DAIRY COWS

It´s all about protein, isn't it?

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Ruminants such as dairy cows accomplish true wonders, as they can transform inedible, low-quality protein in roughage and concentrates into the high-quality protein found in milk and meat. But which role does nitrogen (N) play here and, in fact, how does urea get into milk? And how do natural, plant-based feed additives make a substantial contribution in this context?

Like proteins, the rumen ecosystem is very complex in its structure and function. Proteins are made up of 50 amino acids and more, delivering the material for the building and renewal of cells and tissues. This function cannot be performed by any other food. Cows require specific amounts of amino acids to maintain the body, including muscles and bones, the unfolding of a calf, and the milk production. There are two main sources that contribute to the amino acid pool available at the ruminants' duodenum:

First, the microbial protein, synthesised in the rumen by microbes and with 50-75 percent representing the most important amount of cows' total protein supply. With the energy supply through carbohydrates, the microbes build up their own precious body protein out of nitrogen and amino acids, before they are being washed down to the cow's duodenum where they are digested.

Though the microbial protein production is only ensured by simultaneous availability of ammonia, produced by hydrolysis of degradable protein (or N) sources and carbon skeletons from fermentable carbohydrates.

In case of energy deficiency and protein surplus, the microbes use protein for energy production, resulting in a waste of N. A waste that will be excreted in the cow´s urine and that will be reflected in higher levels of urea nitrogen in blood and milk as well.

Second, the undegradable protein (UDP), the part of feed protein that withstands the processes in the rumen, hence being available for the cow directly at the small intestine.

Regarding the UDP, it is important to make sure that the amino acid balancing of the raw materials of the ration is adjusted to the cows' requirement. Though high yielding cows require more UDP to meet the cows needs of protein, it is always the microbial protein that remains the most important protein source.

It depends on the right dose

This explains the necessity to feed high-performance dairy cows need-based and in the most optimal way possible. Beside adequate crude fibre and feed structure supply, energy and further nutrients, sufficient nitrogen (N) is the most important prerequisite for a high protein synthesis in ruminants.

In return, inefficient N use therefore inevitably leads to higher feed costs and environmental problems. But it's not only the economical and environmental aspects that militate for an optimised N use, also animal welfare seems to be an important aspect in this context.

A balanced N supply reduces the risk of energy shortfalls and positively affects the cow's fertility. Besides, an oversupply of N burdens the liver as the main metabolic organ and should, therefore, be avoided if possible. Finally, as N excretion also affects barn climate, it is obvious to keep concentrations low, hence contributing to animals' wellbeing.

Protein metabolism in ruminants

In the feeding of dairy cows, a high protein synthesis in the rumen (microbial) and in the udder with at the same time low NH3 losses from the rumen is desirable, hence as little urea as possible is excreted by the cows per kilogram of milk produced.

To understand the N metabolism and to improve N utilisation in ruminants, understanding the processes in the rumen and in the splanchnic tissues is crucial (See figure 1).

In ruminants, ingested protein is degraded, and the contained nitrogen used to synthesise valuable edible products (milk or carcass), next to covering the maintenance requirements, yet partially (30-50%) is excreted through faeces and urine. Excess of ammonia in the rumen, that is converted into urea and excreted in urine, constitutes only one part of it.

Indigestible protein, relating to the fibre content of the ration (Neutral Detergent Insoluble Nitrogen = NDIN, acid detergent insoluble nitrogen = ADIN) and being analysed via faeces, compose another amount.

Though also endogenous protein excretion (from digestive enzymes excretion, mucus, desquamation of the wall of the digestive tract) that is verifiable in the faeces and the urine, should also be considered as part of the whole.

Finally, there is also inefficient utilisation of absorbed protein for the metabolism (maintenance, milk production, growing) that contributes to the total protein loss via excretion. This metabolism efficacy is dependent on the quality of the amino acid balancing of absorbed protein.

Ruminohepatic circle and milk urea

The ruminohepatic circle describes the circulation between

rumen and liver in ruminants, leading to better utilisation of feed N. In the rumen, NH3 is produced via deamination of amino acids or non-protein compounds (eg urea and amides).

The ammonia may be used for microbial growth, providing that energy is available. The ammonia released in the proventriculus is directly absorbed, reaches the liver directly (via blood), where it is converted into urea and thus detoxified.

The urea formed in the liver returns to the rumen via the salivary glands and through direct back diffusion via the rumen wall, where it is split into ammonia (NH3) and carbon dioxide (CO2) with the help of a bacterial urease. This makes it available again for amino acid synthesis by the bacteria living in the rumen. Urea that is not recirculated is excreted via the kidneys. Though part of the urea is released via the milk. The milk urea content in milk production describes the urea content in milligrams per liter (mg/l) of milk.

The milk urea content (or the blood urea) represents a helping tool to monitor the nutritional condition of the cow. As a waste product of the amino acid metabolism, it allows conclusions about the protein and energy supply of the animals.

Feeding - the lock, nature – the key

There is no doubt that feed management represents a crucial tool when it comes to protein losses and how to avoid them. Next to high quality provided roughage, optimised need-based rations that support the rumen balance, while at the same time supply the cow with required nutrients and protein amounts in the duodenum, are of upmost importance.

Just when it comes to environmental burden due to oversupply of animals with nitrogen, Mother Nature comes into play. Phytogenic (plant-based) feed additives (PFA) have been able to substantially up-value ruminant rations for years.

Well-formulated formulations, aligned to the animal's needs, are able to support protein efficiency hence helping to keep protein losses low. Delacon, a leading expert in phytogenics, has enormous know-how in selecting, combining and formulating plant-based compounds into effective solutions, tailored to challenges in livestock production.

There is evidence that these natural, holistic solutions, made of essential oils, saponins, pungent substances and condensed tannins unfold their impact on three levels and in various sections of the digestive tract:

First, in the rumen. Improved rumen function leads to improved energy and protein efficiency ratio, increasing the proportion of metabolisable bypass protein and microbial protein (the latter shows a very good amino acid balancing to build up milk casein). Consequently, this will lead to lower ammonia losses from the rumen, via the liver (where it is transformed to urea) into the urine.

Second, a reduction of the protein degradation in the rumen will increase the level of bypass protein, and thus, lowering protein losses.

Moreover, and third, the natural ingredients of selected PFAs positively influence the protein digestibility and absorption in the small intestine. By increasing the proportion of metabolisable bypass protein and microbial protein, the share of indigestible protein is minimised. This will reduce protein in faeces and lower ammonia concentrations.

The positive performance effects of well-formulated phytogenic feed additives are illustrated (See figure 2). Phytogenic substances have shown to reduce both protein losses in the urine and in the faeces.

This means that the intestinal digestibility could be improved, and less ammonia was transformed into urea. The more efficient use of

nitrogen for milk production, maintenance and growing led to an improved protein efficiency by 2.7 percent.

Optimising protein and feed efficiency in ruminants improves the milk quality by raising its protein content whilst simultaneously decreasing urea concentration. Milk urea nitrogen was decreased from 261mg/l in control animals to 219 mg/l in cows fed the PFA (data not shown).

Conclusion

Worldwide, ruminants, especially dairy, supply us with their "white gold", day by day. They transform inedible, low-quality protein in roughage and concentrates into the high-quality protein found in milk. A sophisticated system that requires optimal feeding management to avoid protein or nitrogen losses has not only economic but also environmental consequences.

Feed additives, including phytogenic products, have been able to substantially up-value ruminant rations for years. With the active synergism of well-selected, high-quality phytogenic substances, challenges can be met in support of nature.

Phytogenic feed additives have shown promising effects like increasing the level of rumen degradable protein hence improving the metabolisable protein level, improving the microbial protein synthesis and the general protein metabolism, reducing NH3 losses and, last but not least, improving protein digestibility in the small intestine.

Plant-derived products are foreseen to have a promising future in the feed sector, as they support the environmental thought and are highly accepted by consumers, meeting the growing demand for livestock being kept and fed appropriate to their requirements, and though allowing profitable farming on the other side.

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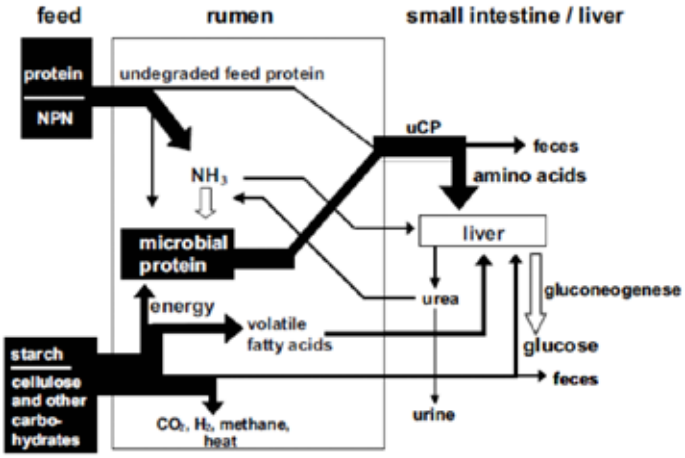

Figure 1: Energy and N metabolism in ruminants (according to Flachovsky and Lebzien, 2006)

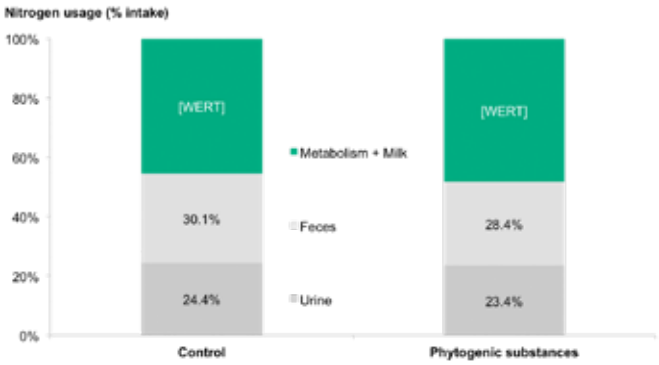

Figure 2: Effect of phytogenic substances on protein efficiency