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Feeding Distillery Stillage to Beef Cattle

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The bourbon industry continues to grow in the United States. The growth of the industry has provided an increase in distillery by-product feedstuffs that can be utilized by cattle as a source of energy and protein. Learning the nutritional characteristics of these feedstuffs will facilitate proper feeding, allowing for improved cattle performance.

Process Overview

Grains commonly used for making bourbon include corn, rye, wheat, and barley malt. The grains are finely ground through a hammermill to increase surface area for starch conversion to simple sugars. After grinding, grains are transferred to a mash tun, a container that allows the grains to be mixed with heated water. Mashing or saccharification is the process of steeping the grain mixture in warm water, near or above 150 degrees Fahrenheit. During mashing, starches are converted to sugars via amylase enzymes. Upon completion, the mash is cooled and transferred to fermentation vessels. The sugary liquid-grain mixture is referred to as wort. Yeast is added to the wort, which convert the sugars to ethanol and carbon dioxide, and fermentation lasts five to seven days. Following fermentation, the alcohol-containing mixture is referred to as beer and is transferred to the still. The still heats the liquid mixture and evaporates the alcohol for separation. The alcohol is collected and placed in barrels for aging. The remaining liquid fraction is now referred to as whole stillage. Although an oversimplified review, this description will give readers a basic understanding of how stillage is derived from the bourbon-making process.

Nutrient Content

Corn contains approximately two-thirds starch. The starch is removed through the fermentation process, leading to a concentration of the remaining nutrients by approximately threefold on a dry matter basis. For example, the crude protein content of corn averages near 8.8 percent on a dry matter basis. Removal of the starch would lead to a distillers by-product feedstuff containing approximately 27 percent crude protein on a dry matter basis.

Stillage contains a high amount of water; moisture levels often range between 92 and 95 percent (Table 1). It is important to evaluate the nutrient content of stillage on a dry matter basis because the moisture level can differ from various distilleries. If a sample is sent to a commercial laboratory for nutrient content analyses, be certain to look at the results on the dry matter basis rather than the as-received or as-fed basis.

Stillage is a good source of protein, often testing in the upper 20s for crude protein (Table 1). The protein content is slightly higher than corn gluten feed with a greater amount being ruminally undegradable or bypassing microbial degradation in the rumen. Stillage can be fed to supplement low quality forages that are limiting in protein and energy.

Supplementing cattle with whole stillage will also provide energy. The oil or fat content in whole stillage may be near 10 percent. In addition, the corn bran is a highly digestible fiber source that will provide energy to cattle. Protein provided by stillage can be digested and utilized as energy as well. In comparison, the gross energy can be similar to corn.

Most bourbon distillers by-product feedstuffs are not modified like some fuel ethanol–derived feedstuffs. Modification may involve removal of corn oil, which reduces the calorie density. Post-fermentation processing such as separation of the liquid from the grain particles is often performed. The separated liquid fraction can then be evaporated to yield condensed solubles or syrup. This process is common in larger distilleries and fuel ethanol plants.

Additives can also alter the nutrient content. The use of sulfide dioxide during the steep can increase sulfur in the distillery feedstuffs from ethanol sources. When discussing bourbon whole stillage, the assumption is that there is no pre- or post-fermentation modification. New technologies are being investigated by some bourbon distilleries that may alter their feeding value. One should test these feedstuffs for nutrient content.

Table 1. Nutrient composition of whole stillage from bourbon distilleries.

Item	Amount
Dry matter	5–8%
Crude protein	25–30%
NEm	0.8–1.2 mcal/lb
NEg	0.51–0.65 mcal/lb
Fat	7–11%
Calcium	0.08–0.15%
Phosphorus	0.75–1.20 %

Feeding Method

Whole stillage should be fed as a supplement; limited feeding will reduce the risk of digestive upsets. Having a nutrient profile similar to dried distillers grains allows stillage to be utilized as both an energy and a protein supplement for forage-based rations.

Figure 1. Converting to dry matter.

		Example	
A	Gallons fed/head:	5	gal
B	Lb/gal for stillage:	9	(9 typical)
C	Lb stillage fed: **A** x **B**	45	lb fed
D	Stillage dry matter %:	7	%
E	Lb stillage DM fed: **C** x (**D**/100)	3.2	lb DM

The common feeding approach of stillage is daily feeding in concrete or metal open troughs. Some farms may add processed hay on top of the stillage to encourage consumption of hay along with stillage. When feeding stillage, the amount offered is often dictated by the volume transported or the volume of the troughs used for feeding. Consider a vehicle with a tank capacity of 1,000 gallons. A farmer may feed 1,000 gallons daily to a group of 100 cows, providing 10 gallons per animal.

Early research with whole stillage indicates the weight per volume or pounds per gallon is approximately nine. Working through the scenario above, 10 gallons per cow would provide 90 pounds of stillage, with the majority of the weight being water. The dry matter content of whole stillage needs to be known or estimated to determine the pounds of dry feed equivalent offered. Using a value of 7 percent dry matter, the 10 gallons of whole stillage would be equivalent to feeding 6.3 pounds of dry distillers grain. Again, the amount of grain or solids in whole stillage may vary load to load, and testing for dry matter and nutrient content is recommended. This may not be feasible due to daily hauling and feeding. However, routine testing will allow for obtaining a range of dry matter and nutrient content values that can be used in formulation of diets.

Stillage may also be mixed into a total mixed ration (TMR) to add moisture and condition hay. Dairy research has shown TMR moisture levels near 50 percent when comprised mostly of haylage, and dry hay reduced sorting and encouraged forage intake. The addition of whole stillage at 20 to 30 percent on a weight basis to dry hay would be a starting place to condition dry hay while increasing the energy and protein levels in the diet.

As an example, 400 pounds of stillage per ton of hay would provide moisture to condition dry hay. This would be a total of 2,400 pounds of feed on an as-fed basis. Applying the dry matter of 7 percent to 400 pounds of stillage, the stillage would provide 28 pounds of dried distillers grain equivalent, and the diet would contain approximately 22 to 25 percent moisture. The upper limit of stillage added to a TMR should be based on both balancing the diet for nutrients and what can be absorbed by the other feedstuffs without leaching out of the mixer.

Developing Feeding Programs

When using whole stillage in a feeding program, use an amount that will provide supplemental nutrients to balance the diet for energy and protein. A common mistake is to maximize the use of stillage due to its low cost, but this may result in nutritional imbalances and the potential for digestive upsets.

The biological feeding value may differ from that calculated based on proximate analyses. The true feeding value will vary based on the level fed. Stillage contains corn fiber, and neutral detergent fiber values are near 30 to 35 percent. Neutral detergent fiber measures the cellulose and hemi-cellulose plus lignin of a feedstuff. The rumen microbes provide the majority of the cellulase enzyme needed to utilize fiber for energy to the animal, as mammals do not produce this enzyme.

In the production of ethanol, the grain is finely ground to a very small particle size. When greater amounts of stillage are consumed it can lead to faster passage rates out of the rumen due to the high moisture and small particle size. The faster passage rate may lead to decreased or incomplete digestion of the corn fiber. This decreased fiber digestion is true for other feedstuffs such as soybean hulls. Soybean hulls have a lower biological feeding value when included into feedlot-type diets compared to forage-based rations due to faster passage rates and lower rumen pH for grain-based diets. Providing long-stemmed forage to slow passage rates will increase rumen degradation of fiber particles.

The fat content of stillage should also be considered. Previous research suggests that total dietary fat levels in excess of 6 percent can suppress fiber digestion. Maintaining a total dietary fat level of 6 percent or less requires that stillage contribute no more than 3 to 4 percent fat to the total diet. Using an average value of 10 percent fat for stillage, the amount of stillage dry matter consumed by a mature cow should not exceed 10 pounds.

To simplify feeding limits, it is recommended that the upper feeding level of stillage not exceed 1 gallon per 100 pounds of live body weight for mature cows. For backgrounded calves, the recommendation is 1.25 gallons per 100 pounds of live body weight since their intakes are often higher when expressed as a function of body weight. These recommendations again are based only on limiting dietary fat level to 6 percent or less. It is important to note that these are upper limit recommendations. Table 2 illustrates upper limits of stillage that can be offered based on intakes.

In many cases, beef cows may not need 15 gallons of stillage daily to balance their energy and protein needs. Recall from above that 10 gallons of stillage provides the equivalent of approximately 6 pounds of dried distillers grains. Few producers would offer cows 9 pounds of dried distillers grains daily, which is equivalent to 15 gallons of stillage. Test your forage and determine how much energy and protein supplementation from stillage or other feedstuffs is needed to meet the needs of the cattle being fed.

Table 2. Suggested upper feeding limits (lb/gal) of whole stillage for cattle with varying levels of dry matter intake for stillage with 10% or 15% extractable oil/fat to provide 3% fat addition to the diet.

Intake (b DM/d)	Example cattle weight (lb)	3% added fat @:	
		10% fat (lb/gal)	15% fat (lb/gal)
14	500	60 / 6.7	40 / 4.4
18	750	77 / 8.5	51 / 5.7
22	1000	94 / 10.5	63 / 7
26	1200	111 / 12.4	74 / 8.3
30	1400	128 / 14.3	86 / 9.5

Source: Five samples analyzed from Kentucky distilleries.

Possible Issues from Feeding

The pH of stillage often ranges from the mid-3s to 4, which is considered acidic. As a comparison, the pH of corn silage will often range from 4 to 4.5. The rumen pH is typically near 6.2 to 6.4, which is conducive to fiber digestion by the rumen microbes. Significant decreases in rumen pH can lead to digestive upsets and possibly rumenitis. Digestive upsets as a result of low rumen pH can lead to synthesis of endotoxins. Some common detrimental impacts of these endotoxins include reduced rumen contractions, cattle going off feed, and laminitis.

Neutralization of the organic acids in the rumen partially occurs via bicarbonate from saliva when the animal chews as well as the buffering capacity of the diet, such as ammonia, magnesium oxide and calcium carbonate content in the feed. Bicarbonate and ammonia may also be derived from the bloodstream and transferred into the rumen. During periods of digestive upsets, intakes and chewing may be suppressed and volatile fatty acid absorption from the rumen can be reduced.

A simple strategy to reduce the risk of digestive upset is to ensure adequate forage intake occurs to stimulate chewing and saliva production. Limiting the amount stillage offered will encourage greater forage intake. Limiting the stillage consumption will also have a direct impact on limiting the reduction of the rumen pH.

Another option is to buffer the stillage using an approved feed additive such as sodium bicarbonate, calcium carbonate, and/or magnesium oxide. Buffer can be added directly to the stillage to bring the pH up closer to neutrality. It may not be necessary to bring the pH near 6; increasing pH to near 5 may be sufficient to reduce the negative impacts. A digital pH meter can be used to monitor pH of stillage and assist in determining the amount of buffer needed. Start with about 1.5 pounds of sodium bicarbonate to 100 gallons of stillage. Bench tests have demonstrated this amount will bring the pH close to 5. Results will vary depending on pH of stillage. Calcium carbonate can be utilized but it does not dissolve as readily and will require additional mixing. Calcium carbonate is a weaker buffer than sodium bicarbonate, so more must to be added to bring the pH up. It is best to adjust pH at the time of feeding. If stillage is stored for a period of time, the pH should not be adjusted with buffer addition. Rather adjust the pH prior to feeding.

Lastly, when feeding corn-derived feedstuffs, the dietary calcium levels need to be considered. Corn is lower in calcium than phosphorus and can result in a situation in which the calcium:phosphorus ratio is inverted. Stillage and all distillers grain coproducts have a calcium:phosphorus ratio that, when fed at high rates, increases the risk of the formation of bladder stones or a disorder known as water belly. The simple prevention is to add calcium carbonate or feed grade limestone to the diet to balance the calcium:phosphorus ratio. Many feed companies have also developed mineral supplement products that have higher calcium levels (20–25%) and no additional phosphorus. Work with your nutritionist to evaluate your feeding program to determine if a change in your mineral program is necessary.

Summary

Distillers stillage can be utilized as an energy and protein supplement for beef cattle. The stillage should be considered a supplement and not a major diet component for beef cattle; limit the amount offered to avoid digestive upsets. For additional information on feeding stillage to beef cattle please contact your nutritionist or county Extension office.

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