Nutrition P+L+U+S

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UNLOCKING THE MYSTERIES OF STARCH

"Starch is starch" is no longer the case in ruminant nutrition. Thanks to the collaborative work of a large team of researchers at the University of Wisconsin-Madison, we now know that the relationship between starch and protein in corn can dramatically impact starch degradability and thus digestibility in dairy cows.

"This has been a long-term project here, and is the result of the work and collaboration of many, many individuals who were excited about breaking down and differentiating the fine characteristics of corn," says Pat Hoffman, Professor and Extension Specialist in Dairy Management at the University of Wisconsin. "We have finally reached the point at which newfound knowledge from our research is being applied successfully in dairy management."

The knowledge to which Hoffman refers is the discovery that the levels of different types of protein present in the endosperm of corn kernels make a difference in starch availability. The endosperm makes up 75 to 80 percent of the total kernel, and contains primarily starch and protein, with virtually no fiber. Prolamins are the proteins that are of primary importance in ruminant nutrition. They are not soluble in water, nor are they soluble in rumen fluid and are broken down very slowly in the rumen.

The higher the level of prolamin, the more "vitreous" or glass-like the kernels become, which encapsulates starch more tightly and makes it less digestible. Floury or opaque endosperm corn types have lower prolamin levels compared to flint or normal dent corn varieties, and have greater starch availability and digestibility.

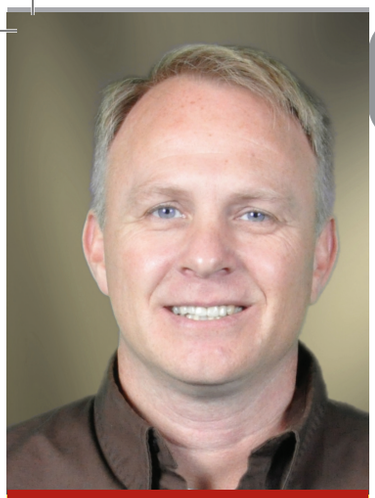
The Wisconsin researchers have found that at similar mean particle size, total tract starch digestibility was decreased 0.86 percentage units for each percentage unit increase in the grain prolamin content, when prolamin was expressed as a percentage of starch. Additionally, they discovered:

• **Fermentation degrades prolamins** – The most detailed work by Wisconsin researchers has quantified the changes in starch digestibility induced by fermentation. As corn within corn silage or *high-moisture* corns ferment, prolamin is broken down and starch becomes more available. The team has discovered that when prolamins are broken down they become soluble protein and a small fraction is further broken down to ammonia. Because ammonia is relatively easy to measure and can be done so precisely, it is an excellent marker of protein breakdown in fermented corns. Ammonia also can be used to define corn as unfermented or fermented, because dry corn or freshly harvested corn at greater than 15 percent moisture does not contain any appreciable amount of ammonia. Using ammonia as a benchmark of fermentation removes confusion as to whether it feeds like dry corn or *high-moisture* corn.. The Wisconsin research also has demonstrated that ammonia helps define the intensity and duration of *high-moisture* corns during the ensiling process.

• **The influence of particle size** – Reducing the particle size of corn always has been a key to improving starch digestibility, but particle size alone only explains about 40 to 50 percent of the variation in starch digestibility. Wisconsin researchers have recently developed a system to adjust particle size of corn based on how tightly the starch is bonded with protein using prolamin and ammonia as markers. This new system is called FeedGrainV2.0.

• **Nitrogen availability affects vitreousness and prolamins** – Substandard nitrogen levels as a result of excessive rainfall, lack of moisture during pollination, and/or poor soil fertility – reduce overall yield but also lower prolamin levels, making the starch potentially more digestible.

The practical application of this information depends on changing concepts and measuring mean particle size, prolamin and ammonia content of dry and high moisture corns. Hoffman suggests evaluating unfermented or dry corn for mean particle size and using a simple prolamin protein assay, which is available at a number of commercial feed and forage testing laboratories. "The prolamin content



Consultants CORNER

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MONITORING PROLAMINS AND STARCH TO ANTICIPATE VERSUS REACT

Gaining a better understanding of the starch profile in corn has helped me to be more proactive in counseling the dairies I serve in eastern Iowa and Wisconsin.

The majority of my clients feed dry corn and/or high-moisture corn. In the case of high-moisture corn, we always knew that new-crop corn was different than fermented corn that had been in the bunker or silo for three to six months. Now we have a better understanding of why that is true.

Monitoring percentages of ammonia nitrogen and soluble protein, and watching the mean particle size of the corn, can help prevent problems before they occur. Evaluating ammonia nitrogen every month is an easy and inexpensive way to stay ahead of potential problems. As I see that percentage starting to creep up, I usually advise adding dry corn, if available, or by-products to "cool down" the ration a bit and supplement the small amount of protein that has been lost via prolamin degradation. This helps prevent low milk fat, rumen acidosis and other changes in cow performance. It is easy to lose components in milk, and very challenging to get them back up again. By keeping a close eye on feed characteristics, we can help prevent these problems instead of being forced to react to them.

Using analytical programs and nutrition models also is useful in this process. Feed Grain V2.0 by Hoffman and Shaver evaluates prolamin levels as both a percentage of dry matter and percentage of starch. The program also calculates starch degradation rate using the key inputs of mean particle size plus prolamin content for dry corn, and mean particle size plus ammonia nitrogen level for fermented corn. The Cornell Net Carbohydrate and Protein System (CNCPS V6.1) now includes soluble protein fractions, ammonia nitrogen levels and starch degradation rate. The information provided by these tools makes it easier to explain our rationale for making ration changes to our dairy clients. Decisions that once were made based on intuition and hunches now are quantifiable and based on sound science.

Finally, access to prolamin values can help us aid our clients in making the most of every crop. Differences in hybrids, growing conditions and soil fertility all can impact the nutritive value of corn. Now we can make adjustments and limit disruption of TMR consistency and subsequent rumen function.

Most dairy clients today are sophisticated customers who expect us to continually bring new concepts and herd performance enhancements to the table. By analyzing grains and utilizing modeling programs to fine-tune rations based on new knowledge of the starch-protein matrix, we can promote success for our clients and ourselves.

FROM THE Maternity Pen

FEEDING FOR OPTIMAL MAMMARY DEVELOPMENT

Can the way heifers are fed influence the development of their mammary systems? Michigan State University researcher Michael VandeHaar thinks so.

"Accelerated feeding programs have led to some heifers being calved as young as 20 or 21 months of age," says VandeHaar. "However, calving heifers this young requires a body growth rate of faster than 2.0 pounds per day to achieve the recommended bodyweight of 1,250 pounds (for Holsteins) after calving. Some in the industry are pushing for faster growth, based partly on data showing if all heifers are managed and fed the same diet, the high performers for growth will someday be the high performers for milk. But this does not mean the rapid growth caused the higher milk. Every study in which some heifers were fed a control diet for gains <1.8 lb/day and some were fed a high energy diet for gains >2.0 lb/day has found that feeding for rapid growth between 3 and 9 months of age decreases subsequent milk production (although in some cases the drop was not statistically significant). " VandeHaar explains that the level of milk production in adult dairy cows is determined by:

(1) The ability of the mammary gland to produce milk. The number of milk-secreting cells at calving is determined by genetics and environment during mammary development. The foundation for future milk secretion is laid in the first eight months of life, before puberty (first ovulation).

(2) The ability of the cow to provide the mammary gland with nutrients. A well-grown heifer comes into the barn ready to eat and convert feed to milk .

(3) The ability of dairy managers to care for the cow. Providing a comfortable environment and delivering excellent nutrition all can help young cows maximize their physical and genetic potential for high milk production.

VandeHaar advises breeding heifers based on size instead of age, suggesting that Holstein heifers should be bred when they weigh 800 to 820 pounds and are 50 to 51 inches tall at the withers. He says that in a well-managed heifer program, this usually will occur at 13 to 14 months of age, thus calving at 22 to 24 months of age. He adds that accelerated growth programs require excellent reproductive management and post-breeding nutrition to prevent fattening but encourage stature growth of pregnant heifers.

Happenings

360 Feeds® Receives Achievement and Growth Award

West Central's livestock nutrition company, 360 Feeds®, has been recognized with the coveted Land O'Lakes Purina Feed Chow Honor Council (CHC) award for achievement and growth among local feed mills.

Each year, the Chow Honor Council recognizes established feed dealers and cooperatives that have shown an increase in sales and achieved growth within their market territory, a commitment to customer service and a dedication to quality. The top dealers and cooperatives are recognized during a yearly banquet hosted by Land O'Lakes and Purina Mills management teams.

360 Feeds was recognized as a gold 2012 CHC award winner. Nationwide, there are approximately 4,000 Land O'Lakes and Purina Feeds dealers and cooperatives, with only 80 being recognized as gold CHC award winners.

Beyond BYPASS

COW BEHAVIOR CAN PREDICT DISEASE

Sick cows—and those at risk of becoming sick—behave differently than healthy ones. Animal welfare and behavior experts Trevor DeVries (University of Guelph) and Marina von Keyserlingk (University of British Columbia [UBC]) have investigated the relationship between animal behavior and various illnesses in dairy cows, and how that information can aid in management improvements. Their collective observations, which all are based on work published in the *Journal of Dairy Science*, include:

• **Acidosis and rumen behavior** – Rumen pH of lower than 5.8 is indicative of sub-acute ruminal acidosis (SARA), which results in poor feed efficiency; reduced feed digestibility and protein synthesis; reduced milk fat; inconsistent dry-matter intake; and increased incidence of diarrhea, ruminal ulcers, parakeratosis, liver abscesses, and laminitis. Research done by DeVries while at Agriculture and Agri-Food Canada has demonstrated that decreased rumination activity can be used as an indicator of SARA (DeVries et al. 2008). A new electronic rumination monitoring system allows for easy detection of rumen function at both the individual-cow and herd levels.

• **Metabolic and infectious disease and feeding behavior** – Several studies undertaken at UBC have correlated decreased prepartum feeding time with postpartum metritis (Urton et al. 2005; Huzzey et al. 2007) and subclinical ketosis (Goldhawk et al., 2009). Observing feeding behavior one to two weeks before calving can identify cows at risk for those diseases. This work clearly identifies the need for adequate feed bunk space for each individual cow during transition, especially in the close-up period.

• **Mastitis and standing behavior** – The common belief is that the longer cows stand after milking, the lower the risk for bacteria to penetrate the teat orifice when the cow eventually lies down, and thus the lower the risk of mastitis. In a recent study undertaken at the University of Guelph (DeVries et al. 2010) it was found that cows that stood for the first 40 to 60 minutes after milking had a lower incidence of subclinical environmental mastitis infections. However, it also was found that cows that stood for very long time periods post-milking had higher odds of acquiring a new subclinical environmental infection. They speculate that this may be due to increased pressure in the mammary system caused by a greater accumulation of milk.

• **Lameness and standing behavior** – Recent UBC research (Proudfoot et al. 2010) reports that cows that developed sole lesions and ulcers in mid-lactation stood for longer periods of time during the two weeks prior to and 24 hours after calving compared to cows with healthy feet. Cows that developed sole lesions and ulcers spent the majority of this extra standing time "perching" half way in the stall compared to their herdmates, while spending the same amount of time standing in other housing areas. This specific behavior allows producers to not only identify the cows at the highest risk for lameness, but to also make housing design adjustments to alter detrimental behavior.

Quality CORNER

Justification for Managing DCAD in Dry Cow Diets

In a recent study with dairy cows, Chapinal et al. (*J. Dairy Sci.* 95:1301-1309) examined the associations of periparturient calcium status with early lactation milk production and pregnancy at first insemination. They found that cows with serum calcium concentrations ≤2.1 mmol/L during the week before calving suffered significant milk loss through the first four DHIA tests. There were some interactions with serum NEFA and BHBA levels in these hypocalemic cows; nonetheless, low blood calcium was an influencing factor in early lactation milk loss. Furthermore, they concluded that cows with low blood calcium during the week before calving through the first three weeks of lactation had a lower probability of pregnancy to the first breeding.

The causes and prevention of hypocalcemia are no longer a biological mystery, and delivering diets that maintain adequate blood calcium has become a mainstream management practice. We have excellent tools at our disposal – laboratory analyses for minerals in feedstuffs; ration balancing programs with which to perform our calculations; herd management software that tells us when to dry cows off and when to move them to the close up pen; and anionic products like SoyChlor® to provide the needed nutrients to properly balance DCAD in pre-fresh diets. As results from new research continue to expand our existing pool of knowledge, we will get even better at making fresh cow problems go away.

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CHANGE SERVICE REQUESTED

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- Nutrition and mammary gland development.
- Animal behavior and disease diagnostics.

Nutrition P+L+U+S

MYSTERIES OF STARCH *continued from page one*

of dry corn ranges from 2.5 to 5.5 percent of dry matter," Hoffman explains. "Corn with higher than 4.5 percent prolamin is more likely to be vitreous with the starch more tightly bonded."

The prolamin protein assay does not measure the degradation of prolamin in high-moisture corn that is induced by fermentation. To keep track of this process, Hoffman advises regularly checking mean particle size and ammonia nitrogen levels, and utilizing the simple FeedGrainV2.0 program to increase knowledge of how these factors dynamically affect starch digestibility.

Iowa-based nutritionist Marty Faldet has been monitoring the fate of prolamin breakdown – mostly by evaluating ammonia nitrogen levels in high-moisture corn for about a year. He says the information is a powerful tool in understanding exactly what is happening with high-moisture corn at any given time.

"It has been pretty common knowledge that high-moisture corn becomes 'hotter' over time, which changes the way it feeds -- sometimes fairly dramatically," he notes. "Now we have a greater understanding of what is actually occurring and how to compensate for those changes."

Hoffman says he hopes the improved understanding of the starch-protein matrix will help producers and their nutritionists fine-tune TMR starch content while concurrently managing feed costs. "I think we've taken some of the mystery out of this and quantified it. Hopefully diets can be adjusted for differences in starch digestibility with more confidence because we better understand some of the basic mechanisms."

To learn more about grain quality and quantifying prolamin content and starch availability, visit http://www.uwex.edu/ces/dairynutrition/.