Effects of Reduced Nitrogen Content and Clinoptilolite Supplementation of Diets on Growth Performance, Nitrogen Excretion, and Odor Production

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ASL-1663

Summary and Implications

Feeding growing-finishing pigs diets with reduced (four percentage units) protein concentrations did not reduce odor intensity of the excreta. There was, however, a trend for reduced odor intensity from excreta from pigs fed diets that included 2% clinoptilolite.

Introduction

Reducing the protein content of diets, but maintaining adequate concentrations of essential amino acids in diets fed pigs should decrease the nitrogen (N)-containing compounds in the excreta, yet allow normal growth. This reduced N has the potential of decreasing odors. Also, incorporation of a zeolite product, clinoptilolite, that has ion exchange properties, could potentially prevent volatilization of odor-producing compounds in excreta. Therefore, we designed an experiment with growing-finishing pigs to demonstrate if feeding a low protein, amino acid-supplemented diet and a diet supplemented with clinoptilolite would decrease odors from the excreta.

Materials and Methods

The experiment was designed as a 2 × 2 factorial arrangement of treatment diets. The first factor was protein concentrations and the second factor was none or 2% added clinoptilolite. Protein concentrations were 11 and 15% for the first 4 weeks and then 14 and 10% for the last 3 weeks. The reduced protein diets were made adequate in all essential amino acids by addition of crystalline lysine, methionine, threonine, and tryptophan. Diet formulas and analyses are presented in Table 1.

The diets were individually fed to pigs housed in metabolism cages in an environmentally controlled room. Pigs were limit-fed twice daily and offered water three times daily. The 12 pigs initially averaged 82.4 lb body weight. They were allotted to pens within the three replications from three groups of four littermates.

Total collections of feces and urine were made daily and accumulated for each 7-day period. Subsamples of feces plus urine were preserved with toluene and hydrochloric acid to prevent volatilization of ammonia and to stop bacterial growth. These subsamples were then freeze dried and analyzed for dry matter and nitrogen. The combined feces and urine for weeks 1, 2, 3, 5, and 6 were placed in simulated pits in Dr. Bundy's olfactometry laboratory and tested for odor threshold. The odor threshold is the number of parts of fresh air mixed with one part of odorous air where the odor is barely detectable.

The data are reported for the overall 7-week experiment. The data were analyzed as a 2 × 2 factorial arrangement of treatments in a randomized complete block design. The main effects of protein concentrations and clinoptilolite and their interaction were tested. The pig (metabolism cage) was the experimental unit.

Results and Discussion

Data for growth performance, N excretion, and odor are presented in Table 2. These results are for the overall 7-week feeding period.

As expected, there was a trend for slower growth rate and less feed intake by pigs fed the low protein, amino acid-supplemented diets. The differences did not reach the statistically significant level of $P<.05$. A number of experiments reported in the literature indicate that when protein concentrations in corn-soybean meal diets are lowered more than two percentage units below requirements, performance suffers, even though all essential amino acid requirements are met by crystalline amino acid supplementation.

Reducing protein concentrations in diets obviously decreased ($P<.0001$) N intakes and this resulted in less ($P<.0001$) N in the excreta. The difference between N intake and N excretion was assumed to be N retained in the body of the pig. This measurement suggests that pigs fed high-protein diets retained more ($P<.0001$) N in their bodies than did those fed low-protein diets. Even though excreta from pigs fed high-protein diets compared with those low-protein diets had 86% more N in the excreta, this difference did not seem to increase the intensity of odor produced by the excreta. The inclusion of 2% clinoptilolite in the feed caused a trend for a decrease ($P<.13$) in odor intensity. It is very possible that the ion exchange properties of this mineral decreased the volatility of odor-producing compounds in the excreta.

Table 1. Experimental diets.[a]

Ingredient	First 4 weeks		Last 3 weeks	
	High Protein	Low Protein	High Protein	Low Protein
	- - - - - - - - - - - - - - - - - - % of diet - - - - - - - - - - - - - - - - - -			
Corn	77.52	87.88	80.42	90.75
Soybean meal, 48% CP	18.00	6.90	15.10	4.04
Choice white grease	2.00	2.00	2.00	2.00
Dicalcium phosphate	.80	1.05	.80	1.05
Calcium carbonate	.90	.85	.90	.85
Salt	.50	.50	.50	.50
Vitamin premix[b]	.20	.20	.20	.20
Trace mineral[c]	.05	.05	.05	.05
Selenium premix[d]	.02	.02	.02	.02
Endox	.01	.01	.01	.01
L-Lysine•HC1		.42		.42
DL-Methionine		.01		-
L-Threonine		.08		.08
L-Tryptophan		.03		.04
Calculated Analysis, %:				
Crude protein	15.3	11.3	14.2	10.2
Lysine	.76	.76	.67	.68
Sulfur amino acid	.56	.46	.53	.42
Threonine	.62	.53	.58	.48
Tryptophan	.19	.16	.18	.15
Analyzed protein, %	16.5	11.0	14.5	10.3

[a] These diets were supplemented with 0 or 2% clinoptilolite.

[b] Contributed 2,000 IU vitamin A; 500 IU vitamin D_3; 3.0 mg riboflavin; 8.0 mg pantothenic acid; 15.0 mg niacin, and 10 mg vitamin B_{12} per pound of diet.

[c] Contributed in ppm of diet: 75 Zn, 87.5 Fe, 30 Mn, 8.75 Cu, 1 I.

[d] Contributed .1 ppm Se to the diets.

Table 2. Effect of reduced protein diets and clinoptilolite on growth performance and N excretion of growing-finishing pigs and odor of excreta over a 7- week period.

Item	Treatments					Significance[a]	
	Protein,	High	High	High	Low		
	Clinoptilolite, %	0	2	0	2	P<	CV, %
Daily gain, lb		1.79	1.94	1.70	1.61	P, .12	11.4
Daily feed, lb		4.88	4.93	4.63	4.61	P, .06	4.5
Feed:gain		2.73	2.54	2.71	2.86	-	9.1
N intake, kg		6.04	5.89	3.88	3.87	P, .0001	4.3
N excretion, kg		2.17	2.15	1.18	1.14	P, .0001	7.2
N retained, kg[b]		3.88	3.74	2.70	2.74	P, .0001	6.5
N efficiency		.640	.636	.697	.706	P, .003	3.4
Odor threshold x 10^{-3}[c]		1.235	.925	1.101	.777	C, .13	31.9

[a] P = protein effect; C = clinoptilolite effect.

[b] Nitrogen retained = N intake – N excretion.

[c] Odor threshold is the number of parts of fresh air per part of odorous air where the odor is barely detectable.