Improving protein quality in silage using lactic acid bacteria

by Dr Ewald Kramer, ISF GmbH, Pinneberg, Germany.

Studies at the University of Hohenheim into protein quality in grass silage have confirmed that Schaumann's Bonsilage Plus increases the amount of bypass protein (UDP). The German protein evaluation system for ruminants is based on the principle of usable crude protein in the small intestine (nXP), which is composed of microbial protein (MP) formed in the rumen and bypass protein. In addition, it is generally known that the amount of UDP in the ration of a high yielding cow needs to be increased compared with an average performing cow, in order to meet its nXP requirements (see Fig. 1).

Protein quality of grass

During silaging, the plant protein undergoes extensive degradation and conversion processes (proteolysis). The amount of UDP is reduced and non-protein nitrogen (NPN) compounds are produced, including NH_3-N, free amino acids (AAs), peptides and biogenic amines.

If present in large quantities, these lead to a considerable surplus of nitrogen (N) in the rumen which has to be detoxified to some extent via urea in the liver. This is often at the expense of the animal's health.

Test laboratories do not record the conversion processes undergone by the plant protein: routine silage analysis determines only the crude protein (XP) and does not provide any further information on UDP content for example.

Recently, an extensive test method has made it possible to calculate the UDP content of silage. To do so, it is necessary to assign the plant protein by means of wet-chemical heating processes to certain fractions depending on their speed and extent of release in the rumen (CNCPS system – see Table 1).

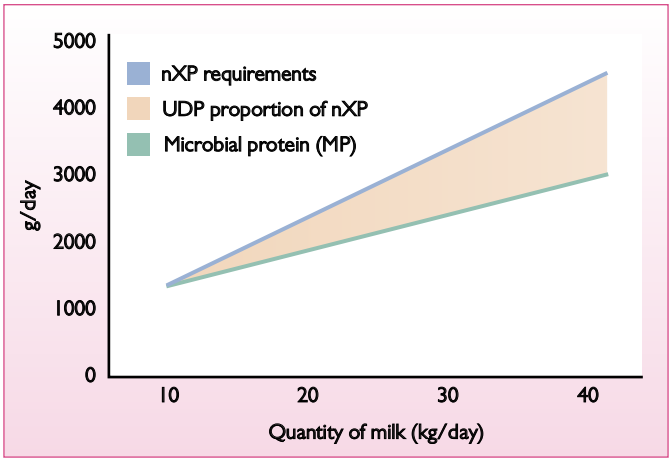
The other main advantage of this method – besides the calculation of UDP content – is the ability to use the determination of protein fractions to document the extent of the changes occurring in the plant protein as it develops from fresh grass into silage.

Proteolytic activity in the silaging process is unavoidable to a certain extent and attributable to the activity of plant enzymes. In addition, protein is broken down by clostridia and enterobacteria, which in turn are suppressed by highly competitive lactic acid bacteria.

This information also explains why some proteolysis is pH-independent, and why its extent can be reduced considerably by means of a rapid and lasting pH reduction at the start of silaging.

Fig. 2 shows the protein fractions according to the CNCPS system for fresh grass, a silage with good fermentation quality and a silage with poorer fermentation quality. The differences are clear. In the silage with poorer fermentation quality, the proportion of fraction A is much higher and the proportion of fraction B2 much lower compared with fresh grass and the good quality silage.

Fig. 1. nXP requirements and composition of nXP depending on milk performance (adapted from Steinhöfel, 2009).



It is an established fact that the targeted use of specialised lactic acid bacteria can improve the fermentation of grass silage. That this also leads to less protein degradation during silaging could previously only be inferred from the proportion of NH_3-N in total nitrogen. With the use of special lactic acid bacteria, that proportion is much lower than in an untreated variant.

Protein quality

As part of a large scale trial, first-cut grass from permanent grassland of the agricultural research from Infeld was silaged in three dry matter ranges (20-30%, 30-40%, 40-50%) and two fertiliser variants ($25m^3$ slurry + 100kg CAN; $25m^3$ slurry + 250kg CAN), each with and without treatment with Bonsilage Plus. The LWK (Chamber of Agriculture of Niedersachsen) investigated basic nutrients and fermentation quality, while the University of Hohenheim carried out the protein fractioning using the above mentioned system.

Fermentation results

Across all the DM ranges and fertiliser variants, Bonsilage Plus showed a clear effect – documented by an average number of DLG (German Agricultural Society) points for fermentation quality of 99.5 out of a possible 100 compared with an average of 71.3 points for the untreated variant.

Protein quality results

With regard to the protein fractioning, clear differences were found between the untreated variants and treatment with Bonsilage Plus. The distribution of protein fractions for

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DM range 30-40% is shown as an example (see Fig. 3).

As already suspected due to the significantly lower NH_3-N proportion (6.2% compared with 9.6%), the use of Bonsilage Plus reduced the proportion of fraction A significantly from 44% to 28% ($p < 0.001$).

In addition, the proportion of protein available moderately quickly in the rumen in fraction B2 increased from 42% to 57% ($p < 0.001$).

The partly rumen stable fraction B3 was almost doubled with Bonsilage Plus ($p < 0.05$).

Overall, the effects described were observed in fractions A and B2 for each DM range and each fertiliser variant – and were statistically significant in each case. This clearly proves that the plant protein is degraded and converted to a significantly reduced extent with the use of Bonsilage Plus.

This is attributable to the fact that the use of the special lactic acid bacteria combinations in Bonsilage products, in this case Bonsilage Plus, reduces the pH much faster in the first few days of silaging and, as silaging progresses, to a lower level than an untreated variant. As a result, there is less time for the pH-dependent plant enzymes and fermentation organisms to break down the plant protein.

Fraction	Availability	Crude protein fraction
A	Rapidly degradable to ammonia in the rumen	NPN* (urea, peptide, amino acids)
B_1	Rapidly degradable to ammonia in the rumen	Pure protein
B_2	Potentially fully degradable in the rumen	Pure protein
B_3	Slowly but not necessarily fully degradable in the rumen	Cell wall bound pure protein
C	Not available in the rumen and small intestine	Protein bound to lignin, tannin or Maillard products

**NPN = non-protein nitrogen compounds*

Table 1. Chemical fractioning of crude protein in feeds for ruminants (Licitra et al., 1996).

For the cow, the shift in the fractions results in a lower ruminal N-balance (RNB), reduced liver stress due to lower quantities of nitrogen to be converted into urea and generally more uniform protein availability in the rumen over time.

The latter is of additional importance with a view to a synchronous supply of protein and energy.

More UDP saves money

As a consequence of the differences in the protein fractions, higher UDP proportions in the crude protein of approximately 2-6% are found, assuming an average rumen passage rate and average feed intake. Based on an example ration, a 4% higher UDP content in the grass silage can save 0.28kg of soya/rapeseed oil meal per cow per day, or approximately €5 cents per cow per day (see Table 2).

The calculations in Table 2 do not take account of the lower DM losses (under the sheet and at the face) which can be achieved with the use of Bonsilage products, or the improved digestibility, which results in energy contents higher by 0.2-0.3 MJ NEL/kg DM on average.

Summary

The use of Bonsilage products improves the protein quality of grass silage with lasting effects. This finding is confirmed by the analytical results obtained by the University of Hohenheim with the extensive research material of the LWK Niedersachsen. Higher UDP contents combined with reduced strain on animals' health are also clearly reflected in terms of economic viability, since they offer potential savings on expensive protein feeds. ■

Table 2. Effect of the improved protein quality of a grass silage treated with Bonsilage, based on an example ration per cow and per day.

UDP content of grass silage	+ 4%
Saving on soya/rapeseed	0.28kg = 8.4ct
Cost of Bonsilage	3.4ct
Potential savings with Bonsilage	5.0ct

** Assumptions: 33kg milk; 18kg DM intake grass silage; 18kg DM intake maize silage; performance-related addition to soya/rapeseed; cost of soya/rapeseed (50/50) = €30/dt; cost of Bonsilage = €1.70/t*

Fig. 2. Protein fractions in fresh grass and silage with good and poorer fermentation quality.

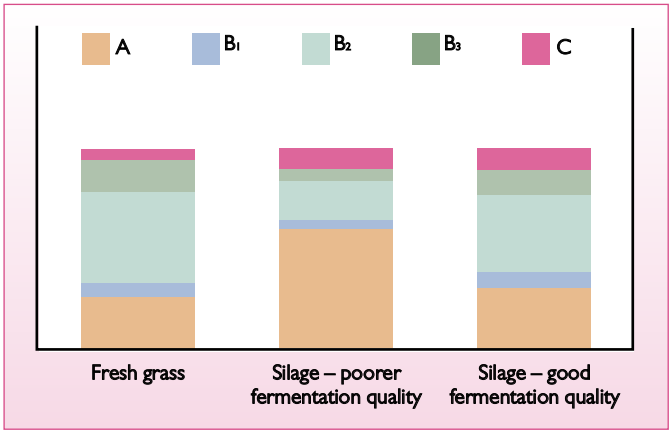

Fig. 3. Bonsilage Plus reduces protein degradation.