

Quality Evaluation Methods for DDGS

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I. Introduction

Distillers dried grains with solubles (DDGS) is not a new by-product to the feed industry. DDGS and brewer's grains have been used in the feed manufacturing process for many years. The recent expansion of the ethanol industry has produced a large supply of DDGS. The increase in the number of plants and differences in processing methods between plants has resulted in greater product variability. Variability in physical characteristics and nutrient content have created handling problems at feed mills and varying matrix values in least cost formulation. Differences in ethanol plant designs (old vs. new generation), processing methods, and storage capacity are the primary drivers of DDGS variability. Researchers have evaluated inclusion levels, physical characteristics, and nutrient variation based on processing method and plant design. However, there are limited reports on how the physical characteristics of DDGS affect the feed manufacturing process. The reports that exist present a wide range of density, moisture, and angle of repose. In addition to the limited literature citations, there are few standard methods to evaluate the physical characteristics of DDGS and a technique to predict flowability at point of delivery. The lack of standard evaluation methods is a contributor to the variability reported by researchers and end-users between plants and within a plant. Transforming DDGS from a variable alternative by-product to a consistent commodity will require consistent processing parameters within a plant, implementation of standard operating procedures, and reliable methods for measuring the nutrient content and physical characteristics of DDGS. A prerequisite to designing new equipment and process methods for engineers and feed mill managers is a consistent and predictable product at time of delivery. Achieving this will require both analytical and physical measurements prior to loading that correlate to the flowability at time of delivery either by truck or rail. Currently nutritionists, purchasing agents, and feed mill managers must consider the added costs of logistics management, unloading time, demurrage, loss of animal performance due to formula changes, and nutrient variability when

developing an economic model to predict the value of DDGS. A feed mill's ability to handle significant quantities of DDGS will be dependent on an ethanol plant's capability to produce a consistent DDGS product with reasonable flowability.

II. Physical Quality Measurements

Bulk density, particle size, angle of repose, and coefficient of friction are used to predict the flow characteristics of an ingredient. Ingredient specifications usually include bulk density and particle size, but rarely address angle of repose, coefficient of friction, or flowability measurements. The challenge with including physical measurements on a specifications sheet is the lack of standardized methods in the industry. The feed industry has standard methods of analysis for particle size (ASAE S319) and pellet durability (ASAE 5269.3). Whereas bulk density is determined by a number of different methods ranging from the test weight method used for cereal grains to measuring the apparent bulk density with a 1 ft³ container. Table 1 illustrates the differences in loose density, vibrated density, and compacted density of corn and SBM.

Table 1. Density measurements

Material	Moisture %	Loose Density lbs/ft ³	Vibrated Density lbs/ft ³	Compacted Density lbs/ft ³
Whole Corn	12.70	49.45	52.75	53.34
Ground Corn	12.70	39.00	48.00	48.00
SBM	12.20	47.95	48.25	48.56

Fairchild (2005)

Angle of repose and coefficient of friction are determined by a diversity of methods; no standard exists in the industry or literature. Research needs to focus on developing repeatable methods that can be performed prior to loading and that will predict flowability during unloading. Ethanol plants and feed mills should clearly define physical testing methods on their ingredient specification sheet to avoid misconceptions on the quality of the product at time of receipt.

Another physical characteristic used to define DDGS quality in the swine and poultry industries is color. Spectrocolorimeters (Hunter or Minolta) are used in research studies to define color and quality, but very seldom are found in feed mill receiving operations. Research indicates a qualitative dark colored DDGS has less available amino acids as compared to a golden color.

III. Physical Characteristics and Properties Research

Knott et al. (2004) evaluated samples from 16 "new generation" plants located throughout the Midwest and found a wide variation in particle size and density (table 2). The researchers also observed more syrup balls were present in the plants that had a larger particle size. The range in both density (30.8-39.3 lbs/ft³) and particle size (612-2125 μ m) between plants indicates a lack of standard post-processing methods.

Table 2. Particle size and density of DDGS.

	Particle Size, dgw (μ m)	Density lbs/ft ²
Average	1282	36
Standard Deviation	305	2.79
Range	612 - 2125	30.8 – 39.3

Rosentrater (2006) evaluated bulk density and angle of repose of samples collected from six plants. The results of seventy-two samples had an average bulk density of 29.9 lbs/ft³, which ranged from 24.1 to 31.1 lbs/ft. The angle of repose for the samples averaged 31.5°, with a range from 26.5 to 34.2°. Johnston et al. (2007) evaluated the effect of flow agents and moisture on the drain angle of repose and flow rate of DDGS after the product had been transported and sat for 60 hrs. The results of the experiment indicate flow agents had no significant effect on flow rate or angle of repose. However, reducing moisture content (mc) from 11.6 to 9% increased flow rate (859 vs. 1368 lbs/min) and decreased drain angle of repose (67.6 vs. 64.6°). Based on the flow rates in this experiment, a 25 ton truck and 100 ton rail car at 11.6% mc would take an extra 20 and 85 minutes to unload respectively. The results of these experiments confirm the greatest challenges facing the end user are the variability in the physical characteristics of shipments. Purchasing from a single plant will reduce the variation; however soluble storage capacity at the ethanol plant, environmental conditions (temperature and humidity), and grinding parameters ultimately impact final product consistency.

IV. Pelleted DDGS

Rosentrauter (2007) conducted a laboratory and commercial pelleting study to evaluate the benefits of pelleted DDGS. The study showed that it was possible to pellet DDGS and there was an increase in density by 20 to 27%. He concluded that pelleted DDGS may be one solution for improving

storage, transportation, and flowability. Pelletizing DDGS may improve their handling characteristics during the receiving processes, but creates a new set of challenges for a feed mill in terms of storage and re-grinding DDGS prior to mixing. Grain storage bins and silos are not typically engineered for storing pelleted ingredients. Additionally, most feed mills are not set up to grind from ingredient storage bins located in the mill tower.

V. Analytical Methods

The American Feed Industry Association (AFIA), Renewable Fuels Association (RFA), and National Corn Growers Association (NCGA) funded a study to evaluate analytical methods (AFIA 2007). The study titled "Evaluation of Analytical Methods for Analysis of Dried Distillers Grains with Solubles" was a comparative study of different analytical methods used to determine the moisture, protein, fat, and fiber of DDGS. The report also recommended approved analytical methods for determining nutrient content of DDGS.

VI. References

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