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Macadamia Oil

Macadamia oils contain 83–85% unsaturated fatty acids and 15–17% saturated fatty acids (Maguire et al., 2004;

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Related terms:

Cultivar, Monounsaturated Fat, Lipids, Nut Oils, Rancidity, Fatty Acids, Hazelnut Oil, Macadamia Nuts, Tocopherols, Macadamia

Macadamia Flours

Kanitha Tananuwong, Siwaporn Jitngarmkusol, in Flour and Breads and their Fortification in Health and Disease Prevention, 2011

Production of macadamia flours

Studies have shown that macadamia oil cake, which may be used alone or mixed with soybean meal, can be an efficient protein source in the feed for cattle and fish without adverse effects (Acheampong-Boateng *et al*., 2008; Balogun and Fagbenro, 1995). This macadamia by-product may also be a source of nutrients for humans, with an insignificant amount of antinutrients. Production of flour from macadamia oil cake or meal is simple. Further drying and defatting may not be required because the oil cake has less than 10% moisture and approximately 13% lipid content (Macfarlane and Harris, 1981). The remaining lipid content in this low-fat macadamia flour is comparable with that found in full-fat soy flour (approximately 20% lipid content) (U.S. Department of Agriculture (USDA), 2009). However, removal of lipids from the flour may provide several benefits, including improvement of some functional properties of the flour (Jitngarmkusol *et al*., 2008) and alleviation of rancid flavor development in the flour during storage.

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Improving the quality and safety of macadamia nuts

M.M. Wall, in Improving the Safety and Quality of Nuts, 2013

12.6.5 Roasting

Macadamia kernels are oil roasted or dry roasted before packaging and storage. Oil roasted kernels have good acceptance by consumers, but dry roasted nuts are popular because they contain only endogenous macadamia oil (Moltzau and Ripperton, 1939; Mason and McConchie, 1994). When oil roasting is used, the high temperature of the cooking oil leads to rancidity and fresh oil must be added continuously (Leverington and Winterton, 1962). Oil roasting at 135°C for 12 to 15 minutes results in nuts of satisfactory quality, but lower temperatures (115°C or 125°C) improve sensory quality further (Isaacs, 1992; Mason *et al*., 1995; Moltzau and Ripperton, 1939). Kernel shelf-life is reduced if roasting times and temperatures are not adjusted to the incoming product (Mason *et al*., 1995). Optimum oil roasting times were 19 to 35 minutes at 115°C, 10 to 14 minutes at 125°C, and 4 to 7 minutes at 135°C (Isaacs, 1992; Mason *et al*., 1995).

Dry roasting at 135°C for 25 minutes was developed as an alternative to oil roasting (Leverington and Winterton, 1962). Later it was shown that kernels dry roasted at 115°C for 75 minutes had better sensory quality than those roasted at 135°C for 27 minutes (Isaacs, 1992). The lower temperature reduces the risk of producing dark kernels. An intermediate approach is to roast kernels for 20–25 minutes at 125 to 127°C (Wall and Gentry, 2007; Wall, 2010). In commercial practice, actual roasting times and temperatures vary according to cultivar, batch size, the scale of roasting equipment used, and the desired color for the final product (Wallace and Walton, 2011).

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Tissue Culture and Genetic Engineering of Oil Palm

Ghulam Kadir Ahmad Parveez, ... Ravigadevi Sambanthamurthi, in Palm Oil, 2012

High Palmitoleate Oil Palm

Palmitoleic acid is an important fatty acid for pharmaceutical applications. It is postulated to have anti-thrombotic effects, which can help prevent stroke (Abraham et al., 1989). At present, it is mainly obtained from Macadamia oil (*Macadamia integrifolia*), which contains ~17% palmitoleic acid. A previous study by PORIM on oil palm protoplasts showed that *E. guineensis* protoplasts can synthesise up to 30% palmitoleic acid in their total lipids (Sambanthamurthi et al., 1996b). This illustrates the palms' inherent ability to produce high levels of this fatty acid.

Palmitoleic acid is produced by desaturation of palmitic acid. It is envisaged that Δ9-stearoyl-ACP desaturase, which acts mainly on stearic acid, can also use palmitic acid as substrate to produce palmitoleic acid. Several mutant stearoyl-ACP desaturases with increased specificity towards palmitoyl-ACP have been created and have been demonstrated to drive high levels of palmitoleic acid synthesis in *Arabidopsis* (Cahoon & Shanklin, 2000; Cahoon et al., 1997). For producing palmitoleic acid in oil palm, a mutant castor Δ9-stearoyl-ACP desaturase will be overexpressed into oil palm.

Seven transformation vectors carrying stearoyl-ACP desaturase driven by the CaMV35S promoter, a double mutant castor desaturase driven by the ubiquitin, CaMV35S and mesocarp-specific promoters, single mutant castor desaturase driven by the ubiquitin and mesocarp-specific promoters, and a single mutant desaturase together with antisense palmitoyl-ACP thioesterase driven by a mesocarp-specific promoter (Fig. 4.35) (Masani, personal communication, 2008) have been constructed. These constructs have been transformed into oil palm calli, and Basta-resistant embryogenic calli has already been obtained. Regeneration of resistant calli is being done with some transgenic plantlets already obtained for majority of the constructs used. Some of the plantlets are already transferred to soil in the biosafety screenhouse.

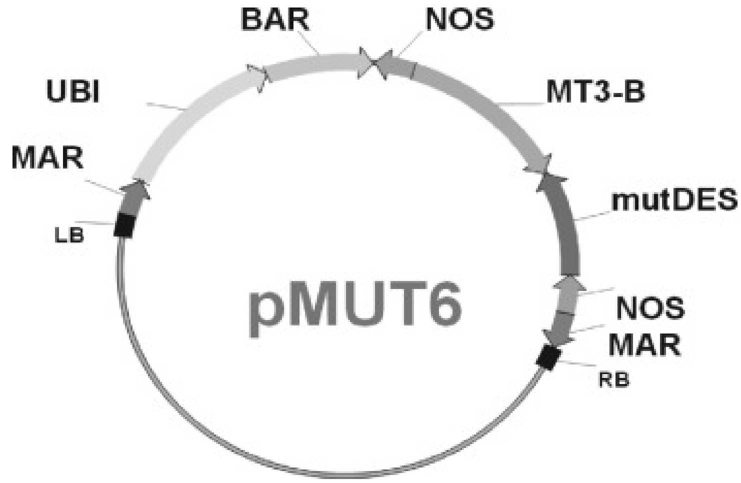

Fig. 4.35. Map of transformation vector carrying high palmitoleic acid gene driven by the mesocarp specific promoter.

Figure courtesy of Mr. Abdul Masani, MPOB.

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Macadamia Nuts (Macadamia integrifolia and tetraphylla) and their Use in Hypercholesterolemic Subjects

Lisa G Wood, Manohar L. Garg, in Nuts and Seeds in Health and Disease Prevention, 2011

Circulating Lipid Profiles

Intervention studies have been used to demonstrate the beneficial effects of macadamia nuts on circulating lipid levels. These include two animal feeding studies (Yan *et al*., 2003; Matthan *et al*., 2009) and six human clinical trials using macadamia nuts or oil (Nestel *et al*., 1994; Colquhoun *et al*., 1996; Curb *et al*., 2000; Garg *et al*., 2003; Hiraoka-Yamamoto *et al*., 2004; Griel *et al*., 2008). Matthan and colleagues (2009) undertook a study in hamsters, to investigate the effect of diets enriched with macadamia, palm (SFA, 16:0), canola (MUFA, 18:1), or safflower (PUFA, 18:2) oils on lipoprotein profiles. After 12 weeks, macadamia oil-fed hamsters had lower non-high density lipoprotein cholesterol (HDLC) and triglyceride (TG) concentrations compared with the palm and coconut oil-fed hamsters. Furthermore, HDLC levels were higher in the macadamia-oil fed hamsters compared with the coconut, canola, and safflower oil-fed hamsters (Matthan *et al*., 2009). In another animal study, hyperlipidemic rats were fed macadamia nuts at doses of between 12.5 and 25.0% of total energy for 6 weeks (Yan *et al*., 2003). The macadamia nuts led to significantly lower levels of serum total cholesterol (TC) and TG, and significantly higher levels of serum HDLC levels, compared to the control group.

The human clinical intervention studies report a consistent reduction in serum/plasma TC and LDLC levels, while the effects on HDLC are variable (Table 85.6). While the details of the supplementation trials are not consistently reported, Table 85.6 summarizes the data that are available. The duration of the studies ranged from 3 to 5 weeks, and the dose of nuts varied from 20 to 100 g/day, accounting for an estimated 10–20% of total daily energy intake. Following a 3-week macadamia nut intervention, Colquhoun and colleagues (1996) reported an 8% reduction in serum TC, an 11% reduction in LDLC, and a 21% reduction in plasma TAG. HDLC was unchanged in this study. Curb and colleagues (2000) conducted a randomized crossover trial of three 30-day diets, in 30 volunteers aged 18–53 years. Each was fed a "typical American" diet high in saturated fat (37% energy from fat), an American Heart Association (AHA) Step 1 diet (30% energy from fat), and a macadamia nut-based monounsaturated fat diet (37% energy from fat), in random order. Mean total cholesterol, LDL cholesterol, and HDL cholesterol levels were significantly lower following the macadamia nut-based diet and the AHA Step 1 diet when compared with a typical American diet (Curb *et al.*, 2000). In the study by Garg and colleagues (2003), hypercholesterolemic men were given macadamia nuts (40–90 g/d), equivalent to 15% energy intake, for 4 weeks. Plasma MUFAs 16:1(n-7), 18:1(n-7), and 20:1(n-9) were elevated after the intervention. Plasma TC and LDLC concentrations decreased by 3 and 5%, respectively, and HDLC levels increased by 8%, after macadamia nut consumption. Hiraoka-Yamamoto *et al.* (2004) studied the effect of a 3-week intervention of macadamia nuts, in young, healthy Japanese female students. Serum concentrations of TC and LDLC were significantly decreased (6 and 7%, respectively), and body weight and body mass index were also decreased in the group fed macadamia nuts, compared to baseline. In this study, plasma HDL cholesterol was unchanged. More recently a study by Griel and colleagues (2008), in mildly hypercholesterolemic subjects, compared a macadamia nut-rich diet (33% total fat, 18% MUFAs) to an average American diet (33% total fat, 11% MUFAs). Serum concentrations of TC, LDLC, and non-HDLC were lower following the macadamia nut-rich diet than the average American diet. In summary, all of these intervention studies consistently show that macadamia nut consumption causes a decrease in TC and LDLC. The effect on HDLC varies, with the intervention studies showing an increase, a decrease, or no change in HDLC levels. It is uncertain why this variability in the data occurs. However, it has been suggested that a decrease in HDLC levels may occur when the proportion of SFA in the diet is simultaneously decreased, as SFA has a cholesterol-raising effect (Griel *et al.*, 2008).

TABLE 85.6. Summary of Macadamia Nut Intervention Studies Researching the Beneficial Effects of Macadamia Nuts on Circulating Lipid Levels

Study	***n***	**Male/Female**	**Age (years)**	**Duration(days)**	**Quantity of Nuts (g)**	**% Energy from Nuts**	**Effect on TC**
1. Colquhoun *et al.*, 1996)	14	7/7	25–59	21	50–100	20	↓
2. (Curb *et al.*, 2000)	30	15/15	18–53	30	NR	NR	↓
3. (Garg *et al.*, 2003)	17	17/0	Mean 54	28	40–90	15	↓

Study	*n*	Male/Female	Age (years)	Duration(days)	Quantity of Nuts (g)	% Energy from Nuts	Effect on TC
4. (Hiraoka-Yamamoto *et al*., 2004)	24	0/24	19–23	21	20	NR	↓
5. (Griel *et al*., 2008)	25	10/15	25–65	35	42.5	NR	↓

Intervention studies consistently show that macadamia nuts consumption causes a decrease in TC and LDLC. The effect on HDLC varies, with the intervention studies showing an increase, a decrease, or no change in HDLC levels.

↓, Decrease; ↑, increase; NC, no change; NR, not reported

While the cholesterol-lowering properties of macadamia nuts are attributed to the presence of a high proportion of MUFAs, it is interesting to consider the role of individual fatty acids. Macadamia nuts are a rich source of the fatty acids 18:1n-9 (43.8% by weight) and 16:1n-7 (13% by weight), and contain small amounts of 20:1n-9. Interestingly, it has previously been suggested that 16:1n-7 may have a detrimental effect on blood lipids (Smith *et al*., 1996), having a similar effect to SFA (Nestel *et al*., 1994). However, there is a now a substantial body of evidence demonstrating that macadamia nuts are beneficial to blood lipid levels. Thus, it must be concluded that the combination of nutrients found in whole macadamia nuts has an overall beneficial effect, irrespective of the effect of 16:1n-7. While it is not possible to elucidate the role of individual nutrients from whole food interventions, it is clear that there is a complementary or synergistic interaction between the nutrients found in macadamia nuts. Furthermore, it is evident that other components, such as dietary fiber, plant sterols, and phytochemicals, are contributing to the modification of lipid profiles in these studies, as the extent of the changes observed cannot be explained by the fat content of the nuts alone (Kris-Etherton *et al*., 1999).

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Macadamia (Macadamia integrifolia, Macadamia tetraphylla and hybrids)

H.M. Wallace, D.A. Walton, in Postharvest Biology and Technology of Tropical and Subtropical Fruits: Cocona to Mango, 2011

19.1.3 Culinary uses, nutritional value and health benefits

Macadamia kernels are eaten raw, used as a cooking ingredient or processed into a variety of products. Popular products include roasted, roasted and salted, chocolate coated, honey-roasted and wasabi-flavoured. They are also used as ingredients for biscuits, cakes and ice cream, processed into a paste and cold pressed to produce an oil. Macadamia oil is used both as cooking oil and as an ingredient for food and cosmetics.

The macadamia kernel has a protein content of around 9.2% of dry material and 4.22–4.75% of total sugar, most of which is sucrose, a non-reducing sugar (Cavaletto, 1983; Fourie and Basson, 1990). The kernel is very rich in oil, ideally containing 75–80% by weight of oil for *Macadamia integrifolia* and slightly less for *Macadamia tetraphylla* (Cavaletto, 1983; Trueman *et al*., 2000). Macadamia oil is one of the most highly mono-unsaturated oils available (Ako *et al*., 1995). Oleic acid is the predominant fatty acid (c.60%), with smaller quantities of palmitoleic (c.22%), palmitic (c.9%), stearic (c.2%) and linoleic (c.2%) acids (Jones, 1937; Saleeb *et al*., 1973). This high degree of unsaturation has an important bearing on the storage characteristics, as monounsaturated oils are less subject to oxidation than poly-unsaturated oils (de Man, 1990).

Regular consumption of monounsaturated fats is associated with lower blood cholesterol and there is evidence to show that regular consumption of macadamia nuts can reduce cholesterol and help to reduce the risk of coronary artery disease. Even short term consumption can improve the biomarkers of oxidative stress, thrombosis and inflammation and lower cholesterol (Garg *et al*., 2003; 2007). Serum concentrations of total cholesterol and LDL cholesterol were lower for subjects on a cholesterol-lowering diet that included macadamia nuts compared to a diet that did not, indicating that macadamia nuts can help to reduce the risk of cardiovascular disease (Griel *et al*., 2008).

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Oxidation of edible oils

B. Matthäus, in Oxidation in Foods and Beverages and Antioxidant Applications: Management in Different Industry Sectors, 2010

6.7.6 Vegetable oils with changed fatty acid composition

One critical point for the oxidative stability of edible oils is the fatty acid composition. Oils with higher amounts of polyunsaturated fatty acids are much more susceptible to oxidation than fats and oils consisting of more saturated fatty acids. Kochhar and Henry (2009) showed a linear relationship of high-level monounsaturated fatty acids between 100 times the reciprocal of the induction period (Rancimat test) and the total unsaturated fatty acids obtained as $\%C18{:}2 + 0.08 \times \%C18{:}1 + 2.08 \times \%C18{:}3$, while polyunsaturated fatty acid oils exhibited an exponential relationship. From this, they found the order of oxidative stability, determined as induction period by the Rancimat test at four temperatures (90°C, 100°C, 110°C, and 120°C), as macadamia oil > rice bran oil ≈ toasted sesame oil > avocado oil > almond oil > hazelnut oil > grape seed oil > walnut oil.

On the other hand, vegetable oils are favoured in nutrition, because of the positive health effects of unsaturated fatty acids. To break this cycle, for some years new plant varieties with significantly higher amounts of oleic acid than the traditional varieties have been available on the market. These new varieties were originally developed for technical applications, but today they are also of interest for human nutrition and the preparation of food, especially if high oxidative stability is desired. These so-called ‘high-oleic’ oils have the advantage of combining consumer demand for natural vegetable oils and the requirement of the industry for high-stability oils (Kochhar, 2001).

Most of the well-known conventional vegetable oils were subject to different breeding programmes, either by conventional methods, or by genetic techniques. The use of genetic engineering for the breeding of new varieties is problematical in Europe, because the products obtained from these seeds are often not welcomed. Another problem is that it is difficult to produce these varieties with sufficiently good agricultural properties, and with an economically interesting seed yield or oil yield. Therefore, at the moment there are only a few varieties from plants with a high content of oleic acid available on the commercial market.

In addition to high-oleic soybean oil, which has different applications in human nutrition, high-oleic sunflower oil also has a certain importance in the oil market. This oil is available with different amounts of oleic acid, from 75% to more than 90%. Meanwhile some high-oleic rapeseed varieties are also available with more than 70% oleic acid and noticeably reduced amounts of linolenic acid. In particular, this reduction of the high amount of linolenic acid seems to have significantly improved the stability of this type of rapeseed oil in comparison with oil from conventional varieties. Carré *et al*. (2003) showed that a content of more than 1.1% linolenic acid already resulted in significantly higher intensities of fishy and paint-like odours.

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Rwanda

Roger D. Norton, in The Competitiveness of Tropical Agriculture, 2017

The Field Findings

Macadamia is a tree that originated in Australia. The German botanist Ferdinand von Müeller discovered it in 1848, and commercial exploitation of the tree began shortly after that. The first macadamia tree planted for cultivation is still yielding nuts because its productive period can exceed 200 years. Macadamia nuts are the highest valued nuts in the world.

They are produced commercially primarily in Australia, Hawaii, South Africa, Kenya, Malawi, Colombia, Costa Rica, Guatemala, and Brazil. To date the United States, Australia, and Japan are the principal consuming nations for macadamia nuts, but European and Asian demand for them is increasing. Taiwan consumes more macadamia nuts and oil per capita than any other country. The nut is not only appreciated for its taste and use in cooking but also is a star ingredient in antiaging creams produced by leading brands such as Lancôme. In addition, more than 40% of its composition is oleic acid, a substance similar to olive oil that helps reduce cholesterol. More than 80% of the fatty acids in macadamia nuts are monosaturated. All these factors contribute to the increasing international demand for the crop.

The possibility of planting macadamia in Rwanda has been mentioned by ISAR in its *Participatory Diagnostic Report for the Cyabayaga Watershed* (2006) and in the RHODA Business Plan, but in both cases without elaboration. Since the crop is not yet well known in Rwanda, a few comments are offered in this section about its cultivation.[7] Macadamia grows well with annual precipitation of 1500–3000 mm, well distributed throughout the year and with no more than 2 months of drought.

Thus irrigation during the dry season can benefit this crop. Its preferred temperature range is 18–29°C. Normally these conditions are found at altitudes of 400–1000 m above sea level, but the crop can be cultivated up to 1200 m.

Establishing nurseries is important for macadamia production, and grafting rather than propagation by seeds is recommended. The trees begin producing in the fifth year, and yields continue to increase until the 50th year.

The nuts that have fallen should be collected at least once every 2 weeks, and then they are carefully dried until the humidity drops to 3.5%. The commercial product is toasted and vacuum-packed nuts. Macadamia trees benefit watersheds by helping conserve sources of water. They are also favored hosts for bees.

Macadamia has significant long-term potential for Rwanda. Among other considerations, its high unit value reduces the importance of international transport costs. However, commercial-scale production would require an investor in the processing industry and a program of training and supervision of producers. The government may wish to try to interest more investors in this crop, and in the meantime it is listed as one of the crops for which it would be worth carrying out trials.

Experimental cultivation of this crop was started at Rwamagana in 2007. Since the original draft of this case study a small but thriving processing and export industry for macadamia nuts has developed in Rwanda, confirming the crop's suitability for the country. NORLEGA Macadamia Rwanda Ltd., FRESHCO Rwanda Ltd., the Rwanda Nut Company Ltd., and Farm Gate East Africa Ltd. are companies producing roasted, well-packaged nuts. NORLEGA in particular has established strong value chain ties to producers. In 2015 a Kenyan company announced plans to plant 1 million macadamia trees and involve 20,000 farmers in its cultivation. It is estimated that in 10 years Rwanda can be earning $200 million per year from macadamia exports. The crop's strong competitiveness is now clearly established, and management of the nurseries, production, and processing segment of the value chain are well developed. Issues that may have arisen for the filters of the value chain have been resolved, or are being resolved, by the actors in the value chain, and therefore there are no issues of significance to report.

Macadamia is an outstanding example of a smallholder crop that can give an enormous boost to their standards of living while having secure links to world markets.

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Healthy Fats and Oils

S.M. Ghazani, A.G. Marangoni, in Reference Module in Food Science, 2016

Classification of Oils and Fats Based on Fatty Acid Profile

Medium-Chain Fatty Acids (C6:0 to C10:0) Subgroup

This group of oils (MCTs) is important in the case of providing an instant source of energy for the body. These fatty acids have small size and higher solubility and are mainly transported directly via portal circulation and metabolized in the liver, whereas longer-chain fatty acids are absorbed via the lymphatic system after micellar transport at the intestinal wall. MCTs are neutral on LDL-, HDL-cholesterol or triacylglycerol concentration in serum and may be beneficial in controlling obesity.

Lauric Acid and Myristic Acid Subgroup

Among saturated fatty acids, lauric acid and myristic acid are the most blood cholesterol and LDL-cholesterol increasing fatty acids. Although, the effect of myristic acid is higher than lauric acid, the position of fatty acids on the glycerol backbone needs to be considered. Coconut oil and palm kernel oil are categorized in this subgroup.

Palmitic Acid Subgroup

The effect of palmitic acid on increasing serum cholesterol and LDL cholesterol is lower than lauric acid and myristic acid. Palm oil and lard are good examples of this group.

Stearic Acid Subgroup

Among saturated fatty acids, stearic acid exhibited as quite neutral with no deleterious effect on plasma lipids. Cocoa butter and shea butter can be in this subgroup because they contain up to 40% of stearic acid.

Oleic Acid Subgroup (> 60%)

Olive oil is the best representative oil of this subgroup, which contains about 80% of oleic acid and then canola oil with about 65% oleic acids. In nuts oil, hazelnut oil and macadamia oil are rich in oleic acid.

Linoleic Acid Subclass (> 60%)

The common vegetable oils gathered in this group are grape seed oil, evening primrose oil, and safflower oil. As the human body cannot synthesize linoleic acid from food components, presence of this fatty acid is essential for good health and termed an essential fatty acid. As mentioned earlier, the inflammatory effect of consuming $n-6$ fatty acids should be considered and $n-6/n-3$ ratio should be balanced in the diet.

Linoleic Acid + Saturated Fatty Acids Subgroup

Cottonseed oil and watermelon seed oil are clustered in this group. Their fatty acid profiles mainly contain linoleic acid, associated with saturated fatty acids (especially palmitic acid).

Linoleic Acid + Oleic Acid Subgroup

Sunflower oil, corn oil, sesame oil, pumpkin seed oil, and borage oil are good examples of this subgroup. In this group, borage oil has a high amount of γ-linoleic acid (about 22% of the total fatty acids).

Conjugated Linoleic Acid

Conjugated linoleic acid (CLA) is a term used for positional and geometric isomers of linoleic acid that can be found in animal fats such as beef, lamb, and dairy foods. CLA are produced by microbial fermentation of PUFAs and isomerization of linoleic acid in the rumens of ruminants. Whereas double bonds in linoleic acid are between the ninth and tenth carbons and the twelfth and thirteenth carbons, CLA has conjugated double bonds at carbon atoms 10 and 12 or 9 and 11, with possible cis and trans combinations. Many clinical studies have shown that conjugated linoleic acid may have physiological effects, including anticarcinogenic, anti-atherogenic, improvement of type II diabetes, and immunomodulating properties of CLA.

Some clinical studies on animals showed that conjugated linoleic acid is quite effective to inhibit the growth and metastasis of breast and prostate cancers.

Trans Fatty Acids

Two types of trans fatty acid (TFAs) isomers can be found in fats as naturally and industrially produced fatty acids. The presence of TFAs in animal fats was revealed some time ago. TFA in tallow and milk fat is vaccinic acid C18:1 ($n-7t$). This TFA is naturally produced during biohydrogenation and isomerization of PUFAs in rumen guts.

Catalytic hydrogenation is an industrial modification process that is applied to reduce the amount of polyunsaturated fatty acids and leads to improvement in oxidative stability of oils and increasing hardness. This industrial process produces TFA, which are almost unavailable in natural fats. TFA levels and isomeric distribution depend on processing factors (nickel catalyst type and concentration, hydrogen pressure, stirring speed, and reaction temperature), fatty acid composition of original oil, and degree of saturation (partially or fully hydrogenation).

Partial hydrogenation produces mostly geometrical and positional trans-18:1 isomers (mainly elaidic acid) while reducing the amount of PUFA. During deodorization of edible oils, a small amount of *trans*-linoleic and *trans*-linolenic acid are produced.

A positive correlation between intake of a high amount of TFAs in a diet with increased risk of chronic diseases such as cardiovascular, inflammatory, autoimmune diseases, and cancer have been found. TFAs raise the amount of LDL cholesterol and lower the level of HDL cholesterol, thus resulting in doubly detrimental effects. New regulations on TFA labeling, which led to a ban on industrially produced trans fats in foods, caused a dramatic reduction in TFAs in food products, but they still can be found in some foods such as confectionery coatings and fillings, biscuits (cookies), pie crusts, toffees, and analogs of dairy products such as butter, cream, and toppings.

Using naturally saturated fats such as palm oil and/or applying fully hydrogenated oils or vegetable oils from new varieties such as high oleic oils could be solutions for food industries to substitute TFAs in their products.

Omega-3 Fatty Acids

The omega-3 fatty acids consist of α-linolenic acid, EPA, and DHA. Several clinical studies showed a positive correlation between consumption of omega-3 fatty acids in the diet and an improved prognosis of CVD and nonalcoholic fatty liver disease. The main sources of α-linolenic are flaxseed oil and walnut oil and oily fishes such as tuna, menhaden, anchovies, sardines, and mackerel are the main sources of EPA and DHA.

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