Distillers Grains: Value-Added Opportunities

Kurt A. Rosentrater, Ph.D.
Distillers Grains Technology Council
Iowa State University
Ames, IA USA
OVERVIEW

1. Distillers Grains Technology Council
2. Motivations
3. Key Issues & Challenges
4. Evolving Processes & New Opportunities
5. Other Issues
DISTILLERS GRAINS TECHNOLOGY COUNCIL
DISTILLERS GRAINS TECHNOLOGY COUNCIL

• Late 1800s
  – Distillers coproducts increasingly used in animal feeds (not rivers anymore…especially Kentucky)

• 1913
  – First AAFCO definition for DDGS
  – Exports to Europe occurring

• 1945
  – Seagram’s Distillers Corporation hosted a meeting of industry, university and government attendees to discuss feed uses of distillery coproducts
  – Distillers Feed Research Council founded
    • Cincinnati, OH
    • Feeding trials, research, annual symposium
DISTILLERS GRAINS IN ANIMAL FEEDS

• "Grain distillers have developed equipment and an attractive market for their recovered grains" (Boruff, 1947)
• "Distillers are recovering, drying, and marketing their destarched grain stillage as distillers dried grains and dried solubles" (Boruff, 1952)
Distillers Feed Research Council Meeting,
March 15, 1951, Cincinnati, OH

Distillers Feed Research Council Meeting,
January 24, 1950, Cincinnati, OH
WHAT DO WE DO?

• Our Mission
  The goals of our organization encompass a broad interest in current issues affecting the beverage, fuel, and livestock industries

• Service Support
  To provide educational and technical services to member producers and users of distillers grains

• Advocacy
  To be the principle voice on nutrition, safety, and regulatory issues affecting distillers grains

• Market Development
  To encourage, administer, and support research and promotion into new and existing market opportunities for distillers grains, and advancing the awareness of coproduct value
19th Annual Distillers Grains Symposium

Researching and promoting the value of distillers grains for the fuel and beverage alcohol industries since 1945

May 13-14, 2015
Sheraton Crown Center
Kansas City, Missouri
MOTIVATIONS
MOTIVATIONS

• Ruminants or monogastrics

O₂ → Feed → Water → Animal → Methane → CO₂ → Water vapor → Methane → Feces → Urine
MOTIVATIONS

Alcohol

Non-fermentable components
DDGS IN THE MARKETS

• As alcohol industry goes, so goes the supply of coproducts
• Balance = key to sustainability
KEY ISSUES & CHALLENGES
ISSUES AND CHALLENGES

• “Mountains of distillers grains”
• Optimizing livestock feed
  – Current generation products
  – Next generation products
  – Processed feeds
  – New species
• Transportation & logistics
  – Domestic
  – International
• Optimizing quality w/ alcohol
  – Mycotoxin contamination
  – Sulfur / phosphorus levels
  – Energy consumption / cost
  – FDA

PROPERTIES & QUALITY = KEY
ISSUES AND CHALLENGES

• Variability negatively impacts sales of DDGS
  – Livestock producers need consistent feed products
  – Inconsistent quality – not good for animals!

• Nutrient content & quality
  – Digestibility
  – Heat damage
  – Residual starches and sugars

• Physical properties
  – Particle size, flowability
EVOLVING PROCESSES & NEW OPPORTUNITIES
FRACTIONATION

What else besides livestock feed?

Biofuel Coproducts → Component Fractionation

Proteins

Fibers

Oils
FRACTIONATION

- Human Foods
- Pet Foods
- Aquafeeds
- Nutraceuticals

Component Fractionation

- Proteins
- Fibers

- Biofuel Coproducts
- Oils

- Livestock Feed
- Biodiesel
- Industrial Products

- Energy
- Bioplastics
- Cellulosic Ethanol
Evolving Coproducts

Source: Dairy One, 2015
Evolving Coproducts

Source: Dairy One, 2015
EVOLVING PROCESSES

• Fractionation (pre- vs. post-fermentation)

• Wet vs. dry coproducts
  – DWGS vs. DDGS

• Reduced coproduct options
## EVOLVING COPRODUCTS

<table>
<thead>
<tr>
<th>Co-products and Products</th>
<th>Dec 2014</th>
<th>Jan 2014</th>
<th>Feb 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry Mill</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condensed distillers solubles (CDS-syrup)</td>
<td>172,082</td>
<td>162,626</td>
<td>128,057</td>
</tr>
<tr>
<td>Corn oil</td>
<td>97,380</td>
<td>105,356</td>
<td>96,347</td>
</tr>
<tr>
<td>Distillers dried grains (DDG)</td>
<td>448,551</td>
<td>438,936</td>
<td>405,025</td>
</tr>
<tr>
<td>Distillers dried grains with solubles (DDGS)</td>
<td>1,919,823</td>
<td>1,862,550</td>
<td>1,649,534</td>
</tr>
<tr>
<td>Modified distillers wet grains (DWG) &lt;65% moisture</td>
<td>1,411,411</td>
<td>1,341,938</td>
<td>1,144,177</td>
</tr>
<tr>
<td>Modified distillers wet grains (DWG) 40-64% moisture</td>
<td>503,258</td>
<td>480,134</td>
<td>421,666</td>
</tr>
<tr>
<td><strong>Wet Mill</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn germ meal</td>
<td>75,031</td>
<td>71,492</td>
<td>48,546</td>
</tr>
<tr>
<td>Corn gluten feed</td>
<td>329,431</td>
<td>321,768</td>
<td>283,990</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>94,777</td>
<td>90,617</td>
<td>80,855</td>
</tr>
<tr>
<td>Corn oil</td>
<td>44,551</td>
<td>41,961</td>
<td>41,020</td>
</tr>
<tr>
<td>Wet corn gluten feed 40-60% moisture</td>
<td>338,077</td>
<td>313,400</td>
<td>274,763</td>
</tr>
</tbody>
</table>

NASS/USDA MONTHLY CO-PRODUCTS PRODUCTION
EVOLVING PROCESSES

- Oil extraction
  - New enzymes
  - New chemicals
  - New treatments
EVOLVING PROCESSES

• Oil extraction from CDS or stillage (40-60 cents/lb)
  – 10-12% down to 5-8% fat
  – Every 1% fat reduction = $3-$6/ton finisher diet increase
  – Jan. 2012: 47% of ethanol plants extracting oil
  – Aug. 2014: ~85%

Now:

1 bu corn =

2.8 gal alcohol
+ 18 lb CO₂
+ 16 lb DDGS
+ 1 lb oil
U.S. ETHANOL GROWTH

Growth of U.S. fuel ethanol industry

"10 million ton question"

Corn oil extraction

Ethanol Production
Coproduct Generation

Year

Fuel Ethanol (gal) x 10^6

Coproducts (t) x 10^6

Number of U.S. Plants
EVOLVING PROCESSES

- Fiber & protein separation
  - From the DDGS or DDG

**Coproducts Processing, Handling, & Storage**

- Backset (10–50% of total Thin Stillage)
- Thin Stillage (5–10% solids)
- Whole Stillage (5–15% solids)
- Syrup (CDS) 25–55% solids
- Heat Chemicals
- Concentrated Oil
- Lower Oil CDS
- Distillers Oil Feed Grade
- CDS Dried Solubles
- DWGS DDGS
- DWG DDG
- Storage Storage Storage Storage
## DDGS Fractionation

### a) Original DDGS; b) big DDGS; c) pan DDGS

<table>
<thead>
<tr>
<th>Property</th>
<th>Big</th>
<th>Original</th>
<th>Pan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St Dev</td>
<td>Mean</td>
</tr>
<tr>
<td>Protein</td>
<td>31.85 a</td>
<td>1.06</td>
<td>33.00 a</td>
</tr>
<tr>
<td>Lipid</td>
<td>8.65 a</td>
<td>0.07</td>
<td>7.95 b</td>
</tr>
<tr>
<td>Ash</td>
<td>4.70 a</td>
<td>0.01</td>
<td>4.70 a</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>54.80 a</td>
<td>1.13</td>
<td>54.35 a</td>
</tr>
<tr>
<td>ADF</td>
<td>11.60 a</td>
<td>0.71</td>
<td>12.40 b</td>
</tr>
<tr>
<td>NDF</td>
<td>34.55 a</td>
<td>0.49</td>
<td>37.80 b</td>
</tr>
<tr>
<td></td>
<td>37.25 b</td>
<td>0.21</td>
<td>50.75 b</td>
</tr>
<tr>
<td></td>
<td>5.00 b</td>
<td>0.01</td>
<td>11.45 a</td>
</tr>
</tbody>
</table>

### Diagram:

- **Sifter**
  - Large Size (>104 micron)
  - Medium Size (680 to 1,041 micron)
  - Small Size (470 to 680 micron)
  - Pan (< 470 micron)

- **Products**:
  - Fiber (Small)
  - Fiber (Medium)
  - Fiber (Large)

- **Output**:
  - 55.6 kg DDGS
  - 27 kg “Big” DDGS
  - 99.3 kg “Pan” DDGS

---

- **Images**:
  - a) Original DDGS
  - b) big DDGS
  - c) pan DDGS
DDGS FRACTIONATION

DDGS fiber

- Protein: 42% db
- Lipid: 1.7% db
- NDF: 52% db
- Ash: 4.0% db
Evolving Processes

- Fiber & protein separation
  - Upstream may be better
EVOLVING COPRODUCTS

• Using coproducts (wet or dry) to grow other organisms
  – Algae
  – Single-cell proteins
  – Fermentation of DDGS & soybean meal
  – Fungal cells for protein
AQUACULTURE

Nile Tilapia  Yellow Perch  Rainbow Trout
AQUACULTURE

• DDGS ~ 1/10 to 1/20 the price of fish meal
OTHER ISSUES
INCLUSION RATES

$\uparrow$

$\downarrow$

$\$
YEAST CELLS

How much protein addition?

• Bauerfeind et al. (1944)
  – $4 \times 10^9$ cells/g dried syrup (CDS)
  – ~20% of syrup

• Ingeldew (1999)
  – DDGS by mass: 3.9%
  – 5.3% of the DDGS protein

• Belyea et al. (2004)
  – 50% of the DDGS protein

• Han and Liu (2010)
  – 20% of the DDGS protein

Saccharomyces cerevisiae
YEAST CELLS
How much residual microbes?

- Yeast have pro-biotic effects in livestock diets
  - Spent grains are already inoculated
- But: spoilage organisms also present

A. Lactic-acid bacteria (*Pediococcus pentosaceus*)
B. Aerobic heterotrophs (*Micrococcus luteus*)
C. Yeasts and molds
“Feed is food”
AAFCO

• Already have definitions established for sales of distillers coproducts
Definition Number: T33.10  Name: ____ Distillers Oil, Feed Grade

Text/Description:

T33.10 ____ Distillers Oil, Feed Grade is obtained after the removal of ethyl alcohol by distillation from the yeast fermentation of a grain or a grain mixture and mechanical or solvent extraction of oil by methods employed in the ethanol production industry. It consists predominantly of glyceride esters of fatty acids and contains no additions of free fatty acids or other materials obtained from fats. It must contain, and be guaranteed for, not less than 85% total fatty acids, not more than 2.5% unsaponifiable matter, and not more than 1% insoluble impurities. Maximum free fatty acids and moisture must be guaranteed. If an antioxidant(s) is used, the common or usual name must be indicated, followed by the words “used as a preservative”. If the product bears a name descriptive of its kind or origin, i.e. “corn, sorghum, barley, rye”, it must correspond thereto with the predominating grain declared as the first word in the name.
Human food processors
• Only CGMP to worry about is contamination when holding
• If further processing (drying)
  • Very small business < $2.5 million sales of animal food
  • 3 years to comply
FINAL THOUGHTS
THANK YOU

Questions?
Comments?

Kurt Rosentrater
Distillers Grains Technology Council
Iowa State University
(515) 294-4019
karosent@iastate.edu
www.distillersgrains.org