Trans fatty acids

Definition

Trans fatty acids are unsaturated fatty acids with at least one double bond in the *trans* configuration. Unsaturated fatty acids are derived metabolically from saturated fatty acids by the abstraction of pairs of hydrogen atoms from adjacent methylene groups. The removal of a pair of hydrogen atoms gives rise to a double bond. The remaining hydrogen atoms can either be on the same side of the fatty acid molecule, in which case the double bond has the *cis* geometrical configuration, or on opposite sides giving the *trans* configuration. *Trans* fatty acids occur naturally in a small amounts in a few foods, however, the majority are formed during the partial hydrogenation of vegetable oils. This process converts vegetable oils into semi-solid **fats** for use in margarines, commercial cooking, and manufacturing processes. There is strong evidence that the consumption of *trans* fatty acids from industrial sources increases the risk of **coronary heart disease** (CHD).

Purpose

Whereas the presence of a *cis* bond in a fatty acid molecule affects the linearity of the fatty acid chain, making it fold back on itself, a *trans* bond has minimal effect on the conformation of the chain, making its physical properties more closely resemble those of a saturated fatty acid. The molecules of a *trans* fatty acid are able to pack together more closely than those of a *cis* isomer and this is reflected in differences in melting points. The melting point of the saturated fatty acid stearic acid (chain length of 18 carbons) is 157.28°F (69.6°C), the melting point of oleic acid (chain length of 18 carbons with one *cis* bond) is 55.76°F (13.2°C), whereas the melting point of eladic acid, the *trans* isomer of oleic acid, is 111.2°F (44.0°C). For this reason, partially hydrogenated vegetable oils are used extensively by the food industry, as their high *trans* fatty acid content gives the oils a longer shelf life and an increased stability during deep-frying. Their semi-solidity can be customized to enhance the palatability of baked goods and sweets.

Description

Sources and consumption of trans fatty acids in the United States diet

The average consumption of industrially produced *trans* fatty acids in the United States is between 2 to 3% of total calories consumed. The major sources of *trans* fatty acids in the American diet are deep-fried foods, bakery products, packaged snack foods, margarines, and crackers. Naturally occurring *trans* fatty acids are found in meats and dairy products from cows, sheep, and other ruminant animals; they are produced in the forestomach of the animal where polyunsaturated fatty acids of plant origin, such as linoleic acid and linolenic acid, can undergo partial or complete hydrogenation by the action of symbiotic anaerobic bacteria present in the ruminant stomach. These naturally occurring *trans* fatty acids are consumed in much smaller amounts, approximately 0.5% of total energy intake.

Trans fatty acids

Food	g/Serving	g/100g	% of total fatty acids	% of daily energy intake for 2000 kcal diet
Breaded fish burger	5.6	3.4	28	2.5
Breaded chicken nuggets	5.0	4.9	25	2.3
French fries	4.7–6.1	4.2–5.8	28–36	2.1–2.3
Pie	3.9	3.1	28	1.8
Danish or sweet roll	3.3	4.7	25	1.5
Pancakes	3.1	2.0	21	1.4
French fries, frozen	2.8	2.5	30	1.3
Doughnuts	2.7	5.7	25	1.2
Crackers	2.1	7.1	34	0.9
Enchilada	2.1	1.1	12	0.9
Cookies	1.8	5.9	26	0.8
Cakes	1.7	2.7	16	0.8
Tortilla (corn) chips	1.6	5.8	22	0.7
Popcorn, microwave	1.2	3.0	11	0.5
Burrito	1.1	0.9	12	0.5
Pizza	1.1	0.5	9	0.5
Brownie	1.0	3.4	21	0.5
Granola bar	1.0	3.7	18	0.5
Hard (stick) margarine	0.9–2.5	6.2–16.8	15–23	0.4–1.1
Muffin	0.7	1.3	14	0.3
Breakfast bar	0.6	1.3	15	0.3
Tortillas	0.5	1.8	25	0.2
Soft (tub) margarine	0.3–1.4	1.9–10.2	5–14	0.1–0.6
Chocolate bar	0.2	0.6	2	0.1
Peanut butter	0.1	0.4	1	0.05

Typical fatty acid content of foods produced or prepared with partially hydrogenated vegetable oils in the United States. *(Illustration by GGS Information Services/Thomson Gale.)*

trans fatty acids from ruminant sources

The predominant *trans* isomer in ruminant animals is vaccenic acid, from which conjugated linolenic acid (CLA) can be formed. It is possible to change the *trans* fatty acid content of ruminant products by altering the animals' feed although levels of *trans* fatty acids in meat and milk are already relatively low, between 1 and 8% of total fat content. With respect to CLA, it is considered desirable to increase levels in foods rather than to

KEY TERMS

Atherosclerosis—The initial stage of CHD where excess cholesterol in the blood is deposited in the walls of arteries causing them to harden and narrow.

Conjugated linolenic acid—A fatty acid suggested to have health benefits.

HDL cholesterol—A carrier of cholesterol in the blood, high levels of which are associated with decrease risk of CHD.

Hydrogenation—The addition of hydrogen atoms to carbon double bonds to make them in to single bonds.

LDL cholesterol—A carrier of excess cholesterol in the blood, high levels of which are associated with increase risk of CHD.

Monounsaturated fatty acid—A fatty acid molecule with one double bonds, known to be beneficial to health when consumed in moderate amounts.

Polyunsaturated fatty acid—A fatty acid molecule with two or more double bonds, known to be beneficial to health when consumed in moderate amounts.

Saturated fatty acid—A fatty acid molecule with no double bonds, known to be detrimental to health when consumed in large amounts.

Tumor necrosis factor—A substance that is part of an inflammatory system and used as a marker to measure inflammation.

decrease levels. This is due to the suggested health benefits of CLA in humans, such as reduced insulin sensitivity and improved immune function, although the evidence remains inconclusive.

There is no association between intake of *trans* fatty acids from ruminant sources and risk of CHD and in fact some studies have shown non-significant trends towards an inverse association. The absence of an positive association of *trans* fatty acids from ruminant sources compared with from industrial sources may be due to lower levels of intake (less than 0.5% of total energy intake), different biological effects of different isomers, or the presence of other factors in meat and diary products that outweigh any effects of the small amount of *trans* fatty acids they contain. Further research in these areas is needed although it would seem that *trans* fatty acids from ruminant sources do not pose a threat to public health.

Precautions

The physiological effects of trans fatty acids from industrial sources

The main effects of *trans* fatty acids are on serum lipid levels. Numerous controlled dietary trials have been conducted to evaluate the effect of isocaloric replacement of saturated or *cis* unsaturated fatty acids with *trans* fatty acids. The data from many of these studies has been used in a number of large meta-analyses, all of which strongly indicate that compared with saturated or *cis* unsaturated fatty acids, the consumption of *trans* fatty acids raises levels of low density lipoprotein (LDL) cholesterol, reduces levels of high density lipoprotein (HDL) cholesterol and increases the ratio of total cholesterol to HDL cholesterol, all of which are powerful risk factors from CHD.

There is substantial evidence to show that *trans* fatty acids also promote systemic inflammation. In a large trial of women, greater intake of *trans* fatty acids was associated with increased activity of the tumour necrosis factor (TFN) system, a biomarker used to measure inflammation. Among those with a higher **body mass index** (BMI), a greater intake of *trans* fatty acids was also associated with other inflammatory substances. The presence of inflammation is an independent risk factor for atherosclerosis, sudden death from cardiac causes, **diabetes mellitus**, and heart failure. Thus the inflammatory effects of *trans* fatty acids contribute further to overall CHD risk.

The risk to health of consuming *trans* fatty acids from industrial sources has been recognized and acknowledged by the United States government. The Food and Drug Administration (FDA) made it compulsory from 2006, for nutrition labels for all conventional foods and supplements to indicate the content of *trans* fatty acids. In addition, the Department of Agriculture has made a limited intake of *trans* fatty acids a key recommendation of the new food pyramid guidelines, following the recommendations of the Dietary Guidelines Advisory Committee that intake of *trans* fatty acids should be less than 1% of total energy. Furthermore, action is being taken at local levels; the New York City Department of Health and Mental Hygiene has asked 20,000 restaurants and 14,000 food suppliers to eliminate partially hydrogenated oils from kitchens and to provide foods free from industrially produced *trans* fatty acids. Although the elimination of these *trans* fatty acids may be challenging, experience in other countries, such as Denmark, indicates that these fats can largely be replaced by *cis* unsaturated fats without increasing the cost or availability of foods.

Health care providers should advise consumers about how to minimize the intake of *trans* fatty acids, consumers should be able to recognize and avoid products containing *trans* fatty acids and restaurants and food manufacturers should use alternative fats in food production and preparation. These measures should ensure a reduction in *trans* fatty acid consumption and result in substantial health benefits particularly a reduction in the incidence of CHD.

Complications

Trans fatty acid intake and risk of disease

***TRANS* FATTY ACID INTAKE AND CHD.** On a per calorie basis, *trans* fatty acids increase the risk of CHD more than any other macronutrient, conferring a substantially increased risk even at low levels of consumption (between 1 to 3% of total energy intake). Even a small rise in energy intake from *trans* fatty acids can cause a large increase risk. A meta-analysis of four prospective cohort studies that included data from 140,000 subjects showed a 23% increase in CHD incidence when energy intake from *trans* fatty acids increased by just 2%. So dramatic is the impact of *trans* fatty acids on CHD risk, another study showed that the positive association between levels of *trans* fatty acids in adipose tissue (a biomarker for dietary intake) and CHD risk was diminished after 1996, when *trans* fatty acids where eliminated from margarines sold in Australia and the population's consumption levels decreased.

The potential benefits of reducing of reducing consumption of *trans* fatty acids from industrial sources on the incidence of CHD in the United States has been calculated. On the basis of predicted changes in total and HDL cholesterol, CHD events could be reduced by between 3 and 6 percent. If the influence of *trans* fatty acids on other risk factors such as inflammatory effects is considered, CHD events could be reduced by 10–19% (equivalent to between 72,000 and 228,000 CHD events each year). This reduction could be even greater, if healthier *cis* unsaturated fatty acids, including **omega-3 fatty acids**, are used to replace *trans* fatty acids.

***TRANS* FATTY ACID INTAKE AND DIABETES.** The association between risk of diabetes and *trans* fatty acid intake is less clear. Three prospective studies have investigated this relationship and in two of the studies, consumption of *trans* fatty acids was not significantly associated with increased risk of diabetes. However, in a study of nearly 85,000 female nurses a strong positive association was found. The nurses were followed for 16 years, information of dietary intake was periodically updated and self-reported diabetes was validated. The conclusions of no association in the first two studies may be explained by the relatively low intake in one cohort of male health professionals (average intake of 1.3% energy).

Parental concerns

Parents should eliminate all sources of *trans* fatty acids from industrial sources from their **children's diets** as these have no intrinsic health value above their energy value. Therefore their consumption is linked with considerable potential harm and no apparent benefit. As adverse effects are seen at even low levels of intake, between 1 and 3% of total energy (2–7g per day for a person consuming 2,000 calories), it seems complete or near complete avoidance of *trans* fatty acids should be advised in order to minimize health risks.

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ORGANIZATIONS

American Dietetic Association (ADA). 120 South Riverside Plaza, Suite 2000, Chicago, IL 60606-6995. Phone: (800) 877-1600. Website: http://www.eatright.org.

American Heart Association. National Center, 7272 Greenville Avenue, Dallas, TX 75231. Phone: 1-800-242-8721. Website: http://www.americanheart .org.

Centre for Science in Public Interest. 1875 Connecticut Ave. N.W. Suite 300, Washington, D.C. 20009. Phone: (202) 332-9110. Website: http://www.cspinet.org.

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Traveler's diarrhea

Definition

Traveler's diarrhea is an increase in loose, watery stools that often occurs when travelers from industrialized countries travel to developing or underdeveloped countries. Traveler's diarrhea has many nicknames such as Montezuma's revenge, Tut's tummy, or tourista.

Description

Traveler's diarrhea is a common disease. It is a form of **food poisoning** caused by consuming **water** or food contaminated with bacteria, viruses, or parasites that attack the digestive system. Normally the disease is mild and does not require professional medical care, but it can alter the plans of travelers' and make them quite miserable for a few days.

Every year, more than 60 million people travel from industrialized countries to developing or underdeveloped countries. Of these, as many has half (estimates range from 20–55%, with most near the higher end) will develop traveler's diarrhea. Other estimates suggest that 50,000 cases of traveler's diarrhea occur each day. The likelihood of getting traveler's diarrhea depends primarily on the traveler's destination. The World Health Organization (WHO) has designated countries as either high, moderate, or low risk for traveler's diarrhea based on their degree of hygiene and public sanitation. Only traveler's, not natives, tend to be affected in high and moderate risk countries. People living in those countries are exposed to the organisms that cause traveler's diarrhea from childhood and their bodies develop ways to combat or tolerate them.

Destinations designated as high risk destinations where there is more than a 50% chance of getting traveler's diarrhea include:

- Mexico
- all of Latin America
- northern and central South America, including Brazil, Venezuela, Colombia, Bolivia, Guyana, and Surinam
- Most of Africa except South Africa
- Most of the Middle East, including Saudi Arabia, Turkey, Iran, and Iraq
- Most of Asia, excluding the former Russian republics, but including China, India, Thailand, Bangladesh, Viet Nam, Korea, Malaysia, and the Pacific Islands north of Australia

Intermediate risk destinations include:

- the countries of Eastern and Southern Europe such as Poland, Romania, Croatia, the Czech Republic, Portugal, Greece, and the Balkan countries
- most islands of the Caribbean
- Argentina
- South Africa
- Israel

Low risk countries are industrialized countries that have in place reliable systems for treating sewage and drinking water. These include: