Effects of adding distiller’s dried grains with solubles to gestation and lactation diets on reproductive performance and nutrient balance in sows

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Introduction

- Adding high fiber ingredients to gestation diets has been shown to increase litter size.
  - Hagen et al., 1987 (alfalfa haylage)
  - Carter et al., 1987 (alfalfa meal)
  - Everts, 1991 (straw and corn silage)
  - Ewan et al., 1996 (wheat straw)
Distiller’s Dried Grains with Solubles (DDGS)
Introduction

• “New Generation” DDGS
  – 0.7% soluble fiber
  – 42.2% insoluble fiber

• These levels of fiber in DDGS are comparable to those found in alfalfa (4.3% and 52.4% respectively).

• Will feeding high amounts of DDGS to sows also result in litter size improvements?
Introduction

- Published recommendations for maximum use of DDGS in sow diets:
  - Feed Co-Products Handbook (1997)
    - up to 50% in gestation diets
    - up to 20% in lactation diets
    - up to 40% in gestation diets
    - up to 10% in lactation diets
Objectives

• To determine the effects of feeding diets containing 50% DDGS during gestation and/or 20% DDGS during lactation on sow and litter performance.

• To determine the effects of feeding a diet containing 50% DDGS on nutrient balance of gestating sows:
  – Nitrogen
  – Phosphorus
  – Sulfur
Methodology – sow performance

- Reproductive cycle 1 (RC1)
  - 93 sows (5 breeding groups)
- Sows were blocked by initial BW and parity
  - randomly assigned to 1 of 4 dietary treatment combinations in a 2 x 2 factorial arrangement
- Each dietary treatment combination consisted of a gestation and lactation diet
  - GC/LC (n = 21)
  - GC/LDG (n = 22)
  - GDG/LC (n = 25)
  - GDG/LDG (n = 25)
Methodology – sow performance

- Reproductive cycle 2 (RC2)
  - 49 sows remained on previous gestation and lactation dietary treatments
- Each dietary treatment combination consisted of a gestation and lactation diet
  - GC/LC (n = 11)
  - GC/LDG (n = 12)
  - GDG/LC (n = 7)
  - GDG/LDG (n = 19)
## Composition of experimental gestation diets

*Other includes salt, vitamin/trace mineral premix, choline, and biotin

** Diets were formulated to contain 0.55% available P, 0.45% app. dig. lysine

<table>
<thead>
<tr>
<th>Ingredient (§%)</th>
<th>Control**</th>
<th>DDGS**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>81.8</td>
<td>36.5</td>
</tr>
<tr>
<td>Soybean Meal, 46%</td>
<td>13.6</td>
<td>8.7</td>
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<tr>
<td>DDGS</td>
<td>0.0</td>
<td>50.0</td>
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<tr>
<td>Dicalcium Phosphate</td>
<td>2.8</td>
<td>0.8</td>
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<tr>
<td>Limestone</td>
<td>0.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Other*</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
### Composition of experimental lactation diets

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Control**</th>
<th>DDGS**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>70.6</td>
<td>52.5</td>
</tr>
<tr>
<td>Soybean Meal, 46%</td>
<td>22.6</td>
<td>20.6</td>
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<tr>
<td>DDGS</td>
<td>0.0</td>
<td>20.0</td>
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<tr>
<td>Tallow</td>
<td>2.5</td>
<td>2.5</td>
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<tr>
<td>Dicalcium Phosphate</td>
<td>2.5</td>
<td>1.7</td>
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<tr>
<td>Limestone</td>
<td>0.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Other*</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Other includes L-Lysine HCl, salt, vitamin/trace mineral premix, and biotin

** Diets were formulated to contain 0.51% available P, 0.79% app. dig. lysine
Methodology - sow performance

• Gestation diets were limit fed:
  – day 0 (1% BW)
  – day 30 (1% BW + 100g)
  – day 60 (1% BW + 300g)
  – day 90 (1% BW + 500g)

• On day 110 of gestation, lactation diets were limit fed

• After farrowing, sows were provided ad libitum access to lactation diets.
Methodology - sow performance

- Sow body weight measurements taken at:
  - breeding (d 0)
  - days 30, 60, and 90 of gestation
  - farrowing (within 24h)
  - weaning

- Litter size and weight were recorded at farrowing
  - total pigs born
  - total pigs born alive
  - individual pig birth weights

- Pigs were cross-fostered among litters within dietary treatment within 24-48 h after birth to equalize litter size

- Pigs were weighed at weaning (18 ± 1 d of age)
Methodology - nutrient balance

• Utilized 14 sows at d 90 of gestation (7 sows per gestation treatment)

• After a 10 d adjustment period, a 5 d collection period was used to collect:
  – total urine (via urinary Foley catheter)
  – total feces

• Feed, feces and urine analyzed for:
  – nitrogen - Kjeldahl analysis
  – phosphorus and sulfur - ICP
Statistical analysis

• Performance
  – Repeated measures in time
    • Litter size
    • Litter weight
  – ANOVA of the GLM procedures of SAS
    • All other data
      – Model included diet, parity, and time effects and their interactions

• Nutrient Balance
  – ANOVA of the GLM procedures of SAS.
Effect of gestation dietary treatment on sow weight gain during gestation (RC1)

(P > .22)
MSE 10.12
Effect of gestation dietary treatment on pigs born alive/litter and litter birth weight (RC1)

- **Litter size**
  - Control: 10 pigs
  - DDGS: 10 pigs
  - (P > .41) MSE 2.77

- **Litter weight**
  - Control: 15 kg
  - DDGS: 20 kg
  - (P > .35) MSE 4.09

Dietary treatments: Control, DDGS.
Effect of dietary treatment combination on weaning litter size and weight (RC1)

Litter size

Dietary treatment combination

Number of pigs

(GC/LC)  (GC/LDG)  (GDG/LC)  (GDG/LDG)

(P > .36)  MSE 7.10

Litter weight

Dietary treatment combination

Weight (kg)

(GC/LC)  (GC/LDG)  (GDG/LC)  (GDG/LDG)

(P > .13)  MSE 87.90
Effect of dietary treatment combination on pre-weaning mortality (RC1)

Mortality, %

Dietary treatment combination

<table>
<thead>
<tr>
<th>Diet</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC/LC</td>
<td>a</td>
</tr>
<tr>
<td>GC/LDG</td>
<td>a</td>
</tr>
<tr>
<td>GDG/LC</td>
<td>a</td>
</tr>
<tr>
<td>GDG/LDG</td>
<td>b</td>
</tr>
</tbody>
</table>

a,b (P < .08)
MSE 7.46
Effect of dietary treatment combination on sow lactation ADFI (RC1)

ADFJ (kg)

GC/LC  GC/LDG  GDG/LC  GDG/LDG

a a, b (P < .02)

MSE 1.04
Effect of dietary treatment combination on wean to estrus interval (RC1)

Wean to estrus interval, days

<table>
<thead>
<tr>
<th>Dietary treatment combination</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>bc</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC/LC</td>
<td>6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>GC/LDG</td>
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<td>4</td>
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<td></td>
</tr>
<tr>
<td>GDG/LC</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>GDG/LDG</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

a,b,c (P < .08)
MSE 1.05
Effect of dietary treatment combination sow weight gain during gestation (RC2)

(P > .30)
SE 44.40
Effect of dietary treatment combination on litter size (RC2)

- **Birth (P > .16)**
- **Weaning \(^{a,b}(P < .07)\)**
- **MSE 5.48**

The diagram shows the number of pigs born alive and weaned under different dietary treatment combinations, with statistics indicating no significant difference in birth rates but a significant difference in weaning rates.
Effect of dietary treatment combination on litter weight (RC2)

- Birth (P > .17)
- Wean (P > .62)
- MSE 28.84
Effect of dietary treatment combination on pre-weaning mortality (RC2)

Dietary treatment combination

Mortality, %

- GC/LC
- GC/LDG
- GDG/LC
- GDG/LDG

MSE 10.25

a,b (P < .09)
Effect of dietary treatment combination on sow lactation ADFI (RC2)

- Dietary treatment combination
- ADFI (kg)

<table>
<thead>
<tr>
<th></th>
<th>GC/LC</th>
<th>GC/LDG</th>
<th>GDG/LC</th>
<th>GDG/LDG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSE</td>
<td>1.00</td>
<td></td>
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</table>

a,b (P < .08)

MSE 1.00
Effect of dietary treatment combination on wean to estrus interval (RC2)

- GC/LC
- GC/LDG
- GDG/LC
- GDG/LDG

Wean to estrus interval, days

(P > .40)
MSE 1.33
Effect of feeding a 50% DDGS gestation diet on nitrogen balance

<table>
<thead>
<tr>
<th>Dietary Gestation Treatment</th>
<th>Intake (g/d)</th>
<th>Excretion (g/d)</th>
<th>Retention (g/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>a</td>
<td>m</td>
<td>x</td>
</tr>
<tr>
<td>DDGS</td>
<td>b</td>
<td>n</td>
<td>y</td>
</tr>
</tbody>
</table>

- Intake $^{a,b}(P < .001)$
  MSE 7.64
- Excretion $^{m,n}(P < .001)$
  MSE 3.50
- Retention $^{x,y}(P < .05)$
  MSE 7.35
Effect of feeding a 50% DDGS gestation diet on phosphorus balance

Intake (P > .58)
MSE 1.04

Excretion $^{m,n}(P < .06)$
MSE 1.31

Retention $^{x,y}(P < .09)$
MSE 1.91

Dietary Gestation Treatment

- Intake
- Excretion
- Retention
Effect of feeding a 50% DDGS gestation diet on sulfur balance

<table>
<thead>
<tr>
<th>Dietary Gestation Treatment</th>
<th>Sulfur (g/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>a</td>
</tr>
<tr>
<td>DDGS</td>
<td>b</td>
</tr>
</tbody>
</table>

Intake (P < .0001) MSE 0.27
Excretion m,n(P < .02) MSE 1.19
Retention x,y(P < .03) MSE 1.06
Summary

• Feeding gestating sows a 50% DDGS vs. a corn-soybean meal diet resulted in:
  – Similar gestation weight gains
  – Similar litter size and weight at birth

• Sows fed a corn-soybean meal gestation diet had reduced lactation feed intake when fed a 20% DDGS lactation diet.
Summary

• Sows fed DDGS diets in gestation and lactation through 2 reproductive cycles weaned larger litters than sows fed corn-soybean meal diets.

• Feeding lactating sows a 20% DDGS diet vs. a corn-soybean meal based diet resulted in:
  – Similar litter weaning weights
  – Similar or reduced wean to estrus interval

• Feeding a 50% DDGS diet:
  – increased N and S intake, excretion, and retention
  – reduced P excretion compared to feeding a corn-soybean meal based gestation diet.
Conclusion

• Feeding diets containing 50% DDGS during gestation will support adequate sow performance.

• Sows fed 20% DDGS diets during lactation should be adapted to a diet containing DDGS at least one week prior to farrowing.

• DDGS addition to the diet could have environmental implications:
  – Increasing N and S excretion
  – Decreasing P excretion
Acknowledgments

- Thank you Midwest DDGS Association for funding this study.