Unlocking the fibre potential in feed

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Today, due to rising feed costs, one of the key objectives for farmers is to optimise the value of the diet. The cornerstone of ruminant health and performance is the rumen, where forage and feed are converted into energy (volatile fatty acids, VFAs)

and microbial protein thanks to the activity of the rumen microflora: bacteria, protozoa and fungi.

The rumen microflora is responsible for fibre degradation, and the extent and efficiency of the process relies on various factors and determines overall feed efficiency and profitability for the farmer.

For a long time, feeding live yeast to ruminants has been empirically known to improve productivity, health and well being by optimising the fermentation conditions of the rumen.

Today, as we have gained better understanding of live yeast effects in the rumen, and knowing that each yeast strain is unique and exerts different activities, we have been able to select specific yeast strains according to their biological activity.

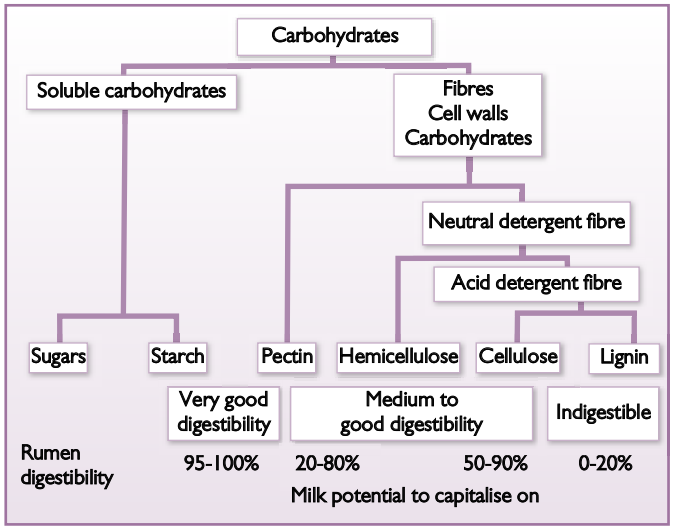
For example, the strain Saccharomyces cerevisiae I-1077 (Levucell SC, Lallemand Animal Nutrition, France) has been selected for its ability to improve rumen conditions, fermentation and function.

The major benefits of this natural feed additive are to stabilise ruminal pH, reducing the risk of sub-acute acidosis, and to increase the milk and milk solids yield, by improving feed efficiency.

These effects have been widely documented by independent scientific studies and validated at farm level in various countries and under different dietary conditions. In particular, the effect of the rumen specific yeast on feed utilisation is linked to increased fibre digestion – especially improved utilisation of the least degradable fraction of the fibres.

A recent study indicates that this effect on fibre degradation is even greater for lower quality forages,

Fig. 1. The different fibre fractions and their digestibility in the rumen.



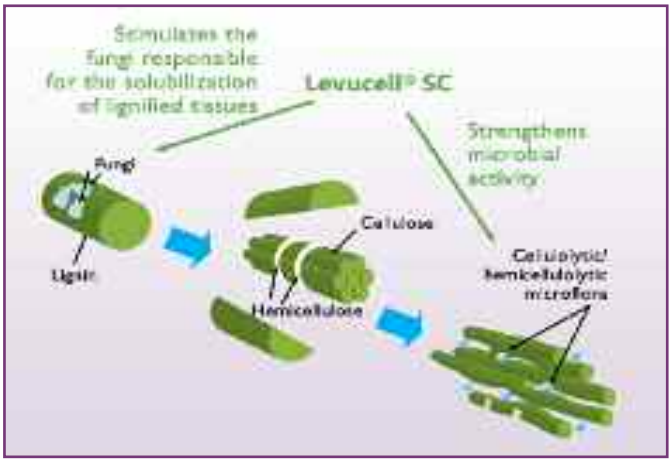


Fig. 2. Live yeast improves fibre degradation by several mechanisms of action on both rumen bacteria and fungi.

when the fibres' initial digestibility was low. Thus, by improving the rumen fermentative process, the live yeast optimises the forage's fibre potential.

Rumen fermentation

The rumen is at the cornerstone of ruminant health and performance. It is a large fermentation vat of around 200 litres capacity, containing 500,000 billion bacteria and 50 billion protozoa. There are over 200 different types of bacteria, all of which have very specific functions in feed breakdown.

One of the most important types is the fibre digesting bacteria, which enables the ruminant to utilise forages.

Protozoa can make up to 50% of the microbial biomass due to their size. Although like the fibrolytic bacteria they can utilise plant material, some also engulf starch particles thereby slowing down bacterial fermentation of this rapidly fermentable carbohydrate thus playing an important role in the complex mechanism regulating rumen pH.

They also feed on the bacteria, thereby affecting the dynamics, type and population sizes of the bacteria present.

There is also a smaller, but significant population of fungi, which play an important role in the digestion of fibre (high cellulase and hemicellulase activities) and they are involved in the initial colonisation of the fibre particle, helping to pull it open so that the bacteria can gain access.

Thus together, cellulolytic bacteria and fungi are able to degrade the plant fibres, both enzymatically and mechanically.

They are essential to produce VFAs, the cows' fuel. All the rumen microbial species interact with one another synergistically to break down feed for the host, with a large degree of interspecies dependence.

They also interact with the animal and the diet. The animal's diet will have a direct effect on the rumen microbial population, and in turn on the fermentation process, affecting the VFAs profile and ruminal pH, with effects on the cows' health (acidosis) and performance: a diet rich in forage will favour cellulolytic micro-organisms and a high rumen pH, while starch rich diets will favour lactic acid producing bacteria, decreasing rumen pH.

Fibre's hidden potential

Fibres are plant cell walls, which contain pectin, hemicellulose, cellulose and lignin.

These different fractions show var-

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ious degrees of digestibility in the rumen. In fact, the major variability factor of feed digestibility (forage or feedstuffs) is their lignin content.

Lignin is an indigestible compound that prevents the rumen micro-organisms from accessing the cellulose and hemicellulose fractions of the fibres. Hemicellulose, cellulose and lignin make for the NDF fraction (neutral detergent fibre).

As seen in Fig. 1, each fraction's digestibility is variable, and by optimizing this digestibility, we could increase the feed milk potential.

The live yeast effect

It has been shown that the rumen specific live yeast SC I-1077 acts at different levels of the fibre digestion process, and as a result improves fibre digestion in several ways:

- SC I-1077 increases the number of fibrolytic micro-organisms in the rumen.
- SC I-1077 stimulates the enzymatic activities (hemicellulase, cellulase) of these fibrolytic bacteria and fungi.

In fact, SC I-1077 acts by creating an optimal rumen environment for fibre degradation.

Rumen microbes are strict anaerobes, but oxygen trapped within feed particles can enter the rumen and detrimentally affect fibrolytic microbes.

SC I-1077 uses this residual oxygen and stabilises the rumen pH, creating optimal conditions for the fibrolytic microflora.

SC I-1077 also provides some of the nutrients and co-factors (vitamins B, amino acids), which are essential to the development of this microflora.

This will, in turn, increase both the mechanical and enzymatic digestion activities of the rumen fungi towards lignified plant tissues, 'unlocking' the fibre's digestible fraction (hemicellulose and cellulose), which will be digested by the cellulolytic micro-organisms, which are also stimulated by the live yeast effects (Fig. 2).

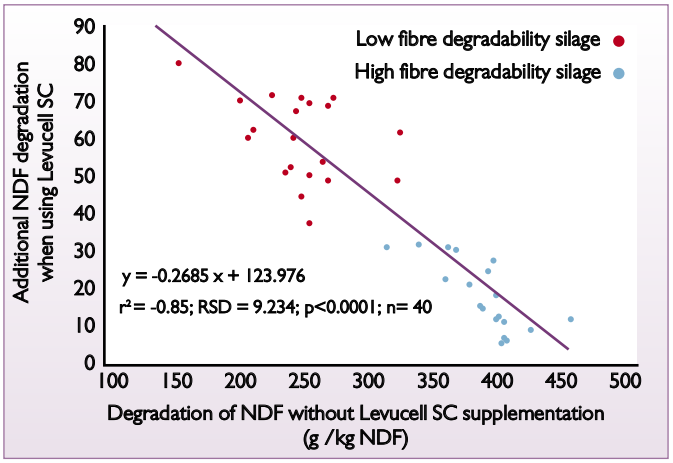
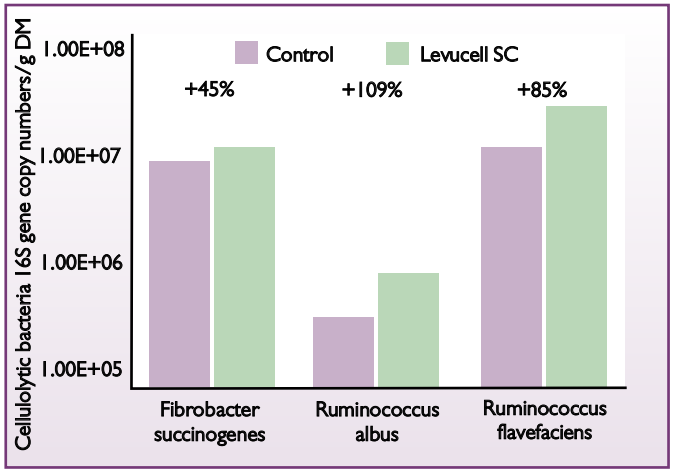


Fig. 4. Effects of Levucell SC supplementation (1g/day of Levucell SC 10ME) on fibre (NDF) degradation of maize silages of various degradability after 36 hours of incubation in the rumen of cows (Guedes et al., 2007).

Fig. 3. Effect of SC I-1077 live yeast on rumen cellulolytic bacteria populations (quantification done by qPCR) (Mosoni et al. 2007).



This enzymatic activity is also subject to a feed-back inhibition and utilisation of sugars by the live yeast results in improved fibrolytic activity.

A recent in vivo trial was conducted at the French National Research Institute (INRA) on rumen-cannulated sheep (diet: 50% hay + 50% concentrate), that confirms the effect of the live yeast on fibrolytic bacteria.

In this trial, daily supplementation with SC I-1077 significantly increased the beneficial fibrolytic bacteria populations (Fig. 3).

Several in vivo studies, performed with different diets have confirmed the significant effect of SC I-1077 on fibre digestibility, with average increases of NDF degradability of around 11% on complete rations.

Thus, the addition of live yeast improves the value of the feed, by unlocking the fibre's hidden potential.

Improving digestibility

Recently, the effect of the rumen specific yeast on fibre degradability was further scrutinised on 40 different corn silages of varying quality, tested on fistulated cows at the University of Portugal (Guedes et al). Interestingly, this study shows a relationship between the forage's initial quality (fibre digestibility) and the improved degradability due to SC I-1077 activity in the rumen.

Here are the main conclusions of the study:

- The use of SC I-1077 in the diet systematically enhances the degradability of the fibre's NDF fraction (hemicellulose, cellulose and lignin).
- This fibre degradability improvement is all the more important as the initial fibre digestibility was low (Fig. 4), with an average increased degradation of +4.3% for higher quality forage, going up to +24% on average for the forages with poorly digestible fibres, with higher lignin.
- VFAs concentrations in the rumen increased by +17.5% at four hours, demonstrating the increased feed utilisation.
- Stabilisation of pH, and decrease in lactate concentration were observed, even under non-acidotic conditions.

The researchers concluded that SC I-1077 rumen specific yeast 'may increase metabolisable energy available from low quality maize silages, and the glucogenic potential of the diet, both of which would increase the efficiency of cattle production'.

These improvements in digestibility can increase microbial protein yield to support increases in milk yield and milk fat percentage.

Conclusions

The rumen specific live yeast strain SC I-1077 is well documented for its effects on fibre degradation, which have recently been officially recognised by the US Food and Drug Administration. Indeed, the Center for Veterinary Medicine of the FDA has allowed the following functionality claim for SC I-1077: 'to aid in maintaining cellulolytic bacteria population in the rumen of animals fed greater than 50% concentrate.'

This claim is based on a solid research dossier gathering production trials and scientific publications such as the latest ones described in this article.

In fact, the claim would apply to most intensive dairy diets containing a total of 30-40% of non fibre carbohydrate in the total ration, including both concentrate and forage.

Rumen specific yeast represents a profitable and natural solution to better optimise feed and forages, resulting in higher available energy from the feed for milk production. ■