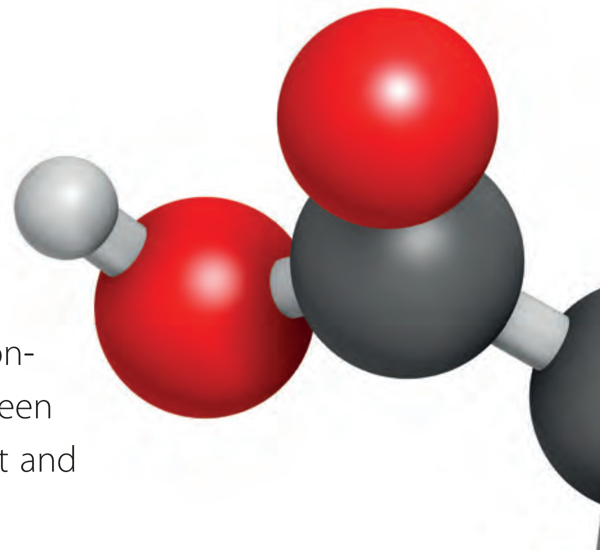
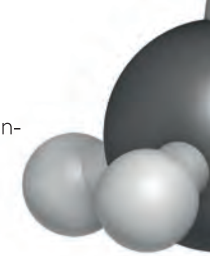
MILK FAT: IT'S IN THE FEED

by Dr Joubert Nolte

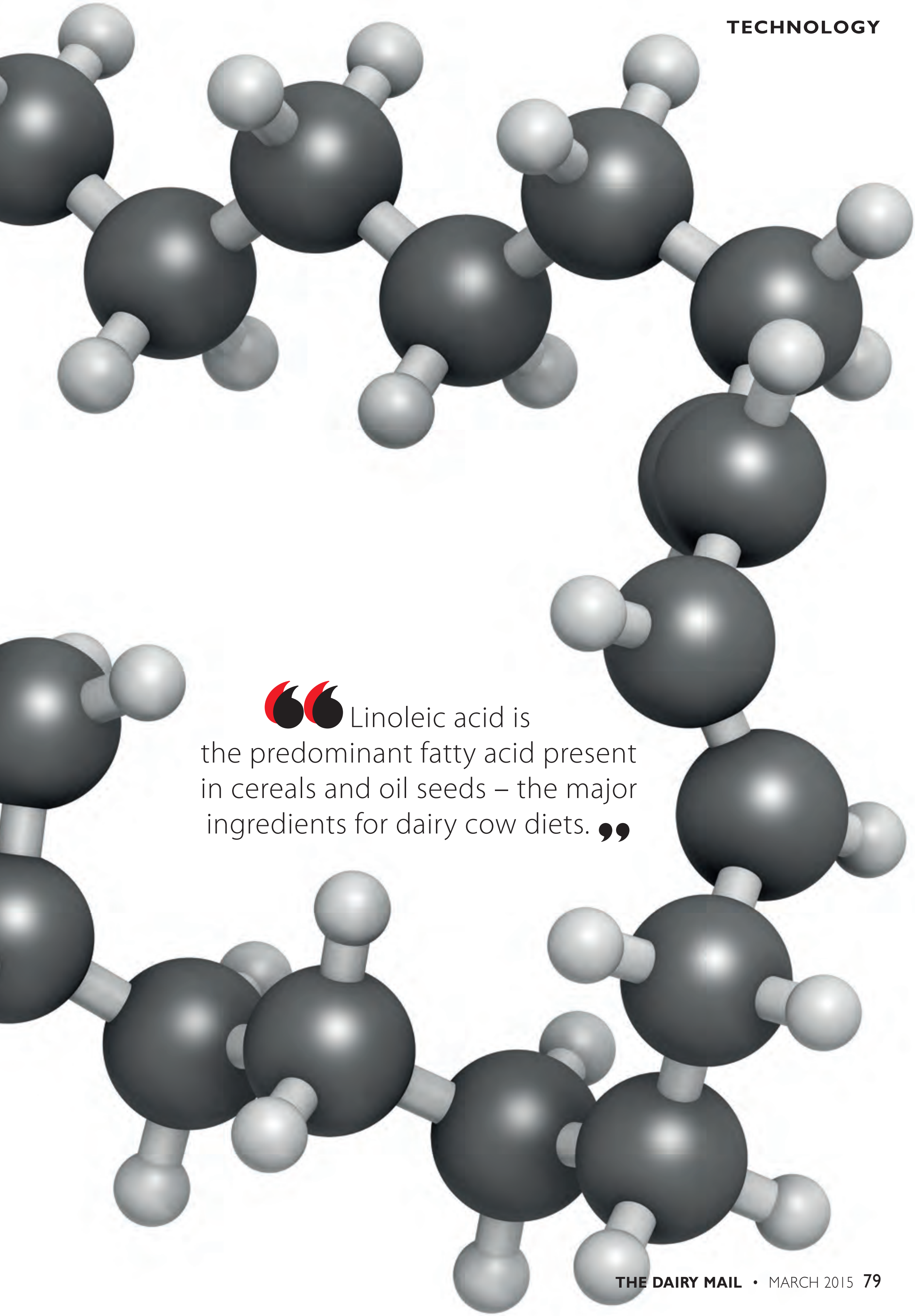
Dairy businesses continuously have to deal with rising input costs and unfavourable climatic conditions that reduce profitability on dairy farms. Most dairy operations frequently have to contend with the inverse relationship between high milk yields and milk solids (milk fat and milk protein) concentration.



This is more complicated than it appears, as milk fat concentration and composition depend on a range of factors such as species, breed, genotype, stage of lactation, feed quality, fermentation rate of carbohydrates, fibre length of roughages, particle size of cereals, health status of the herd and environmental conditions. In general, milk prices are determined by the hygienic quality and milk solids concentration of the milk. To produce maximum milk solids is therefore a primary objective for most dairy farmers and is usually achieved by accomplishing maximum milk yield while maintaining high milk solids concentrations. High milk yields are inversely related to milk solids concentration and tend to decrease as milk yield increases.



This may in part be the result of a dilution effect that decreases solids concentration as milk yield increases, but other inhibitive associated nutritional factors such as rumen pH, dietary fat content and composition may also contribute. Clearly, there is a challenge for scientists working with dairy cows to improve the current understanding and modulation of milk fat content and composition.



> Linoleic acid is the predominant fatty acid present in cereals and oil seeds – the major ingredients for dairy cow diets.

Fatty acids

Milk fat is a complex mixture of lipids that contain more than 400 different fatty acids and is the most variable component of milk. It can be secreted from *de novo* synthesis by the epithelial cells in the mammary gland or absorbed from arterial blood. The generally accepted, but older, understanding of milk fat depression was linked to observations of reduced milk fat concentrations when rumen pH was low as a result of low fibre/high concentrate diets or during heat stress. Cows ingested proportionately less fibre under these conditions, resulting in reduced acetate production in the rumen. Because acetate and butyrate are important building blocks for mammary milk fat synthesis, the generally accepted theory was that milk fat production was restricted under these conditions as a result of a limited supply of acetate and butyrate.

Although this understanding may be partially true more recent research has shown that milk fat depression was more complicated and closer linked to the fatty acid composition and content of the diet. More specifically, the rumen environment directly influences the biohydrogenation pathways and resultant intermediates of biohydrogenation that affect milk fat synthesis in the mammary gland.

The predominant fatty acid present in cereals and oil seeds is the polyunsaturated 18:2 n6 fatty acid (linoleic acid). Marine products such as fish meal and fish oil contain high levels of the very-long-chain unsaturated fatty acids. Long-chain unsaturated fatty acids are extensively metabolised and biohydrogenated in the rumen to form saturated long-chain fatty acids. Under certain dietary conditions the biohydrogenation pathways in the rumen are altered to produce specific fatty acid intermediates, especially the conjugated linoleic acids (CLA). These intermediates can be absorbed from the gut and directly secreted into milk, or it can act as regulators or disruptors of the *de novo* fatty acid synthesis in the mammary gland. Even minute amounts of some of the intermediates can greatly depress milk fat synthesis! This disruption will result in changes to milk fat composition and the amount of milk secreted.

Further research has been conducted to investigate which specific intermediate of rumen fatty acid biohydrogenation was responsible for milk fat depression and gain insight in the mode of action. Milk fat concentrations of dairy cows treated with different conjugated linoleic acid isomers was clearly more depressed with the trans-10, cis-12 conjugated linoleic acid treatment, showing that this specific isomer was primarily responsible for milk fat depression.

Under normal rumen conditions linoleic acid is biohydrogenated through various steps to form the saturated fatty acid, stearic acid. Diets for high-

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production cows are formulated to maximise milk production and therefore include large amounts of readily fermentable carbohydrates and/or additional fatty acids in conjunction with marginal roughages to achieve sufficient energy to drive production. These conditions could be conducive to reduce rumen pH and create a more acidic rumen environment that could alter normal biohydrogenation pathways. The actual amount of fibre in the diet is important, but fibre length also plays an important part. Fibre that is cut too short will reduce the effective fibre in the rumen and contribute to create an environment that will decrease rumen pH, change the rumen microbial population and alter rumen fermentation.

When rumen conditions are altered through basic characteristics of the diet or altered eating behaviour of the cows and/or panting during heat stress (less rumen pH buffering from the sodium bicarbonate contained in saliva) or via relatively high supplementary levels of unsaturated fatty acids, stearic acid is formed via a different biohydrogenation pathway. Under these conditions trans-10, cis-12 conjugated linoleic acid is produced as an intermediate of the biohydrogenation process. A small amount of this specific intermediate that is absorbed from the gut and reaches the mammary gland is sufficient to depress *de novo* milk fat synthesis.

It is important to note that rumen acidotic conditions are not a prerequisite for milk fat depression to occur. In many cases, rumen health is excellent with no signs of rumen acidosis. Low milk fat commonly occurs as a result of several concurrent diet and management factors, rather than one single factor. The fat content of ingredients, as well as the fatty acid composition of the fats in the diet play an important role. Nutritionists must endeavour to optimise rumen fermentation in conjunction with careful consideration of dietary fat content, specifically unsaturated fat content, and use of rumen bypass fats that will not be subject to rumen biohydrogenation.

GET MAXIMUM YIELD

Ensure that the supplier of the feed for your cows understands how the individual raw materials, feed presentation and general management are interrelated to assist you in presenting your cows with the best possible alternative to achieve maximum milk yields with the expected milk solids concentrations. Management of a dairy operation is complex and requires skills in a variety of fields. Specialist knowledge must be deployed to ensure that the nutrition of the cows is cared for taking into consideration the multiple interrelated factors that can affect the cows and ultimately your bottom line. Feeding high-production dairy cows requires the application of the latest technology to modulate and predict as accurately as possible the outcome for the conditions of your farm. Unsaturated fatty acids are not all doom and gloom. On a positive note, there have been reports on the anticarcinogenic health benefits of conjugated linoleic acids, in particular the cis-9, trans-11 isomer, to humans. Scientists working in this field have to improve the current understanding of milk fat production in dairy cows and improve existing modulation to create opportunities for the production of high conjugated linoleic acid milk that can be sold at a premium, without depressing milk fat synthesis

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