Fat in food and the obesity epidemic

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Abstract
Dietary fat is strongly implicated in the development of insulin resistance and obesity, both major public health problems today. While the amount of dietary fat is relevant, the type of fat is important in fuel utilisation, storage and appetite regulatory mechanisms. Human calorimetry research confirms the importance of dietary fat in energy balance, but more work needs to be done to uncover the impact of type of dietary fat in weight control. Population and intervention research confirm the importance of fat in dietary interventions, bearing in mind the contribution of physical activity to energy balance. The food industry has an important role to play in strategic food innovation which addresses this expanding knowledge base.

Keywords
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Fat in food and the obesity epidemic
L.C. Tapsell

Dietary fat is strongly implicated in the development of insulin resistance and obesity, both major public health problems. While the amount of dietary fat is important in total utilisation, storage and appetite regulatory mechanisms. Human calorimetry research confirms the importance of dietary fat in energy balance, but more work needs to be done to uncover the impact of type of dietary fat in weight control. Population and intervention research activity confirm the importance of fat in dietary composition in meeting the contribution of physical activity to energy balance. The food industry has an important role to play in strategic food innovation which addresses this expanding knowledge base.

Obesity and dietary fat
Obesity and Type 2 diabetes mellitus (T2DM) are major public health concerns in Australia today. National surveys show that 60% of men and 29% of women are overweight and a further 18% are obese, with the prevalence in children and adolescents approaching 18-20% (1997). The direct costs of obesity to society have been estimated at $646 million with an additional $272 million in indirect costs (AIHW 1992). An estimated 7% of Australians have T2DM, with an associated healthcare cost likely to exceed $1 billion annually (McCarty 1996). Obese children and adolescents are particularly at risk of developing T2DM as they present with a high prevalence of impaired glucose tolerance (Sinha & others 2002).

Obesity and T2DM are linked under the rubric of 'metabolic syndrome' that is used to describe the co-occurrence of multiple risk factors for diabetes and heart disease, such as abnormal blood lipid levels, glucose intolerance, insulin resistance, high blood pressure and disorders of clotting (Meigs 2000). Obesity can also precipitate non-insulin-dependent T2DM: insulin resistance, hyperinsulinemia and increased circulating free fatty acids (Bierhorsky 1999), but whether obesity causes insulin resistance, vice versa is not known. Dietary fat has been strongly implicated in the development of insulin resistance (Strochen & others 2001) and in obesity (Arterburn 1996), but the story is not simple and approaches to the problem need to be carefully thought through. Because fat lies at the heart of the problem, focusing on dietary fat will illuminate preventive and treatment strategies. As suppliers of food, the food industry has a role in this process, and can help by developing beneficial new products, bearing in mind the challenge of accommodating economic imperatives with health-promoting attributes. Promotion of less energy dense diets (Seidell 1999) and fat modified foods (Zock & Katan 1999) would be most appropriate and made possible through strategic food innovation and nutritionally sound marketing campaigns.

Where is the evidence? Mechanistic and whole body research
The significance of dietary fat in the energy balance equation can be explained on a number of levels. At the molecular level, dietary fat is less well utilised (oxidised) as fuel than protein or carbohydrates, so when overconsumption occurs fat is preferentially stored and the energy efficiency of this storage is high. In this sense energy fat is better than carbohydrate and of fatty acids (polysaturated, saturated and monounsaturated). Polysaturated fatty acids (PUFA) have been shown to be more readily utilised for energy than longer chain saturated fatty acids (SFA) in feeding studies involving animals (Leyton & others 1987) and humans (James & Schoeller 1988, De Launy & others 2000). It has been proposed that obesity results from a defect in the oxidation of dietary long chain triglycerides, which are readily taken up by adipose tissue (Bannert & others 1998). At the same time research in molecular biology and genetics has shows that, in rodents, the fatty acid profile of the non-essential omega fatty acids of the diet can affect cell proliferation (Okuno & others 1997) and lipogenesis, whereas PUFA promote fat oxidation (Chazke 2001). Animal models studying the expression of appetite control mechanisms have also shown that dietary SFA are obesogenic, whereas dietary PUFA (and especially n-3 PUFA) may even protect against obesity (Wang & others 2002). Thus, while the amount of dietary fat is relevant, it would be foolish to ignore the impact of the type of fat on fuel utilisation, storage, and appetite regulatory mechanisms – and then in the context of whole foods and whole diets.

Most food utilisation and nutrient balance, still focuses on total fat, rather than type of fat. This has been useful in determining upper levels of tolerance and the effect of high-fat foods and the distribution of the diet, but there is still much more to know. Precise data are available from studies using whole-body indirect calorimetry where people spend time in a respiration chamber (a closed room), where by measuring oxygen consumed and carbon dioxide produced, energy expenditure and fat and carbohydrate utilisation are estimated. By manipulating diet, within-person and group comparisons (eg obese vs lean) can be conducted (Murgatroyd 1993). To date, this research has

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Communicating the health benefits of functional ingredients
Many functional food products have faltered in the marketplace because people don't understand their benefits. The best way to overcome this is to understand how consumers react to different approaches and to learn the language which consumers use to describe the benefits which are meaningful to them. In order to get in-depth understanding of how consumers react to new ideas about food and health, qualitative research has been undertaken in seven countries around the world already, including in Australia, by ORAFTI Active Food Ingredients. The key objective has been to identify the best way to communicate the nutritional benefits of their products Rapiflavin® (inulin) and Rapiflax® (oligofructo) to consumers.

The research has been undertaken across age groups; singles, couples with no children, and households with children. Focus groups were conducted with young families and older people whose children have left home, and included both men and women. It explores consumers' reactions to nutritional claims about Rapiflavin® and Rapiflax® in the context of people's thoughts about health, staying healthy and eating healthily. It also helps to understand who is influencing consumers' opinions about food and health. It has allowed different ways of marketing the benefits of prebiotic ingredients to be evaluated so that the areas which can generate the highest levels of interest can be differentiated from the pitfalls.

Despite the diverse cultural backgrounds against which this research has been conducted, the results are remarkably consistent.

Two of the outcomes from the research programme to date are that health and diet and exercise, and digestive health is important.

Some of the key things people are looking for from a food ingredient which improves the health of the digestive system are: Feeling better is the end benefit; Explanation of the benefits needs to find the right balance; and Ingredients should be acceptable everyday, staple foods.

These research projects aim to help food and drink manufacturers to take full advantage of these opportunities. A briefing on the findings of the research programme including the work undertaken in Australia is available for food and beverage developers from ORAFTI's Australian agents.

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demonstrated, for example, that only a proportion of dietary fat is oxidised after a meal and that the amount oxidised is highly variable between individuals (Thomas & others 1992, Sonko & others 2001). Further, the adaptation to high fat intakes is dependent on the type of fat. Unsaturated fats, which can adapt to high fat intakes within seven days (Schruner & others 1997) and are able to burn increased amounts of calories, are of particular interest (Thomas & others 1992), but the latter can adapt better when glycochen stores are depleted through previous exercise (Schruner & others 1997). This subject is likely to develop further as the ability to predict fat balance following a shift to higher fat intakes has been linked to the energy cost of consumption (Pitcher & others 2000). Thus, while fat balance lies at the core of energy balance, this relationship appears to be strongly mediated by metabolic factors that are yet to be seen whether the type of fat also influences this.

If the fat component of the diet is reduced, the carbohydrates increase to provide energy. Where these fractions have been manipulated, differences in diet-induced thermogenesis and satiety have been observed (Westerterp & others 1999). While this appears to offer support for a lower fat diet, the levels of fat studied have been extreme (10 vs 60% energy), and do not reflect typical eating patterns with the current food supply. In a clinical setting, increasing the protein fraction of a meal over a lower fat meal (30% energy) does not seem to increase weight loss or reduce the concomitant fall in resting energy expenditure in people over the age of 60 (Barker & others 2002). Likewise, while an upper level of fat tolerance seems reasonable, ad libitum consumption of carbohydrate may be associated with increased risk of type 2 diabetes (Saxby & others 2002) and metabolic complications. Thus, the current body of evidence supports the following: diet-induced thermogenesis increases with a decrease in energy density, low fat intakes are associated with increased satiety and low energy intake.

Controlled trials of caloric restriction are difficult to mount and are expensive, but further evidence for the centrality of fat intake to dietary energy balance is provided by studies that elucidate differences in energy between men and women, and by different dietary fat acids. The large Nurses Health Study (n=84 204) found that total fat was not associated with risk of T2DM in women, but that PUFAs may provide some protection (Salmeron & others 1996). Although it appears that replacing 2% of the energy from trans fatty acids with PUFAs would reduce the risk of T2DM by 40%, this is an estimate that requires further study.

In a similar study of male health professionals (n=42 504), dietary total fat and SFAs were both associated with increased risk of death (van Dam & others 2002). These studies implicate fat, but they remind us that risk varies within population subgroups and in relation to the type of dietary fat.

Clinical and population studies

In an attempt to convert knowledge of fat balance to eating behaviours, many studies have focused on interventions to reduce fat intakes in foods. Although these studies have been able to show reduced energy intake with low fat foods, like the caloricimetry studies, the energy intake is not lower than the original intake level (Heil & others 2000). Randomised controlled trials using a low fat diet approach with a variety of medium to high intervention levels (Heil & others 2000, Poppitt & others 2002). As they have focused on food choice behaviour, few have actually assessed the reduction in energy intake with respect to body weight or energy intake (Heil & others 2000). In essence, the effect of low fat foods may only be significant if they are high in energy intake (Snedell 1999). Weight loss comparable to that achieved with low fat diets has been achieved in modified fat diets, and in the latter cases longer term participation has been found (McManus & others 2001), suggesting this approach may be more feasible.

Dietary recommendations

The evidence provided by this research is considered by governments and professional organisations in the delivery of dietary guidelines for healthcare practitioners, food manufacturers and the general population (NHMRC 1999, ANZEA 2001). The recommendations, published and endorsed, evidence-based guidelines for the primary prevention of T2DM (Diabetes Australia 2001) recommend that individuals in the AusDiab 2000 (n=128 000) with a diet with <30% of total energy as fat and <10% energy as saturated fat. It is important to recognise that these guidelines refer to a world of energy-dense and nutrient-poor foods that are achieved by a combination of foods, some of which are high in total fat. In this sense, the ‘eat less fat’ message may not be having the desired effect. For example, in the United States, fat intake and the prevalence of obesity appear to be going in opposite directions (Allred 1995). A recent analysis in the American Journal of Clinical Nutrition showed shifts from dairy, red meat and added fat to grain-based mixed dishes, higher fat snack foods and higher fat-added foods (Heil & others 2001). In one of our own trials of individuals treated for T2DM we found baseline intakes low in fat (29% energy), but to reduce their fat intake to less than 30% was more difficult (Zock & Katan 1999). The American Diabetes Association recommend that foods in the food industry are strong. There is a clear message that new foods need to be developed in manufactured convenient ready-to-eat foods either saturated fats (Zock & Katan 1999). There also may be opportunities to incorporate new ‘designer fats’ that deliver benefits in fuel efficiency and in general health, along with other benefits already identified with n-3 PUFAs.

Summary

We are clearly moving into a new era in food and nutrition where nutrition problems, which require a sophisticated and integrated understanding of energy balance, are emerging on a large scale. It will be a major challenge to see if now new knowledge and new technologies can match the pace. Obesity and T2DM are apparent and nutrition research seem predicts at the center of the mess. To this end we have a vast and rapidly growing literature on the type and amount of fat in food intake, body composition, energy balance and insulin resistance but still very incomplete understanding. When we consider fat as not just energy source, but a component of a complex network of molecules, the notion that ‘you are what you eat’ has particular meaning.

The lessons we seek are already in nature, but in controlling so many aspects of our environment, we must now take responsibility for the consequences. Food manufacturers and the food industry tie up with economic imperatives. Our current climate comprising an energy dense, abundantly available food supply coupled with technologies which reduce our physical activity suggests we need to make changes to re-balance the energy equation. On the one side, increasing physical activity is vital. On the other, we need demonstration that is focused to the type of fat, are less energy dense, and at the same time fit within an exciting modern cuisine which blends all broad benefits targeting the future. A systematic approach to establishing the evidence of benefits in health outcomes will require an examination of changes in individual and social behaviour, attention to dietary patterns and health and government funding bodies. For fat, in the first instance this will require making changes available to people with the research and health assessments of efficacy under trial conditions. This is the New Nutrition, but it looks like it is here to stay.

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