Objectives of this issue

New research findings emphasize the clinical importance of specific dietary lipids in human health and disease. Reports in this issue consider the significance of *trans* fatty acid isomers in margarine, low-fat diets, and dietary antioxidants in cardiovascular disease, fish-oil supplements in diabetic patients, and the present status of fat substitutes.

Do Margarines Increase Cardiovascular Risk?

Edward A. Emken PhD • Lead Scientist, Food Quality and Safety Research • National Center for Agricultural Utilization Research • Agricultural Research Service • United States Department of Agriculture • Peoria, IL

Margarines are made from partially hydrogenated vegetable oils. The fatty acid content of popular brand margarines ranges from 17-20% saturated, 28-35% monounsaturated, and 25-32% polyunsaturated fatty acids. Percentages for the *trans* acid isomers are included with the *cis* unsaturated fatty acids on product labels. (*"Trans" acids" is a generic term that refers to the various long-chain fatty-acid isomers of the naturally occurring *cis* form of the fatty acid. The *trans* isomers appear in vegetable oils during processing as a result of partial hydrogenation).

**Different properties of *trans* isomers**

The physical, chemical, and biological properties of the *trans* isomers are different from either their *cis* or their saturated fatty acid counterparts. Partially because of these differences, there has been concern that margarines and other food products containing partially hydrogenated oils may contribute to risk factors associated with atherosclerosis.

However, this concern may be exaggerated, since the physical and chemical properties of *trans* acids are between those of oleic and stearic acid, neither of which is thought to be hypercholesterolemic (*N Engl J Med* 318:1244, 1988, *J Lipid Res* 26:184, 1985).

Margarine Facts

**Lower-calorie products contain less fat and more water**

Consumers have been changing their diets by lowering, but not eliminating, their intake of high-fat foods, including low-calorie, low-fat margarine and margarine/butter/oil blends (Inform 1:174, 1990). Some of these diet margarines and spreads may be as low as 40% fat by weight, while regular margarines contain at least 80% fat by weight. These lower-calorie products contain not only less fat but also more water. Gelatin, gums, or modified starches are added to provide texture.

The ingredients found in nearly all margarine and margarine-type products are similar, and include monoand diglycerides and lecithin (as emulsifiers and stabilizers), sodium benzoate, potassium sorbate, and citric acid (as preservatives), beta-carotene (for color and source of vitamin A), diacetyl and lactones (for butter-like flavor).

**Fat and calorie content of different margarine/butter products**

<table>
<thead>
<tr>
<th>Spread (1 tbsp)</th>
<th>Calories</th>
<th>Fat (gm)</th>
<th>Saturated Fat (gm)</th>
<th>Cholesterol (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter</td>
<td>100</td>
<td>11</td>
<td>7.1</td>
<td>31</td>
</tr>
<tr>
<td>Butter-margarine blend</td>
<td>100</td>
<td>11</td>
<td>3.0</td>
<td>12</td>
</tr>
<tr>
<td>Stick, tub, or liquid margarine</td>
<td>100</td>
<td>11</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>Whipped margarine</td>
<td>66</td>
<td>7</td>
<td>1.3</td>
<td>0</td>
</tr>
<tr>
<td>Diet margarine</td>
<td>50</td>
<td>6</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Spread</td>
<td>50-75</td>
<td>6-7</td>
<td>1.0-1.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Adapted from data from the National Association of Margarine Manufacturers

*continued on page 2*
Influence on serum lipid and lipoprotein levels

Mensink and Katan reported that a diet high in saturated fat (lauric and palmitic acid) increased low-density-lipoprotein (LDL) levels 18 mg/dL, whereas a trans fat diet increased LDL levels by 14 mg/dL, when compared to a cis monounsaturated (oleic acid) control diet (N Engl J Med 323:439, 1990). For the trans fat diet, the high-density-lipoprotein (HDL) level decreased 4 mg/dL compared to the saturated and oleic acid diets.

In this study each of the three diets contained approximately 40% energy from fat and was fed in random order to 34 women and 25 men for three weeks with no washout period between diet periods. Blood samples were drawn at the end of each diet period.

The LDL/HDL cholesterol ratio for the trans fat diet was 2.42, compared to 2.21 for the saturated acid diet. The saturated fat diet increased total cholesterol 21 mg/dL and the trans fat diet produced a 10 mg/dL increase, compared to the oleic acid diet.

These changes for total serum cholesterol are consistent with those reported by other investigators (J Nutr 75:338, 1961, Am J Clin Nutr 28:726, 1975), although Laine (Am J Clin Nutr 35:683, 1982) observed that a trans fat diet did not decrease HDL and the increase in LDL was 50% less than that produced by a high palmitic acid (palm oil) diet.

The trans fat diet used in the Mensink and Katan study contained 33 gm of trans fatty acids per day, which is about 4 times the amount present in the average U.S. diet. Assuming the trans acids have a linear dose-dependent effect, replacing the oleic acids in the U.S. diet with trans fatty acids would produce a 3.5 mg/dL increase in LDL, a 1 mg/dL decrease in the HDL levels, and a 0.06 increase in the LDL/HDL cholesterol ratio.

More recently, Katan and Zook reported that diets containing stearic or trans acids have an equivalent influence on plasma cholesterol, LDL, and HDL levels (Inform 2:348, 1991).

Cautions about interpretations

It is tempting to interpret the Mensink and Katan data to mean that consumption of trans acids significantly increases the risk of developing atherosclerosis. For patients with HDL levels below about 35 mg/dL, a negative change in HDL levels of 1 mg/dL is estimated to increase cardiovascular risk by about 1%. For patients with normal to high HDL levels, a 1 mg/dL HDL decrease is not particularly significant.

However, it is not known if the results that Mensink and Katan obtained in healthy normolipidemic individuals can be extrapolated to patients with atherosclerosis and hyperlipidemia, or if the same results will be obtained at lower dietary levels of trans acids.

Trans acid as a risk factor?

It is of course possible that trans acids may intensify cardiovascular risk factors, particularly in patients with health problems associated with dietary fat. However, available data do not support such a concern.

Hudgins and associates found no positive correlations between trans acid levels in adipose tissue and clinical risk factors (serum levels of LDL, HDL, total cholesterol, triglyceride, the LDL/HDL ratio, and blood pressure) in 76 normolipidemic middle-age men and 10 hyperlipidemic patients (Am J Clin Nutr 53:474, 1991).

In general, fatty acid composition of adipose tissue reflects the long-term average composition of dietary fat intake. Thus, if trans acids influence risk factors, these investigators should have found a positive correlation between the trans acid content of the adipose tissue samples and serum indices of risk.

Katan's stearic vs. trans fat data, when coupled with Grundy's stearic acid data and Hudgins’ adipose tissue correlation data, imply that the increase in cholesterol and LDL levels produced by hydrogenated oils is a result of the decrease in the polyunsaturated fatty acid content, rather than the introduction of the trans acids.

Nutritional considerations

Margarines may be a nutritionally better choice than butter, even if one assumes the trans acids are equivalent to the hyperlipidemic palmitic and lauric acids. Margarines have a higher trans content (15-25% vs. 2-6%), but a lower saturated fat content (17-20% vs. 60-62%), and higher polyunsaturated content (25-32% vs 2-3%) than butter. Also, margarines contain no cholesterol, compared to 11 mg of cholesterol per 5 gm pat of butter.

The typical U.S. diet contains about 50% more saturated and 50% less polyunsaturated fatty acids than is currently recommended.

Thus, the higher polyunsaturated content of margarines may be an important contribution. Use of polyunsaturated margarine in place of butter helps both to decrease dietary saturated fat intake and to increase.
polyunsaturated fatty acid levels. For example, total substitution of margarine for butter in a typical diet will increase the P/S ratio from about 0.2 to 0.5.

**Dietary advice**

The difference between the composition of stick or soft-tub margarines or among margarines prepared from hydrogenated soybean, corn, safflower, or cottonseed oil is probably not of great significance. Still, until information from additional studies becomes available, it would be prudent to recommend that hyperlipidemic patients and those with coronary heart disease minimize their consumption of fat in general, including margarines and high-fat snack foods prepared with partially hydrogenated vegetable oil—such as Danish pastries, donuts, muffins, and chips.

Preferably, patients should use soft margarines, which can be spread more sparingly than hard margarines, and substitute low-fat for high-fat snacks. This practice alone will greatly reduce the total dietary fat intake, and this may be more important than the accompanying reduction of trans acid intake.

Existing evidence does not warrant recommending the elimination of all margarine and products containing partially hydrogenated vegetable oil, based on fear that trans acids significantly increase cardiovascular risk.

![An update of trans fatty acids availability in the U.S. diet has recently been published in the American Journal of Clinical Nutrition (54:363, 1991).](image)

**Suggested reading**

