Rumen Bacteria Determine Outcome of Dairy Cattle Feeding Programs

By Donna M. Amaral-Phillips

College of Agriculture, Food and Environment
Cooperative Extension Service

Dairy cows, like all ruminant animals, can digest forages and other fibrous feedstuffs that humans, pigs and chickens cannot. This digestive feat is accomplished through a symbiotic relationship between the cow and the bacteria and protozoa that reside within the cow's rumen. In this relationship, the cow provides a warm, substrate-rich environment suitable for the bacteria and protozoa to grow and reproduce. In return, these microbes provide the cow with an energy and protein source the cow in turn uses to produce milk and for growth and maintenance.

Thousands of species of rumen bacteria

Thousands of different species of bacteria and protozoa have been identified within the rumen contents of cattle. Bacterial species differ between individual cows. These differences in species relate to not only different feeding regimens, but also the individual microbiota of the cows themselves. Studies have fed the same diet to individual cows and identified different populations of bacteria within each of their rumen contents. Next, they swapped the rumen contents and thus bacteria from these 2 cows. Within a short time frame (2 to 9 weeks depending on the cow), the bacterial populations within these cows returned to the original bacterial community. Thus, illustrating that the bacterial populations are unique to not only a particular feeding system, but to the cow herself.

Rumen bacteria feed the cow

In general, the rumen bacterial populations are associated with either the digestion of fiber or carbohydrates, such as starches or sugars. These bacteria produce volatile fatty acids, i.e. acetate, propionate, and butyrate, and microbial protein. Microbial protein is digested in the small intestine of cattle and absorbed as amino acids. Microbial protein accounts for 60 to 75% of the protein or amino acid needs of a cow and has an amino acid profile similar to those needed by the cow to produce milk protein. Propionate is used by the liver to synthesize glucose. The cow then uses this glucose as an energy source and to synthesize milk lactose, which in turn determines milk yield. Acetate and butyrate are used by the cow for energy and by the mammary gland to make milk fat.

Optimizing Rumen Environment

To optimize the digestion of fiber and produce products the cow needs for milk production, feeding programs are designed and implemented on-farm to minimize the amount of time the rumen environment is below a pH of 5.8. Fiber-digesting bacteria prefer a rumen pH greater than 6 whereas starch digesters survive in a slightly lower pH. Ruminal pH varies over the day relative to time fed, composition and processing of feeds consumed, and amount of saliva produced when cows ruminate or chew their cud. With the higher carbohydrate diets normally fed to lactating dairy cows, preventing large swings in ruminal pH and minimizing the time the pH of the rumen contents is below 5.8 becomes a challenge, but is needed to optimize performance. Cows undergoing these sub-acute, ruminal acidotic bouts have reduced fiber digestion, feed

efficiency, and dry matter intake, possibly resulting in lower body condition, milk fat depression, lost milk production, and increased incidence of lameness . Thus, optimizing rumen fermentation to maintain ruminal pH in the ideal range, preventing large swings in rumen pH, and minimizing the amount of time the rumen environment is below 5.8 is important when managing high-producing dairy cows.

Feeding programs influence bacteria

To achieve this objective, dairy cows need to be fed adequate amounts of effective fiber which stimulates cud chewing and minimizes sorting behavior of cows fed a TMR. In component-fed herds do not feed more than 6 to 8 lbs grain within a 4-hour time frame. By paying attention to the behavior of cows and following these feeding practices, the microbes residing in the cow's rumen can provide the cow with the necessary products to produce milk more economically. When implementing and managing feeding programs, we must remember that we are feeding the rumen microorganisms first and they are providing a large component of the nutrients needed by dairy cows to produce milk and for growth in dairy heifers.