Quality and Nutritional Characteristics of Distiller’s Dried Grains with Solubles (DDGS)

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What is DDGS?

- By-product of the dry-milling ethanol industry
- Nutrient composition is different between dry-mill, wet-mill and beverage alcohol by-products
  - DDGS – fuel ethanol
  - DDGS - whiskey distilleries
  - Corn gluten feed – wet mill
  - Corn gluten meal – wet mill
  - Brewer’s dried grains – beer manufacturing
- Nutrient content depends on the grain source used
  - **Corn (maize) DDGS - Midwestern US**
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>“New Generation” Corn DDGS</th>
<th>Corn Gluten Feed (NRC)</th>
<th>Corn Gluten Meal (NRC)</th>
<th>Corn Germ Meal (Feedstuffs)</th>
<th>Brewer’s Dried Grains (NRC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein, %</td>
<td>30.6</td>
<td>23.9</td>
<td>66.9</td>
<td>22.2</td>
<td>28.8</td>
</tr>
<tr>
<td>Fat, %</td>
<td>10.7</td>
<td>3.3</td>
<td>3.2</td>
<td>1.1</td>
<td>7.9</td>
</tr>
<tr>
<td>NDF, %</td>
<td>43.6</td>
<td>37.0</td>
<td>9.7</td>
<td>No data</td>
<td>52.9</td>
</tr>
<tr>
<td>DE, kcal/kg</td>
<td>4011</td>
<td>3322</td>
<td>4694</td>
<td>No data</td>
<td>2283</td>
</tr>
<tr>
<td>ME, kcal/kg</td>
<td>3827</td>
<td>2894</td>
<td>4256</td>
<td>3222</td>
<td>2130</td>
</tr>
<tr>
<td>Lys, %</td>
<td>0.83</td>
<td>0.70</td>
<td>1.13</td>
<td>1.00</td>
<td>1.17</td>
</tr>
<tr>
<td>Met, %</td>
<td>0.55</td>
<td>0.39</td>
<td>1.59</td>
<td>0.67</td>
<td>0.49</td>
</tr>
<tr>
<td>Thr, %</td>
<td>1.13</td>
<td>0.82</td>
<td>2.31</td>
<td>1.22</td>
<td>1.03</td>
</tr>
<tr>
<td>Trp, %</td>
<td>0.24</td>
<td>0.08</td>
<td>0.34</td>
<td>0.22</td>
<td>0.28</td>
</tr>
<tr>
<td>Ca, %</td>
<td>0.06</td>
<td>0.24</td>
<td>0.06</td>
<td>0.33</td>
<td>0.35</td>
</tr>
<tr>
<td>Available P, %</td>
<td>0.80</td>
<td>0.54</td>
<td>0.08</td>
<td>0.17</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Corn Dry-Milling Process Overview

1. Corn Cleaning
2. Hammermill
3. Mix Slurry
4. Liquefaction
5. Cooker
6. Centrifuge
7. Evaporator
8. Rotary Dryer
9. Ethyl Alcohol
10. Distillers Wet Grains
11. Distillers Dried Grains with Solubles
12. Cond. Distillers Solubles

Key Components:
- alpha amylase enzyme
- CO2
- Yeast and Glucoamylase Enzyme

Feed Industry Co-products

Processing Steps:
- Cleaning
- Milling
- Liquefaction
- Fermentation
- Distillation
- Evaporation
- Drying
- Ethyl Alcohol Production
- Co-products
Dry-Milling Average Ethanol Yield Per Bushel (25.4 kg) of Corn

- Ethanol: 10.2 liters
- DDGS: 8.2 kg
- CO₂: 8.2 kg
U.S. DDGS Production

Source: Steve Markham – Commodity Specialists Company
U.S. DDGS Consumption

Estimate 2001

- Dairy: 6%
- Beef: 4%
- Poultry/Swine & Other: 60%

Estimate 2002

- Dairy: 5%
- Beef: 15%
- Poultry: 5%
- Swine: 45%

Estimate 2003

- Dairy: 4%
- Beef: 11%
- Poultry: 39%
- Swine: 46%
### Current and Potential DDGS Export Markets

**Current**
1. Ireland
2. Denmark
3. United Kingdom
4. Spain
5. Portugal
6. Columbia
7. Mexico
8. Canada
9. Germany
10. Costa Rica

**Potential**
1. China
2. Brazil
3. Philippines
4. Japan
5. Thailand
6. Republic of Korea
7. Taiwan
8. Vietnam
9. Malaysia
10. Indonesia
What Are the Challenges?

1. DDGS - “new” feed ingredient for many customers
   - education and technical service is needed
     (www.ddgs.umn.edu)

2. Inconsistent quality
   - nutrient content
   - color
   - particle size

3. No grading system to differentiate quality and price

4. Misrepresenting quality and nutrient specifications and blending DDGS with other ingredients
DDGS Varies Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources
## Comparison of Nutrient Composition (Dry Matter Basis) of “New Generation” DDGS to Other “DDGS Sources”

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>“New Generation” Corn DDGS</th>
<th>Solulac</th>
<th>Badger State Ethanol</th>
<th>ADM - Peoria</th>
<th>Extruded DDGS/Soy (XDS Plus)</th>
<th>AGP Pelleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein, %</td>
<td>31.82</td>
<td>29.32</td>
<td>31.62</td>
<td>30.12</td>
<td>34.44</td>
<td>27.0</td>
</tr>
<tr>
<td>Fat, %</td>
<td>11.32</td>
<td>3.52</td>
<td>15.25</td>
<td>8.96</td>
<td>13.33</td>
<td>9.00</td>
</tr>
<tr>
<td>Crude fiber, %</td>
<td>6.25</td>
<td>7.90</td>
<td>No data</td>
<td>7.77</td>
<td>7.78</td>
<td>15.10</td>
</tr>
<tr>
<td>ADF, %</td>
<td>12.37</td>
<td>11.80</td>
<td>17.91</td>
<td>20.95</td>
<td>14.44</td>
<td>No data</td>
</tr>
<tr>
<td>Ash, %</td>
<td>6.93</td>
<td>5.29</td>
<td>4.58</td>
<td>7.30</td>
<td>5.56</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>3749</td>
<td>No data</td>
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<tr>
<td>Lys, %</td>
<td>0.92</td>
<td>0.61</td>
<td>0.90</td>
<td>0.83</td>
<td>1.67</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>2.50</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>0.39</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>0.22</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>0.72</td>
<td>0.62</td>
</tr>
</tbody>
</table>

*Calculated energy values for swine
Potential Categories of Distiller’s By-Products

- Dakota Gold
  - Solulac
  - Corn DDGS < 75% solubles added to grains
- DDGS Blends
  - Corn Condensed Distiller's Solubles
  - Corn/Wheat Blends
- Corn DDGS > 75% solubles added to grains
- Wet Distiller’s Grains (Cattle Only)
  - High ADF and Ca, Reduced Energy (Not for Monogastrics)
  - High Fat/High Protein DDGS
- Golden Lix (Cattle Only)
- Spray Dried Distiller’s Solubles
- DDGS/Soy Hull Blends
- Corn - Beverage Distilleries
Most of the Newer Ethanol Plants in the Midwestern U.S. Produce High Quality, Relatively Consistent Golden Corn DDGS

- VeraSun - Aurora, SD
- CVEC - Benson, MN
- Al-Corn - Claremont, MN
- MGP – Lakota, IA
- CMEC - Little Falls, MN
- Agri-Energy - Luverne, MN
- LSCP - Marcus, IA
- Denco – Morris, MN
What Are the Challenges?

5. System to directly connect customers to suppliers
   - Nutrient profile section of www.ddgs.umn.edu

6. Flowability

7. Relatively low bulk density – high freight costs
“Old Generation” vs. “New Generation” DDGS

Lower Quality, Less Digestible DDGS

High Quality, Highly Digestible DDGS
Corn DDGS Color and Smell are Indicators of Digestibility for Monogastrics

- **Color varies among sources**
  - ranges from dark to golden (Cromwell et al., 1993)
  - golden color of corn DDGS is correlated with higher amino acid digestibility in swine and poultry

- **Smell varies among sources**
  - ranges from burnt or smoky to sweet and fermented (Cromwell et al., 1993)
  - golden DDGS has a sweet, fermented smell
  - smell may affect palatability
Fig. 1. Regression of digestible lys (%) and color (L*, b*)

R² = 0.71

R² = 0.74
The Use of DDGS in Swine Diets
Maximum Inclusion Rates of “New Generation” DDGS in Swine Diets
(Based Upon University of Minnesota Performance Trials)

- Nursery pigs (> 7 kg)
  - Up to 25%

- Grow-finish pigs
  - Up to 20% (higher levels may reduce pork fat quality)

- Gestating sows
  - Up to 50%

- Lactating sows
  - Up to 20%

Assumptions: no mycotoxins
formulate on a digestible amino acid and available phosphorus basis
The Use of DDGS in Poultry Diets
Recommended Inclusion Rates of DDGS for Poultry

- **Broilers and Turkeys**
  - 5-10% inclusion rates (Starter/Finisher)
    - Without energy adjustments
  - > 10%
    - With adjustments for lys, met, thr, trp, and energy

- **Chicken Egg Layers**
  - 10% inclusion rate
The Use of DDGS in Dairy Rations
Recommended Feeding Levels of DDGS for Dairy Cows and Replacements

- **Lactating dairy cows**
  - Up to 30% DMI under normal feeding conditions
  - > 30% DMI if BST is used

- **Calves**
  - Up to 20% DMI

- **Replacement heifers**
  - Up to 25% DMI
The Use of DDGS in Beef Rations
Recommended Feeding Levels of DDGS for Beef Cattle

- Creep feeding
  - Up to 20%
- Feedlot cattle
  - Up to 40% DMI
- Receiving/starting cattle
  - Up to 20%
- Brood cows
  - Up to 35% of supplement
We have developed a DDGS web site featuring:

* nutrient profiles and sample photos of DDGS sources

* research summaries
  - swine, poultry, dairy, & beef
  - DDGS quality

* presentations given

* links to other DDGS related web sites

* international audiences