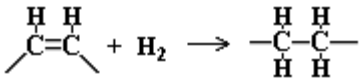
What is Hydrogenation and Partial Hydrogenation?

Unsaturated fats exposed to air oxidize to create compounds that have rancid, stale, or unpleasant odors or flavors. Hydrogenation is a commercial chemical process to add more hydrogen to natural unsaturated fats to decrease the number of double bonds and retard or eliminate the potential for rancidity. Unsaturated oils, such as soybean oil, which contain unsaturated fatty acids like oleic and linoleic acid, are heated with metal catalysts in the presence of pressurized hydrogen gas. Hydrogen is incorporated into the fatty acid molecules and they become saturated with hydrogen. Oleic acid (C18:1) and linoleic acid (C18:2) are both converted to stearic acid (C18:0) when fully saturated. The liquid vegetable oil becomes a solid saturated fat (shortening with a large percentage of tristearin). By comparison, animal fats seldom have more than 70% saturated fatty acid radicals. **Lard**, for example, has 54% unsaturated fatty acid radicals.



Hydrogenation Process

Trans Fats in Foods

Metabolism of natural 20-carbon polyunsaturated fatty acids like arachidonic acid results in the biosynthesis of mediators with potent physiological effects such as prostaglandins, prostacyclins, thromboxanes, leukotrienes, and lipoxins. These substances are known collectively as *eicosanoids* because they contain 20 carbon atoms (Greek *eikosi* = 20). However, polyunsaturated *trans* fatty acids cannot be used to produce useful mediators because the molecules have unnatural shapes that are not recognized by enzymes such as cyclooxygenase and lipoxygenase.[21,22] Although low levels of *trans*-vaccenic acid occur naturally in some animal food products, partially hydrogenated oils contain a large proportion of diverse *trans* fatty acids. *Trans* fatty acids that are incorporated into the cell membranes create denser membranes that alter the normal functions of the cell.[20]

Effect of *trans* fats on the heart. Dietary *trans* fats raise the level of low-density lipoproteins (LDL or "bad cholesterol") increasing the risk of coronary heart disease. *Trans* fats also reduce high-density lipoproteins (HDL or "good cholesterol"), and raise levels of triglycerides in the blood. Both of these conditions are associated with insulin resistance which is linked to diabetes, hypertension, and cardiovascular disease. Researchers have reported that **people who ate partially hydrogenated oils, which are high in *Trans* fats, worsened their blood lipid profiles and had nearly twice the risk of heart attacks compared with those who did not consume hydrogenated oils**.[1,2,3,4] Because of the overwhelming scientific evidence linking *trans* fats to cardiovascular diseases, the Food and Drug Administration started requiring all food labels to disclose the amount of *trans* fat per serving in 2006.

Effect of *trans* fats on the brain. *Trans* fats also have a detrimental effect on the brain and nervous system. Neural tissue consists mainly of lipids and fats. Myelin, the protective sheath that covers communicating neurons, is composed of 30% protein and 70% fat. Oleic acid and DHA are two of the principal fatty acids in

myelin. Studies show that *trans* fatty acids in the diet get incorporated into brain cell membranes, including the myelin sheath that insulates neurons.[10] These synthetic fats replace the natural DHA in the membrane, which affects the electrical activity of the neuron. *Trans* fatty acid molecules alter the ability of neurons to communicate and may cause neural degeneration and diminished mental performance. Neurodegenerative disorders such as multiple sclerosis (MS), Parkinson's Disease, and Alzheimer's Disease appear to exhibit membrane loss of fatty acids.[12,19] Unfortunately, our ingestion of *trans* fatty acids starts in infancy. A Canadian study showed that an average of 7.2% of the total fatty acids of human breast milk consisted of *trans* fatty acids which originated from the consumption by the mothers of partially hydrogenated vegetable oils.[11]

The Politics of Fats

The production of edible fats is a large commercial enterprise worth millions of Dollars that involves many segments of our society, including farmers who cultivate oil-bearing plants, ranchers and fishermen who provide sources of animal fats, and a variety of industries that extract, process, store, and distribute the resulting fats and oils. There is a constant tug-of-war between manufacturers, consumers, special interest groups, and government regulatory agencies, each trying to advance their own agenda. Fats and sugars have been blamed for the epidemic increase of obesity during the last thirty years, and well-intentioned government agencies and public advocacy groups have influenced official policy decisions, but not always based on a sound scientific foundation because it takes many years to determine the health consequences of specific products or policies. Many times, policies are enacted for political reasons to benefit farmers and manufacturers at the expense of public health.

Hydrogenated fats

By now, it is a well-established fact that *trans* fats are harmful and are responsible for causing thousands of deaths per year from cardiovascular diseases, but hydrogenated fats continue to be added to so many food products that it almost impossible to avoid them. Frequently, even **lard** is hydrogenated! Why aren't these products banned? Because manufacturers with a lot of political influence don't want to lose money on products that might turn rancid before they are sold. Fast modern distribution methods, good packaging, and controlled temperature storage could solve this problem and deliver healthier products to the consumers, but it would increase costs. One of the latest trends used by manufacturers is to avoid the word "hydrogenated" and to obtain oils from foreign sources where our regulations do not apply. Some products use "Modified Palm Oil" without mentioning the process used to modify the oil. The modification could be a simple fractionation to separate high-melting from low-melting triglycerides, but it could involve hydrogenation.

The Fat Free Craze

The concept that some fats are essential for good health is just emerging in the awareness of the general public, but the aversion to fat resulting from many years of indoctrination against fat has resulted in great consumer demand for low-fat or nonfat products. Some manufacturers, eager to increase their sales, concoct products that use monoglycerides, diglycerides, or fatty acid esters of polyglycerol, and argue that these products are "Fat Free" because only triglycerides are fats. Average consumers eat these products under the illusion that they are low in calories because the manufacturers do not disclose the calories of these components in the

Nutrition Facts. In addition, most products containing monoglycerides, diglycerides, or artificial fats do not state whether the constituent fatty acids are saturated or hydrogenated. New regulations are often adopted as a reaction to abuses like this, but it is a slow process that may be further delayed by lobbying and enables manufacturers to continue reaping profits in the meantime.

Saturated Fats
For many years, saturated fats were equated with the "artery clogging" deleterious health effects associated with *trans* fats. Many authoritative medical sources advise decreasing the consumption of saturated fats because there is a relationship between serum total cholesterol concentrations and saturated fatty acid intake. However, several scientific studies indicate that saturated fats have beneficial biological effects and differ significantly from *trans* fats which are always bad. It is worthwhile noting that **the butterfat in human milk has 20% more saturated fats than lard**. Saturated fatty acids, particularly medium chain fatty acids such as lauric and capric acids, have been found to play an important role in supporting the immune system. Studies of the effects of specific fatty acids on serum cholesterol levels have shown that of the three most common saturated fatty acids in tallow and lard, only myristic acid increases the level of cholesterol in the blood substantially, whereas stearic acid has no effect, and the polyunsaturated linoleic acid decreases it. The quantitative relationship expressed by the Hegsted equation suggests that blood cholesterol levels may be lowered naturally by adding to our diet sources of polyunsaturated fatty acids such as safflower, sunflower, or grape seed oils.

Our knowledge of the metabolism of fats continues to increase and it will take many years of research and expensive long-term studies to establish objective facts to clarify the conflicting statements from government agencies, short-term studies, advocacy groups, commercial interests, and the latest diet fads. If you are confused about what fats to eat because of the barrage of advertisements, inflammatory language, and misinformation, here is some simple advice**:** consume unaltered natural oils and fats that have been used traditionally for hundreds or thousands of years, and avoid oils that have been chemically modified or created in a laboratory. If your weight is in the normal range, animal fats such as lard can be used to meet a portion of your caloric needs, as long as the lard originates from organically raised animals and it is not hydrogenated. Many pesticides used in farms concentrate in fatty tissues and can result in high pesticide residues in fat from animals that are not raised organically.

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    The Hegsted Equation:
    $\Delta TC = + 8.45\ \Delta C14{:}0 + 2.12\ \Delta C16{:}0 - 1.87\ \Delta Poly + 5.64\ \Delta DietaryCholesterol - 6.24$
    Where ΔTC is in mg/dL. $\Delta C14{:}0$, $\Delta C16{:}0$, and $\Delta Poly$ are in %kcal.
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