New Findings, New Tools Aid Scientists in Their Search for Improved Silage Inoculants

Richard Muck, Lori Bocher, U.S. Dairy Forage Research Center

The silage making process is a race against time between 1) enzymes that begin to degrade the plant as soon as it is cut, causing a loss of energy, protein, and other nutrients in the feed, and 2) the growth of lactic acid bacteria that convert plant sugars into lactic acid which lowers the pH until most degrading enzymes are inhibited and the growth of lactic acid bacteria itself is inhibited – thus preserving the feed.

Microbial inoculants have become the dominant silage additive type and have been available in the U.S. for decades. Until recently, most of these products were strains of facultative heterofermentative lactic acid bacteria (commonly called homofermenters) such as *Lactobacillus plantarum*, *L. casei*, various *Pediococcus* species, and *Enterococcus faecium*. The goal was to have a rapid and efficient fermentation that produced mostly lactic acid, minimizing dry matter losses and attempting to keep nutritive value similar to that of the crop at ensiling. The best of these products have not only enhanced silage fermentation and dry matter recovery but also improved animal performance: milk production, gain, and feed efficiency.

However, these products have had a negative effect on aerobic stability in whole-crop corn and small grain silages, presumably due to the reduction in acetic acid. In the late 1990s, a new class of inoculants, based on obligate heterofermenters such as *L. buchneri*, entered the market. These strains grow slowly even after the active fermentation period is finished, producing acetic acid from sugars or lactic acid. The primary goal is to increase acetic acid so yeast and mold growth is inhibited and aerobic stability is improved. However, these products, in general, appear to have limited effects on animal performance other than keeping silage cool.

Today, there is a third class of inoculants that combine *L. buchneri* with more traditional strains attempting to get the dry matter recovery and animal performance of the facultative heterofermentative strains along with the aerobic stability improvements provided by *L. buchneri*.

Additional Animal Response

As stated above, research has shown some lactic acid bacteria inoculants also cause an animal response (i.e., increased milk and meat production) above and beyond what one would expect from the inoculant-induced improvement in forage quality. While the return on investment for silage inoculants is basically 1:1 based on dry matter recovery alone, if there is a 3-5% increase in milk production as some studies have shown, the return on investment could be as high as 10:1. Now that researchers know there is an animal response with some inoculants, they are trying to determine the causes of that response in an effort to lead to improved inoculants with a higher return on investment for farmers.

The animal response to inoculants has been observed in some studies for more than 30 years. Unfortunately, the reasons for improved milk production, for example, have not been obvious. Various recent studies have suggested possible means by which inoculants may alter animal responses to treated silages. Results from these studies suggest that some, but not all, inoculants are altering the in vitro ruminal fermentation in ways that should lead to increased animal performance, whether by reduced methane and milk urea nitrogen production (suggesting better nitrogen utilization) or increased microbial biomass production (these microorganisms are the biggest source of protein for the cow).

Certainly there is considerably more research to be done in this area; researchers still do not understand the mechanisms involved in the animal response to lactic acid bacteria. Fortunately, it appears that in vitro analyses and new PCR-based tools (see page 21 for sidebar) may be helpful in uncovering the secrets of how inoculation of silages by particular lactic acid bacteria strains affects silage utilization by ruminants.