Quality Issues Related to DDGS

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Problem 1 – Variability in Nutrient Content and Digestibility
DDGS Varies in Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources
Averages, Coefficients of Variation, and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>89.3</td>
<td>87.3 – 92.4</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>30.9 (4.7)</td>
<td>28.7 – 32.9</td>
</tr>
<tr>
<td>Crude fat, %</td>
<td>10.7 (16.4)</td>
<td>8.8 – 12.4</td>
</tr>
<tr>
<td>Crude fiber, %</td>
<td>7.2 (18.0)</td>
<td>5.4 – 10.4</td>
</tr>
<tr>
<td>Ash, %</td>
<td>6.0 (26.6)</td>
<td>3.0 – 9.8</td>
</tr>
<tr>
<td>Swine ME, kcal/kg</td>
<td>3810 (3.5)</td>
<td>3504 – 4048</td>
</tr>
<tr>
<td>Lysine, %</td>
<td>0.90 (11.4)</td>
<td>0.61 – 1.06</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.75 (19.4)</td>
<td>0.42 – 0.99</td>
</tr>
</tbody>
</table>
Variability – Possible Solutions

- Use defined quality criteria for screening corn
- Minimize the number of corn varieties used
- Blend a consistent amount of solubles with grains
- Minimize excessive drying/heating
  - Dryer temperatures range from 260°F to 1100°F
  - Reduces amino acid digestibility
- Develop and implement standardized production procedures for all plants within the company
Effect of Acid Detergent Insoluble Nitrogen (ADIN) and Color Score on Growth Performance of Pigs fed Three Blended Sources of DDGS.

<table>
<thead>
<tr>
<th>Source</th>
<th>Hunter Lab Color $^3$</th>
<th>ADIN%</th>
<th>ADG $^2$</th>
<th>ADFI, g$^2$</th>
<th>F/G$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>29.0  6.5  12.7</td>
<td>27.1</td>
<td>218</td>
<td>1,103</td>
<td>5.05</td>
</tr>
<tr>
<td>E</td>
<td>31.1  6.1  13.1</td>
<td>36.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>38.8  6.8  16.5</td>
<td>16.0</td>
<td>291</td>
<td>1,312</td>
<td>4.52</td>
</tr>
<tr>
<td>I</td>
<td>41.8  6.5  18.8</td>
<td>26.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>53.2  4.7  21.8</td>
<td>8.8</td>
<td>390</td>
<td>1,416</td>
<td>3.61</td>
</tr>
<tr>
<td>D</td>
<td>51.7  7.1  24.1</td>
<td>12.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$ Modified form Cromwell et al., 1993.
$^2$ Difference among diets (P < 0.01)
$^3$ L=lightness 0=black; 100=white; The higher the a* and b* values, the greater degree of redness and yellowness, respectively.
Comparison of the Nutrient Content of Corn Distiller’s Grains and Corn Condensed Distiller’s Solubles

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Corn Distiller’s Grains</th>
<th>Corn Condensed Distiller’s Solubles</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM, %</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>CP, %</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Fat, %</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>CF, %</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Ash, %</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Ca, %</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>P, %</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
Effect of Solubles Addition to Distillers Grains on Color of DDGS (Ganesan et al., 2005)

\[ a^* = 0.1953x + 11.666 \]

\[ R^2 = 0.63 \]

\[ L^* = -0.7703x + 62.524 \]

\[ R^2 = 0.76 \]

\[ b^* = 0.2856x + 58.71 \]

\[ R^2 = 0.72 \]
Problem 2 - Flowability
Flowability of DDGS

- Some sources of DDGS do not consistently flow through transport and feed handling systems
- Problem worse in summer
- Problem worse with higher moisture DDGS
Factors That May Affect Flowability of DDGS

- Moisture (humidity)
- Temperature
  - Related to moisture content
  - Above freezing not a real issue
- Pressure (compaction)
- Fat content
- Particle size
- Bulk density

Source: Ganesan et al. 2005
Physical Characteristics of DDGS

- **Bulk density**
  - $35.7 \pm 2.79$ lbs/ft$^3$
  - Range 30.8 to 39.3 lbs/ft$^3$

- **Particle size**
  - $1282 \pm 305$ microns
  - Range 612 to 2125 microns
Possible Solutions

- Dry the product more
  - Cost?
  - Regain moisture?
  - Packaging?

- Change the particle size

- Change solubles addition

- Add flow agents
  - Which ones?
  - How much?
U of M Flowability Research Study

- **Treatments**
  - Moisture level of DDGS:
    - 9% moisture
    - 12% moisture
  - Flowability agents:
    - Control
    - 5 lbs/ton DMX-7 (Delst, Inc.)
    - 2% Calcium carbonate (Unical-P, ILC Resources)
    - 1.25% zeolite (St. Cloud Mining, NM)
Effect of DDGS Moisture Level on Flow Rate and Discharge Score

\[ \begin{align*}
\text{Flow rate (lb/ min)} \\
9\% & \quad 1368^a \\
12\% & \quad 859^b
\end{align*} \]

\( ab(P < 0.05) \)
Effect of Adding Flowability Agents on Flow Rate and Discharge Score

<table>
<thead>
<tr>
<th></th>
<th>Flow Rate (lb/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.0&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>DMX-7</td>
<td>6.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>CaCO3</td>
<td>5.5&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Zeolite</td>
<td>4.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>ab (P < 0.05)</sup>
Effect of Adding Flowability Agents on Drained Angle of Repose

<table>
<thead>
<tr>
<th></th>
<th>At loading (degrees)</th>
<th>After storage (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>DMX-7</td>
<td>65.1</td>
<td>65.1</td>
</tr>
<tr>
<td>CaCO3</td>
<td>60.4</td>
<td>60.4</td>
</tr>
<tr>
<td>Zeolite</td>
<td>60.3</td>
<td>60.3</td>
</tr>
</tbody>
</table>

\( a, b (P < 0.05) \)
Problem 3 – Antimicrobial Residues??

- Antimicrobials in ethanol production
  - Used to control bacterial (lactobacillus) contamination
  - Can increase ethanol yield by as much as 25%
  - Which ones are used?
    - Virginiamycin (0.25 to 2.0 ppm)
    - Penicillin (1 g/1000 liters)
  - Unique compared to forms used in animal feeds
Virginiamycin

- Does not affect yeast productivity
- Does not remain in ethanol after distillation
- Is destroyed at temperatures > 93°C
- Dryer temperatures range from 93 to 232°C
- Is destroyed and there are no detectable residues in DDGS
Penicillin

- Most stable at pH 6.0 to 6.4
- Half life of 14 days when in solution at 24° C
- Easily inactivated by primary alcohols and some sugars
- At pH of 4.5 or 9.0, rate of inactivation increases 10-fold
- At pH 3.2 or 10.5, rate of inactivation increases 100-fold
- Completely degraded at pH 3 and a temperature of 37° C for 30 min.
- No residues in DDGS
Possible Solutions

- Conduct a well designed, objective scientific study and publish the results in the public sector, demonstrating that no detectable or biologically active antimicrobial residues are present in distiller’s by-products.
Problem 4 - Mycotoxins

- Main concerns
  - Aflatoxins – carcinogenic, regulated by FDA
  - Vomitoxin (DON) – feed refusal
  - Fumonisin - carcinogenic
  - Zearalenone – reproductive problems

- If contaminated corn is used, mycotoxins are concentrated 3x in DDGS
  - ELISA tests for mycotoxins may give false positive results
  - Use HPLC/TLC for accurate quantification
Possible Solutions

- Adopt a rigorous mycotoxin screening quality assurance program for incoming corn
- Reject corn loads that exceed QA standards
- Test and monitor prevalence and/or level of mycotoxins in DDGS
Problem 5 – Sulfur Content

- Sulfur levels
  - Range from 0.31 to 1.93%

- Variation partially due to use of sulfuric acid to clean fermenters

- High levels of sulfur in DDGS with high dietary inclusion rate, high S forages/water
  - Polioencephalomalacia in cattle

- Affect on feed intake and palatability of DDGS for swine at high levels
Problem 6 – Sodium Content

- Na content - 0.01 to 0.52%
- Primarily an issue for poultry
- High levels may cause wet litter and dirty eggs if diet adjustments for salt are not made
Some of the Nutrient Variability Among DDGS Sources is Due to the Use of Different Laboratory Testing Procedures
Comparison of AOAC Approved Moisture Testing Methods

- 130-135° C for 1 hour
- 100-105° C for 3 hours
- 100-105° C for 4 hours
- 60-70° C for 24 hours
**Variability of Laboratory Results from the Same DDGS Sample Sent to 5 Different Commercial Laboratories**

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>Fat</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab 1</td>
<td>12.69</td>
<td>13.73</td>
<td>26.00</td>
</tr>
<tr>
<td>Lab 2</td>
<td>10.48</td>
<td>10.01</td>
<td>26.30</td>
</tr>
<tr>
<td>Lab 3</td>
<td>10.09</td>
<td>10.04</td>
<td>27.02</td>
</tr>
<tr>
<td>Lab 4</td>
<td>10.64</td>
<td>8.73</td>
<td>26.13</td>
</tr>
<tr>
<td>Lab 5</td>
<td>13.30</td>
<td>10.15</td>
<td>26.29</td>
</tr>
<tr>
<td>NIR</td>
<td>12.60</td>
<td>9.40</td>
<td>25.00</td>
</tr>
</tbody>
</table>
We have developed a DDGS web site featuring:

* nutrient profiles and photos of DDGS samples
* research summaries
  - swine, poultry, dairy, & beef
  - DDGS quality
* presentations given
* links to other DDGS related web sites
* international audiences