by John Goeser

Is your corn's starch in a cage?

FINDING another pound or two of milk always pays dividends. Economic conditions are tough for the dairy industry, but the aim needs to be improving how we provide for animals, especially within the realm of nutrition.


Goeser

How can we squeeze more energy from a pound of TMR? We can fulfill this dream — ultimately unlocking this desired additional energy and offering greater production, by releasing grain from its cage and allowing starch to reach its full potential.

Grain and corn silage starch digestion (starchD) has gained momentum as a focal point in dairy nutrition programs over the course of the past five years. Nutrition and ration models are better incorporating starchD as research has mounted demonstrating rumen and total tract starch digestibility's impact on animal performance.

But what causes starchD to vary? Rumen bacteria are floating around, suspended in rumen fluid. Starch should also be suspended, free floating in the rumen, but this is not always the case.

Why is access to starch limited? How can we impact and improve grain and silage digestion to improve performance? The key lies in enhancing rumen bacterial access to starch. This is possible by opening up the grain, which breaks the water insoluble protein cage and gives the microbes more surface area to attach to and consume the starch granules.

Biology's barrier

Thinking simply, corn grain is a seed for the next crop generation. Native corn evolved with rigid defense mechanisms to protect the baby plant (germ) and its food supply (starch) from the harsh environment.

The kernel features a water repelling seed coat (pericarp) to prevent rain from penetrating the starch and a crystalline and hydrophobic protein cage (zein proteins) to shield the starch underneath the coat. Both serve to effectively protect the baby plant's food. As the plant grows and the grain matures in the field, the protein cage grows and solidifies. The cage starts to form before silage maturity and strengthens through physiological maturity.

Over 100 years of plant breeding have further hardened the grains since grain fines are less than desirable as corn travels through combines, augers, elevators, bins, barges, and ultimately into a mill. The stronger protein cage can withstand long travels on trucks, trains, or barges.

Unlocking the cage

Remembering that rumen starchD is limited by the grain surface area open for bacteria to attach and digest (think finer particle size) and the protein cage, there are some strategies your consultant and dairy can implement to remove these limits to optimal production.

1. Ensiling chops up the protein cage.

In 2011, Wisconsin dairy scientist Pat Hoffman and colleagues showed, on a microscopic level, that extended fermentation breaks apart the protein cage, leading to better solubility and rumen bacterial access to starch. This is why a well-fermented, high-moisture corn or grain in silage becomes so soft that it turns into a paste that can be smeared across your fingers when rubbed together.

Starch digestion in the rumen can be less than 50 percent with fresh harvested corn but can expand to over 80 percent with adequate fermentation and protein cage breakdown. For a farm feeding 10 pounds of high-moisture corn and 20 pounds of corn silage, this could equate to 6 pounds of milk per cow. The connection between ensiling and digestibility can also largely explain the new crop slump historically experienced by many dairies when feeding fresh corn or silage.

2. Grinding and corn silage kernel processing improve grain surface area for bacteria to attach and digest.

The alternate avenue to reduce the protein cage impact on starch digestion is to process, process, and process. In corn grain, we have discussed geometric mean particle size (microns) as the indicator for grain processing, with the goal being less than 500 microns for dairy fine ground corn.

However, our understanding of rumen degradation is moving beyond particle size, with recent research finding that measured surface area (cm^2/gram) is better related to rumen starch digestion than mean particle size. Surface area is reported with your ground corn particle size analyses and takes into account both mean particle size and the standard deviation around the mean. Early indications to optimize rumen starch digestion suggest surface area on dry corn should be greater than 130 cm^2/gram.

For snaplage, earlage, or corn silage, isolating the grain and determining surface area is tough, although research is currently taking place to develop methods. Until these newer laboratory methods are mainstream, corn silage kernel processing score (KPS) has been readily accepted as a means to assess processing.

Greater KPS has been thought to improve total tract starchD by enlarging the silage starch surface. In 2005, Gonzalo Ferreira and Dave Mertens developed this fantastic tool, which assesses the percent of starch in silage that is less than 4.75mm in size. Thousands of dairies use this now, and the top 15 percent can process their silage grain to greater than 75 percent of starch passing 4.75mm (KPS greater than 75).

Measuring success

Can your dairy directly assess the protein cage and surface area impact on rumen starchD?

If you suspect starch is limiting performance, start by checking your high-performing pen cows' manure. Fecal starch is an exceptional tool to assess total tract starch digestion. High-performing dairies are achieving less than 2 percent fecal starch levels through great processing and adequately fermented silage.

While total tract digestion is a great place to start, also focus on the rumen. Forage testing labs are offering various rumen starchD estimates (that is, 7h starchD), but there is still considerable evaluation to be done.

As experience has taught us, not all feed tests were created equal. For example, Lab-bench rumen simulating in vitro 7h starchD (ivSD7) measures may rank feeds but have been shown not to be in agreement with cows. Recent research found the ivSD measures lacked any relationship with total tract starch digestion by high-producing dairy cows on commercial farms.

Rumen incubation (in situ) measures may offer some promise. Studies show in situ 7h rumen digestion measures may be in better agreement with cows. However, there is substantial work ahead for scientists and nutritionists to continue honing in on how starch is metabolized by today's high-performing cattle.

Work with your consulting team to discuss the protein cage that could be holding your starch hostage and in turn limiting your herd's starch digestion. Determining the potential impact starch digestion may have for your herd and administering new strategies to capitalize on this starch availability could reap rewards when you most need it.


"Some skimming was involved, but that's all I can say at this time."

Goeser is the director of nutritional research and innovation with Rock River Lab Inc., Watertown, Wis., and adjunct assistant professor, dairy science department, University of Wisconsin-Madison.