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# DIET COMPOSITION AFFECTS ODOR CHARACTERISTICS FROM SWINE MANURE

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## Summary

Ten diets were formulated to contain a variety of feedstuffs that were expected to alter swine manure characteristics and therefore odor emission. Odor characteristics of manure were assessed by means of a human odor panel. Results from this study indicate that ingredient composition of swine diets has a significant impact on odor production from manure.

## Introduction

Odors emanating from swine operations are recognized and regulated as a public nuisance in every state in the U.S. (Minor et al., 1997). These odors are a complex array of volatile organic compounds resulting from fermentative degradation of carbohydrates, fatty acids, and proteins by a variety of indigenous bacterial species present in the large intestine and manure of swine (Zhu and Jacobson, 1999). Several key factors have been associated with malodorous gas emissions from swine manure. These include diet composition, manure pH and temperature, and genera of bacteria present (Zhu and Jacobson, 1999; Sutton et al., 1999). The objective of this pilot-scale study was to demonstrate how ingredient selection in swine diets might affect odor production from swine manure.

## Materials and Methods

Ten pigs (Hampshire x Yorkshire) of approximately 25 kg were used in this experiment. Animals were housed in individual concrete pens (3'x 5') and were allowed *ad libitum* access to feed and water. Each pig was randomly assigned to one of ten diets (Table 1.). Diets were formulated to contain varying levels and sources of major feedstuffs while maintaining identical levels of CP (except for the high CP diet). The experimental protocol consisted of a 5-d dietary adaptation period followed by a 1-d total fecal and urine collection. Feces and urine from each pig were weighed, mixed (in a 2:1 urine to feces ratio), and frozen in labeled 1- L plastic bottles. Samples were removed from the freezer approximately 24 h prior to odor assessment by the odor panel. Odor production from manure samples was evaluated and recorded on odor score sheets by each member of the odor panel. Odor sheets consisted of three main odor parameters (pleasantness, irritation, and odor intensity) to be evaluated. Scoring was based on a scale of 1 to 8 with a standard corn-soybean meal diet serving as the control (defined as a score of 4). Data obtained from the study were subjected to ANOVA using the SAS statistical package. Differences among diet means were determined by Tukey's

studentized range test ($P < .05$).

**Results and Discussion**

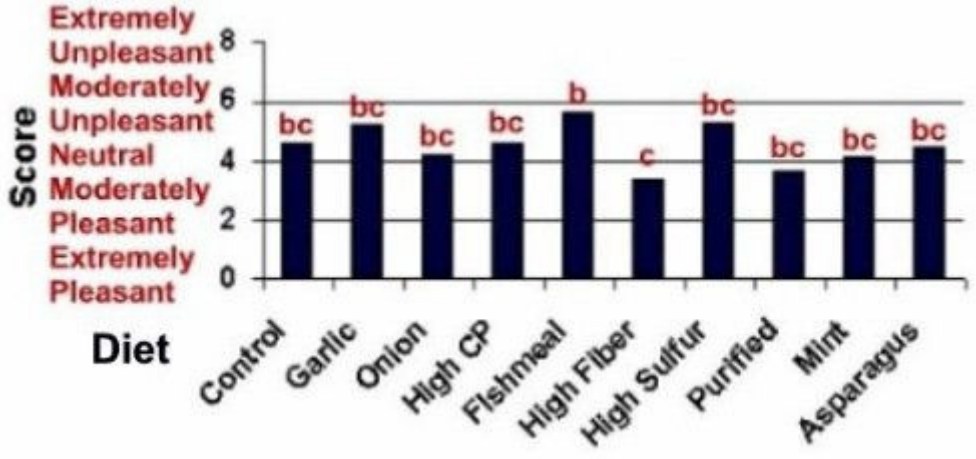
Selection of the various feedstuffs used in this study was based upon their ability to markedly affect manure characteristics and subsequent odor production. In general, results from this study agree with expected results in that feeding swine diets containing malodorous compounds or their precursors resulted in a perceived increase in odor production from manure when measured by a human odor panel. From the data in Figure 1, diet composition had a significant impact on the pleasantness of odor of manure samples ($P < .02$). On a scale of 1 to 8 (1 = extremely pleasant; 8 = extremely unpleasant), the diet containing fishmeal and high levels of sulfur had the highest odor scores and therefore were considered to be the most unpleasant.

**Table 1. Composition of Diets, as-fed basis (%)**

| Diet | Control | Garlic | Onion | High CP | Fish meal | High Fiber | High Sulfur | Purified | Mint | Asparagus |
|---|---|---|---|---|---|---|---|---|---|---|
| Corn | 72.9 | 71.6 | 71.6 | 31.6 | 78.0 | 50.0 | 83.0 | - | 71.6 | 71.6 |
| Soybean meal | 22.1 | 22.4 | 22.4 | **63.4** | - | 20.0 | - | - | 22.4 | 22.4 |
| Menhaden fishmeal | - | - | - | - | **17.0** | - | - | - | - | - |
| Soybean hulls | - | - | - | - | - | **25.0** | - | - | - | - |
| Feathermeal | - | - | - | - | - | - | **12.0** | - | - | - |
| Corn Starch | - | - | - | - | - | - | - | **81.6** | - | - |
| Casein | - | - | - | - | - | - | - | **12.93** | - | - |
| Garlic powder | - | **1.0** | - | - | - | - | - | - | - | - |
| Onion powder | - | - | **1.0** | - | - | - | - | - | - | - |
| Peppermint extract | - | - | - | - | - | - | - | - | **1.0** | - |
| Dehydrated asparagus | - | - | - | - | - | - | - | - | - | **1.0** |
| Corn oil | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| $CaSO_4$ | - | - | - | - | - | - | **1.0** | - | - | - |
| $CaCO_3$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | - | 1.0 | 1.0 | 1.0 |
| Dicalcium $PO_4$ | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Vitamin/mineral | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| NaCl | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | .5 | .5 | .5 | .5 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

On the other hand, the high fiber diet and purified diet scored the lowest and therefore were perceived to be the most pleasant. It is not surprising that diets containing fishmeal and high levels of sulfur ranked the highest in the odor scoring. The fishmeal diet was comprised of 17 % fishmeal which is known to contain high levels of the malodorous omega-3 fatty acids (C18:3, C20:5, and C22:6) and sulfur amino acids which are precursors for odorous mercaptans, whereas the high sulfur diet was formulated to contain high levels of sulfur, a key odor component. The latter was accomplished by dietary incorporation of feathermeal, a protein source containing high levels of the sulfur containing amino acid cysteine, and by replacing $CaCO_3$ with $CaSO_4$

as the main Ca source. Hobbs et al (1995) reported that sulfur-containing compounds have one of the lowest odor detection thresholds from manure. As mentioned previously, the high fiber diet and purified diet were perceived to be the most pleasant smelling diets. The high fiber diet was formulated to contain high levels of crude fiber through the addition of 25% soybean hulls to the diet. Although no data exists in the available literature that specifically addresses the effects of fiber on odor production, it seems plausible that feeding high fiber diets to swine will be associated with the production of more malodorous compounds in the manure. This is mainly attributed to the negative impact of fiber on ileal nutrient digestibility resulting in more bacteria fermentable substrates (complex carbohydrates and N) entering the large intestine. In this experiment, however, the high fiber diet resulted in less odor. A longer adaptation period to the high fiber diet allowing for a more adequate proliferation and colonization of the intestinal microbiota may have produced different results. The purified diet was composed of cornstarch and casein, both assumed to be almost completely hydrolyzed before the terminal ileum. The highly digestible nature of this diet would, in essence, minimize odor production by supplying fewer bacterially fermentable substrates in the large intestine. When comparing diets to the control, only the fishmeal diet and high fiber diet were significantly different ($P < .05$).

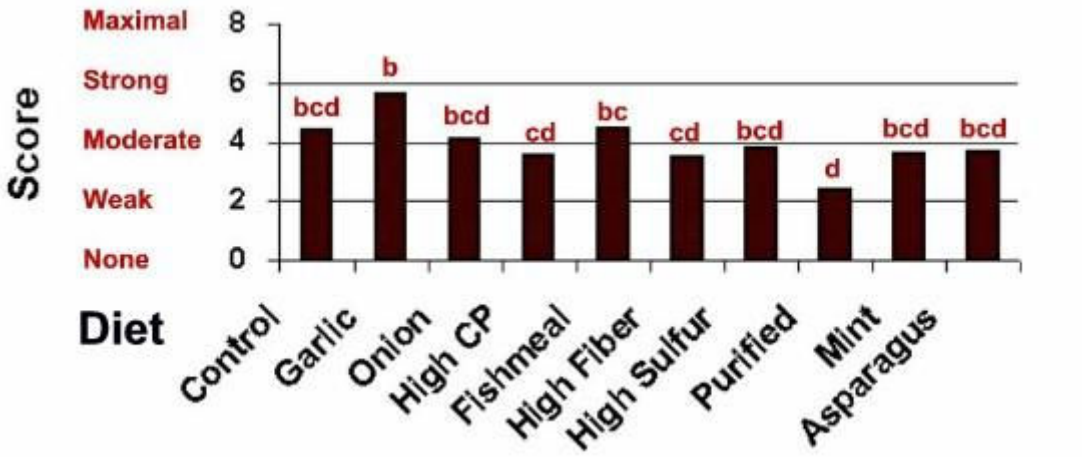



[a] $P < .02$
[b,c] Bars lacking common letter differ by $P < .05$

**Figure 1. Impact of diet composition on odor emission: pleasantness of samples[a]**

The impacts of dietary composition on irritation of manure samples are presented in Figure 2 and were similar to pleasantness scores. However, discrepancies among the expected vs. observed results were more evident. Manure samples from swine fed the diets containing 1% garlic powder and fishmeal were perceived as most irritating whereas samples from the high fiber diet and purified diet were least irritating ($P < .001$). When comparing means of the experimental diets to the control, the garlic diet and fishmeal diet were perceived as more irritating and the high CP diet, high fiber diet, and purified diet were perceived as less irritating ($P<.05$). Although not considered to be more unpleasant, the garlic diet was perceived as more irritating than the control. Due to scarce information in the literature pertaining to garlic as a feed ingredient for

livestock, this finding cannot be discussed more extensively. When observing data from samples that were perceived as less irritating than the control, High CP Diet provided confusing results. Our hypothesis in formulating Diet 4 was that if we increased the amount dietary CP two-fold (34% CP in High CP Diet vs. the Control Diet), we would increase the levels of odorants derived from protein degradation and volatilizable urinary $NH_3$-N, a major irritant.




[a] P<.001
[b,c,d] Bars lacking common letter differ by $P < .05$

**Figure 2. The effect of diet composition on irritation intensity of manure samples[a]**

Why the high CP diet was perceived by the odor panelists as less irritating is unclear. However, experimental procedures and the amateur status of the odor panel may ascribe for some of the discrepancies observed in this study. For instance, manure samples were frozen immediately upon collection and therefore were not fresh samples. The possibility that freezing samples may have altered some of the $NH_3$ emitting properties of the sample cannot be excluded. The failure to detect $NH_3$ irritation in this trial may also be due to the inability of the odor panel to accurately distinguish between the different olfactory parameters, i.e., pleasantness vs. irritation. The odor panel in this current study was comprised mainly of state extension agents and faculty and not professionally trained odor panelists. With exception of the high CP diet, diets perceived as less irritating than the control are in agreement with anticipated results. As mentioned above, the high fiber diet contained high levels of crude fiber which has proven to have a negative effect on $NH_3$ emissions from swine manure (Mroz et al., 2000). This is predominantly due to the impact of fiber on shifting the excretory pattern of N from rapidly degradable urea-N in the urine to fecal N, a less degradable substrate for $NH_3$ volatilization. The effect of dietary composition on odor intensity was not significant ($P = .11$) and therefore not reported.

**Implications**

Malodor from swine production sites is one of the predominant socio-economic issues existing in the swine industry today. Increasing numbers of odor-related lawsuits in recent years has negatively impacted the profitability and social acceptance of pork

production and therefore attempts to minimize odor are vital to the sustainability of swine production. Results from this preliminary study illustrate that altering diet composition has potential as an odor abatement strategy. However, more quantitative research pertaining to the effect of diet composition on odor-specific microbes inhabiting the intestinal tract of swine is needed to determine the extent of its practical application.

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