Corn Silage Quality: What's Coming Down the Road?

Rick Grant, Miner Institute

Corn silage is often referred to as the "king" of forages based on its widespread use and importance in dairy rations. A crowning achievement of this crop is the highly digestible fiber and starch it brings to the diet. For average corn silage, about 65% of the digested nutrients come from nonfiber components of the plant and 35% from fiber. This means starch plays a critical role in determining the nutritive value of corn silage. This article focuses primarily on fiber, the results of some new research on corn silage digestibility, and what might be coming down the road in the future.

It has been known for a long while that lignin reduces forage fiber digestibility. But, it is also clear when forages are harvested at a similar stage of maturity, such as corn silage is, the negative relationship between lignin and fiber digestibility weakens considerably. For instance, several years ago Cornell researchers evaluated a number of corn hybrids and found as much as a 20% range in fiber digestibility for hybrids of similar NDF and lignin content. The potential feeding implications are substantial given that a 1% increase in NDF digestibility correlates with a 0.4 lb/day increase in dry matter intake and a 0.5 lb/day increase in milk yield. A range of 20 points in NDF digestibility could translate into 10 pounds of milk, and yet the lignin to NDF ratio would predict similar NDF digestibility among these corn hybrids.

What explains this variability in fiber digestion for forages with similar lignin content? Recent research has suggested that lignin composition and the type and degree of cross-linking of lignin with hemicellulose are the answer. More particularly, Minnesota researchers (Hans Jung and collaborators at the ARS station at the University of Minnesota) discovered lignin composition itself likely does not affect fiber digestibility, but the linkages between lignin and carbohydrates certainly do.

In grasses (which corn silage is), lignin is cross-linked to hemicellulose by ferulate molecules. The ferulates are esterified to arabinose side chains of the hemicellulose and then may be ether bonded to lignin. Some ferulate esters combine to form diferulates that cross-link hemicellulose chains. One can think of these ferulate cross-linkages as bracing in the structure of a house – they confer strength. These cross-linkages reduce fiber digestibility because they bring the indigestible lignin into very close contact with the otherwise digestible carbohydrate. In fact, research has shown higher concentrations of ferulate ethers and cross-linking are negatively associated with fiber digestibility.

In a recent issue of *Journal of Dairy Science*, researchers from USDA-ARS evaluated a new genetic mutation in corn that results in lower content of ferulate esters and ether cross-links at typical silage maturity stages (abbreviated as *sfe*). This is a different mutation than brown midrib (bmr) which lowers the content of lignin in the corn plant. Dairy cows fed this *sfe* corn silage had greater dry matter intake and milk production compared with a near isogenic control silage which reflected its greater NDF digestibility. In fact, the relative increase in milk yield for cows fed this new corn silage was similar to the bmr response in the ARS-USDA study.

The researchers also wondered whether the reduction in cross-linking might increase the silage fragility and how rapidly it would break down during processing and chewing. In fact, they found that lambs fed this lower cross-linked corn silage spent less time chewing per unit of NDF consumed. It has also been found that cows spend less time chewing bmr versus conventional corn silage. So, there may be a real biological effect here. In the lab at Miner Institute, the fragility of bmr corn silages have been measured to be 5-30% greater than conventional silages. In feeding studies, less chewing per pound of NDF consumed with bmr corn silage, lower rumen pH, and reduced feed efficiency has been observed. In order to avoid these problems, more total forage needs to be fed in the diet or supplemented with high "chew factor" forages such as straw when bmr corn silage are fed.

In the future it would be interesting to see what might happen if these two mutations (*sfe* and bmr) could be combined within the same corn line. BMR exerts its effect primarily through less lignin, while this new mutation reduces ferulate cross-linking. It might be possible to have corn silage with much improved feed intake, digestibility, and milk yield characteristics. Look for research in the future to test this idea.

Four bmr mutations exist for corn (bmr 1, 2, 3, and 4), with the bmr3 being marketed for many years. In 2012, bmr1 corn will also be available, so now farmers will have a choice between these low-lignin corn silages. Research is needed to fully assess the nutritional and agronomic differences between these two bmr mutations. It is known from extensive research with sorghums that "bmr is not bmr" and that substantial differences in composition and fiber digestibility may exist among them. It is exciting to see more potential sources of digestible NDF from corn silage available for dairy farmers. Stay tuned over the next year or two as data become available that compare

the relative nutritive value and yields of bmr1 and bmr3 corn silages.

And what about starch? Although this article has focused mostly on advancements in NDF digestibility, starch is important. If the factors affecting starch availability to the cow are ranked, particle size is first, moisture is second, and vitreousness is third. Corn processing method and moisture during storage (such as silage or high moisture grain) will largely determine starch digestibility. But, research advances over the next few years could well result in corn silage hybrids with much improved starch digestibility characteristics – so be sure to stay tuned.

As shown, there is a lot more to these scientific stories than is captured here, but the bottom line is that dramatic improvements in the nutritional value of corn silage are near. In the coming years, corn silage should have greater fiber and starch digestibility, as well as better agronomic performance. What an exciting time to be feeding dairy cows!