Role of sugars in boosting ration protein efficiency

Improving how efficiently protein is used in dairy diets could have important benefits, helping to offset higher feed prices and reducing the environmental impact of herds.

Farmers are having to struggle this winter with higher feed prices and, in particular, protein costs in dairy diets. This is partly a consequence of global rises in the price on most principal protein sources, including rape and soya. More recently urea prices have also increased. At the same time, protein feed rates have had to increase to compensate for lower protein levels in grass silages.

"The net result is that in many cases feed costs per litre have risen significantly," comments Georgina Chapman, technical support manager with liquid product specialist ED&F Man. "We can't just cut protein back as it is essential for all aspects of maintenance, production and reproduction."

Improving efficiency

"If, however, efficiency of protein use could be improved then feed rates could be reduced, which will have both economic and environmental benefits. This means understanding how protein is used by the cow and specifically by the rumen."

Ms Chapman explains that protein in dairy diets can be split into rumen degradable (RDP) and rumen undegradable protein (DUP). The RDP is the fraction of total protein consumed by the cow that is degraded by the rumen microbes. The DUP fraction passes through the rumen untouched and is absorbed in the intestines.

Table 1: Effect of carbohydrate source on microbial protein production

	Silage alone	Added sucrose six-carbon sugar	Added starch	Added xylose five-carbon sugar
Microbial protein production (g/day)	64	93	74	82
Rumen ammonia concentration	255	157	213	180

"In the rumen the RDP fraction is broken down into smaller molecules, with ammonia the end product of degradation. Ammonia can then be utilised by the rumen microbes to synthesise microbial protein. Microbial protein can contribute up to 80% of the cow's total protein requirements due to its high digestibility value and optimal amino acid profile.

"The combination of DUP and microbial protein is the protein actually available to the cow and is referred to as metabolisable protein (MP).

"If rumen microbes produce more ammonia than can be utilised, the excess ammonia is converted to urea by the liver—with much of it then excreted which is a waste of protein. Furthermore, energy is diverted from production to fuel this process."

Studies indicate that the efficiency of protein digestion is typically around 25% to 30%. This means that only between a quarter and a third of the nitrogen fed is captured and used by the cow, with the balance being excreted in the faeces and urine. The excretion of excess protein can cause soil acidification and, if ammonia is released into the atmosphere, can lead to reduced air quality and issues with odour.

"The balance of RDP and DUP is important when developing dairy diets. But, if we can improve the efficiency of protein metabolism in the rumen and boost the output of microbial protein, we can potentially reduce the crude protein content of diets to reduce feed costs and lessen the environmental impact of milk production," maintains Ms Chapman.

She says that in order to maximise production of microbial protein it is important to balance the supply of RDP and energy to rumen microbes.

If RDP is deficient, then the production of microbial protein will be reduced. If protein levels are in excess of available energy, then the microbes will not be able to utilise all the available nitrogen—leading to increased protein inefficiency and pollution.

Six-carbon sugars

In particular it is important to provide rapidly fermentable carbohydrates without increasing the risk of acidosis which will compromise microbial protein production. She recommends considering feeding a molasses-based liquid feed which contains sugars and numerous organic acids. The sugar fraction is a combination of mainly sucrose and glucose which are the important six-carbon sugars for rumen fermentation.

"Six-carbon sugars are proven to be more beneficial to dairy cows than the five-carbon sugars found in other feeds. They are more highly rumen fermentable and more effective at improving fibre digestion, increasing microbial protein production.

"Table 1 shows the effect of different carbohydrate sources on microbial protein yield and

Table 2: Effect of adding a molasses blend on microbial protein production			
Feed (kg)	Without molasses	With molasses	
Grass silage	45.0	45.0	
DDG wheat	2.0	2.0	
Wheat	2.0	2.0	
Dried molasssed SBP	3.0	3.0	
Hipro soya	1.0	1.0	
EDF Stockmol	-	1.0	
Total	53.0	54.0	
Nutrient analysis			
Dry matter intake	21.0	21.7	
Forage dry matter	13.9	13.9	
Ration dry matter	39.7	40.2	
Energy (MJ ME)	247	255	
M/D (MJ/Kg dry matter	11.7	11.8	
Crude protein (% DM)	16.2	16.0	
MPB (bypass)	923g	955	+32g
MPN (nitrogen)	2335g	2389g	+54g
MPE (energy)	2107g	2172g	+65g
Excess MPN	228g	217g	

six-carbon sugars are the most efficient. In addition, six carbon sugars have the greatest effect in reducing rumen ammonia concentration. This means that more of the available ammonia in the rumen has been captured, so less is being wasted and excreted."

Ms Chapman says that cane molasses also has a significant impact on the rate of rumen fermentation. Sugars are rapidly fermented, and most will have been fermented within two to three hours of feeding. But trials show that the rumen fermentation remains more active long after the sugars have been utilised.

Promoting fermentation

"By promoting faster and more active fermentation, this will increase rumen throughput and so stimulate dry matter intakes. By raising the sugar levels in the diet to 6-8%, while holding overall starch and sugar at around 28-32%, we can create a more efficient fermentation without increasing the acidosis risk."

Table 2 shows two diets for a cow targeted to produce 30 litres per day to demonstrate the effect that the addition of a molasses-based liquid feed has on metabolisable protein supply. The second diet is identical except for adding 1kg of Stockmol 20, a high sugar molasses blend with no extra protein fed.

Although the crude protein content of the second diet is marginally lower, the predicted supply of metabolisable protein from bypass (MPB), nitrogen (MPN) and energy (MPE) have all increased, meaning that there is more protein available to the cow. In addition, the predicted excess protein in the diet has been reduced.

"By stimulating the efficiency of rumen protein digestion, the addition of the molasses blend improves the use of all the protein in the diet and increases microbial protein supply. As well as making better use of the diet, increasing microbial protein is important for milk quality as it is a major source of the amino acids essential for milk protein production.

"With protein prices likely to remain high all winter, stimulating microbial protein production through the addition of molasses could be an effective way to help control feed costs," Ms Chapman suggests.

"Even if protein prices fall back in the future, the greater efficiency achievable will allow the protein content of diets to be reduced—increasing protein efficiency and reducing the impact on the environment."