Nitrogen and P Use by Feedlot Cattle

The N requirements for feedlot cattle

Most all beef cattle finishing diets are formulated on the basis of CP and are commonly formulated to contain greater than 12.5% CP. Crude protein systems consider all protein equal in value; even urea is considered equal in value to other natural protein sources. Over the past 15 to 20 years, research has distinctly pointed out that all protein sources are not nutritionally equal in beef cattle diets.

Much of this work has led to the development of a metabolizable protein (MP) system (Figure 13-1). Currently, the National Research Council (NRC 1996) has published an MP system for beef cattle. The MP system describes animal requirements and differentiates feedstuffs into two categories: degraded intake protein (DIP) and undegraded intake protein (UIP). Crude protein systems use a single requirement (dietary CP). The MP system determines the requirements of the ruminal microorganisms, also known as DIP, and the protein requirement of the host animal. Metabolizable protein is defined as the total amount of protein entering from the animal's small intestine. The MP is derived from microbial protein (BCP) arising from ruminal fermentation and UIP presented to the small intestine.

Basically what this protein model attempts to control is the balance of DIP and UIP from feed grains and supplemental protein sources to ensure that microbial N requirements and the host animal requirement for MP are satisfied. For example, corn grain contains about 8.5% CP. Of that CP, 60% is considered UIP and 40% is considered DIP. Therefore, dry-rolled, corn-based finishing diets typically need sources of supplemental protein that are degradable (DIP). The microbial protein that is produced from the digestion of corn grain in combination with the high UIP fraction of corn protein will meet the animal's MP needs. Conversely, high-moisture ensiled corn is 8.5% CP, but only 40% of the CP is UIP and 60% is DIP. When high levels of high-moisture corn are used in finishing diets, especially for young calves, a supplemental source of UIP may be needed in combination with the supplemental DIP to ensure that the animal's MP requirements for maximal growth are met. Feeding the incorrect source of protein will result in subpar performance and unnecessary overfeeding of protein. **The bottom line: Reducing N excretion in feedlot cattle depends on the total amount of protein (N) fed and on the source of protein.** This protein model may allow producers to formulate for lower total CP requirements but still meet the animal's MP needs for optimal gain and efficiency. This was the basis for the experiment presented in Table 13-3. The control diet was formulated simply on CP alone, while the experimental diet was formulated based on the animal's supplemental DIP and UIP needs. Without compromising animal performance, the researchers in that study lowered the CP fed by 1.5% to 2% of diet dry matter (DM) and reduced N excretion by 15% to 20%.

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With regard to finishing younger animals, like calf-fed steers (550-lb starting weight), the type of supplemental protein needed to meet the MP requirement changes significantly during the feeding period. Figure 13-2 illustrates the need for supplemental UIP and DIP in finishing calves fed a corn-based finishing diet. The total MP requirement does not necessarily change with time, but the ratio of DIP and UIP needed in the diet does. As time on feed increases for the calf-fed animal, two things happen. First, feed intake increases and more feed (typically) protein is consumed. Thus, a larger supply of UIP is provided to the animal. Second, as the animal approaches

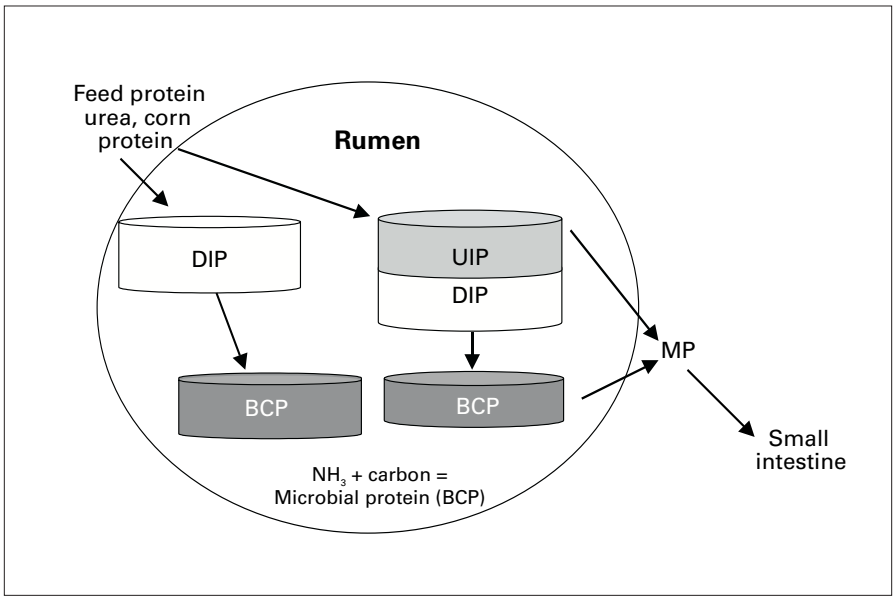

Figure 13-1. Metabolizable protein system.

finished weight, the composition of gain changes from less muscle to more fat deposition, reducing the amount of MP needed for muscle growth. Although the amount of muscle growth decreases, the need for MP for maintenance increases as the animal becomes larger. With these biological changes of the animal and increased UIP supply from the basal ration, supplemental UIP can be reduced, and consequently, the total amount of supplemental protein fed can be reduced as the animal approaches finished weight. This point is demonstrated in Table 13-3 with the calf feeding experiments. The control diet was formulated to provide 13.5% CP throughout the feeding period. By changing the amount of supplemental UIP during the feeding period, calves on the experimental diet consumed about 9 pounds less protein and maintained similar performance.

Obviously, protein supplementation for feedlot cattle is a rather dynamic and complex issue. When formulating diets to reduce N excretion in feedlot cattle, consider the following issues:

- Type of animal being fed (calf-fed steer vs yearling steer)
- How much and what type (DIP or UIP) of protein the basal dietary ingredients provide
- What type of supplemental protein source (DIP or UIP) is needed to complement basal ingredients, meeting the animal's needs

As a general rule, feedlot diets contain excess UIP, which leads to excess N excreted in the urine. In the future, methods to lower the UIP content of the diet need attention and the DIP requirements of various diet scenarios need further evaluation. In conclusion, performance does not need to be sacrificed to minimize N excretion from feedlot cattle.

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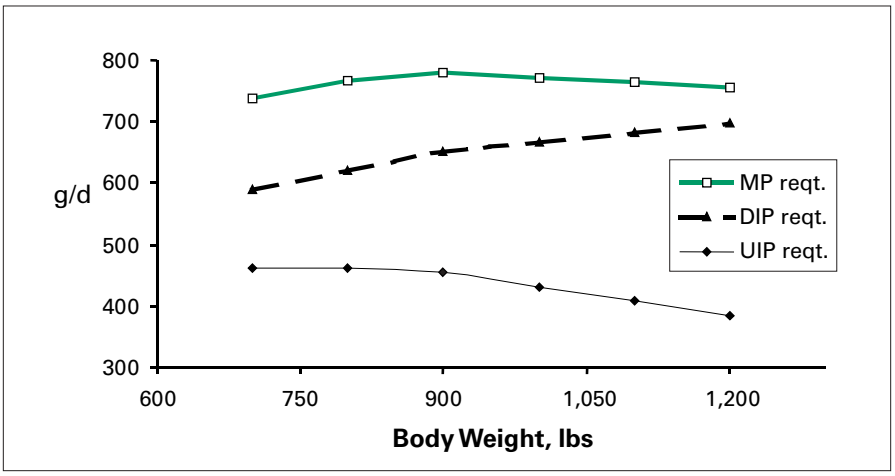

Figure 13-2. Influence of body weight on MP, DIP, and UIP requirements (reqt.) in finishing calves.

The P requirements of feedlot cattle

Phosphorus is both expensive to supplement and may have some of the most deleterious effects on the environment. Most of the beef cattle research conducted on P requirements has been performed with cattle less than 5 months of age and weighing less than 500 pounds, clearly a different animal than is typically found in a feedlot. Erickson and coworkers (1999b) have demonstrated that supplemental P in feedlot finishing diets appears to be unnecessary. Their research was conducted on yearling steers (850 lbs) fed diets in which the P concentration ranged from 0.14% to 0.34% of the diet dry matter (Table 13-4). Normally, corn grain contains about 0.32 ± 0.04% P (NRC 1996) on a DM basis. Thus the contribution of P from corn grain alone is adequate for feedlot cattle.

However, the steers used in the yearling trial were larger than some calves that may be fed in feedlots (initial weights of 550-600 lbs) subsequent to weaning. Therefore, an experiment was conducted that evaluated the P requirements of finishing calves (580 lbs) fed for 204 days. Calves were fed one of five different levels of P ranging from 0.16% to 0.40% P (76%-190% of NRC recommendations). Similar to the yearling steer study, performance and bone data were not affected by P supplementation (Table 13-5). Based on more recent data about feedlot cattle and the fact that corn contains relatively large amounts of P, P supplementation is unnecessary and should be discontinued.

Phytate-P is readily available to ruminants such as feedlot cattle. On average, 95% or more of the P bound to phytate is released during ruminal fermentation for the animal's subsequent use (Morse et al. 1992). Based on current data, supplementation of inorganic P is not necessary to compensate for phytates in feed grains or other feedstuffs for feedlot cattle.

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Table 13-4. Effect of dietary P level on finishing steer performance and bone ash concentration for yearlings.

	Dietary P level, % of Dry Matter				
Item	**0.14**	**0.19**	**0.24**	**0.29**	**0.34**
Phosphorus intake, g/d	16.4	19.9	27.6	32.0	36.2
Performance					
Dry matter intake, lbs/day	24.3	22.7	25.4	24.5	23.8
Daily gain, lbs/day	3.88	3.57	3.79	3.85	3.37
Gain/feed	6.49	6.36	6.71	6.32	7.04
Bone ash					
Grams	28.3	27.5	28.9	27.5	28.5
Grams/100 kg of BW	8.01	8.02	8.20	7.83	8.46

Source: Erickson et al. 1999.

Table 13-5. Effect of dietary P level on finishing steer performance and bone ash concentration with calves fed 204 days.

	Dietary P level, % of Dry Matter				
Item	**0.14**	**0.19**	**0.24**	**0.29**	**0.34**
Phosphorus intake, g/d	14.2	20.2	23.4	31.7	35.5
Performance					
Dry matter intake, lbs/day	19.7	19.8	18.1	20.4	19.5
Daily gain, lbs/day	3.35	3.38	3.95	3.54	3.24
Gain/feed	5.85	5.85	6.13	5.75	6.02
Bone ash					
Grams	27.8	29.3	27.8	30.9	27.6
Grams/100 kg of BW	3.96	3.71	3.78	3.81	3.58

Source: Erickson et al. 2001.