Supporting Information
for

Maturation of manure for swine emission feeding trials

S. L. Trabue, B. J. Kerr, B. L. Bearson, M. Hur, E.S. Wurtele, T. Parkin, and C. J. Ziemer

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**Animal Management and Manure Storage**

The experiment was approved by the Iowa State University Animal Care and Use Committee and used a total of 36 finishing pigs. Pigs were fed a diet typical for pigs of this body weight (BW) (Table S1), which was formulated to be adequate in all nutrients. Finishing gilts (initial BW, 84 kg) were randomly allotted to individual metabolism crates (0.51 × 1.84 m) and allowed free access to feed and water. Pigs were fed, twice daily (0700 and 1900 h), an amount of feed that approximated 3% of their BW (full feed). Due to the length of the collection period, three groups of 12 gilts were used to provide 15 wk of manure (feces and urine) collection. Consequently, each group of gilts remained in the metabolism crate for approximately 30 d. However, all pigs were fed the same diet throughout the study.

After each feeding, feces and urine from each of the 12 metabolism crates were collected and added to an assigned manure storage container (each crate was assigned to its corresponding storage container). Each stainless steel manure storage container measured 122 cm high and was 96.5 cm in diameter. The lid on each container was fitted with threaded couplers to accompany fittings and tubing from which to add manure and take air samples. Headspace air in the manure storage container was constantly mixed with an internal fan positioned 0.5 m below the container lid. A vacuum system pulled a constant stream of air over the manure (8 L min⁻¹). Air samples were taken before manure sample collection so as not to agitate the manure and inflate air emissions that would occur from manure stored at swine production facilities.
Table S1 Swine diet composition

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage of dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>78.95</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>16.31</td>
</tr>
<tr>
<td>Animal fat</td>
<td>2.00</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.93</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.88</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0.30</td>
</tr>
<tr>
<td>Vitamin + trace mineral mix$^1$</td>
<td>0.52</td>
</tr>
<tr>
<td>L-Lysine•HCl</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Calculated Composition

| Nitrogen                    | 2.33                     |
| Calcium                     | 0.55                     |
| Phosphorus                  | 0.50                     |

$^1$Provided the following per kilogram of complete diet: 6,600 IU vitamin A, 1,650 IU vitamin D$_3$, 33 IU vitamin E, 33 μg vitamin B$_{12}$, 9.9 mg riboflavin, 49.5 mg niacin, 26.4 mg pantothenic acid, 17.5 mg Cu (oxide), 175 mg Fe (sulfate), 2 mg I (Calcium), 60 mg Mn (oxide), 150 mg Zn (oxide), and 0.3 mg Se.
Air Sampling and Analysis of Odorants

*Reduced sulfur (Hydrogen Sulfide, H₂S)*

A single sample was taken from each of the 12 manure storage tanks for H₂S analysis at weeks 1, 5, 7, 9, and 13 of the study. Headspace air samples were taken using Tedlar bags that were sampled at 1 L min⁻¹ flow rate into 10-L Tedlar bags using a sampler box (model 1062; Sigma-Aldrich, Bellefonte, PA). Concentrations of H₂S in headspace air were monitored using an API model 101E H₂S analyzer (Teledyne Technologies, Inc., Thousand Oaks, CA). Instruments such as the API model 101E analyze air directly by converting H₂S into sulfur dioxide (SO₂) and then quantifying SO₂ using ultraviolet florescence. However, due to the high moisture content of the headspace air (close to 100% relative humidity), the conversion efficiency of the heated molybdenum catalytic converter was greatly reduced. Consequently, headspace air was first sampled with sampler box (model 1062; Sigma-Aldrich) into 10-L Tedlar bags and held overnight before analysis. This was done because H₂S has been shown to be stable in Tedlar bags (Akdeniz et al., 2010) and because Tedlar bags equilibrate to outside relative humidity conditions within hours (Cariou and Guillot, 2006).

The API model 101E convert not only H₂S into SO₂ but convert other reduced sulfur compounds as well (Summer et al., 2005). However, the conversion efficiency is much lower for those compounds (Summer et al., 2005), and recent work by Trabue et al. (2010a) and Feilberg et al. (2010) shows that H₂S makes up over 90% of the total reduced sulfur compounds. Consequently, it can be assumed that H₂S measured in this test system using the API model E instrument is almost exclusively H₂S. Room air concentrations in which the animals were housed were analyzed directly by the API
model 101E instrument without first sampling into Teldar bags. Room air concentrations were measured only at weeks 1 and 5.

**Ammonia Sampling**

Duplicate samples were taken from each of the 12 manure storage tanks for NH$_3$ concentrations at weeks 1, 5, 7, 9, and 13 of the study. Samples for NH$_3$ quantification were taken from the headspace air by pulling air through a 15 mL, 0.1 mol L$^{-1}$ phosphoric acid solution in a 40-mL glass impinge (Sigma-Aldrich) with a fritted glass end at 200 mL min$^{-1}$ using diaphragm vacuum pump (model N.85.3 KNI; KNF Neuberger, Inc., Trenton, NJ) controlled by mass flow controller (Mass Trak; Sierra Instruments, Inc., Monterey, CA). The total volume of air collected was approximately 5 L of headspace air. Phosphoric acid solution was analyzed for NH$_3$ using a QuickChem 8500 flow injection analyzer (Lachat Instruments, Hatch Co., Loveland, CO) using QuickChem method 12-107-06-2-A. At weeks 1 and 5, concentrations from the rooms containing animals were analyzed directly using an Ion Pro-IMS (Molecular Analytics, Sparks, MD) while avoiding the initial capture in an acid trap. Ammonia monitoring with the Ion Pro was abandoned when concentrations in the manure storage tanks greatly exceeded the instrument’s recommended quantitation limits of 21,000 mg m$^{-3}$.

**References:**


Data generated in Kerr et al. (2006) showed that manure total ammoniacal nitrogen (TAN) and volatile fatty acid (VFA) concentrations were increasing up to eight weeks as a feeding trial progressed (Figure S1).

**Figure S1.** Total ammoniacal nitrogen (TAN) and total VFA concentrations in stored manure from pigs fed a combination of diets over an 8 week period. Regression analysis of TAN: standard deviation = 711; P =0.01; Linear = 0.01; and Quadratic = 0.31. Regression analysis of VFA: standard deviation SD = 808; P = 0.01; Linear = 0.02; and Quadratic = 0.97.

**Reference:**

Data presented in Figure S2 shows the build-up of salt in our manure storage system (conductivity); whereas, pH and temperature are more stable.

**Figure S2.** Conductivity and pH in manure derived from pigs fed a common diet over 13 weeks. Regression analysis of conductivity: standard deviation = 2.9; P = 0.01; Linear = 0.01; and Quadratic = 0.01. Regression analysis of pH: standard deviation = 0.02; P = 0.40; Linear = 0.24; Quadratic = 0.23;
Figure S3. Cluster analysis of denaturing gradient gel electrophoresis (DGGE) banding patterns for manure samples from manure storage tanks.
Figure S4. Cluster analysis of substrate utilization patterns for EcoPlate™ of individual manure storage tanks on Wks 5, 9, and 13.
Figure S5. Cluster analysis of substrate utilization for individual tanks at weeks 5, 9, and 13 for AN MicroPlate™.
Figure S6. Principle component analysis of substrate utilization by tank inoculums at weeks 5, 9, and 13 for A) EcoPlate™ and B) AN MicroPlate™.