

Bypass Protein

1. Background

Over the past 10 years, we have conducted many experiments to determine the bypass protein values of feeds and to evaluate lactation responses to feeding bypass protein. In this first article of a series, we will discuss some of the background necessary to understand the concepts involved. In subsequent articles, we'll present the results of our research.

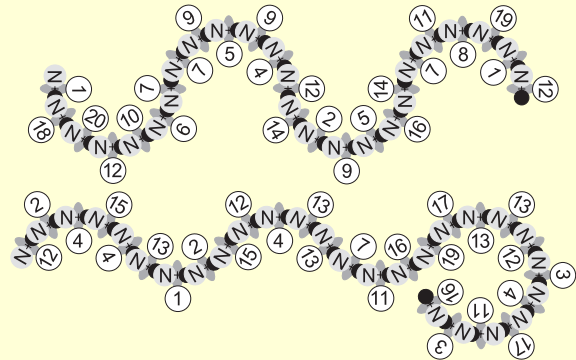


Figure 1 : Schematic diagram of true protein. Each unique protein has a characteristic shape and amino acid sequence. Most proteins consist of chains of several hundred to several thousand amino acids.

Crude protein and true protein

There are three major classes of organic components in feeds: carbohydrates (e.g. cellulose and starch), lipids (fats and oils) and proteins. True proteins are composed of long chains of amino acids, each protein distinguishable by its unique sequence of the 20 different amino acids (figure 1).

In the feed lab, protein is distinguishable from carbohydrate and lipid due to its content of nitrogen (N) - feed proteins typically contain about 16% N. This property makes it possible to estimate the protein content of a feedstuff by measuring its N content and multiplying by 6.25 (the inverse of 16%). However, not all N in feed is associated with protein. *Non-protein nitrogen* (NPN) is found in feed components such as urea, ammonium salts and single amino acids. The value calculated by multiplying total N by 6.25 is therefore labelled *crude protein*.

Since many of the most rapidly degraded proteins in feed are soluble, a feed lab measurement of *soluble protein* content may indicate the proportion of degradable crude protein which will be most quickly broken down in the rumen. However, it is important to realize that some soluble protein sources (e.g. blood meal) are degraded relatively slowly.

As shown in figure 2, the end products of DIP breakdown (mainly ammonia and amino acids) are used to build microbial cells to replace those that are constantly being swept from the rumen and ultimately, into the small intestine.

Protein degradability

Some of the crude protein in feed consumed by the cow (*intake protein*) is broken down (*degraded*) by rumen microbes. In the NRC system, this is labelled *degradable intake protein* (DIP).

The rate of degradation varies among different true proteins: some may be almost completely degraded within the first 30 minutes after entering the rumen; others may take several days. The NPN component of crude protein is degraded almost instantaneously.

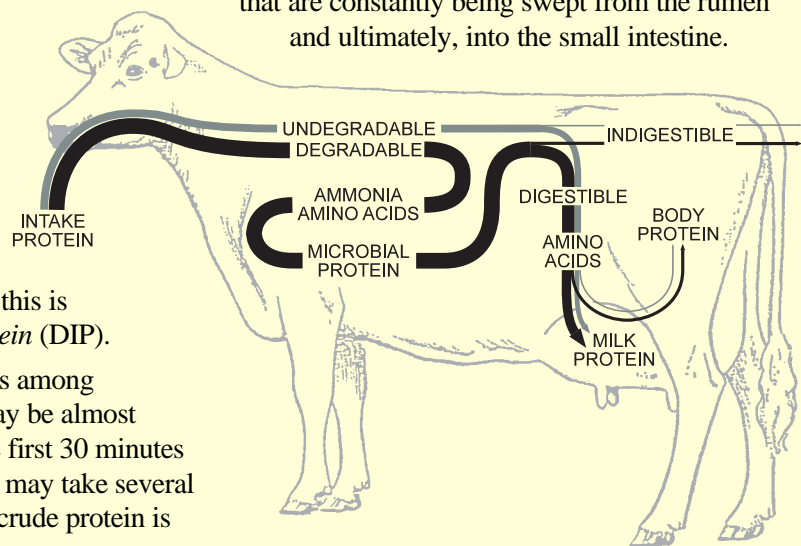


Figure 2 : Protein flow in the lactating cow.

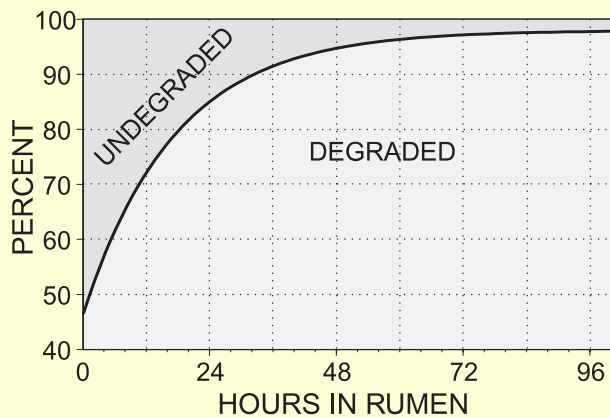


Figure 3 : Degradation depends upon both the nature of the protein and the length of time it remains in the rumen. As feed intake and passage rate through the rumen increase, retention time in the rumen and degradation decrease.

At the same time that protein is being degraded in the rumen, feed residues are flowing out of the rumen through the omasum and abomasum and into the small intestine. Therefore, when the rate of protein degradation is slow, relative to the rate of flow out of the rumen, some protein escapes microbial degradation. Commonly called *escape* or *bypass protein*, the NRC system refers to this as *undegradable intake protein (UIP)*.

Bypass increases with higher feed intake

For slowly degraded proteins, the slower the *passage rate* of feed through the rumen, the longer the feed will be exposed to microbial degradation and the smaller will be the UIP fraction (figure 3). And passage rate increases with higher feed intake. Therefore, when a bypass protein source like corn gluten meal is fed to a dry cow consuming 2% of her body weight in feed dry matter, it will have a lower UIP value than it would when fed to a lactating cow consuming twice as much. Since rumen retention time influences the extent of rumen degradability, the bypass value of a feed is not a constant, but will vary with the level of feed intake.

Protein digestibility

About 80-85% of the microbial protein and UIP which flows out of the rumen is digested in the small intestine. However, UIP fractions from some feeds are significantly less digestible. In particular, forages and by-products that have been overheated may

contain heat-damaged protein, measured in the feed lab as *acid detergent insoluble nitrogen (ADIN)*. Although moderate heating may actually improve the bypass value of some feeds, excessive heat can render a portion of the UIP completely indigestible and of no value to the cow.

Amino acid balance

The end products of protein digestion in the small intestine are amino acids. These are absorbed into the bloodstream and utilized by the cow for growth, tissue maintenance and milk production. Of the 20 amino acids commonly found in feed proteins, 10 cannot be manufactured by the cow. These *essential amino acids (EAA)* must appear in the small intestine in either microbial protein or feed UIP.

Ideally, the relative proportions of each of the EAA absorbed by the cow would exactly match her requirements, because a shortage of one can limit the utilization of the others. This reduces feed efficiency. Compare this with mixing 7 ingredients in a TMR. The ration requires constant proportions of each of the 7 ingredients. If you run short of one ingredient, then the size of the batch you can mix is limited by the availability of that limiting ingredient and the other ingredients cannot be utilized.

Microbial protein contains a blend of EAA which is far from ideal relative to the requirements of the high producing cow. The objective in choosing bypass protein ingredients is to deliver UIP which provides a blend of EAA complementing that provided by microbial protein. Much of the current research in this area is aimed at defining the cow's EAA requirements more precisely and predicting

which specific EAA might be limiting.



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