Feeding Value of Corn DDGS for Poultry

Sally Noll, Ph. D.
University of Minnesota
What does corn-derived DDGS contribute to poultry diets?

- Protein (corn)
  - Amino acid content
  - Amino acid digestibility
- Energy (metabolizable energy)
  - Proximate Composition
- Phosphorus
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
What does DDGS contribute to poultry diets

- Protein (corn)
  - Amino acid content/balance
  - Influence of dietary protein level
    - Lowered protein diets
- Research by Parsons ('83)
- Lysine – 1st limiting
  - Supplementation with lysine
- Tryptophan and arginine almost equally limiting
Limiting nature of tryptophan and arginine in DDGs for turkey toms

- University of Minnesota Trial (2003)
- No performance difference – control diet & 10% DDGS diet
- Lowered protein diet (LP) with 10% DDGs resulted in poorer F/G
- F/G restored with try & arg supplementation

Noll et al, 2003
What does DDGS contribute to poultry diets

- Protein (corn)
- Amino acid content/balance
  - Corn protein in DDGS limiting in lysine, arginine and tryptophan (Parsons et al 1983; Noll, 2003)
  - Source of threonine (Noll, 2003)
  - Important to formulate with minimums for:
    - Lys
    - Arg
    - Try
What does DDGS contribute to poultry diets

- Protein (corn)
  - Amino acid digestibility
    - Ingredient processing in particular that of heating decreases digestibility of amino acids
      - Oil seed meals
      - Meat and bone meal
    - Associated with color change - darkening
  - In DDGs, digestibility of amino acids is *variable among sources*, in particular that of lysine (Ergul et al, 2003)
Lysine Digestibility for Poultry as Affected by Production Source

Digest. AA Coeff.

Noll and Parsons

Amino acid

Lys

S1
S2
S3
S4
S5
S6
S7

(%)
What does DDGS contribute to poultry diets

- **Protein**
  - DDGS Amino acid digestibility and color
    - Lysine digestibility was shown to be correlated with Chromameter readings for L* and b* values (Ergul et al., 2003)
Fig. 1. Regression of digestible lys (%) and color (L*, b*)

R² = 0.71
R² = 0.74
Economics and DDGs
Quality-Lysine Digestibility

DDGS Opportunity Cost in Commercial Poultry Grower Diet
Comparison of DDGS Quality Total Amino Acids (Digestible)

<table>
<thead>
<tr>
<th>%</th>
<th>Hi Dig Lys</th>
<th>Lo Dig Lys</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>26.4</td>
<td>27.8</td>
</tr>
<tr>
<td>Met</td>
<td>.49(.43)</td>
<td>.51(.44)</td>
</tr>
<tr>
<td>Cys</td>
<td>.53(.42)</td>
<td>.49(.32)</td>
</tr>
<tr>
<td>Lys</td>
<td>.81(.64)</td>
<td>.72(.46)</td>
</tr>
<tr>
<td>Thr</td>
<td>1(.82)</td>
<td>1.03(.75)</td>
</tr>
<tr>
<td>Tryp</td>
<td>.24(.19)</td>
<td>.2(.16)</td>
</tr>
</tbody>
</table>
Influence of digestible lysine on value of DDGs (US $/cwt)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Cost</th>
<th>High Dig Lys</th>
<th>Low Dig Lys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn, 3.10</td>
<td>4.78</td>
<td>4.28</td>
<td></td>
</tr>
<tr>
<td>Corn, 3.50</td>
<td>5.00</td>
<td>4.54</td>
<td></td>
</tr>
<tr>
<td>Corn, 5.30</td>
<td>6.02</td>
<td>5.70</td>
<td></td>
</tr>
<tr>
<td>SBM, 8.25</td>
<td>5.00</td>
<td>4.54</td>
<td></td>
</tr>
<tr>
<td>SBM, 8.70</td>
<td>5.21</td>
<td>4.72</td>
<td></td>
</tr>
</tbody>
</table>
What does DDGS contribute to poultry diets

- Recommendations re. amino acids
  - Formulate with minimums for lys, arg, & try
  - Formulate on a digestible amino acid basis
What does DDGS contribute to poultry diets

- Protein (corn)
  - Amino acid balance
  - Amino acid digestibility
- Energy (metabolizable energy)
- Phosphorus
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
Metabolizable Energy for DDGS

- Importance of energy level
  - Feed conversion
  - Least cost formulation for high energy diets
- More recent determinations much higher than NRC (1994) reported value of AMEn 2480 kcal/kg (9% fat vs 10-11% in current DDGS)

<table>
<thead>
<tr>
<th>Source</th>
<th>AMEn (kcal/kg)</th>
<th>TMEn</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRC, 1994</td>
<td>2480</td>
<td></td>
</tr>
<tr>
<td>Potter, 1966</td>
<td>2880</td>
<td></td>
</tr>
<tr>
<td>Noll, 2004</td>
<td>2810-2850</td>
<td>2833</td>
</tr>
<tr>
<td>Roberson 2004</td>
<td>2760</td>
<td></td>
</tr>
<tr>
<td>Batal &amp; Dale, 2004</td>
<td></td>
<td>2831</td>
</tr>
</tbody>
</table>

(TMEn = TMEn)
## DDGs Economics and AME Energy Level

<table>
<thead>
<tr>
<th>DDGs ME Kcal/kg</th>
<th>Fat Cost $/100 lbs</th>
<th>% DDGs Inclusion $4/100 lbs</th>
<th>DDGs Opportunity Cost, $/100 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2810</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2810</td>
<td>15</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2480</td>
<td>11</td>
<td>0</td>
<td>3.82</td>
</tr>
<tr>
<td>2480</td>
<td>15</td>
<td>0</td>
<td>3.34</td>
</tr>
</tbody>
</table>
What does DDGS contribute to poultry diets

- Protein
- Energy (metabolizable energy)
- **Phosphorus**
  - Availability
- Xanthophylls (yolk and carcass pigmentation)
## 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>.73</td>
<td>~.6</td>
<td>76-85 (80)</td>
</tr>
</tbody>
</table>

*NRC, 1994*
What does DDGS contribute to poultry diets

- Protein
- Energy (metabolizable energy)
- Phosphorus
- Xanthophylls
  - yolk and carcass pigmentation
DDGs and Xanthophylls – Book Values

- Corn 15-25 mg/kg
- Corn Gluten Meal 130-170 mg/kg
- DDGs 15-20 mg/kg
  - Limited analytical results
  - May have value in diets low in corn grain
DDGS and Egg Yolk Pigmentation

- Roberson (2004) –
  - 10% 2 wks fed (Exp 1)
  - 5% at 3 wks (Exp 2)
- Lumpkins (2003) – no change
- Sanfandila field trial (Shurson, 2003) slight change in yolk color (10.6 vs 10.8)
## Roberson Experiment 2 – Yolk Color (9 wks)

<table>
<thead>
<tr>
<th>DDGS</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>Roche</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 %</td>
<td>77.9  ^a^</td>
<td>2.70  ^d^</td>
<td>88.1</td>
<td>8.63  ^b^</td>
</tr>
<tr>
<td>5 %</td>
<td>75.9  ^b^</td>
<td>4.19  ^c^</td>
<td>86.7</td>
<td>8.98  ^a^</td>
</tr>
<tr>
<td>10 %</td>
<td>76.2  ^b^</td>
<td>4.74  ^b^</td>
<td>87.5</td>
<td>9.02  ^a^</td>
</tr>
<tr>
<td>15 %</td>
<td>75.9  ^b^</td>
<td>6.11  ^a^</td>
<td>87.7</td>
<td>9.22  ^a^</td>
</tr>
<tr>
<td>SE</td>
<td>0.4</td>
<td>0.19</td>
<td>0.6</td>
<td>0.08</td>
</tr>
<tr>
<td>Trt, p&lt;</td>
<td>0.004</td>
<td>&lt;0.001</td>
<td>0.352</td>
<td>0.001</td>
</tr>
<tr>
<td>Linear, p&lt;</td>
<td>0.007</td>
<td>&lt;0.001</td>
<td>0.846</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
DDGS and Carcass Skin Pigmentation

Lu and Chen, 2004
- Domestic color chicken
- Control and pigments (AP)
- 10 or 20% DDGS
- 20% DDGS plus AP
- Xanthophyll content of
  - DDGS 20 mg/kg
  - Corn 6-7 mg/lg
- Diets fed to 16 wks of age
- DDGS provided some pigmentation to abdominal fat pad and cooked carcass skin
- Concluded AP use could be decreased by 50% with DDGs use

Graph:
- Control
- Control + AP
- 10% DDGS
- 20% DDGS
- 20%+ 1/2 AP

Fat Pad Color score

Age (wks)
Inclusion levels for poultry

- Broilers
  - Waldroup (1981) up to 25% (adjusted for lys and ME)
  - Lumpkins et al (2004) up to 15%
Performance Response of Broiler Chickens (0-42 days) to DDGS in Diets Adjusted and Not Adjusted for Energy

*Different from control

Waldroup et al, 1981
DDGs – Broiler Diets (Lumpkins et al., 2004)

- Experiment 1 - 0 and 15% DDGs at two dietary energy levels (3200 and 3000 kcal/kg)
- Experiment 2 – 0, 6, 12, & 18%
### DDGs and Broiler Performance

<table>
<thead>
<tr>
<th>Diet Density &amp; DDGs Level</th>
<th>Gain 18d G</th>
<th>G:F 18d</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, 0%</td>
<td>556a</td>
<td>782a</td>
</tr>
<tr>
<td>High, 15%</td>
<td>555a</td>
<td>772a</td>
</tr>
<tr>
<td>Low, 0%</td>
<td>523b</td>
<td>712b</td>
</tr>
<tr>
<td>Low, 15%</td>
<td>518b</td>
<td>705b</td>
</tr>
</tbody>
</table>

Lumpkins et al., 2004
## DDGs and Broilers

<table>
<thead>
<tr>
<th>Level of DDGs</th>
<th>Gain 42d (kg)</th>
<th>G:F 0-42 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.31a</td>
<td>566</td>
</tr>
<tr>
<td>6</td>
<td>2.29a</td>
<td>554</td>
</tr>
<tr>
<td>12</td>
<td>2.29a</td>
<td>565</td>
</tr>
<tr>
<td>18</td>
<td>2.24b</td>
<td>554</td>
</tr>
</tbody>
</table>

Lumpkins et al., 2004
DDGs – Broiler Diets (Lumpkins et al., 2004)

- **Experiment 1** - 0 and 15% DDGs at two dietary energy levels (3200 and 3000 kcal/kg – no difference in performance to 18 d re. DDGs

- **Experiment 2** – 0, 6, 12, & 18%
  - BW to 42 days similar to 12%
  - Slight depression in BW at 18%
    - Lowered wts through 16 da
DDGs in Chicken Broiler Diets

- Adjustment for lysine and energy level
  - Lowered level of use without adjustment
- Inclusion level of 15% possible
  - Starter diets 6%
  - Grower/Finisher 15%
Inclusion levels for poultry

- **Chicken Layers**
  - Roberson 2004 up to 15%
  - Lumpkins 2003 up to 15% in diets of commercial energy density
DDGs and Chicken Layers

- Roberson, 2004
- Hy-line W36
- 48 wk old hens
- Two 9/10 wk trial
- Level
  - 0, 5, 10, 15% DDGs

![Graph showing %EP over weeks of study for different levels of DDGs in two experiments.](image-url)
Laying Hen Study (Roberson, 2004)

- Inconsistent level effects on:
  - Weekly egg production (1 wk of 9 wks)
  - Specific gravity
    - Exp 1 (1 wk of 4)
    - Exp 2 – no effect
- No effect on egg weight
DDGS and Layer Performance
(Lumpkins, et al. 2003)

- Treatments
  - 0 or 15% DDGs
  - Energy density
    - Commercial (2870 kcal/kg; 18.5% CP)
    - Low energy density (2800 kcal/kg; 17% CP)
- Hy-line W36 White Leghorns
- Summer trial (20 wk trial, June-October)
DDGS and Layer Performance (Lumpkins, et al. 2003)

No effect of DDGs on:
- Hen feed intake
- Egg weight
- Yolk color
- Egg quality
- Interaction of DDGs level & diet energy
Egg production of hens fed diets with and without DDGs (0, 15%) at commercial or low energy density

From: Lumpkins et al., 2003
DDGS and Layer Performance (Lumpkins, et al. 2003)

- Low energy & 15% DDGs slight depression in egg production
  - Insufficient caloric intake
  - Amino acid digestibility
    - Diets formulated on total amino acid basis
DDGs and Recent Chicken Layer Studies

- Field trial – Sanfandila (Shurson, 2003)
  - Babcock 300
  - 12 wk trial
  - 10% Norgold DDGs
## Sanfandila Field Trial

<table>
<thead>
<tr>
<th>Performance</th>
<th>Control</th>
<th>Norgold DDGS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP, %</td>
<td>68.7</td>
<td>72.4</td>
<td>.02</td>
</tr>
<tr>
<td>First class EP, %</td>
<td>66.2</td>
<td>68.9</td>
<td>.10</td>
</tr>
<tr>
<td>EW/hen/wk, kg</td>
<td>.31</td>
<td>.32</td>
<td>.11</td>
</tr>
<tr>
<td>Cull eggs, % of total</td>
<td>2.2</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Dirty Eggs</td>
<td>1.4</td>
<td>2.2</td>
<td>.002</td>
</tr>
<tr>
<td>Egg Quality</td>
<td></td>
<td></td>
<td>NS</td>
</tr>
</tbody>
</table>
Summary: DDGs and Recent Chicken Layer Studies – Inclusion Levels

- Roberson, 2004
  - 0, 5, 10, 15%

  - 0, 15%

- Field trial – Sanfandila (Shurson, 2003)
  - 10% inclusion
DDGs in Chicken Layer Diets

- Possible source of xanthophyll
- Inclusion level of 15 %
  - Acceptable performance
  - Less than 15% for low density diets
Current Market Turkey Research

- Roberson, 2003
  - Hen turkeys – grow/finish diets
  - Isocaloric; digestible amino acids
- Noll ongoing – several experiments
  - 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, kg</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>8.53*</td>
<td>2.99</td>
</tr>
<tr>
<td>9</td>
<td>8.41</td>
<td>3.07</td>
</tr>
<tr>
<td>18</td>
<td>8.23</td>
<td>3.21</td>
</tr>
<tr>
<td>27</td>
<td>8.16</td>
<td>3.21</td>
</tr>
<tr>
<td>Exp. 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8.51</td>
<td>3.44</td>
</tr>
<tr>
<td>7</td>
<td>8.46</td>
<td>3.54</td>
</tr>
<tr>
<td>10</td>
<td>8.50</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, kg</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>0</td>
<td>18.9</td>
<td>2.44</td>
</tr>
<tr>
<td></td>
<td>DDGs</td>
<td>12-8</td>
<td>19.0</td>
<td>2.48</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>0</td>
<td>19.2</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td>DDGs</td>
<td>11-8</td>
<td>19.2</td>
<td>2.65</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>0</td>
<td>18.4</td>
<td>2.67</td>
</tr>
<tr>
<td></td>
<td>DDGS</td>
<td>10</td>
<td>18.3</td>
<td>2.63</td>
</tr>
</tbody>
</table>

*Trial weeks of age; 1=5-19 wks; 2=8-19 wks; 3=11-19 wks
Market Tom Trials-Level of Inclusion
UM Trial 4 (Winter Trial)

Noll et al., 2004
Market Tom Trials-Level of Inclusion
UM Trial 5 (Summer Trial)

Noll et al., 2005
Differences
Trial 4 vs 5

- Feed intake levels
  - Winter vs summer rearing conditions
- Formulation – diet protein level
  - No supplemental thr vs .05% thr use
  - Lowered dietary protein with .05% thr
Inclusion levels for poultry

- Market Turkeys
  - Hens
    - Up to 10% (Roberson et al 2003)
  - Toms (Noll, 2004)
    - Up to 10% in summer or lowered protein diets
    - Up to 20% in winter or normal protein diets
Recommendations for Use of DDGs

- Corn DDGs (to 15%) can be fed to chicken layers and broilers; Turkeys - to 10% for hens; 20% of diet for toms
  - Lower levels in diets for young poultry
- Formulate with minimums for tryptophan and arginine
- Formulate on basis of digestible amino acid content
- Lower maximum level of use in low density or low protein diets
- Consider AMEn value of 2750 to 2850 kcal/kg
- Increase available phosphorus (higher than NRC '94) – 65%
University of Minnesota
DDGS Webpage

www.ddgs.umn.edu
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