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The Effects of Reducing Dietary Crude Protein Concentration on Odor in Swine Facilities

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Summary and Implications

The effect of dietary manipulation on odor emission in a research pig facility was evaluated with 26 finishing gilts (initial weight 161 lb). The two diets were formulated to contain 13% crude protein or 9% crude protein supplemented with crystalline amino acids. Two environmental chambers were used and each housed a group of four or five gilts for 21 days. Relative humidity, temperature and air exchange were maintained throughout the experiment. Samples of feces and air were taken on days 4, 7, 11, 14, 18 and 21 of the experiment. Aerial ammonia and hydrogen sulphide concentrations were measured using detector tubes. Air samples were collected in 25 L Tedlar bags and analyzed within 24 hours, by an olfactometer and a trained panel at Iowa State University. Hydrogen sulphide concentration was < .25 ppm for both treatments. Ammonia concentration was significantly higher when the 13% crude protein diet was provided (P < .01). Odor levels measured by the olfactometer were not different between treatments. These results suggest one method by which the odors produced by swine units can be decreased to potentially benefit both animal and human health.

Introduction

Odor emission from swine facilities is a major pork industry issue. Producers are facing stricter federal, state and local regulations, and lawsuits concerning odor issues are becoming more frequent. The study of odor is complex, both in terms of identifying the combinations of odor-causing compounds and quantifying the odor. Several compounds (e.g., hydrogen sulphide, ammonia, indole phenol, p-cresol and skatole) and measuring techniques have been used to assess odor. Most identified compounds are related to the degradation of excess amino acids commonly found in swine diets. Although new odor control products and techniques appear regularly, a different approach to reduce odor emission is to manipulate the pig's diets.

The objective of this experiment was to reduce total crude protein intake through the use of crystalline amino acids in the diet and examine the effect of the reduced protein intake on odor and ammonia emission into building air.

Materials and Methods

Twenty-six finishing gilts (initial weight 161 lb) were divided into six groups and kept in two environmental chambers (five gilts/chamber for replicate one and four gilts/chamber for replicates two or three) for 21 days (the experiment was replicated three times). Each group was housed in a completely slotted floor pen, raised 18 inches above a solid concrete floor. Manure and urine remained undisturbed in the chamber until the gilts were removed. In both chambers, humidity (maintained at 74%) , temperature (maintained at 70^{o}F) and air exchange (74 ft^{3}/min) were computer controlled throughout each of the three experimental replications. The chambers were vacant for one week between replicates and cleaned thoroughly with a chlorine solution to avoid odor carryover.

Table 1. Diet composition (as-fed basis)

Ingredient, %	Control diet	Treatment diet
Corn	82.00	92.78
Soybean meal, 46.5% CP	13.75	2.25
Tallow	2.00	2.00
L-lysine HCl	.00	.35
L-tryptophan	.00	.06
L-threonine	.00	.09
DL-methionine	.00	.02
Dicalcium phosphate	.80	1.05
Limestone	.40	.35
Vitamin premix	.70	.70
Trace mineral mix	.10	.10
Salt	.25	.25
Formulated composition:		
Metabolizable energy, Mcal/lb	1.55	1.54
Crude protein, %	13.60	9.40
Lysine, %	.64 (.48)[a]	.59 (.48)
Tryptophan, %	.14	.13 (.10)
Threonine, %	.52	.42 (.34)
Methionine + cystine, %	.51	.40 (.34)
Calcium, %	.55	.56
Phosphorus, %	.45	.45

[a]Values in parenthesis are on an available basis.

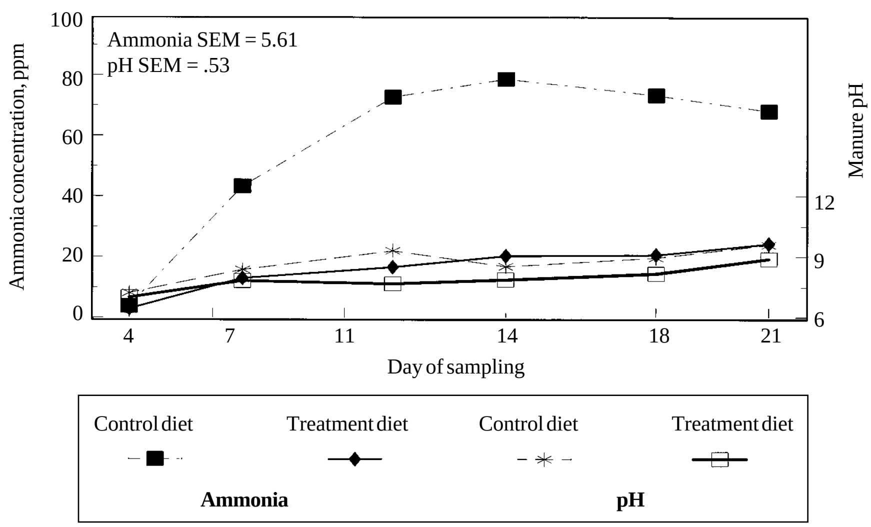

Figure 1. The effect of reducing dietary crude protein on aerial ammonia concentration and manure pH. Control diet = 13% CP and treatment diet = 9% CP.

One of two dietary treatments (Table 1) were randomly assigned to each chamber. The control diet was corn-soybean-meal based and was formulated to meet or exceed nutrient requirements for finishing gilts (NRC, 1988). The treatment diet was formulated by reducing the crude protein concentration and supplementing crystalline amino acids for the first four limiting amino acids (Table 1). Both diets were formulated to contain .48% available lysine. The ratios (available basis) of tryptophan, threonine and methionine + cystine to lysine were set at .20, .70 and .70, respectively. All pigs had ad libitum access to feed and water throughout the experiment.

Manure and air samples were taken on days 4, 7, 11, 14, 18 and 21. An electronic pH meter was used to determine pH in manure. Aerial ammonia was measured using low and mid-range detector tubes and low-range detector tubes were used to determine aerial hydrogen sulfide concentration. For the sensory analysis, air samples were collected directly into 25-L Tedlar bags by creating a negative pressure in a cylinder containing the Tedlar bag. Air samples were transported to Iowa State University and analyzed within 24 hours. The sensory analysis consisted of an olfactometer through which a trained odor panel was presented with various concentrations of odorous air samples. The trained panel smelled the air samples to determine the lowest concentration at which odor was detectable.

Results and Discussion

Temperature, relative humidity and air exchange were similar in both chambers throughout this study. Aerial ammonia concentration was affected by diets ($P < .01$, Figure 1). The average ammonia concentration in air from chambers housing pigs fed the control diet was 56.6 ppm. In the chambers housing pigs consuming the treatment diet, the average ammonia concentration was 16.3 ppm. Ammonia concentration reached a plateau after day 11 ($P < .01$). Hydrogen sulphide concentration for both treatments was < .25 ppm, below the minimum range detectable with commercially available detector tubes.

Manure pH increased significantly throughout the 21 days of experiment ($P < .05$) but did not differ between diets (Figure 1). A plateau in pH was observed on day seven ($P < .01$). The average pH for the control diet and treatment diets were 8.66 and 7.91, respectively. Because pH did not differ between treatments, the difference in ammonia concentration was attributed to the difference between diets.

Sensory analysis results are shown in Figure 2. Although the odor threshold between treatments were not statistically different, odor unit threshold was greater in control pigs on days 11, 14, 18 and 21. Order units threshold is

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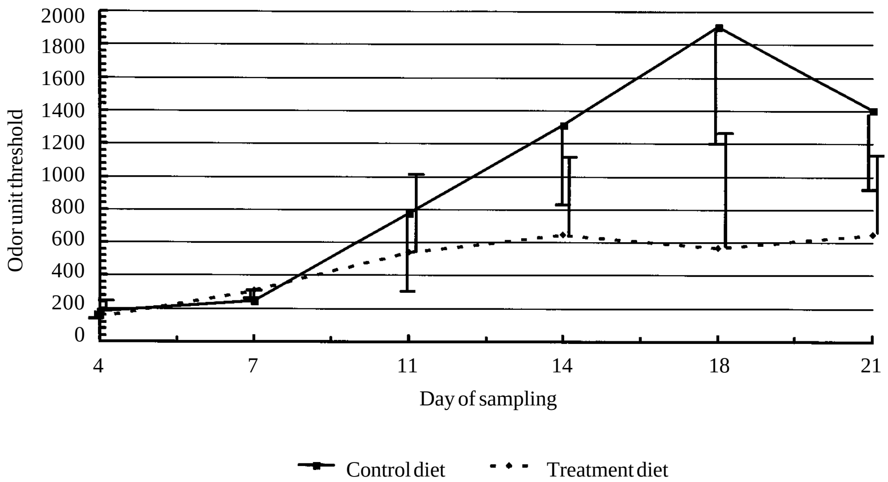

Figure 2. Effect of crude protein reduction on odor unit threshold. Control diet = 13% CP and Treatment diet = 9% CP. Odor unit threshold is defined as the dilution ratio (odor-free air: odorous air) at which 50% of the test subjects cannot detect the odor.

defined as the dilution ratio (odor-free air:odorous air) at which 50% of the test subjects cannot detect the odor. Larger odor threshold units indicate a greater odor concentration in the air sample. Threshold results suggest more replications are necessary to confirm the numerical differences observed in this study.

Conclusions

Reducing dietary crude protein by 4% and formulating the diet to meet the requirements for the first four limiting amino acids decreased aerial ammonia concentration by 29%. Although odor units thresholds were not statistically different, the numerical differences present an indication that there is a reduction of odor emission when feeding a 9% crude protein diet supplemented with crystalline amino acids to gilts in the finishing phase.

These results suggest one method by which the odors produced by pig units can be reduced. A decrease in ammonia concentration within buildings should benefit both animal and human health.

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