microbial efficiency

maintenance levels by nearly 18-fold (Russell, 2007).

A shortfall of RDP may exist today in dairy diets with high corn silage inclusion levels. As corn silage increasingly replaces alfalfa or grass silage, replacing the RDP typically provided from alfalfa/grass silage becomes more of an issue.

Fine-tuning the RDP levels may be further challenged, given the commonly held concern of nutritionists and laboratories about the ability of the Borate-Buffer Method to accurately measure the soluble protein needed to fuel microbial growth.

Personal experience has shown me that improvements in herd production occurred when additional RDP was added to diets despite the Borate-Buffer Method indicating that an adequate soluble protein level was present in the diet, even though the microbial soluble protein method provided on the Fermentrics analysis showed lower-than-recommended levels.

Dietary RDP levels may also need adjusting throughout the feeding season in response to the increase in ruminal starch digestibility observed over time in ensiled corn silage and high-moisture grains.

Energy spilling is most common when cells are limited for nutrients other than energy, but even rapidly growing cells can spill a significant amount of energy (Russell, 2007). The author has observed an unexplained lack of microbial biomass yield in certain high-quality alfalfa silages, suggesting that there may be other growth-limiting factors besides nitrogen-based compounds. The only cells that do not seem to spill energy are those limited for energy (Russell, 2002).

Microbial villains

Streptococcus bovis is typically associated with ruminal acidosis due to its unmatched growth rate when fermenting carbohydrate to lactate and reducing rumen pH to levels where only acid-tolerant lactobacillus can survive (Hackmann, 2014). However, it is also known that non-growing S. bovis are capable of “spilling” as much ATP as is utilized by those that are rapidly growing (Russell, 2007). This is because S. bovis lacks the ability to store energy as glycogen, so spilling inevitably occurs when growth is limited from the futile cycle of protons out of the cell, only to return later (proton pump) with the net production of heat (Hackmann, 2014).

Although S. bovis is associated with high-concentrate diets, it is still present in high-forage diets and, thus, is a natural target for reduction in an attempt to improve overall dietary efficiency.

It is additionally known that other populations of microbial villains are also responsible for spilling energy even when lactate is not produced (Hackmann, 2014). To date, there has been limited success in reducing populations of rumen microbes known for their energy spilling tendencies through the use of antibiotics, bacteriophages or vaccines.

One area that merits more investigation involves in vitro evidence that live yeast (Saccharomyces cerevisiae) competes with S. bovis for carbohydrates, but it is not known how extensive the possible competitive inhibition is.

The Bottom Line

One approach to increasing the efficiency of ruminal microbial biomass production is to minimize the impact of bacterial maintenance expenditure, glycogen storage and energy spilling.

Laboratory methods, such as Fermentrics, that allow for direct measurement of microbial biomass can prove extremely helpful in understanding the associative effects of dietary ingredients and why some diets perform as predicted while others don’t seem to elicit the expected response.

It may be that these associative effects are influencing whether ATP is being efficiently utilized for microbial growth, stored as glycogen for later use or wasted via energy spilling due to a lack of synchrony of dietary nutrients.

References


“Bill Mahanna (Ph.D., Dipl. ACAN) is a collaborative faculty member at Iowa State University and a board-certified nutritionist for DuPont Pioneer based in Johnston, Iowa. To expedite answers to questions concerning this article, please direct inquiries to Feedstuffs, Bottom Line of Nutrition, 7900 International Drive, Suite 650, Bloomington, Minn. 55425, or email comments@feedstuffs.com.”