Increasing the Utilization of Distiller’s Dried Grains with Solubles in Livestock and Poultry Production Systems

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Components of Yellow Dent Corn

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>61.0 %</td>
</tr>
<tr>
<td>Corn Oil</td>
<td>3.8 %</td>
</tr>
<tr>
<td>Protein</td>
<td>8.0 %</td>
</tr>
<tr>
<td>Fiber</td>
<td>11.2 %</td>
</tr>
<tr>
<td>Moisture</td>
<td>16.0 %</td>
</tr>
</tbody>
</table>

Production of DDGS

- Yeasts and enzymes are used to ferment the starch fraction of corn
- Ethanol and carbon dioxide are produced
- Distiller’s grain and distiller’s solubles are the residues remaining after fermentation
- These fractions and blended and dried to produce distiller’s dried grains with solubles (DDGS)
Corn Dry-Milling Process Overview

**Corn Cleaning**

- Hammermill
- Mix Slurry
- Liquefaction
- Cooker
- Fermentation
- Evaporator
- Centrifuge
- Rotary Dryer
- Distillers Wet Grains
- Distillers Dried Grains with Solubles
- Cond. Distillers Solubles

**Feed Industry Co-products**

- Ethanol: 2.7 gallons
- DDGS: 18 lbs
- CO₂: 18 lbs

Dry-Milling Average Yield Per Bushel

Slide courtesy of Ms. Kelly Davis, CVEC
Map of U.S. Ethanol Plants

Source: Bryan & Bryan Inc. September 1999
DDGS Production and Use

- 3.2 to 3.5 million metric tonnes (MT) of DDGS are produced in North America/year
  - ~ 900,000 MT produced in MN-Dakota region
  - ~ 700,000 MT exported to the EU
  - ~ 2.65 million MT fed in U.S. and Canada
    - ~ 2.58 million MT (80%) fed to ruminants
    - ~ 45,000 MT fed in MN turkey industry
    - ~ 27,000 MT used in swine diets

Markets for DDGS Produced in North America

- Ruminants
- MN Turkey
- Swine
- Exported EU
The Minnesota Ethanol Industry

- 145 million bu. of corn is made into ethanol and other products (14% of MN crop)
- 14 plants produce
  - 300 million gallons of ethanol/yr
  - 1.4 million tons of DDGS
- Existing plants have (are expanding) and new plants are being built

WHAT DO WE DO WITH ALL OF THE DDGS THAT WILL BE PRODUCED?

Source: Ralph Groshen, Minnesota Dept. of Agriculture (2000)

Options for Increasing Markets for DDGS

- Domestic use (most feasible)
  - Dairy and beef
    - Some opportunity
  - Swine and poultry
    - Significant opportunity but must be high quality
    - "Produce it and feed in our own backyard"
- Exports (some opportunities?)
  - High transportation costs
  - Poor geographical location of plants
Options for Increasing Markets for DDGS

- Value added components of DDGS
  
  **What are the possibilities?**
  
  - High insoluble fiber may improve gut health of pigs and poultry
  - May have advantages for improving on-farm food safety production procedures (e.g. Salmonella reduction)
  - Solubles may contain biologically active compounds that could provide growth and/or reproductive benefits

The Use of DDGS in Dairy Rations
**Nutritional Value of DDGS for Dairy Cows**

- Excellent protein source (28% crude protein)
- High in by-pass protein
- High in NDF (44%)
- Very palatable – increases dry matter intake
- Effective partial replacement for corn and soybean meal

**Recommended Feeding Levels of DDGS for Dairy Cows and Replacements**

- Lactating dairy cows
  - Up to 30% DMI under normal feeding conditions
  - > 30% DMI if BST is used
- Calves
  - Up to 20 % DMI
- Replacement heifers
  - Up to 25% DMI
The Use of DDGS in Beef Rations

Nutritional Value of DDGS for Beef Cattle

- Excellent protein source (28% crude protein)
- High by-pass protein
- Excellent source of essential minerals (P and K)
- Improves rumen health
- Very palatable
- 1.8 times more value compared to soybean meal
Recommended Feeding Levels of DDGS for Beef Cattle

- Creep feeding
  - Up to 20%

- Feedlot cattle
  - Up to 40% DMI

- Receiving/starting cattle
  - Up to 20%

- Brood cows
  - Up to 35% of supplement

The Use of DDGS in Swine Diets
Nutritional Value of DDGS for Swine

- Must use high quality DDGS
  - Light color = high amino acid digestibility
- Excellent energy and available phosphorus source
- Nutritional value higher than previously thought
- May improve gut health (i.e. ileitis, gut edema)
  - Decreased mortality and improved growth performance
- Effective partial replacement for corn and soybean meal

Maximum Recommended Inclusion Rates of DDGS in Swine Diets

- Nursery pigs (>15 lbs)
  - Up to 25%
- Grow-finish pigs
  - Up to 20% (higher levels reduce pork fat quality)
- Gestating sows
  - Up to 40%
- Lactating sows
  - Up to 20%
The Use of DDGS in Poultry Diets

Nutritional Value of DDGS for Poultry

- Must use high quality DDGS
  - Light color = high amino acid digestibility
- Excellent energy and available phosphorus source
- Nutritional value higher than previously thought
- Unidentified growth factors?
  - 5% DDGS resulted in 17-32% improvement in gain
  - 3% DDGS in turkey breeder hen diets increased egg numbers and hatch
- Effective partial replacement for corn and soybean meal
**Recommended Maximum Inclusion Rates of DDGS in Turkey Diets**

- Turkey poults
  - Up to 2.5%
- Turkey grow-finish
  - Up to 12%

**Recommended Feeding Levels of DDGS for Broilers**

- Broiler chicks – up to 2.5%
- Broiler finisher – up to 5.0%
Recommended Maximum Inclusion Rates of DDGS in Layer Diets

- Layers – up to 15%
- Breeders – up to 20%
- Pullets – up to 5%

DDGS Quality is Highly Variable

- Nutritionists want PREDICTABILITY AND CONSISTENCY in feed ingredients.
- The keys for getting maximum value from DDGS are:
  “Know what you have (or want)”
  And
  “Know how to use it”
DDGS Quality is Highly Variable

- Color ranges from very light to very dark
- Odor ranges from sweet to smoky or burnt
- Range in concentration in selected nutrients:
  - Dry matter – 87 to 93%
  - Crude protein – 23 to 29%
  - Crude fat – 3 to 12%
  - Ash – 3 to 6%
  - Lysine – 0.59 to 0.89%

Source: Cromwell et al. (1993)

Growth of Chicks Fed Nine Sources of DDGS

![Bar chart showing growth of chicks fed different sources of DDGS. The x-axis represents DDGS sources (A to I), and the y-axis represents grams per day. The chart shows varying levels of growth for each source.](image-url)
Feed Conversion of Chicks Fed Nine Sources of DDGS

![Bar chart showing feed conversion of chicks fed nine sources of DDGS.]

Considerations for Selecting DDGS Sources for Swine and Poultry

- Must be golden color
  - higher amino acid digestibility
- Produced by new Midwestern plants
  - higher nutrient content and digestibility than DDGS from older plants
Quality Considerations for Selecting DDGS Sources for Swine and Poultry

- Nutrient Specifications
  - Moisture – maximum 12%
  - Protein – minimum 26.5%
  - Fat – minimum 10%
  - Fiber – maximum 7.5%
Quality Considerations for Selecting DDGS Sources for Swine and Poultry

- **Physical characteristics**
  - Bulk density – .44 to .48 kg/cubic meter
  - Particle size:
    - maximum coarse particles - 10% on 2000 screen
    - maximum fine particles - 15% on 600 screen & in pan
  - Smell – fresh, fermented
  - Color – goldenrod

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Nutrient Profile of Corn Distiller’s Dried Grains with Solubles

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>MW DDGS</th>
<th>Low Quality DDGS</th>
<th>NRC (1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>88.9</td>
<td>88.3</td>
<td>93.0</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>30.2</td>
<td>28.1</td>
<td>29.8</td>
</tr>
<tr>
<td>Fat, %</td>
<td>10.9</td>
<td>8.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Fiber, %</td>
<td>8.8</td>
<td>7.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.06</td>
<td>0.44</td>
<td>0.22</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.89</td>
<td>0.90</td>
<td>0.83</td>
</tr>
<tr>
<td>P availability, %</td>
<td>90.0</td>
<td>?</td>
<td>79.0</td>
</tr>
<tr>
<td>DE, kcal/kg</td>
<td>3965</td>
<td>3874</td>
<td>3449</td>
</tr>
<tr>
<td>ME, kcal/kg</td>
<td>3592</td>
<td>3521</td>
<td>3038</td>
</tr>
<tr>
<td>Lys, %</td>
<td>0.83</td>
<td>0.53</td>
<td>0.67</td>
</tr>
<tr>
<td>App. Dig. Lys, %</td>
<td>0.44</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Met, %</td>
<td>0.55</td>
<td>0.50</td>
<td>0.54</td>
</tr>
<tr>
<td>App. Dig. Met, %</td>
<td>0.32</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Thr, %</td>
<td>1.13</td>
<td>0.98</td>
<td>1.01</td>
</tr>
<tr>
<td>App. Dig. Met, %</td>
<td>0.62</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Trp, %</td>
<td>0.24</td>
<td>0.19</td>
<td>0.27</td>
</tr>
<tr>
<td>App. Dig Trp, %</td>
<td>0.15</td>
<td>0.15</td>
<td></td>
</tr>
</tbody>
</table>
**Limitations of Using DDGS in Swine Diets**

- Must be golden color and highly digestible
- High fiber limits its use in starter diets
- Excess nitrogen can be minimized by using synthetic amino acids
- High oil content limits maximum inclusion rates in grow-finish diets due to pork fat quality

**Maximizing the Value of Corn DDGS in Swine Diets**

- Formulate diets using digestible amino acid values
- High available P reduces the level of dietary P supplementation
- Adding 5 to 10% DDGS to grow-finish diets appears to reduce mortality due to ileitis and gut edema
### Example Swine Grower Diet with Containing 20% DDGS

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
<th>Nutrient Composition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>60.05</td>
<td>Crude protein, %</td>
<td>19.07</td>
</tr>
<tr>
<td>DDGS</td>
<td>20.00</td>
<td>App. Dig. Lysine, %</td>
<td>0.74</td>
</tr>
<tr>
<td>Soybean meal, 46%</td>
<td>17.70</td>
<td>App. Dig. M + C, %</td>
<td>0.51</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.60</td>
<td>App. Dig. Thr., %</td>
<td>0.48</td>
</tr>
<tr>
<td>Limestone</td>
<td>1.05</td>
<td>App. Dig. Trp, %</td>
<td>0.15</td>
</tr>
<tr>
<td>Salt</td>
<td>0.30</td>
<td>ME, kcal/kg</td>
<td>3309</td>
</tr>
<tr>
<td>Vitamin-TM premix</td>
<td>0.15</td>
<td>Ca, %</td>
<td>0.60</td>
</tr>
<tr>
<td>L-lysine HCl</td>
<td>0.15</td>
<td>P, %</td>
<td>0.53</td>
</tr>
<tr>
<td>Phytase - 1000</td>
<td>0.05</td>
<td>Avail. P, %</td>
<td>0.30</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Example Swine Grower Diet with Containing 20% DDGS and 100 FTU/kg Phytase

<table>
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<th>Ingredient</th>
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<td>0.15</td>
<td>Ca, %</td>
<td>0.44</td>
</tr>
<tr>
<td>L-lysine HCl</td>
<td>0.15</td>
<td>P, %</td>
<td>0.43</td>
</tr>
<tr>
<td>Phytase - 1000</td>
<td>0.05</td>
<td>Avail. P, %</td>
<td>0.20</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Calculating the Value of DDGS in Swine Diets Using Soybean Meal 44%

Additions/1000 kg diet
+ 100 kg DDGS x cost/kg = $
+ 1.5 kg limestone x cost/kg = $
TOTAL ADDITIONS (A) = $

Subtractions/1000 kg diet
- 88.5 kg corn x cost/kg = $
- 10 kg SBM (44%) x cost/kg = $
- 3 kg dicalcium phosphate x cost/kg = $
TOTAL SUBTRACTIONS (S) = $

S - A = Opportunity cost for DDGS/100 kg

Calculating the Value of DDGS in Swine Diets Using Soybean Meal 46%

Additions/1000 kg diet
+ 100 kg DDGS x cost/kg = $
+ 1.5 kg limestone x cost/kg = $
TOTAL ADDITIONS (A) = $

Subtractions/1000 kg diet
- 89 kg corn x cost/kg = $
- 9.5 kg SBM (46%) x cost/kg = $
- 3 kg dicalcium phosphate x cost/kg = $
TOTAL SUBTRACTIONS (S) = $

S - A = Opportunity cost for DDGS/100 kg
We have developed a DDGS web site featuring:
* research summaries (swine, poultry, dairy, & beef)
* presentations given
* links to other DDGS related web sites

Visit this web site at:
www.ddgs.umn.edu