

## Ruminant or industrial sources of *trans* fatty acids: public health issue or food label skirmish?<sup>1,2</sup>

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In this issue of the Journal, 2 groups of investigators report carefully conducted controlled feeding studies in healthy volunteers that compared the effects on blood lipids of *trans* fatty acids (TFA) from industrial (partially hydrogenated vegetable oil) and from dairy (ruminant or “natural”) sources. Chardigny et al (1) compared industrially derived and ruminant-derived TFA at ≈5% of energy. Motard-Belanger et al (2) compared industrially derived and ruminant-derived TFA at 3.7% of energy and also included a third arm with only 1.5% of energy from ruminant-derived TFA and a control arm with 0.8% of energy from TFA.

In the study of Chardigny et al, the industrial TFA diet lowered HDL-cholesterol, LDL-cholesterol, and triacylglycerol concentrations compared with dairy TFA only in women; in men, significant differences between the TFA diets were not seen. The ratio of total to HDL cholesterol and the concentration of lipoprotein(a) [Lp(a)] also tended to be higher with the industrial TFA diet, but these differences were not significant. As the authors noted, a control arm replacing TFA with nonhydrogenated fats would have made the study more informative. Fortunately, Motard-Belanger et al had the equivalent of 2 control arms, comparing high-industrial and high-ruminant TFA diets (3.7% of energy) with both a lower-ruminant TFA diet (1.5% of energy) and a low total TFA diet (0.8% of energy). Compared with the 2 lower-TFA diets, the diets with 3.7% of energy from TFA, whether from ruminant or industrial sources, each had similar adverse effects on blood lipids and lipoproteins, including increases in LDL cholesterol, decreases in HDL cholesterol, and increases in the ratio of total to HDL cholesterol (although power to achieve statistical significance for some comparisons was limited because of dropouts). However, consumption of 1.5% of energy from ruminant TFA did not have significantly different effects on blood lipids or lipoproteins than did consumption of the low-TFA (0.8% of energy) diet.

The interpretation of both studies is somewhat limited because, as in most of the earlier controlled feeding trials of TFA, the durations of each diet were relatively brief (3–4 wk), the diets also contained different amounts of some specific saturated fatty acids, and statistical power to detect some differences may have been limited. In addition, participants were selected to be leaner, younger men and women, whereas those at risk of heart disease typically are overweight persons who are middle-aged or older. Because the metabolic effects of TFA are similar to several features of the metabolic syndrome (3), it is worrisome that adverse effects could be underestimated in healthier persons and

more prominent in persons with greater underlying insulin resistance.

These 2 studies are the first controlled feeding studies to directly compare industrial with “natural” TFA. Others have found that feeding dairy products enriched with ruminant-derived TFA, compared with control diets, has adverse effects on blood lipids (4, 5); the changes were qualitatively similar to those produced by industrial TFA in other studies. In one trial, a butter enriched with natural TFA increased total cholesterol less than did a control butter, but the ratio of total to HDL cholesterol was not significantly different (6).

As both of the present reports acknowledge, the amount of TFA from dairy sources used in these studies greatly exceeded the intake of ruminant TFA in usual diets. Bacteria in the stomachs of ruminants (eg, cattle, sheep, and goats) can biohydrogenate the relatively small amounts of polyunsaturated fatty acids present in ruminant feed to form TFA isomers, the most abundant of which is an 18:1 *trans* isomer, vaccenic acid. These TFA, incorporated into milk and beef fat, typically constitute <5% of the total fatty acids. Thus, if a person were to consume the entire maximum recommended saturated fat intake (10% of energy) from ruminant sources, that would correspond to 20% of energy from ruminant fats (given that ruminant fats are roughly 50% saturated fatty acids), and the intake of “natural” TFA would be <5% of that amount, or <1% of total energy. Because nonruminant sources also significantly contribute to saturated fat intake in most diets, ruminant TFA consumption in most persons is substantially lower than 1% of energy, and far smaller than the 3.7% and 5% (and even the 1.5%) used in these trials. Although Chardigny et al did not describe the methods used to obtain the high amounts of TFA in their dairy products, the investigators presumably used methods similar to those of Motard-Belanger et al—ie, feeding cows large amounts of polyunsaturated oils, which is certainly not what is “naturally” done.

Whether equal amounts of TFA from industrial and ruminant sources have similar effects on blood lipids is an interesting scientific question, but it does not appear to be a critical public health or policy issue. The relation of TFA from natural versus

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industrial sources to the risk of heart disease was examined in prior epidemiologic studies. In the Nurses' Health Study (7), the relative risk for the top versus bottom quintile of industrial TFA was 1.94 ( $P$  for trend = 0.001), whereas for ruminant TFAs, the relative risk across quintiles was 0.59 ( $P$  for trend = 0.23). Similar findings were also seen in the large Finnish Alpha-Tocopherol Beta-Carotene Study (8) (in which the inverse association of ruminant TFA intake with coronary disease risk was statistically significant) and the Boston Area Health Study, a population-based case-control study (9). In the smaller Zutphen Heart Study (10), statistical power was limited to distinguish among the sources of TFA. Thus, the epidemiologic evidence indicates that total TFA from natural sources, in actual amounts consumed in diets, do not contribute importantly to risks of coronary heart disease. The findings by Motard-Belanger et al lend further credence to this by showing that even the upper limits (1.5% of energy) of normally achievable ruminant TFA consumption, in healthy young adults, do not affect blood lipid or lipoprotein concentrations. This evidence does not exclude the possibility that natural TFA could have adverse effects if consumed in the higher amounts equivalent to industrial TFA intakes, or that specific TFA isomers in ruminant fats may have particular effects; however, with regard to policy and public health, adherence to guidelines for saturated fat intake will ensure low total consumption of ruminant TFA.

If this issue is not a critical public health issue, what motivated these authors (and the dairy industry sponsors of both studies) to conduct these trials? Some have hypothesized that ruminant TFA may be beneficial for health, because of the production of conjugated linoleic acid (CLA) from vaccenic acid, a major TFA isomer in ruminant fats. However, the evidence to date, including that from the present studies, does not strongly support an overall beneficial effect of ruminant TFA or CLA. The dairy and beef industries also have reason to wish that ruminant TFA would be excluded in the *trans* fat category on food labels or in regulations limiting TFA intakes. Not to include all sources of TFA on food labels would, however, create regulatory complexity, especially for prepared dishes with mixed animal and vegetable constituents, because of the lack of simple methods to distinguish analytically among ruminant and industrial TFA. Although the possibility remains that subtle differences are present between the metabolic effects of industrial and ruminant TFA at the rather small amounts actually consumed, at present there is no compelling evidence to exclude natural TFA from the total TFA on food labels.

Beyond the details of food labeling, the broader public health issue is the identification of ways in which to reduce the intake of industrial TFA, ideally by replacing them with *cis* unsaturated fatty acids. When food manufacturers and restaurants do not voluntarily remove industrial TFA, both the Danish government and the New York City Department of Public Health have shown

that, with a reasonable allowance of time to make the transition, legislation to limit the use of partially hydrogenated vegetable oils in foods is feasible and effective. Contrary to concerns raised by some, evidence suggests that this legislation did not result in overall higher intakes of saturated fat (11). To its credit, the food industry appears to be generally taking advantage of the costs and effort of reformulation to make an overall healthier product and to avoid replacing one problem with another. In recent years, multiple national and international committees have reviewed the health effects of TFA and concluded that TFA intake should be as low as possible. Current TFA consumption accounts for many thousands of premature deaths each year (12), and continued efforts to eliminate the consumption of partially hydrogenated vegetable oils are strongly warranted.

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