

Transfats in the Biological System

Dr. Anil Batta*

Head, Dept. of Medical Biochemistry, Govt. Medical College, Amritsar

Review Article

*Corresponding author

Dr. Anil Batta

Article History

Received: 12.10.2018

Accepted: 22.10.2018

Published: 30.10.2018



Abstract: Some meat and dairy products contain small amounts of naturally occurring trans fat. But most trans fat is formed through an industrial process that adds hydrogen to vegetable oil, which causes the oil to become solid at room temperature. This partially hydrogenated oil is less likely to spoil, so foods made with it have a longer shelf life. Some restaurants use partially hydrogenated vegetable oil in their deep fryers, because it doesn't have to be changed as often as do other oils. High intakes of industrial trans fatty acids (iTFA) increase circulating low density lipoprotein cholesterol (LDL-C) levels, which has implicated iTFA in coronary heart disease (CHD) risk. Published data on iTFA and LDL-C, however, represent higher intake levels than the U.S. population currently consume. Number of studies is under process. Findings indicated that a wide range of oils and interventions were used, limiting the ability to determine an isolated effect of iTFA intake. Further, it appears that few dose-response data points are available to assess the relationship of low levels of iTFA, particularly from PHO exposure, and LDL-C. Therefore, limited evidence is available to determine the effect of iTFA at current consumption levels on CHD risk.

Keywords: iTFA, LDC, Fatty acids, Industrial waste CHD, Transfats, oils.

INTRODUCTION

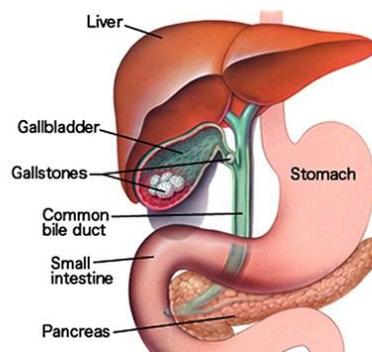
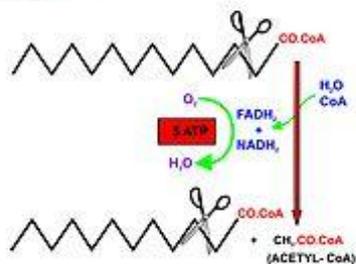
Trans fat in your food

The manufactured form of trans fat, known as partially hydrogenated oil, is found in a variety of food products, including:

Saturated fat raises your total cholesterol. In a healthy diet, 20 to 35 percent of your total daily calories can come from fat — but saturated fat should account for less than 10 percent of your total daily calories. Monounsaturated fat — found in olive, peanut and canola oils — is a healthier option than is saturated fat. Nuts, fish and other foods containing unsaturated omega-3 fatty acids are other good choices of foods with healthy fats. All food products that contain trans-fatty acids will have to be labeled on the nutritional panel of packaging labels by January 2006. Consuming foods rich in saturated fats and trans-fatty acids are known to raise blood cholesterol and triglycerides, while diets high in unsaturated and polyunsaturated fatty acids do not. When liquid vegetable oils undergo hydrogenation, trans-fatty acids are formed. Because hydrogenated fat is solid at room temperature and has a longer shelf life, it is preferred by food processors. However, considerable evidence suggests that trans-fatty acids raise LDL cholesterol, which can lead to logging of arteries and heart attack. There exists a

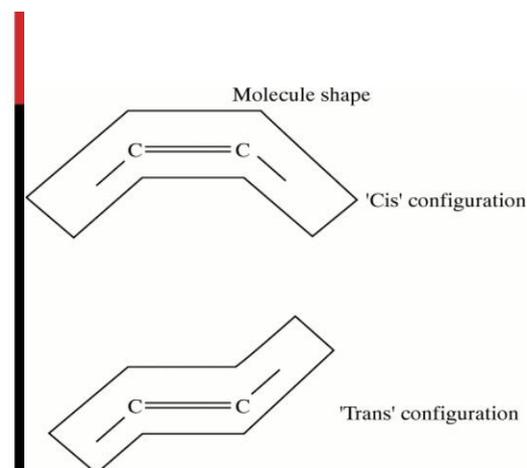
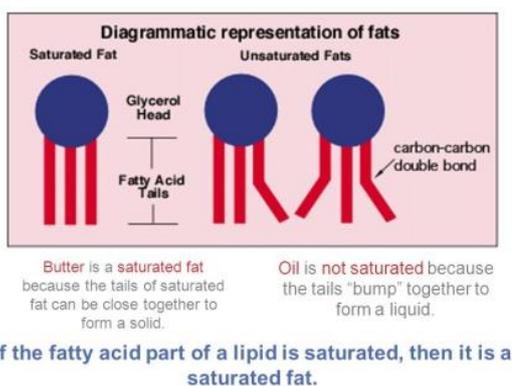
dilemma on the mechanism by which trans-fatty acids raise cholesterol. A recent study by Harvard scientists in the journal *Cell* sheds light on this issue. The findings suggest that the harmful effects of saturated and trans-fatty acids are set in motion by a biochemical switch by liver cells called PGC-1beta. When activated by trans-fatty acids, this switch sets a cascade of biochemical signals leading to an upsurge in liver's production of very low density lipoprotein (VLDL) cholesterol the precursors of LDL. By providing evidence of a mechanism through which dietary saturated fats can stimulate hyperlipidaemia and atherogenesis, these findings could also open up opportunities for food scientists working on technologies to remove trans-fatty acids from food formulations. Eating too much fat can cause health problems. But even in moderation, some fats are healthier than others. Now studies suggest that synthetic trans fats — a type made by adding extra hydrogen atoms to the chain-like molecules of vegetable oil — can act like a dietary villain.

β-OXIDATION OF FATTY ACIDS



Doctors once thought trans fats might be better for health than those found in meats and *dairy*. And because trans fats are cheap, food companies were eager to substitute them in foods. But over time, scientists slowly began to realize that artificial trans fats were no healthier than butter or other animal fats. Indeed, they might actually be worse for health. Now, the U.S. Food and Drug Administration — which helps to regulate the foods that go on our grocery store

shelves — has declared that trans fats are not “generally recognized as safe,” or GRAS. This means food companies now have less than two years to get rid of them for good. This series of events might seem like a failure of science. But the rise and fall of trans fats is actually an example of the scientific process at work. Science can yield new and seemingly useful inventions, such as trans fats. But sometimes those things may have unintended side effects.



DISCUSSION

Before 1910, people in the United States used butter and animal fats almost exclusively for cooking and baking. These were rich in saturated fatty acids, which are defined chemically as fat molecules with no double bonds between carbon atoms of the hydrocarbon chain. Saturated fats are solids at room temperature. In contrast, most vegetable oils such as corn, soybean, and canola/rapeseed oils are liquids at room temperature and contain primarily unsaturated fats, either monounsaturated (one double bond in the hydrocarbon chain) or polyunsaturated (multiple double bonds). In 1910, cooking with vegetable oils was virtually unheard of—oils were instead used to make soaps, candles, lubricants, and other nonedible products. But then a dramatic change occurred. As the process of hulling and pressing seeds and beans was mechanized, vegetable oils became cheaper than raising and slaughtering animals for butter or animal fat. Aggressive marketing by vegetable oil companies claimed that vegetable oils

were a more healthful, easier-to-digest, and more sanitary alternative to animal fats. In 1911, Proctor & Gamble applied for a US patent for the process of hydrogenating vegetable oil; in other words, adding hydrogen molecules to remove some of the double bonds in unsaturated fatty acids. This process enabled the production of solid vegetable oils such as Crisco shortening and margarine, increasing the shelf lives of oils and paving the way for their use in baking and frying. From 1909–1999, consumption of soybean oil in the United States increased by more than 1,000-fold per person and margarine consumption increased 12-fold, whereas consumption of butter and lard decreased by about four-fold each [1]. These changes in consumption are depicted in Fig. 1. Before 1910, people in the United States used butter and animal fats almost exclusively for cooking and baking. These were rich in saturated fatty acids, which are defined chemically as fat molecules with no double bonds between carbon atoms of the hydrocarbon chain. Saturated fats are

solids at room temperature. In contrast, most vegetable oils such as corn, soybean, and canola/rapeseed oils are liquids at room temperature and contain primarily unsaturated fats, either monounsaturated (one double bond in the hydrocarbon chain) or polyunsaturated (multiple double bonds). In 1910, cooking with vegetable oils was virtually unheard of—oils were instead used to make soaps, candles, lubricants, and other nonedible products. But then a dramatic change occurred. As the process of hulling and pressing seeds and beans was mechanized, vegetable oils became cheaper than raising and slaughtering animals for butter or animal fat. Aggressive marketing by vegetable oil companies claimed that vegetable oils were a more healthful, easier-to-digest, and more sanitary alternative to animal fats. In 1911, Proctor & Gamble applied for a US patent for the process of hydrogenating vegetable oil; in other words, adding hydrogen molecules to remove some of the double bonds in unsaturated fatty acids. This process enabled the production of solid vegetable oils such as Crisco shortening and margarine, increasing the shelf lives of oils and paving the way for their use in baking and frying. From 1909–1999, consumption of soybean oil in the United States increased by more than 1,000-fold per person and margarine consumption increased 12-fold, whereas consumption of butter and lard decreased by about four-fold each [1]. These changes in consumption are depicted in Fig. 1. Another major dietary change that has taken place in the past 50 years is the substitution of fats in the diet with carbohydrates such as pasta, grains, sugar, fruit, and starchy vegetables. Another major dietary change that has taken place in the past 50 years is the substitution of fats in the diet with carbohydrates such as pasta, grains, sugar, fruit, and starchy vegetables. Cholesterol and other fats are transported in the bloodstream by different lipoprotein complexes. Low-density lipoproteins (LDL), or “bad cholesterol,” can contribute to plaques in the arteries, increasing the risk for cardiovascular disease. However, high-density lipoproteins (HDL), or “good cholesterol,” have the opposite effect: They transport cholesterol away from artery walls, reducing the risk of heart disease. The propensity of saturated fat in the diet to raise LDL cholesterol is what nutrition researchers have found so worrisome. In contrast, mono- and polyunsaturated fats tend to lower LDL cholesterol, which is why the *Dietary Guidelines* recommend replacing saturated fats in the diet with unsaturated fats. However, saturated fats also raise HDL cholesterol more than any other type of fat, possibly mitigating the harmful effects of LDL cholesterol. Trans fats, the intended replacement for saturated fats, raise LDL cholesterol even more than saturated fats, while lowering HDL cholesterol levels. Total cholesterol levels in the blood do not always correlate well with a person’s risk for heart disease risk because the measurement includes both LDL and HDL cholesterol. A more sensitive and

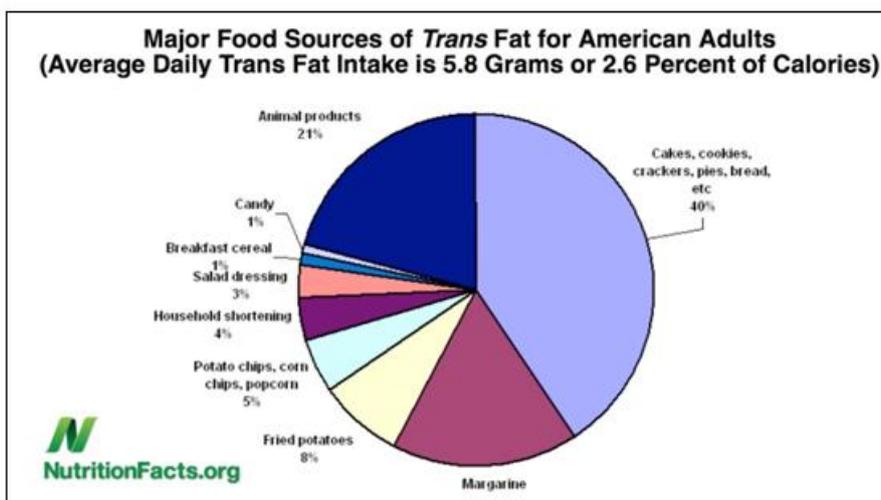
specific predictor is the ratio of total cholesterol to HDL cholesterol (total: HDL) [2]. Mono- and polyunsaturated fats lower total: HDL cholesterol, suggesting that they reduce the risk of heart disease. In contrast, trans fats increase the ratio, presumably increasing the risk of heart disease. However, because of their effects on both types of cholesterol particles, saturated fats neither raise nor lower total: HDL cholesterol [3], suggesting little or no effect on cardiovascular disease risk. More recently, researchers led by Rajiv Chowdhury at the University of Cambridge, in the UK, performed a meta-analysis of 32 observational studies that examined people’s intake of different types of fat and their risk of heart disease (<http://dx.doi.org/10.7326/M13-1788>, 2014). Because study participants sometimes misreport what they eat, the researchers also analyzed 17 studies that actually measured fatty acids circulating in people’s blood as an indication of their diet. In addition, Chowdhury and his colleagues found no significant associations between dietary, circulating, or supplementary fatty acids and heart disease risk, with the exception of dietary trans fats, which slightly increased risk in the five studies analyzed. “Current evidence does not clearly support guidelines that encourage high consumption of polyunsaturated fatty acids and low consumption of total saturated fats,” the authors conclude.

Time for a change

With an updated version of the *Dietary Guidelines for Americans* set to be released in the third quarter of 2015, some researchers were hopeful that, given new evidence over the past five years, saturated fat would be at least partially exonerated. However, the Scientific Report of the 2015 Dietary Guidelines Advisory Committee continues to identify saturated fat as a “nutrient of concern for overconsumption” that should be limited to less than 10% of total calories. Although the federal government will have the final say on the *Dietary Guidelines*, it is unlikely that the guidelines will diverge significantly from the scientific report of the committee. Krauss considers it a good sign that the Dietary Guidelines Advisory Committee hasn’t recommended cutting saturated fat even further, down to the Draconian 5–6% of total calories suggested by the American Heart Association. “Ten percent is a reasonable amount of saturated fat,” he says. “But rather than the notion that people should be fanatically adding up the saturated fats in their diet and figuring out how much they should be eating, people should be more concerned about their overall dietary pattern and the types of foods they choose.” He notes that the type of food in which the saturated fat is contained, or the “food matrix,” may influence heart disease risk. For example, some studies suggest that fermented dairy products such as cheese—often avoided because of its high saturated fat content—may contain specific saturated fatty acids that, in the context of other

components in the cheese, may actually lower the risk of heart disease and type 2 diabetes. With regard to food choices, Krauss was dismayed when press coverage of his 2010 meta-analysis tended toward sensational headlines proclaiming it's okay to load up on sticks of butter and triple burgers with cheese. "That's not the message," says Krauss. "The message is to make food choices that are balanced in the overall diet and not to consider any given food the salvation of health or the kiss of death." Teicholz believes that, in light of recent evidence, the *Dietary Guidelines* should ditch limits on saturated fat, but she thinks that change is unlikely to occur. "We're in the third generation of scientists who believe fat, and especially saturated fat, is bad for health," she says. "The bias is deeply entrenched, and it's very hard to reverse that." They're recommending an essentially meatless diet for all Americans, and that's based primarily on this saturated fat concept," she says. Not only is a vegetarian diet impractical for many, but Teicholz worries that people will get the erroneous message that it's more healthful to replace meats with carbohydrates such as rice, pasta, or bread. Although polyunsaturated fats do lower LDL

cholesterol and total: HDL cholesterol, their double bonds make them more prone to oxidation than saturated fats, especially when heated during food preparation. Aldehydes produced from polyunsaturated fats can react with DNA, proteins, and lipids in the body, possibly interfering with their functions [4]. Some studies suggest that omega-6 polyunsaturated fatty acids, contained in many vegetable oils, increase inflammation and even promote diseases such as cancer, cardiovascular disease, and type 2 diabetes [5]. In a promising sign that the Dietary Guidelines Advisory Committee is, in some instances, willing to change its course, the 2015 Committee recommended withdrawing its longstanding warnings about dietary cholesterol. This reversal comes after years of studies showing that eating foods rich in cholesterol, like eggs, doesn't actually raise cholesterol levels in the blood or contribute to heart disease. Perhaps in 2020 saturated fat will join cholesterol in exoneration, but the pervasive messages that these dietary components are bad for health will likely take decades to erase in the minds of nutritionists and the general public alike.



Sidebar

Saturated and trans fat alternatives

The fact that dietary guidelines in many countries continue to vilify saturated fats, along with more recent warnings about trans fats, has put many food manufacturers between a rock and a hard place. "Partially hydrogenated vegetable oils were meant to replace saturated fats," says Nina Teicholz, author of *The New York Times* bestselling book *The Big Fat Surprise: Why Butter, Meat & Cheese Belong in a Healthy Diet*. "Now, because of the trans fat scare, the food industry can't use partially hydrogenated vegetable oils, which the FDA is on the verge of banning anyway, and they can't use saturated fats because people are so afraid of them." Solid fats are particularly needed in the bakery industry. "In bakery products, fat plays several roles beyond just flavor and succulence," says Charles

Speirs, baking science and technology manager at Campden BRI, a membership-based food and beverage research facility with headquarters in Gloucestershire, UK. "For example, in cakes you need saturated fats to help sustain the bubble structure that you get during rising and baking." Speirs says that liquid vegetable oils do not have the same functional properties and therefore cannot replace saturated fats in products such as cakes, cookies, and pastries.

Dietary fat and cancer

The evolution in scientific thinking about dietary fat and cancer has followed a similar narrative to that of dietary fat and heart disease. The diet-cancer connection was a corollary to the diet-heart hypothesis pushed by Ancel Keys and others from the early 1950s forward. In fact, a report in 1982 by the National

Research Council (NRC) suggested the evidence supporting the association of dietary fat with cancer was so irrefutable that the report likened those researchers who remained skeptical with “certain interested parties [who] formerly argued that the association between lung cancer and smoking was not causal.”

CONCLUSION

Establishing a legal limit for the content of trans-fats in all foods is likely to be the most effective option for decreasing population means intake of artificial trans fats and potentially the only option available that reduces the risks associated with trans fats faced by all consumers. Mandatory labeling and voluntary reformulation may not achieve full market coverage, with unpackaged foods and products produced/used by small and medium enterprises possibly continuing to contain trans fats. Further, mandatory labeling is to a large extent reliant on nutritional literacy (regarding the health risks of trans fat), which could disadvantage low socioeconomic groups and may contribute to widening inequalities. Thus, a legal limit can help to avoid a situation where pockets of the population continue to consume foods or combinations of foods that result in an overall diet containing very high levels of trans fat; based on the previous evidence reviewed this could be the case for low-income groups, ethnic minorities, adolescents and young adults, and groups frequently purchasing from some fast-food outlets. Mandatory labeling and voluntary reformulation may exacerbate existing inequalities in consumption; further research on socioeconomic inequalities in trans fat consumption would be valuable. However, a legal limit appears as the option with the most potential to bring about decreases in the availability of trans fats, consumption and the disease burden attributable to trans-fat consumption in those European countries where average intakes are already low. Furthermore, voluntary reformulation might not work in some settings and, for some countries; imported products with a high content of trans fat might counteract such an initiative. Other advantages of a policy limiting trans-fat content in food include low implementation and monitoring costs, as

well as low cost to industry. Apart from the possibility of being met with criticism by the food industry, it is unlikely that legally limiting trans-fat content in food would have any major negative consequences for the industry or consumers, and doing so may contribute to reducing inequalities. Such a policy is unique in its combination of efficacy, cost-effectiveness and low potential for negative impact. Removing trans fats from the food supply is possibly one of the most straightforward public health interventions for reducing CVD risk and improving nutritional quality of diets. The experiences of countries in both Europe and North America support these conclusions and show that any unexpected consequences of this type of policy are unlikely.

REFERENCES

1. Blasbalg, T. L., Hibbeln, J. R., Ramsden, C. E., Majchrzak, S. F., & Rawlings, R. R. (2011). Changes in consumption of omega-3 and omega-6 fatty acids in the United States during the 20th century-. *The American journal of clinical nutrition*, 93(5), 950-962.
2. Kinosian, B., Glick, H., Preiss, L., & Puder, K. L. (1995). Cholesterol and coronary heart disease: predicting risks in men by changes in levels and ratios. *Journal of investigative medicine: the official publication of the American Federation for Clinical Research*, 43(5), 443-450.
3. Mensink, R. P., Zock, P. L., Kester, A. D., & Katan, M. B. (2003). Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials. *The American journal of clinical nutrition*, 77(5), 1146-1155.
4. Grootveld, M., Ruiz-Rodado, V., & Silwood, C. (2014). Detection, monitoring and deleterious health effects of lipid oxidation products generated in culinary oils during thermal stressing episodes.
5. Lawrence, G. D. (2013). Dietary fats and health: dietary recommendations in the context of scientific evidence. *Advances in nutrition*, 4(3), 294-302.