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Value of Distiller's Grains as a Feed for Sheep

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The rapid rise in the number of processing plants that utilize corn to produce ethanol has increased the availability of co-product feeds. Feedstuffs produced from the ethanol industry have now become mainstream commodities, particularly in the beef industry. For various reasons, however, the sheep industry has been slower to incorporate these feedstuffs. One reason is that information on feeding ethanol co-products to sheep is less available in both research results and educational publications. Sheep producers also tend to have fewer animal units, thus bulk commodity use is less common than in the beef and dairy industries.

Typical dietary inclusion levels of dried distiller's grains with solubles (DDGS) on a dry matter basis in feed for livestock species other than sheep has been approximately 20% for beef and dairy cattle, 10% for swine, and 5% for poultry (Lemenager et al, 2006). However, because use of DDGS is not widespread in the sheep industry when compared to other livestock industries, sheep producers seem to be less sure about levels of DDGS to feed. This publication will offer some insight into how to incorporate DDGS into common sheep feeding programs.

Distiller's Grains and Other Types of Co-products

Ethanol can be produced through methods of wet milling or dry grind processing. Corn is the grain used predominantly in the United States for ethanol production, although other cereal grains such as sorghum, wheat, or barley can also be used to produce ethanol. Dry-grind processing is the primary method used for ethanol production in newer ethanol plants. Dry-grind processing of corn to ethanol is a multi-step process described in detail in Purdue University Extension Publication ID-328, *How Fuel Ethanol Is Made from Corn* (Mosier and Ileleji, 2006).

The process of dry milling creates dried distiller's grains with solubles, as well as several other types of corn co-products, including condensed distillers solubles (CDS) and dried distiller's grains (DDG). Below are descriptions of some major co-products.

Dried distiller's grains with solubles (DDGS) is a co-product of ethanol production formed when wet distiller's grains are combined with condensed distiller's solubles (CDS), and the resulting mixture is dried. In the Midwest, DDGS is the co-product of most interest to sheep producers, because they have the greatest potential for application as a feedstuff. Because DDGS is a dried product, it can be stored longer than wet distiller's grains, and has more practical implications for small- to medium-sized sheep producers.

Condensed distiller's solubles (CDS), also known as syrup, is the liquid remaining after solubles undergo evaporation. Condensed distiller's solubles is primarily comprised of fat, and, therefore, is a rich source of energy. However, CDS is low in fermentable carbohydrates (fiber), and much higher in minerals, including phosphorus, potassium, and sulfur. The CDS can be used as a liquid feed supplement, or added back to distiller's grains. As more CDS is added back to distiller's grains, the fat and mineral content of the co-product increases, but the crude protein of the final co-product decreases due to a dilution effect of syrup on the grains.

Dried distiller's grains (DDG) is formed when wet distiller's grains are dried, and solubles are not added back. As described earlier, DDGS is formed when wet distiller's grains are combined with CDS, and the mixture is dried.

Methods of wet milling involve steeping the raw corn to moisten and soften kernels, followed by milling and

separating the kernel components by filtering and centrifuging. The primary end products of wet milling are industrial cornstarch and ethanol, with feed co-products of corn gluten feed (CGF) and corn gluten meal (CGM).

Corn gluten feed (CGF) is made up of the portion of the corn kernel remaining after the starch, gluten, and germ have been removed. This co-product contains mainly rumen-degradable protein (RDP), and is a good source of highly digestible fiber. Caution should be used when formulating diets containing CGF as it contains high levels of phosphorus (often greater than 1%).

Corn gluten meal (CGM) is comprised of the gluten protein from starch after the germ and fiber have been removed. This co-product contains high levels of rumen-undegradable protein but is low in fiber. For this reason, CGM is included in ruminant diets as primarily a crude protein source. It is important to note that mineral concentrations, especially sulfur, may be high in CGM.

Feed Value of DDGS in Sheep Diets

Although DDGS can serve as an energy source in sheep diets, it is primarily classified as a protein feed. Dietary inclusions of 20% to 25% can often meet the crude protein requirements of finishing lambs and ewes in lactation. Actual inclusion rates depend on crude protein content of other dietary ingredients and specific animal needs. The DDGS is also a good source of ruminally undegradable intake protein (RUP, which is sometimes referred to as by-pass protein).

The DDGS is also a high-energy feedstuff. Distiller's grains generally contains 10% to 15% more energy than corn grain (Hippen et al, 2008). This is due to the high fat content of DDGS. Most of the starch from the original corn is removed during the fermentation process. Carbohydrates remaining are mostly structural in nature and are reflected in the NDF content. The fiber fraction is highly digestible. Replacing a portion of the corn in a traditional diet with DDGS shifts the ingested energy source from starch to digestible fiber and fat. The inclusion of DDGS in the diet could result in reduced potential for rumen acidosis compared to grain-based diets, as the lower starch content does not dramatically alter the rumen pH immediately after feeding.

The DDGS can be included in the diet as either a protein source or an energy source, depending on the animal nutrient requirements, type of diet being fed, and economic considerations. The DDGS can be used in a total mixed ration, as a portion of the grain mix, or as a supplement to marginal quality forage. The DDGS can be used as a dietary ingredient for most classes of sheep.

Whether DDGS is included in a diet depends in large part on its availability and cost relative to other feedstuffs. Including DDGS in the diets of finishing lambs and ewes tends to be more economical for producers. The cost of DDGS generally fluctuates with the price of corn, but considering the density of crude protein found in DDGS, it is generally a practical, cost-effective protein source, which is usually beneficial because protein is the most expensive fraction of the diet.

When used as a feedstuff for growing/finishing lambs, DDGS can be fed at a level of 25% to 50% of the diet dry matter (see upcoming sections on precautions and research results). At these levels of dietary inclusion, DDGS is used as both an energy and protein source. With ewes, DDGS can be used as a crude protein supplement to low-quality forage, most likely during mid-gestation or when ewes aren't pregnant. Levels of 0.5% to 1.0% of body weight daily of DDGS can be fed to ewes consuming low quality forages. During late gestation and lactation, DDGS can be used as a source of protein or energy, depending on forage quality.

The nutritional profile of DDGS (Table 1) allows for flexibility while potentially creating challenges for the producer when formulating diets. The DDGS is a concentrated source of protein, high in fiber and low in starch content, similar to forages. The majority of the starch from the corn is removed during the process of producing ethanol, so what the animal can use as an energy source is mainly fat and digestible fiber.

Table 1. Nutritive Profile of DDGS

Nutrient/Component[a]	Corn	DDGS
	Reference	Range
Crude Protein, %	8.5 - 9.9	28 - 32
NDF, %	9.0 - 10.0	37 - 45
Fat, %	3.5 - 4.7	9.0 - 12.0
Phosphorus, %	0.28 - 0.34	0.7 - 1.3
Sulfur, %	0.12	0.4 - 0.8

[a] Nutrient values are reported as a percent of total dry matter.

Precautions When Using DDGS in Sheep Diets

While DDGS can be used safely and effectively in sheep feeding programs, as with most feedstuffs, some precautions must be taken to avoid potential problems. Problems include variability of nutrient content of DDGS, anti-nutritional properties, physical properties that can affect handling and storage, and balancing the total diet for individual nutrients when DDGS is added.

Nutrient variation. There can be considerable variation in the nutrient content and availability of DDGS. Due to variation in protocol between distilling plants across the country, the chemical composition of the resulting co-products may be different. This variation in nutrient content, digestibility, and availability is usually related to the drying process and amount of solubles added back to the distiller's grains. The drying process can result in heat damage, which binds nutrients such as crude protein and reduces their availability for digestion and absorption. Routine chemical and nutritional analyses of DDGS are important to determine nutritional value and nutrient availability.

Storage and handling. Many sheep operations in the Midwest are small to medium in size. Therefore, the use of DDGS is more practical than using wet distiller's grains with solubles (WDGS). Storage time for WDGS depends on environmental temperature, but generally its "shelf-life" is 3 to 7 days. Due to the short storage times for WDGS, daily or frequent delivery of co-product is best for quality and freshness, but not economical in many cases. For the average Midwest sheep producer, a load of WDGS would most likely spoil before being used. Larger producers, or those who also have cattle operations, may be able to use WDGS. The DDGS presents fewer challenges for producers than WDGS in terms of handling, storage, and transportation. They have more application as a feedstuff for sheep, as they are a dried product that can be stored longer than wet products. The fine texture of DDGS, however, may also cause bridging in feeders and storage units. Therefore, loose or bunker storage may be beneficial for DDGS. These physical and chemical characteristics of DDGS should be taken into account when formulating diets to include the co-product.

Nutrient concerns. Several considerations should be taken into account when balancing diets to include DDGS. Feeding DDGS at excessive levels can have potentially negative implications on not only performance, but also the environment. The DDGS contains high levels of sulfur, phosphorus, and nitrogen. Excess nutrients will be excreted by the animal, which may affect applications of manure to land areas. Rations which incorporate DDGS may likely exceed the animals' requirements for these nutrients, as well as for sodium and fat.

High levels of dietary phosphorus may cause a disproportionate ratio of calcium to phosphorus. This disproportionate ratio may predispose male sheep to develop urinary calculi, which are mineral deposits in the bladder and urinary tract that result in difficult urination and can actually block the urethral tract (a life-threatening situation). This imbalance between calcium and phosphorus may be offset by feeding supplemental limestone and adding a urine acidifier to the diet.

The higher fat content of DDGS must also be taken into consideration when formulating diets with DDGS. Ruminant diets should not contain more than 8% total dietary fat, as higher fat content can depress fiber digestion in the rumen and result in suppressed performance. This is more of a concern in animals fed high levels of forage as their primary nutrient supply, and is less of a concern in lambs fed high concentrate diets typical of the feedlot finishing phase. Too much fat, however, has been shown to reduce feedlot performance as well.

Diets that use DDGS likely include elevated levels of sulfur compared to traditional diets. High dietary sulfur, compounded by other sulfur sources such as water, fish meal, and sulfur-based drugs used to control coccidiosis, can result in polioencephalomalacia due to an excess production of hydrogen sulfide gas and depressed thiamine uptake in the rumen. In research trials at Purdue University, 10 mg of thiamine per pound of dietary intake has been used successfully to prevent polioencephalomalacia in lambs fed diets containing 25% to 50% DDGS.

High levels of dietary copper are always a concern in sheep, as they are especially sensitive to copper poisoning. As with any dietary ingredient fed to sheep, the level of copper in DDGS should be analyzed.

Mycotoxins. Situations where mycotoxins are a concern with corn can also be problematic with DDGS. Mycotoxins are not destroyed in the fermentation process. The removal of the starch

fraction of corn during fermentation concentrates the remaining fraction by a factor of approximately three times. Therefore, if mycotoxins were a problem in the original corn, they will be further concentrated in DDGS.

Although distiller's grains such as DDGS have been utilized efficiently in the beef feedlot industry, as well as with swine and poultry, knowledge of the effect of DDGS on animal performance and end-product quality across species is limited. Additional research is required to determine the effects of including DDGS in sheep rations in terms of weight gain, feed efficiency, reproductive capabilities, and longevity, as well as carcass composition and fatty acid content of the end-product.

Results of Previous Research Studies on Feeding DDGS to Sheep

Until recently, use of DDGS in lamb growing and finishing diet formulation has been limited, and published research in this area scarce. This lack of data could be due in part to current lamb feeding practices. Lamb rations are usually fed ad libitum in self-feeders for maximum expected gain. Pelleted supplements containing protein, minerals, vitamins, and feed additives are commonly provided to reduce feed ingredient sorting and refusal. The rising expense of traditional protein supplements has encouraged producer interest in including DDGS in lamb diets to supply protein more economically.

South Dakota State University. Research studies from South Dakota State University demonstrated that DDGS fed at 17.3% of the dietary dry matter and combined with soybean hulls can be utilized as the primary protein source in lamb diets with no effect on growth performance or carcass traits compared to traditional soybean meal diets (Zelinsky, 2006). Additional studies revealed that diets containing DDGS can also be used as the primary protein source for lactating ewes with no significant effect on ewe body condition score or average daily gain of suckling lambs, compared to diets which utilize soybean meal as the primary protein source (Held, 2006).

North Dakota State University. Research performed at North Dakota State University suggests that DDGS, with supplemental thiamin, can effectively replace up to 60% of a lamb finishing ration with no negative effects on feedlot performance or carcass traits (Schauer et al, 2008). Diets were balanced to meet crude protein, energy, and Cu requirements in order to evaluate the effects of increasing levels of DDGS, especially when sulfur concentrations became potentially toxic. The majority of carcass traits, as well as final weight, average daily gain, and feed efficiency, were not affected by level of DDGS inclusion. Only slight increases in flank streaking were observed as DDGS inclusion level was increased. Feed intake increased linearly as the level of DDGS inclusion increased. There were no deleterious effects due to increasing dietary sulfur concentrations, presumably because supplemental thiamin was provided to prevent polioencephalomalacia.

Purdue University. Research performed at Purdue University supports NDSU data, suggesting that feedlot lambs can be fed a 50% DDGS ration without negatively affecting performance or carcass characteristics. Furthermore, data from Purdue has shown no differences in the fatty acid profile of meat from lambs fed 50% DDGS when compared to lambs fed 25% DDGS.

Research has shown that feeding DDGS at up to 60% of a lamb finishing ration appears to have no negative effects on feedlot performance, while feeding up to 50% DDGS has no negative effect on fatty acid profile of the resultant meat product.

Conclusions

Distiller's grains are quickly gaining value as a feedstuff for sheep. Although further research is necessary to better manage variation in the nutrient profile of ethanol co-products in order to realize the full benefits as livestock feed, including DDGS in a diet may result in a more cost-effective diet for producers.

Producers utilizing these co-products in their individual operations should consider both the nutritional and economic aspects of the feedstuff. As with any feed ingredient, total diets should be balanced for intake, energy content, protein, minerals, and vitamins. Distiller's grains can be added to diets as either a protein or energy supplement, or a combination of both. Research conducted by North Dakota State and Purdue Universities indicates that feedlot diets can have 50% DDGS without negatively affecting growth performance, carcass composition, or fatty acid profile of the meat. Dried distiller's grains with solubles can make an excellent feed for sheep if diets are formulated to incorporate guidelines discussed in this publication.

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