

## Strategies to improve nutritive value of corn and sorghum silage

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Forages are the primary feed ingredients of dairy diets and are fundamental for keeping animal productivity and health. Besides providing energy for maintenance and lactation, forages stimulate chewing and salivation, rumination, gut motility and health, regulate feed consumption and are the structural basis of the ruminal mat, which is crucial for ruminal digestion. Whole-plant corn silage (**WPCS**) is the predominant forage used in dairy cattle diets worldwide. Although WPCS is the predominant forage used to feed dairy cows in the United States, sorghum has become an important silage crop for dairy farmers. This is related to some of its unique characteristics. Compared to corn, sorghum uses water more efficiently, have lower fertilizer requirements, may potentially reduce soil erosion and pesticide usage, and have reduced seed and irrigation costs. Furthermore, whole-plant sorghum silage (**WPSS**) can be used as a second crop after corn silage harvesting. Starch and fiber are the main sources of energy for dairy cows fed corn silage-based diets and therefore improvements in digestibility of these nutrients may increase milk production or reduce feed costs through enhanced feed efficiency. Greater digestibility of fiber and starch is desired for productivity, profitability and environmental reasons. The purpose of this paper is to review selected recent developments and strategies that may influence the nutritive value of WPCS.

Corn kernels and sorghum berries have a hard coat, the pericarp, which surrounds the endosperm and is highly resistant to microbial attachment and inhibits digestion of starch; therefore, the breakdown of the pericarp and correspondent exposure of the starch endosperm must be the primary objective at harvest to maximize energy availability. In addition, starch accessibility is dependent upon the intricate starch-protein matrices surrounding starch granules.

Recently, prolonged storage has been featured an important tool to optimize starch digestibility in starchy feeds. Hoffman et al. (2011) observed a decrease in zein protein concentrations, as well as an increase in concentrations of soluble CP and ammonia-N, when HMC was ensiled for 240 d. These data suggested that proteases in the silo were responsible for degrading the zein protein matrix surrounding starch granules in corn kernels. Because the protein matrix is hydrophobic and represents a physicochemical barrier to rumen microorganisms, degradation of the matrix with prolonged storage was suggested to improve ruminal starch digestibility (Hoffman et al., 2011). Both, plant and microbial proteases in the silo are capable of degrading plant proteins to peptides and free amino acids. Experiments evaluating extended storage length in WPCS, earlage, and HMC consistently reported a gradual increase in ruminal in vitro or in situ starch digestibility (**ivSD** or **isSD**, respectively) as fermentation progressed. Recently, we observed a similar scenario for WPSS (Fernandes et al., unpublished).

Lignin is the key obstacle to fiber digestion as it obstructs the enzyme access to the digestible fiber fractions, cellulose and hemicellulose. In addition, rumen microorganisms cannot breakdown lignin. Due to its importance to animal performance, this association between lignin and other fibrous fractions (i.e. cellulose and hemicellulose) is considered in many diet formulation models. This undigested or indigestible NDF fraction is estimated using either lignin

or quantified as the proportion of NDF remaining after in vitro or in situ ruminal incubations (i.e. 240 h uNDF). Thus, the reduction of lignin or indigestible NDF fractions in forages improves fiber digestibility.

A harvesting management option to reduce lignin concentration is chop height. With enhanced chop height more lignin is left with the portion that remains in the field, and thus, digestibility of the harvested material is greater. A previous study from our group compared 6 vs. 24 inches, these results are similar to other trials comparing 6 vs. 18 inches of chop height. Briefly, DM yield is reduced as the row-crop head is raised. This is consistent across several studies conducted across the United States. However, decreased DM yields are offset by an increase in the milk per ton estimates at the higher chop height. Greater milk estimate is a response to the greater fiber digestibility and starch concentration of the harvested material. In addition, most studies reported that estimated milk per acre is reduced by only 1 to 3% with high-chop. Also, increased quantities of high-chop silage could be included in the diet, rather than corn grain being added to the diet, providing an economic benefit to implementing increased chop heights. As a follow-up study, we conducted a meta-analysis to evaluate the effects of chop height on nutrient composition and yield of WPCS (Paula et al., 2019). Yield of DM was reduced by 0.05 ton/ac for each inch of increased chop height. However, for each inch of increase in chop height there was an increase of 0.23, 0.20, and 0.20%-units in DM, starch, and ruminal in vitro NDF digestibility, respectively. A negative linear effect was observed for NDF, with a 0.25%-unit decrease per inch of increase in chop height.

Low lignin hybrids are also a very important alternative to enhance fiber digestibility. Brown-midrib corn hybrids had 0.9%-units lower lignin concentration and 11.4%-units greater ruminal in vitro NDF digestibility (% of NDF); this translated into greater total tract fiber digestibility (% of NDF). Cows fed BMR corn hybrids consumed 2.0 lb/d more DM and improved milk yield by 3.3 lb/d (Ferraretto and Shaver, 2015). As for corn, BMR sorghum has reduced lignin concentration and greater fiber digestibility compared to conventional sorghum. A meta-analytic review (Sanchez-Duarte et al., 2019) reviewed that cows fed BMR sorghum silage had greater intake (+1.8 lb/d), milk production (+3.6 lb/d) and milk fat concentration (+0.09%-units) than cows fed conventional sorghum. It was also reported that compared with conventional corn silage, cows fed BMR sorghum had greater milk fat (+0.10%-units) but lower milk protein (-0.06%-units) concentrations. No differences in intake and milk yield were observed.

### References

- Ferraretto, L. F., and R. D. Shaver. 2015. Effects of whole-plant corn silage hybrid type on intake, digestion, ruminal fermentation, and lactation performance by dairy cows through a meta-analysis. *J. Dairy Sci.* 98: 2662–2675.
- Hoffman, P. C., N. M. Esser, R. D. Shaver, W. K. Coblenz, M. P. Scott, A. L. Bodnar, R. J. Schmidt, and R. C. Charley. 2011. Influence of ensiling time and inoculation on alteration of the starch-protein matrix in high-moisture corn. *J. Dairy Sci.* 94:2465-2474.
- Paula, E. M., B. A. Saylor, J. Goeser, and L. F. Ferraretto. 2019. Influence of cutting height on nutrient composition and yield of whole-plant cutting height through a meta-analysis. *ADSA Abstract Accepted*.
- Sanchez-Duarte, J. I., K. F. Kalscheur, A. D. Garcia, and F. E. Contreras-Govea. 2019. Short communication: Meta-analysis of dairy cows fed conventional sorghum or corn silages compared with brown midrib sorghum silage. *J. Dairy Sci.* 102:1-7. *In press*