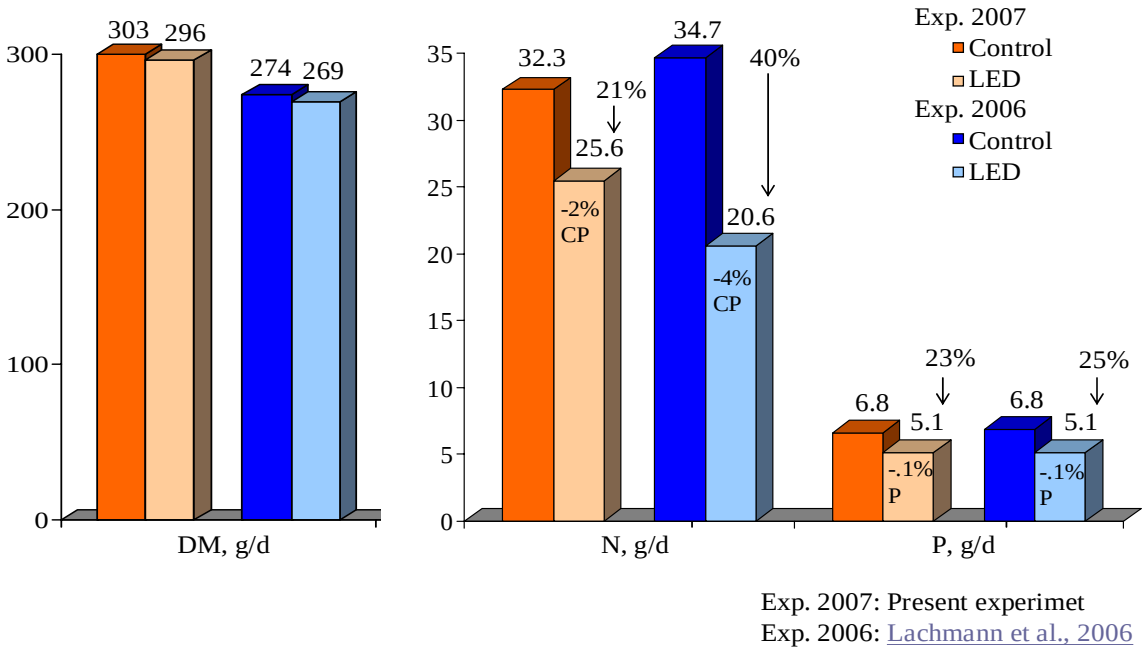

Figure 1. Reduction in DM, N and P excretion by reduced CP and P diets

Based on these results, a reduction of 2% units in CP and .1% unit in P in grower-finisher diets fed during the entire grow-finishing period (106 d) decreased daily N and P excretion by 21 and 23%, respectively. Also, it tended to decrease total N and P excreted per finished pig by 20% and 24%, respectively.

Literature Cited

Carter et al. 2003. Animal Agricultural and Food Processing Waste IX. 285-295.

Cromwell et al. 1995. J. Anim. Sci. 73:449-456.

Deng et al. 2007. Livestock Science. 109:200-223.

Harper et al. 1997. J. Anim. Sci. 75:3174-3186.

Knowlton et al. 2004. J. Anim. Sci. 82(E. Suppl.):E173-E195.

Kornegay and Harper. 1997. The Professional Animal Scientist. 13:99-111.

Kornegay and Verstegen. 2001. In: Swine Nutrition. 2nd Ed. pg 609-630.

Lachmann et al. 2006. Oklahoma State University Research Report.

Shriver et al., 2003. J. Anim. Sci. 81:492-502.

Acknowledgements

The authors express thanks to USDA-CSREES, the Oklahoma Pork Council, and the Oklahoma Agriculture Experiment Station for their support of this experiment.

Authors

Lachmann, M.B. - Graduate Research Assistant

Carter, S.D. - Associate Professor

Buhay, T.A. - Graduate Research Assistant

Bundy, J. W. - Graduate Research Assistant

Jenkins, S.K. - Graduate Research Assistant

Marable, Z. - Undergraduate Research Assistant