Total Protein Requirement of Beef Cattle II: Protein Components[1]

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As the use of bulk co-product feeds in beef cattle diets increases, it may be important to understand their true nutritional contributions. 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. Protein is likely the most expensive component of any beef cattle diet on a per 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:

- **Rumen degradable protein (RDP)** is defined as that portion of dietary protein that can be degraded in the rumen, the largest of the multi-compartmental stomach, by microorganisms (both bacteria and protozoa) that use the protein to manufacture high quality microbial cell proteins, also known as microbial crude protein (MCP).
- **Rumen undegradable protein (RUP)** is defined as that portion of dietary protein that escapes degradation by ruminal microorganisms and is passed into the small intestine for digestion and absorption. The proportion of total feed protein that is undegradable is 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 utilized by the microorganisms as a substrate to make MCP.
- **Metabolizable protein (MP)** is defined as the true protein absorbed in the small intestine and is composed of RUP and MCP.

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

Generally, crude protein (CP) is a gross measure of the nitrogen (N) contained in a feedstuff. Rumen microorganisms are unique in their ability to manufacture high-quality proteins for use by the animal from relatively low-quality feedstuffs, as long as they have an adequate supply of N, and a source of energy. Crude protein valuations of feedstuffs, however, do not account for rumen degradation and re-synthesis of MCP 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 microorganisms and those of the animal.

Feedstuffs are not equal in the extent to which CP is degraded in the rumen (RDP) and used by microorganisms.

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Differing amounts of dietary protein remain undegraded (RUP) 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 RUP. Alone MCP may be sufficient for lower levels of production and mature cattle. However, young developing and growing calves or lactating cows may require additional protein (usually RUP) derived from dietary sources to achieve performance expectations.

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

One source of RDP 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 microorganisms. 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 potentially dangerous because of the rapid release of ammonia. Additionally, diet RUP levels may be insufficient. For these diets, natural proteins (those from plant-base sources) 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% CP. However, as the level of production increases and cows lactate more heavily, their MP requirements increase, which may require an RUP increase, as well. The increase in RUP requirement can also occur in 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* (http://edis.ifas.ufl.edu/AN128); or *Strategies for Cost-effective Supplementation of Beef Cattle* (http://edis.ifas.ufl.edu/AN085).

References

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Table 1. Protein components and energy concentrations of selected feedstuffs[a]

Feedstuff	CP %	TDN %	TDN:CP[b]	RDP %	RDP:TDN[c]	RUP %
Protein Feeds:						
Corn gluten feed	25.0	80.0	3.5	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
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
Cottonseed meal	30.0	88.0	2.9	26.0	8.9	74.0
Dried distillers grains	46.0	75.0	1.6	57.0	20.8	43.0
Wet brewers grains	29.0	74.0	2.6	36.0	14.1	64.0
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

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