

Starch versus Highly Digestible Fiber as a Supplemental Energy Source

Introduction

Hay samples submitted to the University of Arkansas Agricultural Services Laboratory have indicated that approximately 70% of hays produced in Arkansas do not meet the energy (TDN, total digestible nutrient) requirement of lactating beef cattle. Alternatively, 40% do not meet protein requirements. In an effort to maintain animal performance, providing supplemental energy more often becomes necessary than providing supplemental protein. In recent years, questions have developed concerning supplementing with high starch feeds such as corn (Figure 1) as compared to highly digestible fiber feeds such as soybean hulls (Figure 1). The following discussion is to inform the reader of factors to consider when selecting either a high starch or highly digestible, fiber feed.



Figure 1. Cracked corn (left) is a highly digestible high starch, low fiber feed, whereas soybean hulls (right) are a highly digestible low starch, high fiber feed.

The Starch Story

During the past 25 years, researchers have evaluated the performance of cattle supplemented with traditional grain-based supplements such as corn. A study conducted at Oklahoma State University, published in 1987, was one of the landmark studies demonstrating the negative impact of starch on forage intake and digestibility. Since then, scientists have worked toward gaining a better understanding of the relationship between the interaction of starch intake and forage intake and digestion (commonly termed negative associative effects). The foundation for what is being observed when supplementing with high starch grains on forage intake and digestibility lies within the microbial population and the rumen environment.

The Rumen Environment

The rumen contains numerous types of microbes and species of microbes, and it is these microbes that the animal relies upon to digest fiber (cellulose) found within feeds, primarily forages, that otherwise could not serve as a source of energy for the ruminant. As microbes digest feeds, the microbes produce fermentation by-products called volatile fatty acids. The ruminant animal (e.g. cattle) can readily absorb and utilize these volatile fatty acids as an energy source.

The largest population of microbes in the rumen is bacteria. Some species of bacteria readily feed upon fiber while others prefer starch as an energy source. As more starch is incorporated into the diet, the microbial population begins to shift from a population that greatly supports forage fiber digestion to a population that prefers starch. Another reason this shift occurs beyond the mere increase in amount of starchy grains in the diet is a change in the pH of the rumen caused by a shift in the type of volatile fatty acids produced. The by-product of starch digestion is the production of stronger acids as compared to weaker acids produced during fiber digestion. The production of stronger acids as a result of starch digestion causes a reduction in rumen pH. As the pH begins to decline, the rumen environment reaches a point where it is no longer suitable for the fiber digesting bacteria to digest fiber efficiently. This change in rumen environment results in a reduction in how fast fiber is digested. Since forage intake is generally regulated by gut fill, a declining rate of fiber digestion due to increasing levels of starch supplementation means that less fiber will be digested and pass from the rumen, resulting in greater forage fill and lower intake of hay or pasture.

Starch Thresholds

Research has demonstrated that reductions in fiber digestion begin to occur at levels as low as 0.3% of body weight of supplemental high-starch grain. As a rule of thumb, the negative impact on intake will likely occur when corn is fed at levels greater than 0.5% body weight. When balancing rations that require greater than 0.5% body weight as supplemental high starch grains such as corn, supplementation adjustments should be made because of the expectations for a reduction in forage intake.

The Fiber Story

The processing of grains for human consumption, e.g. extraction of oils or fermentation in breweries and ethanol production, has yielded by-products of grains that contain more fiber and less starch. In most instances, the fiber of these by-products, such as soybean hulls, are highly digestible by rumen microbes. Exceptions to this include cottonseed hulls and rice hulls which are not readily digestible.

The thought process now suggests that if a supplement is high in fiber and the fiber is more digestible than the forage fiber, then supplementing with a highly digestible source of fiber should increase energy (TDN) consumption without negatively impacting forage digestibility. Any reduction in hay intake would likely be due only to a substitution of the supplement with hay and not a result of a negative associative effect observed such as that between starch supplementation and forage intake. In addition to containing digestible fiber, many by-products contain a greater level of protein as compared to corn and milo.

Research has shown that when soybean hulls are supplemented at less than 0.5% body weight, the energy value of soybean hulls is equivalent to corn (90% TDN, dry matter basis). At higher levels, the observed TDN value for soybean hulls is reduced. Research at the University of Florida demonstrated that at a low level of supplementation (0.38 and 0.48% body weight for corn and soybean hulls, respectively) steers gained similarly (1.36 lbs per day) when fed bermudagrass hay and supplemented with corn plus soybean meal as compared to soybean hulls. However, when supplemented at a higher level (0.83 and 1.04% body weight for corn and soybean hulls, respectively) the cattle supplemented with soybean hulls gained 0.42 lbs per day more.

In a Missouri study, mid-summer fescue pasture digestibility was reduced with ground corn fed at 1% body weight; whereas, forage digestibility was maintained when cattle were supplemented with corn gluten feed at 1% body weight. In that study, the negative impact on forage digestion did not obtain a reduction in forage intake. Cattle supplemented with corn at 0.5% body weight gained slightly more per day (0.08 lb) than cattle supplemented with corn gluten feed in an Illinois study. However, when supplementation was increased to 1% body weight, cattle fed corn gluten feed out gained the corn supplemented cattle by 0.12 lbs per day. Interestingly, calves supplemented with a low level of corn gained 0.06 lbs per day more than cattle fed the high level of corn.

Cattle are sometimes fed a supplement on high quality pasture. A common example is supplementing cattle on wheat pasture. Cattle gains have been shown to respond positively to energy supplementation on wheat pasture because of an improved balance between the supply of energy and protein to the ruminant. In addition, supplementing high quality pasture often results in a high substitution rate (the pounds of forage replaced in the diet per pound of supplement fed). Research in Oklahoma showed that the substitution rate for cattle on wheat pasture was high (almost a pound per pound) and did not differ between the starch or fiber feed. In this scenario, high starch or high fiber feeds could be used to increase stocking rates when prices (cattle and feed) prove to be an economically advantageous practice.

Consideration for Price

Although supplementing with highly digestible fiber complements forage digestion, the economics between animal performance and cost of supplementation must be considered. First and foremost, if an animal requires supplementation to maintain performance, the cost of lost production (the added cost of maintaining an open cow for a year plus the loss of revenue) will generally outweigh the cost of supplementation.

Secondly, choosing the most economical source of supplemental energy will determine the profitability of supplementing with a high starch feed or a feed containing highly digestible fiber. For example, if the cost of corn is less than the cost of soybean hulls, it may be more cost effective to supplement with corn, adjusting for some expectations of lowered hay intake and digestibility, as compared to feeding soybean hulls. The lowered cost of feeding corn as opposed to a high fiber by-product feed often occurs when the cost of protein (soybean meal) is high, driving the price of higher protein by-product feeds upward. In addition, prices will reflect availability whether it is supply based on production or local availability.

When the cost of supplements does not dictate choice, a digestible fiber source that complements forage digestion should be chosen as a supplement for cattle grazing forages that warrant energy supplementation.

Conclusion

Replacing starchy grains such as corn with highly digestible fiber, associated with many by-product feeds, can help circumvent the negative associative effect on forage intake and digestibility that occurs with feeding starch. However, the cost of supplementing with starch versus digestible fiber must be considered in making the final decision in regards to the type of supplement to feed.

For more information on the nutrient composition of by-product feeds, ask your local county Extension agent for fact sheet, [FSA 3047 Alternative Feeds for Beef Cattle](#).