How Does PRO Work?

The rumen of a cow is a very important part of the digestive system. It allows the cow to consume fibrous materials from which energy and protein are extracted via fermentation. The fermentation is carried out by a variety of species of microbes that co-exist in the rumen. The cow obtains most of her energy needs from the volatile fatty acids that are the end product of fermentation. The microbial mass produced provides bacterial protein that will supply about ½ of the cow's need for metabolizable amino acids.

Dairyman's Edge® PRO is a product that is designed to augment the fermentation rate by providing nutrients for the rumen microbes and by assisting in the liberation of carbohydrates from fibrous feeds (i.e. cellulose and hemicelluloses). By increasing the supply of raw materials for the microbes, there will be more energy and metabolizable protein available to the cow.

Live yeast and **yeast culture** are excellent sources of nucleic acids, the backbone structures of DNA. Bacteria incorporate nucleic acid directly into the cells in order to manufacture DNA and reproduce. Adding the yeast with its nucleic acids means that the bacteria do not have to absorb amino acids to convert into nucleic acids for DNA, with the result that there is more protein available for microbial growth.

Yeast culture is also an excellent source of iso acids, branch chain amino acids such as leucine, isoleucine and valine, which fiber-digesting bacteria use for protein. Yeast culture contains a vast array of metabolic byproducts such as vitamins, enzymes and co-factors that promote the rapid production of rumen microbes.

Live yeast ferments without producing hydrogen ions, which helps stabilize the rumen pH by preventing the rumen mixture from becoming acidic. **Live yeast** may also promote bacteria that use up lactate, which helps prevent an acidic environment. Oxygen scavenging after feeding is a key attribute of **Live yeast**, which in turn assists in initiating rumen fermentation.

There are two pathways in which glucose is catabolized. In glycolysis a cell (rumen microbe) will split the 6 carbon glucose molecule into 2 three carbon molecules of pyruvate which is converted to 2 molecules of lactic acid (also 3 carbon) with the capture of energy from the process. In fermentation (yeast) the pyruvate is reduced to a 2 carbon molecule (ethanol) by the liberation of carbon dioxide. Both glycolysis and fermentation requires 2 hydrogen atoms per unit of glucose to complete the process; however, with glycolysis the lactic acid will ionize to release H+ which reduces the pH of the rumen whereas the ethanol of fermentation is pH neutral.

The **bacteriae** in Dairyman's Edge® PRO, **Enterococcus Faecium, Lactobacillus Acidophilus, Lactobacillus Plantarum, Lactobacillus Brevis and Bacillus Subtilus** are added for the purpose of competitive exclusion of pathogenic bacteria (More "Good" versus "Bad" bacteria). These five bacterial species are known for their ability to attach to the gut wall, thus taking up the attachment sites and preventing pathogens such as E-coli and salmonella from establishing in the gut. For these bacteria to be effective, they must be species native to the rumen. Our addition of these 5 bacterial cultures simply adds more that can be attached to the gut wall. The 5 species that we have added will do far more than simply adding lactobacillus acidophilus. In addition to competitive exclusion, the bacteria also provide enzymes, vitamins and other nutritional factors that the rumen microbes can utilize.

The **enzymes** in Dairyman's Edge® PRO are added to help break down starch and fiber compounds into simpler substances such as glucose, which are more easily digested by the rumen microbes. As a result, more nutrients will be available to the cow and less nutrients, whole grain and fiber, will end up in the manure.

The extracts of **Aspergillus Oryzae, Trichoderma Longibrachiatum, and Bacillus cultures** are sources of enzymes that aid in the breakdown of carbohydrates in the rumen. The rumen microbes utilize the carbohydrates of the forages and grains, ie cellulose, hemicellulose, beta-glucans, pectin, starch and sugar, as energy sources and building blocks for the production of microbial protein.

As with all digestive systems, the bacteria secrete enzymes into the rumen liquor in order to break apart the various chemical bonds holding the carbohydrates in place. It is relatively easy to reduce the sugars, starches, and pectin into simpler carbohydrates. But the structural carbohydrates are a different matter. The bonds that give the cellulose and hemicellulose structural strength are difficult and require specialized enzyme systems.

Given enough time, the rumen bacteria can accomplish their tasks. However, today's high milk production level and greater feed intake of cows means a faster feed turnover rate and thus less time for the rumen microbes to do their job. This is why adding exogenous enzymes gives a boost to the system and the cow benefits by reaching a higher plane of production.

By adding these enzymes, we can increase the rate of carbohydrate assimilation by the rumen microbes. Adding exogenous enzymes to the rumen has shown a synergy with up to 40% more total activity being measured. The natural enzymes of the rumen have their maximum activity at a pH of 6.0, and appear to lose about 50% of this activity when the pH is lowered to 5.0. Conversely, commercial enzymes are most active at pH 5.0 and lose half or more of their potency at the higher pH level of 6.5. The use of added enzymes would tend to help the cow in times of grain overload and lower pH in the rumen.

The significant enzymes being supplied in Dairyman's Edge® PRO are **cellulase, hemicellulase, b-glucanase and amylase.** Cellulase attacks the beta 1-4 bonds of the glucose units in cellulose and liberates glucose into the rumen liquor. Hemicellulase or xylanase breaks apart the xylan back bone of the hemicellulose molecule. Other enzymes then can complete the digestion and liberate glucose, ribose, arabinose and other sugars. Beta glucan is a complicated structure made up of glucose held together by both beta 1-4 and beta 1-3 bonds. The enzyme beta glucanase attacks these bonds and liberates the glucose. Amylase, which liberates glucose found in starch by breaking the alpha 1-4 bonds, is important in solublizing the starch of dry corn and making it available to the rumen microbes.

The **Salt of Glutamic** Acid aids in the formation of microbial protein in the rumen. The microflora needs to make protein in order to multiply. The bacteria absorb free amino acids, some polypeptides and ammonia from the rumen liquor and use these resources to build its own proteins. Glutamic acid can be transaminated into a multitude of different amino acids and is an important building block in protein formation. Adding small amounts of glutamic acid to rumen fluid has been shown to stimulate microbial protein production.

To **understand how all this works** Papillon undertook some detailed experiments using fistulated cows in which selected feedstuffs (corn silage, alfalfa silage, timothy hay, dry corn grain and soybean meal) were incubated in the rumen. After 6, 12 and 24 hours of incubation the samples were removed and chemical tests were done. Fermentation rates, lag times, and solubility's were established.

Each feedstuff is different and Dairyman's Edge® PRO will affect them differently:

- Corn silage has mainly cellulose and less hemicellulose than alfalfa or grass; beta glucans are higher in grasses and small grains
- Forages contain other complex carbohydrates in significant amounts
- Corn grain has starch that is not soluble
- Soybean meal has high levels of complex carbohydrates

With corn silage the lag time for NDF fermentation decreased by 1 hour and for ADF by 4 hours. The fermentation rates remained constant at about 2.5%/hr. Thus the digestion of the NDF would be increased by 1.0% and the ADF by 4.0% over a 24 hour rumen turnover. The corn silage had 48% NDF and 29% ADF.

The NDF fermentation rate of alfalfa silage did not change but the ADF rate doubled from 1% to 2%. Lag times of both NDF and ADF decreased by 1 hour. With rate constants of about 2%, this means that digestibility of NDF fractions were unchanged and ADF increased by 7.3%. The alfalfa silage had 47% NDF and 36% ADF.

The NDF fermentation rate of timothy hay increased from 2.16% to 2.55% and the ADF rate increased from 1.98% to 2.35%. Lag times of both NDF and ADF went unchanged. Overall the digestibility of NDF fractions were increased by 5.00% and ADF increased by 2.00%. The timothy hay had 69% NDF and 36% ADF.

The solubility of the dry corn grain doubled from 15% to 30% of the dry matter. The lag times were unaffected but the NDF fermentation rate increased from 4.89% to 7.15%. The ADF rate was only slightly increased by 0.35%/hr. Corn has much less of these components and thus we could expect over a 24 hour incubation that the grain had a 5.50% increase in NDF digestion and the ADF digestion was unchanged.

Soybean meal reacted somewhat like corn grain in that the solubility of the dry matter increased by about 15%. Lag times were unaffected but the fermentation rates of the NDF and ADF were increased by about 1.5%/hr. Soybean meal was 9.5% NDF and 7.5% ADF. Therefore, the improvement in digestibility was 3.00% of the NDF fraction and 1.80% of ADF fraction.

These improvements in digestibility will deliver more glucose for the rumen microbes to feed upon. With the protein, nucleic acids and other nutrients supplied by the yeast, yeast culture and bacteria the microflora can grow more rapidly and in the end produce more microbial protein. Increases of 24% in metabolizable protein from the rumen microbes have been measured.

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