Feed Manufacturing with DDGS

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Values are Underestimated

Dry-Milling Average Yield Per Bushel of Corn

Ethanol 2.7 gal. (10.2 liters); CO₂ 18 lbs. (8.2 kg); DDGS 18 lbs. (8.2 kg)
• Every gallon of ethanol produced = 6.67 lbs. (3.02 kg) of DDGS
• Current estimate is ?? million gallons = ???. mmt of DDGS

Source: H. D. Tilstra
What is DDGS?

- DDGS is a by-product of fuel ethanol production
  - Typically from a dry-grind facility
    - Whole kernel processing
- Nutrient content of DDGS depends on the grain source
  - Corn DDGS – Midwest US
  - Wheat DDGS – Canada
  - Sorghum (milo) DDGS – Great Plains US
  - Barley DDGS – Canada/US
- Other by-products
  - DDGS from beverage alcohol – whiskey distilleries (dry grind)
  - Corn gluten feed – high fructose corn syrup, starch (wet mill)
  - Corn gluten meal – high fructose corn syrup, starch (wet mill)
  - Brewer’s grains (wet/dry) – beer production (dry grind)
- Nutrient profile of by-products from dry-mill, wet-mill, and beverage alcohol production is different

from Shurson, 2006
Dry Milling Process

Corn → Ground Cooked → Liqui-faction → Distiller's Grains (DDG) → Separated Thin Stillage Condensed Solubles (CDS) → Distilled Ethanol

DDG + S (DDGS)

Source: H. D. Tilstra
Dry-Grind Ethanol By-Products used by Livestock (Poultry)

- Wet distiller’s grains
  - Fed primarily to beef, some dairy – Total Mixed Rations (TMRs)
- Dry distiller’s grains (DDG)
  - Fed to beef and dairy – concentrates
- Wet distiller’s grains with solubles (WDGS)
  - Fed to beef and dairy - TMRs
- Dried distiller’s grains with solubles (DDGS)
  - Fed to dairy, swine, poultry, some beef – concentrates, complete feeds
- Modified wet cake (blend of wet and dry distiller’s grains)
  - Fed primarily to beef, some dairy - TMRs
- Condensed distiller’s solubles (CDS)
  - Fed to beef and dairy – TMRs
  - Ontario, Canada – swine liquid feeding system

from Shurson, 2006
DDGS Physical Characteristics

Knott, Shurson and Goihl
- Bulk Density
  - Average = 45.9 kg/hl
  - Range 39.6 – 50.6 kg/hl
- Particle Size
  - Average = 1,282 microns
  - Range 612 – 2,125 microns

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- Bulk Density
  - Average = 48.4 kg/hl
  - Range 45.4 – 51.3 kg/hl
- Particle Size
  - Average = 588 microns
  - Range 387 – 810 microns
Angle of Repose

- Similar to Dehy Alfalfa, corn bran, dry malt
  - Range 40 - 80°
DDGS Nutrient Characteristics

- **Knott, Shurson and Goihl**
  - Protein
    - Average = 26.6
    - Range 24.54 – 28.4
  - Fat
    - Average = 10.0
    - Range 9.2 – 11.6
  - Fiber
    - Average = 6.9
    - Range 5.8 – 9.1

- **Koch**
  - Protein
    - Average = 27.6
    - Range 26.3 – 29.9
  - Fat
    - Average = 9.2
    - Range 8.1 – 10.2
  - Fiber
    - Average = 10.0
    - Range 5.5 – 16.0
DDGS - Handling

- DDGS sets up in rail cars, trucks, containers, barges, (ocean-going vessels ?)
  - DDGS will set up more than once
    - Will set up in silos and bins
- Currently no flow agents have been found that completely correct the flow/handling problems associated with DDGS
  - Some may reduce unloading time
    - from 10 hrs to 5 hrs
- Some reports that “New” generation products improve handling characteristics
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
    - Multiple producers, brokers/consolidators, shippers
  - Handling
    - Flowability – flat storage is recommended

- Availability
  - Price

- Mycotoxins

- High fiber limits its maximum inclusion level in poultry feed
DDGS and Pellet Production

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

- **Koch**
  - DDGS and Durum wheat midds
    - 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
DDGS and Pellet Production

Koch

- DDGS and barley malt sprouts
  - 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
DDGS and Pellet Production

- **Koch**
  - DDGS, Durum wheat midds and dry peas
    - DDGS at 20%, peas at 20%, midds at 60%
      - **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
Koch

- DDGS, Durum wheat midds and dry peas
  - DDGS at 30%, peas at 20%, midds at 50%
    - 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
**DDGS and High Shear Conditioning**

- Alteration of protein and fiber
  - Operate at greater temperature, pressure and moisture than pellet mills
    - Low bulk density materials (DDGS) do not absorb moisture readily in pellet mill conditioner
    - High natural protein materials (DDGS) becoming “gummy” when moisture addition exceeds 4% and plasticize at temperatures in excess of 63° C
Things to Remember

- DDGS is a by-product of fuel ethanol production
  - Typically corn – but can be from other cereals
- Physical characteristics of DDGS are dissimilar
  - Bulk density, particle size and angle of repose are not uniform
- Nutrient content of DDGS depends on the grain source
  - Changes nutrient value

- The above alter performance of pellet mills and other feed manufacturing equipment
Thank You
Die – Roller interaction

- Feed on the die face must be compressed and extruded through the die holes during successive rotations

  - Excess moisture (> 17%) in the feed will cause the roll to slip
    - Resist compression
  - Materials high in natural protein and low bulk density are difficult to pellet
    - DDGS become “gummy” with the addition of moisture > 4%
    - DDGS do not absorb steam well
In order to make pellets, all forces must be balanced.

- Moisture, fat, fiber, and protein play a crucial role in pellet production.
  - If the slip-resisting force is greater than the roll force, the material will not compress.
    - Caused by moisture, fat, and protein.
  - If the flow resisting force is greater than the roll force, the material will not extrude.
    - Caused by fiber and particle size.
Feed material is compressed into the die hole and extruded through the effective length.

- Factors that determine Pellet Quality
  - Performance ratio (d/L)
  - Compression ratio (D/d)