Protein efficiency in dairy cows: a promising future for phytogenics

In dairy milk production attention is mostly concentrated on efficiency. On the one hand there is talk of efficiency of animal production and on the other, there is talk about feed efficiency.

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Farmers of today invest a lot in high quality genetics – it is much more important to maintain very high quality rations as well, hence making it possible to fully exploit the genetic potential of dairy cows. Phytogenic (plant-based) feed additives (PFA) have been able to substantially up-value ruminant rations for years – and their future is promising.

Milk and protein synthesis in the udder

Dairy cows are true top athletes. To produce 1kg of milk, about 500 litres of blood flow through the udder, which means that for today’s high-performance cows about 20,000 litres of blood are required. Of course, these processes represent a great physiological strain for lactating cows – accompanied by special feeding requirements that must be met in the best possible way.

The udder is a very big organ weighing around 50kg, including milk and blood. The mammary gland comprises secreting tissue and connective tissue, the former representing the main limiting factor for milk production.

The secretory cells (alveoli) synthesise the milk which is stored in the lumen of each alveoli. Clusters of alveoli that drain to a common duct form a lobule, from which the milk is squeezed into the milk duct, hence to the gland cistern. Once the cistern is filled, the milk remains in the lobule.

The milk protein (largely casein, and to a smaller extent whey protein) is synthesised from blood derived amino acids and peptides.

The main part of casein occurs in the form of so-called casein micelles (small spherical aggregates, each containing thousands of casein molecules), whose aggregation takes place in the Golgi vesicles of the secretory cells in presence of calcium and phosphorus.

In addition to being processed, casein plays an important role from a nutritional point of view due to its favourable amino acid pattern.

The milk protein content is influenced by endogenous and exogenous factors such as genetic potential, lactation stage, feeding and husbandry.

But before the milk protein is synthesised, it is the cow that must first be supplied with sufficient protein.

Protein supply in ruminants

The protein supply in dairy cows is ensured by a sufficient content of crude protein in the ration and the amount of available protein in the small intestine.

Crude protein is broken down to ammonia in the rumen with the help of microbes, which then convert the ammonia into precious microbial protein, given that the microbes are provided with energy from fermentable carbohydrates.

If there is a crude protein surplus and/or energy deficiency, an ammonia surplus is produced which must be detoxified via the liver in the form of urea, being measurable in the blood, urine and milk. The decisive factor is the amount of protein that reaches the small intestine, where it is available to the animal.

This amount mainly consists of microbial protein (50-75%) and to a lesser extent of undegradable protein, which passes the rumen and reaches the small intestine directly.

This explains the necessity to feed high-performance dairy cows pm a needs basis and in the most optimal way possible.

Beside adequate crude fibre and feed structure supply, energy and further nutrients, sufficient nitrogen is the most important prerequisite for a high protein synthesis in ruminants. A balanced N supply reduces the risk of energy shortfalls and positively affects the cow’s...
Excess dairy protein

Stage of lactation | <9 | 9-11 | 12-14 | 15
---|---|---|---|---
Early (0-30 days) | Lack of dietary protein | Intake and milk yield may be sub-optimal | Most desirable | Acceptable
Peak and post peak (31-150 days) | | | |
Mid-late (150 days) | | | | Check RDP, RUP and/or adjust NFC

Fig. 2. Guideline for interpreting whole herd MUN values (mg/dl, according to Hutjens & Chase, 2012).

Fig. 3. Effect of Actifor Pro on protein efficiency.
decreasing urea concentration. MUN was decreased from 261mg/l in control animals to 219mg/l in cows fed the PFA (data not shown).

Another study using Actifor Pro was undertaken in Brazil, to look at the potential to improve performance in dairy cows over a period of 12 weeks (see Table 1 and Fig. 4). The inclusion of the phytogenic feed additive mainly increased milk production (+1.6kg/cow/day) and the energy corrected milk production (+2.5kg/cow/day). At the same time, body condition score was increased by 0.15. Supplementing lactating dairy cows with well selected phytogenic feed additives like Actifor Pro appears to be a promising strategy to improve milk performance, whilst at the same time reduce protein losses in dairy production systems.

Possible reduction of crude protein level in diets due to in-feed phytogenics will consequently lead to decreased feed costs as well.

Table 1. Effects of Actifor Pro on dairy cows performance (according to Rodrigues et al., 2019; DIM = days in milk, MUN = milk urea nitrogen, SCC = somatic cell count, BCS = body condition score).

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Actifor group</th>
<th>Actifor Pro Effect</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM at beginning [days]</td>
<td>84.9</td>
<td>87.6</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Milk yield [kg/cow/day]</td>
<td>27.9</td>
<td>29.5</td>
<td>+1.6</td>
<td>0.04</td>
</tr>
<tr>
<td>Energy Corrected Milk [kg/cow/day]</td>
<td>30.5</td>
<td>33.0</td>
<td>+2.5</td>
<td>0.01</td>
</tr>
<tr>
<td>Fat corrected milk [kg/cow/day]</td>
<td>30.0</td>
<td>32.6</td>
<td>+2.6</td>
<td>0.02</td>
</tr>
<tr>
<td>Milk fat [TB] (%)</td>
<td>4.01</td>
<td>4.10</td>
<td>+0.09</td>
<td>NS</td>
</tr>
<tr>
<td>Milk protein [TP] (%)</td>
<td>3.35</td>
<td>3.34</td>
<td>+0.01</td>
<td>NS</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>4.59</td>
<td>4.66</td>
<td>+0.07</td>
<td>NS</td>
</tr>
<tr>
<td>MUN (mg/dL)</td>
<td>13.5</td>
<td>13.3</td>
<td>-0.02</td>
<td>NS</td>
</tr>
<tr>
<td>SCC (log/mL)</td>
<td>5.11</td>
<td>5.02</td>
<td>-0.09</td>
<td>NS</td>
</tr>
<tr>
<td>BCS change</td>
<td>+0.07</td>
<td>+0.22</td>
<td>+0.15</td>
<td>0.05</td>
</tr>
<tr>
<td>Energy output [Mcal/day]</td>
<td>20.5</td>
<td>22.3</td>
<td>+1.8</td>
<td>0.01</td>
</tr>
</tbody>
</table>

In dairy milk production attention is mostly concentrated on efficiency. Therefore, maintaining very high-quality rations, hence making it possible to fully exploit the genetic potential of the dairy cows, plays an important role in optimal management.

There is evidence that optimising rations with phytogenic feed additives represents reliable, cost effective ways, ensuring feed and protein efficiency respectively. This not only leads to improved animal performance but also contributes to cost-efficient milk production, animal well-being and environmental protection.

References are available from the author on request.

Fig. 4. Effects of Actifor Pro on milk yield in dairy cows (Rodrigues et al., 2019).