Feedlot Technical Bulletin

Protein and Energy Nutrition in the Feedlot: The Role of NPN

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The ruminant animal and rumen digestion is quite fascinating. With all the moving parts involved and the continued evolvement in promoting rumen efficiency, the complexities become apparent. A primary reason for this complexity is the rumens reliance upon a variety of different organisms and their interactions for its overall production. Despite this complexity the rumens overall function is quite simple. Consistent and adequate supply of protein (nitrogen, N) and energy (fermentable organic matter) is the backbone of promoting a highly efficient rumen.

Efficient rumen digestion is driven by the coupling of available fermentable organic matter and nitrogen. Why is this coupling important? These substrates drive all rumen microbial growth and production. They account for all energy derived from rumen fermentation (60-80% of animal requirements), for the ruminal formation of amino acids and thus microbial protein and are essential for cellular function, growth, and reproduction. A shortage of either fermentable organic matter or rumen available nitrogen, limits optimal rumen production and, therefore, animal production. In the feedlot, this particularly means coupling of starch with sufficient N to enable rumen bacteria to achieve maximal efficiency. In traditional feedlot diets this coupling is best accomplished by pairing starch with true protein (distillers grains (DG), soybean meal), and urea (NPN). Urea is essential to “fill in the gap” ensuring rumen N concentration is adequate as the N from more slowly degraded protein feeds are released over time. True protein and NPN work in concert to provide a steady supply of N, ensuring N does not become limiting for efficient rumen fermentation.

Coupling of energy and N in the rumen is important to promote rumen efficiency. In the feedlot, starch is commonly a significant energy contributor. **Table 1**, adapted from Lardy (2002), illustrates the relative rates of fermentation for some energy concentrate sources commonly found in feedlot diets. Faster rates of fermentation, as found with high moisture corn (HMC) and steam flaked corn (SFC) relative to dry rolled corn (DRC) (**Figure 1**) results in the faster production of fermentative end-products (VFA’s). Generally speaking, the faster the rate of fermentation signifies a need for more readily available N, such as urea may provide. **Figure 2** illustrates this greater N demand with the rapid depletion of rumen ammonia associated with the more rapidly fermentable grain. To sustain efficient fermentation, rumen microbes require adequate N to sustain microbial production, i.e. the faster the fermentation rate, the faster the N is utilized by rumen bacteria. In the event adequate rumen N is not available, microbial production does not cease but instead the process of N fixation becomes an energy dependent (requires energy) process, instead of an energy independent (no energy requirement) process.

Urea provides valuable degradable intake protein (DIP) to a diet. Overall, energy drives production and protein, particularly DIP, drives intake. Rumen DIP requirement is estimated by TDN intake and microbial efficiency (bacterial CP produced / 100 g TDN). From this relationship, it becomes apparent that to achieve maximal production and efficiency, both are equally important and altering one variable affects the other. Subtle alterations in the rumen environment can dictate dramatic changes in rumen production. Changes in rumen pH can alter microbial efficiency. Changes in DMI alters TDN intake, may alter passage rates and may alter microbial efficiency. Due to these relationships, it is feasible that DIP requirement is a moving target rather than a static number.

The benefits of supplying adequate DIP, in the form of urea, has been demonstrated (**Table 2**) in conventional diets and generally accepted. The value of urea, however, is commonly questioned in diets containing DG that may already contain significant levels of protein. Uwituze (2008) compared alfalfa/ SFC diets and corn silage/SFC diets with and without DG noting a numerical reduction in DMI when DG was fed along with a corresponding reduction in ADG (**Table 3**). Even though DG are high in CP, only about 45% of the protein is ruminally available and at times may be significantly lower. As demonstrated by Uwituze et.el (2008), diets that match high levels of readily fermentable carbohydrate with DG are likely to diminish rumen ammonia concentrations due to a lack of DIP which in turn may diminish microbial efficiency. Research conducted by Brown et al (2010) at West Texas A&M University reported an increase in ADG and DMI with increasing NPN concentration from 0 to 3% of the diet when the diet contained 15% WDGS (DMB). Similarly, Ceconi et al. (2012) reported an increase in ADG (**Table 4**) when a 20% DG diet contained 0.6% urea.

In summary, the need or benefit of additional urea is dependent upon several factors, many of which are difficult to understand or measure. Urea provides a cost effective means of ensuring an adequate rumen ammonia concentration is maintained across a variety of diets so that performance and efficiency potential are not wasted. Greater knowledge would be useful in identifying the full potential of urea in a variety of ruminant diets and situations, however, it is apparent that urea has a place in feedlot diets regardless of the ingredients used. Contact your local QLF representative for help in understanding the potential of urea in your feeding program.

Table 1. Relative rumen fermentation rates of common energy concentrates (Developed from Lardy, 2002)

Faster	– Dry Rolled Wheat
↑	– Dry Rolled Barley
	– Whole Barley
	– High Moisture Corn
	– Steam Flaked Corn
	– High Moisture Corn (stored whole)
↓	– Dry Rolled Corn
Slower	– Dry Whole Corn

Figure 1. Rumen VFA concentration of cattle fed DRC, HMC, and SFC based diets overtime (Included 2% urea; Cooper et al., 2002).

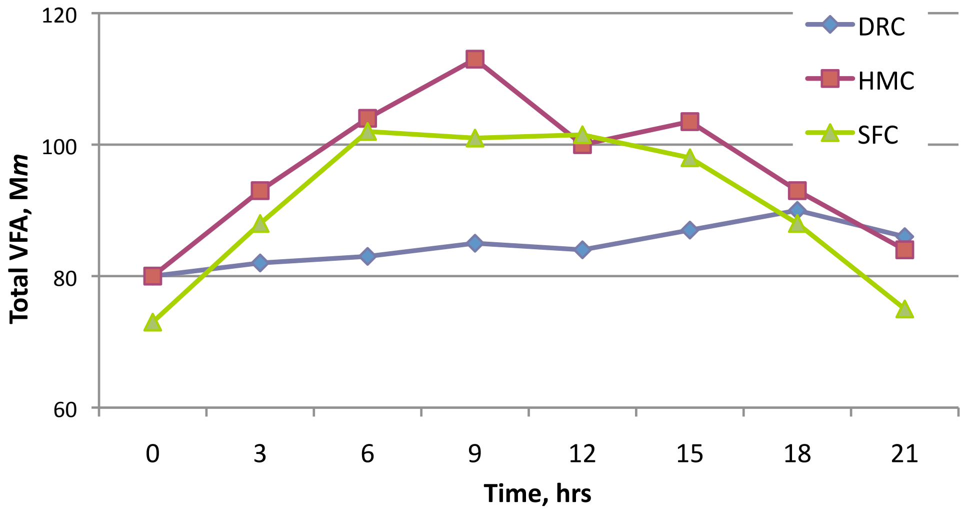

Figure 2. Rumen ammonia-N concentration of cattle fed DRC, HMC, and SFC based diets overtime (Included 2% urea; Cooper et al., 2002).

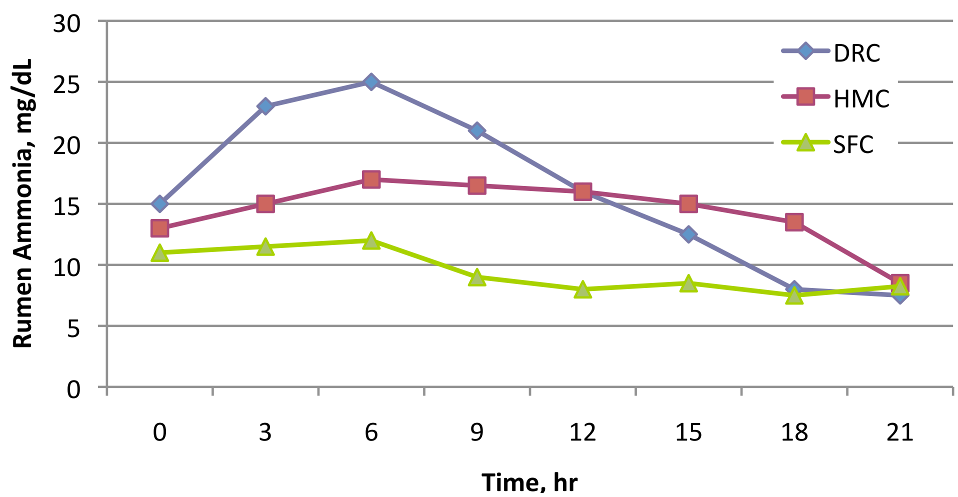

Table 2. Feedlot performance of cattle supplemented with urea, fish meal, or SBM (Zinn and Shen, 1998).

		Fish Meal, %			
	Urea	1.5	3	4.5	SBM
CP, % of DM	11.0	9.7	10.7	11.6	11.0
DIP, % of DM	7.0	5.2	5.6	5.7	6.3
DMI, lb/d	16.5	14.6	15.2	15.2	15.4
ADG, lb/d	3.73	3.11	3.44	3.57	3.44
Feed:Gain	4.43	4.69	4.43	4.27	4.48

Table 3. Feedlot performance of cattle fed alfalfa/SFC or corn silage/SFC based diets with or without distillers grains (Uwituze et al., 2008).

	Alfalfa		Corn Silage	
Item	0% DG	25% DG	0% DG	25% DG
DMI, kg/d	8.02	7.83	8.33	8.09
ADG, kg/d	1.49	1.44	1.53	1.46
Feed:Gain	5.38	5.44	5.44	5.54

Table 4. Feedlot performance of cattle fed a 20% DG diet either with no urea (CON) or 0.6% urea (HU) (Ceconi et al., 2012).

Item	CON	HU
Final BW, lb	1,323	1,351
DMI, lb/d	27.7	28.4
ADG, lb	4.21[b]	4.67[a]
Feed:Gain	6.53	6.06

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