Trans Fatty Acids

Sources and Physiological Functions

Trans fatty acids (TFA) are unsaturated fatty acids (FA) with at least one double-bond in the trans-configuration. Their *trans*-configuration makes them physiochemically more similar to saturated fatty acids than to regular unsaturated fatty acids with the double bond in the *cis* configuration (Katan 1995; Koletzko & Decsi 1997; Teegala 2009). The human body does not endogenously synthesize TFAs (Sommerfeld 1983; Tvrzicka 2011), so TFAs in the human body are derived from dietary sources.

Naturally occurring TFAs are formed via the biohydrogenation or isomerization of cis-unsaturated fatty acids. The formation is facilitated by bacteria in the rumen of ruminant animals such as cows and sheep. Such TFAs are found in products such as beef, milk, butter, and cheese (Brouwer 2010; Kuhnt 2011). Industrially produced TFAs are formed via partial hydrogenation of oils, a process that converts polyunsaturated fatty acids into less unsaturated fatty acids. As by-products, cis-bonds in vegetable oils are converted to trans-bonds, which results in a melting point between that of saturated and cis-unsaturated fatty acids. Partially hydrogenated oils (PHOs) have been used in the manufacture of shortenings such as margarine. These shortenings are mainly used for making pastries and other baked goods (Brouwer 2010).

There are many different TFAs reported in PHOs and ruminant fat. The same trans isomers can be found in both natural and industrially produced fats. However, the proportions of each isomer from either source varies. A major naturally occurring TFA is vaccenic acid (C18:1n-7t) (Kraft 2003). In PHOs, the predominant isomer is elaidic acid (Gebauer 2007; Kuhnt 2011).

Health Effects

High TFA intake is associated with an increase in total cholesterol and LDL-cholesterol ("bad cholesterol"). High intake is also associated with a decrease in HDL-cholesterol ("good cholesterol"), which leads to an increased risk of cardiovascular disease (CVD) (Brouwer 2010; Mensink and Katan 1990). A small increase in TFA intake can lead to large negative health effects. For example, a meta-analysis of about 140,000 subjects from four prospective studies found a 2% increase in daily energy intake from TFAs was associated with a 23% higher risk of coronary heart disease (Mozaffarian 2006). TFAs reduce the particle size of LDL-cholesterol, increase levels of Lp(a) lipoprotein, and increase triglycerides levels in blood (Mozaffarian 2006). Moreover, high TFA

intake was found to promote inflammation (Mozaffarian 2004) and insulin resistance (Riserus 2009). High plasma TFA concentrations have also been associated with increased risk of metabolic syndrome (Zhang 2017). Epidemiological data suggests that there is no threshold below which the association between TFA concentration and lipid profiles may become undetectable (Yang 2017; Zhang 2017).

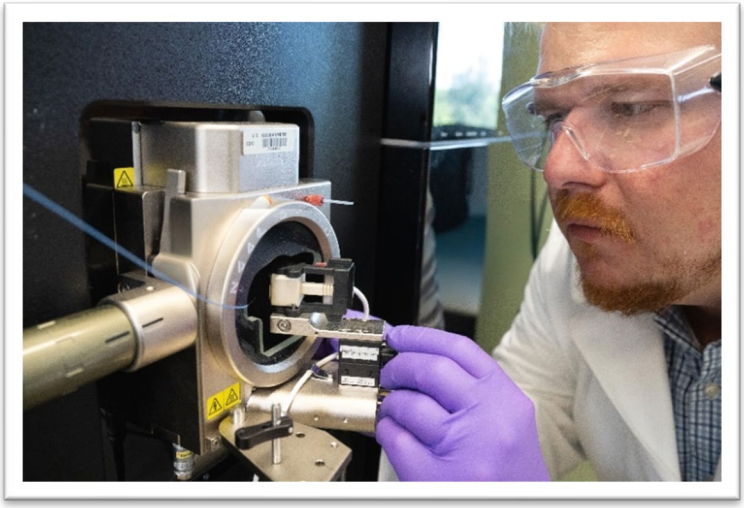
Intake Recommendations

In 2003, the U.S. Food and Drug Administration (FDA) ruled that TFAs must be declared on nutrition labels. In 2015, the FDA determined that partially hydrogenated oils (PHOs), the major dietary source of TFAs, were no longer "generally recognized as safe" to be used in food production. As of June 2018, PHOs are no longer used in food production (U.S. Food and Drug Administration 2024). Because of the negative health effects of TFA consumption, the Institute of Medicine (2006), The American Heart Association (Lichtenstein 2006), and the World Health Organization (WHO 2023) all recommend limiting TFA intake while consuming a nutritionally adequate diet. In 2023, the FDA issued a direct final rule to remove outdated references to PHOs in various regulations (U.S. Food and Drug Administration 2023). Eliminating industrially produced TFAs from the global food supply by 2025 is a WHO flagship priority (WHO 2024).

Biochemical Indicators

Changes in TFA intake or blood levels before and after policy implementation can be used to assess the impact of public health initiatives. Such changes can be measured using food intake survey data along with data from food samples, or by measuring TFAs in blood. Since the human body does not synthesize TFAs, it is assumed that TFAs in blood are derived from diet. Measurements in blood can provide reliable information on the impact of policies. There are over 30 different TFAs reported in blood and no single one is a specific biomarker for PHO or ruminant fat. Given that public health efforts aim to reduce overall TFA intake, selected TFAs can be used to obtain information about the magnitude of change in overall intake as a result of policy implementation.

Analytical Methods



The CDC method for TFA analysis in blood was developed to measure four select TFAs: palmitelaidic acid, vaccenic acid, elaidic acid, and linoelaidic acid. The primary goal of analysis is to assess the impact of policies to reduce TFA in the food supply. These four TFAs were commonly reported to occur in blood and represented 40–60% of total TFA in these reports (Gebauer 2007). This laboratory method has also been adopted by WHO and made publicly available for global use (https://www.who.int/teams/nutrition-and-food-safety/replace-trans-fat/trans-fat-laboratory-analysis). The method has been optimized to measure the four TFAs with high specificity and sensitivity in plasma or serum using small volumes (Kuiper 2018). It employs gas chromatography for chromatographic separation and mass spectrometry for detection. A high level of specificity is achieved using a 200-m column to separate the geometric isomers with high resolution. Mass spectrometry allows for accurate identification of TFAs by the mass/charge ratio. Additionally, compound-specific stable isotope labelled internal standards are used for accurate quantitation. Since TFAs are present at low concentrations in blood, this method employs negative chemical ionization, which keeps the TFAs intact and allows for sensitive detection.

Common Name	Chemical Name
Palmitelaidic acid	*trans*-9-hexadecenoic acid
Vaccenic acid	trans-11-octadecenoic acid
Elaidic acid	trans-9-octadecenoic acid
Linoelaidic acid	trans-9, trans-12-octadienoic acid

Findings from NHANES

The National Health and Nutrition Examination Survey (NHANES) is the only source for nationally representative data on plasma TFA for the U.S. population (Pfeiffer 2026). Food consumption data from NHANES 2009–2010 suggest the following foods are the main dietary source of TFA in the United States: cream substitutes, cakes, cookies, pastries, pies, milk and milk desserts, beef/veal, lamb/goat, venison/deer, and butters (Li 2021). The FDA used intake survey and food data to estimate changes in TFA intake between 2003 and 2010 (U.S. Food and Drug Administration 2013). The estimated changes from 2003–2010 were similar to the changes observed for four TFA measured in blood in the NHANES surveys from 1999–2000 and 2009–2010 (Vesper 2017).

Data in the 2026 tables

Data presented are from univariate analysis that was not adjusted for demographic variables (e.g., age, sex, race and Hispanic origin) or other blood concentration determinants (e.g., dietary intake, supplement use, smoking, BMI). Data for four select plasma TFAs (palmitelaidic acid, vaccenic acid, elaidic acid, and linoelaidic acid) and their sum were available for different population subgroups sampled in two NHANES cycles. Biomarker data were generated by use of a GC-MS method optimized for high specificity and sensitivity to allow the use of small volumes of plasma or serum (Kuiper 2018).

NHANES cycle	Population subgroup
1999–2000	Persons ≥6 years of age (fasting for persons ≥12 years of age)
2009–2010	Persons ≥3 years of age (fasting for persons ≥12 years of age)

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