Corn Processing Options

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ISU Extension and Outreach
Overview

- Corn grain – large focus of processing
- What about whole plant corn or corn stover?
Outline

- Alkaline treatment of corn stover
- Corn silage processing – shredlage
Alkali Treatment

• Not new - alkali treatment processes:
  – NaOH
  – NaOH + CaO
  – Ammonia

• Latest – calcium hydroxide
How does it work?

[Diagram showing the process of lignin treatment with chemicals and temperatures]

Electron micrographs courtesy of MS Lime
Treatment Process

• Reduce particle size – increase surface area (3 to 6” screen)

• Add 5% wt:wt dry CaO and water to create Ca(OH)$_2$, or add Ca(OH)$_2$ directly.

• pH increase to 10-12; above 8 for storage

• Hold 5-7 days before feeding

• Long term storage – oxygen exclusion; not fermentation process
Processing

*ADM Commercial Demonstration Trials
# Feeding Corn Stover

<table>
<thead>
<tr>
<th>Item</th>
<th>Baled Stover</th>
<th>Untreated Stover Silage</th>
<th>CaO-Treated Silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestion coefficients, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>75.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>75.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>83.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NDF</td>
<td>70.8</td>
<td>68.7</td>
<td>81.7</td>
</tr>
<tr>
<td>ADF</td>
<td>62.5</td>
<td>62.7</td>
<td>75.9</td>
</tr>
</tbody>
</table>

ISU Animal Industry Report, 2011 (R2586)
# Hydrated Lime – Stover Digestibility

<table>
<thead>
<tr>
<th>Iowa State University&lt;sup&gt;a&lt;/sup&gt;</th>
<th>University of Nebraska&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Stalks</strong></td>
</tr>
<tr>
<td>Baled</td>
<td>Stover silage</td>
</tr>
<tr>
<td></td>
<td>75.9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Lamb digestion study

<sup>b</sup>IVDMD, 50% DM
Lactating Cows

• Purdue University
  – Mid lactation cows
  – Replaced corn silage
  – Short term – 21d
<table>
<thead>
<tr>
<th>Treated stover % of dry ration wt.</th>
<th>Control</th>
<th>On-farm</th>
<th>Extruded</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, lbs/d</td>
<td>52.9</td>
<td>49.3</td>
<td>47.7</td>
</tr>
<tr>
<td>Milk, lbs/d</td>
<td>64.5</td>
<td>61.0</td>
<td>63.6</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1.22</td>
<td>1.24</td>
<td>1.33</td>
</tr>
<tr>
<td>% Milk Fat</td>
<td>3.92</td>
<td>3.64</td>
<td>4.0</td>
</tr>
<tr>
<td>% Milk Protein</td>
<td>2.99</td>
<td>3.06</td>
<td>3.06</td>
</tr>
<tr>
<td>% Milk Lactose</td>
<td>4.71</td>
<td>4.62</td>
<td>4.63</td>
</tr>
</tbody>
</table>
# Stover vs Grain

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>4 stover for corn grain</th>
<th>8 stover for corn grain</th>
<th>12 stover for corn grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter intake, lb/d</td>
<td>59.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>51.7&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Milk yield, lb/d</td>
<td>92.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>90.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>86.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>81.4&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>4.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.18&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.05&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>3.5% FCM, lb/d</td>
<td>105.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>101.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>95.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>90.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Treatment Recipe

• The Recipe to make 50% DM treated stover
  Water 1000 lb
  Stover DM 950 lb
  Lime 50 lb
  \[ \text{Total} = 2000 \text{ lb (as fed) treated stover} \]

• Dry baled stover (90% DM)
  As fed stover \((950 \div 0.90)\) 1055 lb
  Added water 1000 lb – (1055-950) 895 lb (112 gallons)
  \[ \text{Total} = 2000 \text{ lb (treated stover)} \]

• To treat 50 tons of 90% DM Stover you need 10,600 gallons of water!

Combs, UW-Madison
Costs

- CaO - $350/t
- Labor and machinery = $10/t minimum
- Cost of corn stover: $80/t
- Cost of Grinding: $140-400/hr
  - Instances of over $400/hr
- Additional costs
  - Packing tractor, loader, storage: bagger, or plastic cover
Summary

• CaO ↑ digestibility 8-15%

• Feeding rate – 20% in feeding studies

• Short term work in lactating dairy cattle
  – Caution for dry, transition cows

• What are the costs
Corn Silage
Shredlage

• Missouri dairy farmer

• Built prototype in shop

• Prototype in less than 60-days

• Development to today
Kernel Processor
Feeding

• Shreddlage vs KP
• 50% of ration
• Cow ~ 114 - 117 DIM
• 8 wks
3.5% FCM Yield by Week

<table>
<thead>
<tr>
<th>Week on Treatment</th>
<th>Shreddlage</th>
<th>KP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100.1</td>
<td>100.9</td>
</tr>
<tr>
<td>4</td>
<td>101</td>
<td>98.1</td>
</tr>
<tr>
<td>6</td>
<td>99.4</td>
<td>96.9</td>
</tr>
<tr>
<td>8</td>
<td>99.8</td>
<td>95.4</td>
</tr>
</tbody>
</table>

* P < 0.10
** P < 0.01

Ferraretto and Shaver
# Penn State Shaker Box (as-fed basis)

Samples obtained during feed-out from the silo bags

<table>
<thead>
<tr>
<th>Screen, mm</th>
<th>Shredlaje</th>
<th>KP</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>31.5%</td>
<td>5.6%</td>
</tr>
<tr>
<td>8</td>
<td>41.5%</td>
<td>75.6%</td>
</tr>
<tr>
<td>1.18</td>
<td>26.2%</td>
<td>18.4%</td>
</tr>
<tr>
<td>Pan</td>
<td>0.8%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>
NDF Digestibility

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shreddlage</td>
<td>36.1</td>
</tr>
<tr>
<td>KP</td>
<td>32.2</td>
</tr>
</tbody>
</table>

Treatment $P < 0.04$
Settings

Shredlage
• 26-30 mm (1-1.2 in.) TLOC; 2-3 mm roll gap
• Reduce knife numbers

Kernal Processing
• 19 mm (3/4 in) TLOC; 2-3 mm roll gap
Questions

• Availability and price

• Impact on drought stressed corn

• Long term storage

• High corn silage diet – reduce/eliminate hay
Summary

• New technology
• Positive response when fed to cows
• Availability and price
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