Update-Utilization of Feed Byproducts of the Biofuels Industry in Turkey Diets

Sally Noll, Ph.D.
University of Minnesota
nollx001@umn.edu

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Research Areas

- Amino acids (Digestibility & content)
  - Lysine and heat damage
  - Limiting in lys, arg, try
- Phosphorus availability (Greater than 60%)
- Inclusion Levels for turkeys
  - 10-20%
- Energy
  - Batal, 2006 - 2820 kcal/kg; Noll, 2004 - 2830 kcal/kg
  - Manangi et al., 2007
    - Correlated with NDF
DDGS Update
Corn, Conventional Product

- Research Areas
  - Nutrient Characteristics & Variability
    - Variability exists (Variation Among Plant > Within Plant)
      - Solubles Addition
      - Type of product
# DDGs Nutrient Characteristics*

*Noll & Parsons, unpublished data

<table>
<thead>
<tr>
<th>Content, %</th>
<th>Sample Range</th>
<th>Ave.</th>
<th>NRC, 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>25.5-30.8</td>
<td>27.8</td>
<td>27.4</td>
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<tr>
<td>Fat</td>
<td>8.9-11.1</td>
<td>10</td>
<td>9</td>
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<tr>
<td>Fiber</td>
<td>5.4-6.5</td>
<td>5.7</td>
<td>9.1</td>
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<tr>
<td>Ca</td>
<td>.017-.045</td>
<td>.05</td>
<td>.17</td>
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<tr>
<td>P</td>
<td>.62-.88</td>
<td>.75</td>
<td>.72</td>
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<tr>
<td>Na</td>
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<td>.12</td>
<td>.48</td>
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<tr>
<td>Cl</td>
<td>.13-.19</td>
<td>.17</td>
<td>.17</td>
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<tr>
<td>K</td>
<td>.87-1.11</td>
<td>.95</td>
<td>.65</td>
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</tbody>
</table>
### DDGs Nutrient Characteristics

<table>
<thead>
<tr>
<th>AA, %</th>
<th>Range</th>
<th>Ave.</th>
<th>NRC, 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methionine</td>
<td>.41-.6</td>
<td>.49</td>
<td>.6</td>
</tr>
<tr>
<td>Cystine</td>
<td>.42-.67</td>
<td>.53</td>
<td>.4</td>
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<tr>
<td>Lysine</td>
<td>.55-.89</td>
<td>.73</td>
<td>.75</td>
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<tr>
<td>Arginine</td>
<td>.89-1.31</td>
<td>1.1</td>
<td>.98</td>
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<tr>
<td>Tryptophan</td>
<td>.18-.26</td>
<td>.22</td>
<td>.19</td>
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<tr>
<td>Threonine</td>
<td>.85-1.14</td>
<td>.98</td>
<td>.92</td>
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</table>

*Noll & Parsons, unpublished data*
# DDGs Nutrient Characteristics*

<table>
<thead>
<tr>
<th>Amino acid</th>
<th>Digest Coeff (%)</th>
<th>Ave</th>
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<tbody>
<tr>
<td>Methionine</td>
<td>80-90</td>
<td>87</td>
</tr>
<tr>
<td>Cystine</td>
<td>66-85</td>
<td>77</td>
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<tr>
<td>Lysine</td>
<td>37-84</td>
<td>68</td>
</tr>
<tr>
<td>Arginine</td>
<td>80-90</td>
<td>85</td>
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<tr>
<td>Tryptophan</td>
<td>76-87</td>
<td>83</td>
</tr>
<tr>
<td>Threonine</td>
<td>67-81</td>
<td>75</td>
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</tbody>
</table>

*Noll and Parsons, unpublished data*
DDGS Update
Corn, Conventional Product

- Research Areas
  - Nutrient Characteristics & Variability
    - Variability exists (Variation Among Plant > Within Plant)
      - Solubles Addition
      - Type of product
Variability in Nutritional Characteristics

- Corn nutrient content
- Processing
  - Drying conditions
  - Solubles addition (amount)
Varying Solubles Addition

- Measure effect on nutritional characteristics of resulting DDGS
- Can rate of addition indirectly effect amino acid digestibility?

Noll & Parsons, 2007
Variable Solubles Addition & DDGS Characteristics-Pilot Study

- Four Syrup Addition Rates
  - 42, 25, 12, 0 gal/min
- DDGS samples taken from each lot
  - Chemical analyses
  - Amino acid digestibility
  - TME
- Pearson Correlations with addition rate
Variable Solubles Addition & DDGS Characteristics

- No effect
  - Protein, amino acids content
  - Amino acid digestibility mostly not affected

- Significant correlation found for:
  - Color
  - Crude fat
  - Ash
  - Minerals
    - P
    - TMEn
Influence of syrup addition on DDGS fat content and TME_{n} (DM basis)

![Graph showing the effect of syrup addition on TME and fat content.](image)
Influence of syrup addition on DDGS ash and phosphorus content (DM basis)
Influence of syrup addition on color ($L^*$, $b^*$) of DDGS
Variable Syrup Addition

- Changed composition of resulting DDGS
- Minerals (P), fat, color, and energy changed
- Particle size – “syrup balls” at highest level of solubles addition
Variability – Type of product

- Ethanol processing methods continue to evolve & change to improve production efficiency
  - Corn fractionation
  - Manipulation of DDGS
- Composition very different from conventionally produced DDGS
## Nutrient Characteristics of Alternative “DDGS” Products (Batal, 2007)

<table>
<thead>
<tr>
<th>(%)</th>
<th>Conv. DDGS</th>
<th>HP-DDGS</th>
<th>Dehy. Corn germ</th>
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<tbody>
<tr>
<td>Protein</td>
<td>27</td>
<td>44</td>
<td>15.5</td>
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<tr>
<td>Crude fiber</td>
<td>7</td>
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<td>4.5</td>
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<tr>
<td>Crude fat</td>
<td>10</td>
<td>3</td>
<td>17</td>
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<tr>
<td>P, total</td>
<td>.77</td>
<td>.35</td>
<td>1.18</td>
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<tr>
<td>P, Avail</td>
<td>60</td>
<td>47</td>
<td>31</td>
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<tr>
<td>Lysine, total</td>
<td>.79</td>
<td>1.03</td>
<td>.83</td>
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<tr>
<td>Lys, Avail</td>
<td>81</td>
<td>72</td>
<td>80</td>
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</table>
Dietary Inclusion Levels of DDGS
Previous Research Results
Heavy Tom Grow/Finish Diets

- Up to 10-20% in heavy tom grow/finish diets possible in corn-soy based diets
  - Growth & Feed/gain similar to Control
- Some slight reduced performance at 20%
  - Reduced intact protein (lower protein diets + supplemental thr) + limited intake (summer)
  - High levels of animal byproduct
    - >8% PBM
Current Study Objectives

- Determine:
  - Maximal inclusion levels of DDGS in corn-soy-meat based diet when started at different ages and effect on:
    - Turkey performance
    - Litter moisture
Methods

- **Ingredients (corn, soy, PBM, DDGS)**
  - Nutrient analyses plus digestible amino acids
- **Diets formulated to 100% NRC digestible lys, TSAA, thr**
  - Supplemental lys & met; some thr
  - Three wk feeding periods 2-19 wks of age
- **Inclusion level of PBM limited to prevent excess dietary phosphorus**
- **Diets fed as mash**
Each diet fed to 9 replicate pens of toms (Nicholas, 10b/pen) (90 pens total)

Trial started at 2 wks of age and finished at 19 wks of age

Individual bird weights and pen feed intake

Experimental Design – randomized block design

Statistical analyses – ANOVA, LSD, and contrasts
## Treatments - DDGS Inclusion Levels (% of Diet)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Age Period (wks)</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>2-5</td>
<td>5-8</td>
<td>8-11</td>
<td>11-14</td>
<td>14-17</td>
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<td>20</td>
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<td>20</td>
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<td>5</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>40</td>
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</tbody>
</table>
Results
DDGS Level (2-5 wks of age) and Poult Body Weight

No DDGS vs DDGS (P<.05)
DDGS Level (2-19 wks of age) and 19 wk Tom Weight

No DDGS vs DDGS (NS)
Linear Trend (NS)
DDGS Level (11-19 wks of age*)
and 19 wk Tom Weight

Linear Trend (P<.03)

*Lower levels fed 2-11 wks
DDGS Level (11-19 wks of age*) and gain

ADG (lb/day)

0% 20% 30% 40%

11 to 14 14 to 17 17-19

*Lower levels of DDGS fed during 2-11 wks of age
DDGS Level (11-19 wks of age*) and Litter Moisture (15 wks)

Moisture (%)

Treatment (NS)
No DDGS vs DDGS (NS)
Linear Trend (NS)

*Lower levels fed 2-11 wks
Summary

- Inclusion up to 30% DDGS was possible in turkey poult starter diets
- Inclusion of 40% DDGS depressed 19 wk body weight
  - Gain during 17-19 wks depressed
- Litter moisture was not affected by DDGS inclusion
Feeding High Levels of DDGS
Dependent on:

- Good quality product (KNOW YOUR SOURCE)
- Analyzed nutrient content available
  - CP, fiber, fat, amino acids, electrolytes
- Formulate on a digestible amino acid basis
  - Lys, TSAA, thr, arg, tryp
- Phosphorus availability adjustment
- Appropriate energy level assignment
- No mycotoxins
- Effects on pellet quality
Crude Glycerol (Glycerine) as a Feed Ingredient

- Potential energy source
  - Gross energy of ~ 3600 kcal/kg
- By-Product of Biodiesel Process
  - Feedstocks (oils, fats, grease)
  - Utilizes the fatty acid portion of the triglyceride molecule leaving glycerol behind
  - During production add
    - Methanol
    - Catalyst - sodium or potassium
## What’s in Crude Glycerol?

<table>
<thead>
<tr>
<th>(%)</th>
<th>Lammers ‘08</th>
<th>Noll ’08</th>
<th>Thompson &amp; He ‘06**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycerol</td>
<td>87</td>
<td>83.5</td>
<td>75-83</td>
</tr>
<tr>
<td>Moisture</td>
<td>9.22</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>3.19</td>
<td></td>
<td>.25-2.80</td>
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<tr>
<td>Methanol*</td>
<td>.028</td>
<td>LT .015</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>.12</td>
<td></td>
<td>2-13%</td>
</tr>
<tr>
<td>Protein</td>
<td>.41</td>
<td></td>
<td>.05-.2</td>
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<tr>
<td>Sodium</td>
<td>1.26</td>
<td>.98</td>
<td>1-1.2</td>
</tr>
<tr>
<td>Potassium</td>
<td>&lt;.005</td>
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</tr>
<tr>
<td>Chloride</td>
<td>1.86</td>
<td>1.52</td>
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*FDA limit of .015% or 150 ppm  **Produced from various veget. oils
Inclusion of Glycerin and Diet Formulation (Turkey Grower Diet Example)

<table>
<thead>
<tr>
<th>Ingredient (%)</th>
<th>0%</th>
<th>4%</th>
<th>8%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>58.53</td>
<td>54.21</td>
<td>49.89</td>
</tr>
<tr>
<td>SBM</td>
<td>18.28</td>
<td>18.95</td>
<td>19.62</td>
</tr>
<tr>
<td>MBM</td>
<td>8</td>
<td>8</td>
<td>8</td>
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<tr>
<td>DDGS</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Fat</td>
<td>3.84</td>
<td>3.61</td>
<td>3.38</td>
</tr>
<tr>
<td>CP</td>
<td>20.38</td>
<td>20.37</td>
<td>20.35</td>
</tr>
<tr>
<td>ME (kcal/kg)</td>
<td>3230</td>
<td>3230</td>
<td>3230</td>
</tr>
</tbody>
</table>
Recent Studies with Feeding of Glycerin

- **Broiler studies (Cerrate et al., 2006)**
  - Used an AMEn value of 3527 for diet formulation
    - Gross energy was 3596 kcal/kg
    - Fed as crumbles/pellets
  - 0, 5, 10% inclusion
    - 10% decrease growth, increased litter moisture
      - Flowability of feed
  - 0, 2.5, 5% inclusion
    - No effect on BW or F:G
    - Improved breast meat yield
Glycerin and Broiler Breast Meat Yield (Exp. 2, Cerrate et al., 2006)
Recent Studies with Feeding of Glycerin

- Laying Hen (Lammers et al., 2008)
  - 0, 5, 10, 15% to 40wk old W36 hens
  - Short term study no effect on performance
  - AMEn 3805 (+/- 240 kcal/kg)
Market Tom Response to Crude Glycerol

- Glycerin additions (0, 2, 4, 6, 8%)
  - Replaced corn – weight equivalent
- Two diet regimens (HND and LND)
- Experimental period 8-19 wks of age
- Diets fed as mash

Noll, Preliminary Results

Funded by MTGA, MPRP; Glycerol supplied by Central Bi
Market Tom Response to Glycerol Addition (TG074 Preliminary Results)

Glycerol Addition and BW at 14 wks of age

Feed efficiency 11-14 wks of age

Noll, University of Minnesota
Crude glycerol and pellet production
(Swine feeding trials, Groesbeck, KSU 2007)

- **Experiment 1**
  - Glycerol addition to 9% increased PDI
  - Decreased production energy

- **Experiment 2**
  - Glycerol of 3 and 6% increased PDI

- Flowability improved in meal diets with hammer mill grd. corn
Summary - Glycerin as a source of energy

- Provides primarily energy & some minerals
  - No significant protein content!
- GE 3625 kcal/kg
  - Chickens - AMEn 3600-3800 kcal/kg
  - Turkeys (preliminary) - 3600 kcal/kg
- Variability in content
  - Glycerol, methanol, Na and K
Summary - Glycerin as a source of energy

- Meat yield/quality characteristics?
- Seasonal product flowability changes (cold temperature)
- Handling and flowability issues at high inclusion levels?
  - Improve pellet quality?
  - Decrease dust
- Economics of use
  - Tied to cost of protein and ME sources
Concluding Remarks

- What will future poultry diets contain for ingredients?
  - Potential loss of corn, SBM, fat
  - Including more alternatives
    - Dealing with nutrient variability
    - Higher levels of alternatives can be utilized
      - Detrimental properties
Acknowledgments-UM Turkey Research Program

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  - Central Bi-Products
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  - ADM
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  - UI – C. Parsons, P. Utterback
University of Minnesota
DDGS Webpage

• www.ddgs.umn.edu