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Milk Urea Nitrogen

Optimizing protein in the ration

A new study confirms the ideal range for milk urea nitrogen.

Daniel Lefebvre, Ph.D., agronome
General Manager
Research and Development Manager
and
René Lacroix, Ph.D., ing.
Analyst – Data valorisation
Valacta Research and Development

Last May, the Valacta laboratory analyzed its 10,000,000th sample for milk urea nitrogen (MUN) since the introduction of this service in June 1998. With a utilization rate above 45 per cent (of all Quebec milk recording samples), this province is a world leader for this particular management tool. By integrating MUN results with production and feed data, we have indeed a database that is positively unique, allowing us to shed some light on the factors affecting MUN concentration and optimal levels.

As you may know (see box), MUN is a good indicator of the efficiency of protein digestion in the ration. A higher MUN means a larger amount of feed protein wasted, and a higher nitrogen excretion through urine. On the other hand, in order to optimize microbial growth, a minimum concentration of ammonia is required in the rumen all day long. In the absence of ammonia, microbes could face a lack of nitrogen, which would deprive the cow of microbial protein.

Hence, the optimal MUN concentration should be the lowest concentration which has no negative effect on milk production. Indeed, a low concentration is better, first, from an economic viewpoint, since we make the best use of feed protein, and second, from an environmental viewpoint, since we reduce waste. However, any nitrogen deficiency in the rumen resulting in a lower milk production would of course negate these benefits.

8,000,000 samples

With this in mind, we recently studied a large subset of the Valacta data base, which was collected for a research project on milk composition (project by Dr Kevin Wade of McGill University, financed by Novalait). This subset includes data from the years 2000 to 2009 and comprises more than 8,000,000 MUN results.

Variation according to breed

The average MUN rate in all these samples is 10.8 mg N/dL, with a standard deviation of 3.4, which means that 50 per cent of samples are within the 8-14 mg/dL range. We first studied a few factors influencing MUN concentration, beginning with the effect of breed. Whereas the average concentrations for Holstein and Ayrshire are similar, the average for Jersey is higher by almost 1 mg nitrogen by decilitre. The difference climbs to more than 2 mg for the Brown Swiss. Similar disparities have been reported in other studies. For the Jersey, it is interesting to note that the variation observed VS the Holstein has almost vanished in the last few years, a period in which the number of Jerseys has increased markedly, notably within herds that were predominantly Holstein.

IN ORDER TO OPTIMIZE MICROBIAL GROWTH, A MINIMUM CONCENTRATION OF AMMONIA IS REQUIRED IN THE RUMEN ALL DAY LONG

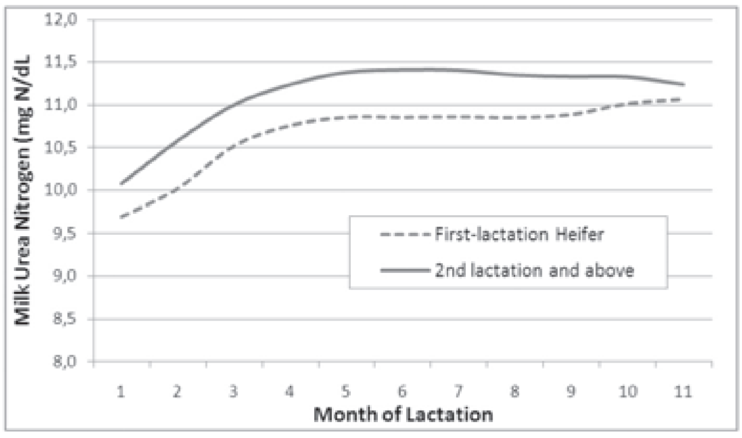
Variation according to parity and stage of lactation

We have also evaluated the effect of parity and stage of lactation on MUN. Figure 1 shows that first-lactation heifers have a MUN concentration lower than 2nd lactation cows by about 1 mg N/dL. This can probably be explained by a lower dry matter intake and a difference in protein metabolism due to ongoing growth. As for lactation stage, the effect is the same whatever the lactation number: MUN is lower in early lactation and reaches a plateau around the 4th month. This is due to an increase in dry matter intake as well as rations richer in grains.

Optimal Concentration

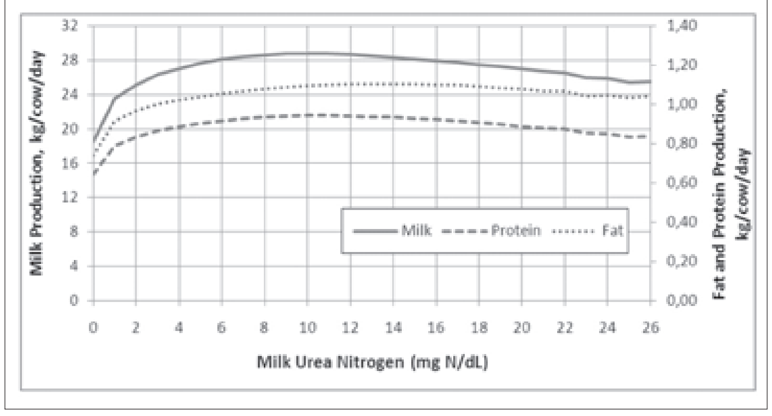
Finally, we wanted to confirm the optimal MUN concentration, the one that results in the maximum milk, fat and protein production, while keeping nitrogen waste down. Figure 2 shows that milk, fat and protein are at their maximum between 8 and 14 mg/dL MUN. Consequently, these are the new values to aim for (previously, the optimal range was thought to be between 10 and 16). So, MUN values below 8 will result in a lower production, corresponding to a shortage of protein available in the rumen. Conversely, MUN values higher than 14 will not translate into higher production. They correspond to a non-optimal use of feed protein and, consequently, increased nitrogen waste.

Figure 1. Effect of parity and stage of lactation on MUN



Source: Valacta database, Quebec herds on milk recording, 2000-2009

Figure 2. Milk, fat and protein production versus MUN



Source: Valacta database, Quebec herds on milk recording, 2000-2009

Finally, a detailed study reveals (not surprisingly) that cows in early lactation (100 days and less) respond a little better to higher MUN than cows in later lactation. The data also indicate that the optimal range is probably slightly higher for coloured breeds.

New: Bulk tank MUN

In collaboration with the *Fédération des producteurs de lait du Québec*, Valacta will soon offer MUN analysis for bulk tank ("payment") milk samples. This new service will allow a closer monitoring of MUN over time, and earlier detection of any change in the use of feed protein, since these MUN results will be available weekly. Of course, bulk tank MUN provides only an average, without any info on the distribution and homogeneity of individual results, which are as relevant as the average itself. So, this new tool should be used as a complement to individual cows' MUN.

The ABC of MUN

Urea is a small molecule, soluble in water, coming mainly from the liver. The liver synthesizes urea in order to eliminate excess nitrogen coming either from the cow's protein metabolism, or ammonia coming from the rumen. The later source is usually the most important. Urea generated in the liver is then carried by the blood toward the kidneys, where it is filtrated and transferred to urine, which is the main form of nitrogen excretion. Since urea is water-soluble, its concentration tends towards an equilibrium between the blood and other bodily fluids, notably saliva and milk. Saliva urea can be recycled toward the rumen and be used as a nitrogen source for microbes. In the case of milk, this equilibrium allows us to use the milk urea nitrogen concentration as a reflection of the urea concentration in the blood. Blood urea concentration varies along the day, notably in response to feeding. Since we take milk samples two (or three) times a day, the MUN concentration from a specific milking reflects the average blood concentration since the previous milking.

As stated earlier, the main source of urea is ammonia coming from the rumen. Ammonia comes from the degradation of the feed protein by the rumen bacteria. Also, silage can provide part of its own nitrogen as ammonia. In order to be used by the cow, this ammonia must be picked up by the rumen bacteria and incorporated into microbial protein, since this is the main source of metabolizable protein for the cow. In order to pick up this ammonia, bacteria need to multiply. The available energy (coming from fiber and non-fiber carbohydrates) determines the speed at which they will multiply and, consequently, the amount of ammonia that will be picked up. Hence, the amount of ammonia coming out of the rumen depends directly on the amount of degraded protein in the rumen and the energy available to capture it.

This is why milk urea nitrogen is a good indicator of the efficiency of protein digestion in the ration.