Pelleting and Distiller’s Dried Grains with Solubles

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North Dakota State University
Practical issues with DDGS Used in Feed Manufacturing

- **Product is Inconsistent – Unpredictable**
  - Nutrient content
    - Protein, Fat, Fiber, Moisture, etc.
  - Nutrient digestibility
    - esp. for lysine
  - Physical Characteristics
    - Bulk density, Particle size, Angle of Repose
- **Logistics**
  - producers, brokers/consolidators, shippers
- **Handling**
  - Flowability
- **Availability**
  - Price
## DDGS Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Bulk Density, kg/hl</th>
<th>Particle Size, microns</th>
<th>Protein, %</th>
<th>Fat, %</th>
<th>Fiber, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knott, Shurson, Goihl</strong></td>
<td>Avg. 45.9 Range 39.6 – 50.6</td>
<td>Avg. 1282 Range 612 – 2125</td>
<td>Avg. 26.6 Range 24.5 – 28.4</td>
<td>Avg. 10.0 Range 9.2 – 11.6</td>
<td>Avg. 6.9 Range 5.8 – 9.1</td>
</tr>
<tr>
<td><strong>Koch</strong></td>
<td>Avg. 48.4 Range 45.4 – 51.3</td>
<td>Avg. 588 Range 387 – 810</td>
<td>Avg. 27.6 Range 26.3 – 29.9</td>
<td>Avg. 9.2 Range 8.1 – 10.2</td>
<td>Avg. 10.0 Range 5.5 – 16.0</td>
</tr>
</tbody>
</table>
Decreased pellet quality?

- Depends on physical and nutrient characteristics of DDGS
  - Particle size, density
  - Fat, fiber, protein, moisture
- Depends on ingredients
  - Some are complementary
- Depends on pellet mill operation
  - Die specifications
    - Performance ratio
  - Die speed
  - Conditioning time and temp
DDGS and Pellet Production

- Pellet trials
  - Pellet die specifications
    - .25 inch hole (6.4 mm)
    - 10:1 performance ratio
  - Pellet die peripheral speed
    - 1,200 ft/min. (365.8 m/min.)
  - Conditioning chamber
    - 150 rpm
    - Retention time = 30 sec.
  - Feed rate
    - Constant
      - Same setting all trials
## Pellet Production

### Durum wheat midds + DDGS (Koch)

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>80/20</th>
<th>70/30/</th>
<th>60/40</th>
<th>50/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts</td>
<td>458.7</td>
<td>456.7</td>
<td>456.0</td>
<td>451.3</td>
<td>452.8</td>
</tr>
<tr>
<td>Amps</td>
<td>24.2</td>
<td>28.8</td>
<td>28.5</td>
<td>34.5</td>
<td>32.7</td>
</tr>
<tr>
<td>Kw</td>
<td>17.3</td>
<td>21.0</td>
<td>20.6</td>
<td>25.2</td>
<td>24.4</td>
</tr>
<tr>
<td>P.F.</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>mt/hr</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>23.8</td>
<td>26.0</td>
<td>23.9</td>
<td>27.3</td>
<td>27.5</td>
</tr>
<tr>
<td>PDI %</td>
<td>96.1</td>
<td>96.3</td>
<td>94.4</td>
<td>95.3</td>
<td>93.3</td>
</tr>
<tr>
<td>kg/hl</td>
<td>66.6</td>
<td>63.1</td>
<td>63.3</td>
<td>63.6</td>
<td>60.0</td>
</tr>
<tr>
<td>C°</td>
<td>57</td>
<td>72-75</td>
<td>68-70</td>
<td>48-50</td>
<td>53</td>
</tr>
</tbody>
</table>
DDGS and Pellet Production

Koch

- Durum wheat midds and DDGS
  - Increasing DDGS from 0 – 50%
    - A 35% increase in amperage
    - A 41% increase in kilowatts
    - A 15.5% increase in kwh/mt
    - A 3% decrease in pellet quality measured as Pellet Durability Index (PDI)
    - An 11% decrease in pellet bulk density
  - Increased energy use
    - Added $0.11/mt to production costs
  - Decreased pellet quality may cause:
    - reduced feed efficiencies
    - Increased transportation costs
## Pellet Production

### Durum wheat midds + DDGS + Peas

(Koch)

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>60/20/20</th>
<th>60/40</th>
<th>50/30/20</th>
<th>50/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts</td>
<td>458.7</td>
<td>448.1</td>
<td>456</td>
<td>451.3</td>
<td>452.8</td>
</tr>
<tr>
<td>Amps</td>
<td>24.2</td>
<td>33.9</td>
<td>28.5</td>
<td>34.5</td>
<td>32.7</td>
</tr>
<tr>
<td>Kw</td>
<td>17.3</td>
<td>24.5</td>
<td>20.6</td>
<td>25.2</td>
<td>24.4</td>
</tr>
<tr>
<td>P.F.</td>
<td>.9</td>
<td>.92</td>
<td>.92</td>
<td>.92</td>
<td>.93</td>
</tr>
<tr>
<td>mt/hr</td>
<td>.7</td>
<td>.9</td>
<td>.8</td>
<td>.9</td>
<td>.8</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>23.8</td>
<td>26.9</td>
<td>23.9</td>
<td>27.3</td>
<td>27.5</td>
</tr>
<tr>
<td>PDI %</td>
<td>96.1</td>
<td>96.6</td>
<td>94.4</td>
<td>95.3</td>
<td>93.3</td>
</tr>
<tr>
<td>kg/hl</td>
<td>66.6</td>
<td>67.6</td>
<td>63.3</td>
<td>63.6</td>
<td>60</td>
</tr>
<tr>
<td>C°</td>
<td>57</td>
<td>48 - 50</td>
<td>68-70</td>
<td>48 - 50</td>
<td>53</td>
</tr>
</tbody>
</table>
Durum wheat midds, DDGS and dry peas

- midds at 60%, DDGS at 20%, peas at 20%,
  - Compared to 100% midds
    - 40% increase in amps
    - 42% increase in kw
    - 13% increase in kwh/mt
    - 0.5% increase in PDI
  - Compared to 60% midds, 40% DDGS
    - 21% increase in amps
    - 18% increase in kw
    - 7.6% increase in kwh/mt
    - 2% increase in PDI
DDGS and Pellet Production

Koch

- Durum wheat midds, DDGS and dry peas
  - midds at 50%, DDGS at 30%, peas at 20%,
    - Compared to 100% midds
      - 43% increase in amps
      - 46% increase in kw
      - 15% increase in kwh/mt
      - 0.8% decrease in PDI
    - Compared to 50% midds, 50%DDGS
      - 6% increase in amps
      - 3% increase in kw
      - 2% increase in PDI
      - 1% decrease in kwh/mt
## Pellet Production
### Barley malt sprouts and DDGS (Koch)

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>90/10</th>
<th>80/20</th>
<th>70/30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts</td>
<td>447.3</td>
<td>451.4</td>
<td>449.6</td>
<td>454.4</td>
</tr>
<tr>
<td>Amps</td>
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<td>43</td>
<td>35.2</td>
<td>28.3</td>
</tr>
<tr>
<td>Kw</td>
<td>34.8</td>
<td>32.1</td>
<td>26.9</td>
<td>21</td>
</tr>
<tr>
<td>P.F.</td>
<td>0.93</td>
<td>0.93</td>
<td>0.95</td>
<td>0.93</td>
</tr>
<tr>
<td>mt/hr</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>46.1</td>
<td>41.4</td>
<td>33.4</td>
<td>24.6</td>
</tr>
<tr>
<td>PDI %</td>
<td>95.9</td>
<td>97.1</td>
<td>96.1</td>
<td>92.5</td>
</tr>
<tr>
<td>kg/hl</td>
<td>63.5</td>
<td>60.2</td>
<td>59.3</td>
<td>57.6</td>
</tr>
<tr>
<td>C°</td>
<td>43</td>
<td>48</td>
<td>52</td>
<td>52</td>
</tr>
</tbody>
</table>
DDGS and Pellet Production

- Koch
  - Barley malt sprouts and DDGS
    - Increasing DDGS from 0 – 30%
      - A 40% decrease in amperage
      - A 40% decrease in kilowatts
      - A 47% decrease in kwh/mt
      - A 3% decrease in pellet quality measured as Pellet Durability Index (PDI)
      - A 10% decrease in pellet bulk density
    - Decreased energy use
      - saved $0.65/mt in production costs
    - Decreased pellet quality may cause
      - reduced feed efficiencies
      - Increased transportation costs
## Pellet Production

Typical swine grower diet (Koch)

<table>
<thead>
<tr>
<th></th>
<th>Swine grower</th>
<th>substitute 10% DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts</td>
<td>467.6</td>
<td>459.1</td>
</tr>
<tr>
<td>Amps</td>
<td>42.1</td>
<td>41.6</td>
</tr>
<tr>
<td>Kw</td>
<td>31.3</td>
<td>32.1</td>
</tr>
<tr>
<td>P.F.</td>
<td>.9</td>
<td>.9</td>
</tr>
<tr>
<td>mt/hr</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>10.2</td>
<td>9.5</td>
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<tr>
<td>PDI %</td>
<td>84.7</td>
<td>70</td>
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<tr>
<td>C°</td>
<td>77</td>
<td>76</td>
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</table>
DDGS and Pellet Production

Koch

- Comparing a typical swine grower to the same diet with 10% substituted DDGS
  - Substituting 10% DDGS
    - A 1% decrease in amperage
    - A 2% increase in kilowatts
    - A 7% decrease in kwh/mt
    - A 7% increase in production rate (mt/hr)
    - A 17% decrease in pellet quality measured as Pellet Durability Index (PDI)
  - Decreased energy use
    - saved $0.02/mt in production costs
  - Decreased pellet quality may cause
    - reduced feed efficiencies