DN FORUM
DAIRY NUTRITION FORUM
PUBLICATION FOR INDUSTRY & HEALTH PROFESSIONALS

Saturated fat – exploring the dairy paradox

Volume 15, Issue 2 | October 2023

Summary Points

- For the past number of decades, there has been a strong public health message to reduce the overall population intake of saturated fat. This is due to an association with raised LDL-cholesterol, a recognised risk factor for cardiovascular disease. Therefore, nutrient based-guidelines in Ireland and worldwide, recommend to choose 'low-fat' and consume no more than 10% daily energy from saturated fat.
- As nutrition science has advanced, this simple 'reductionist' message, that all saturated fat is unhealthy, is now being re-examined. The growing understanding of saturated fat has become more nuanced and now relates to the overall nutritional profile and structure of the food, known as the 'food matrix'.
- Studies examining the relationship between the cheese matrix and cholesterol levels have observed less-atherogenic lipid profiles following cheese intake and there is growing scientific evidence to support whole fat dairy products as part of a healthy dietary pattern.
- Specific elements within the cheese matrix may be collectively responsible for these cardiovascular benefits. These include the bioactive peptides (VPP and IPP), which have recognised anti-hypertensive activity, vitamin K2, the milk-fat globule membrane, and the rich sphingolipid content of cheese.
- If focusing on the nutrient profile alone, there is a danger that new dietary guidelines or food reformulation policy aimed at reducing saturated fat, could inadvertently reduce the beneficial matrix effects associated with cheese intake. Therefore, a focus on whole food effects rather than single nutrients is becoming more important as nutrition science advances.

Editorial

Public health challenges linked to nutrient shortfalls or excessive intakes are an important consideration when setting dietary guidelines or food reformulation policy. For example, nutrient profiling of a food is often driven by its fat, sugar or salt content and the association of those nutrients to specific health conditions, such as obesity or cardiovascular disease.

However, a focus on single nutrients alone can lead to an oversimplification of the complex relationship between food and health, and in some cases, result in an unjust classification of certain foods. It is therefore important that the wider scientific evidence is considered. In this edition, we explore the latest research on saturated fat and examine the food matrix as an important consideration in planning food policy.

On page 4 of this publication, we feature our new 'Nutrition & You' Older Adults, 65+ Years booklet.

We hope you enjoy this edition and look forward to any feedback or comments you wish to share: nutrition@ndc.ie

Dr Marianne Walsh

Nutrition Manager
The National Dairy Council (NDC)

Saturated fat – exploring the dairy paradox

INTRODUCTION

Cardiovascular disease (CVD) is a major cause of death across the world, and in Ireland it is thought to be responsible for 9,000 deaths annually. According to a recent report published by the National Institute of Prevention and Cardiovascular Health and the Irish Heart Foundation, up to 80% of CVD cases could be preventable[1]. A range of modifiable risk factors for CVD were listed, including diet and lifestyle-related risks, such as high blood pressure, smoking, inactivity and being overweight or obese.

Of the dietary factors, one of the most commonly cited is the dietary guideline that recommends limiting intakes of saturated fat. Indeed, for the past number of decades, there has been a strong public health message to reduce the overall population intake of saturated fat, due to the association with raised LDL-cholesterol, a generally-recognised risk factor for CVD, hypertension and stroke[1,2]. Currently, Irish dietary intake recommendations are to consume no more than 10% daily energy from saturated fat[3] and many worldwide recommendations echo the same limit[4].

Dairy foods, due to the relatively high level of saturates within their total fat content, are a significant contributor to population intakes of saturated fatty acids. In Ireland, data from the 2010 National Adult Nutrition Survey (www.iuna.net) shows that dairy foods as a group contribute on average approximately 20% to overall population intakes of saturated fat[5]. Therefore, the Health Service Executive recommend 'low fat' versions of dairy where possible. This is also the case more widely - a recent review of dietary guidelines worldwide highlighted that the majority of recommendations that include dairy call attention to 'low fat' or 'fat-free' dairy as being the 'healthier' choice[4]. Similarly, these wider recommendations are driven by the continuation of the nutrient based-guidelines that saturated fat intakes should account for no more than 10% of total energy intake[6].

In recent years however, the rationale for public messages to keep saturated fat as low as possible is being challenged among the scientific community[7,8]. As nutrition science has advanced, the understanding of saturated fatty acids (SFAs) and their role within the body has become much more nuanced. The simple 'reductionist' message that all saturated fat in the diet is unhealthy and should therefore be reduced is now being re-examined[8,9]. Such new research is timely for consideration when dietary guidelines and food reformulation policy is updated.

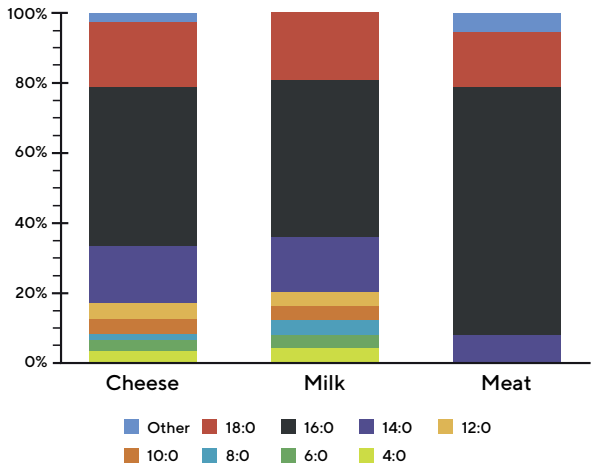

Figure 1 - Diversity of saturated fatty acid profiles in dairy and meat (figure adapted from Astrup et al.[10])

Dr Emma Feeney

Lecturer and Assistant Professor,
UCD Institute of Food and Health,
University College Dublin, Ireland

Saturated fat is often considered as a single entity, but it should be noted that there is considerable variety in the individual fatty acid structures, and their physiological functions within the body[11]. Even more importantly, different foods consist of a range of different SFAs, contained within the overall food matrix. Indeed, there is now very strong evidence to suggest differential response to these individual fatty acids, determined by the overall food matrix in which they are found[12,13,14].

HOW THE FOOD MATRIX IMPACTS DIGESTION AND ASSIMILATION OF NUTRIENTS

The overall chemical and physical composition or 'matrix' of a food can affect digestion, absorption and assimilation of the nutrients present, including the lipid, carbohydrate, and protein components. This results in differences in postprandial levels of glucose, lipids and amino acids, even when foods are matched for the macronutrient contents[14].

A 2022 study by Chen et al.[15] shows clearly that two foods, both containing the same overall carbohydrate level (chickpeas and brown rice), can result in post-prandial differences in blood glucose, due to differences in how the carbohydrate is digested and absorbed from those different food matrices. Similarly, a number of studies have tested a range of dairy food matrices and how they impact post-prandial amino acid and lipid concentrations, again showing that even within dairy foods, small differences in the structure can affect aspects of digestion. In a 2021 study by Thogersen et al.[16], a total of 18 healthy males were fed one of four different foods, randomly, over four days; cheese, homogenised cheese, a liquid micellar casein isolate (MCI)-based drink, or an MCI gel, in a crossover study design. All these foods were matched for fat and protein content and type (casein); only the texture and fat droplet size differed between them. The authors observed that the liquid matrix of the casein resulted in a much more rapid absorption of amino acids as opposed to the semi-solid or solid matrices tested.

Likewise, a separate analysis of the post-prandial lipid responses from the same trial,[17] observed differences in lipid profiles after ingestion of the four dairy matrices. Free fatty acids were lower for both cheese products compared to the MCI gel and drinks. The triglyceride levels were significantly higher following the MCI gel, yet the marker of intestinal chylomicron particles, ApoB-48 levels, did not differ. The authors suggested that this indicated that the MCI gel was potentially more atherogenic than the other matrices since triglycerides are associated with VLDL-c, (a cholesterol particle that is known to be atherogenic).

It should be noted that postprandial lipaemia is also independently associated with CVD risk[7,18,19], and thought to be a more specific risk marker for CVD than simple LDL-c, since our bodies are so often in a post-prandial state. Again, this highlights that the overall food matrix in which these nutrients are consumed is a key consideration for the health outcomes, more so than the macronutrient content alone. Further, the most recent scientific evidence, supports whole fat dairy products as part of a healthy dietary pattern that is associated with reduced risk of CVD[20,21].

CHEESE – A UNIQUE FOOD MATRIX

The matrix of cheese specifically seems to have a beneficial impact on lipid profiles[13, 22, 23]. A recent study of 160 adults at University College Dublin, gave 120g of Cheddar cheese, or a deconstructed version, daily for 6 weeks. The groups received the equivalent macronutrients in different matrices: group A received Cheddar; group B, a reduced-fat Cheddar, plus the equivalent remaining fat as butter; and group C received butter, a calcium caseinate powder, and a calcium supplement. Thus all 3 groups were matched for calcium, total fat, saturated fat and protein content. There was a significant difference between the 3 groups at the end of the 6 weeks, whereby those in the Cheddar group (A) had significantly lower fasting levels of total and LDL-cholesterol compared to both group B and C. A 'stepwise matrix' effect was observed, where the more of the fat contained within the matrix of cheese, the less the impact on LDL-c[13]. A 'responder analysis' of those who responded the most to the diets compared to those who did not, showed that individuals with higher starting blood lipid profiles were more likely to have a reduction in cholesterol[24]. While 'regression to the mean' cannot be fully ruled out, the results do suggest that those who would benefit most from the addition of cheese to their diet are those with elevated LDL-c and triglycerides at the outset.

A further exploratory and more in-depth analysis of the blood lipids from the same study, published in 2023[23], examined the individual particle sizes of the cholesterol. A move towards a less-atherogenic lipid profile (larger, more buoyant particles) was observed following 6 weeks intake of dairy fat, and this was seen for the participants across all the food matrix groups. This potentially suggests that a high SFA diet does not always lead to an atherogenic risk profile, although more research in needed to fully understand the implications and health outcomes longer-term.

These findings are supported with recent meta-analyses on health outcomes from cheese[25, 26], with a 2023 meta-analysis concluding that there was an inverse association between cheese consumption and a range of cardiovascular health outcomes, including death from all-causes and from CVD specifically, as well as with incident CVD, incident CHD, and stroke[26].

These beneficial associations for cheese with respect to heart health may seem paradoxical, given that this is a food often highlighted for its relatively high salt[27]and saturated fat content[5]. The explanation appears to be partly due to the matrix of cheese itself, and the range of bioactive components it contains. Two well-known bioactive peptides, VPP and IPP, have recognised anti-hypertensive activity, and are found in a wide range of cheeses including Edam and Gouda, as well as some blue-veined cheeses[28, 29, 30]. Some studies have shown that amounts of as little as 30g per day hard Italian cheese (Grana-Padano) can be as effective as certain anti-hypertensive medications at lowering blood pressure[31]. Cheese also contains significant levels of milk-fat globule membrane, which is the bioactive membrane surrounding the native milk fat that is rich in sphingolipids [32]. Some studies suggest that the sphingolipid content may also contribute to the LDL-c lowering effect of cheese consumption, potentially via down-regulation of cholesterol-metabolism genes[12].

Further to these components, cheese is a source of vitamin K[33], which is the name given to a group of compounds that include phylloquinone (vitamin K1), and menaquinones (Vitamin K2). Relatively recently, vitamin K has emerged to be a vitamin of interest, and it has been suggested that it could be an important contributor to the strong associations seen for beneficial effects of cheese consumption on heart health outcomes[33] in a range of meta-analyses[26, 34, 35]. In summary, the specific nature of cheese and the range of bioactive components within it, appear to collectively contribute to these heart-health benefits that are emerging in recent years.

FOOD BASED VS NUTRIENT BASED DIETARY GUIDELINES, AND NUTRIENT PROFILING

From the most up to date scientific research discussed above, the overall food matrix clearly plays a key role in the digestion, absorption and assimilation of nutrients, impacting the health outcomes of a food. However, by focusing on the nutrient content alone, there is a danger that some of these health benefits from the whole food are overlooked. This is particularly troubling in the context of food reformulation. In Ireland, there is currently a focus on reducing energy, sugar, salt and saturated fat in the food categories which contribute most to these nutrients. Taking the example of cheese, this is a food that could likely be targeted for reformulation, due to its salt and fat content, and considering that it is a contributor to population intakes of these nutrients (Figure 2). However, the updated evidence now clearly shows that the whole food matrix effect of cheese may outweigh potential negative effects of individual nutrients present. If focusing only on the nutrient profile, there is a danger that reformulation could inadvertently reduce fat-soluble vitamins, or worse, could result in a reduction of the beneficial matrix effects observed from cheese consumed as a whole food. Thus, targeting this food for reformulation could result in poorer health outcomes from the reformulated products. While sugar, fat and salt reduction at a population intake level is certainly commendable and the benefits are evidence-based, caution is advised in how this is approached. Smaller portion sizes, reduction in variety and availability, and behavioural tactics to make fruit, vegetables and other whole foods more easily accessible in supermarkets are other potential ways to achieve population reductions in these nutrients.

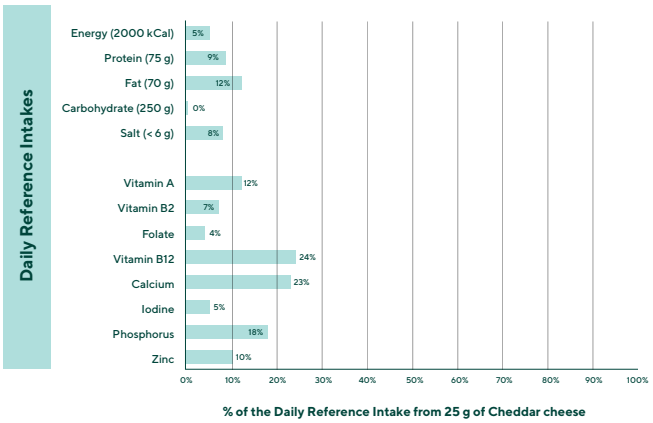

Figure 2 - A 25g serving of cheddar cheese contributes to the recommended intake of several nutrients

CONCLUSION

The scientific evidence for a link between saturated fat and CVD risk has been re-visited in recent years. While early evidence was focused on overall reduction of SFA intakes, it is now clear that a more nuanced approach to this issue is needed. It should consider, not only total SFA, but also the individual food sources, since they vary considerably in the mixtures of different fatty acids present, but also in how these fatty acids interact with the whole food structure and consequent metabolism.

Substantial, high-quality evidence in the last decade now points to beneficial effects from dairy fat on a range of health outcomes, including cardio-metabolic health. For these reasons, a blanket recommendation to reduce SFA intakes is not necessarily based on the most up to date evidence, and unfortunately has the potential to reduce sources of key nutrient in the diet, such as dairy foods. Some scientists are now cautioning against this approach to dietary guidelines. The introduction of food-based dietary guidelines can help to combat this. Blanket consideration of nutrients is also a concern for ongoing food reformulation initiatives, which are focused solely on profiling foods based on individual nutrients and may not consider the totality of the evidence in terms of health outcomes.

References

1. Foundation IH (2023). Mission statement. [Online] Available from: https://irishheart.ie/our-mission/who-we-are/ [Accessed on 12/09/2023].
2. Walldius G, Jungner I (2007) Is there a better marker of cardiovascular risk than LDL cholesterol? Apolipoproteins B and A-I – new risk factors and targets for therapy. Nutr Metab Cardio Dis 17, 565-571.
3. HSE (2016) Healthy Food for Life [HS Executive, editor].
4. Comerford KB, Miller GD, Boileau AC et al. (2021) Global Review of Dairy Recommendations in Food-Based Dietary Guidelines. Front Nutr 8.
5. Feeney EL, Nugent AP, Mc Nulty B et al. (2016) An overview of the contribution of dairy and cheese intakes to nutrient intakes in the Irish diet: results from the National Adult Nutrition Survey. Br J Nutr 115, 709-717.
6. United States Department of Agriculture (2020) Dietary Guidelines for Americans, 2020-2025. 9th Edition.
7. Astrup A, Bertram HC, Bonjour JP et al. (2019) WHO draft guidelines on dietary saturated and trans fatty acids: time for a new approach? Br Med J 366, l4137.
8. Hirahatake KM, Astrup A, Hill JO et al. (2020) Potential Cardiometabolic Health Benefits of Full-Fat Dairy: The Evidence Base. Adv Nutr 11, 533-547.
9. Mozaffarian D (2019) Dairy foods, dairy fat, diabetes, and death: what can be learned from 3 large new investigations? Am J Clin Nutr 110, 1053-1054.
10. Astrup A, Magkos F, Bier DM J et al. (2020) Saturated Fats and Health: A Reassessment and Proposal for Food-Based Recommendations: JACC State-of-the-Art Review. J Am Col Cardio 76, 844-857.
11. Legrand P, Rioux V (2010) The complex and important cellular and metabolic functions of saturated fatty acids. Lipid 45, 941-946.
12. Rosqvist F, Smedman A, Lindmark-Mansson H et al. (2015) Potential role of milk fat globule membrane in modulating plasma lipoproteins, gene expression, and cholesterol metabolism in humans: a randomized study. Am J Clin Nutr 102, 20-30.
13. Feeney EL, Barron R, Dible V et al. (2018) Dairy matrix effects: response to consumption of dairy fat differs when eaten within the cheese matrix-a randomized controlled trial. Am J Clin Nutr 108, 667-674.
14. Michalski MC, Genot C, Gayet C et al. (2013) Multiscale structures of lipids in foods as parameters affecting fatty acid bioavailability and lipid metabolism. Prog Lipid Res 52, 354-373.
15. Chen Y, Stieger M, Capuano E et al. (2022) Influence of oral processing behaviour and bolus properties of brown rice and chickpeas on in vitro starch digestion and postprandial glycaemic response. Eur J Nutr 61, 3961-3974.
16. Thøgersen R, Egsgaard KL, Kjølbæk L et al. (2021) Effect of dairy matrix on the postprandial blood metabolome. Nutrients 13, 4280.
17. Kjølbæk L, Schmidt JM, Rouy E et al. (2021) Matrix structure of dairy products results in different postprandial lipid responses: a randomized crossover trial. Am J Clin Nutr 114, 1729-1742.
18. Hyson D, Rutledge JC, Berglund L (2003) Postprandial lipemia and cardiovascular disease. Curr Athero Rep 5, 437-444.
19. Pirillo A, Norata GD, Catapano AL (2014) Postprandial lipemia as a cardiometabolic risk factor. Curr Med Res Opin 30, 1489-1503.
20. Mente A, Dehghan M, Rangarajan S et al. (2023) Diet, cardiovascular disease, and mortality in 80 countries. Eur Heart J 44, 2560-2579.
21. Yuan M, Singer MR, Pickering RT et al. (2022) Saturated fat from dairy sources is associated with lower cardiometabolic risk in the Framingham Offspring Study. AM J Clin Nutr 116, 1682-1692.
22. Drouin-Chartier JP, Tremblay AJ, Maltais-Giguere J et al. (2017) Differential impact of the cheese matrix on the postprandial lipid response: a randomized, crossover, controlled trial. Am J Clin Nutr 106, 1358-1365.
23. Dunne S, McGillicuddy FC, Gibney ER et al. (2023) Role of food matrix in modulating dairy fat induced changes in lipoprotein particle size distribution in a human intervention. Am J Clin Nutr 117, 111-120.
24. O'Connor A, Bhargava N, Feeney E et al. (2021) Factors Influencing Serum Cholesterol Response to Dairy Fat Consumption in Overweight Adults: Secondary Analysis From an RCT. Curr Dev Nutr 5, 602.
25. Chen G-C, Wang Y, Tong X et al. (2017) Cheese consumption and risk of cardiovascular disease: a meta-analysis of prospective studies. Eur J Nutr 56, 2565-2575.
26. Zhang M, Dong X, Huang Z et al. (2023) Cheese consumption and multiple health outcomes: an umbrella review and updated meta-analysis of prospective studies. Adv Nutr 14, 1170-1186.
27. Kawther MH, Feng JH, Katharine HJ et al. (2014) Cross-sectional survey of salt content in cheese: a major contributor to salt intake in the UK. Br Med J Open 4, e005051.
28. Sieber R, Bütikofer U, Egger C et al. (2010) ACE-inhibitory activity and ACE-inhibiting peptides in different cheese varieties. Dairy Sci Tech 90, 47-73.
29. Meyer J, Butikofer U, Walther B et al. (2009) Hot topic: Changes in angiotensin-converting enzyme inhibition and concentrations of the tripeptides Val-Pro-Pro and Ile-Pro-Pro during ripening of different Swiss cheese varieties. J Dairy Sci 92, 826-836.
30. Iwaniak A, Mogut D (2020) Metabolic Syndrome-Preventive Peptides Derived from Milk Proteins and Their Presence in Cheeses: A Review. App Sci 10, 2772.
31. Crippa G, Zabzuni D, Bravi E et al. (2018) Randomized, double blind placebo-controlled pilot study of the antihypertensive effects of Grana Padano D.O.P. cheese consumption in mild - moderate hypertensive subjects. Eur Rev Med Pharmacol Sci 22, 7573-7581.
32. Thorning TK, Bertram HC, Bonjour JP et al. (2017) Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. Am J Clin Nutr 105, 1033-1045.
33. Zhou S, Mehta BM, Feeney EL (2022) A narrative review of vitamin K forms in cheese and their potential role in cardiovascular disease. Int J Dairy Tech 75, 726-737.
34. Giosuè A, Calabrese I, Vitale M et al. (2022) Consumption of Dairy Foods and Cardiovascular Disease: A Systematic Review. Nutrients 14, 831.
35. de Goede J, Geleijnse JM, Ding EL et al. (2015) Effect of cheese consumption on blood lipids: a systematic review and meta-analysis of randomized controlled trials. Nutr Rev 73, 259-275.

NEW NUTRITION & YOU BOOKLET - OLDER ADULTS

Developed by the National Dairy Council and endorsed by the Irish Nutrition and Dietetic Institute, the Nutrition & You booklet series highlights the importance of a balanced diet across the life stages. Our latest booklet, which focuses on nutrition for older people, is now available. Free copies are available to download from www.ndc.ie or order by contacting nutrition@ndc.ie

Contact us

National Dairy Council

The National Dairy Council

+353 (0)1 290 2451
info@ndc.ie

www.ndc.ie

Mission:
To deliver real and unique value to Irish dairy farmers by protecting and promoting the image, quality, taste and nutritional credentials of Irish dairy produce to a wide variety of audiences in a clearly defined, focused and effective manner.

@NDC_ie /NDCIreland

FOOD FOR HEALTH IRELAND

Food for Health Ireland
Science Centre South
University College Dublin

+ 353 (0)1 716 2391
info@fhi.ie

www.fhi.ie

Mission:
To leverage the world-class capabilities of the Irish academic partners, with the market expertise of the industry partners, into a pipeline of innovative, nutritional functional ingredients/ products for the global food industry.

@fhi_tweets /Food for Health Ireland

While the National Dairy Council and Food for Health Ireland have made all reasonable efforts to ensure the accuracy of the information presented in this document, no responsibility is taken by the National Dairy Council or Food for Health Ireland for any errors or omissions. The individual views expressed in this publication do not necessarily constitute the views or policies of the National Dairy Council or Food for Health Ireland.