In Situ Digestibility of Tall Fescue Fertilized with Different Swine Manure Treatments and Harvested on Four Dates

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Story in Brief

Forage digestibility varies across a growing season due to factors such as fertility and harvest date. Our objective was to evaluate dry matter digestibility (in situ) of tall fescue (Lolium arundinacea, Schreb.) fertilized with different swine manure treatments and harvested on different dates. Tall fescue (‘GA-Jessup’ variety) infected with a non-ergot alkaloid producing endophyte (Max-Q®) was either not fertilized (CONT) or fertilized (113 lb N/acre) with normal swine manure (NORM), swine manure from pigs fed phytase (PHY), or PHY treated with aluminum chloride (PHY+AL). Forage was allowed to accumulate before harvesting by clipping with hand shears (1-inch stubble height) on April 3, April 28, May 15, and June 23, 2003. Ruminally cannulated steers (n = 5; 1,208 lb BW) were used to evaluate these forages in situ. Degradation rate of DM was greater (P < 0.05) from NORM and PHY than from CONT and decreased (P < 0.05) with advancing harvest dates through the May 15 harvest. A fertility treatment by harvest date interaction was detected (P < 0.05) for most variables. The water-soluble fraction and effective degradability were greater (P < 0.05) from fertilized than CONT fescue harvested April 3, but the improvement was not consistent across harvest dates for either measurement. Therefore, inclusion of phytase in swine diets along with subsequent treatment of the manure with aluminum chloride did not have consistent impacts on forage degradation compared with normal swine manure. Furthermore, fertilization with swine manure increased effective degradability of fescue initially, but the impact was not consistent at later harvest dates.

Introduction

Swine manure is used as a fertilizer for forages that may be used as pasture or harvested for later use. When swine manure is used as a source of N fertilizer, excess levels of phosphorus (P) are typically applied to the forage. The excess P can affect forage quality and, if extreme or poorly applied, can also pollute water sources due to runoff. Recent research has focused on methodology to limit the amount of P that is excreted from growing pigs. One such practice, feeding phytase, has been shown to improve P use by pigs and thereby reduce P excretion. This study was conducted to determine the impact of swine dietary or manure treatments on digestibility of tall fescue (Lolium arundinacea, Schreb.) fertilized with swine manure and harvested on different dates.

Experimental Procedures

Growing pigs were fed a normal growing and finishing ration, or a ration where phytase (0.03%) was added to the mixture. Phytase is an enzyme that breaks down phytate, which contains an indigestible form of P and is used to increase P availability. Manure was collected separately from pigs fed the normal and the phytase diets. Manure was analyzed, then applied to supply 113 lb N/acre to three of four experimental pastures. One pasture received no swine manure and served as a negative control (CONT). One pasture received normal manure (NORM), one pasture received the manure from pigs fed phytase (PHY), and one pasture received manure from pigs fed phytase with the manure treated with aluminum chloride (0.75%) at the time of application (PHY+AL). The manure was treated with aluminum chloride to chemically bind the P and prevent it from being solubilized and potentially leach into ground water. The experimental pastures were established originally from a field predominated by bermudagrass that was used as a hay meadow.

Representative sites within each pasture were chosen and enclosed with cattle panels bent into circles to protect those sites from grazing. Samples were collected on April 3, April 28, May 15, and June 23, 2003 to correspond to vegetative, boot, full bloom, and soft dough maturity stages. The forage was harvested by clipping with hand shears to a 1-inch stubble height. Samples were gathered at multiple locations on the April 3 sampling date prior to initiation of grazing. Thereafter, samples were clipped from one enclosure selected at random within each pasture. Samples were then dried to a constant weight under forced air (122°F) and ground through a 2-mm screen.

Five ruminally cannulated steers (1,208 lb BW) were used to determine the in situ ruminal degradation kinetics of the different tall fescue samples. Steers were adapted to a diet of alfalfa hay and concentrate mix for 10 days before initiation of the in situ study. Steers had ad libitum access to water.

Eight hundred (50/fertility x date) Dacron bags were filled with 5 g (0.18 oz) of dried forage and placed into separate mesh bags for each of nine time periods. Mesh bags were soaked in warm water prior to ruminal incubation to ensure accessibility of microorganisms to the samples. Bags were inserted simultaneously into the rumen of all steers prior to feeding. Bags were incubated for 3, 6, 9, 12, 24, 36, 48, 72, and 96 hours then placed into a washing machine and rinsed with cold water for 10 cycles consisting of a 1-minute agitation and 2-minute rinse. One bag for each forage and date combination was not inserted in the rumen but was washed as described above to determine the water-soluble fraction of each forage. Following rinsing, bags were dried to a constant weight under forced air (122°F), then weighed to determine forage degradation.

The forage fractions remaining in the in situ bags at the different time periods were analyzed using SAS (PROC NLIN; SAS Inst., Inc., Cary, N.C.) to determine degradation rate constants. These rate

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The water-soluble fraction of a forage represents the portion of the carbohydrates, protein, and minerals that are very rapidly solubilized and rapidly available for use by the rumen microorganisms and/or the ruminant animal. The influence of fertility source on the water-soluble fraction varied across harvest dates (fertility by date interaction; Table 1). The water-soluble fraction of forage harvested on April 3 was lower (P < 0.05) from CONT than from forages fertilized with the swine manure treatments. On April 28, NORM had a greater (P < 0.05) water-soluble fraction than PHY + AL, and CONT and PHY were intermediate. Fescue fertilized with PHY had a higher (P < 0.05) water-soluble fraction on May 15 than the other forages. The water-soluble fractions of PHY and PHY+AL were higher (P < 0.05) on the June 23 harvest date compared with NORM, and CONT was intermediate and did not differ (P > 0.10) from the other treatments. The water-soluble fraction generally declined (P < 0.05) with advancing maturity within each fertility treatment. Therefore, the concentration of rapidly available nutrients declined with advancing maturity, but fertilizing with swine manure from pigs fed phytase appeared to help the forage maintain a higher level of rapidly available nutrients as the forage advanced in maturity.

Forage intake is generally limited by gut fill along with numerous other factors. A faster digestion rate of a forage means that gut fill will be reduced more rapidly following forage consumption, thereby allowing more room in the rumen for intake of a greater quantity of forage. In situ dry matter disappearance rate is a measure of the rate at which forage will be digested in the rumen and is directly proportional to forage intake.

The swine manure treatment by harvest date interaction was not significant (P > 0.10) for DM degradation rate. Degradation rate declined (P < 0.05) with advancing maturity through the May 15 harvest date but did not further decline (P > 0.10) through the June 23 harvest (Figure 1). Therefore, forage intake would likely decline through May 15, then level off. When averaged across harvest dates, DM degradation rate was greater (P < 0.05) from NORM and PHY than from CONT, and PHY+AL was intermediate and did not differ (P > 0.10) from the other fertility treatments (Figure 2). Therefore, it is possible that intake of NORM and PHY would be greater than that from CONT.

Effective ruminal degradation represents the ruminal digestibility of a particular forage. A fertility source by harvest date interaction was detected (P < 0.05) for effective ruminal degradation (Figure 3). Effective degradation decreased (P < 0.05) with each advancing harvest date within each fertility source, but the decrease over time was greater from fertilized forages (avg. 37% decline) compared with CONT (27% decline). Effective degradation was greater (P < 0.05) on April 3 from pastures fertilized with swine manure compared with CONT, but effective degradation did not differ (P > 0.05) among the three swine manure sources. Effective degradation did not differ (P > 0.10) among the four fertility treatments on April 28. By May 15, forage harvested from CONT had greater (P < 0.05) effective degradation than forage harvested from NORM and PHY+AL. On the June 23 harvest, effective degradation was greater (P < 0.05) from CONT and PHY than NORM, and PHY+AL was intermediate and did not differ (P > 0.10) from the other treatments. Changes in effective degradation over time are likely a result of differential plant maturity and seedhead formation. Fertilized plants appeared to produce greater leaf tissue, but likewise produced a greater number of stems per unit of area and the stems were much taller from fertilized plants. The shorter and less frequent stem production in the unfertilized pasture likely resulted in a greater leaf to stem ratio in those plants, resulting in increased digestibility of the whole plant at later maturity.

**Implications**

Addition of swine manure resulted in increases in the water-soluble components and effective ruminal degradation of tall fescue harvested at the late vegetative stage, but those improvements were not maintained as the forage advanced in maturity. Fescue fertilized with swine manure from pigs fed phytase appeared to maintain higher quality than fescue fertilized with other swine manure treatments. Therefore, impacts of maturity on forage quality were not reduced by increased fertilization with swine manure, and dietary manipulation to reduce phosphorus runoff may enhance forage quality.

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**Table 1. Water-soluble fraction of tall fescue forage fertilized with different types of swine manure and harvested on different dates.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Fertility treatment¹</th>
<th>CONT</th>
<th>NORM</th>
<th>PHY</th>
<th>PHY+AL</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Apr-03</td>
<td>27.6 w² b³</td>
<td>31.5 w a</td>
<td>33.2 w a</td>
<td>31.8 w a</td>
<td></td>
</tr>
<tr>
<td>28-Apr-03</td>
<td>26.7 wx ab</td>
<td>27.4 x a</td>
<td>27.2 x ab</td>
<td>25.4 x b</td>
<td></td>
</tr>
<tr>
<td>15-May-03</td>
<td>24.9 x b</td>
<td>23.4 y b</td>
<td>27.4 x a</td>
<td>23.7 xy b</td>
<td></td>
</tr>
<tr>
<td>23-Jun-03</td>
<td>21.5 y ab</td>
<td>20.6 y b</td>
<td>23.4 y a</td>
<td>22.6 y a</td>
<td></td>
</tr>
</tbody>
</table>

¹ CONT = no swine manure applied, NORM = conventional swine manure applied, PHY = manure applied from pigs fed a diet with phytase; PHY+AL = manure applied from pigs fed phytase and then treated with aluminum chloride.

² w,x,y,z Means for harvest dates within a fertility treatment (column) that are not followed by a common letter differ (P < 0.05).

³ a,b,c Means for fertility treatments within a harvest date (row) that are not followed by a common letter differ (P < 0.05).
Fig. 1. Rate of ruminal DM degradation of tall fescue harvested on different dates. Means represent an average across different swine manure fertility treatments.

Fig. 2. Rate of ruminal DM degradation of tall fescue fertilized with different swine manure fertility treatments. Means represent an average across forage harvested on different dates. Means without a common superscript letter differ (P < 0.05). CONT = no swine manure applied, NORM = conventional swine manure applied, PHY = manure applied from pigs fed a diet with phytase, PHY+AL = manure applied from pigs fed phytase and then treated with aluminum chloride.

Fig. 3. Effect of swine manure treatment on effective ruminal DM degradation of tall fescue forage harvested on different dates. Means within a swine manure treatment differed (P < 0.05) with each advancing harvest date. CONT = no swine manure applied, NORM = conventional swine manure applied, PHY = manure applied from pigs fed a diet with phytase, PHY+AL = manure applied from pigs fed phytase and then treated with aluminum chloride.