Growth Performance of Nursery Pigs Fed Diets Containing Increasing Levels of Corn Distiller’s Dried Grains with Solubles

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Distiller’s Dried Grains with Solubles (DDGS)

• Co-product of ethanol dry-milling industry
  – 100 kg corn yields:
    • 40 liters ethanol
    • 33 kg carbon dioxide
    • 33 kg DDGS
  – ∼3x concentration of amino acids, fat, fiber, and minerals compared to corn

• Significant increase in number and capacity of ethanol plants in U.S.
  – “New generation” plants have increased supply of DDGS.
Distiller’s Dried Grains with Solubles (DDGS)

- Historically not used in swine diets:
  - Nutrient variability
  - Inferior amino acid profile
  - Poor amino acid digestibility
  - Concerns over energy density and fiber level

- Feeding recommendations:
  - 5% max in nursery (Newland and Mahan, 1990)
Distiller’s Dried Grains with Solubles (DDGS)
Recent Research Results

- “New generation” DDGS vs. reference values (NRC, 1998):
  - Less variability of nutrients (Spiehs et al., 2002)
  - Increased metabolizable energy (Spiehs et al., 1999)
  - Greater digestible amino acid levels (Whitney et al., 2000)
  - Improved phosphorus availability (Whitney et al., 2001)

- DDGS from “new generation” ethanol plants:
  - Is of high nutritional quality
  - Should serve as an acceptable partial substitute for corn, soybean meal, and dicalcium phosphate in nursery diets
Objectives

- Evaluate the effect of including increasing levels of DDGS from “new generation” ethanol plants in nursery diets on growth rate, feed intake, and feed efficiency

- Determine the maximum inclusion rate of “new generation” DDGS in nursery diets
Materials and Methods

• 2 growth performance experiments
• 0, 5, 10, 15, 20, or 25% DDGS in nursery diet
• 96 pigs in each experiment
  – Blocked by gender and ancestry, then randomly allotted within each block
  – 4 pigs/pen (0.37 m²/pig)
  – 4 pens/dietary treatment
• 3-phase feeding program
  – Phase 1: commercial, pelleted diet fed first 4 d post-weaning
  – Phase 2: fed for 14 d, meal form
  – Phase 3: fed for 21 d, meal form
## Nursery Phase 2 Diets*

<table>
<thead>
<tr>
<th>Ingredient, %</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>50.1</td>
<td>45.4</td>
<td>40.5</td>
<td>35.7</td>
<td>30.9</td>
<td>26.1</td>
</tr>
<tr>
<td>Soybean meal (47% CP)</td>
<td>23.4</td>
<td>23.2</td>
<td>23.1</td>
<td>22.9</td>
<td>22.7</td>
<td>22.5</td>
</tr>
<tr>
<td>DDGS</td>
<td>0.0</td>
<td>5.0</td>
<td>10.0</td>
<td>15.0</td>
<td>20.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Whey, dried</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Fish meal, select menhaden</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Choice white grease</td>
<td>2.5</td>
<td>2.6</td>
<td>2.6</td>
<td>2.7</td>
<td>2.7</td>
<td>2.8</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.2</td>
<td>1.0</td>
<td>0.9</td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

* Diets formulated to contain: 3340 kcal/kg ME 1.35% AID Lys 0.80% AID Met&Cys 0.95% Ca 0.80% P
# Nursery Phase 3 Diets*

<table>
<thead>
<tr>
<th>Ingredient, %</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>61.5</td>
<td>57.0</td>
<td>52.3</td>
<td>47.8</td>
<td>43.2</td>
<td>38.7</td>
</tr>
<tr>
<td>Soybean meal (47% CP)</td>
<td>32.6</td>
<td>32.2</td>
<td>31.8</td>
<td>31.4</td>
<td>30.9</td>
<td>30.5</td>
</tr>
<tr>
<td>DDGS</td>
<td>0.0</td>
<td>5.0</td>
<td>10.0</td>
<td>15.0</td>
<td>20.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Choice white grease</td>
<td>2.4</td>
<td>2.4</td>
<td>2.5</td>
<td>2.5</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.7</td>
<td>1.5</td>
<td>1.4</td>
<td>1.2</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Other</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

* Diets formulated to contain: 3390 kcal/kg ME 1.15% AID Lys 0.65% AID Met&Cys 0.80% Ca 0.70% P
Experiment 1

• Pigs:
  – Weaned at 19.0 ± 0.3 d of age
  – Weighed 7.10 ± 0.07 kg body weight

• Pig weight and feed consumption:
  – Measured for each phase

• Statistics
  – Utilized GLM procedure of SAS with repeated measures in time
    • Pen = experimental unit
  – Orthogonal comparisons to determine linear, quadratic, and/or cubic responses to increasing DDGS level in the diet
Effect of DDGS Level on Growth Rate, Exp. 1

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

![Bar chart showing the effect of DDGS level on growth rate in different phases of the experimental period with standard errors.](chart.png)
Effect of DDGS Level on Feed Intake, Exp. 1

![Graph showing the effect of different levels of DDGS on feed intake during Phase 2 and Phase 3. The graph includes bars representing feed intake (ADFI) in grams per day (g/d) for 0%, 5%, 10%, 15%, 20%, and 25% DDGS levels. The standard errors (SE) are 46.9 and 82.6 for Phase 2 and Phase 3, respectively. The graph indicates a significant difference (P < .01) between the DDGS levels during the experimental period.]
Effect of DDGS Level on Feed Efficiency, Exp. 1

Experimental period

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>G/F</td>
<td>G/F</td>
</tr>
<tr>
<td>0% DDGS</td>
<td>0% DDGS</td>
</tr>
<tr>
<td>5% DDGS</td>
<td>5% DDGS</td>
</tr>
<tr>
<td>10% DDGS</td>
<td>10% DDGS</td>
</tr>
<tr>
<td>15% DDGS</td>
<td>15% DDGS</td>
</tr>
<tr>
<td>20% DDGS</td>
<td>20% DDGS</td>
</tr>
<tr>
<td>25% DDGS</td>
<td>25% DDGS</td>
</tr>
</tbody>
</table>

SE = 0.11  SE = 0.06
Effect of DDGS Level on Final Body Weight, Exp. 1

SE = 1.4

Body weight, kg

Dietary treatment

0% DDGS
5% DDGS
10% DDGS
15% DDGS
20% DDGS
25% DDGS
Summary of Results – Exp. 1

- No effect of increasing dietary DDGS level on:
  - Growth rate
  - Feed intake
  - Feed efficiency
  - Final nursery weight

- Pigs were able to effectively consume and convert high levels of DDGS (up to 25%) without any apparent adverse effects on growth
Experiment 2

• Pigs:
  – Weaned at 16.9 ± 0.4 d of age
  – Weighed 5.26 ± 0.07 kg body weight

• Pig weight and feed consumption:
  – Measured for each phase

• Statistics
  – Utilized GLM procedure of SAS with repeated measures in time
    • Pen = experimental unit
  – Orthogonal comparisons to determine linear, quadratic, and/or cubic responses to increasing DDGS level in the diet
Effect of DDGS Level on Growth Rate, Exp. 2

Linear effect of diet ($P = .09$)

Phase 2

Phase 3

Experimental period

$SE = 55.1$

$SE = 51.1$

Phase ($P < .01$)

0% DDGS

5% DDGS

10% DDGS

15% DDGS

20% DDGS

25% DDGS
Effect of DDGS Level on Feed Intake, Exp. 2

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

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

Phase ($P < .01$)

Phase x Diet ($P = .02$)

Experimental period

$SE = 41.6$

$SE = 60.9$
Effect of DDGS Level on Feed Efficiency, Exp. 2

- **Phase 2**: SE = 0.13
  - 0% DDGS
  - 5% DDGS
  - 10% DDGS
  - 15% DDGS
  - 20% DDGS
  - 25% DDGS

- **Phase 3**: SE = 0.03
  - 0% DDGS
  - 5% DDGS
  - 10% DDGS
  - 15% DDGS
  - 20% DDGS
  - 25% DDGS

Experimental period

Phase (P = .06)
Effect of DDGS Level on Final Body Weight, Exp. 2

![Bar chart showing the effect of different levels of DDGS on final body weight. The x-axis represents dietary treatment levels (0%, 5%, 10%, 15%, 20%, 25% DDGS), and the y-axis represents body weight in kg. The standard error (SE) is 1.3.](chart.png)
Summary of Results – Exp. 2

• Increasing level of DDGS during Phase 2:
  – Decreased feed intake
  – Tended to decrease growth rate
  – No effect of feed efficiency

• No effect of DDGS on ADG, ADFI, or G/F during Phase 3

• No effect of DDGS on ending nursery body weight
Implications

• DDGS from “new generation” ethanol plants is an acceptable partial substitute for corn, soybean meal, and dicalcium phosphate in nursery diets
  – Formulate diets on ME and digestible amino acid basis
  – Can include up to 25% DDGS in Phase 3 with no detrimental effects on growth performance
  – In younger, lighter pigs, including greater than 5% DDGS in Phase 2 may decrease feed intake and subsequent growth rate
    • No detrimental effect in older, heavier pigs
    • No difference in body weight at end of the nursery period
Acknowledgement

Thanks to the Midwest DDGS Association for funding this study