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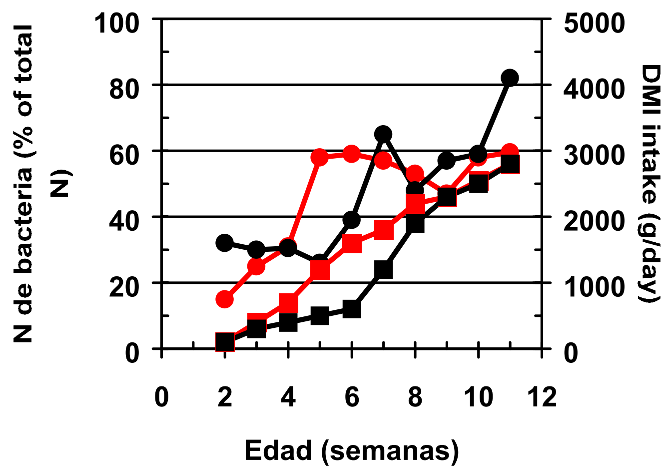
Calf Note #31 – Microbial Protein Synthesis in the Rumen

Note: This Calf Note is designed to provide some background into the formulation of liquid and solid diets for young dairy calves. Other Notes will address other aspects of ration formulation for calves.

Introduction. Functional ruminants have the ability to utilize cellulose in forages. Preruminants (ruminants without functional rumens) do not have this ability. Although there is a large population of bacteria in the rumen from an early age, there is a delay in the ability of the microbial population and the calf to utilize forages.

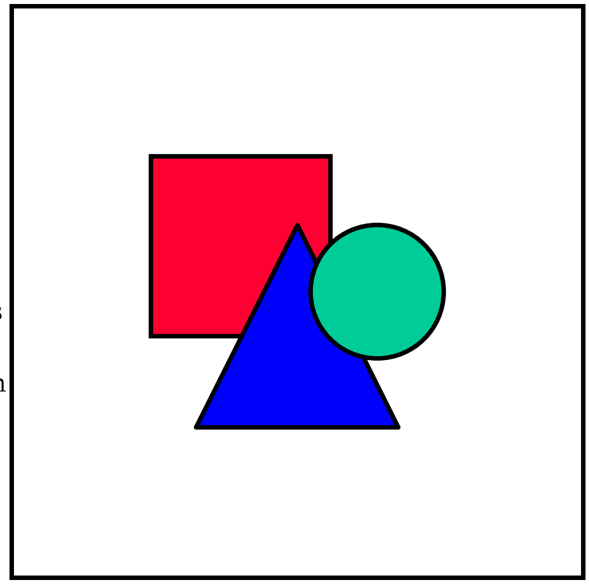
In addition to cellulose fermentation, the functional rumen also produces a large amount of bacterial protein that can be digested and absorbed by the ruminant. This bacterial protein contains large amounts of essential amino acids and is an excellent source of protein for the animal. Two interesting questions related to rumen development in calves are: when does microbial protein become a significant source of protein for the animal, and does the amino acid profile of the microbial protein change as the microbial population develops in the calf?



Percent bacterial N in total abomasal N (circles) and DM intake (squares) in calves weaned at 4 (red) or 8 (black) weeks of age.

Naturally, if the amount of protein (or the amino acid profile) changes as the rumen of the calf develops, then it becomes extremely difficult to develop feeding programs for young calves utilizing the concepts of rumen degradable protein (**RDP**) and rumen undegradable protein (**RUP**). The RDP:RUP concept is widely utilized in ration balancing for mature ruminants.

Research done at the University of New Hampshire addressed the question of when microbial protein becomes a significant source of protein for the calf. The contribution of microbial protein to total protein in the young calves changes with age (see figure). As calves age (and, more importantly, intake of starter increases), the amount of microbial protein in total protein reaching the small intestine increases, until it approaches 80% of all protein leaving the rumen by about 3 to 4 weeks after weaning.



The question of amino acid composition of bacterial protein was also addressed. It is important to note that the populations of bacteria change as the calf's rumen develops (for more information, see "Calf Note #05 - Rumen bacteria in calves"). Aerobic bacteria (oxygen utilizers) are replaced by anaerobes (bacteria that don't utilize oxygen) and facultative anaerobes (bacteria that can use or not use oxygen) as the rumen develops. However, the research done at UNH determined that although there were changes in bacterial populations, there was little change in the overall amino acid composition of the bacteria. This means that when we add RUP to supplement microbial protein, we won't have to factor in changes in the amino acid composition of the rumen bacteria. This makes the job of formulating calf diets significantly easier.

Balancing rations for calves can be a particular challenge. As the rumen develops, there are profound changes in the amounts and types of nutrients that reach the intestine. Also, changes in the animal's digestive system further complicate the formulation of diets for young calves. This means that diets properly formulated for a 2-week old calf may not be appropriate for an 8-week old calf. High quality nutrient sources, including proper combinations of RDP and RUP will be necessary to maximize rates and efficiency of body weight gain in calves.

For more information related to microbial protein synthesis in calves, see the Journal of Dairy Science article:

Quigley, J. D., III, C. G. Schwab, and W. E. Hylton. 1985. Development of rumen function in calves: nature of protein reaching the abomasum. Journal Dairy Science 68:694-702.