Feeding Value of DDGS for Swine

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University of Minnesota
Why is there so much interest in feeding DDGS to swine?

- Golden DDGS is high in digestible nutrients
- Economical partial replacement for:
  - corn
  - soybean meal
  - dicalcium phosphate
- Increasing production and supply
- Unique properties
  - reduce P excretion in manure
  - increase litter size weaned/sow
  - gut health benefits
Maximum Inclusion Rates of “New Generation” 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 20%

Assumptions: no mycotoxins
formulate on a digestible amino acid and available phosphorus basis
Feeding Golden DDGS to Weaned Pigs
Materials and Methods – Nursery Experiments

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

- **Experiment 2**
  - Pigs weaned at 16.9 ± 0.4 d of age
  - Weighed 5.26 ± 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
Effect of DDGS Level on Growth Rate (Experiment 1)

Means not sharing a common superscript letter are significantly different ($P < .05$)
Effect of DDGS Level on ADFI (Experiment 1)

ADFI (g/d)

Phase 2

Phase 3

SE = 46.9

SE = 82.6

Phase (P < .01)

Experimental period

0% DDGS
5% DDGS
10% DDGS
15% DDGS
20% DDGS
25% DDGS

SE = 46.9

SE = 82.6
Effect of DDGS Level on Gain/Feed (Experiment 1)
Effect of DDGS Level on Growth Rate (Experiment 2)

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG (g/d)</td>
<td>ADG (g/d)</td>
</tr>
<tr>
<td>0% DDGS</td>
<td>SE = 55.1</td>
</tr>
<tr>
<td>5% DDGS</td>
<td>SE = 51.1</td>
</tr>
<tr>
<td>10% DDGS</td>
<td>Linear effect of diet ( (P = .09) )</td>
</tr>
<tr>
<td>15% DDGS</td>
<td></td>
</tr>
<tr>
<td>20% DDGS</td>
<td></td>
</tr>
<tr>
<td>25% DDGS</td>
<td></td>
</tr>
</tbody>
</table>

Experimental period

Phase (\( P < .01 \))
Effect of DDGS Level on Feed Intake (Experiment 2)

Means not sharing a common superscript letter are significantly different ($P < .05$)

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**Linear effect of diet ($P = .05$)**

- Phase 2:
  - 0% DDGS
  - 5% DDGS
  - 10% DDGS
  - 15% DDGS
  - 20% DDGS
  - 25% DDGS

- Phase 3:
  - 0% DDGS
  - 5% DDGS
  - 10% DDGS
  - 15% DDGS
  - 20% DDGS
  - 25% DDGS

**Phase ($P < .01$)**

**Phase x Diet ($P = .02$)**
Effect of DDGS Level on Gain/Feed (Experiment 2)

![Graph showing the effect of DDGS level on gain/feed.](chart)

- Phase 2: SE = 0.13
- Phase 3: SE = 0.03

- 0% DDGS
- 5% DDGS
- 10% DDGS
- 15% DDGS
- 20% DDGS
- 25% DDGS

Phase (P = .06)
Effect of DDGS Level on Final BW (Experiment 2)

Body weight, kg

Dietary treatment

SE = 1.3

- 0% DDGS
- 5% DDGS
- 10% DDGS
- 15% DDGS
- 20% DDGS
- 25% DDGS
Feeding Golden DDGS to Grow-Finish Pigs
Materials and Methods

- 240 crossbred pigs (approx. 28.3 kg BW)
  - Grow-finish facilities at WCROC – Morris, MN
  - Blocked by weight, gender and litter
  - Blocks randomly assigned to 1 of 4 diet sequences
    - 5-phase feeding program
  - 0, 10, 20, or 30% DDGS diets *formulated on total lysine basis*
  - 24 pens, 10 pigs/pen, 6 replications/treatment
Effect of Dietary DDGS Level on Overall ADG of Grow-Finish Pigs

0 % and 10 % DDGS > 20% and 30% DDGS (P < .10)
Effect of Dietary DDGS Level on Overall ADFI of Grow-Finish Pigs

No significant differences among dietary treatments
Effect of Dietary DDGS Level on Overall G/F of Grow-Finish Pigs

0 %, 10 % and 20% DDGS > 30% DDGS (P < .10)
Effect of Dietary DDGS Level on Carcass Weight

0 % and 10 % DDGS > 20% and 30% DDGS (P < .01)
Effect of Dietary DDGS Level on % Carcass Lean

No significant differences among dietary treatments
Effect of Dietary DDGS Level on Carcass Loin Depth

Linear decrease with increasing dietary level of DDGS (P < .02)
Effect of Dietary DDGS Level on Carcass Backfat Depth

No significant differences among dietary treatments
**Muscle Quality Characteristics from G-F Pigs Fed Diets Containing 0, 10, 20, and 30% DDGS**

<table>
<thead>
<tr>
<th>Trait</th>
<th>0 %</th>
<th>10 %</th>
<th>20 %</th>
<th>30 %</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>L*&lt;sup&gt;a&lt;/sup&gt;</td>
<td>54.3</td>
<td>55.1</td>
<td>55.8</td>
<td>55.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Color score&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.2</td>
<td>3.2</td>
<td>3.1</td>
<td>3.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Firmness score&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.2</td>
<td>2.0</td>
<td>2.1</td>
<td>2.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Marbling score&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.9</td>
<td>1.9</td>
<td>1.7</td>
<td>1.9</td>
<td>0.6</td>
</tr>
<tr>
<td>Ultimate pH</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>0.2</td>
</tr>
<tr>
<td>11-d purge loss, %</td>
<td>2.1&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.4&lt;sup&gt;fg&lt;/sup&gt;</td>
<td>2.8&lt;sup&gt;g&lt;/sup&gt;</td>
<td>2.5&lt;sup&gt;fg&lt;/sup&gt;</td>
<td>1.2</td>
</tr>
<tr>
<td>24-h drip loss</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Cooking loss, %</td>
<td>18.7</td>
<td>18.5</td>
<td>18.3</td>
<td>18.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Total moisture loss&lt;sup&gt;e&lt;/sup&gt;, %</td>
<td>21.4</td>
<td>21.5</td>
<td>21.8</td>
<td>22.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Warner-Bratzler sheer force, kg</td>
<td>3.4</td>
<td>3.4</td>
<td>3.3</td>
<td>3.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<sup>a</sup> 0 = black, 100 = white  
<sup>b</sup> 1=pale pinkish gray/white; 2=grayish pink; 3=reddish pink; 4=dark reddish pink; 5=purplish red; 6=dark purplish red  
<sup>c</sup> 1 = soft, 2 = firm, 3 = very firm  
<sup>d</sup> Visual scale approximates % intramuscular fat content (NPPC, 1999)  
<sup>e</sup> Total moisture loss = 11-d purge loss + 24-h drip loss + cooking loss
## Fat Quality Characteristics of Market Pigs Fed Corn-Soy Diets Containing 0 to 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 Adding 10% DDGS to Grow-Finish Diets on ADG, ADFI, and F/G for a 64 d Grow-Finish Period

Lawrence (2003) – Hubbard Milling Commercial Feeding Trial
Feeding Golden DDGS to Sows
Effect of Feeding a 50% DDGS Diet on Sow Weight Gain During Gestation (Reproductive Cycle 1)

(P > .22) MSE 10.12
Effect of Feeding 0 or 50% DDGS Gestation Diets and 0 or 20% DDGS Lactation Diets on Pigs Weaned/Litter

Different superscripts indicate significant difference (P < .10).
Effect of Dietary Treatment Combination on Sow Lactation ADFI

A bar chart showing feed intake (kg/day) for different dietary treatment combinations. The chart includes cycles 1 and 2, and indicates that different superscripts (a, b, x, y) represent significant differences (P < .10).
DDGS and Phytase are a Key Part of Manure Phosphorus Management

- Adding 20% DDGS to a corn-soy diet and formulating on an available P basis
  - can reduce manure P by > 12%

- Adding phytase to a corn-soy diet
  - increases P bioavailability from 15% to > 45%

- Lowering dietary P, adding 20% DDGS & phytase
  - can reduce manure P excretion by 40 to 50%
## Diet Composition When 18.8% DDGS and Phytase are Added to the Diet

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Corn-SBM-1.5 kg Lysine</th>
<th>18.8% DDGS + Phytase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn, kg</td>
<td>798.3</td>
<td>636.3</td>
</tr>
<tr>
<td>Soybean meal 44%, kg</td>
<td>176.9</td>
<td>159.4</td>
</tr>
<tr>
<td>DDGS, kg</td>
<td>0.0</td>
<td>188</td>
</tr>
<tr>
<td>Dicalcium phosphate, kg</td>
<td>11.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Limestone, kg</td>
<td>7.2</td>
<td>9.8</td>
</tr>
<tr>
<td>Salt, kg</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>L-lysine HCl, kg</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>VTM premix, kg</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Phytase, 500 FTU/kg</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>TOTAL, kg</td>
<td>1000.0</td>
<td>1000.0</td>
</tr>
</tbody>
</table>
Does Feeding DDGS Improve Gut Health?
What is Ileitis?

- Porcine Proliferative Enteropathy
- Caused by *Lawsonia intracellularis*
  - Present in 96% of U.S. swine herds (Bane et al., 1997)
    - 28% of pigs affected (NAHMS, 2000)
  - Can be shed in infected pigs for up to 10 weeks
- Animals are infected by oral contact with feces from animals shedding the bacteria
- 7-10 days after infection:
  - Lesions of the intestinal wall begin to form
  - Lesions maximized around 21 days post-infection
Clinical Forms of Ileitis

- **Porcine Intestinal Adenomatosis (PIA)**
  - Chronic form
  - Seen in growing pigs (6 - 20 weeks of age)
  - Decreased feed intake, lethargic

- **Porcine Hemorrhagic Enteropathy (PHE)**
  - Acute form, affects heavier pigs
    - Greatest frequency appears to be from 65 – 110 kg pigs
  - Massive intestinal hemorrhaging, bloody diarrhea, increase in mortality
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 ($P < .01$).

* SE = 6.3 6.4 3.6 5.0

Section of gastro-intestinal tract

Jejunum*  Ileum*  Cecum  Colon*
Are There Components of Corn Distiller’s Solubles that Are Responsible for Enteric Health Benefits?
Residual Solubles

Yeast Cream

Condensed Distiller’s Solubles

Residual Solubles
Materials and Methods

- 7 dietary treatments fed from day 0 to 10 post-weaning

- NC = negative control
- DS = spray dried distiller’s solubles
  - 15% of the diet
- YC = spray dried yeast cream
  - 7.5% of the diet
  - replaced animal fat
- RS = spray dried residual solubles
  - 15% of the diet
- AB = carbadox
  - 50 g/ton
- PP = spray dried porcine plasma
  - 6% of the diet
- PC = spray dried porcine plasma + carbadox
  - 6% PP + 50 g/ton AB
Effect of Dietary Treatment on Phase 1 ADG and ADFI (Trial 1)

NC = negative control
DS = 15% spray dried distiller’s solubles
YC = 7.5% spray dried yeast cream
RS = 15% spray dried residual solubles
AB = 55 ppm carbadox
PP = 6% spray dried porcine plasma
PC = 55 ppm + 6% spray dried porcine plasma

a, b = Least squares means with different superscripts are different (P < .05)
Effect of Dietary Treatment on Relative Change in ADG (Trial 1)

NC = negative control
DS = 15% spray dried distiller’s solubles
YC = 7.5% spray dried yeast cream
RS = 15% spray dried residual solubles
AB = 55 ppm carbadox
PP = 6% spray dried porcine plasma
PC = 55 ppm + 6% spray dried porcine plasma

Trt P-value=0.09 PSE=8.59
Time P-value=0.77 PSE=5.25
Time x Treatment P-value=0.91
Villi Height and Crypt Depth in the Upper 25% of the Small Intestine

Villi Height, um | Crypt Depth, um
NC = negative control
DS = spray dried distiller’s solubles
YC = spray dried yeast cream
RS = spray dried residual solubles
AB = carbadox
PP = spray dried porcine plasma
PC = spray dried porcine plasma + carbadox

a, b = Least squares means with different superscripts are different (P < .05)
Villi Height:Crypt Depth Ratio in the Upper 25% of the Small Intestine

NC = negative control
DS = spray dried distiller’s solubles
YC = spray dried yeast cream
RS = spray dried residual solubles
AB = carbadox
PP = spray dried porcine plasma
PC = spray dried porcine plasma + carbadox

a, b = Least squares means with different superscripts are different (P < .05)
Villi Measurements from the Upper 25% of the Small Intestine from a Pig Fed the Residual Solubles Diet (10X)
Villi Measurements from the Upper 25% of the Small Intestine from a Pig Fed the Carbadox Diet (10X)