Introduction & Objectives

- Animal manure is key resource in farming systems of arid and semi-arid regions
- Improper storage of manure leads to carbon (C) and nitrogen (N) losses
- Charcoal and tannins used as feed additives can stabilize organic matter and nitrogen (N) in manure
- **Research question:** Can feed additives reduce gaseous N and C losses during sun-drying and storage of manure

Materials & Methods

- Basal diet: 50% Rhodes grass hay
- 46.5% Maize
- 3.5% Soya
- 2.5% Activated charcoal (AC)
- 3.4% Quebracho tannin (QT)

**Figure 1** Schematic illustration of experimental treatments, manure properties and set-up of manure

- Manure from male Jebel Al Akhdar goats fed the three diets Co, AC, and QT in Sohar, Oman
- Pooled manure dried on plastic sheets in the sun in three experiments
- NH₃, N₂O, and CO₂ emissions from drying manure measured for five days
- Photo-acoustic multi-gas analyzer (Innova 1312) connected by Teflon tubing to a closed chamber (4 min accumulation period)
- Gas flux calculation (R²>0.6) using linear regression (R package ‘gasfluxes’)

**Figure 2** Goat with fecal collection bag in individual crates

**Figure 3** In-field gas emission measurement

**Table 1** Conditions of the three manure drying experiments conducted in Sohar.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Time until DM &gt; 90%</th>
<th>Manure kg FM m⁻²</th>
<th>Mean Temp. °C</th>
<th>Min. RH %</th>
<th>Max. RH %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1.4</td>
<td>32.2</td>
<td>36.4</td>
<td>83.8</td>
</tr>
<tr>
<td>2</td>
<td>79</td>
<td>10.8</td>
<td>29.6</td>
<td>8.5</td>
<td>71.7</td>
</tr>
<tr>
<td>3</td>
<td>84</td>
<td>8.8</td>
<td>20.5</td>
<td>43.8</td>
<td>82.2</td>
</tr>
</tbody>
</table>

Results and Discussion

**Figure 4** Boxplots of NH₃-N (a), N₂O-N (b), and CO₂-C (c) emission rates from drying manure (< 90% DM) and after reaching constant weight (> 90% DM) measured in three experiments in Sohar, Oman.

- Under quick drying conditions (experiment 1) low CO₂ emission and considerable NH₃ volatilization rates, even after reaching > 90% DM (→ storage losses)
- Slow drying (experiments 2 and 3) lead to high CO₂ emissions and very low NH₃ volatilization (→ microbial immobilization)
- N₂O emissions were insignificant and unaffected by treatment
- AC did not consistently affect gaseous C and N losses
- QT reduced N and C losses by up to 64% in two experiments

**Table 2** Cumulative N and C emissions during drying of manure in three experiments conducted in Sohar, Oman, and overall N and C losses related to C and N input. Letters indicate significant treatment effects.

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th>Experiment 2</th>
<th>Experiment 3</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg N kg⁻¹ (SD)</td>
<td>mg N kg⁻¹ (SD)</td>
<td>mg N kg⁻¹ (SD)</td>
<td>% of initial N</td>
</tr>
<tr>
<td>Co</td>
<td>252 (51.9)</td>
<td>138 (27.9)</td>
<td>295 (12.5)</td>
<td>0.6-1.4</td>
</tr>
<tr>
<td>AC</td>
<td>207 (38.0)</td>
<td>151 (31.1)</td>
<td>112 (33.1)</td>
<td>0.6-1.1</td>
</tr>
<tr>
<td>QT</td>
<td>128 (18.4)</td>
<td>208 (17.2)</td>
<td>107 (17.2)</td>
<td>0.5-0.9</td>
</tr>
<tr>
<td>g C kg⁻¹ (SD)</td>
<td>0.1 (0.09)</td>
<td>7.9 (0.07)</td>
<td>10.2 (0.49)</td>
<td>0.0-2.2</td>
</tr>
<tr>
<td>Co</td>
<td>0.0 (0.00)</td>
<td>10.5 (11.12)</td>
<td>7.2 (0.64)</td>
<td>0.0-2.1</td>
</tr>
<tr>
<td>AC</td>
<td>0.3 (0.19)</td>
<td>5.4 (1.34)</td>
<td>4.3 (0.32)</td>
<td>0.1-1.2</td>
</tr>
<tr>
<td>QT</td>
<td>0.0 (0.00)</td>
<td>0.5 (0.06)</td>
<td>0.2 (0.04)</td>
<td>0.0-0.5</td>
</tr>
</tbody>
</table>

Conclusions

- Only minor amounts of initial C and N lost from manure via gaseous emissions during sun-drying
- Slow drying favors (Exp. 2-3) microbial activity (CO₂ emissions) possibly immobilizing N and lowering NH₃ volatilization also during storage
- **Feeding QT** reduces gaseous C and N losses by up to 64% → promising feed additive for improved N cycling

References


1. Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics (OPATS), Universität Kassel-Witzenhausen, Germany
2. Royal Gardens and Farms, Royal Court Affairs, Sultanate of Oman
3. Animal Husbandry in the Tropics and Subtropics (AHTS), Universität Kassel-Witzenhausen, Germany

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