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Total Protein Requirement of Beef Cattle II: Feeding By-Product Feedstuffs.[1]

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As the use of bulk by-product feeds in beef cattle diets increases, it may be important to understand their true nutritional contributions. There are various ways to describe any given product's feeding and economic value. Feedstuffs should always first be compared on their dry matter basis. Then, the most common nutritive descriptors used in developing beef cattle diets are total digestible nutrients (TDN; representative of the energy density of the feedstuff) and crude protein (CP). Protein is likely the most expensive component of any beef cattle diet on a unit basis; therefore, it may be important to describe the qualitative differences between how a feed is valued for protein and how the animal uses protein.

Here are some definitions that will be relevant in this discussion:

Degradable intake protein (DIP) is defined as that portion of dietary protein that can be degraded in the rumen, the largest of the multi-compartmental stomach, by microbes (both bacteria and protozoa) that use the protein to manufacture high quality microbial cell proteins, also known as microbial crude protein (MCP).

Undegradable intake protein (UIP) is defined as that portion of dietary protein that escapes degradation by ruminal microbes and is passed into the small intestine for absorption. UIP levels are not constant from one feedstuff to another. Although frequently referred to as bypass proteins, they technically do not bypass the rumen, but are simply not selected by the microbes as a substrate to make MCP.

Metabolizable protein (MP) is defined as the true protein absorbed by or in the small intestine and is composed of UIP and MCP.

When balancing diets, some feedstuffs deliver primarily energy, while others deliver more protein. If energetic by-products are used to supplement low-quality forage or hay, an additional by-product that will deliver adequate protein to feed the ruminal microbes may be necessary.

Generally, crude protein is a gross measure of the nitrogen (N) contained in a feedstuff. In fact, protein is the only nutrient class that contains nitrogen. Ruminal microbes are unique in their ability to manufacture high quality proteins for use by the animal from relatively low quality feedstuffs, as long

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as they have an adequate supply of N, and a source of energy (technically speaking, carbon). Crude protein valuations of feedstuffs, however, do not account for rumen degradation and re-synthesis of protein for use by the animal. Therefore, the use of metabolizable protein (MP) values has been adapted to describe animal protein requirements. This method accounts for the separate nutrient requirements of the microbes and those of the animal.

Feedstuffs are not equal in the extent to which their protein is degraded in the rumen (DIP), or used by microbes. Differing amounts of dietary protein remain undegraded (UIP) in the rumen and pass into the small intestine where they may be absorbed and used by the animal directly. The total amount of protein delivered to the small intestine for absorption is the sum of microbial crude protein (MCP) and UIP. Although MCP alone may be sufficient for lower levels of production, young, fast growing calves or lactating cows may require additional protein (usually UIP) derived from dietary sources to achieve performance expectations.

Table 1 is presented to display the variation in CP, DIP, UIP, TDN, and DIP:TDN ratios among common by-product feedstuffs; these are grouped by whether they are either proteinaceous or energetic in overall nutritive value and feeding purpose. Note that some feedstuffs in each category have more DIP than UIP, or vice versa, and some are more balanced in their DIP / UIP levels. Therefore, based on the combination of feedstuffs you are considering, it is important to be aware of the DIP / UIP balance of these by-products, as well as the ratio of DIP:TDN, and not just the percent of crude protein. When supplementing low-quality forages, supplemental DIP may be important. Therefore, balancing supplement DIP and TDN is also important. The suggested optimal ratio of DIP:TDN is approximately 8-13%. Generally, providing supplements with DIP:TDN ratios greater than this level ensures that an adequate level of DIP is available to rumen microbes, thus enhancing the utilization of low-quality forage by the animal.

One super-source of DIP omitted from the table is urea. Urea is not really a protein, but is a highly soluble source of non-protein nitrogen (NPN), and thus provides an abundant source of N to rumen microbes. Urea is likely most appropriate in high-grain, or concentrate diets because of the high rate of starch degradation in the rumen. The starch provides a carbon supply while the urea delivers N, and fermentation is more closely balanced. Utilization of urea and other NPN sources in forage or other low-protein diets may be less effective and even dangerous because of the rapid release of ammonia, but may also be due to insufficient UIP. For these diets, natural proteins like some of those described above produce more favorable results and are safer to feed.

Generally, dry pregnant cows and even lactating cows with low levels of milk production can subsist on fairly low protein diets, i.e., less than 10% crude protein. However, as the level of production increases and cows lactate more heavily, their protein, and probably UIP requirements increase, as well. This is especially true for young, fast-growing calves whose total protein requirements at times can be more than twice that of their dams.

For additional information on the use of by-product feedstuffs in beef diets, access either of the following EDIS documents: Alternative feeds for beef cattle edis.ifas.ufl.edu/AN128; or Strategies for cost effective supplementation of beef cattle edis.ifas.ufl.edu/AN085.

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Table 1. Protein (CP, DIP, UIP) and energy (TDN) concentrations of selected feedstuffs

Feedstuff	CP % [1]	TDN % [1]	TDN:CP[2]	DIP %[1]	DIP:TDN[3]	UIP %[1]
Protein Feeds:						
Corn gluten feed	25.0	80.0	3.2	75.0	23.4	25.0
Corn gluten meal	46.0	89.0	1.9	38.0	19.6	62.0
Cottonseed meal	49.0	77.0	1.6	57.0	36.3	43.0
Blood meal	93.0	66.0	0.7	25.0	35.2	75.0
Feather meal	85.0	69.0	0.8	30.0	36.9	70.0
Soybean meal	49.0	87.0	1.8	65.0	36.6	35.0
Energy Feeds:						
Citrus pulp	6.0	79.0	13.0	42.0	3.2	58.0
Corn grain	10.0	88.0	8.8	57.0	6.5	43.0
Cottonseed	23.0	95.0	4.1	70.0	17.0	30.0
Molasses	5.0	74.0	14.8	100.0	6.8	0.0
Soybean hulls	12.0	77.0	6.4	58.0	9.0	42.0
Wheat middlings	18.0	82.0	4.6	77.0	16.9	23.0

[1]Tabled values derived from 1996 NRC Nutrient Requirements of Beef Cattle, 7th Ed. and other sources; CP=crude protein, TDN=total digestible nutrients, DIP=degradable intake protein, UIP=undegradable intake protein.
[2]In this representation, protein feeds have a TDN:CP ratio of 4.0:1 or less; energy feeds have ratios greater than 4.0.
[3]This represents the ratio of DIP to TDN and is calculated as follows: DIP as a percentage of CP:TDN.