Waste or Wonder: Distillers Dried Grains with Solubles in Swine Diets

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Production of DDGS

- Co-product from the dry-milling of corn for production of ethanol
- 1 bu of corn yields:
  - 2.7 gallons of ethanol
  - 18 lbs of DDGS
  - 18 lbs of CO$_2$
- Other grains can be used
  - Sorghum
Historical Use of DDGS

- Used in ruminant (Beef and Dairy) diets primarily (> 90%)
- Not used in swine or poultry diets:
  - Lack of nutritional information
  - Variability of nutrient content
  - Cost and supply
  - Poor amino acid digestibility
  - Viewed as having low energy density
  - Digestibility of nutrients (amino acids)
Production of DDGS

As of 5 years ago:
- 3.2 to 3.5 million MT of DDGS produced annually in North America
- ~ 700,000 MT are exported to the EU
- ~ 2.65 million MT are fed in U.S. and Canada

Level of production has doubled since then:
- Increased number and capacity of ethanol plants
- Cost of transporting prohibitive
- ↑ supply and ↓ cost of DDGS in midwest
Currently 14 ethanol plants in Minnesota
13 are farmer cooperative plants
Ethanol production can \(\uparrow\) value of corn by $0.30/bu
Government subsidies have encouraged increase in number of plants in MN
May change with economic conditions currently
Ability to derive income from DDGS and CO\textsubscript{2} produced becomes more important
DDGS Swine Research Conducted at Univ. of MN

12 experiments conducted so far:
- DDGS Database
- Determine DE and ME Values for DDGS (2)
- Manure Composition and Gas/Odor Emission
- Apparent Ileal Amino Acid Digestibility
- P Availability Study
- Grow-Finish Performance/Carcass Quality
- Sow Reproductive Performance
- Nursery Performance
- Gut Health / Ileitis
# DDGS Nutrient Database

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>MN-SD*</th>
<th>OMP</th>
<th>NRC(1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>88.9</td>
<td>88.3</td>
<td>93.0</td>
</tr>
<tr>
<td>Crude fat</td>
<td>10.9</td>
<td>8.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>8.8</td>
<td>7.1</td>
<td>4.8</td>
</tr>
<tr>
<td>DE*</td>
<td>3965</td>
<td>3874</td>
<td>3449</td>
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<tr>
<td>Crude protein</td>
<td>30.2</td>
<td>28.1</td>
<td>29.8</td>
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<tr>
<td>Lys</td>
<td>0.85</td>
<td>0.53</td>
<td>0.67</td>
</tr>
<tr>
<td>Met</td>
<td>0.55</td>
<td>0.50</td>
<td>0.54</td>
</tr>
<tr>
<td>Thr</td>
<td>1.13</td>
<td>0.98</td>
<td>1.01</td>
</tr>
<tr>
<td>Trp</td>
<td>0.25</td>
<td>0.19</td>
<td>0.27</td>
</tr>
</tbody>
</table>

*Number of samples = 120 (10 plants, 12 samples each*
Higher nutrient content compared to
- NRC (1998)
- Sample from “old generation” plant (OMP)

Variation within and among plants
- Less than in the past
- Lysine most variable (CV = 17%)
- Color differences

Some year-to-year differences
ME and DE values obtained were significantly higher than NRC 1998 but were highly variable

- 3380 to 5905 kcal DE/kg (3963 kcal DE/kg)
- 3315 to 5930 kcal ME/kg (3917 kcal ME/kg)

Calculated DE and ME values:

- DE kcal/kg = 3965 (CV=2.2%) Range: 3883 to 4020 kcal/kg
- ME kcal/kg = 3592 (CV=2.4%) Range: 3510 to 3654 kcal/kg
Nutrient Balance / Odor Study

- 10-wk trial
- Individual daily collection of manure and addition to 2 DPSM’s/collection
Nutrient Balance / Odor Study

Nitrogen intake and excretion increased when DDGS was added to the diet
- no adverse effect on ammonia emissions from the manure storage facility during the 10-wk study.

Phosphorus retention and excretion were not affected by dietary treatment
- level of inorganic phosphorus supplementation was reduced in diets containing 20% DDGS, thereby reducing diet cost

No appreciable affect on hydrogen sulfide, ammonia, or odor emissions
## DDGS Apparent Ileal Amino Acid Digestibility Comparison

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Lys</td>
<td>0.83 (53) 0.44</td>
<td>0.68 (0) 0.00</td>
<td>0.67 (46) 0.31</td>
</tr>
<tr>
<td>Met</td>
<td>0.55 (58) 0.32</td>
<td>0.49 (49) 0.24</td>
<td>0.54 (72) 0.39</td>
</tr>
<tr>
<td>Thr</td>
<td>1.13 (55) 0.62</td>
<td>1.01 (36) 0.36</td>
<td>1.11 (50) 0.56</td>
</tr>
<tr>
<td>Trp</td>
<td>0.24 (63) 0.15</td>
<td>0.27 (56) 0.15</td>
<td>0.20 (70) 0.14</td>
</tr>
</tbody>
</table>
DDGS P Availability Study

Phosphorus balance study

Regression analysis of P excretion & retention

- Relative to P intake for DDGS and Dical Phosphate
- Excretion: 87.5% availability of P ($r^2 = .47$)
- Retention: 92.2% availability of P ($r^2 = .72$)
- DDGS = 0.89% total P x 90% avail = 0.80% avail P
- Corn = 0.28% total P x 14% avail = 0.04% avail P
- SBM (44% CP) = 0.65% total P x 31% avail = 0.20% avail P
DDGS Nursery Performance Study

2 experiments
- 19 and 17 days of age (15.6 vs 11.6 lbs)
- Commercial pelleted diet first 4 days
- 0, 5, 10, 15, 20, or 25% DDGS
- Formulated on App III Dig AA basis
- Phase 2 (2 weeks), Phase 3 (3 weeks)

Similar growth, feed intake, and G/F
- Slight lag during Phase 2 for younger pigs, but they caught up by end of nursery period
DDGS Grow-Finish Performance and Carcass Composition Study

- Diets formulated to contain same total lysine, phosphorus, and ME
  - 240 crossbred pigs (24 pens), 60 – 250 lbs
  - Diets contained 0, 10, 20, or 30% DDGS
  - 5-phase feeding program
    - Diet switches based on average pen weight
  - At slaughter, carcass/meat/fat quality measurements conducted by Shanks/Wulf (SDSU)
DDGS Grow-Finish Performance and Carcass Composition Study

Performance
- Growth rate similar at 0 and 10% DDGS levels
  - Drop at 20 & 30% levels
- No difference in feed intakes
- Decrease in G/F at 30% DDGS inclusion level

Carcass composition
- % lean and backfat depth unaffected

Importance of using available vs. total amino acid levels when formulating and using DDGS
DDGS Sow Gestation/Lactation

- Study just completed
- 2 x 2 factorial arrangement of treatments:
  - Gestation: 0 or 50% DDGS
  - Lactation: 0 or 20% DDGS
- Followed through 2 parities (mixed parity sows)
- Initial results suggest an increase of ≈ 1 pig born alive for the 2nd litter
  - Insoluble fiber effect?
DDGS Ileitis Challenge Studies

**Ileitis – What is it?**

- Porcine Proliferative Enteropathy
- Caused by *Lawsonia intracellularis*
  - Intracellular, microaerophilic bacteria
  - Infects immature epithelial cells located in the crypts of the lower small intestine
  - Inhibits maturation of cells, resulting in cells multiplying without being sloughed off
- **Pigs affected:** (Glock et al., 1994)
  - 40-100 lb growing pigs*
  - Bred gilts
  - Sows and boars
  - Finishing pigs
Field reports from a number of pork production operations have indicated:

- Adding 5 to 10% DDGS to grow-finish diets in ileitis swine herds
  - Improved performance
  - Reduced mortality (> 50%)
  - Ability to remove part or all of sub-therapeutic antibiotics without ileitis outbreak
- Similar results have been reported with using soy hulls
DDGS Ileitis Challenge Studies

- Substantial crude fiber level (8 – 10%)
  - High insoluble (42.2 %) vs soluble (0.7 %) (Shurson et al., 2000)
  - Feeding diets that are low in soluble NSP can reduce the proliferation of pathogenic organisms in the gastrointestinal tract (Hampson, 1999).
    - Reduced pathogen substrate availability?
    - Fiber may influence the secretory function of the epithelium, which are implicated with bacterial adhesion (Smith and Halls, 1968)
    - May have a “cleansing” effect in gut through changes by reducing the viscosity of digesta (Lawrence, 1972)

- Presence of yeast cells from fermentation
  - May have some “MOS-like” properties
DDGS Ileitis Challenge Studies

- Developed disease challenge model
  - Early weaned (17 days of age) pigs
  - Feed experimental diets for 4 weeks
  - Challenge pigs with mucosal homogenate dose
  - Feed and observe pigs for additional 3 weeks
    - Collect fecal samples for PCR analysis
  - Conduct necropsy
    - Evaluate presence of lesions, length, and severity
    - Analyze ileal tissue via IHC
DDGS Ileitis Challenge Studies

Just completed 3\textsuperscript{rd} challenge study:

- Variable results with DDGS in diet
  - 1 study – positive effect on lesion prevalence, length, and severity in ileum and colon
    - 10% inclusion rate
    - Similar to effect of an antimicrobial/antibiotic treatment (BMD/CTC)
  - 2 studies – no beneficial effect of DDGS inclusion
- Dosage rate very high in one study
  - Probably higher in all studies than would occur in field
- Other potential nutritional strategies:
  - Soybean hulls, polyclonal antibody product
How is DDGS included in Swine Diets?

- Land O’ Lakes Farmland
  - 200 lb DDGS and 3 lb Limestone replace 159 lb Corn, 39 lb SBM (46%), & 5 lb Dical

- Agri-Nutrition Services
  - 200 lb DDGS and 3 lb Limestone replace 178 lb Corn, 19 lb SBM (46%), & 6 lb Dical
# DDGS Breakeven Price

- Using Land O’ Lakes Farmland

<table>
<thead>
<tr>
<th>Corn price</th>
<th>$140/ton</th>
<th>SBM price</th>
<th>$160/ton</th>
<th>$180/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2.00/bu</td>
<td>$89/ton</td>
<td>$93/ton</td>
<td>$97/ton</td>
<td></td>
</tr>
<tr>
<td>$2.50/bu</td>
<td>$103/ton</td>
<td>$107/ton</td>
<td>$111/ton</td>
<td></td>
</tr>
<tr>
<td>$3.00/bu</td>
<td>$118/ton</td>
<td>$121/ton</td>
<td>$125/ton</td>
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</tbody>
</table>
Cost Savings?

Assuming: 10% DDGS Inclusion in G/F

- $2.50/bu corn
- $160/ton Hi-Pro SBM
- $85/ton DDGS

Save: $2.20/ton finished feed (avg)
     or $0.75/pig marketed

Plus: Decreased phosphorus excretion
     Improved gut health?
Quality Criteria

- Establish relationship with supplier
  - Quality control measures in place
    - Nutrient specs, mycotoxins, handling characteristics
  - Consistency of product
    - Proportion of solubles standardized
    - Grading system in place?

- Color: generally, lighter is better
  - Indicates higher amino acid digestibility

- Smell: shouldn’t have burnt smell
  - May affect palatability
  - Can indicate protein damage
Quality Criteria
We have developed a DDGS web site featuring:
* research summaries
  - swine, poultry, dairy, & beef
  - DDGS quality
* presentations given
* links to other DDGS related web sites
* international audiences

www.ddgs.umn.edu