

Institution: University of Reading
Unit of Assessment: Agriculture, Veterinary & Food Science
Title of case study: Production of dairy products with reduced saturated fat content
<p>1. Summary of the impact</p> <p>Since 2011, an estimated 3 million UK milk consumers have benefitted each year from research conducted at the University of Reading, which has helped reduce saturated fatty acids (SFAs) in milk and milk products. The research, which was carried out between 2004 and 2013, manipulated dairy cows' diets to produce milk with reduced saturated fat and increased unsaturated fat content. Leading UK retailer, Marks and Spencer (M&S), used this research to support its suppliers in providing a new diet regime for their dairy cows, launching a new low saturated fat M&S milk in October 2011. The launch of this healthier milk product has led to (i) improved diets and reduced associated health risks (heart disease, obesity and cancer) for M&S customers (ii) reduced use of non-sustainable palm oil in cow diets (iii) reduced harmful greenhouse gas emissions (iv) increased sales for M&S and enhanced reputation in terms of quality and corporate social responsibility (v) increased payment contracts for milk producers and (vi) new techniques to measure fatty acids in milk for the dairy industry.</p>
<p>2. Underpinning research</p> <p>Background</p> <p>Adults, and especially children, exceed the dietary target (11% of food energy intake) for SFA in the UK. Consumption of SFA increases the risk of cardiovascular disease, obesity (and the diseases and health problems associated with obesity) and, according to mounting evidence, various cancers (such as breast and colon cancers). Milk and milk products are the largest single dietary source (about 30-40%) of total SFA and therefore recent research has focused on sustainable methods of producing milk with a lower SFA concentration. Moreover, there is concern that milk production is contributing to global climate change due in large part to the production of methane – a potent green house gas - by dairy cows (typically 500-600 litres/cow/day). Though there has been considerable research on the role of cow nutrition on milk fat content, there has been little research on the impact of diet on milk fatty acid composition. Research carried out between 2004 and 2013 at the University of Reading examined how different types and quantities of feed affected the various SFA found in milk in different breeds of cow. The research was led by Reading staff that have expertise specifically in fatty acids in the food chain, ruminant physiology and health quality of milk - Ian Givens, Professor of Food Chain Nutrition and Director of Food Production and Quality Research Division (2003-), Chris Reynolds, Professor of Animal and Dairy Science (2000-), Dr Kirsty Kliem, Research Fellow (2001-) and Mr Dave Humphries Senior Research Associate and Manager of Animal Facilities (1992-).</p> <p>The role of nutrition on milk fatty acid composition</p> <p>In 2008, Givens explored options for replacing some of the SFA in milk fat with more beneficial cis-monounsaturated fatty acids through alteration of the cow's diet. He provided preliminary evidence that changing diet was a viable strategy for achieving health benefits for milk consumers [1]. Givens and his Reading colleagues then conducted extensive feeding trials of dairy cattle to identify the types and quantities of UK-grown feed (maize, rapeseed and linseed) that result in substantially reduced quantities of the various SFAs found in milk. They tested the effects of: replacing grass silage with maize silage [2], different forms of rape seed (whole, milled or oil) [3], different varieties of rape oil (normal vs. high oleic acid) [4], and the inclusion of an extruded linseed product, on different cow breeds [5] on milk fatty acid composition.</p> <p>Their studies demonstrated that including processed rapeseeds (and other oil-rich products) in the diet of the dairy cow reduced potentially harmful SFAs typically from 70 to 55-60% total fatty acids whilst increasing more beneficial cis-monounsaturated fatty acids from 20 to 33% [3], [4]. They also showed that the proportionate changes milk fatty acid composition was different in different breeds, highlighting the importance of considering genetic interactions [5].</p>

In 2011, Givens and his colleagues presented results from a four year study that assessed the persistence of changes to milk fatty acid content in response to diet change. New innovative techniques were developed to accurately measure the fatty acid content of milk in terms of the type of fatty acids and their quantities. The key findings were that 1) for a given diet imposed, changes in milk fatty acid composition were persistent at least over the 12 week study period and 2) the milk fatty acid composition of individual cows varied a lot but were consistently different ie high SFA cows were always high SFA. The results are important because they confirm that the effect of diet changes are consistent and that there is probably a sizable genetic component to milk fatty acid composition but we have not done anything on this.

A key product of the work was the development of clear 'blue prints' in the published literature, which defined the parameters for more sustainable milk production with lowered SFA content.

Sustainability was related to the use of oilseeds that are grown extensively in the UK rather than imported feed stocks such as palm oil and the reduced amount of methane produced by the cow. Thus the production of milk with lower SFA can be achieved whilst also reducing the environmental impact of milk production providing beneficial impacts on both human health and the environment [2], [6], [7]

3. References to the research

Research that has led to the impact has been published in peer review journals and has been assessed as of at least 2* quality.

- [1] Givens, D. I. (2008) Impact on CVD risk of modifying milk fat to decrease intake of saturated fatty acids and increase intake of cis-monounsaturates. *Proceedings of the Nutrition Society*, 67 (4): 419-427. DOI: 10.1017/S0029665108008707
- [2] Kliem K. E., Morgan R., Humphries D. J., Shingfield K. J. and Givens D. I. (2008) Effect of replacing grass silage with maize silage in the diet on bovine milk fatty acid composition. *Animal*, 2 (12):1850-1858. DOI: 10.1017/S1751731108003078
- [3] Givens D. I., Kliem K. E., Humphries D. J., Shingfield K. J. and Morgan R. (2009) Effect of replacing calcium salts of palm oil distillate with rapeseed oil, milled or whole rapeseeds on milk fatty-acid composition in cows fed maize silage-based diets. *Animal*, 3 (7):1067–1074. DOI: 10.1017/S175173110900442X
- [4] Kliem, K.E., Shingfield, K.J., Humphries, D.J and Givens, D.I. (2011) Effect of replacing calcium salts of palm oil distillate with incremental amounts of conventional or high oleic acid milled rapeseed on milk fatty acid composition in cows fed maize silage-based diets. *Animal*, 5 (8):1311-1321. DOI: 10.1017/S1751731111000310
- [5] Kliem, K.E., Aikman, P. C., Humphries, D. J., Morgan, R., Shingfield, K. J. and Givens, D. I. (2009) Effect of replacing calcium salts of palm oil distillate with extruded linseeds on milk fatty acid composition in Jersey and Holstein cows. *Animal*, 3(12): 1754–1762. DOI: 10.1017/S1751731109990723
- [6] Kliem, K.E., Reynolds, C.K., Humphries, D.J., Kirkland, R.M., Barratt, C.E.S., Livingstone, K.M., and Givens, D.I. (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. *Journal of Dairy Science*, 96 (5): 3211-3221. DOI: 10.3168/jds.2012-6211
- [7] Crompton, L.A., Mills, J.A.N., Kliem, K.E. and Reynolds, C.K. (2011). Effect of milled rapeseed on methane emissions and milk quality in lactating dairy cows. *Advances in Animal Biosciences*, 2, p75

Key research grants

- [8] Gibney (UCD, Dublin) & Givens (2004-2009) *LIPGENE: Diet, genomics and the metabolic syndrome: an integrated nutrition, agro-food, social and economic analysis*, European Commission, FP6 (FOOD-CT-2003-505944), €12 million total (€450k to Reading).

[9] Givens (2010 – 2014) *Reducing saturated fatty acids in the food chain through alteration of milk fat composition*, BBSRC-DRINC (BB/1006087/1), £363k (FEC).

4. Details of the impact

Route to impact

As well as being published in peer-reviewed journals, the results of the Reading research were disseminated at public events held during regular intervals across the EU between 2007 to 2013. These events were attended by a wide range of delegates including food manufacturers, processors, retailers, health care professionals, policy makers and government agencies. Members of the media also attended bringing the research results into the popular media, such as newspapers and radio broadcasts.

Research leads to development and sale of new product by leading UK retailer

As a result of the dissemination events, the University of Reading developed a working relationship with Marks and Spencer plc (M&S) to improve the health, welfare and sustainability in the retailer's milk supply chain. In 2010, M&S launched the "Healthier Milk" project, which used the research results from the University of Reading to develop a feeding regime that reduced saturated fatty acids and increased unsaturated fatty acids, and also reduced environmental impact by reducing methane production by dairy cows and reducing reliance on imported Malaysian Palm oil [a]. The University of Reading then helped M&S trial this feeding regime with milk producers, with positive results. The outcome was the launch of a 'new' reduced saturated fat milk product in October 2011, which was not a niche product but the mainstream milk retail offering by M&S. To date, M&S is the only retailer to adopt this approach [a].

M&S benefits from increased sales of milk and improved corporate social responsibility

M&S is one of the UK's leading retailers with 21 million customers visiting its 600+ UK stores each week [a]. Since the launch of M&S's Healthier Milk in 2011, sales have increased and the relationship with their suppliers has strengthened [a]. Also, this initiative has met several of the pillars defined in M&S's corporate sustainability plan, known as Plan A, and has been identified as the retailer's iconic food sustainability product [a].

The public benefits from reduced saturated fat in milk products

M&S sells 75 million litres of milk to around 1.5 million customers each year [e]. Assuming there are at least 2 people per household, this translates to an estimated 3 million people per year in the UK benefitting from reduced SFA/increased unsaturated fat in their diet. Indeed, M&S have estimated that 84 tonnes of saturated fat/year have been removed from the diets of their customers due to the research and accordingly reduced health risks associated with consumption of SFAs [e]. Longer term benefits, such as improvements in risk factors for cardiovascular disease, obesity and cancers, are yet to be realised.

Environment benefits from reduced greenhouse gas emissions and reduced carbon footprint

M&S estimates that the "Healthier Milk" initiative has reduced the need for Malaysian Palm oil by 1000 tonnes per year. The reduced demand for palm oil means fewer Malaysian rainforests converted to palm plantations and reduced carbon emissions associated with shipping to the UK.

Reductions in harmful greenhouse gas emissions from the 10 thousand dairy cows producing milk for M&S amount to around 66-110 million litres of methane per annum (18-30 litres of methane less per cow per day) helping to reduce climate change and achieve UK targets for reduced emissions.

Milk producers benefit from increased payments

Since the 2011 launch of M&S's healthier milk product, milk producers who convert to the new feeding regime have benefitted from new payment contracts that recognise the increased costs associated with the new diet for dairy cows [b].

Impact case study (REF3b)**Cows benefit from improved diet**

Farmer's Guardian also reported that cow fertility increased and that cows had glossier coats and were generally calmer, which all suggest improved health and well being for the animals [b]. There are 10,000 dairy cows that produce milk for M&S, all of which have benefitted from this research.

The development of commercial milk testing for fatty acids has provided a new dimension to quality testing of milk for the dairy industry and paved the way for incentive payments to producers according to fatty acid profile (see supporting Arla letter). The dairy industry and dairy farmers more generally (i.e. in addition to those 36 dairy farmers contracted to M&S who benefit from higher milk payments from the company noted above) have very considerably benefitted from seeing and understanding the scope to manage fatty acids in milk production and in the dairy supply chain (see supporting evidence from National Milk Records plc and Arla). The research has also helped all of these companies to further their corporate social responsibility agendas and to gain commercial advantage (for example, see letter from Arla).

5. Sources to corroborate the impact

- [a] Food Business, "M&S – Healthier milk from healthier cows", Compassion in World Farming Case Study. URL: <http://www.compassioninfoodbusiness.com/case-studies/ms-%E2%80%93-healthier-milk-from-healthier-cows/> [accessed online 24 Sept 2013]. Links Reading research with M&S development and launch of healthier milk and provides statistics for the number of people in the UK that visit the retailer.
- [b] Walsh, H. (6 July 2011) "New contract for M&S 'healthier' milk", *Farmers Guardian* < <http://www.farmersguardian.com/home/business/new-contract-for-ms-%E2%80%93healthier%E2%80%99-milk/40109.article>> Provides evidence of increased payment contracts for milk producers.

Supporting letters available upon request from:

- [c] Agricultural Manager, Arla Foods (Can provide evidence on the impact of changing milk fat composition on the thinking of dairy farmers in their supply chain and on the possibilities for producing new dairy products.)
- [d] Business Development Manager, National Milk Records plc (can comment on how our work has aided NML's development of mid-infrared calibrations which allow large-scale measurement of key fatty acids in milk very rapidly. This is now a commercial operation and has shown their customers opportunities for them to develop.)
- [e] Head of Nutrition and Science – M&S Food (Can comment on removal of saturated fat from customers' diets without them changing purchasing behaviour. Specifically removal of palm oil from the food chain and the inevitable benefit to the environment and associated customer and press feedback. Also the novel payment terms for farmers producing milk with reduced saturated fat.)