Using Distiller’s Dried Grains with Solubles in Poultry Diets

Dr. Jerry Shurson
Professor
Department of Animal Science
University of Minnesota

An Overview of DDGS Production
Production of DDGS

- Tightly linked to the production of fuel ethanol
- DDGS is a co-product of the dry milling ethanol production process
- About 40% of ethanol is produced using dry milling
- The other 60% of ethanol is produced by wet milling
  - co-products include: corn gluten feed, corn gluten meal, and corn germ meal

Components of Yellow Dent Corn

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>61.0 %</td>
</tr>
<tr>
<td>Corn Oil</td>
<td>3.8 %</td>
</tr>
<tr>
<td>Protein</td>
<td>8.0 %</td>
</tr>
<tr>
<td>Fiber</td>
<td>11.2 %</td>
</tr>
<tr>
<td>Moisture</td>
<td>16.0 %</td>
</tr>
</tbody>
</table>

Slide courtesy of Ms. Kelly Davis, CVEC
Production of DDGS

- Yeasts and enzymes are used to ferment the starch fraction of corn
- Ethanol and carbon dioxide are produced
- Distiller’s grain and distiller’s solubles are the residues remaining after fermentation
- These fractions and blended and dried to produce distiller’s dried grains with solubles (DDGS)
Dry-Milling Average Yield Per Bushel

- Ethanol 4.2 liters
- DDGS 8.2 kg
- CO$_2$ 8.2 kg

Slide courtesy of Ms. Kelly Davis, CVEC
19 new ethanol plants are currently under construction
- additional capacity is being added to existing plants
- DDGS will increase from 3.3 million tonnes in 2000 to 5.5 million tonnes in 2005
  - 66% increase in supply of DDGS
**DDGS Production and Use**

- 3.2 to 3.5 million metric tonnes (MT) of DDGS are produced in North America/year
  - ~ 900,000 MT produced in MN-Dakota region
  - ~ 700,000 MT exported to the EU
  - ~ 2.65 million MT fed in U.S. and Canada
    - ~ 2.58 million MT (80%) fed to ruminants
    - ~ 45,000 MT fed in MN turkey industry
    - ~ 27,000 MT used in swine diets

**Markets for DDGS Produced in North America**

- Ruminants
- MN Turkey
- Swine
- Exported EU
Use of DDGS in Swine and Poultry Diets is Increasing

- DDGS produced by new Midwestern ethanol is higher in nutrient content and digestibility than DDGS from older plants
- Increased supply of DDGS has made it more economical to replace some of the corn, soybean meal, and dicalcium phosphate

The Use of DDGS in Poultry Diets
**Historical Use of DDGS in Poultry Diets**

- Fed at low inclusion rates in U.S. poultry industry for many years
  - High B vitamin content (solubles)
  - Source of unidentified growth/reproduction factors?
  - Positive effect on palatability (Alenier and Combs, 1981)
  - Protein source at higher dietary inclusion levels

**Unidentified Growth or Hatchability Factor**

- Growth response (Couch et al., 1957)
  - 5% DDGS in turkey diets
  - 17-32% improvement in gain

- Feed preference (Alenier & Combs, 1981)
  - 10% DDGS in chicken layer diets

- Reproduction improvement (Manley, 1978)
  - 3% DDGS in turkey breeder hen diets
  - Improvement in egg numbers and hatch (late lay)
DDGS As Protein Supplement

- Limiting amino acids (Parsons et al., 1983)
  - Lysine
  - Tryptophan
  - Arginine (perhaps equally limiting with trp)

- Dietary lysine and energy adjustments are needed with inclusion of DDGS
  - Growth
  - Feed conversion

Performance of Broiler Chickens (0-42 days) to DDGS in Diets Adjusted and Not Adjusted for Energy (Waldroup et al., 1981)

<table>
<thead>
<tr>
<th>DDGS Inclusion Level (%)</th>
<th>BW (g)</th>
<th>Gain/Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed Energy</td>
<td>Variable Energy</td>
</tr>
<tr>
<td>0</td>
<td>1288</td>
<td>1206</td>
</tr>
<tr>
<td>5</td>
<td>1237</td>
<td>1227</td>
</tr>
<tr>
<td>10</td>
<td>1237</td>
<td>1203</td>
</tr>
<tr>
<td>15</td>
<td>1220</td>
<td>1165</td>
</tr>
<tr>
<td>20</td>
<td>1240</td>
<td>1164</td>
</tr>
<tr>
<td>25</td>
<td>1247</td>
<td>1096*</td>
</tr>
</tbody>
</table>

* Different from control
Lysine Digestibility of DDGS for Poultry

- Lower than corn due to drying process
- Lysine bioavailability = 66%
  - Parsons et al. (1983)
- Lysine digestibility = 65%
  - NRC (1994)

Lysine Availability (%)

<table>
<thead>
<tr>
<th>Source</th>
<th>Lysine Bioavail.</th>
<th>Lysine Digest.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combs &amp; Bossard (1969)</td>
<td>71-93</td>
<td>----</td>
</tr>
<tr>
<td>Parsons (1983)</td>
<td>66</td>
<td>82</td>
</tr>
<tr>
<td>Heartland (1998)</td>
<td>----</td>
<td>57</td>
</tr>
</tbody>
</table>
### Ingredient Amino Acids (% of Protein)

<table>
<thead>
<tr>
<th>AA</th>
<th>SBM</th>
<th>Corn</th>
<th>MBM</th>
<th>Canola</th>
<th>DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>M+C</td>
<td>3.0</td>
<td>4.6</td>
<td>2.4</td>
<td>4.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Lys</td>
<td>6.2</td>
<td>3.0</td>
<td>5.4</td>
<td>5.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Iso</td>
<td>4.3</td>
<td>3.2</td>
<td>3.0</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Arg</td>
<td>7.2</td>
<td>5.0</td>
<td>6.7</td>
<td>6.0</td>
<td>4.4</td>
</tr>
<tr>
<td>Trp</td>
<td>1.5</td>
<td>0.9</td>
<td>0.7</td>
<td>1.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Thr</td>
<td>4.0</td>
<td>3.5</td>
<td>3.2</td>
<td>4.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Val</td>
<td>4.6</td>
<td>4.8</td>
<td>3.8</td>
<td>4.8</td>
<td>4.8</td>
</tr>
</tbody>
</table>

### Amino Acid Digestibility (% of total)

<table>
<thead>
<tr>
<th>AA</th>
<th>Corn</th>
<th>SBM</th>
<th>MBM</th>
<th>DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met</td>
<td>97.9</td>
<td>94.3</td>
<td>92.3</td>
<td>88.5</td>
</tr>
<tr>
<td>Cys</td>
<td>88.2</td>
<td>-----</td>
<td>84.7</td>
<td>78.4</td>
</tr>
<tr>
<td>Lys</td>
<td>86.2</td>
<td>91.8</td>
<td>90.3</td>
<td>78.6</td>
</tr>
<tr>
<td>Arg</td>
<td>96.1</td>
<td>93.5</td>
<td>94.0</td>
<td>92.5</td>
</tr>
<tr>
<td>Tryp</td>
<td>96.8</td>
<td>93.7</td>
<td>95.1</td>
<td>91.8</td>
</tr>
<tr>
<td>Thr</td>
<td>81.1</td>
<td>84.3</td>
<td>90.1</td>
<td>82.5</td>
</tr>
<tr>
<td>Iso</td>
<td>86.4</td>
<td>90.9</td>
<td>92.2</td>
<td>89.1</td>
</tr>
<tr>
<td>Val</td>
<td>93.3</td>
<td>89.4</td>
<td>90.2</td>
<td>88.1</td>
</tr>
</tbody>
</table>
**Energy Utilization of DDGS by Poultry**

- Crude protein = 27.4%
- Crude fat = 9%
- ME, kcal/kg = 2,480
- ME/GE, % = 49.1
- ME (% of corn) = 74.1

**Maximum Inclusion Rates of DDGS in Poultry Diets**

- Turkey, pullet, and broiler starter = 5%
- Turkey and broiler finisher = 15%
- Pullet developer = 10%
- Layer (peak) = 10%
- Layer (late lay) = 10%

Source: ME Jackson, 2002 Midwest Poultry Federation Convention, St. Paul, MN
Use of DDGS in Poultry Diets

- High inclusion rates have also provided good results
  - Favorable results with 25% DDGS in broiler diets
    - Waldroup et al., 1981
  - 15% DDGS in layer diets reduces fatty liver incidence
    - Jensen et al., 1974; Jensen, 1987; Akiba et al., 1983
  - 12% DDGS turkey diets gave similar performance to corn-soybean meal diets
    - Noll, 2002

DDGS Quality is Highly Variable

- Nutritionists want PREDICTABILITY AND CONSISTENCY in feed ingredients.
- The keys for getting maximum value from DDGS are:
  - “Know what you have (or want)”
  - and
  - “Know how to use it”
DDGS Quality is Variable

- Color ranges from very light to very dark
- Odor ranges from sweet to smoky or burnt
- Range in concentration in selected nutrients:
  - Dry matter – 87 to 93%
  - Crude protein – 23 to 29%
  - Crude fat – 3 to 12%
  - Ash – 3 to 6%
  - Lysine – 0.59 to 0.89%

Source: Cromwell et al. (1993)
## Nutrient Profile of Corn Distiller’s Dried Grains with Solubles (DM Basis)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>MW DDGS</th>
<th>Low Quality DDGS</th>
<th>NRC (1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>88.9</td>
<td>88.3</td>
<td>93.0</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>30.2</td>
<td>28.1</td>
<td>29.8</td>
</tr>
<tr>
<td>Fat, %</td>
<td>10.9</td>
<td>8.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Fiber, %</td>
<td>8.8</td>
<td>7.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.06</td>
<td>0.44</td>
<td>0.22</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.89</td>
<td>0.90</td>
<td>0.83</td>
</tr>
<tr>
<td>P availability, %</td>
<td>90.0</td>
<td>?</td>
<td>79.0</td>
</tr>
<tr>
<td>DE, kcal/kg</td>
<td>3965</td>
<td>3874</td>
<td>3449</td>
</tr>
<tr>
<td>ME, kcal/kg</td>
<td>3592</td>
<td>3521</td>
<td>3038</td>
</tr>
<tr>
<td>Lys, %</td>
<td>0.83</td>
<td>0.53</td>
<td>0.67</td>
</tr>
<tr>
<td>App. Dig. Lys, %</td>
<td>0.44</td>
<td>0.00</td>
<td>0.34</td>
</tr>
<tr>
<td>Met, %</td>
<td>0.55</td>
<td>0.50</td>
<td>0.54</td>
</tr>
<tr>
<td>App. Dig. Met, %</td>
<td>0.32</td>
<td>0.24</td>
<td>0.42</td>
</tr>
<tr>
<td>Thr, %</td>
<td>1.13</td>
<td>0.98</td>
<td>1.01</td>
</tr>
<tr>
<td>App. Dig. Met, %</td>
<td>0.62</td>
<td>0.36</td>
<td>0.60</td>
</tr>
<tr>
<td>Trp, %</td>
<td>0.24</td>
<td>0.19</td>
<td>0.27</td>
</tr>
<tr>
<td>App. Dig Trp, %</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

## Growth of Chicks Fed Nine Sources of DDGS

![Graph showing growth of chicks fed nine sources of DDGS]

- **DDGS Source**
  - A
  - B
  - C
  - D
  - E
  - F
  - G
  - H
  - I

- **Grams Per Day**
  - 0
  - 50
  - 100
  - 150
  - 200
  - 250
  - 300
  - 350
  - 400
  - 450
  - 500

- **Gain**
Feed Conversion of Chicks Fed Nine Sources of DDGS

Nutritional Value of DDGS for Poultry

- Must use high quality DDGS
  - Golden color = high amino acid digestibility
- Excellent energy and available phosphorus source
- Nutritional value higher than previously thought
- Unidentified growth factors?
  - 5% DDGS resulted in 17-32% improvement in gain
  - 3% DDGS in turkey breeder hen diets increased egg numbers and hatch
- Effective partial replacement for corn and soybean meal
Quality Considerations for Selecting DDGS Sources for Swine and Poultry

Nutrient Specifications
- Moisture – maximum 12%
- Protein – minimum 26.5%
- Fat – minimum 10%
- Fiber – maximum 7.5%

Physical characteristics
- Bulk density – .44 to .48 kg/cubic meter
- Particle size:
  - maximum coarse particles - 10% on 2000 screen
  - maximum fine particles - 15% on 600 screen & in pan
- Smell – fresh, fermented
- Color – goldenrod
Maximizing the Value of Corn DDGS in Poultry Diets

- Formulate diets using digestible amino acid values
- High available P reduces the level of dietary P supplementation
- Adding 5% DDGS may improve feed preference, egg number, and hatchability in breeder hens

Limitations of Using DDGS in Poultry Diets

- Must be golden color and highly digestible
- High fiber limits its maximum inclusion rate in poultry diets
- Excess nitrogen can be minimized by using synthetic amino acids
U of M DDGS Web Site

We have developed a DDGS web site featuring:
* research summaries (swine, poultry, dairy, & beef)
* presentations given
* links to other DDGS related web sites

Visit this web site at:
www.ddgs.umn.edu