Distillers Dried Grain (DDG) Use in Livestock Diets

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Introduction and Ethanol Production Overview

Distillers grains are a product of the alcohol or ethanol manufacturing industry. The majority of the ethanol in the United States is made from corn using a dry mill process. The ethanol production has several steps which impact the nutritional and feeding value for livestock of the coproducts of distillers grain. During the alcohol production process, enzymes, live yeast culture, and other additives are mixed with milled corn or other high quality grains (wheat, sorghum, and barley). The starch portion of the corn is fermented into sugar and then distilled into alcohol. The complete ethanol processes starts with milling the grain into a fine powder. The next step of liquefaction is when the starch is liquefied by mixing the grain flour with water and the enzyme, alpha-amylase then cooked at a high temperature. The mash from the cookers is cooled and the enzyme, gluco-amylase, is added to convert the liquefied starch to fermented sugars (glucose). This step is called saccharification. Fermentation is started by adding yeast to ferment the sugars into ethanol and carbon dioxide. The fermented mash (10 % alcohol) is then distilled (96 % alcohol) in order to separate the ethanol from the non-fermentable components and water. The alcohol is dehydrated and denatured to produce fuel ethanol. However, after the distillation process, the whole stillage (nonfermentable components) is centrifuged into wet grains (35 % solids) and thin stillage. The thin stillage goes through an evaporation process resulting in syrup or condensed distillers solubles (25 to 50 % solids). Both the wet grains and syrup can be marketed directly as-is. But, generally, the syrup is added back to the wet grains (centrifuged solids) for sale as wet distillers grain with solubles or placed in a thermal dryer for production of dried distillers grain with solubles. The chemical compositions of corn distillers dried coproducts compared to corn and soybean meal are shown in Table 1.

Table 1. Chemical Composition of Distillers Grain Coproducts (dry matter basis)

Item	CDS	WDGS	DDGS	SBM	CORN
Dry matter, %	23 to 45	25 to 35	88 to 90	88 to 90	88 to 90
Crude protein, %	20 to 30	30 to 35	25 to 35	47.5	7 to 9
Fat, %	**9 to 15**	8 to 12	8 to 10	2.5 to 3.5	3 to 4
Phosphorus, %	**1.3 to 1.45**	0.5 to 0.8	0.6 to 0.9	0.6 to 0.8	0.2 to 0.3

National Research Council

Historically, distillers grains have been a simple alternative energy source when corn is in short supply or expensive. Distillers grains nutrient profile varies slightly to the typical energy source of livestock diets, yellow dent corn. Distiller grains have higher protein (20 to 35 %), lysine (0.59 to 0.89 %), fat (3 to 12 %), and crude fiber (4 to 12 %) content than corn due to the fermentation process removing the starch component. Distillers byproducts do have several features that limit their use in livestock diets particularly for nonruminants. The main obstacle is variation in final coproduct nutrient content, digestibility, and physical appearance. The variability is caused by variation in nutrient content of grain delivered, type of yeast used, fermenting efficiency, distillation efficiency, drying temperature, drying time and amount of syrup or solubles blended back into the wet grains. The most easily observed variation is in the color and smell of the distillers dried grain. Color variation can be from a light golden to a dark brown. The smell of distillers grain can be from sweet to smoky or burnt. Distillers dried grains will vary in particle size from 125 to over 1,000 microns, which will affect flowability and digestibility of the coproduct. The storage time of distillers grain is quite short due to the high amount of polyunsaturated fatty acids in the product that can go rancid very rapidly. The recommendation for wet distillers grain is 5 to 7 days in the summer and 2 to 3 weeks in the winter. The recommendation for dried distillers grain is 1 month in the summer and 3 months in the winter. However, these times may vary depending on geographical location.

Distillers dried grains also vary in amino acid digestibility from 17.7 to 74.4 %. The amino acid profile is not well balanced. For example, distiller grains are quite low in lysine content (0.6 to 0.9 %). Therefore, livestock diets containing distillers dried grain with solubles (DDGS) need to be formulated on a digestible lysine and energy basis. Formulating the diet on a crude protein basis will result in a lysine deficiency and possible a deficiency of other amino acids, such as tryptophan, methionine or threonine, which will reduce growth performance of nonruminant livestock. Therefore, it is recommended that producers calculate the lysine to crude protein ratio and only use DDGS if this ratio is greater than 2.8 %. The gross energy concentration of DDGS is greater than in corn, but because of a lower digestibility (76.8 vs. 90.4 %, respectively) of energy in DDGS than in corn, there is no difference in the concentration of digestible and metabolizable energy between DDGS and corn. Distillers dried grain is low in calcium and high in phosphorus and potassium, so proper mineral supplementation is required as well.

Monogastric

It has been known for decades that distiller byproducts can be used in growing pigs and poultry diets; and the reproducing sow or layer diets. Distillers dried grain with solubles (DDGS) is the major distiller byproduct used in nonruminant diets. Several researchers reported no differences or either slight improvements in growth and feed efficiency of nursery pigs fed low concentrations (2.5 to 5 % of DDGS). The use of DDGS in grow-finish diets has been limited no more than 20 % inclusion rates. It is more common to limit the inclusion rate to 10 % in grow-finish diets. In general, 10 % DDGS can replace approximately 4.25 % soybean meal and 5.7 % corn, if 0.10 % crystalline lysine is included in the diet. If more than 20 % DDGS is used, 0.015 % crystalline L-tryptophan needs to be included in the diet for each 10 % DDGS that is used. The digestibility of phosphorus in DDGS is approximately 59 %. This value is greater than in corn. Therefore, if DDGS is included in the diet, less inorganic phosphorus is needed (0.20 % monocalcium phosphate for each 10 % DDGS used) and less phosphorus will be excreted in the manure. Additional limestone is needed to maintain proper concentration of calcium.

In addition, the fat quality of the pork carcass could be poor due to the high amount of polyunsaturated fatty acids in the distillers dried grain. The breeding herd diet is probably the best place to use DDGS with a maximum inclusion rate of 40 % in gestation diets. However, the lactation diets should not contain more than 10 % distillers dried grain. The handling and storage of diets containing distillers dried grain is an issue because of particle size, flowability and pelletability.

Ruminants

The same reason distiller grains are beneficial for nonruminant diets makes DDGS ideal for feeding to ruminant animals. Distillers dried grain is typically substituted into livestock diets in replace of corn or soybeans since DDGS is an effective replacement of either protein or energy. When distiller grains are fed at 15 to 20 % of the dietary dry matter (3 lbs/d), replacing corn, finishing cattle had an increase in final weight, daily gain and feed efficiency. The recommendation would be to feed no more than 4 to 6 lbs/d to finishing cattle (> 900 lbs). Distillers dried grain has a calculated undegradable intake protein of 60 to 70 % making DDGS a very effective replacement for soybean meal as a rumen by-pass protein for ruminant animals. For lactating ruminants, DDGS diets need to be supplemented with ruminally protected lysine and methionine in order to increase milk yield and milk protein yield. Usually, cows can be fed 5 to 7 lbs/d of distillers dried grain. However, dairy cattle are not fed over 20 % of the total ration (DM) of distillers dried grain due to the high phosphorus and fat content.

Conclusion

In conclusion, distillers dried grain with solubles (DDGS) can be efficiently used in livestock diets at limited quantities; however, coproduct and dietary formulations should be evaluated before implemented by a nutritionist to ensure growth performance is maintained. If an acceptable quality of DDGS is used and if diets are carefully formulated then higher inclusion rates may be possible. The major limitation for feeding DDGS to livestock is the variation in nutrient content, digestibility, and quality

(mycotoxin). Therefore, producers should develop a relationship with the manufacturer and distributors of the distillers dried grain to either develop specification sheets of the coproduct to guarantee nutrient content within an acceptable range.