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Autor: Korver, Onno
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Fat and Fat Replacement: Some Relevant Issues*

Key words: Fat reduced products, Reduced energy intake, Vitamin supply, Health claims, Product safety

Onno Korver

Unilever Research Laboratory, Vlaardingen

Introduction

Fat plays an important role in the food supply: it brings energy and is important for the delivery of flavours and micronutrients. It is not really surprising that as soon as income rises populations tend to consume more fat in their diet. It is interesting to note that the increase in fat consumption for populations does not go much further than approximately 40% of energy.

In the past decades more and more evidence has accumulated, showing that high energy intakes (and for our western diets this cannot be separated from high fat consumption) and the obesity that may be a consequence of these high intakes are main causes of the development of some chronic diseases, i.e. some forms of cancer and cardiovascular disease. It is not the place here to go into the evidence for these relations. There is general consensus in the scientific world that energy reduction, which cannot be achieved without fat reduction in our type of diets, is a desirable goal. This is reflected in the nutritional recommendations of most countries in the developed world:

- reduce energy intake
- reduce fat intake (< 30% energy)
- reduce saturated fat intake (< 10% energy)
- increase unsaturated fat intake
- increase intake of complex carbohydrates
- consume salt and alcohol in moderation
- limit cholesterol intake (< 300 mg/day)

In these nutritional recommendations one finds also statements about the fat composition, i.e. the saturated fat content should be reduced (to less than 10% of energy, instead of the 15–20% energy found in many countries) and the relative

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amount of unsaturated fat increased. Any strategy to reduce total fat content should take into account that the overall fat composition should be in line with these recommendations.

Visible and invisible fats

To see the consequences of this it is necessary to introduce the concept of «visible and invisible fats». Visible fat is the fat which is immediately recognizable as such, e.g. oils, butter, margarine. Invisible fat is the fat which is hidden in e.g. cheese, meat, bakery products. Figure 1 shows that the distribution is about 30% visible, 70% invisible in a country like the Netherlands (1). In general the intake of invisible fat has been increasing over the past 10 years. It is also evident from the figure that most of the saturated fat, which should be reduced is in the invisible part.

The consequence of the latter observation is that when recommendations to lower fat intake are followed by consumers via reduction of that part of the fat which they can see (and this is what often happens), the fat composition changes in an undesirable direction. In product development the aim should be to design

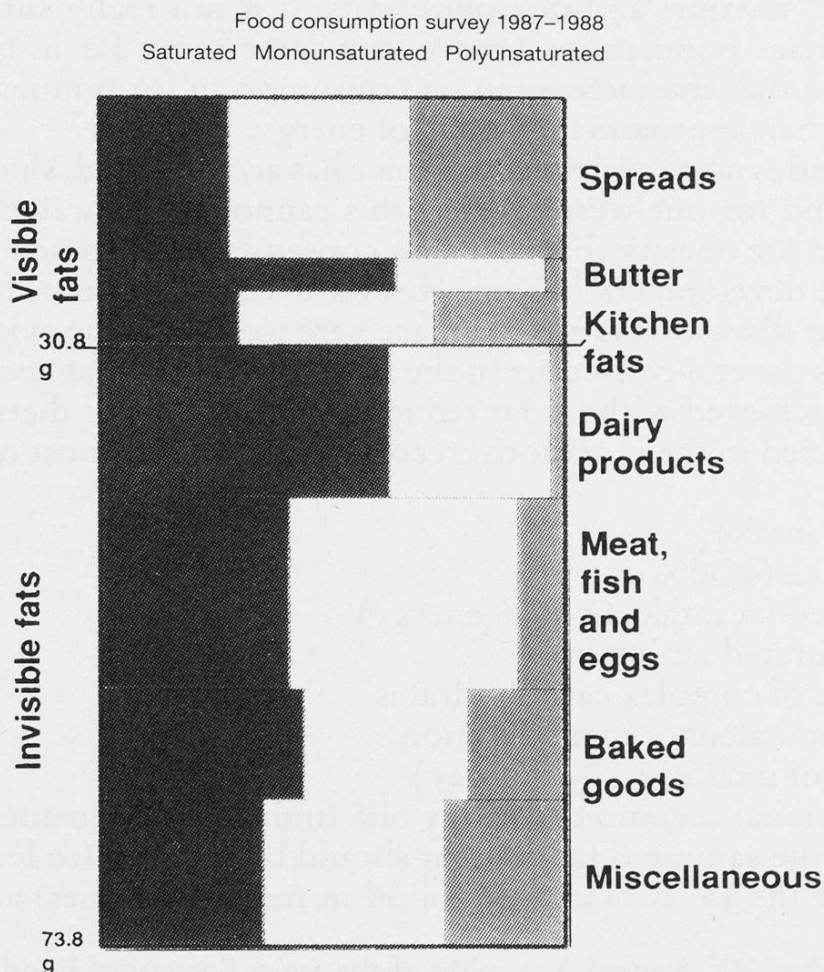


Fig. 1. Visible and invisible fat consumption in The Netherlands (1)

products that enable consumers to reduce fat intake, while retaining their habitual dietary pattern (it is very difficult to change these patterns), that provide optimal taste and that do not change the overall dietary composition in an undesirable direction.

Approaches to new products

What kind of approaches have been taken to develop low fat products? This is obviously different for different types of products. For instance in «spreads» the traditional 80% of fat has gradually been lowered to 40, then to 25% with very high quality. This is reflected in the growth of the market of these products in recent years. The technology is based on the use of proteins or carbohydrates as structuring agents of the (increased) water phase.

For cheese the ideal solutions are further away: low fat cheeses suffer still from quality defects (e.g. rubbery texture). Also the fact that the variety of cheeses that is available with the traditional fat content is not repeated in the low fat varieties is a factor in the relatively low consumption.

For a product like a frying oil the protein and carbohydrate approaches are not working for obvious reasons. Here fat replacement might be carried out with synthetic fat replacers as olestra (sucrose polyester) that has been under investigation for a number of years.

Fat replacers and fat replacement

Looking at the technology used in making these products it is useful to differentiate between fat replacers and fat replacement. *Fat replacers* are ingredients that are available as such with all their specific advantages and disadvantages. A number of important fat replacers, either commercially available or under investigation are collected in table 1.

Fat replacement is the development of methodology that leads to complete products, analogous to full fat products in properties, but with a lower fat content. The food ingredients companies often bring fat replacers on the market, while the food industry designs processes where a combination of measures gives rise to high quality low calorie products.

Low energy products and reduced energy intake

The low fat products are produced with the objective to offer the consumer alternatives that fit in his or her traditional eating pattern. The question may

Table 1. Fat replacers on the market or under investigation

■ Water phase structuring compounds	
Particle gel	
- (denatured) proteins	simplese
- carbohydrates	paselli, oatrim
- polar crystals	avicel
Thickening agents	
- proteins	gelatin
- carbohydrates	guar gum xanthan gum
■ Synthetic lipids	
- Sucrose polyester	olestra
- Triglycerides with reduced absorption	caprenin

legitimately be asked, whether introducing this type of products into the diet, really leads to a reduced energy intake.

The evidence which is available indicates that under free living conditions and up to 3–4 weeks (this is the duration of most of the trials that have been reported) a reduction of energy intake is indeed observed. Even after 11 weeks as is shown in figure 2 (2), the effect remains. Compensation for the lower energy density of the diet by eating more grammes (as is often observed in animal trials) is not complete.

One can ask whether longer duration of the experiment would show full compensation. This is not known. There is a 6 month trial under preparation in Europe at the moment. When this logistically difficult task is finalized in 1994, an answer might be given.

Other consequences of lowering fat content

It is good to mention that there are other properties than taste that are extremely important in designing low calorie foods, namely the microbiological stability and the micronutrient content.

Low calorie products are often more sensitive for microbiological spoilage, because of the higher water content and the higher levels of protein/carbohydrate, which constitutes a favourable environment for microbial growth. In low calorie spreads there is also a less good control on water distribution and the reduced protection which is given by the compartmentalization in high-fat emulsions. Choice of optimal raw materials and careful hygienic process design has made it

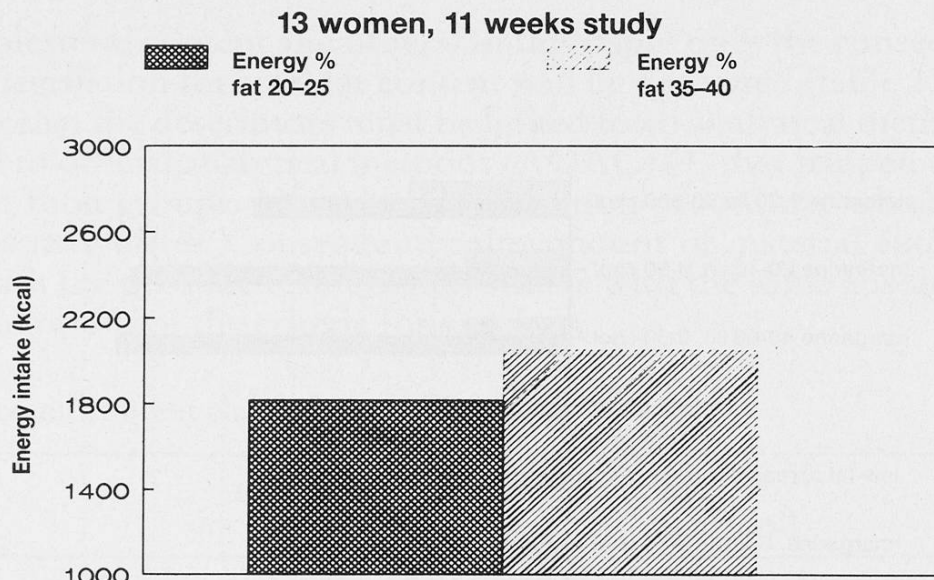


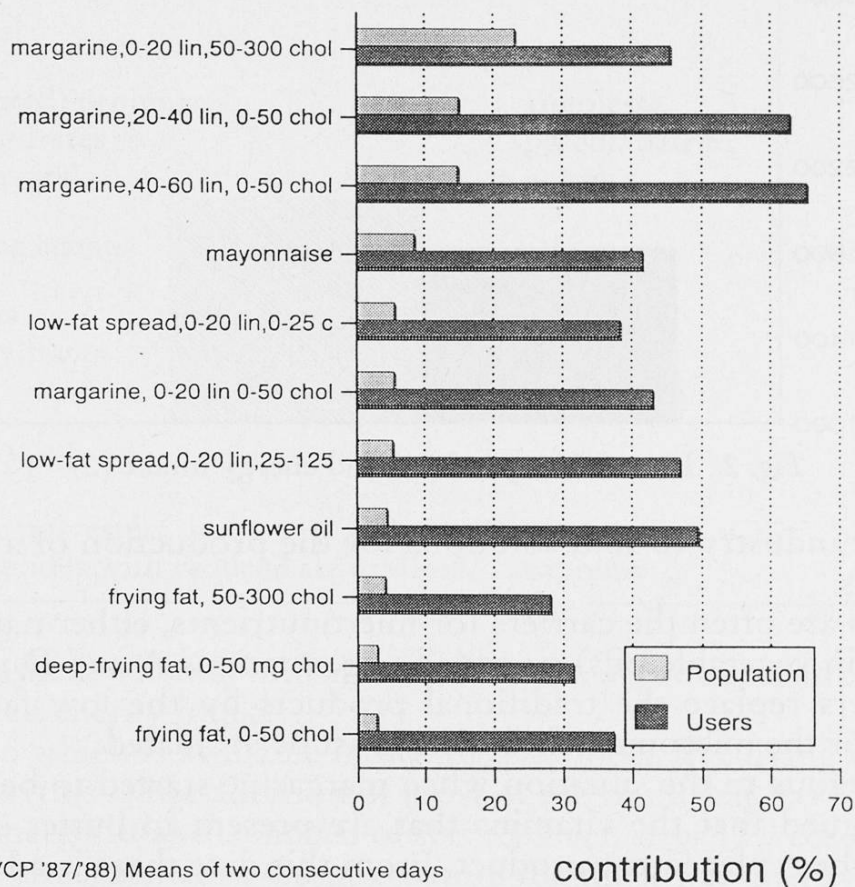
Fig. 2. Low calory products and energy intake (2)

possible for the industry to find solutions for the production of a wide range of low fat products.

Fat products are often the carriers for micronutrients, either naturally present (e.g. vitamin E in vegetable oils) or added (e.g. vitamins A and D in margarines). When consumers replace the traditional products by the low fat product, the consequences for the micronutrient intake must be evaluated.

This is analogous to the situation when margarine started to be marketed and nutritionists argued that the vitamins that are present in butter should also be available from the replacement product. From this date there is a legal obligation in many countries to fortify margarines with vitamin A and D. Margarines are often made from vegetable oils and consequently are a major source of vitamin E. Consumption figures as presented in figure 3 are fairly typical for N.W. Europe. The products have been put together in categories defined by the fat level (margarine 60-80% fat, low fat spreads 25-40% fat), the linoleic acid content (0-20 lin, 20-40 lin, 40-60 lin, high linoleic acid products contain high vitamin E levels from the oils used) and cholesterol (50-300 chol = animal fat containing product, 0-50 chol = predominantly vegetable product). Replacing margarines by minarine then leads to a reduction in vitamin E intake. How important this may be is shown in the following example: replacing a 80% fat margarine by a 40% minarine in the diet of an individual and assuming that the size of the serving used remains the same, the intake of the vitamins that are present in margarine (i.e. A, E, D) will be halved unless their level in the fat phase is doubled. For vitamin E, which comes for a significant part from spreads and for which intake equals approximately recommendation, this is a highly relevant issue.

When developments go in the direction of what is called zero fat spreads (in the USA there are products in this category on the market) the issue becomes even more important.



(VCP '87/'88) Means of two consecutive days

contribution (%)

Source: TNO Nutrition and food research '92

Fig. 3. Vitamin E intakes and sources in The Netherlands (3)

It is clear that a lot of thought has already gone into the development of new products with lower fat contents. The industry has carefully considered nutritional, microbiological safety and taste arguments. To develop this market further there should be adequate incentives for industry to invest in further development. The incentives may be found in two areas: legal issues relating to terms indicating the level of fat or other components (nutrient content claims) and the formulation of health claims.

Messages to the consumer

The background for nutrient content claims is the wish to provide the consumer with clear information on the composition and nutrient content of a food product. There are descriptors relating to free/no, low, reduced and rich. Proposals have been made for total fat content, amount of saturated fat, polyunsaturated fat

content, cholesterol content and others. In this paper only the consequences of the (proposed) legislation for total fat content will be discussed (table 2).

It is clear that the descriptors must be linked to an analytical method. The FDA has referred to official analytical methods (AOAC) (4) that happen to be different for different food groups. Notably the extraction procedure, which is part of all the methods may differ. Consequently the amount of material extracted may be different, with the possible result that products with the same absolute amount of fat may be in or out of the criteria for «no fat».

Table 2. Nutrient content claims for total fat

	USA	EEC (proposal)
Free/no	< 0.5 g/serving	0.5 g/100 g
Low	< 3 g/serving	< 5 g/100 g
Reduced	25% less	< 75% of similar product

The extraction procedures extract in principle all lipid like material, irrespective whether this material is absorbed and contributes to the energy intake. Since reduction of energy intake is clearly the objective of products with reduced fat intake this is not an approach that serves the nutritional objectives in all cases. The following examples may make this clear:

- A product, where all the fat has been replaced by a fat replacer like «olestra» (sucrose polyester) would nutritionally qualify as a «no fat» product. The common extraction methods would however extract an amount of material that would classify as «lipid» according to the definition. Since «olestra» has not yet been approved and legislators would be wise enough to create an exception in this case, it might not be a very relevant example.
- A product where the fat has been replaced by «caprenin», a triglyceride containing one very long chain fatty acid (C 22). It has been reported that this fat is only absorbed partially. Depending on the circumstances (rest of the diet, time of eating) absorption may vary from 20 to 70%. The material will be extracted completely and consequently products may not be classified as «no fat» or perhaps not even as «low fat». Nutritionally this does not make sense, moreover the consumer is not served by withholding this information and there is not much incentive for the food industry to invest in this type of products. But in this case the nutritionist's wish may be the legislator's nightmare.

The description «low fat» may only be used if the total amount of fat is less than 5 g per 100 g product. This implies that a 40% fat product, which replaces a 80% fat product cannot be called «low fat», although with a serving size of e.g. 5 g an absolute intake reduction of 2 g per serving would be achieved. On the other hand a hypothetical 4% fat product that replaces a 10% fat product may be called «low

fat» although the absolute intake reduction with a serving size of 5 g would only be 0.3 g. Clearly, the nutritional benefit of the first change is greater than that of the second one and to give the food industry incentives to follow such routes, this should be communicable to the consumer.

The use of health claims on packs is regulated to protect the consumer. In the USA and (seeing the way the discussion proceeds) in the future probably also in the EU there is a limited list of allowed claims. Claims are only allowed in those areas where a scientific consensus, based on sufficient data is reached. It is in reality a positive list approach in which two health claims proposals for fats are included: (5)

- low fat/low cholesterol diets and decreased risk for coronary heart disease
- low fat diets and reduced risk for some types of cancer

One of the US allowed claims is directly related to reduced fat: the «dietary fat and cancer claim». A model claim proposed by the FDA is: «Development of cancer depends on many factors. A diet low in total fat may reduce the risk of some cancers». To bear the claim, foods must meet the requirements for a low fat product. This again means that products that have already a low fat content may be claimed, while low fat analogues for high fat products, that do not come under the 5 g/100 g level are outside the claim.

Similar contradictions between nutritional objectives and (proposed) legislation exist for other issues e.g. saturated fat level, cholesterol levels. The food industry is active in the discussion of these subjects, but perhaps the nutrition community should be more involved.

It may be concluded that many alternative products with lower fat content than the traditional ones have been brought to the market. Developing legislation, which should be informative to the consumer, is not always providing incentives to the food industry to develop the nutritionally optimal products. The nutritional community, legislators and industry should operate jointly to achieve improved solutions.

Summary

The rising fat consumption in affluent countries has led to nutritional guidelines recommending lower energy intake and lower fat intake. Products that may help consumers to follow the recommendations while retaining their habitual eating pattern have been developed by the food industry. Different approaches using fat replacers and fat replacement technologies have been used. They have resulted in a number of food product categories in high quality, safe and healthy alternatives for traditional products. Scientific results become available showing that the use of these products reduces energy intake under realistic conditions. Discussions about the level of micronutrients and the way in which the nutritional benefits may be communicated take place between the industry and the legal authorities and to a lesser extent the nutritional scientific community.

Zusammenfassung

Zunehmender Fettverzehr in den wohlhabenden Ländern hat zu Ernährungsempfehlungen geführt, die Energie- und Fettzufuhr zu senken. Produkte, die den Konsumenten helfen können, dieses Ziel innerhalb ihrer gewohnten Ernährung zu erreichen, sind von der Industrie entwickelt worden.

Verschiedene Wege zur Fettreduktion mit Technologie und Ingredients sind besprochen worden. Viele Produkte von hoher Qualität sind als unbedenkliche gesunde Alternativen zu traditionellen Produkten entwickelt worden.

Wissenschaftliche Daten zeigen, dass diese Produkte unter realistischen Bedingungen auch wirklich zu einer erniedrigten Energiezufuhr führen.

Diskussionen über den wünschenswerten Gehalt an fettlöslichen Vitaminen und über die Art und Weise der Anpreisung der ernährungsphysiologischen Vorteile dieser Produkte sind zwischen Industrie und Behörden im Gang.

Résumé

La consommation de graisse dans les pays occidentaux augmente. Les recommandations nutritionnelles dans ces pays préconisent en général de réduire l'apport en énergie et surtout celui en graisse dans le régime alimentaire. L'industrie alimentaire a développé des produits réduits en graisse qui peuvent aider les consommateurs à suivre ces recommandations tout en maintenant leur alimentation habituelle.

Des méthodes différentes, en variant les ingrédients et les technologies, ont été décrites pour atteindre ce but. On trouve aujourd'hui un grand nombre de produits de bonne qualité qui peuvent remplacer les produits traditionnels.

Des résultats scientifiques récents tendent à montrer que l'utilisation de ces produits dans des conditions réalistes réduit la consommation de calories.

Des discussions concernant la teneur en vitamines liposolubles et quant à la façon de communiquer les qualités nutritionnelles de ces produits, sont en cours entre l'industrie et les autorités et, dans une moindre mesure la communauté scientifique.

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Dr. Onno Korver
Unilever Research Laboratory
Postbus 114
NL-3130 AC Vlaardingen