Reducing saturated fatty acids in the food chain through alteration of milk fat composition

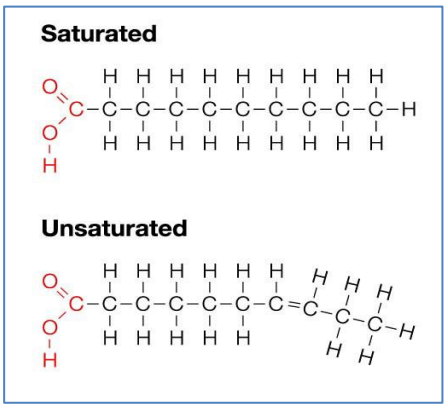
A BBSRC/DRINC funded study

Fats in dairy products: health implications

The UK, in common with the majority of Western countries, exceeds its targets for saturated fats in the diet, with milk and milk products constituting the single largest source. Excessive consumption of saturated fat is a risk factor for cardiovascular disease (including stroke) which remains the UK's largest cause of premature death. There are, conversely, also many likely health benefits from increased milk consumption, including a reduced risk of vascular disease and some cancers. Milk and dairy products are also a vital source of many nutrients, including calcium and vitamin B_{12}, so simply reducing our consumption of milk would be counterproductive in terms of its public health value. Changing the diet of dairy cows can lead to milk being produced with reduced saturated fats, and there is evidence to suggest that this may be a potential means of reducing saturated fat intake in humans whilst retaining the health benefits of milk.

What are fatty acids?

Fatty acids consist of chains of hydrocarbons with a carboxyl group (COOH) at one end. They can be saturated, where all the carbon atoms are surrounded by hydrogen, or unsaturated, where there are double bonds between two (mono unsaturated fatty acids; MUFA) or more (polyunsaturated fatty acids; PUFA) carbon atoms. Unsaturated fatty acids can be *cis* or *trans* configured, referring to the arrangement of hydrogen atoms around the carbon double bond. If adjacent hydrogen atoms are on the same side, as illustrated, the fatty acid is *cis*- configured: this is the case with most naturally occurring fatty acids. If, in contrast, the hydrogen atoms are on opposite sides of the double- bond, the fatty acid is *trans*-configured. *Trans* fatty acids (TFA), although unsaturated, increase the risk of coronary heart disease by raising blood levels of LDL-cholesterol ('bad cholesterol'). The majority of TFAs are produced as a result of industrial food processing but a different type does occur naturally in trace amounts in meat and dairy products, originating from microbiological activity in the ruminant gut. The level of TFAs in the general diet is now at its lowest level for decades, largely as a result of removing them from the food chain, and, as a direct result of this, the proportion of TFAs originating from microbial activity in the gut of ruminants has increased in relative terms. While some studies have suggested that naturally occurring TFAs, in contrast with those artificially produced, may have health benefits, there is, overall, no scientific consensus about differences in their health effects. Strategies to reduce the saturated fatty acid (SFA) content of milk should also, therefore, minimise increases in TFAs.



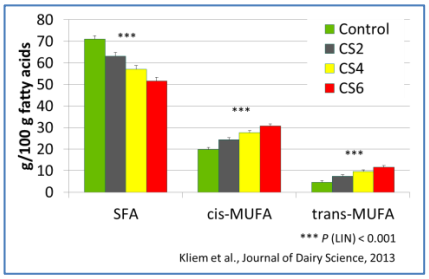
Further reading: Livingstone, K.M., Lovegrove, J.A. and Givens, D.I. (2012). The impact of substituting SFA in dairy products with MUFA or PUFA on CVD risk: evidence from human intervention studies. Nutrition Research Reviews. 25:193-206.

Reducing the saturated fatty acid content of milk

Previous studies at the University of Reading have demonstrated that including processed oilseeds in the feed of dairy cows can significantly reduce the SFA content of milk whilst increasing cis-MUFA. These results have been observed in detailed studies conducted in controlled environments using small numbers of animals, and an objective of the present study was to replicate these results in commercial dairy herds. Cows were fed an oilseed based supplement, either high in unsaturated fatty acids or approx. 50:50 saturated: unsaturated fatty acids, for a four week period. Milk was monitored daily for fat, protein, SFA, MUFA, and PUFA content. The supplements high in unsaturated fatty acids were all effective at decreasing the SFA content of the milk over the four-week period, and at increasing MUFA and PUFA. Small increases in TFA concentrations were also observed with these supplements. Overall, the response observed in this study was typical of the results obtained in detailed studies, demonstrating the viability of reducing SFA concentrations in milk on a commercial scale.

Protection from microbial biohydrogenation

Feeding strategies that increase MUFA concentrations in milk without the associated increases in TFA concentration resulting from microbial hydrogenation would be preferred by milk processors and retailers. A combination of new high cis-MUFA varieties of rape/sunflower seeds and new approaches to oilseed processing may provide benefits over existing approaches in this regard. Calcium saponification of an unsaturated fatty acid, the process of reacting fatty acids with calcium to produce a rumen-insoluble fat source, is thought to minimise the production of TFAs through prevention of microbial hydrogenation in the rumen. The effect of feeding increasing amounts of a calcium-salt of high *cis*-MUFA on feed intake, milk yield and composition, and milk fatty acid composition was therefore also explored in this study. Cows were given increasing concentrations of saponified *cis*-MUFA (Ca-MUFA; 0, 20, 40 & 60g/kg of dry feed matter (Control, CS2, CS4 & CS6)). The supplement was extremely effective at reducing SFA in the milk, partially replacing it with *cis*-MUFA, as illustrated in the figure (right), without incurring any negative effects on milk yield (results not shown).



There was also an associated increase in *trans*-MUFA suggesting that the saponified MUFA did not provide complete protection against microbial hydrogenation in the gut. The substantial replacement of SFA with *cis*-MUFA, however, demonstrates that this is a successful means of improving the health qualities of milk.

Impact

Reducing the mass of SFAs in the food chain would bring substantial benefits in many areas:

Commercial

This technology is already being applied on a commercial scale, with Marks & Spencer selling milk with up to 6% less saturated fat as a result of changes to the dairy cows' diet. There are also associated environmental benefits due to the reduction in use of palm oil in the feed and reduced methane production by the cows. This technology may have the potential to stimulate demand for dairy products in an increasingly health conscious society, which would improve margins for dairy farmers and may also increase export demand, in turn increasing the competitiveness of the UK food industry.

Public health and finances

Cardiovascular disease currently costs the UK in the region of €18 billion per year, one of the highest per capita in the EU. Meeting nutritional guidelines on saturated fat intake could save £20 billion per year.

Individuals

In the longer term, reducing the SFA content of milk is likely to have a significant impact on health and quality of life, particularly in an ageing population. Milk has a number of benefits to older people and an improved product, in terms of reduced SFA, would encourage increased consumption, helping the maintenance of muscle mass and bone strength.

Further reading: Kleim, K. E., C. K. Reynolds, D. J. Humphries, R. M. Kirkland, C. E. S. Barratt, K. M. Livingstone, & D. I. Givens. 2013. Incremental effect of a calcium salt of cis-monounsaturated fatty acids supplement on milk fatty acid composition in cows fed maize silage-based diets. J. Dairy Sci. 96: 3211 - 3221.

Next steps: An MRC –funded human intervention study is underway to investigate the effects of replacing saturated fat in dairy products on risk factors for developing heart disease.

Centre for Food Security webpage: www.reading.ac.uk/food-security/