Milk Urea Nitrogen - A Nutritional Evaluation Tool?

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Milk urea nitrogen (MUN) is another tool nutritionists and veterinarians can use to monitor the protein nutritional status of dairy cows. Milk urea nitrogen reflects the amount of urea found in milk and these values are closely correlated with the concentration of urea found in the blood. MUN values should not be used by themselves when evaluation a herd's feeding program but can be used in conjunction with evaluating milk production records, feeding management practices, and dry matter, ruminally degradable protein (RDP), ruminally undegradable protein (RUP), nonstructural carbohydrates, and water intakes.

Sources of the Urea Found in Milk Urea Nitrogen

When cows consume a diet, the microbes within the rumen degrade the protein to ammonia. The microbes, in turn, use ammonia and fermentable carbohydrates to make amino acids and microbial protein which then are degraded to amino acids and absorbed by the cow in her small intestine. Excess ammonia is absorbed across the rumen wall and passes to the liver via the portal vein where it is converted to urea. Urea can either be recycled back to the rumen through saliva or be excreted in the urine.

The amount and rate of carbohydrate digestion in the rumen are the primary regulators of microbial protein synthesis. In order to capture the ammonia, the bacteria require an energy source, fermentable carbohydrates. Dietary fats are not used as an energy source by the bacteria. Thus, sufficient, but not excessive, amounts of fermentable carbohydrates (nonstructural carbohydrates) must be provided for optimum rumen function and microbial protein synthesis.

Cows have to expend 2 Mcal or more of energy to excrete the excess urea through the urine. Thus, excretion of excess urea is an energy requiring process. Excess concentrations of urea in the blood are believed to have detrimental effects on milk production, reproductive efficiency, embryo survivability, and immune function. In addition, excess urea excreted in the urine has to be dealt with from an environmental standpoint.

Urea also is an end product from tissue metabolism. When the cow's tissues are energy deficient, proteins are broken down within the cow's body to supply an energy source. Increasing the amount of energy supplied by digestion in relation to the cow's needs will decrease protein breakdown (protein catabolism) and result in lower concentrations of urea in the blood.

Urea readily diffuses from the blood into the milk. Shortly after milking, the concentration of urea in milk found in the mammary gland closely parallels the concentration of urea found in the blood. As the interval after milking increases, slight differences will be seen in the concentration of urea found in milk and the concentration found in the blood since milk is "pooled" over time in the mammary gland. Since milk samples can be collected easily especially when the DHI supervisor is present, milk has become the media of choice for estimating the concentration of urea found in the body. (Urea is normally part of the nitrogen fractions found in milk.)

Nutrition and Management Influence MUN

The concentration of urea in milk is influenced by the concentration of nutrients provided in a balanced diet and the manner in which these nutrients are presented to the rumen microorganisms. For the optimum utilization of ammonia by the rumen microorganisms for microbial protein synthesis, the correct proportions of ruminally degradable intake protein and nonstructural carbohydrates must be present at the correct time. Diets which are high in ruminally degradable protein (RDP) and do not contain adequate amounts of nonstructural carbohydrates will result in higher concentrations of MUN. Examples of these types of diets include those composed of a very high percentage of alfalfa haylage, lush vegetative pasture, or diets which are improperly balanced. Carbohydrates must be available for bacteria at the correct time for optimum utilization of ruminal ammonia. Thus, the feeding sequence is important for optimum microbial protein synthesis. Diets containing too much ruminally undegradable protein may be deficient in ruminally degradable protein (RDP). Thus, these diets do not supply adequate amounts of ammonia for optimum microbial protein synthesis (low MUN). In addition, diets deficient in protein will result in low MUN values.

Factors Which Influence MUN Concentration

1. Ruminally degradable protein intake
2. Ruminally undegradable protein intake
3. Amount of non-structural carbohydrates
4. Water intake
5. Dry matter intake
6. Time of feeding in relation to milking
7. Method of feeding TMR vs. forages/ concentrate fed separately

The amount of water a cow consumes also will influence the concentration of MUN. Increasing water intake, which may increase urinary production, will tend to decrease blood and milk urea concentrations. Conversely, inadequate water (seen also during dehydration) would be expected to increase the concentration of urea in the blood and milk.

Blood urea concentrations fluctuate throughout the day and directly reflect feeding times. Blood urea concentrations are the highest four to six hours post-feeding and are the lowest just prior to feeding. If cows are fed forages separately from concentrates in the milking parlor, MUN values may be lower than those fed total mixed rations where cows eat continuously over the course of the day.

Collection of Milk Samples

Careful collection of milk samples from individual cows is necessary to ensure that the concentration of urea in the milk sample is not reduced by microbial activity. Milk samples should be preserved with a fermentation inhibitor or refrigerated until analyzed. MUN values have been shown to decrease by 50% in milk samples without a preservative which were kept at room temperature for 48 hours. Samples representing the entire milking which can be collected from milk meters or weigh jars are preferred. When this is not possible, Gustafsson and Palmquist have suggested that milk samples be collected at the end of milking rather than at the beginning.

Previous recommendations have suggested that milk samples should be collected from at least 10 cows within the herd or production group. However, sampling this small number of cows greatly increase the coefficient of variation for error. Thus, to minimize the variation needed to see a real difference in the means, 50 to 75% of the cows should be sampled. For herds with 125 cows or less, it is best to sample all cows and then look at the mean value for all cows (if one feeding program is in place) or group cows based on their management or feeding group. MUN values need to be evaluated on a group, not individual, basis. Samples from individual cows are recommended over bulk tank samples. Routine MUN testing through DHIA will allow nutritionists, veterinarians, and dairy producers to detect changes in the feeding program against an established base line.

Interpretation of the results

Milk urea nitrogen (MUN) can be used to evaluate the overall protein nutritional status of a group of cows. However, like other nutritional evaluation tools, MUN's can help determine the protein status of a group of cows, not individual cows. The concentration of MUN's does vary between cows, season of the year, and breed (Jerseys are higher than Holsteins). Generally, the MUN concentration should be between 10 to 14 mg MUN/dl. All scientists concur that individual cows will range between 8 to 25 mg/dl to have averages fall between their suggested "normal values". Table 1 is a summarization on how to interpret MUN results and which aspects of the diet to review. However, besides reviewing the ration balanced on paper, the ration actually consumed by the cows, the order feeds are consumed, and other feeding management protocols need to be critically reviewed.

Conclusions

The average value for milk urea nitrogen can be used effectively by nutritionists, veterinarians, and dairy producers to detect when major inadequacies in protein or energy nutrition are occurring at the rumen level. When evaluating the feeding program, the protein fractions and amount of nonstructural carbohydrates supplied in the balanced ration first should be re-evaluated. In addition, this re-evaluation needs to center around a review of how the ration is being fed as well as reexamining dry matter and water intake.

Table 1. Interpreting MUN Values

MUN value	Ration parameters to evaluate
Less than 9	Rumen bacteria do not have enough ammonia for optimum synthesis of microbial protein. -- Inadequate amounts of RDP (ruminally degradable protein) -- Protein content of diet lower than expected -- Check protein content of corn, other byproducts and forages to make sure current feedstuffs being fed reflect the nutrient composition used to balance rations. -- Composition of the diets consumed by the cows contains the amounts of dry matter and forage/grain ingredients specified and suggested by your nutritionist.
Greater than 15	Rumen bacteria cannot utilize the ammonia produced in the rumen—the excess is absorbed across the rumen wall, converted to urea in the liver and transported in the blood which is detected in milk -- Too much RDP in the diet -- Not enough carbohydrates present or present at the correct time in the rumen -- Usually seen on pasture diets, high alfalfa haylage/baleage diets -- High MUN concentrations may decrease reproductive performance