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Soybean Meal Inclusion Rate Effects on Odor Intensity, Hydrogen Sulfide and Ammonia in Commercial Swine Production Units

A.S. Leaflet R2230

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Summary and Implications

Three commercial swine farms with side-by-side 1100-head finishing units were fed two diets with varying protein levels. Odor threshold, ammonia and hydrogen sulfide were collected from the pit fans. The high protein (HP) treatment averaged 1420 odor units compared to 1035 odor units for the low protein (LP) treatment, reducing odor by 27% (P= 0.02). Reduction in H_2S concentration was not significant, averaging 0.92 ppm and 0.59 ppm for the HP and LP treatments, respectively (P = 0.09). Concentrations of NH_3 were 12.3 ppm and 9.1 ppm for the HP and LP treatments, respectively (P =0.10). Seasonal differences in H_2S (P= 0.002) and NH_3 (P=0.05) were indicated but the cause of this difference was not diet related and could be due to a number of seasonally-related operation attributes. This study demonstrates that dietary manipulation by addition of synthetic amino acids replacing soybean meal is a method pork producers can use to decrease the odor intensity of their pork production site.

Introduction

Recent research has shown that changes in excreta nutrient profile will impact gaseous emissions, such as ammonia, hydrogen sulfide, and odor intensity. Undigested nutrients in soybean meal are excreted to the manure storage (probably as nitrogen or protein) and that nutrient will be utilized by the bacteria in the manure resulting in odorous decomposition products. In a commercial swine operation, small changes in diet formulation will result in large changes in nutrient loading in the manure due to a large number of animals involved. For example, a 1100 head finishing barn will consume close to 1.8 million lbs of feed a year. If that feed contains 1% more protein than needed, 18,000 lbs of excess protein goes through the pig into the pit annually.

The concentration of nutrients in the pit can be changed substantially through the diet by at least three methods. These methods include:

- Overfeeding a nutrient beyond what is necessary for optimal growth rate will result in excess nutrients excreted. This occurs when lean gain is overestimated and protein is overfed resulting in excess nutrient nitrogen going into the pit.
- The digestibility of the nutrients fed will change the amount of nutrient not utilized by the pig. Addition of enzymes such as phytase or xylanase increase the digestibility of nutrients resulting in less going into the pit if the total volume fed is decreased.
- Synthetic amino acids can be added to the diet to create an amino acid balance closer to the pig's amino acid profile, therefore soybean meal inclusion can be decreased without impacting performance.

The purpose of this project was to determine if a dietary change, made in a commercial swine setting, could be measured in terms of gaseous concentrations. Synthetic lysine was added to each half of the sampling sites in order to achieve two levels of nutrients passing through the pig into the pit.

Materials and Methods

Three commercial farms were identified as suitable for comparison. Farms 1 and 2 had side by side 1100 head capacity finisher barns; farm 3 had side by side 1100 head barns and a third 1100 head barn with split pits. All barns were finishers with pigs typically being placed at 50 lbs and being marketed at 270 lbs. Various diets were fed to the pigs over the growing period. The cooperators fed over 12 million pounds of feed per year while on test. Total dietary protein was reduced by adding crystalline amino acids and corn as a replacement for an equivalent amount of soybean meal (SBM). While the diet nutrient level changed as the pigs requirements changed, the SBM to corn/amino acid substitution between the two treatments remained consistent throughout the trial based on pig requirements. Table 1 shows an example of one of the 18 diets fed during the various phases. The substitutions of SBM for corn and synthetic lysine varied depending on nutrient needs that changed with pig size.

Table 1. An example diet.

Ingredient	Diet	
lbs.	HP	LP
High oil corn	1265.0	1370.0
SBM 46.5%	480.0	370.0
DDGS	200.0	200.0
GF DDGS Basemix	50.0	50.0
L-Lysine HCL	3.0	6.5
L-Threonine	0.0	1.2
Copper sulfate	2.0	2.0
Formula Totals:	2000.0	2000.0
Formula $/Ton:	$100.74	$99.46
Dry matter (%)	88.38	88.24
Crude protein (%)	20.00	18.15
Lysine, total (%)	1.08	1.07
Metabolizable energy	1526	1532
Fat (ether extract) (%)	4.65	4.88
Calcium (%)	0.62	0.60
Phosporus (%)	0.58	0.56
Phosphorus, available (%)	0.30	0.29
Calcium: Phosphorus	1.07	1.08
Salt (%)	0.42	0.42

Pigs were put on test from Mar 2004 through Oct 2005 for farm 1, May 2005 through Oct 2005 for farm 2 and from Mar 2005 to Oct 2006 for farm 3. Filling schedule was slightly different. Farm 1 was filled within 2 weeks, while farms 2 and 3 typically had 80 to 100 pound differences per head alternating between buildings. A double odor sample was taken from each building seasonally in spring (late March), summer (late July), and fall (early Oct) varying slightly according to odor panel availability. It is important to note in these curtain sided barns, wind speed and direction will tend to vary the odor and gas concentration coming out the pit fans. Side by side buildings were sampled the same day through similarly located manure pit fans on each building under the same weather conditions. Air samples (10 L tedlar bags) were collected at the manure pit fans of each barn and analyzed at the ISU olfactometry lab for odor threshold, H_2S concentration (Jerome meter) and NH_3 concentration (Draeger tubes).

Results and Discussion

Table 2 shows the air quality data as related to diet protein level. The HP treatment averaged 1420 odor units compared to 1035 odor units for the LP treatment, reducing odor by 27% (P= 0.02). Reduction in H_2S concentration was not significant, averaging 0.92 ppm and 0.59 ppm for HP and LP treatments, respectively (P = 0.09). Concentrations of NH_3 were 12.3 ppm and 9.1 ppm for the HP and LP treatments, respectively (P =0.10).

Table 2. Pooled air quality analysis for samples grouped by diet.

	High protein	**Low protein with AA**	**P Value**
Odor threshold	1420	1035	0.02
H_2S (ppm)	0.92	0.59	0.09
NH_3 (ppm)	12.3	9.1	0.10

Table 3. Pooled air quality analysis for samples grouped by season.

	Spring	**Summer**	**Fall**	**P Value**
Odor threshold	1278	1611	794	0.21
H_2S (ppm)	0.61	1.27	0.38	0.002
NH_3 (ppm)	13.5	11.7	6.9	0.05

Table 3 provides air quality analysis by season. For odor threshold, there was no significant seasonal effect (P=0.21). There was a strong seasonal effect on H_2S concentration (P=0.002) and an effect on NH_3 concentration measurements (P=0.05). These effects could be related to attributes which are seasonal such as manure pit depth, temperature of manure in the pit, ventilation rate at the time of sampling or some combination of factors.

This field research project at a commercial level shows that removal of soybean meal and replacement with corn and synthetic amino acids will reduce odor threshold detection levels. Concentrations of H_2S and NH_3 were shown to vary by season but with no diet effect. The lack of a diet effect for H_2S and NH_3 could be due to the intermittent emissions of specific gases from a pit leading to day-to-day variation in emission rate.

Reformulating the diets by removing 100 lbs of soybean meal and replacing it with 97 lbs of corn plus synthetic amino acids will potentially reduce odor thresholds. This data shows that lowering the total amount of excess nitrogen in the manure storage can contribute to reduced odor. However, more field research should be conducted to evaluate diet impacts on odor and other gases. The increased temperature of the manure pit during summer and early fall may increase bacterial activity thereby increasing production of H_2S and NH_3. While this may contribute to significantly different H_2S and NH_3 concentrations by season, other factors may also be involved.