Quality Characteristics and Nutritional Profiles of DDGS

Dr. Jerry Shurson
Department of Animal Science
University of Minnesota
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>
How Does DDGS Compare to Soybean Meal?
## Variability (CV, %) of Selected Nutrients Among U.S. DDGS Sources vs. U.S. Soybean Meal Sources

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>DDGS</th>
<th>Soybean Meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>4.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Crude fat</td>
<td>17.1</td>
<td>30.9</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>18.9</td>
<td>9.5</td>
</tr>
<tr>
<td>Ash</td>
<td>27.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Lysine</td>
<td>12.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Methionine</td>
<td>8.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Threonine</td>
<td>5.8</td>
<td>4.2</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>12.0</td>
<td>7.3</td>
</tr>
<tr>
<td>Calcium</td>
<td>117.5</td>
<td>25.8</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>19.4</td>
<td>9.1</td>
</tr>
</tbody>
</table>
Variation in Particle Size Among DDGS Samples Representing 25 U.S. Ethanol Plants 2005
Variation in Particle Size Among Soybean Meal Samples Representing 6 U.S. Plants 2005
Variation in Bulk Density (Lbs/Cubic Ft.) Among DDGS Samples Representing 25 U.S. Ethanol Plants
1/05
Variation in Bulk Density (Lbs/Cubic Ft.) Among Soybean Meal Samples Representing 6 U.S. Plants 2003
DDGS Definition and Terminology in the Market
Distillers Products Definitions

☐ 27.6 ___ Distillers Dried Grains with Solubles is the product obtained after the removal of ethyl alcohol by distillation from the yeast fermentation of a grain or a grain mixture by condensing and drying at least \( \frac{3}{4} \) of the solids of the resultant whole stillage and drying it by methods employed in the grain distilling industry. The predominating grain shall be declared as the first word in the name.
Comparison of the Nutrient Content of Corn Distiller’s Grains and Corn Condensed Distiller’s Solubles
## Comparison of Nutrient Composition of Golden DDGS to Other “DDGS Sources” (100% Dry Matter Basis)

<table>
<thead>
<tr>
<th></th>
<th>Golden Corn DDGS</th>
<th>“DDGS”</th>
<th>High Fat DDGS</th>
<th>Partial De-germed DDGS</th>
<th>Whiskey DDGS</th>
<th>Pelleted DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein, %</td>
<td>31.8</td>
<td>29.3</td>
<td>31.6</td>
<td>30.1</td>
<td>29.9</td>
<td>27.0</td>
</tr>
<tr>
<td>Fat, %</td>
<td>11.3</td>
<td>3.5</td>
<td>15.3</td>
<td>8.9</td>
<td>8.8</td>
<td>9.00</td>
</tr>
<tr>
<td>Crude fiber, %</td>
<td>6.3</td>
<td>7.9</td>
<td>No data</td>
<td>7.8</td>
<td>10.6</td>
<td>15.10</td>
</tr>
<tr>
<td>ADF, %</td>
<td>12.4</td>
<td>11.8</td>
<td>17.9</td>
<td>21.0</td>
<td>20.2</td>
<td>No data</td>
</tr>
<tr>
<td>Ash, %</td>
<td>6.9</td>
<td>5.3</td>
<td>4.6</td>
<td>7.3</td>
<td>3.7</td>
<td>4.28</td>
</tr>
<tr>
<td>DE, kcal/kg*</td>
<td>4053</td>
<td>3808</td>
<td>No data</td>
<td>3796</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>ME, kcal/kg*</td>
<td>3781</td>
<td>3577</td>
<td>No data</td>
<td>3560</td>
<td>3789</td>
<td>No data</td>
</tr>
<tr>
<td>Lys, %</td>
<td>0.92</td>
<td>0.61</td>
<td>0.90</td>
<td>0.83</td>
<td>0.99</td>
<td>No data</td>
</tr>
<tr>
<td>Met, %</td>
<td>0.62</td>
<td>0.54</td>
<td>0.54</td>
<td>0.66</td>
<td>0.61</td>
<td>No data</td>
</tr>
<tr>
<td>Thr, %</td>
<td>1.17</td>
<td>1.01</td>
<td>1.04</td>
<td>1.13</td>
<td>1.10</td>
<td>No data</td>
</tr>
<tr>
<td>Trp, %</td>
<td>0.25</td>
<td>0.18</td>
<td>0.23</td>
<td>0.25</td>
<td>0.27</td>
<td>No data</td>
</tr>
<tr>
<td>Ca, %</td>
<td>0.07</td>
<td>0.12</td>
<td>0.06</td>
<td>0.51</td>
<td>0.04</td>
<td>0.17</td>
</tr>
<tr>
<td>P, %</td>
<td>0.77</td>
<td>0.78</td>
<td>0.89</td>
<td>0.68</td>
<td>0.57</td>
<td>0.62</td>
</tr>
</tbody>
</table>

*Calculated energy values for swine
Grain Source Affects Nutrient Content and Digestibility
Comparison of Nutrient Composition of Corn DDGS, Sorghum DDGS, and a Corn-Sorghum Blend (As-is basis)

Urriola et al. (2006)
Comparison of Total Lysine, Methionine, Threonine, and Tryptophan of Corn DDGS, Sorghum DDGS, and a Corn-Sorghum Blend of DDGS for Swine

Urriola et al. (2006)
Comparison of Lys, Met, Thr, and Trp Digestibilities of Corn DDGS, Sorghum DDGS, and a Corn-Sorghum Blend of DDGS for Swine

Urriola et al. (2006)
Standardized Ileal Lysine Digestibility Coefficients Among 10 “Golden” Corn DDGS Sources for Swine (Stein et al., 2005)
Differences in Digestible Amino Acid Content Among DDGS Sources for Poultry

Noll et al. (2006)
Prediction of Amino Acid Digestibility Among Sources of DDGS for Swine and Poultry
Hunter Lab and Minolta Color Measurements

Commission of illumination color scale (Minolta):
*L* = Lightness
*a* = redness
*b* = yellowness

Lightness 25%

Lightness 50%

Lightness 75%
Fig. 1. Regression of digestible lys (%) and color (L*, b*)

Source: Dr. Sally Noll (2003)
Prediction of Digestible Lysine from Color (L*, a*, and b*) Among DDGS Sources for Swine

\[ R^2 = 0.12, \ RMSE = 0.10, \ PC = 1 \]

Urriola et al. (2006)
Prediction of Digestible Lysine from Color L*, a*, and b* (L* < 50 in corn DDGS)

\[ R^2 = 0.40, \ RMSE = 0.07, \ PC = 1 \]

\( \text{In vivo digestible lysine, } \% \)

Lightness (L*)

Urriola et al. (2006)
Prediction of Digestible Lysine Content of DDGS Using Optical Density
Prediction of Digestible Lysine from Optical Density (400 to 700 nm)

$R^2 = 0.86$, RMSE = 0.05, PC = 14

Urriola et al. (2006)
Prediction of Digestible Lysine in DDGS Using Front Face Fluorescence

Urriola et al. (2006)
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>
An “Ideal” DDGS Quality Assurance Program for Ethanol Plants

- Monitor incoming corn for mycotoxins and reject positive loads
- Standardize the amount of solubles added to the grains fraction to produce DDGS
- Use minimal drying time and temperature to produce DDGS
  - Dryer temperatures range from 445° F to 1150°F
- Segregate poor quality DDGS from good quality DDGS when it is produced
  - Price different qualities accordingly
- Provide transparent and frequent nutrient profile information to customers on the DDGS being produced
- Specify the testing procedures used to determine nutrient content
- Become ISO 9000:2001 and HAACP certified
Physical Characteristics to Monitor

- Bulk density
- Particle size
- Hunter color scores
  - L*
  - a*
  - b*
- pH
Nutrients to Monitor

- Moisture
- Crude protein
- Crude fat
- Crude fiber
- ADF
- NDF
- Ash
- Swine DE, ME, NE (calculated)
- Starch
Minerals

- Calcium
- Phosphorus
- Sulfur
- Chloride
- Sodium
Amino acids

- Lysine
- Methionine
- Threonine
- Tryptophan
- Cystine
Mycotoxins

- Aflatoxins
  - B$_1$, B$_2$, G$_1$, G$_2$
- Deoxynivalenol (DON)
- Zearalenone
- Fumonisins
  - B$_1$, B$_2$, B$_3$
The Value of New Distiller’s By-Products in Swine Diets
Comparison of Mineral Content of Dakota Gold DDGS with High Protein Dakota Gold and Corn Protein Concentrate (100% DM Basis)
Comparison of Nutrient Content of Dakota Gold DDGS with High Protein Dakota Gold and Corn Protein Concentrate (100% DM Basis)
Comparison of Amino Acid Content of Dakota Gold DDGS with High Protein Dakota Gold and Corn Protein Concentrate (100% DM Basis)
## Opportunity Costs of Corn By-Products in Swine and Poultry Diets

<table>
<thead>
<tr>
<th></th>
<th>DDGS Spec. 1</th>
<th>DDGS Spec. 2</th>
<th>HP DDGS</th>
<th>Glutenol</th>
<th>CPC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swine</strong></td>
<td>$80.00</td>
<td>$78.00</td>
<td>$51.00</td>
<td>$63.40</td>
<td>$61.60</td>
</tr>
<tr>
<td><strong>Poultry</strong></td>
<td>$80.00</td>
<td>$75.20</td>
<td>$53.00</td>
<td>$75.20</td>
<td>$43.00</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