Feeding DDGS to Pigs

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University of Minnesota
North American DDGS Production

Source: Sean Broderick, Commodity Specialists Company
Estimated DDGS Usage in U.S. Swine Feeds 2001-2005 (Metric Tonnes)
Current Commercial Dietary DDGS Inclusion Rates and Estimated Usage

- Grower-finisher diets ~85-90%
  - 10-15% dietary inclusion rates

- Sow diets ~5-10%
  - Gestation - up to 30% dietary inclusion
  - Lactation - 5-10% of the diet

- Late nursery diets < 5%
  - Added at 5-10% of the diet
Maximum Inclusion Rates of Golden High Quality DDGS in Swine Diets
(Based Upon University of Minnesota Performance Trials)

- Nursery pigs (> 7 kg)
  - Up to 25%

- Grow-finish pigs
  - Up to 20% (higher levels may reduce pork fat quality)

- Gestating sows
  - Up to 50%

- Lactating sows
  - Up to 30%

Assumptions: no mycotoxins
formulate on a digestible amino acid and available phosphorus basis
## Benefits and Limitations of Feeding DDGS Diets to Swine

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>✦ Energy value = corn</td>
<td>✦ Low protein (lysine) quality</td>
</tr>
<tr>
<td>✦ High available P</td>
<td>✦ Variability in nutrient content and digestibility among sources</td>
</tr>
<tr>
<td>✦ Reduce diet P supplementation</td>
<td>✦ Manure N excretion increases</td>
</tr>
<tr>
<td>✦ May reduce manure P excretion</td>
<td>✦ Belly firmness and pork fat quality may be reduced when &gt; 20% in the diet</td>
</tr>
<tr>
<td>✦ Partially replaces some corn, soybean meal, and dicalcium phosphate and reduces diet cost</td>
<td>✦ Fine particle size causes flowability problems in bins and feeders</td>
</tr>
<tr>
<td>✦ Commonly fed at 10% of diet</td>
<td>✦ Difficult to pellet and maintain throughput of pellet mills</td>
</tr>
<tr>
<td>✦ Higher levels can be used if amino acids are supplemented</td>
<td>✦ Mycotoxin free grain should be used to produce ethanol and DDGS</td>
</tr>
<tr>
<td>✦ Only “golden” DDGS should be used</td>
<td>✦ Short-term feed intake may be reduced when feeding high DDGS diets to sows</td>
</tr>
<tr>
<td>✦ High amino acid digestibility</td>
<td>✦ Belly firmness and pork fat quality may be reduced when &gt; 20% in the diet</td>
</tr>
<tr>
<td>✦ Appears to reduce gut health problems due to ileitis</td>
<td>✦ Fine particle size causes flowability problems in bins and feeders</td>
</tr>
<tr>
<td>✦ May increase litter size weaned when fed at high levels to sows</td>
<td>✦ Difficult to pellet and maintain throughput of pellet mills</td>
</tr>
<tr>
<td>✦ Increases pig weight gain when fed to sows during lactation</td>
<td>✦ Mycotoxin free grain should be used to produce ethanol and DDGS</td>
</tr>
</tbody>
</table>
DDGS Varies in Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources
Averages, Coefficients of Variation, and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>89.3</td>
<td>87.3 – 92.4</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>30.9 (4.7)</td>
<td>28.7 – 32.9</td>
</tr>
<tr>
<td>Crude fat, %</td>
<td>10.7 (16.4)</td>
<td>8.8 – 12.4</td>
</tr>
<tr>
<td>Crude fiber, %</td>
<td>7.2 (18.0)</td>
<td>5.4 – 10.4</td>
</tr>
<tr>
<td>Ash, %</td>
<td>6.0 (26.6)</td>
<td>3.0 – 9.8</td>
</tr>
<tr>
<td>Swine ME, kcal/kg</td>
<td>3810 (3.5)</td>
<td>3504 – 4048</td>
</tr>
<tr>
<td>Lysine, %</td>
<td>0.90 (11.4)</td>
<td>0.61 – 1.06</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.75 (19.4)</td>
<td>0.42 – 0.99</td>
</tr>
</tbody>
</table>
Standardized Ileal Lysine Digestibility Coefficients Among 10 “Golden” Corn DDGS Sources (Stein et al, 2005)
Prediction of Digestible Lysine from Optical Density (400 to 700 nm)

In vitro digestible lysine, %.

In vivo digestible lysine, %.

$R^2 = 0.86$, RMSE = 0.05, PC = 14

Urriola et al. (2006)
Prediction of Digestible Lysine in DDGS Using Front Face Fluorescence

$R^2 = 0.98$, $RMSE = 0.07$, $PC = 9$

Urriola et al. (2006)
Variation in Particle Size Among DDGS Samples Representing 25 U.S. Ethanol Plants 2005
Variation in Bulk Density (Lbs/Cubic Ft.) Among DDGS Samples Representing 25 U.S. Ethanol Plants
1/05
Feeding High Quality DDGS to Weaned Pigs
Nursery Experiments

- **Experiment 1**
  - Pigs weaned at $19.0 \pm 0.3$ d of age
  - Weighed $7.10 \pm 0.07$ kg

- **Experiment 2**
  - Pigs weaned at $16.9 \pm 0.4$ d of age
  - Weighed $5.26 \pm 0.07$ kg

- Pigs were fed a commercial pelleted diet (d 0 to 3 postweaning)

- Phase II (d 4-17) and Phase III (d 18 – 35) diets were formulated on a digestible amino acid basis.
  - Diets contained 0, 5, 10, 15, 20, or 25% DDGS
Results

Feeding Phase II and Phase III nursery diets containing up to 25% DDGS:

- Had no effect on ADG, ADFI, F/G for pigs weaned at 19 d of age and weighing at least 15 lbs.
- Linearly reduced ADG and ADFI in Phase II but not Phase III for pigs weaned at 17 d of age and weighing 11.5 lbs.
Effects of Feeding DDGS to Grow-Finish Pigs on Growth Performance, Carcass, and Pork Quality
Take Home Messages from 4 Experiments

- Diets containing 10% DDGS will provide the same ADG as pigs fed typical corn-SBM diets
  - Diets formulated on a total lysine basis
  - Diets formulated on a digestible amino acid basis

- If >10% DDGS is added to G-F diets, diets should be formulated on a digestible amino acid basis to achieve good performance.

- Feed intake may decline with increasing levels of DDGS in the diet
  - Unclear why different studies show different feed intake responses
  - Diets containing >10% DDGS may result in improved feed efficiency
Take Home Messages from 4 Experiments

- Carcass yield is slightly linearly reduced with increasing dietary DDGS levels
  - No difference in % lean
  - No difference in backfat
  - May be due to increased viscera weight from increased dietary fiber?

- Backfat thickness is unaffected, and may be slightly reduced, with increasing dietary levels of DDGS

- Bellies will be less firm as higher dietary levels of DDGS are fed

- Belly thickness may or may not be affected by increasing dietary DDGS levels

- No concern about reduced shelf life and fat oxidation in loins under typical retail storage conditions for at least 28 days.

- Muscle quality and eating characteristics of loins and bacon are unaffected by feeding diets containing increasing levels of DDGS
Fat Quality Characteristics of Market Pigs Fed Corn-Soy Diets Containing 0, 10, 20, and 30% DDGS

<table>
<thead>
<tr>
<th></th>
<th>0 %</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belly thickness, cm</td>
<td>3.15a</td>
<td>3.00a,b</td>
<td>2.84a,b</td>
<td>2.71b</td>
</tr>
<tr>
<td>Belly firmness score, degrees</td>
<td>27.3a</td>
<td>24.4a,b</td>
<td>25.1a,b</td>
<td>21.3b</td>
</tr>
<tr>
<td>Adjusted belly firmness score, degrees</td>
<td>25.9a</td>
<td>23.8a,b</td>
<td>25.4a,b</td>
<td>22.4b</td>
</tr>
<tr>
<td>Iodine number</td>
<td>66.8a</td>
<td>68.6b</td>
<td>70.6c</td>
<td>72.0c</td>
</tr>
</tbody>
</table>

Means within a row lacking common superscripts differ (P < .05).
Effect of Formulating G-F Diets on a Digestible Amino Acid Basis, with Increasing Levels of DDGS, on Overall Growth Performance

<table>
<thead>
<tr>
<th></th>
<th>0% DDGS</th>
<th>10% DDGS</th>
<th>20% DDGS</th>
<th>30% DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial wt., lbs</td>
<td>49.7</td>
<td>50.3</td>
<td>49.7</td>
<td>49.7</td>
</tr>
<tr>
<td>Final wt., lbs</td>
<td>252</td>
<td>253</td>
<td>251</td>
<td>250</td>
</tr>
<tr>
<td>ADG, lbs</td>
<td>2.00</td>
<td>2.00</td>
<td>1.99</td>
<td>1.99</td>
</tr>
<tr>
<td>ADFI, lbs</td>
<td>5.76</td>
<td>5.58</td>
<td>5.55</td>
<td>5.45</td>
</tr>
<tr>
<td>F/G</td>
<td>2.88</td>
<td>2.80</td>
<td>2.79</td>
<td>2.75</td>
</tr>
</tbody>
</table>

Xu et al. (2006) unpublished
Data from 32 pens, 8 pens/treatment
Effects of Dietary DDGS Level on % Carcass Lean

Xu et al. (2006) unpublished
30% DDGS tended to be higher than 0% DDGS (P = 0.11)
Adding DDGS to Grower-Finisher Diets Slightly Reduces Carcass Yield

Xu et al. (2006) unpublished
Linear effect (P < 0.01)
Unique, Value-Added Attributes of DDGS Have Been Identified

- DDGS may improve gut health related to *Lawsonia intracellularis*
- Phytase and DDGS can reduce manure P excretion
- Feeding high levels of DDGS to sows may improve litter size weaned and pig weaning weights
Effect of Dietary Treatment on Lesion Length (21 d Post-Challenge) Experiment 2

* Effect of disease challenge ($P < .01$).
Effect of Dietary Treatment on Lesion Severity (21 d Post-Challenge) Experiment 2

* Effect of disease challenge ($P < .01$).
Effect of Dietary Treatment on Lesion Prevalence (21 d Post-Challenge) Experiment 2

* Effect of disease challenge (*P* < .01).
Effects of Feeding DDGS to Swine on Dry Matter Digestibility (Manure Volume)
Effects of Adding Phytase and/or 20% DDGS to Corn-SBM Diets on DM Digestibility in G-F Pigs

Xu et al. (2006)
Effect of Adding Phytase and/or 20% DDGS to Corn-SBM Diets on DM Digestibility in Nursery Pigs

DDGS reduced DM digestibility 3.3% (P = .01)
Effect of Feeding Corn-SBM Diets With or Without 20% DDGS or Phytase to Nursery Pigs on Fecal Phosphorus Concentration (%)

a,b Means with different superscripts are significantly different (P < .05).
Effect of Feeding Corn-SBM Diets With or Without 20% DDGS or Phytase to Nursery Pigs on Daily Fecal Phosphorus Excretion (g/d)

a,b,c Means with different superscripts are significantly different (P < .05).
x,y Means with different superscripts are significantly different (P < .15).
Feeding High Quality DDGS to Sows
Effect of Feeding 0 and 50% DDGS Gestation Diets and 0 and 20% DDGS Lactation Diets on Sow Lactation ADFI

![Graph showing feed intake in kg/day for different dietary treatments. For each dietary treatment, two cycles are shown with different superscripts indicating significant differences (P < .10).]

Dietary Treatment

\[ a, b, x, y \] Different superscripts indicate significant difference (P < .10).
Effect of Feeding 0 or 50% DDGS Gestation Diets and 0 or 20% DDGS Lactation Diets on Pigs Weaned/Litter

![Graph showing number of pigs weaned per dietary treatment cycle](image)

Number of Pigs

<table>
<thead>
<tr>
<th>Dietary treatment</th>
<th>Cycle 1</th>
<th>Cycle 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control/DDGS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDGS/Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDGS/DDGS</td>
<td></td>
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</tr>
</tbody>
</table>

Different superscripts indicate significant difference (P < .10).
Effects of Feeding Increasing Levels of DDGS to Lactating Sows on Average Daily Feed Intake and Average Pig Weight at Weaning

Utilized 323 lactating sows (65 sows/dietary treatment)
Song et al. (2006), unpublished
We have developed a DDGS web site featuring:

* nutrient profiles and photos of DDGS samples
* research summaries
  - swine, poultry, dairy, & beef
  - DDGS quality
* presentations given
* links to other DDGS related web sites
* international audiences