ROCK RIVER LABORATORY, INC.
AGRICULTURAL ANALYSIS

TECHNICAL BULLETIN

Rumen Starch Digestion Methodology

Background:
Commercial laboratories aim for logical laboratory science and accuracy, defined as agreement with cow responses. One of the most scrutinized nutritive assessments, in regards to accuracy and on-farm agreement, is rumen starch digestion. This measurement can be a critical component in: Identifying slow digesting grain or silage to find more milk, better understanding rumen fermentable starch load to manage butterfat, and understanding if there is too much rumen bypass starch, which could contribute to hind-gut digestive upset in dairy or beef animals.

Two practical rumen starch digestion measures have been adopted by a number of commercial laboratories: *in vitro* and *in situ*. *In vitro* rumen starch digestion analysis refers to the lab-bench technique that attempts to simulate the rumen environment and digestion. The *in vitro* technique for starch analysis can typically offer users quick sample analysis turnaround, at a lesser cost than other techniques.

In situ rumen starch digestion analysis references the rumen digestion technique that incorporates actual animal rumen incubation, providing measures to help separate higher quality feeds. Because this *in situ* rumen digestion technique incorporates live animals, it demands more effort than that of *in vitro* analysis techniques.

Overview:
Understanding nutrient digestion is critical to optimizing dairy and beef animal performance, but measuring and interpreting rumen, and total-tract digestion, can prove challenging.

Details:
Following multiple years of research, Rock River Laboratory has employed the *in situ* rumen digestion technique for starch digestion analysis since 2014. This technique allows the laboratory to utilize larger sample sizes (enough sample to hold in your hand) as opposed to the fine sample grind that is necessary with *in vitro* rumen lab-bench techniques. Rock River Laboratory has also developed accurate NIR calibrations for 7-hour *in situ* rumen starch digestion, along with 0, 3, and 16-hour starch digestion.

Discussion:
Rumen *in situ* starch digestion may best reflect how dairy cattle will respond to differences in corn grain, snaplage or earlage, and corn silage. Heuer (2014) compared rumen *in vitro* and *in situ* rumen digestion techniques using high-moisture corn, dry corn, grain, and corn silage samples. The *in vitro* digestion measures were completed on a lab bench, using samples ground to pass a 4 millimeter (mm) screen. The *in situ* technique within the same study involved incubating samples ground to pass a 6 mm screen in several lactating dairy cattle rumens. Heuer (2014) found poor agreement between the two techniques and noted *in vitro* rumen starch digestion over-estimated *in situ* rumen digestion.

Powell-Smith et al. (2015) demonstrated that commercial laboratory *in vitro* rumen starch digestion was not correlated to *in vivo* (within the animal) starch digestion for commercial dairies. Later, Schuling et al. (2016) evaluated both *in vitro* and *in situ* rumen starch digestion offered by commercial laboratories. The authors found similar results as Powell-Smith et al. (2015), in that *in vitro* rumen starch digestion was not related to commercial dairy cattle starch digestion. However, Schuling et al. (2016) found commercial laboratory *in situ* rumen starch digestion results, measured by Rock River Laboratory, were significantly related to *in vivo* commercial dairy cattle starch digestion. The authors also found that rumen starch digestion rates (k_d), calculated from 7-hour *in situ* measures, improved the CNCPS v6.5 model milk prediction (when using feed library versus *in situ* measured starch k_d, R^{2*} improved from 0.69 to 0.76, respectively).

Conclusion:
Starch digestion measures will continue to evolve and improve. However, Rock River Laboratory *in situ* rumen starch digestion is related to actual on-farm commercial dairy cattle starch digestion and the results from this analysis can improve diet formulation accuracy.

*The coefficient of determination; a common statistical measure of how close the data are to the fitted regression line.

For references, see next page.

References:
Heuer, C.R. 2014. Ensiling and processing of corn silage and high moisture corns and laboratory method comparison of starch digestion in ruminants. M.S. Thesis. University of Wisconsin – Madison, Madison, USA.

Powel-Smith, B., L.J. Nuzback, W.C. Mahanna and F.N. Owens 2015. Starch and NDF digestibility by high-producing lactating cows: A field study. J Dairy Sci. 98:E-suppl. 2. pg. 467.

Schuling, S.E., D. Schimeck, and B. Vander Wal. 2016. Evaluation of in vitro and in situ starch digestibility assays. J Dairy Sci. 99:E-suppl. 1. pg. 777.