Can Additives Improve Flowability of DDGS in Commercial Systems?

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The ethanol industry in the U.S. is expanding rapidly. Large quantities of Dried Distillers Grains with Solubles (DDGS) are available for feeding livestock domestically and internationally. DDGS has many positive attributes for the feeding of livestock. Unfortunately, DDGS can have some undesirable handling characteristics related to poor flowability under certain conditions. Reduced flowability and bridging of DDGS in bulk storage containers and transport vehicles limits the use of DDGS in feeding livestock. Livestock producers and feed mills do not want to deal with the inconvenience and expense of handling a feedstuff that does not flow through their feeding and milling systems. Consequently, some pork producers have used DDGS in the past but have discontinued their use of DDGS due to poor flowability.

Very few attempts to characterize factors affecting flowability of DDGS have been reported in controlled studies. The Agricultural Utilization Research Institute (AURI) and MN Corn Growers Assoc. reported that relative humidity greater than 60% seemed to reduce flowability of DDGS which was likely due to the product's ability to adsorb moisture. While moisture of the environment and moisture content of DDGS likely influence flowability, many other factors have been suggested as possible controllers of flowability such as: particle size, content of solubles, dryer temperature, moisture content at dryer exit, and others.

Interventions to improve flowability of DDGS have been limited to trial and error approaches within ethanol plants. These interventions relate to the completeness of fermentation, adjusting moisture content, and changing particle size but have not been reported in the public domain. Because moisture and relative humidity seem to play an important role in flowability of DDGS, some have suggested use of zeolites and/or grain conditioners as a way of controlling moisture migration through DDGS. However, no controlled studies of this concept have been reported.

Realizing the importance of handling challenges presented by DDGS and the lack of controlled studies under commercial conditions that evaluate solutions to these handling problems, we designed a study to determine if the addition of selected flowability agents is effective in improving flowability of DDGS under practical commercial conditions.

Procedures of the experiment

This experiment was conducted at a dry-grind ethanol plant (BushMills Ethanol Inc., Atwater, MN) constructed in 2005. Two sets of treatments (flowability agents and moisture levels) were imposed at the same time. We studied four flowability treatments. These treatments included: 1. Control (no treatment); 2. a grain conditioner, DMX-7 from Delst, Inc. purported to control moisture migration; 3. calcium carbonate included at 2% from ILC Resources, Inc; and 4. a clinoptilolite zeolite at 1.25% from St. Cloud Mining Co. in St. Cloud, New Mexico. The calcium carbonate and zeolite are very fine powders that work through different mechanisms to improve flow of other feedstuffs. These four flowability treatments were imposed on DDGS that contained 9 or 12%

moisture. The moisture treatments were selected to represent DDGS that was expected to flow readily (9%) and DDGS that was expected to present poor flowability (12%).

The ethanol plant produced DDGS containing 9% or 12% moisture and placed it in two separate stockpiles in their warehouse. About 5,000 lbs of DDGS was augered into a New Holland portable, on-farm grinder mixer bypassing the grinding hammers and the appropriate flowability agent was added. This mixer was equipped with a single vertical screw in the mixing hopper and an electronic scale for weighing contents of the mixer. Treated lots of DDGS were loaded into one of eight individual compartments in an auger-equipped feed truck. Weight of each lot at loading was recorded.

Once the truck was loaded on Friday afternoon, it traveled 150 miles and sat idle for about 60 hours over the weekend. On Monday morning, the truck traveled 150 miles back to the ethanol plant where it was unloaded back into the warehouse. Time required to unload each compartment was recorded and flow rate (pounds/minute) for DDGS in each compartment was calculated. The operator assigned a subjective flowability score (scale: 1 = free flowing; 10 = completely bridged) to each compartment based on the number of pokes, prods or blows to side of compartment required to unload the compartment. The same truck and operator were used on four different days to complete the experiment. This procedure was implemented to simulate the transport of DDGS that often occurs in the commercial feed industry. Bumps in the road and vibrations during travel along with cooling of the DDGS all increase the chance that the DDGS will bridge and not flow freely. We wanted to know if our treatments would be effective under commercial conditions.

Results of the experiment

Flow rate was clearly poorer for DDGS with 12% moisture compared with 9% DDGS (Figure 1). Similarly, the subjective flowability score was significantly higher for the wetter DDGS (Figure 2) which indicates it was more difficult for the operator to unload compartments containing DDGS with 12% moisture compared with those containing the dryer DDGS. Reduced flowability of 12% DDGS was confirmed by other laboratory measures of flowability. This result is consistent with our expectations before the start of the experiment. Most people that have used DDGS will agree with the observation that wetter DDGS does not flow as well as a dryer product. While this may seem intuitive, it is an important result. Ethanol plants would like to produce a wetter product if possible because it would require less time and expensive fuel to dry the product. However, the time and money saved in the drying process is quickly negated by the time and frustrations if the product does not flow freely through commercial feed systems.

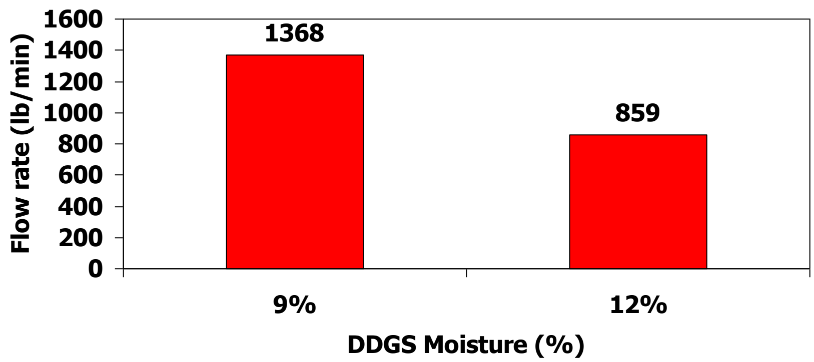

Figure 1. Effect of DDGS moisture content on flow rate of DDGS out of a feed truck

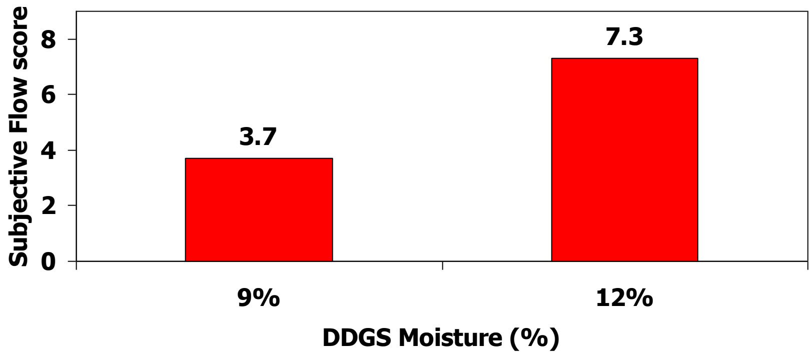

Figure 2. Effect of DDGS moisture content on subjective flow score of DDGS out of a feed truck

None of the flowability agents significantly altered the flow rate of DDGS compared to the control treatment which used no flowability agents (Figure 3). While there were numerical differences in flow rate for various treatments, our analysis of the data suggested that these differences were not consistent enough to expect them to occur routinely. The flow rate of DDGS treated with DMX-7 was significantly lower than that of Zeolite-treated DDGS but neither of these was different than using no additive (Control). Similar to the flow rate, subjective flow score was not consistently changed by the addition of the flowability agents we tested (Figure 4).

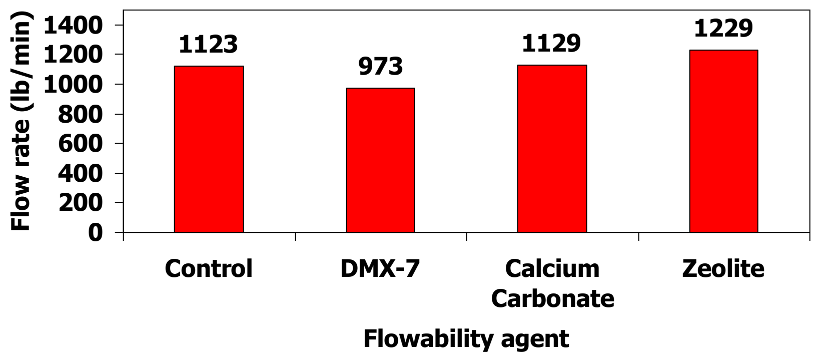

Figure 3. Effect of flowability agents on flow rate of DDGS

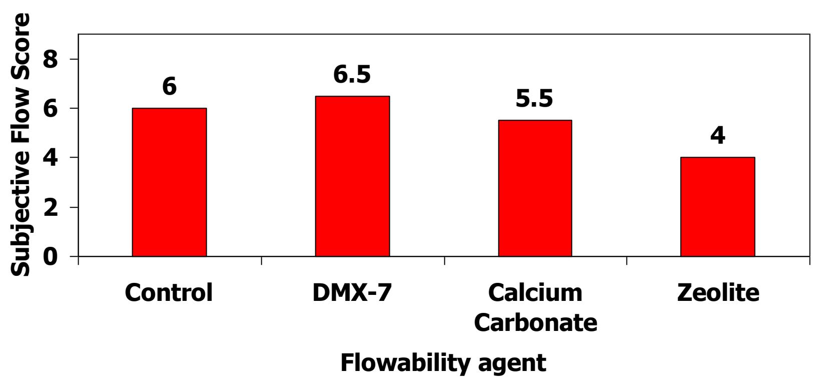

Figure 4. Effect of flowability agents on subjective flow score

This is our first attempt to use additives for improving flow rate of DDGS. Possibly, different inclusion rates of our flowability agents or different flowability agents need to be tested to determine usefulness of this concept. We are continuing this work in an attempt to understand what characteristics of DDGS will be predictive of flowability problems under commercial conditions.

Conclusions

Clearly, increasing moisture content of DDGS from 9 to about 12% significantly decreases flowability of DDGS. The flow agents and concentrations selected for this experiment provided little evidence for improved flowability of DDGS. An upcoming statistical analysis will attempt to describe characteristics of DDGS samples that are predictive of DDGS flowability.

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