Animal Agriculture and the Environment

Milk Urea Nitrogen, Protein Utilization, and Water Quality

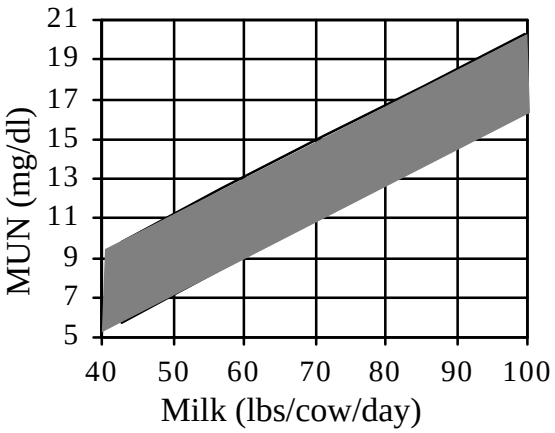
By Katharine F. Knowlton, Ph.D., Research Scientist, Department of Dairy Science, Virginia Tech, and Rick Kohn, Ph.D. and Jamie Jonker, Assistant Professor and Graduate Research Assistant, Department of Avian and Animal Science, University of Maryland

Nitrogen (N) and phosphorus (P) contamination of ground and surface water are the leading environmental issues facing dairy farmers in Virginia. Previous articles in this column have discussed how improved nutrition can reduce losses of these nutrients from dairy farms. Now farmers have a new tool to help them more precisely define and meet their cows' protein requirements, reducing both feed costs and potential N losses from farms.

Milk urea N (MUN) analysis was developed as a tool to monitor protein utilization by dairy cows. Recent research by scientists in Maryland indicates that this tool has real potential to help farmers minimize the impact of their farms on the environment.

Milk urea N content is a quick, accurate reflection of how much N was absorbed by the cow but not used for growth or milk protein synthesis. When cows are overfed protein relative to their needs, the N from the unused protein is excreted in urine as urea. Urea is a small metabolic byproduct of protein utilization, and diffuses into milk from the cow's bloodstream. With overfeeding of protein, the concentration of urea in milk increases, and the Maryland scientists discovered that urinary N excretion increases as well. Thus the MUN assay is a powerful tool to tell us when the cow is wasting protein and excreting excessive N. Elevated MUN indicates an opportunity to reduce protein content of diets, maintain or improve milk yield, reduce N excretion, and likely reduce feed costs.

How high is too high when it comes to MUN concentrations? A general rule of thumb is that average group or herd MUN should fall between 8 and 16 mg/dl. This range is appropriate for most levels of production, but target MUN varies with milk yield. Herds with high milk production tend to be near the high end of the range, while a herd with lower production would be closer to the low end of the target MUN range. A group of 25 cows averaging 80 pounds/day of milk would have a target MUN between 13 and 17 mg/dl, while a group of 25 cows producing 50 pounds/day of milk would have a target MUN between 7 and 11 mg/dl. The target MUN values in the figure below are for a group of 25 Holstein cows with milk averaging 3.5% milk fat and 3.0% milk protein.



An important point is that individual milk samples may vary enormously in MUN, and a single sample from an individual cow tells you very little. Factors unrelated to herd protein status (i.e., recent low water consumption) may have a strong impact on an individual cow's MUN concentration. Analysis of milk samples from at least 10 cows in a feeding group are necessary to yield an accurate picture of the protein status of the group. The larger the group, the more accurate the picture, and the smaller the range of expected MUN values. A group of 100 cows would have a target MUN range of 12 to 14 mg/dl, for instance.

Farmers should be cautious about making feed changes from information from just one test. Instead, watch for a trend in MUN results. If your MUN levels are consistently high (or consistently low) for several months, or if there is an abrupt change between tests, then changes in the ration may be appropriate. Be aware, though, that many herds perform quite well when MUN is below target.

What does it mean when a group of cows has an average MUN concentration higher than this normal range, and how do you determine what changes might be needed? High MUN levels indicate an excess of N in the cow relative to the animal's level of production. More specifically, elevated MUN concentrations may be caused by a number of nutritional factors, including, but not limited to, too much rumen degraded protein (RDP), too little energy, an imbalance of carbohydrate and protein, or not enough rumen undegraded protein (RUP).

None of these factors alone tells the complete story; high levels of MUN depend on a combination of factors. The following checklist should help to systematically isolate the true cause of high MUN levels.

1. Milk Production - Are the cows producing as much milk as expected? If the cows are producing less than expected, excess protein consumption results in elevated MUN levels. The reason for lower milk production needs to be examined. Lower than expected milk production can be caused by management (i.e., stalls are too short, cows are uncomfortable, and mastitis incidence is high) or ration formulation (i.e., not enough energy).
2. Diet Formulation - Is the diet formulated to meet the cows' nutrient requirements? While computer programs have made ration formulation easier, results are only as good as the expertise of the person doing the formulation and the accuracy of the program used. If, for example, a ration is balanced only for crude protein level and not for RDP and RUP, an imbalance in these protein fractions may be causing high MUN levels.
3. Feed Analysis - Are all forages analyzed routinely? Differences may exist between the nutrient composition of feed ingredients and the nutrient composition used in ration

balancing. Nutrient composition of forages can vary dramatically from field to field and cutting to cutting, so frequent forage testing is necessary.

4. Feeding Management - Are the cows being fed the diets as formulated, or is something lost in the translation from nutritionist ➪ manager ➪ feeder? For instance, is the TMR being mixed thoroughly? An improperly mixed TMR can result in inadequate distribution of nutrients with some cows getting more than their share. Is the ration being mixed accurately or is one ingredient being over- or under-fed? If soybean meal is overfed and cornmeal underfed, protein will be in excess in the diet relative to available energy, and high MUN levels will result.
5. Animal Consumption - Are the cows eating what is offered, or are they sorting and selecting part of the ration? Once the ration is properly balanced and mixed, the ration as it is fed to the animal may still not match what the cow actually consumes. Feed left in the bunk by the cows should look like the ration that was fed. If cows are able to sort the ration, they may consume concentrate preferentially over forage, and high MUN levels may occur.

MUN is a powerful tool to reduce feed costs, and reduce potential N losses from your farm. From June of 1997 to June of 1998, 650 herds had their milk periodically analyzed for MUN by Lancaster DHIA, and received feeding advice with their analyses. During that year, the average MUN concentration decreased substantially. Farmers decreased the amount of protein fed to their cows by about 7% and milk yield increased by about 3%. Higher milk production per cow, combined with more precise feeding of protein resulted in increased milk income and decreased feed costs per hundredweight.

At the same time, reduced MUN indicates reduced N excretion. High protein diets increase manure N, increasing potential N losses from the farm. MUN is a powerful new tool to help you identify when protein is being overfed, and identify opportunities to reduce feed costs, reduce manure N, and reduce N lost to the environment. This is the sort of powerful, cost-effective approach we need to protect water quality while maintaining the economic viability of Virginia dairy farms.