THE ROLE AND IMPORTANCE OF CANE MOLASSES BLENDS AND SUGARS IN RUMINANT DIETS

By Dr Phil Holder, ED&F Man

A recent major conference drawing together speakers from leading research institutes confirmed that sugar in ruminant diets offers considerably more than just being an energy source. By better understanding more about the considerable variety of roles performed by sugars, it will be possible to improve rumen health and efficiency to help underpin dairy farm profitability.

As the leading supplier of cane molasses and liquid products for animal feed, fermentation and other industrial uses, we specialise in the sourcing, shipping, storage and distribution of cane molasses, molasses blends and liquid products. We therefore have a vested interested in the efficient and optimum use of molasses blends in ruminant diets.

Given the volume and quality of new research into the role of sugars in ruminant diets, this conference which I chaired gave 350 nutrition professionals from 10 countries, including a large UK contingent, the opportunity to explore how and why sugars can promote more efficient, and more profitable dairy cows.

In feed production, for years, cane molasses has been seen simply as a source of energy and as a binder but little more. Inclusion rates were kept to a minimum as molasses was seen as an expensive source of energy when compared to starch and included primarily as a binder and to ensure good pellet quality. The value of sugar and therefore molasses wasn't appreciated in nutritional terms

This situation is now changing. It is now understood that different sugars are digested in different ways. The six carbon sugars such as sucrose and glucose, found in molasses blends are proven to be more beneficial to ruminants than the five carbon sugars found in fermentation co-products, wheat syrup, processed feeds and silages.

A secondary role in both compound feeds and TMR diets was as a way to improve palatability and de-dust rations to stimulate intakes. But the more we find out about cane molasses and sugars, the more it becomes clear they play a number of roles which together can help improve animal performance.

Table 1: The detailed composition of cane molasses (%)

	%
DM	76.8
CP	4.8
Sucrose	37.5
Fructose	6.2
Glucose	4.1
Starch and others	2.5
Lactic acid	4.7
Organic acids	1.8
Ash	11.0
Sulphates – Phosphates	3.1
DM DESCRIBED	**97.4**

It is important to appreciate that cane molasses is a complex product which contains a number of compounds and substances in addition to sugars. The sugar fraction, which in standard cane molasses accounts for around 47% of the dry matter, is actually a blend of different sugars including sucrose and glucose. The remainder of the dry matter contains crude protein, starch, lactic acid and a range of other organic acids, all of which have an effect within the rumen (Table 1). Significantly, we can now describe over 97% of the dry matter, meaning we know more about how molasses delivers benefits in ruminant diets.

The key to unlocking the full potential of molasses is understanding how it influences the rumen.

Rumen ecology and fermentation

Research by Dr Paul Weimer at The University of Madison, Wisconsin shows that sugars have a significant impact on the rumen ecology. He pointed out that the rumen microbiota is a complex ecosystem and that different interactions among multiple species yield a network of interactions.

The diet is the main driver of the composition of the microbial community and so influences how diets are utilised. For example feeding diets high in concentrates and rapidly fermentable carbohydrates decreases the levels of fibrolytic bacteria which can lead to a reduction in fibre digestion. Because of their abundance in a range of feeds, sugars are metabolised by a large fraction of the rumen community.

In the rumen, sugars are fermented by a wide range of bacteria and also by protozoa, producing higher levels of propionate and butyrate. The breakdown of fibre on the other hand produces higher levels of acetate. Butyrate has positive effects on rumen pH, milk solids and rumen papillae.

Protein metabolism is also affected. When sugars are fermented, microbial yields are increased and methane emissions are reduced indicating improved nitrogen utilisation.

Work at the University of Bologna, led by Dr. Alberto Palmonari demonstrates some of the ways in which sugars are moderating rumen performance.

In vitro assessments confirm that sugars are rapidly degraded in the rumen. While initial rates vary, all sugars are effectively fully digested within four hours of feeding. For sucrose 94.2% has been digested within an hour of feeding with 100% digested within four hours. This might lead to the conclusion that sugars therefore only have a short-term influence on overall rumen function. However, when gas production rates are analysed a different picture emerges.

Figure 1: The addition of cane molasses on rumen gas production

Gas production is an indicative measure of rumen microbial activity. When molasses was added to *in vitro* diets a significant and sustained increase in gas production was observed (Fig. 1).

While the sugars in molasses were effectively exhausted within four hours, they had effectively kick started the fermentation, increasing overall rumen microbial activity. The consequence will be increased feed utilisation and nutrient capture and also a greater rumen throughput which may explain why molasses has a reputation for stimulating intakes. There is evidence that shows adding molasses can increase the overall total digestibility of the other feed ingredients.

The addition of molasses also has an impact on rumen VFA production, both the total production and also the relative proportions of VFAs produced. Fig. 2 shows the effect of molasses inclusion on VFA production. At all time-points the total VFAs produced is higher in the molasses supplemented diets, indicative of greater rumen microbial activity and an enhanced energy supply to the cow.

Figure 2: The effect of the addition of cane molasses on rumen VFA production (mmol/L)

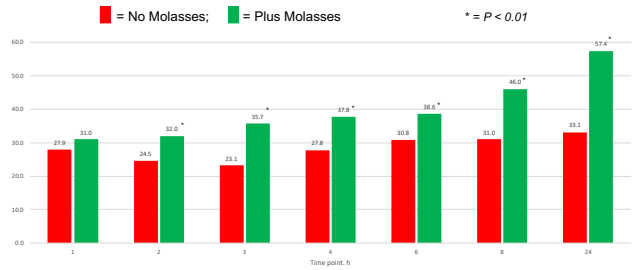
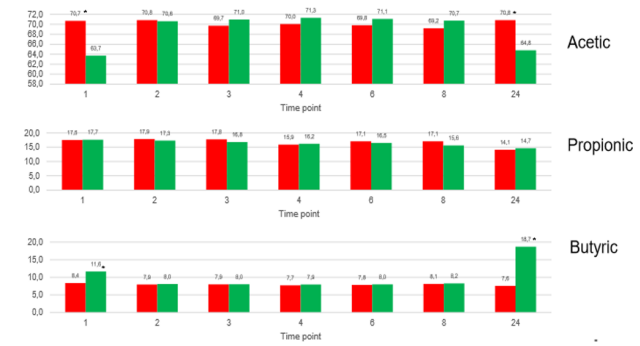


Fig. 3 looks at the production of the key VFAs – acetate, propionate and butyrate. The increase in butyrate production is particularly significant.

Figure 3: The effect of the addition of cane molasses on key rumen VFA ratios



Butyrate is known to stimulate rumen, abomasum and small intestine development. It also modulates the secretion in the gastro-intestinal tract of gut regulatory peptides and hormones. Together these effects increase the nutrient absorption in the digestive tract. By increasing the proportion of butyrate, molasses has been shown to improve overall diet utilisation.

In addition, by increasing the butyrate:acetate ratio the addition of sugars can help reduce problems with rumen acidosis. Increased production of butyrate and reduced acetate output reduces the acid load in the rumen because butyrate is a less powerful acid. Butyrate can also increase the absorption of acids from the rumen, further helping moderate acid loading.

High yielding dairy cows, in particular, require a high supply of fermentable carbohydrates, but increasing levels can increase the risk of acidosis. Carbohydrate levels are usually assessed in diets as combined starch and sugars with a maximum of around 30-35% in the dry matter.

The new research indicated a benefit from considering sugars and cane molasses more closely. Increasing the proportion of sugars to starch would allow an increase in total fermentable carbohydrates while reducing the risk of acidosis. The trend has been to higher starch diets, increasing the risk of cows being prone to acidosis. Starch fermentation tends to increase rumen lactic acid production, which has a more dramatic effect on pH than other rumen VFA's. Increasing the sugar levels in the diet to 7% while holding overall starch and sugar at around 30% will allow a more efficient fermentation without increasing the acidosis risk.

Table 2: The effect of higher sugar content on the digestibility of dry matter and fibre in the diet

Sugar content (%)	2.6%	4.9%	7.4%
Starch content (%)	31.4%	29.1%	27.5%
Total starch and sugar (%)	34%	34%	34.9%
Digestibilities (%)			
DM	63.6	62.1	65.4
NDF	36.3	36.3	44.6
ADF	42.2	42.4	49.6

Table 2 shows the impact of increasing the proportion of sugars in the diet. All three diets contain a similar total percentage of starch and sugar, with starch reducing as sugar content increases. The digestibilities of the dry matter, NDF and ADF all increased.

Fibre digestion

Ruminants rely on being able to digest fibre. Effective digestion of fibre is vital as we strive to increase forage intakes to maximise production from forage and reduce costs per litre. Rather than striving to get more forage into cows, the goal must be to utilise it better.

Micro-biological analysis confirms that the addition of molasses stimulates the populations of fibre digesting micro-organisms in the rumen. Table 3 shows the impact of a number of fermentable carbohydrate sources on NDF digestibility. The ED&F man blend and

Table 3: The effect of different readily fermetable substrates on NDFom digestibility (% differences compared to control forage)

	8h	24h	48h
Cane Molasses	+10,61	+19,98	+20,19
Pure Starch	+9,65	+14,26	+15,03
Glycerol	+10,08	+7,40	+7,77
Milk Whey	+5,68	+2,29	+2,54
Malt	+7,09	+16,93	+17,38
ED&F Man blended liquid	+3,19	+25,45	+27,18

the straight cane molasses had the biggest impact on the digestibility of fibre in the diet.

Practical implications

The challenges facing dairy nutritionists are complex. You need to formulate rations which are adequate in terms of rumen and intestinal digestible nutrients to meet the cow's requirements, to stimulate milk and milk constituent production while reducing the risks of metabolic disease.

To achieve this is hard enough in perfect controlled conditions, but becomes harder still when we factor in on-farm factors such as forage and feed variability, overcrowding, accuracy of diet mixing and presentation and general management.

The new research shows that the addition of molasses does more than supply a direct energy source, improve diet presentation and palatability. We understand how it influences rumen function and impacts on a range of factors that can improve performance.

The industry needs to treat sugars as a nutrient in their own right, rather than bundling them up with starch when accessing rapidly fermentable carbohydrates, because they perform differently and sugars deliver significant additional benefits.

To optimise rumen fermentation we should be formulating diets to include 6-8% sugar in the dry matter with a high proportion of six carbon sugars. Starch content should be 22-30% in cows 20-200 days in milk, falling to 18-27% in cows more than 200 days in milk.

This will require a change in the way rationing programmes treat molasses. Currently we often see diets include 1kg per cow per day as much to aid palatability and to reduce dust as to include a source of this key nutrient.

Feed rates of 1.5-2.0kg/day in dairy diets (typically 1-1.5kg for beef) will ensure adequate sugar to stimulate rumen fermentation and dry matter intake to increase the consumption and utilisation of forage.

Feed miller and blenders have different production and nutritional requirements, and this is why ED&F Man offer a range of molasses blends to suit individual needs.

Developed as a result of extensive customer research, our high sugar Millspec range offers a choice of sugar, protein and energy levels and handling characteristics to suit individual customer needs. We also have the flexibility to offer bespoke products to suit specific feed production needs. As we understand more of the unique benefits of molasses blends in adding sugars to ruminant rations, we expect to see nutritionists looking to take advantage of these benefits and working together with formulators and buyers to optimise feed formulations.