

Trans fat reduction and replacement in Europe

Trans fatty acids (or TFAs, *trans* fats) are unsaturated fatty acids with at least one double bond in the *trans* configuration, whereas most unsaturated fatty acids have a *cis* configuration. *Trans* fats can be formed during the food production process and during the natural biohydrogenation in the rumen of cattle and sheep.

Trans fats have been widely used in the food industry since the 1950s. There is now broad scientific consensus that industrial *trans* fats have detrimental effects on cardiovascular health. Based on these insights, industries and governments have taken actions to limit the intake of *trans* fats. Palm oil has emerged as a versatile, cost-effective solution for elimination of *trans* fats in products that require a solid fat for functionality.

Today, the intake of *trans* fats in many European countries is below recommended thresholds and no longer a public health concern. However, efforts need to continue to reduce *trans* fats in the last pockets of products or populations (mostly) in Eastern European countries, where progress has not been equally fast.



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What are *trans* fats?

Chemistry and physical properties

Trans fatty acids (or TFAs, *trans* fats) are unsaturated fatty acids with at least one double bond in the *trans* configuration, whereas most unsaturated fatty acids have a *cis* configuration.

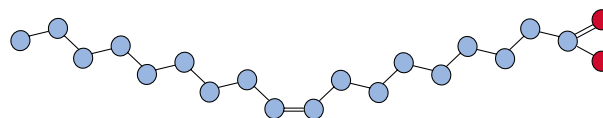
A double bond in the *cis* configuration is asymmetric and forces a kink or bend into the carbon chain. As a result, unsaturated fatty acids are unable to pack so closely together, or crystallise so readily as straight-chain saturated fatty acids (SAFA). This is why unsaturated oils are mostly liquid, while more saturated fats are hard at room temperature.

A *trans* double bond does not form a sharp angle, as does a *cis* double bond. Instead the molecular chain forms a straight line, except with a small kink at the double bond site. Consequently, *trans* fats have functional properties similar to those of saturated fats. *Trans* isomers have a higher density and a higher melting point than the corresponding *cis* isomers, and thus will be more solid at room temperature.

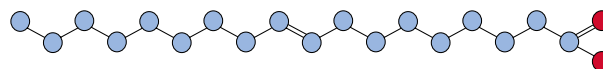
“*Trans* fats have functional properties similar to those of saturated fats.”

Trans fats are unsaturated fats that have at least one double bond in the *trans* configuration

Unsaturated fat (≥ 1 double bond)

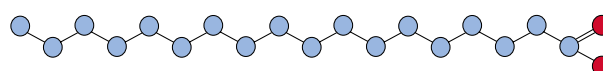


Cis double bond (bent form)



Trans double bond (straight form)

Saturated fat (no double bond)



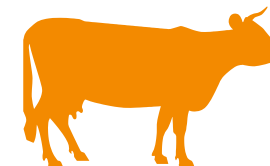
● carbon ● oxygen

The TFA content of partially hydrogenated oils can range from a few up to 60% of total fatty acids. Ruminant fats (e.g. dairy products, meat from cattle and sheep) contain 2-9% TFA, while unsaturated oils deodorised at high temperature may contain 1-3% TFA (Duijn-van 2005; Mouratidou et al. 2014; Tarrago-Trani et al. 2006).

Trans fats can be formed during the food production process and during the natural biohydrogenation in the rumen of cattle and sheep



Industrially formed



Naturally formed

Natural and industrial source

There are three different sources of *trans* fats in the diet:

1. *Trans* fats formed during industrial hydrogenation of vegetable oils. Partially hydrogenated oils, high in TFA level, were used for the production of margarines, and as ingredients for shortenings, frying fats, etc.
2. *Trans* fats from isomerisation during heat processing of unsaturated oils, especially during deodorization (high temperature step of oil refining).
3. *Trans* fats formed during biohydrogenation, i.e. the bacterial transformation of unsaturated fatty acids in the rumen of cattle and sheep.

Detrimental effects on health

Increased risk of heart disease

In the early 1990s metabolic studies showed that consumption of industrial *trans* fats raised low-density lipoprotein (LDL) and lowered high-density lipoprotein (HDL) cholesterol levels in the blood. Furthermore, observational studies showed that a higher intake of *trans* fats was associated with a higher risk of coronary heart disease (CHD) (Brouwer et al. 2013).

On a calorie basis, *trans* fat appears to increase the risk of CHD more than any other macronutrient. An analysis of several prospective studies indicated a 24, 20, 27 and 32% higher risk of myocardial infarction or CHD-related death for isocaloric replacement of 2 energy percent of carbohydrates, SAFA, mono unsaturated fatty acids (MUFA), and poly unsaturated fatty acids (PUFA), respectively by TFA (Mozaffarian et al. 2009).

“On a calorie basis, *trans* fat appears to increase the risk of CHD more than any other macronutrient.”



Industrial and ruminant *trans* fats largely contain the same compounds, yet in different proportions. *Trans* fats from both sources appear to have the same adverse effects on blood lipids and lipoproteins when consumed in equal amounts.

At the same time, there is insufficient evidence to establish whether there is any difference between ruminant and industrial *trans* fats on the risk of heart disease (EFSA 2010).

Other health concerns

The European Food Safety Authority (EFSA) concluded that human studies revealed no consistent evidence of any effect of *trans* fats on blood pressure or insulin sensitivity associated with diabetes. Epidemiological evidence for a possible relationship of *trans* fats intake with cancer, type 2 diabetes, or allergy is weak and inconsistent. No causal link has been established for the suggested adverse effects of *trans* fats on foetal and infant development although further research is needed in this area (EFSA 2004).

Why industrial *trans* fats were used

Alternative for animal fat

In the beginning of the 20th century the majority of cooking, baking, and frying was carried out using animal fats (mainly lard, beef tallow, and butter). These fats are semisolid at room temperature and resistant to oxidation during frying.

In the 1950s, lard was the ideal shortening for baked goods because it naturally possessed a soft texture, a desirable flavour, and was the cheapest fat available. It also had excellent aerating properties that were essential for the creaming process in many baked goods.

Early in the 19th century, large quantities of liquid polyunsaturated vegetable oils became available as by-products from cottonseeds and later from

soybeans. Other sources of liquid oils became commercially available around the world, including sunflower and canola (rapeseed) oils. Direct use of liquid oils in baked goods was limited because they did not naturally possess a semisolid texture. They also had limited use in deep fat frying due to high levels of polyunsaturated fat (Kodali 2014).

Technological breakthrough

Hydrogenation or ‘hardening’ of edible oils was invented at the beginning of the 20th century and converted vegetable oils into semisolid fats. Partially hydrogenated vegetable oils (PHVOs) are resistant to oxidation and have a texture and functionality similar to animal fats due to the presence of *trans* fat. PHVOs were, and in some cases still are, used in products requiring structure, endurance against repeated heating or prolonged shelf life and they may improve sensory aspects of foods, such as mouthfeel.

“Hydrogenation of edible oils was invented at the beginning of the 20th century and converted vegetable oils into semisolid fats.”

By varying the reaction conditions of the hydrogenation process, a broad range of stable products with different physical characteristics could be made from liquid oils. This technological breakthrough resulted in a surge in innovation within the modern baking and snack food industries.

Trans fat reduction measures

Legislative actions

In 2003, Denmark was the first country in the world to adopt legislation limiting the content of industrial *trans* fat in food to a maximum of 2 gram TFA per 100 gram of total fat.

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In the following years, Switzerland (2008), Austria (2009), Iceland (2011), and most recently Hungary (2013) and Norway (2014) have also introduced legislations limiting the content of *trans* fat in food (Mouratidou et al. 2014).

The EU does not have legislations regulating the content of *trans* fats in food products or requiring their labelling. Thus, should a product contain partially hydrogenated oils (and hence, possibly *trans* fats), its label will indicate this, but it will not indicate the exact amount of *trans* fats present.

There has been growing pressure to establish legal limits as an EU-wide practice. In a report on *trans* fats published in December 2015, the European Commission concluded that a legal limit for industrial TFA content would be the most effective measure for tackling the problem (EC 2015).

Voluntary measures

There are several examples of voluntary reformulation efforts by the industry accompanied or not by public-private partnerships.

IMACE Code of Practice on Trans Fatty Acids

The margarine industry in Europe has made consistent commitments in reducing *trans* fat content in its products. The IMACE (Margarine Association of the Countries in Europe) Code of Practice states that all retail margarines and fat spreads should contain no more than 2% TFA on a fat basis (IMACE 2013).

FEDIOL Code of Practice on oil refining

FEDIOL (the Federation representing the EU Vegetable Oil and Proteinmeal Industry) developed a Code of Practice in which all the technical parameters have been specified to ensure the quality and safety of refined vegetable oils and fats. This ensures that during refining, no more than 2% TFA on fat basis will be formed (FEDIOL 2002).

BRC Commitment to removing trans fats

The BRC (British Retail Consortium) announced its intentions to voluntarily cease the use of *trans* fat in foodstuffs in 2007. Around the same time, the UK Food Standards Agency advised the UK Department of Health to maintain its successful voluntary approach rather than adopt a mandatory approach to regulate *trans* fat content of foodstuffs. (Mouratidou et al. 2014).

Task Force for the Improvement of the Fatty Acid Composition – The Netherlands Oils and Fats Industry

In 2003 ‘the Dutch Task Force for the Improvement of the Fatty Acid Composition’ started as a self-regulatory initiative. This task force stimulated

the food industry to reformulate foods towards a lower SAFA and TFA content. The task force comprised suppliers and purchasers of vegetable oils and fats, collaborating specifically on TFA and SAFA in industrial fats. (Task Force Verantwoorde Vetzuursamenstelling 2010).

Dietary recommendations

Recommendations from national healthy authorities and governments on maximum *trans* fat intakes range from ‘as low as possible’ to <2 percent of energy. For an adult consuming 2000 kcal/day, this would mean less than 4.4 grams of *trans* fat per day. The EFSA states that ‘*trans* fat intakes should be as low as possible within the context of a nutritionally adequate diet’ (EFSA 2010).

“*Trans* fat intakes should be as low as possible within the context of a nutritionally adequate diet.”

Recommendations on daily dietary intake of *trans* fat in Europe, range from 'as low as possible' to <2 percent of energy

Organisation issuing the recommendation	Country	Year	TFA intake recommendation
European Food Safety Authority	Europe	2010	As low as possible
Nordic Council of Ministers	Nordics	2012	As low as possible
The Health Council of the Netherlands	NL	2015	As low as possible
Conseil Supérieur de la Santé	BE	2009	<1 E%
German Nutrition Society, Austrian Nutrition Society, Swiss Society for Nutrition Research & Swiss Nutrition Association	DE, AT, CH	2008	<1 E%
Sociedad Española de Nutrición Comunitaria	ES	2011	<1 E%
French Food Safety Authority	FR	2001	<1 E%
The Committee on Medical Aspects of Food Policy, United Kingdom	UK	1991	<2 E%

(Mouratidou et al. 2014; Health Council of the Netherlands 2015; Aranceta-Bartrina et al. 2011; Conseil Supérieur de la Santé 2009).

Replacement solutions

Food manufacturers have different options to reduce the *trans* fat content of foods, including:

Full hydrogenation

During the process of hydrogenation, conditions can be selected that result in the almost complete conversion of all the unsaturated fat into saturated fat, while maintaining a low level of residual *trans* fat (<5%). Due to the high content of saturated fat, fully hydrogenated fat has limited functionality because it is a hard waxy fat that does not melt in the mouth. Nevertheless, it can be used in frying and bakery applications after interesterification with liquid oils and blending.

Interesterification of mixed fats

The interesterification reaction is usually carried out on a single fat or blend of different fats or oils, e.g. fully hydrogenated fat, palm oil or fractions, lauric oil and/or liquid oil, leading to an exchange of fatty acids within and between fats. The newly formed fats have chemical properties in between those of the initial starting materials and unique physical properties (desirable plasticity, texture, and mouthfeel) with essentially no *trans* fat.

Selective breeding and genetic modification

Plants that grow in moderate climates produce seeds with a high content of unsaturated fat in order to remain liquid at ambient temperatures and allow proper germination. Selective breeding and genetic engineering has been and is still used to create varieties of sunflower seeds, soybeans, and canola seeds high in oleic acid, an unsaturated fatty acid that

is more stable against oxidation, thereby increasing shelf life.

Efforts to significantly increase the saturated fat content in the seed oils using genetic modification techniques have resulted in unintended effects that adversely affect plant seed germination. The maximum saturated fat content in commercial oilseeds produced in moderate climates is 30%.

Animal fats

A logical replacement for partially hydrogenated vegetable oil is animal fat. Fats such as lard, tallow, and butter are high in saturated fats (50-65%) and have been used for baking for centuries. Nevertheless their popularity declined in view of their limited availability, high price, and cholesterol content.

Tropical oils

Plants that produce oils that are solid or semisolid at room temperature include the oil palm, coconut, and cacao tree. The oils are contained in the fruit, kernel, bean or nut and are all high in saturated fat (50-90%). Palm fruit oil, with a natural mixture of 50% saturated fat and 50% unsaturated fat is relatively soft and possess a similar texture and stability to animal fats and partially hydrogenated vegetable oils. The other highly saturated plant oils, including the kernel of the palm fruit are hard and brittle in texture and are traditionally useful in the manufacture of chocolate, chocolate alternatives and coating fat in confectionary products (Kodali 2014; Tarrago-Trani et al. 2006).

The palm oil alternative

What is palm oil?

Palm fruit oil, generally known as palm oil, is produced from the pulp of the fruit of the oil palm tree. Crude palm oil is naturally reddish in colour because of the fruit pulps' high carotenoid content.

The oil palm tree grows in regions around the equator. Originally found in West Africa, the oil palm tree is now mostly cultivated in Indonesia and Malaysia, the world's top palm oil-producing nations.

Among major oilseed crops, oil palm accounts for the smallest percentage (5.5 per cent) of all the cultivated land for oils and fats globally, but produces the largest percentage (32 per cent) of total output. It uses less than half the land required by other crops (such as sunflower, soybean or rapeseed) to produce the same amount of oil.

Despite these advantages, the impact of oil palms growing on High Conservation Values Areas, peatland, and former tropical forests, are issues that need to be adequately addressed. Production and use of sustainable palm oil will help to maintain or enhance biological, ecological and social values in the countries of origin.

Palm oil and health

Palm oil consists of equal amounts of saturated and unsaturated fats.

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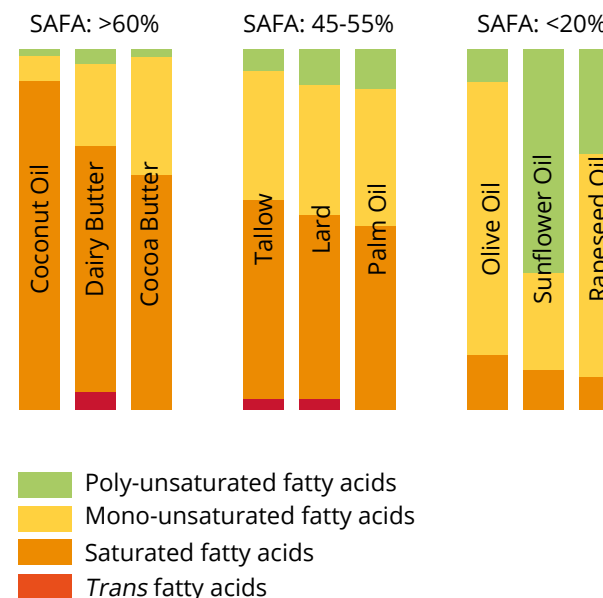


The proportion of saturated fats in palm oil is lower than the saturated fat content of other fats of similar application: coconut oil, butter and cocoa butter.

In food products palm oil is often used in combination with other fats and oils which together determine the fatty acid composition of the product and eventually the effects on health. Importantly, palm oil virtually contains no *trans* fatty acids (<1 per cent). Using palm oil instead of partially hydrogenated vegetable oils reduces the content of *trans* fats in foods made with these oils.

“Palm oil virtually contains no *trans* fatty acids.”

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Versatility and functional benefits

Palm oil is comprised of many structurally unique fat “components”, each with different melting points and physical properties. Many of these components can be separated from the original oil by a physical process called fractionation and can then be further processed for specific purposes (Kodali 2014).

In many food applications, the use of palm oil and palm oil fractions has been instrumental in lowering *trans* fat levels. The successful reduction of *trans* fats in margarine for example, has been predominantly the result of using specific combinations of palm oil and liquid oils. No other vegetable fat with a semi-solid texture at room temperature and providing the same features exist in sufficient quantity (Eckel et al. 2007).

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	Melting Point	Properties	Uses
 <p>Palm Oil</p>	 <p>35 °C</p>	Semisolid at room temperature (RT)	Bakery applications, frying oil
 <p>Palm Olein</p>	 <p>20 °C</p>	Liquid at RT	Cooking oil and deep frying
 <p>Palm Stearin</p>	 <p>48 °C</p>	Hard, waxy, solid at RT	Pastry and margarine fats
 <p>Double Olein</p>	 <p>10 °C</p>	Good resistance to oxidation	Salad oil, frying oil
 <p>Palm Mid Fraction</p>	 <p>25-30 °C</p>	Solid at low temperature but melts quickly	Ganache type confectionery fillings, biscuit fillings, frying oil
 <p>Double Stearin</p>	 <p>60-62 °C</p>	Very hard, waxy, solid at RT, easy to flake or powder	Dry mixes (cake, soup)
 <p>Mid Stearin</p>	 <p>30 °C</p>	Mid range melting point	Hard stock for spreads

Adapted from GreenPalm www.greenpalm.org

Decreased intake of *trans* fats in Europe

Reduction of industrial *trans* fat in foods

Europe was at the front of the discovery of the negative health effects of *trans* fats, and has taken rapid actions to remove them from most products. Reductions of *trans* fat are targeted to industrially produced *trans* fat because the proportion of *trans* fat in those fats can be modified whereas the proportion of *trans* fat in ruminant fats is relatively stable (EC 2015).

In the case of frying oils, successful implementation of breeding methods resulted in high-oleic seed oils that deliver superior stability in use. In the case of margarine, application of tropical oils (mainly palm oil and its fractions as well as coconut oil), in combination with fully hydrogenated oils helped to populate the list of potential hardstocks (Kodali 2014).

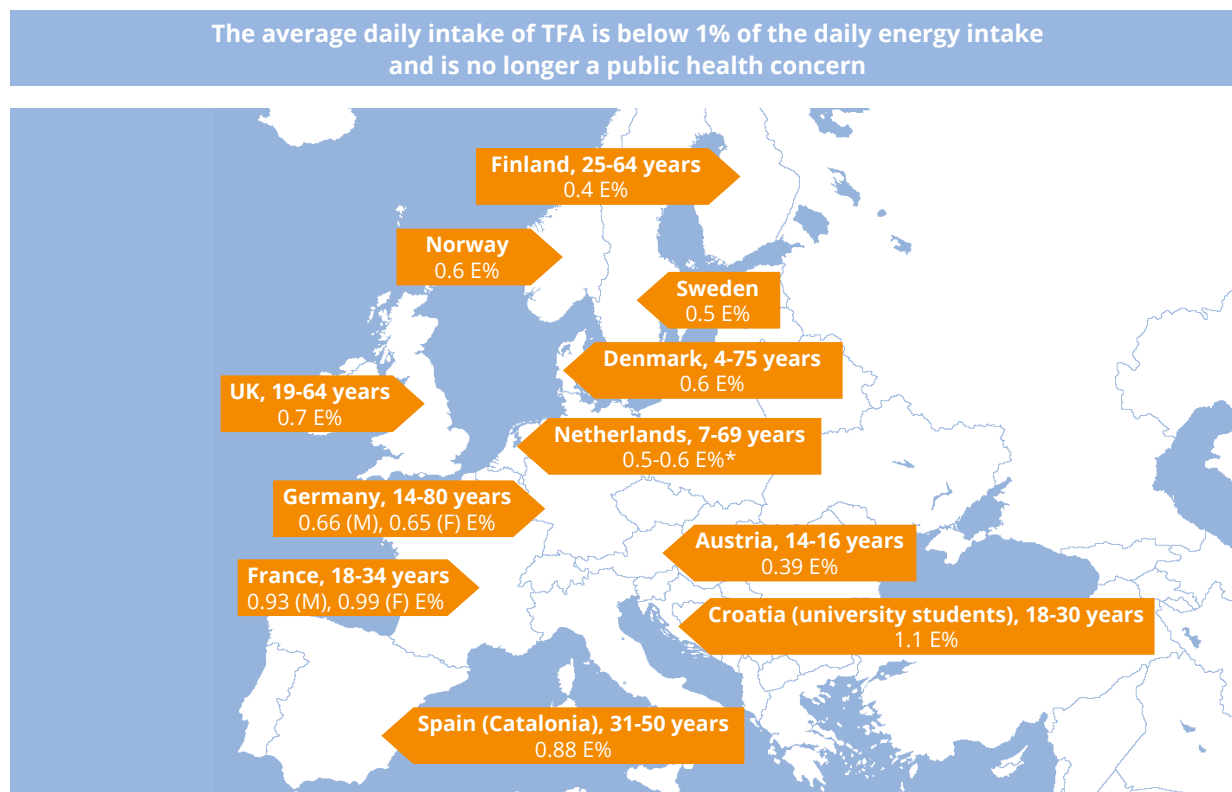
According to an analysis of the most recent available data on the presence of *trans* fat in European food markets, the majority of products contain less than 2 gram TFA/100 gram fat (the lowest limit set in EU countries with limiting legislation). 77 Per cent of these are below 0.5 gram TFA/100 gram fat. However, the data also show that there are still products in some (Eastern) European markets with high levels of *trans* fat (e.g. biscuits or popcorn with values in the order of 40-50 gram TFA/100 gram fat). These also include non-pre-packed foods such as bakery products that contain *trans* fat (> 2 gram of TFA per 100 gram fat) (Mouratidou et al. 2014).

Trans fats no longer a public health concern

The intake of *trans* fats has decreased considerably over the past two decades because the food industry has largely eliminated industrial *trans* fats from foods. Results gathered from dietary surveys and consultations indicate that in many European countries the average daily intake of TFA is below 1% of the daily energy intake and is no longer a public health concern. In many countries in Europe, intakes of ruminant *trans* fat are now higher than those of industrial *trans* fat due to these significant industrial reformulations (Kodali 2014).

However, there are subpopulations exceeding this recommended threshold. Indeed, specific population groups may be at risk of high *trans* fat intake as long as products with high levels of *trans* fat remain in the food market (Mouratidou et al. 2014).

Efforts need to continue to reduce *trans* fats in the last pockets of products or populations (mostly) in Eastern European countries, where progress has not been equally fast.



Source: Mouratidou et al. 2014; Johansson et al. 2006; Pedersen et al. 2015; Becker et al. 2015
*median intake

About the European Palm Oil Alliance

The European Palm Oil Alliance (EPOA) was founded to create a platform for palm oil-related issues and discussions. The goal of EPOA is to create a balanced and objective view on the nutritional and sustainability aspects of palm oil, by providing science-based information. EPOA is committed to sustainable palm oil production. EPOA facilitates and supports together with The Sustainable Trade Initiative (IDH) and The Roundtable on Sustainable Palm Oil (RSPO) new national industry alliances in Europe providing clear commitment and monitoring on the use of certified sustainable palm oil.

Informed by science

EPOA is supported by a Scientific Advisory Panel (SAP). The SAP was established in 2013 and provides independent insights, advice and guidance on nutrition issues and discussions related to palm oil. It is intended to safeguard the sound scientific base and ensure validity and reliability of communication and messaging.

Currently, Prof. dr. Jean Michel LeCerf (Institut Pasteur de Lille, France), Prof. dr. Sebastiano Banni (Universita degli Studi Cagliari, Italy) and Prof. em. dr. Gerard Hornstra (NUTRI-SEARCH, Netherlands) participate in the SAP.

Current participants of EPOA are:



IOI Loders Croklaan



References

- Aranceta-Bartrina J. et al. (2011) Objetivos nutricionales para la población española consenso de la Sociedad Española de Nutrición Comunitaria 2011. Revista española de nutrición comunitaria. 17(4):178-199.
- Becker W. et al. (2015) Contents of total fat, fatty acids, starch, sugars and dietary fibre in Swedish market basket diets. Br J Nutr 113(9):1453-1465.
- Brouwer IA. et al. (2013) Trans fatty acids and cardiovascular health: research completed? European Journal Clinical Nutrition 67(5):541-547.
- Conseil Supérieur de la Santé. (2009) Publication du Conseil Supérieur de la Santé No 8309. Recommandations nutritionnelles pour la Belgique. Révision 2009. Bruxelles, Belgique.
- Duijn G. van (2005) Technical aspects of trans reduction in modified fats. OCL journal. 12(5-6):422-426.
- Eckel RH. et al. (2007) Understanding the Complexity of Trans Fatty Acid Reduction in the American Diet American - Heart Association Trans Fat Conference 2006 Report of the Trans Fat Conference Planning Group. Circulation 115:2231-2246.
- European Commission (EC) (2015) Report from the Commission in the European Parliament and the Council regarding *trans* fats in foods and in the average diet of the Union population, Brussels, Belgium.
- European Food Safety Authority (EFSA) (2004). Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on Trans fatty acids in foods and the effect on human health of the consumption of trans fatty acids. EFSA Journal 81:1-49.
- European Food Safety Authority (EFSA) (2010). Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, monounsaturated fatty acids, and cholesterol. EFSA Journal 8(3):1461.
- FEDIOL. Code of Practice on Oil Refining, FEDIOL. 2002. http://www.fediol.eu/data/fediol_02COD395_0466.pdf
- GreenPalm. Palm and Palm Kernel Supply Chain - Fractions Derivatives & Product Uses <http://greenpalm.org/about-palm-oil/about-palm-oil-downloads>
- Health Council of the Netherlands. Dutch dietary guidelines 2015. The Hague: Health Council of the Netherlands, 2015; publication no. 2015/24E. ISBN 978-94-6281-104-1
- IMACE Code of Practice on Trans Fatty Acids, IMACE. 2013. <http://77.245.87.41/Portals/0/publicaties/Magazine/2013/04/1311%20European-Margarine-Sector-Code-of-Practice-on-Trans-Fatty-Acids.pdf>
- Johansson L. et al. (2006) Transfettsyreer i norsk kosthold. Tidsskr Nor Lægeforen 126:760-763
- Kodali DR. (2014) Trans Fats Replacement Solutions, Urbana, Illinois, USA: AOCS press. ISBN-9780983079156
- Mouratidou T. et al. (2014). Trans fatty acids in Europe: where do we stand? A synthesis of the evidence: 2003-2013. JRC Science and Policy Reports. European Commission, Joint Research Centre.
- Mozaffarian D. et al. (2009). Health effects of trans-fatty acids: experimental and observational evidence. European journal of clinical nutrition 63 (Suppl 2):S5-21.
- Pedersen AN. et al. (2015). Danskernes kostvaner 2011-2013. DTU Fødevareinstituttet, Søborg, Denmark.
- Tarrago-Trani MT. et al. (2006) New and Existing Oils and Fats Used in Products with Reduced Trans-Fatty Acid Content. J Am Diet Assoc; 106:867-80.
- Task Force Verantwoorde Vetzuursamenstelling (2010). VErantwoord. Betere vetzuursamenstelling in producten met plantaardige oliën en vetten. Eindrapportage Task Force Verantwoorde Vetzuursamenstelling 2003 - 2010. Rijswijk, Nederland. http://www.vetzuursamenstelling.nl/download/MVO_Taskforce-eindrapportage-2010.pdf

European Palm Oil Alliance

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