Iowa Beef Center

ETHANOL COPRODUCTS FOR BEEF CATTLE

Second in a series of six ethanol coproducts publications from the Iowa Beef Center

The Changing Distillers Grains for Feedlot Cattle

Distillers coproducts have a long, and nearly as colorful, history as the distilling industry itself. The Bourbon Beef Association established the Bourbon Beef Show in Louisville, Kentucky, shortly after World War II to showcase prize beef animals raised on wet distillers grains. Prize money was sizable, even by today's standards. Iowa State College research in 1936-37 showed a $7.92 per head advantage to distillers grains fed cattle compared to soybean meal fed cattle (Distillers Feed Research Council, 1951). Today, distillers grains and solubles produced by the ethanol industry are among the most abundant feed coproducts available to beef cattle and have become standard components of beef diets. These products include dried, modified, and wet distillers grains, and corn condensed distillers solubles. However, with technology advancements such as oil and fiber extraction in ethanol production, the products are changing and will continue to change. This publication evaluates the effects of these changes on the nutritional value of distillers grains for feedlot cattle.

Dried Distillers Grains

Dried distillers grains and dried distillers grains with solubles were originally fed primarily as a "rumen bypass" or rumen undegradable protein source. This characteristic may be important for some production situations with cattle and lambs. For example, when soybean meal is fed, approximately 75% of the soy protein is degraded to ammonia in the rumen. This ammonia can be assimilated in bacterial protein by the rumen microorganisms and eventually used by the animal if sufficient energy is present. The remaining 25% of the soy protein is not degraded in the rumen and is directly available for absorption by the animal. In light calves and lambs where energy intake is insufficient in lactating dairy cows with greater protein demands, a higher bypass protein source may be beneficial. Studies estimate that protein distillers

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grains are about 50% degraded by the rumen microflora. Therefore, distillers grains allow a lower protein diet to meet animal requirements or more urea to be fed to lower ration costs, compared to soybean meal for ruminants. As the price of distillers grains is reduced, these grains often are fed as a corn or energy replacement in many diets.

Wet Distillers Grains

In the late 1970s and 1980s, several studies were conducted to evaluate the feeding value of wet distillers grains generated from farm scale stills. These studies generally concluded that wet distillers grains have a similar energy value to corn grain, but cattle performance may be limited by the ration's moisture, particularly at high levels. Distillers grains from these smaller stills were typically strained but not pressed; therefore, average moisture content was approximately 80%. In the early 1990s, University of Nebraska—Lincoln (UNL) researchers reported finishing trials with calves and yearlings that were conducted over a two-year period. They calculated that the wet distillers/thin stillage feed had 150%–180% of the energy value in corn for yearlings and 120%–130% of the energy value of corn for calves.

In 1996, Iowa State University (ISU) reported one of the first finishing cattle studies comparing the feeding value of wet distillers grains with solubles from a commercial ethanol plant to a traditional corn-based diet. Sixteen percent dried distillers grains with solubles and increasing levels of wet distillers grains with solubles up to 40% of the diet were compared to both a urea and soybean meal control. The calculated net energy value of wet and dried distillers grains with solubles were 150% and 92% of corn grain, respectively.

From the late 1990s through early 2010s, dozens of feeding trials on various aspects of wet distillers grains were conducted at ISU and UNL.

Modified Distillers Grains

As the ethanol industry expanded over the period of 2006 to 2012, several plants began producing modified distillers grains with solubles. Modified distillers grains are partially dried before solubles are added back to the product. Research during this time period focused on not only establishing the feeding value of wet and modified distillers grains, but also interactions with management practices. Management interactions evaluated included grain processing and limitations to feeding higher levels of distillers such as sulfur and fat levels contained in these feeds (Lundy and Loy, 2014: IBCR 200A).

Corn Condensed Distillers Solubles (CCDS)

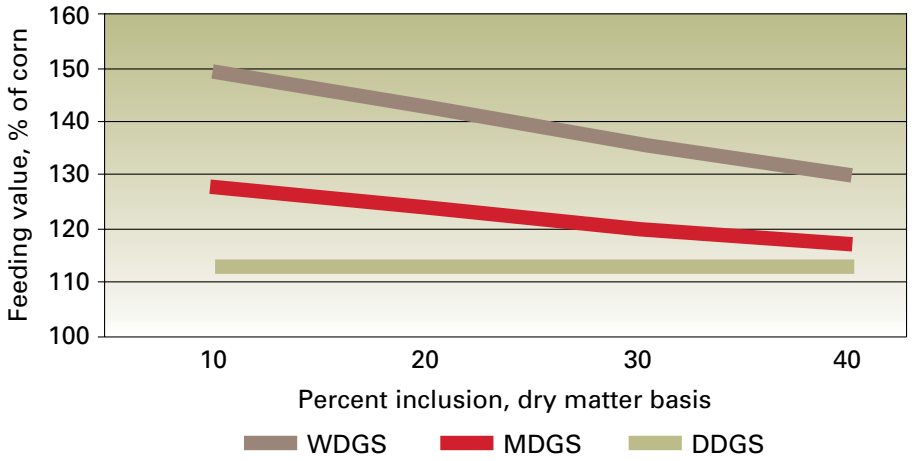
A 1997 ISU study of CCDS added at 6.5% of the ration dry matter showed improvement in average daily gain and feed conversion compared to urea or soybean meal supplemented heifers. The calculated energy value of the CCDS was 1.9 times the energy in corn. These data contrasts with a 1996 South Dakota State University study and a 2001 ISU study where intake and feed conversion responses were more variable.

More recent work at UNL (2012) found that adding varying levels of CCDS, from 9% to 36%, improved feed conversions more than 10% when substituting for corn in the ration. Results from feeding CCDS to feedlot cattle are more variable, probably due to higher and more variable levels of fat and sulfur, but researchers concluded that CCDS are higher in energy than distillers grains.

The Feeding Value of Distillers Grains

In 2011, Bremer and co-authors from UNL published a meta-analysis of feeding trials to date comparing the feeding value of wet, modified, and dried distillers grains with solubles as the rate of inclusion increased. This summary confirms that as the moisture increases, distillers grains have greater feeding value especially at lower levels of inclusion (Figure 1).

Figure 1. University of Nebraska–Lincoln meta-analysis of finishing steer performance when fed different levels of wet, modified, or dried distillers grains with solubles[1]



[1] Source: Bremer et al., (2011). Feeding value is calculated based on change in feed conversion per unit of substitution with corn

Changing Distillers Grains

Effect of Oil Removal

Expansion within the ethanol industry has led to a recent trend for ethanol plants to extract corn oil during production resulting in decreased oil (fat) content in distillers grains. This is accomplished primarily through two methods: pre-fermentation fractionation and partial oil removal from the condensed corn distillers solubles, both of which are described in further detail in IBCR 200A by Lundy and Loy, 2014. Oil extraction through these methods has become popular with an estimated 85% of ethanol plants adapting some form of the processes. However, due to the variation of oil extraction methods from plant to plant, the nutrient profile of the distillers grains can vary greatly and thus have varied effects on cattle performance.

Pre-fermentation fraction process separates the germ from the endosperm and bran of the corn kernel. Since the majority of the oil is concentrated in the germ, this process can result in significant oil reduction in the distillers grains and bran feeds. Previous research with pre-fermentation fractionation distillers grains resulted in no effect on average daily gain, feed efficiency, or carcass characteristics between cattle finished on the fractionated distillers grains compared to the traditional distillers grains. However, cattle fed the fractionated distillers grains have consistently demonstrated reduced dry matter intake.

A series of UNL trials with reduced fat distillers grains (produced via centrifugation of the solubles prior to being adding back to the distillers grains) has shown variable results in cattle performance ranging from no change in performance to a moderate depression in cattle performance between cattle fed de-oiled and normal fat distillers grains (Table 1). The variation in the results is believed to be dependent on the amount of oil reduction and the inclusion rate of distillers grains in the diet.

Because of the variation in results, it is difficult to quantify how removal of oil impacts cattle performance. In an effort to classify the effects of oil removal, we have compiled data from 13 paired comparisons (from 9 studies) of reduced fat to normal fat distillers grains (Table 1). Within each comparison, diets differed only by the oil content of the distillers grains. In summary, for each 1% change in oil content of distillers grain, the feeding value was changed by 1.64%.

For example, if comparing normal (11.5% fat) to reduced fat (7.6% fat) distillers grains, the reduced fat distillers grains are 3.9% lower in fat content. Therefore, the feeding value of the reduced fat distillers grains would be 6.4% lower compared to the traditional, normal fat distillers grains (3.9 × 1.64 = 6.40). Thus, it is expected that cattle fed the reduced distillers grains would experience a slight decrease in performance.

Table 1. Effects of oil removal on distillers grains coproduct feeding value[1]

	Oil content of treatment comparisons, %	Level(s) of inclusion, %	Change in feeding value per unit of oil content	Reference
WDG[2]	6.7 vs 12.9 7.9 vs 11.3 7.9 vs 12.4	35 26 35 – 65	4.27 4.53 1.13	Gigax et al., 2011 Bremer et al., 2014a Jolly et al., 2014
MDG[3]	9.2 vs 11.8 7.2 vs 12.0	40 15 – 30	0.34 3.27	Jolly et al., 2013 Bremer et al., 2014b
DDG[4]	4.0 vs 12.0 5.1 vs 10.9 5.5 vs 13.0	13 35 19	1.45 -0.19 -0.84	Depenbusch et al., 2008 Kelzer et al., 2011 Anderson et al., 2014
CCDS[5]	6.0 vs 21.1	27	0.76	Jolly et al., 2013
Average[6]			**1.64%**	

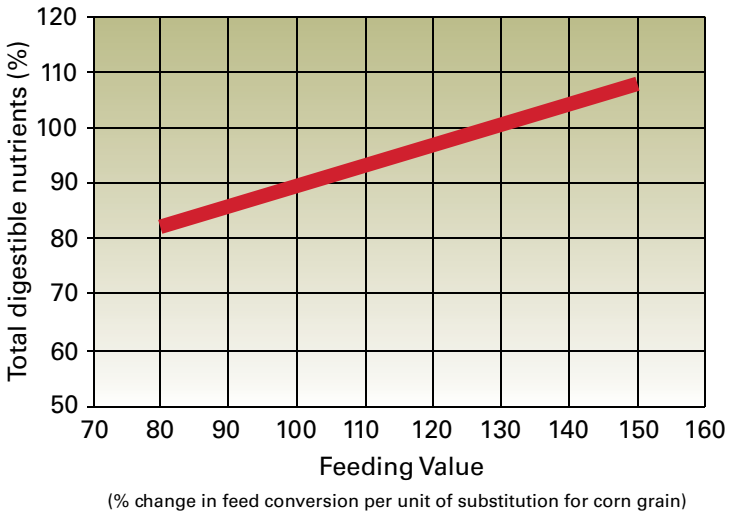
[1] Feeding value calculated based on change in feed conversion per unit of substitution for corn
[2] Wet distillers grains
[3] Modified distillers grains
[4] Dried distillers grains
[5] Corn condensed distillers solubles
[6] Average change in feeding value per unit of oil content of distillers grains from 9 summaries with 13 comparisons

Feeding Value and Net Energy of Distillers Grains

The data summarized in Figure 1 establish the relative differences between the common distillers grains products that are widely available in the upper Midwest. However, given the effect of changes in oil content on feeding value and the variation that exists in products currently being produced by the ethanol industry, the average adjustment summarized in Table 1 (1.64% reduction in feeding value per each percentage reduction in oil content of the distillers product on a dry matter basis) can be a useful factor to adjust energy values. One important consideration is that feeding value as defined here is not directly equivalent to energy value of the feedstuff. Figure 2 demonstrates the actual relationship.

Figure 2 was developed by substituting distillers grains of differing energy value for corn grain into typical Iowa finishing rations and evaluating the resultant change in feed conversion, and therefore, feeding value. Outputs were generated using the ISU Beef Ration and Nutrition Decision Software (BRaNDS) utilizing the 2000 Beef NRC model. Basically, the change in feeding value overestimates the energy value necessary to create the same difference in feed conversion.

Figure 2. Relationship between feeding value and energy value (expressed as TDN)



For example, if traditional, normal-fat wet distillers grains (11.5% fat) are 130% of the feeding value of corn at the highest inclusion (40%, Figure 1), Figure 2 would estimate a percent total digestible nutrients (TDN) of 100%. If reduced oil distillers grains are 7.8% oil (3.7% less fat than traditional wet distillers grains), then the reduced feeding value would be (3.7 × 1.64 = 6.1) 6.1% lower compared to the traditional, normal fat wet distillers grains. However, based on the relationship established in Figure 2 between feeding value and energy value, the TDN percentage of the reduced oil distillers grains would be estimated at 96.7%. This methodology is used in the first fact sheet of this series (Lundy and Loy, 2014: IBCR 200A) to estimate energy values of several classes of distillers coproducts based on moisture and fat level.

Changing Distillers Grains

Pre-fermentation Fractionation

As mentioned, pre-fermentation fractionation distillers grains (typically known as high protein dried distillers grains) have been shown to have minimal effects on cattle performance compared to cattle fed the traditional distillers grains. The fractionation process also results in a lower protein, high fiber feedstuff from the bran component of the corn kernel. This feed when mixed

with CCDS has been previously evaluated in feeding trials. In these studies, the bran feed improved cattle performance when substituting for up to 45% of the diet. The researchers estimated that this bran feed maintains 100%–108% of the energy value of corn.

Cellulosic Ethanol Processes

Even though pre-fermentation fractionation and partial oil-removal from the solubles have been successful methods of oil extraction, the ethanol industry continues to look for for ways to extract more value from the corn kernel. Recent advancements in technology have allowed ethanol plants to accomplish this by fiber extraction due to conversion of the corn kernel fiber into cellulosic ethanol. One of the first fiber extraction processes (known as Cellerate™) developed includes a pretreatment with cellulosic enzymes, yeast, and heat and results in a novel wet distillers grains.

The first distillers grains produced from fiber extraction processes were evaluated in 2014 at ISU to aid in determining the feeding value of wet distillers grains from a secondary fermentation process (cellulosic ethanol wet distillers grains) in finishing cattle diets compared to traditional wet distillers grains. Regardless of whether steers were fed cellulosic or traditional wet distiller grains, results showed the cattle had similar average daily gain, final body weights, and carcass characteristics. However, the steers that were finished on cellulosic ethanol wet distillers grains were less feed efficient due to increased dry matter intakes compared to the cattle fed traditional wet distillers grains. Based on this initial study, the authors estimate that distillers grains produced from this process maintains 109%–113% of the energy value of corn (additional information on this trial can be found in the November 2014 Iowa Beef Center Newsletter: www.iowabeefcenter.org/growingbeef.html).

The Future

As the ethanol industry continues to expand across Iowa and the Midwest and plants continue to look for additional ways to extract more value from corn, the supply of corn coproducts will most likely become abundant but also more variable, especially between plants and regions. Coproducts have proven to be a source of high quality energy, protein, and various minerals; however, the composition of distillers grains is changing and is expected to continue to change. Additional management practices such as routine feed analysis and communication between producers, nutritionists, and coproduct suppliers will be key. Proper ration formulation, economic analysis, and feeding management are important in developing the most cost-competitive and profitable feeding systems using coproducts in finishing diets.

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