Using Corn Distillers By-Products in Turkey Rations

Sally Noll
Extension Poultry Specialist
University of Minnesota
**What is DDGS?**

- **Distiller’s dried grains with solubles (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 DDGS - Midwestern US**
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS
Corn Processing

- Wet milling-starch, oil
- Dry milling
  - Human food application (Cereals, oil, corn meal)
  - Ethanol production
  - Brewing
- Large variety of products available
  - Seeing different by-product compositions as corn processors meet specific markets
Wet Milling

- Used for the production of starch and oil
- Feed products produced
  - Condensed corn fermented extractives
  - Corn germ meal (oil removed)
  - Corn gluten feed (bran, fiber)
  - Corn gluten meal (gluten protein)
Corn Wet-Milling Process Overview

Corn Cleaning

Steep Tanks → Steepwater Evaporation

Germ Separation → Germ Extraction → Corn Oil

Grinding Mills

Washing Screens

Centrifugal Separators

Starch washing

Starch and Nutritive Sweeteners

Corn Gluten Meal

Corn Germ Meal

Corn Gluten Feed

Cond. Fermented Extractive

Feed Industry Co-Products
Dry mill – ethanol production

- Fermentation process
  - Several potential starch sources – grains, etc.
- Feed products produced-defined by input grain – corn, rye, wheat, sorghum, etc.
  - Condensed solubles
  - Distiller grains (wet or dry)
  - Distiller grains with solubles (wet or dry)
Corn Dry-Milling Process Overview

- Corn
  - Corn Cleaning
  - Hammermill
  - Mix Slurry
  - Liquefaction
    - CO₂
    - Yeast and Glucoamylase Enzyme
    - Fermentation
    - Distillation
    - Whole Stillage
    - Centrifuge
    - Thin Stillage
    - Evaporator
      - Thin Stillage
      - Coarse Solids
    - Rotary Dryer
      - Distillers Wet Grains
      - Distillers Dried Grains with Solubles
      - Cond. Distillers Solubles
      - Feed Industry Co-products
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.
## Corn By-Products
Why proper identification is important

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Distillers Grains Dehyd</th>
<th>Distillers Solubles Dehyd.</th>
<th>Distillers Grains Plus Solubles Dehyd (DDGS)</th>
<th>Corn Gluten Meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME kcal/lb</td>
<td>1519</td>
<td>894</td>
<td>1330</td>
<td>1125</td>
<td>1687</td>
</tr>
<tr>
<td>Protein %</td>
<td>8.5</td>
<td>27.8</td>
<td>28.5</td>
<td>27.4</td>
<td>62</td>
</tr>
<tr>
<td>Lysine %</td>
<td>.26</td>
<td>.78</td>
<td>.9</td>
<td>.75</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Book values, NRC 1994
Benefits and Limitations of DDGS for Poultry

**Benefits**

- Moderate energy and amino acid source when limited to < 20% of the diet
- Source of highly available P
  - Reduce manure P
- May improve egg yolk and skin color (xanthophyll)
- Source of “unidentified growth factors” (yeast components?)
- Palatable (no feed rejection)
- Reduced ammonia emissions (ISU, Bregendahl, 2006)
  - Chicken layers
  - Turkeys???

**Limitations**

- Energy value ~ 84% of corn
- Low protein quality
  - Low in lys, arg, trp
- Sources high in sodium may increase litter moisture if adjustments to dietary salt levels are not made
- Phosphorus levels can be in excess in combination with animal by-product inclusion
Questions to Ask When Using DDGS

- What is the nutrient composition of the product (variability)?
- What does the diet look like with DDGS?
- What levels of inclusion?
- Mesh with alternative protein ingredients
DDGS Varies Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources
Questions to Ask When Using DDGS

- What is the nutrient composition of the product?
  - Energy
  - Lysine content
    - Total
    - Digestible
  - Phosphorus
    - Bioavailability
# Lysine Content and Digestibility

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of Samples</th>
<th>Lysine Content (%)</th>
<th>Lysine Digestibility Coefficient (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ave.</td>
<td>Range</td>
<td>Ave.</td>
</tr>
<tr>
<td>Ergul et al. 2003¹</td>
<td>20</td>
<td>.73</td>
<td>.59-.89</td>
</tr>
<tr>
<td>Batal and Dale 2006²</td>
<td>8</td>
<td>.71</td>
<td>.39-.86</td>
</tr>
<tr>
<td>Fastinger et al. 2006¹</td>
<td>5</td>
<td>.64</td>
<td>.48-.75</td>
</tr>
</tbody>
</table>

¹ Range
² Average
³ Digestibility
Lysine Digestibility for Poultry as Affected by Production Source

Digest. AA Coeff.

Ergul et al., 2003
Fig. 1. Regression of digestible lys (%) and color (L*, b*)

\[ R^2 = 0.71 \]

\[ R^2 = 0.74 \]

Source: Dr. Sally Noll (2003)
### Metabolizable Energy for DDGS

- **Energy level**
  - Feed conversion
  - Least cost formulation for high energy diets

- **Other determinations higher than NRC reported value of AMEn 1125 kcal/lb**

<table>
<thead>
<tr>
<th>Source</th>
<th>AMEn (kcal/lb)</th>
<th>TMEn</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRC, 1994</td>
<td>1125</td>
<td></td>
</tr>
<tr>
<td>Potter, 1966</td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td>Noll, 2004</td>
<td>1280</td>
<td>1280</td>
</tr>
<tr>
<td>Roberson 2004</td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>Batal &amp; Dale, 2006</td>
<td></td>
<td>1280</td>
</tr>
</tbody>
</table>
## Availability of Phosphorus

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>P, %</th>
<th>P, avail. %</th>
<th>% P Avail.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn*</td>
<td>.28</td>
<td>.08</td>
<td>28</td>
</tr>
<tr>
<td>SBM*</td>
<td>.62</td>
<td>.22</td>
<td>35</td>
</tr>
<tr>
<td>DDGs*</td>
<td>.72</td>
<td>.39</td>
<td>54</td>
</tr>
<tr>
<td>DDGs (UGA)</td>
<td>.74</td>
<td>~.47</td>
<td>61-68 (64)</td>
</tr>
<tr>
<td>DDGs (UI )</td>
<td>.73</td>
<td>~.6</td>
<td>69-102 (82)</td>
</tr>
<tr>
<td>DDGs (MSU)</td>
<td></td>
<td></td>
<td>76-85 (80)</td>
</tr>
</tbody>
</table>

*NRC, 1994*
Questions to Ask When Using DDGS

- What is the nutrient composition of the product (variability)
- What does the diet look like with DDGS
- What levels of inclusion
- Mesh with alternative protein ingredients
<table>
<thead>
<tr>
<th>Tom Turkey Grower Diets</th>
<th>DDGS Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestible basis, 8-11 wks</td>
<td>Spec.</td>
</tr>
<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Corn</td>
<td>55.11</td>
</tr>
<tr>
<td>SBM</td>
<td>32.40</td>
</tr>
<tr>
<td>DDGS</td>
<td>0</td>
</tr>
<tr>
<td>PBM</td>
<td>6</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.711</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>0.614</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>0.201</td>
</tr>
<tr>
<td>L-Lysine·HCL</td>
<td>0.145</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.050</td>
</tr>
<tr>
<td>Animal fat</td>
<td>4.044</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

**Nutrients**

<table>
<thead>
<tr>
<th></th>
<th>Spec.</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td></td>
<td>22.7</td>
<td>23.0</td>
<td>23.3</td>
<td>23.6</td>
</tr>
<tr>
<td>Metabolizable energy (kcal/kg)</td>
<td>3150</td>
<td>3150</td>
<td>3070</td>
<td>3150</td>
<td>3150</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.10</td>
<td>1.10</td>
<td>1.10</td>
<td>1.10</td>
<td>1.10</td>
</tr>
<tr>
<td>Phosphorus, total (%)</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>0.84</td>
<td>0.85</td>
</tr>
<tr>
<td>Phosphorus, available (%)</td>
<td>0.55</td>
<td>0.55</td>
<td>0.55</td>
<td>0.55</td>
<td>0.56</td>
</tr>
<tr>
<td>Met + Cys (%)</td>
<td>0.805</td>
<td>0.805</td>
<td>0.805</td>
<td>0.805</td>
<td>0.805</td>
</tr>
<tr>
<td>Lysine (%)</td>
<td>1.219</td>
<td>1.219</td>
<td>1.219</td>
<td>1.219</td>
<td>1.219</td>
</tr>
<tr>
<td>Arginine (%)</td>
<td>1.348</td>
<td>1.306</td>
<td>1.263</td>
<td>1.221</td>
<td></td>
</tr>
<tr>
<td>Tryptophan (%)</td>
<td>0.212</td>
<td>0.200</td>
<td>0.187</td>
<td>0.174</td>
<td></td>
</tr>
<tr>
<td>Threonine (%)</td>
<td>0.768</td>
<td>0.768</td>
<td>0.768</td>
<td>0.768</td>
<td>0.768</td>
</tr>
</tbody>
</table>
## Tom Turkey Grower Diets

**Digestible basis**

<table>
<thead>
<tr>
<th>8-11 wks of age</th>
<th>DDGS Level</th>
<th>Change in ingred. levels</th>
<th>With DDGS</th>
<th>lbs per 100 lbs DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>10</td>
<td>%</td>
<td>lbs per ton</td>
</tr>
<tr>
<td>Corn</td>
<td>55.11</td>
<td>49.64</td>
<td>-5.47</td>
<td>-109</td>
</tr>
<tr>
<td>SBM</td>
<td>32.40</td>
<td>27.80</td>
<td>-4.61</td>
<td>-92</td>
</tr>
<tr>
<td>DDGS</td>
<td>0.00</td>
<td>10.00</td>
<td>10.00</td>
<td>200.00</td>
</tr>
<tr>
<td>Dical</td>
<td>0.71</td>
<td>0.45</td>
<td>-0.26</td>
<td>-5.22</td>
</tr>
<tr>
<td>Ca. carb.</td>
<td>0.61</td>
<td>0.79</td>
<td>0.18</td>
<td>3.62</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>0.20</td>
<td>0.18</td>
<td>-0.02</td>
<td>-0.37</td>
</tr>
<tr>
<td>L-Lysine . HCL</td>
<td>0.15</td>
<td>0.22</td>
<td>0.07</td>
<td>1.50</td>
</tr>
<tr>
<td>Animal fat</td>
<td>4.04</td>
<td>4.24</td>
<td>0.19</td>
<td>3.88</td>
</tr>
</tbody>
</table>
Questions to Ask When Using DDGS

- What is the nutrient composition of the product (variability)
- What does the diet look like with DDGS
- What levels of inclusion
- Mesh with alternative protein ingredients
Feeding DDGS to Market Turkeys

- What are maximum feeding levels
  - 5, 10%
  - 20% or greater??
Early research prior to 1970’s – turkey poults to 8 wks
Levels of 10% similar or improved growth
Levels of 20% increased feed/gain
Current Market Turkey Research

- Roberson, 2003
  - Hen turkeys – grow/finish diets
  - Isocaloric; digestible or total amino acids
- Noll ongoing
  - Tom turkeys – grow/finish diets (5-19 wks)
  - Formulation - isocaloric; digestible amino acids
## DDGs and Turkey Hen Diets

<table>
<thead>
<tr>
<th>DDGs %</th>
<th>BW 105 da, lb</th>
<th>F/G 75-105 da</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp. 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>18.81*</td>
<td>2.99</td>
</tr>
<tr>
<td>9</td>
<td>18.54</td>
<td>3.07</td>
</tr>
<tr>
<td>18</td>
<td>18.14</td>
<td>3.21</td>
</tr>
<tr>
<td>27</td>
<td>18.00</td>
<td>3.21</td>
</tr>
<tr>
<td>Exp. 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>18.76</td>
<td>3.44</td>
</tr>
<tr>
<td>7</td>
<td>18.65</td>
<td>3.54</td>
</tr>
<tr>
<td>10</td>
<td>18.74</td>
<td>3.46</td>
</tr>
</tbody>
</table>

* Significant Linear Component From: Roberson, 2003
## Market Tom Trials-Grow/Finish Diets
(University of Minnesota)

<table>
<thead>
<tr>
<th>Trial*</th>
<th>Trt</th>
<th>DDGs, %</th>
<th>BW, lb</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>0</td>
<td>41.7</td>
<td>2.44</td>
</tr>
<tr>
<td></td>
<td>DDGs</td>
<td>12-8</td>
<td>41.9</td>
<td>2.48</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>0</td>
<td>42.2</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td>DDGs</td>
<td>11-8</td>
<td>42.2</td>
<td>2.65</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>0</td>
<td>40.4</td>
<td>2.67</td>
</tr>
<tr>
<td></td>
<td>DDGS</td>
<td>10</td>
<td>40.2</td>
<td>2.63</td>
</tr>
</tbody>
</table>

*Trial weeks of age; 1=5-19 wks; 2=8-19 wks; 3=11-19 wks
Levels above 10%  
(Trials 4 & 5)

<table>
<thead>
<tr>
<th>Level (%)</th>
<th>BW 19 wks lbs</th>
<th>Level (%)</th>
<th>BW 19 wks lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>38.5</td>
<td>0</td>
<td>38.4\textsuperscript{a}</td>
</tr>
<tr>
<td>10</td>
<td>38.8</td>
<td>10</td>
<td>38.2\textsuperscript{ab}</td>
</tr>
<tr>
<td>20</td>
<td>38.6</td>
<td>20</td>
<td>37.6\textsuperscript{b}</td>
</tr>
</tbody>
</table>
Trial Differences

- Trial 4
  - Winter season
  - Normal protein
  - Low levels of MBM

- Trial 5
  - Spring/summer
  - Reduced protein
  - Low levels of MBM
Market Turkey Study 2006

- Diet Inclusion Levels
  - DDGS inclusion levels 0, 10, and 20%
  - PBM inclusion levels of 0, 8, and 12%
Methods

Diets
- Ingredients assayed for proximates and digestible amino acids
- Formulated to provide 100% digestible thr and supplemented with met and lys
- Isocaloric to control
- Ratio of calcium to available phosphorus maintained at 2:1
- Fed as mash
- Experimental period 5 – 19 wks of age

Turkeys
- Male Large White, Nicholas strain
- 10 birds/pen, 8 replicate pens/treatment
## Diet Composition (%)
### Selected Diets 5-8 wks of Age

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Trt 1</th>
<th>Trt 3</th>
<th>Trt 5</th>
<th>Trt 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>46.62</td>
<td>55.10</td>
<td>33.60</td>
<td>41.24</td>
</tr>
<tr>
<td>SBM</td>
<td>43.05</td>
<td>29.62</td>
<td>35.36</td>
<td>22.07</td>
</tr>
<tr>
<td>PBM</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>DDGS</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>DL-met</td>
<td>.18</td>
<td>.17</td>
<td>.155</td>
<td>.147</td>
</tr>
<tr>
<td>L-lys HCl</td>
<td>.112</td>
<td>.137</td>
<td>.289</td>
<td>.312</td>
</tr>
<tr>
<td>Animal fat</td>
<td>5.27</td>
<td>2.01</td>
<td>6.03</td>
<td>3.08</td>
</tr>
<tr>
<td>Dical</td>
<td>2.56</td>
<td>.03</td>
<td>2.259</td>
<td>-----</td>
</tr>
</tbody>
</table>
Results

- Diet affected body weight and feed efficiency
- Response to DDGs was dependent on PBM level
  - body weight at 11 wks of age
  - feed efficiency (5-19 wks of age)
Body weight response to DDGS and PBM at 11 wks of age

DDGS*PBM P<.023
Body weight response to DDGS and PBM at 19 wk BW
Interaction of DDGS and PBM on 5-19 wk F:G

DDGS x PBM (P<.02)
Summary

- In comparison to a corn-soy control diet, addition of PBM at 8 or 12% depressed body weight to 11 wks of age.
- In comparison to a corn-soy control diet, addition of 10 or 20% DDGS resulted in similar performance.
- In comparison to a corn-soy control diet, addition of both PBM and 20% DDGS resulted in poorer performance, although performance of birds in the trial was very acceptable regardless of treatment.
  - Potential amino acid imbalance or deficiency (?)
  - Excess calcium & phosphorus (?)
Inclusion levels for turkeys

- Market Turkeys
  - Hens
    - Up to 10% (Roberson et al 2003)
  - Toms (Noll, 2006)
    - Up to 10% in summer season or lowered protein diets
    - Up to 20% in winter season or normal protein diets; or diets without animal protein
New Processes and New Distiller’s Grains Co-Products

Driven by:
- Improve efficiency in ethanol production
- Reduce fuel costs
  - Utilize solubles as liquid
    - Combustion
    - Extract - Biodiesel
- Develop value added products
New Corn Processing Methods for Ethanol

- Examples of modified processes
  - Use of new technology to concentrate protein
    - Enzymes
    - Steam/acid processing
  - Fractionation – remove nonfermentables
    - Removal of bran and/or germ prior to fermentation
  - Removal of phosphorus
  - Removal of oil/solubles (fuel source)
  - Removal of fiber (elusieve)
New co-products

- High protein
  - Dakota Gold
- Corn germ, dehyd
  - Dakota Gold
- Others – research/development
  - NREL/Minnesota – high protein
  - University of Illinois
  - QTI (Glutenol)
## Nutrient Content

### Corn Co-Products

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>“Traditional” DDGS</th>
<th>High Protein DDGS</th>
<th>Corn Germ, Dehyd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>90.7</td>
<td>91.9</td>
<td>93.7</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>26.6</td>
<td>43</td>
<td>15.6</td>
</tr>
<tr>
<td>Crude fat, %</td>
<td>9.7</td>
<td>3.0</td>
<td>17.8</td>
</tr>
<tr>
<td>ME (poultry), kcal/lb</td>
<td>1297</td>
<td>1222</td>
<td>1775</td>
</tr>
<tr>
<td>NDF, %</td>
<td>23.6</td>
<td>18.7</td>
<td>22.8</td>
</tr>
<tr>
<td>Ash, %</td>
<td>4.1</td>
<td>1.8</td>
<td>5.4</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.79</td>
<td>0.37</td>
<td>1.40</td>
</tr>
<tr>
<td>Lysine, %</td>
<td>0.83</td>
<td>1.19</td>
<td>.82</td>
</tr>
<tr>
<td>Methionine, %</td>
<td>0.52</td>
<td>0.85</td>
<td>0.26</td>
</tr>
<tr>
<td>Cystine, %</td>
<td>0.73</td>
<td>0.96</td>
<td>0.48</td>
</tr>
<tr>
<td>Threonine, %</td>
<td>1.01</td>
<td>1.63</td>
<td>.57</td>
</tr>
</tbody>
</table>
Summary

- Variability exists among sources of DDGS

  - To minimize:
    - Use color as a quick measure of quality
    - Get product from one source
    - New plants – time to produce a consistent product
    - Request current analyzed values or obtain analyses
    - Make sure product is correctly identified
      - DDGS vs DDG vs corn germ vs high protein DDG
Incorporation of DDGs into turkey diets

- Replaces corn and soy
- Less supplemental methionine & dicalcium phosphate needed
- Need more supplemental fat and lysine to keep energy and lysine levels
Recommendations for Use of DDGs

- Corn DDGs can be fed to market turkeys
  - Up to 10% for hens and 20% for toms
  - Lower levels in diets for young poultry (2-5%)
- Formulate with minimums for tryptophan and arginine in addition to those for lys, TSAA, and thr
- Formulate on basis of digestible amino acid content and adjust for higher phosphorus availability
- Lower maximum level of use in low density or low protein diets
University of Minnesota
DDGS Webpage

- www.ddgs.umn.edu
Acknowledgments

UM Turkey Research Program

- University of Minnesota staff - Jeanine Brannon, Fred Hrbek
- University of Illinois – Carl Parsons
- Michigan State University – Kevin Roberson, Jayne Kalbfleisch
- University of Wisconsin River Falls – Bonnie Walters
- MTGA Nutrition Subcommittee - Dick Nelson, George Speers, Jim Halvorson, Gary Johnson, Greg Engelke, Virgil Stangeland,
- Funding – Minnesota Turkey Research & Promotion Council, Central Bi-Products, ADM, Minnesota Corn Growers Association, Commodity Specialist Company, AURI, DakotaGold, Midwest Poultry Research Program