Impacts of Distillers Grains in Cheese Quality

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Eric Testroet (PhD candidate), Matthew O’Neil (PhD student)
PROBLEM

• Cheese producer complaints of unwanted gas formation ("late blowing" in cheese)
  • Source of problems hypothesized to be distillers grains
  • Heat-resistant spores
TWO CONTROLLED STUDIES

- Milk composition and cheese quality: investigating the impact of distillers dried grains with solubles (DDGS)
- Reduced fat DDGS feeding: Investigating impact on milk composition and cheese quality
Study Design

- 24-36 mid-lactation multiparous Holstein dairy cows received each of 2 or 3 diets
  - Total mixed ration (TMR) (both studies)
  - 10% of dry matter in TMR as 10% DDGS (1st study)*
  - 20% of DM in TMR as 20% DDGS*
    - Mean 13% fat (1st study)
    - Mean 6.5% fat (2nd study)
- Isoenergetic, isonitrogenous diets
  - Contained similar available amino acid concentrations
  - Individual Calan® gate feeding
  - Feed intake recorded

*in place of soybean meal
Study Design

• Cross-over design
  • 2 treatment periods (35 days)
  • Each cow served as her own control

• Milk collected for analysis
  • Weekly
  • Individual cows
    • Proximate analyses
      • Fat, protein, total solids, lactose
    • Fatty acid analysis
Cheese Study Design

- Pooled milk taken to ISU CCUR pilot plant for processing
  - Allowed 3-week acclimation to diets
    - Weeks 4 & 5

- Pooled milk
  - Baby Swiss cheese production
    - 24-hour process
    - 6 cows per “batch”
    - 2 batches per day
    - At least 12 distinct batches of cheese
RESULTS
## Study 1: Full-Fat DDGS Milk Proximate Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>0% DDGS</th>
<th>10% DDGS</th>
<th>20% DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>3.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.94&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.67&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lactose*</td>
<td>5.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.17&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Protein</td>
<td>3.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.62&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.65&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Solids non-fat</td>
<td>9.33&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.47&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.55&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a, b</sup> Values not sharing the same superscript, within a row, differ significantly (<i>p < 0.05</i>)

* Lactose determined by algorithm built into LactiCheck device (difference mathematically exaggerated?). NOTE: lactose measured chemically in study 2.
STUDY 1: FULL-FAT DDGS CHEESE PROXIMATE ANALYSIS

No significant differences found based upon diet or period (P > 0.05)

NOTE: All cheeses within typical standard of identity for Baby Swiss Cheese

<table>
<thead>
<tr>
<th>LEVELS</th>
<th>0% DDGS</th>
<th>10% DDGS</th>
<th>20% DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese pH</td>
<td>5.15</td>
<td>5.14</td>
<td>5.13</td>
</tr>
<tr>
<td>Moisture</td>
<td>41.28</td>
<td>41.67</td>
<td>41.36</td>
</tr>
<tr>
<td>Fat</td>
<td>30.18</td>
<td>29.70</td>
<td>29.50</td>
</tr>
<tr>
<td>Fat in solids</td>
<td>51.37</td>
<td>50.92</td>
<td>50.33</td>
</tr>
<tr>
<td>Protein</td>
<td>23.83</td>
<td>23.60</td>
<td>24.13</td>
</tr>
</tbody>
</table>
STUDY 1: FATTY ACID COMPOSITION OF BABY SWISS CHEESE FROM FULL-FAT DDGS

- Decrease in short-chain and saturated, increase in long-chain and unsaturated fatty acids with DDGS feeding.
**FULL-FAT DDGS CHEESE SENSORY ANALYSIS**

- **Baby Swiss cheese characteristics**
  - Typical Swiss cheese aroma, including propionic and lactic acid aroma.
  - Glossy round eyes were rarely found.
  - Slits, pin holes, and cracks were evident in all cheeses.
  - Blindness was sometimes exhibited, within 1/2 inch of cheese surface.
  - Body/texture was less rubbery and more soft than expected.

- **No diet treatment effect**
  - *Suggests either all cheeses were contaminated, and/or cheese pressing (moisture removal) issues.*
### Study 1: Full-Fat DDGS Microbiology

- Results confirm milk contamination was an issue
- TMR or the cow environment was the source for gas-forming spores, *not* DDGS
- *Antimicrobials effect of DDGS?*

<table>
<thead>
<tr>
<th>Sample</th>
<th>Gas formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMR</td>
<td>Yes</td>
</tr>
<tr>
<td>DDGS</td>
<td>No</td>
</tr>
<tr>
<td>Milk</td>
<td>Yes</td>
</tr>
<tr>
<td>Cheese</td>
<td>Yes</td>
</tr>
<tr>
<td>Manure</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Manure samples showing gas formation
ANTIMICROBIAL TESTING OF DDGS

- 17 antibiotics quantified
  - All below detection limit in DDGS and milk
- No antimicrobial effect of DDGS against:
  - 5 spoilage microorganisms
  - 3 pathogenic organisms (plus 1 Listeria surrogate)
  - 2 lactic acid bacteria used in cheese making
- Take-home: this source of DDGS can be used as livestock feed without the fear of inadvertent feeding of antibiotics

Study 1: Conclusions

- Feeding 10% and 20% DDGS decreased % fat but increased polyunsaturated fatty acids, % SNF, % lactose and % protein in milk.

- The DDGS source used for this research did not contain spore-forming, gas-producing bacteria or antimicrobial properties.

- Gas-forming bacteria found in cheese likely originated from TMR, or the cow environment, rather than DDGS.

- Feeding DDGS did not cause late blowing defects in cheese.
**FOLLOW-UP QUESTIONS**

- How does milk of cows fed reduced-fat DDGS differ from milk of cows fed TMR?

- Does milk production, metabolic profile, and/or feed efficiency of cows fed reduced-fat DDGS differ from cows fed TMR?

- Does cheese made from milk of cows fed reduced-fat DDGS differ from cheese from cows fed TMR?

*Come see Corn Utilization Technology Conference posters, this June 6-8, St. Louis, MO
## STUDY 2: REDUCED-FAT DDGS MILK PROXIMATE ANALYSIS

<table>
<thead>
<tr>
<th>Component</th>
<th>Control TMR</th>
<th>20% RF DDGS</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>3.70</td>
<td>3.63</td>
<td>0.18</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.73</td>
<td>4.70</td>
<td>0.78</td>
</tr>
<tr>
<td>Protein</td>
<td>3.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Total solids</td>
<td>12.32</td>
<td>12.37</td>
<td>0.58</td>
</tr>
</tbody>
</table>

<sup>#</sup>Analyses conducted at Dairyland Laboratories, Inc.

<sup>a, b</sup> Values not sharing the same superscript, within a row, differ significantly (p < 0.05)

### Additional notes:
- total milk fat, total protein, and total lactose production per day (kg/d) ALSO did not differ by diet (p > 0.05).
- milk urea nitrogen was lower when cows were fed DDGS (p < 0.05); better protein utilization.
STUDY 1: FATTY ACID COMPOSITION OF BABY SWISS CHEESE FROM FULL-FAT DDGS

Currently underway
**STUDY 2: REDUCED-FAT DDGS CHEESE PROXIMATE ANALYSIS**

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<td></td>
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<td>Fat in solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^Analysis conducted by collaborators at South Dakota State University after 60 days aging

Begins next week!
REDUCED-FAT DDGS CHEESE SENSORY ANALYSIS

^ 14 specific quality attributes evaluated by trained panelists (>5 hr training) at Iowa State University after 60 days aging.
REduced-FAT DDGS CHEESE SENSORY ANALYSIS

• Appearance (to date)
  • All cheeses:
    • a lot of small eyes (overset)
    • some irregular-shaped eyes
  • Some cheeses:
    • Slits (atypical gas formation)
      • Microbial analysis yet to be conducted
  • Differences in cheese appearance do not seem to be associated with one particular diet
Aroma and Flavor (to date)
- Typical for baby Swiss
  - nutty aroma and flavor
  - slightly bitter
- Body and Texture (to date)
  - Typical for baby Swiss
  - firm, curdy
- No apparent effect of diet on aroma, flavor, body or texture

**Ongoing in coming weeks!**
Study 2: Conclusions

• Reduced-fat DDGS can be effectively fed at a 20% (dry matter) inclusion rate without having negative effects on:
  • Milk composition (fat, protein, lactose)
  • Production of milk components (lb/day)
  • Baby Swiss cheese appearance
  • Baby Swiss cheese aroma and flavor
  • Baby Swiss cheese body and texture
Overall Conclusions

- Reduced-fat DDGS appears to be MORE suitable for dairy cattle TMR supplementation than full-fat DDGS.
ACKNOWLEDGEMENTS

- Graduate students
  - Eric Testroet
  - Matthew O’Neil
  - Vaishnavi Sankarlal

- ISU Dairy Farm staff

- Cow feeders

- Milk collectors and cheese makers

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- Ranae Jorgensen (AURI technician)

- SDSU collaborators (Dr. Lloyd Metzger)