

## ***Trans* Fatty Acids: Current Contents in Canadian Foods and Estimated Intake Levels for the Canadian Population**

W.M. NIMAL RATNAYAKE, MARY R. L'ABBE, SARA FARNWORTH, LYDIA DUMAIS, CLAUDE GAGNON, BRIAN LAMPI, VALERIE CASEY, DAYANI MOHOTTALAGE, ISABELLE RONDEAU, and LYNNE UNDERHILL

Health Canada, Health Products and Food Branch, Bureau of Nutritional Sciences, 251 Sir Frederick Banting Dr, Ottawa, ON, Canada K1A 0K9

MICHELE VIGNEAULT

Health Canada, Health Products and Food Branch, Bureau of Food Policy and Science Integration, 251 Sir Frederick Banting Dr, Ottawa, ON, Canada K1A 0K9

WILLIAM LILLYCROP, MARY MELETA, LYNN Y. WONG, TRAN NG, YU GAO, KERI KWONG, SHIRLEY CHALOUH, and PETER PANTAZOPOULOS

Health Canada, Food Laboratory Division, Ontario Region, 2301 Midland Ave, Toronto, ON, Canada M1P 4R7

HASANTHA GUNARATNA, ADELINE RAHARDJA, RICHARD BLAGDEN, VERONICA ROSCOE, THOMAS KRAKALOVICH, GARY NEUMANN, and GARY A. LOMBAERT

Health Canada, Food Laboratory Division, Manitoba and Saskatchewan Region, 510 Legimodiére Blvd, Winnipeg, MB, Canada R2J 3Y1

Research conducted in the mid-1990s indicated that the levels of *trans* fats in Canadian diets were among the highest in the world. The consumption of *trans* fats raises blood levels of low-density lipoprotein (LDL)-cholesterol, while reducing levels of high-density lipoprotein (HDL)-cholesterol. In June 2007, Health Canada called on the food industry to voluntarily reduce levels of *trans* fats in vegetable oils and soft (tub)-margarines to <2% of total fat, and in all other foods, to <5%. Industry must show satisfactory progress by June 2009, or Health Canada might have to introduce legislation to ensure that recommended limits are achieved. Since 2005, Health Canada has been performing a national assessment of prepackaged and restaurant foods that likely contain *trans* fats. From 2005 to 2009, 1120 samples were analyzed, of which 852 or approximately 76% met the recommended *trans* fat limits. As a result of reformulation, most of the products had decreased *trans* + saturated fat content. The estimated average intake of *trans* fatty acids (TFA) in Canada significantly dropped from the high value of 8.4 g/day in the mid-1990s to 3.4 g/day (or 1.4% food energy) in 2008. However, this TFA intake of 1.4% of energy is still above the World Health Organization recommended limit of TFA intake of <1% of energy, which suggests that the Canadian

food industry needs to put more effort into reducing the TFA content in its products, especially in tub-margarines, donuts, and bakery products.

*Trans* fat or *trans* fatty acids (TFAs) are formed during the industrial partial hydrogenation of unsaturated fats. Vegetable oils are partially hydrogenated to increase their melting point so that they are solid or semisolid at room temperature. The resulting partially hydrogenated vegetable oils (PHVOs) are attractive to the food industry in the manufacture of margarines and shortenings and in the preparation of commercial baked products because of their better functional properties, longer shelf life, oxidative stability and semisolidity. Some products made with PHVOs have been found to contain up to 40–50% TFA as a percent of total fat (1). TFAs are also found naturally at relatively low levels (between 2 and 6% of the total fat content) in dairy products and meat from ruminant animals (2). Some liquid vegetable oils such as canola and soybean, can also contain small amounts of TFAs (0.2–2% of total fatty acids), which can be formed during the commercial refinement of these oils (1, 3).

TFAs are undesirable components of the diet because they affect a wide range of lipid and nonlipid cardiovascular risk factors (4). In particular, TFAs, compared to either polyunsaturated fatty acids, monounsaturated fatty acids, or saturated fatty acids (SFAs), decrease high-density lipoprotein cholesterol (HDL-C) and increase the total cholesterol to HDL-C ratio, the ratio of apolipoprotein (B) to apolipoprotein A, and lipoprotein (a) levels, which are all strong risk factors for cardiovascular disease (5, 6).

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Corresponding author's e-mail: nimal\_ratnayake@hc-sc.gc.ca

TFAs have also been implicated in systemic inflammation, endothelial dysfunction, adiposity, and insulin resistance (4). Dietary TFAs are considered to pose an even greater risk to health than SFAs (7–10).

With the mounting evidence linking TFAs to heart disease, the Panel on Macronutrients of the U.S. National Academies' Institute of Medicine, in 2002, advised that TFA consumption be as low as possible within a nutritionally adequate diet (11). Subsequently, in 2003, the World Health Organization (WHO) advised that TFA intake be limited to <1% of total energy (12).

In Canada, scientists raised concerns about the detrimental effects of TFAs and their levels in the Canadian diet as far back as the late 1970s, focusing first on margarines (13), and later on the total diet, recommending that consumption levels should not increase (14). These warnings led to the development of a number of margarine products with low TFA levels, targeted to health-conscious consumers (15–17). While some progress was being made in the margarine/spread sector, the use of PHVOs continued to increase in other food categories (18, 19). By the mid-1990s, using both dietary intake data and analysis of human tissue samples, researchers estimated that Canadians had one of the highest average intakes of TFAs in the world, estimated to be approximately 8.4 g/day (20).

In recognition of the high intake of TFAs and the adverse impact on the health of Canadians, Canada became the first country to require that the levels of TFAs in prepackaged food be included on the mandatory Nutrition Facts table appearing on food labels (21). The nutrition labeling regulations took effect in December 2005. The regulations require that calories and the content of 13 core nutrients, including TFAs, be listed on the labels in a standardized format (21). As a result of the nutrition labeling regulations, accompanied by intense media attention and mounting consumer concerns about TFAs, many companies began decreasing TFA levels in their products (22). Consequently, by 2005, average TFA intake had decreased from 8.4 to 4.9 g/day (23). Despite the successful reduction in TFA consumption, it was recognized that in order to have consumption of TFAs by Canadians below the WHO recommendation of <1% of overall energy intake, i.e., approximately 2 g/day for a 2000 Kcal diet, further action would be necessary.

In November 2004, an Opposition Day motion in the House of Commons of the Canadian Parliament called on Health Canada and the Heart and Stroke Foundation of Canada to co-chair a multistakeholder task force whose mandate would be “to provide the Minister of Health with concrete recommendations and strategies to effectively eliminate or reduce processed TFAs in Canadian foods to the lowest level possible” (24). Members of the task force, named in early 2005, included individuals from the food manufacturing and food service sectors, the federal government, nongovernmental health organizations, professional associations, academia, consumer groups, and oilseed producers and processors. After 16 months of deliberations, the Trans Fat Task Force released its final report, entitled “*TRANS*forming the Food Supply,” on

June 28, 2006 (23). In this report, the task force recommended limiting the total amount of TFAs in foods by regulation (23). The recommendations were (1) for all vegetable oils and soft, spreadable margarines sold to consumers or for use on site by retailers or food service establishments, the total TFA content would be limited by regulation to 2% of total fat content; and (2) for all other foods purchased by a retail or food service establishment for sale to consumers or for use as an ingredient in the preparation of foods on site, the total TFA content would be limited by regulation to 5% of total fat content.

Health Canada evaluated the overall effect of limiting the TFA content of foods on the total dietary intake of TFA by modeling a number of possible limits. Based on the dietary intake modeling using the recommended TFA limits above, it was estimated that the average daily intake of TFA for all age groups would represent less than 1% of energy intake (23), consistent with the WHO recommendation (12). The modeling results also showed that a lower limit would not provide a significant additional decrease in average TFA intake, but would increase the effort and challenge for industry (23).

The Minister of Health announced, on June 20, 2007, that Health Canada had adopted the recommendations of the Trans Fat Task Force to limit the amount of TFAs in foods. Recognizing the significant progress that had already been made in decreasing TFAs in the Canadian food supply, Health Canada gave industry a 2-year window to decrease TFAs to the recommended levels; otherwise, the department would introduce regulations to enforce the limits. The department is currently using the 2 and 5% limits as the standard for assessing industry's performance during the 2-year period following this announcement. In June 2007, Health Canada established a Trans Fat Monitoring Program (25) to analyze the TFA content and the fatty acid profile of foods sold in Canada, and to closely monitor the efforts of industry to ensure that significant progress is being made to achieve the recommended limits. The results from the Trans Fat Monitoring Program were posted on Health Canada's Web site on a regular basis (26–28). An overview of the preliminary results obtained in the first year of the program was published previously (29).

The purpose of this paper is to provide some of the results of the Trans Fat Monitoring Program for the period of 2005 to April 2009. The fatty acid profile obtained from the monitoring program will also be useful for gaining an understanding of the alternatives used in reformulated products. In addition, a new TFA intake is estimated for the Canadian population and is compared to the WHO recommendation of 1% or less total energy intake.

## Material and Methods

### Sample Selection

The focus of the Trans Fat Monitoring Program was to analyze the TFA content of foods that, as indicated by earlier food analyses and surveys, were significant sources of TFAs, i.e., foods with high levels of TFAs or foods with lower levels

**Table 1. Percentage of samples meeting the 2% (for soft margarines and other spreads) or 5% (for all foods other than soft margarines/spreads) TFA of total fat limit from 2005 to 2009<sup>a</sup>**

Food category	2005	2006	2007	2008	2009	Cumulative results for 2005–2009 <sup>b</sup>
Prepackaged foods from grocery stores						
Chicken strips/nuggets, frozen	ND <sup>c</sup>	83% (5/6)	ND	ND	ND	83% (5/6)
Coffee whiteners	ND	ND	ND	53% (9/17) <sup>e</sup>	ND	53% (9/17)
Cookies	33% (5/15)	60% (9/15)	ND	65% (48/74) <sup>e</sup>	ND	68% (54/80) <sup>d</sup>
Crackers	59% (13/22)	85% (17/20)	ND	86% (44/51) <sup>e</sup>	ND	94% (60/64) <sup>d</sup>
Desserts, frozen prepackaged	ND	ND	ND	71% (36/49) <sup>e</sup>	ND	71% (36/49)
Desserts, baked prepackaged	ND	ND	ND	84% (73/87) <sup>e</sup>	ND	84% (73/87)
Garlic spreads	ND	ND	33% (2/6)	ND	ND	33% (2/6)
Granola bars	83% (19/23)	ND	100% (8/8)	ND	ND	80% (16/20)
Tub-margarines	58% (15/26)	ND	65% (20/31)	ND	ND	62% (23/37)
Print-margarines	0% (0/3)	ND	0% (0/3)	ND	ND	0% (0/6)
Muffins	ND	100% (2/2)	ND	ND	ND	100% (2/2)
Noodles, instant	ND	ND	ND	86% (19/22) <sup>e</sup>	ND	86% (19/22)
Potato products, prefried, frozen	ND	75% (9/12)	ND	91% (10/11) <sup>e</sup>	ND	90% (19/23) <sup>d</sup>
Pizzas, frozen	ND	ND	67% (4/6)	ND	ND	67% (4/6)
Shortenings-vegetable	ND	ND	50% (2/4)	ND	ND	50% (2/4)
Shortenings-lard	ND	ND	100% (4/4)	ND	ND	100% (4/4)
Snacks	ND	ND	ND	92% (85/92) <sup>e</sup>	ND	92% (85/92)
Snack puddings	ND	ND	ND	78% (21/27) <sup>e</sup>	ND	78% (21/27)
Popcorn	ND	ND	ND	82% (18/22) <sup>e</sup>	ND	82% (18/22)
Bakery products from grocery stores						
Breads and buns	ND	ND	100% (20/20)	ND	ND	100% (20/20)
Brownies	ND	ND	ND	45% (5/11)	ND	45% (5/11)
Cakes	ND	ND	ND	43% (6/14)	ND	43% (6/14)
Croissants	ND	ND	ND	25% (4/16)	ND	25% (4/16)
Danishes	ND	ND	ND	45% (5/11)	ND	45% (5/11)
Garlic breads	ND	ND	55% (6/11)	ND	ND	55% (6/11)
Pies	ND	ND	ND	36% (4/11)	ND	36% (4/11)
Tarts	ND	ND	ND	67% (10/15)	ND	67% (10/15)
Fast foods from restaurant establishments						
Chicken products	ND	29% (4/14)	76% (13/17)	85% (60/71)	ND	79% (75/95)
Donuts	ND	35% (15/43)	23% (6/26)	57% (17/30)	ND	29% (10/35)
Fish products	ND	ND	86% (6/7)	76% (19/25)	ND	83% (19/25)
French fries	ND	0% (0/5)	68% (15/22)	81% (58/71)	ND	79% (71/90)
Miscellaneous <sup>f</sup>	ND	ND	78% (11/14)	50% (11/22)	ND	82% (9/11)
Muffins	ND	ND	ND	89% (25/28)	ND	89% (25/28)
Onion rings	ND	ND	60% (6/10)	83% (5/6)	ND	75% (9/12)
Pizzas	ND	ND	100% (13/13)	ND	ND	100% (13/13)
Pizza dipping sauces	ND	ND	ND	100% (8/8)	ND	100% (8/8)
Ethnic foods	ND	ND	ND	89% (56/63)	ND	89% (56/63)

Table 1. (continued)

Food category	2005	2006	2007	2008	2009	Cumulative results for 2005–2009 <sup>b</sup>
Foods from restaurants in institutions						
Chicken products	ND	ND	ND	ND	80% (12/15)	80% (12/15)
Cookies	ND	ND	ND	ND	76% (22/29)	76% (22/29)
Desserts	ND	ND	ND	ND	63% (5/8)	63% (5/8)
Fish products	ND	ND	ND	ND	50% (1/2)	50% (1/2)
French fries	ND	ND	ND	ND	71% (15/21)	71% (15/21)
Fried onion rings	ND	ND	ND	ND	67% (2/3)	67% (2/3)
Margarines	ND	ND	ND	ND	50% (2/4)	50% (2/4)
Muffins	ND	ND	ND	ND	100% (22/22)	100% (22/22)
Total	58%	57%	68%	77%	78%	76%
	(52/89)	(77/136)	(139/205)	(674/871)	(81/104)	(852/1120)

<sup>a</sup> The proportion of the number of samples meeting the TFA limit to the total number of samples analyzed is given in parentheses.

<sup>b</sup> Some samples analyzed in 2007 and 2008 included samples that were analyzed in 2005 and 2006. The 2005 and 2006 data for those samples that were re-analyzed in 2007 and 2008 were not included in the cumulative results for 2005–2009.

<sup>c</sup> ND = Not determined.

<sup>d</sup> Data include results from both laboratory analysis and label review.

<sup>e</sup> Data from label review.

<sup>f</sup> Miscellaneous (apple turnover, hash browns, sweet potato, spring rolls, taters, apple pie, cinnamon melts, cheese sticks, etc.).

of TFAs that were consumed in large quantities by a large number of consumers. The samples analyzed included prepackaged foods, bakery products, margarines, shortenings, ethnic foods, fast foods from family, regular restaurant chains, and cafeterias of institutions. For prepackaged foods, the individual products that were analyzed represented the majority of products sold within a particular food category, and for most of these food categories, represented approximately 80% of the market share. The food samples were collected between 2005 and 2009 from major grocery stores and from major fast food chains, as well as from small and medium-sized restaurants across Canada (Toronto, Ottawa, Winnipeg, Vancouver, Halifax-Dartmouth, and Montreal). Cafeteria foods from institutions were collected from hospitals, universities, and colleges in Ottawa, Montreal, Charlottetown, Winnipeg, and Victoria. The samples collected in 2007 and 2009 included foods that were previously identified (in 2005 and 2006) as having high levels of TFAs. Full details of the sample collection for individual food products, organized by food category, company, date of collection, and brand name within each category can be found on Health Canada's Web site (26–28). The Web site also provides information on the fat content and TFA and SFA levels of all the individual food products sampled.

From grocery stores, samples consisted of three consumer-sized packages from the same lot. For most food categories, at least two samples from different lots were purchased. The entire content packages/samples were homogenized, and from that well-mixed composite a small

subsample was taken for fat analysis. Samples of foods from fast-food and restaurant establishments consisted of a single portion from a single lot. Samples of prepackaged foods and foods from grocery stores included breads, buns, brownies, cakes, cookies, crackers, croissants, danishes, donuts, frozen potato products (frozen French fries, etc.), frozen chicken strips/nuggets, garlic breads, garlic spreads, tub-margarines, print-margarines, granola bars, and muffins. Fast foods sampled included chicken strips/nuggets, donuts, fish products, French fries, miscellaneous fast foods (apple turnovers and hash browns), muffins, onion rings, pizzas, pizza dipping sauces, and ethnic foods.

#### Analytical Methodology

The analysis of fat content and the fatty acid profile were conducted in three Health Canada laboratories (Ottawa, Toronto, and Winnipeg). All three laboratories used the same analytical procedure. Samples were homogenized in a blender before subsampling.

#### Fat Extraction

Fat extraction was performed according to a slightly modified AOAC Official Method<sup>SM</sup> 996.06 (30). The slight modification was the use of a test tube instead of a Mojonnier flask for fat extraction. An accurately weighed homogenized food sample (containing nearly 100–200 mg fat) was placed in a Teflon<sup>®</sup>-lined screw-capped glass test tube (30 mL capacity). A 2 mL portion of triglyceride (Nu Chek Prep, Elysian, MN) internal standard solution (either 5 mg

**Table 2. Fat content (g/100 g food) and fatty acid composition (g/100 g total fatty acids) for prepackaged foods from grocery stores with TFA level above and below 2% (tub-margarines) or 5% (all foods except tub-margarines) limit<sup>a</sup>**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Cookies >5% TFA (n = 21)	19.3(4.4) (13.1–30.4)	26.9(10.4) (7.4–45.7)	37.8(17.3) (20.7–68.2)	64.1(10.1) (51.7–83.0)	8.0(10.4) (0.0–26.1)	3.4(4.2) (0.1–9.6)	11.5(3.1) (6.8–22.1)	14.5(7.4) (6.8–35.4)	26.8(9.6) (9.6–41.8)	6.5(3.2) (1.7–10.2)	0.3(0.1) (0.1–0.6)
Cookies ≤5% TFA (n = 16)	17.9(3.2) (11.0–21.6)	0.9(0.6) (1.4–2.1)	52.6(12.7) (31.0–72.2)	53.6(13.0) (31.4–73.3)	7.3(9.8) (0.1–25.8)	4.3(4.2) (0.7–11.5)	27.9(7.7) (18.1–42.3)	11.4(9.0) (2.5–28.7)	33.8(7.6) (20.6–43.9)	0.5(4.5) (3.4–17.8)	2.1(2.3) (0.2–6.9)
Crackers >5% TFA (n = 10)	15.0(6.1) (8.9–25.4)	28.1(14.9) (7.1–40.7)	22.3(2.3) (19.6–24.9)	50.4(13.0) (31.1–60.6)	0.5(0.5) (0.2–2.0)	12.3(1.6) (10.8–14.1)	8.3(1.2) (6.7–9.5)	29.3(6.2) (20.0–35.9)	17.8(17.1) (5.2–42.6)	2.0(2.3) (0.4–5.2)	0.4(0.2) (0.1–0.6)
Crackers ≤5% TFA (n = 30)	16.9(5.2) (4.6–27.7)	1.2(1.0) (0.4–4.7)	40.3(18.7) (9.6–60.1)	41.6(18.3) (10.4–60.8)	5.7(5.9) (0.0–21.7)	3.3(2.6) (0.0–10.3)	25.3(12.1) (5.0–36.9)	4.5(1.1) (2.5–8.2)	37.1(13.0) (23.1–79.4)	19.6(13.1) (9.5–51.7)	1.7(2.0) (0.3–6.7)
Granola bars >5% TFA (n = 4)	10.6(5.5) (6.9–20.2)	16.4(8.0) (8.5–20.3)	36.4(21.8) (20.5–72.6)	52.8(20.3) (34.8–87.2)	6.9(10.4) (0.0–23.3)	3.2(4.5) (0.1–10.1)	15.1(3.6) (10.4–17.8)	10.0(5.4) (4.4–18.8)	32.9(14.2) (9.7–47.9)	13.7(9.5) (3.0–28.0)	0.6(0.5) (0.1–1.5)
Granola bars ≤5% TFA (n = 16)	10.5(6.2) (4.9–18.8)	1.2(0.3) (1.0–1.7)	32.0(15.5) (11.0–44.3)	33.2(15.6) (12.1–45.3)	3.8(5.5) (0.0–11.7)	2.1(2.6) (0.1–5.9)	19.5(12.6) (7.6–37.0)	5.5(4.0) (2.2–11.3)	42.1(9.7) (33.3–55.0)	21.4(3.3) (17.0–24.7)	3.3(4.4) (0.6–9.8)
Frozen chicken nuggets/strips >5% TFA (n = 1)	10.5	19.0	11.3	30.3	0.0	0.1	6.2	4.0	63.3	6.0	0.4
Frozen chicken nuggets/strips ≤5% TFA (n = 5)	7.0(3.2) (5.8–15.9)	2.3(3.2) (2.0–2.9)	17.5(4.4) (11.3–22.6)	19.9(4.4) (13.7–24.7)	0(0) (0–0)	0.2(0.1) (0.1–0.3)	12.0(3.4) (7.3–14.0)	4.5(1.2) (2.7–5.5)	34.4(13.8) (25.8–58.4)	36.2(11.9) (19.7–44.0)	5.6(4.4) (3.9–8.4)
Frozen potato products >5% TFA (n = 3)	6.5(2.6) (4.4–9.4)	29.7(19.7) (7.3–44.2)	18.5(6.3) (13.6–25.6)	48.1(23.2) (23.6–69.8)	0.0(0.0) (0.0–0.0)	0.1(0.1) (0.1–0.1)	8.8(3.3) (5.1–11.2)	8.6(4.3) (5.1–13.4)	34.4(10.3) (28.4–46.3)	15.3(23.2) (1.5–42.2)	2.2(3.2) (0.3–5.9)
Frozen potato products ≤5% TFA (n = 9)	6.9(3.0) (2.3–11.3)	2.1(0.9) (1.3–4.5)	11.9(7.3) (7.5–34.4)	14.0(7.7) (9.2–37.1)	0.0(0.0) (0.0–0.0)	0.1(0.1) (0.1–0.3)	7.3(5.2) (4.6–23.2)	3.3(2.0) (2.0–9.4)	56.6(13.2) (26.2–64.3)	21.2(12.1) (13.2–47.9)	6.8(2.2) (0–9.2)
Muffins ≤5% TFA (n = 2)	17.0(6.7) (8.8–25.1)	1.5(0.6) (0.5–1.9)	18.0(2.8) (14.4–21.2)	19.4(2.5) (16.3–22.3)	0.2(0.0) (0.1–0.2)	0.1(0.0) (0.0–0.1)	9.9(1.5) (7.9–11.5)	7.9(1.2) (6.4–9.4)	45.3(1.4) (43.6–47.0)	29.6(0.9) (28.5–30.7)	5.8(0.2) (5.6–6.0)
Tub-margarine >2% TFA (n = 22)	68.4(8.7) (45.2–81.4)	17.0(1.9) (14.7–21.0)	19.0(2.7) (13.0–21.1)	36.0(1.6) (34.0–38.7)	0.4(0.4) (0.0–1.1)	0.2(0.2) (0.0–0.5)	10.1(1.9) (5.6–11.3)	7.3(0.7) (5.9–8.2)	26(9.2) (20.6–48.9)	32.5(6.0) (12.7–38.2)	5.4(0.5) (4.4–5.9)
Tub-margarine ≤2% TFA (n = 35)	68.2(15.0) (38.3–81.4)	0.8(0.2) (0.5–1.4)	19.8(5.7) (15.6–29.2)	20.6(5.7) (15.4–30.1)	2.3(1.2) (1.2–4.7)	1.0(0.5) (0.1–1.8)	11.8(3.3) (8.8–16.4)	3.5(1.6) (2.3–7.9)	43.6(16.6) (19.4–58.2)	28.5(11.6) (17.3–47.6)	7.3(0.7) (6.0–8.9)
Print-margarine >5% TFA (n = 3)	73.5(2.8) (70.8–76.3)	39.3(4.6) (32.2–40.0)	19.2(2.5) (16.4–20.0)	58.5(2.5) (55.9–60.9)	0.0(0.0) (0.0–0.1)	0.1(0.0) (0.1–0.1)	10.6(0.3) (10.3–10.9)	7.5(2.4) (4.9–9.5)	33.1(1.1) (32.0–33.8)	7.7(3.3) (4.8–3.3)	0.7(0.2) (0.5–0.8)
Snacks >5% TFA (n = 3)	13.8(8.8) (7.6–20.0)	21.8(22.9) (5.6–38.0)	19.0(11.3) (11.0–27.0)	41.0(33.9) (65.0–17.0)	0.1(0.1) (0.0–0.2)	0.7(0.8) (0.1–1.2)	10.7(4.7) (7.3–10.0)	6.4(5.2) (2.7–10.0)	44.5(17.7) (32.0–57.0)	13.3(15.2) (2.5–24.0)	1.1(1.1) (0.3–1.9)
Snacks <5% TFA (n = 15)	22.2(10.9) (5.2–40.0)	1.5(1.1) (0.5–3.4)	23.5(17.5) (8.1–54.0)	25.1(18.3) (9.2–15.6)	0.3(0.5) (0.0–1.4)	1.7(2.7) (0.1–8.4)	15.9(13.0) (4.8–43.0)	4.3(2.9) (1.7–10.0)	46.1(15.5) (19.0–61.0)	24.8(15.9) (8.4–54.0)	4.2(3.1) (0.2–7.9)

**Table 2. (continued)**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Garlic spreads >2% TFA (n = 2)	67.1(7.9) (61.5–72.7)	13.8(0.6) (13.4–14.2)	20.2(0.1) (20.0–20.3)	34.0(0.4) (33.7–34.2)	1.3(1.0) (0.6–2.0)	0.1(0.0) (0.1–0.1)	10.8(0.1) (10.7–11.0)	7.3(0.3) (7.1–7.6)	21.6(0.1) (21.6–21.7)	40.0(0.1) (38.9–40.1)	4.9(0.9) (4.0–5.8)
Garlic spreads ≤2% TFA (n = 4)	54.1(4.6) (49.8–59.0)	2.1(2.5) (0.6–5.0)	36.5(25.9) (15.9–65.6)	38.6(28.4) (16.5–70.7)	2.2(1.7) (0.6–4.0)	4.5(6.8) (0.4–12.4)	21.4(11.7) (9.4–32.7)	6.2(5.1) (2.4–12.0)	36.1(19.1) (24.1–58.1)	20.1(19.1) (2.4–40.4)	5.0(3.8) (0.6–7.6)
Frozen pizzas >5% TFA (n = 2)	9.8(2.1) (5.4–11.5)	10.7(1.8) (7.3–12.7)	43.4(6.3) (32.6–48.8)	52.8(9.2) (35.5–60.0)	1.3(0.5) (0.8–2.4)	4.1(1.8) (2.3–8.1)	25.8(6.3) (18.9–27.7)	10.5(2.5) (7.3–13.4)	30.5(3.2) (27.5–37.0)	13.9(5.7) (11.1–26.5)	1.5(0.9) (0.7–3.5)
Frozen pizzas ≤5% TFA (n = 4)	7.6(2.1) (5.8–10.8)	2.5(0.4) (2.2–2.8)	38.5(4.5) (32.9–45.1)	38.7(7.2) (27.7–48.2)	1.3(0.2) (0.9–1.5)	4.1(0.7) (3.0–4.8)	21.6(3.3) (16.2–25.9)	9.3(1.8) (6.8–10.9)	34.8(8.5) (26.8–46.3)	20.6(6.6) (14.4–29.6)	3.4(1.3) (2.0–5.5)
Vegetable shortening >5% TFA (n = 2)	100	30.8(0.2) (30.6–30.9)	27.0(0.6) (26.6–27.4)	57.8(0.4) (57.5–58.0)	0.6(0.1) (0.6–0.7)	0.4(0.0) (0.4–0.4)	14.3(0.2) (14.1–14.5)	10.6(0.2) (10.4–10.8)	30.7(2.2) (29.1–32.2)	10.1(1.9) (8.7–11.4)	0.6(0.0) (0.6–0.6)
Vegetable shortening ≤5% TFA (n = 2)	100	3.8(0.1) (3.8–3.9)	27.3(0.1) (27.2–27.3)	31.1(0.0) (31.1–31.1)	0.3(0.2) (0.2–0.5)	0.2(0.0) (0.2–0.2)	14.2(0.1) (14.1–14.2)	11.6(0.1) (11.6–11.7)	19.4(0.1) (19.4–19.5)	43.5(0.1) (43.4–43.5)	6.0(0.0) (6.0–6.0)
Lard shortening <5% TFA (n = 4)	100	1.5(0.4) (1.1–2.0)	42.2(0.3) (41.9–42.8)	43.7(0.6) (43.0–44.3)	0.6(0.0) (0.6–0.7)	1.4(0) (1.4–1.4)	25.2(0.2) (24.9–25.4)	14.6(0.3) (14.3–15.1)	42.2(0.2) (42.0–42.3)	13.4(0.4) (13.3–13.4)	0.6(0.0) (0.6–0.7)

<sup>a</sup> The values are given as mean and SD (in parentheses) for all the samples for each food category collected from 2005 to 2009. The ranges are given in parentheses.

**Table 3. Fat content (g/100 g food) and fatty acid composition (g/100 g total fatty acids) for bakery products foods from grocery stores with TFA level above and below 5% limit<sup>a</sup>**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Breads & buns $\leq$ 5% TFA (n = 20)	3.4(1.0) (2.2–6.0)	2.1(1.0) (0.7–3.2)	27.1(5.0) (17.4–35.6)	29.2(6.0) (18.1–38.7)	0.0(0.0) (0.0–0.1)	0.1(0.0) (0.1–0.2)	16.2(2.3) (10.0–20.0)	9.6(4.1) (0.1–16.4)	18.7(3.4) (15.3–28.6)	42.8(6.4) (26.3–49.3)	9.2(8.0) (0.3–34.9)
Brownies >5% TFA (n = 6)	18.4(5.6) (9.9–24.1)	20.3(7.9) (5.5–26.2)	32.1(14.3) (21.2–58.0)	52.4(6.5) (46.9–63.5)	1.1(1.7) (0.1–4.5)	18.8(10.1) (10.4–36.4)	9.6(1.3) (7.3–11.1)	35.7(4.8) (34.0–41.1)	9.9(1.9) (7.2–12.5)	1.4(0.9) (0.4–2.6)	1.6(3.2) (0–8.0)
Brownies $\leq$ 5% TFA (n = 5)	16.3(6.0) (12.3–28.2)	1.3(0.8) (0.7–2.8)	30.3(10.4) (17.5–43.0)	32.1(10.8) (18.4–45.2)	0.5(0.8) (0–2.1)	0.7(0.3) (0.2–1.1)	20.3(10.3) (11.1–35.0)	7.9(4.0) (4.6–15.1)	42.5(6.8) (32.7–50.8)	21.2(9.1) (12.7–36.1)	4.1(2.1) (1.6–6.5)
Cakes >5% TFA (n = 8)	21.8(4.5) (13.7–25.9)	14.3(7.2) (5.6–27.1)	32.8(12.0) (16.9–54.5)	47.1(10.6) (28.5–60.1)	4.1(7.2) (0.2–20.7)	2.5(2.8) (0.3–7.1)	15.3(3.9) (8.7–21.0)	9.4(2.5) (6.6–12.8)	32.6(10.7) (16.3–51.9)	17.3(5.8) (12.4–27.9)	2.5(1.2) (0.5–4.1)
Cakes $\leq$ 5% TFA (n = 6)	17.0(4.7) (15.1–25.6)	2.2(1.1) (0.8–3.7)	36.9(20.3) (14.3–45.8)	39.1(20.7) (16.9–70.7)	7.3(10.9) (0–28.4)	3.7(3.9) (0.1–9.3)	16.9(11.5) (8.2–39.8)	6.8(4.6) (3.3–9.2)	36.6(14.0) (18.7–56.2)	19.7(15.2) (8.7–49.5)	4.5(2.8) (1.7–7.8)
Croissants >5% TFA (n = 12)	17.9(2.5) (12.2–20.7)	37.2(11.0) (5.9–45.3)	22.0(4.0) (19.0–31.2)	59.4(10.4) (26.7–65.0)	0.2(0.2) (0–0.9)	0.4(0.5) (0.1–1.5)	13.5(3.2) (11.5–19.9)	7.0(0.6) (6.4–8.2)	30.2(4.7) (21.9–31.1)	9.9(10.0) (5.2–40.7)	1.0(1.7) (0.2–6.1)
Croissants $\leq$ 5% TFA (n = 4)	17.8(2.6) (14.4–20.6)	0.9(0.2) (0.7–1.2)	43.9(2.4) (40.4–45.5)	44.8(2.2) (41.6–45.8)	0.4(0.2) (0.2–0.6)	1.0(0.2) (0.8–1.3)	37.5(2.7) (33.5–39.0)	4.5(0.2) (4.3–4.8)	37.4(1.2) (35.6–38.1)	14.5(3.8) (12.0–20.1)	3.1(0.4) (2.5–3.3)
Danishes >5% TFA (n = 7)	11.7(2.5) (9.3–16.6)	25.9(10.6) (14.3–38.6)	30.7(5.8) (22.9–36.0)	56.8(4.7) (50.3–61.8)	0.1(0.1) (0–0.3)	0.4(0.2) (0.2–0.7)	19.5(7.6) (12.5–30.5)	9.8(4.1) (5.9–14.5)	29.2(3.7) (24.8–30.9)	12.1(0.8) (11.0–13.4)	1.6(0.9) (0.7–2.8)
Danishes $\leq$ 5% TFA (n = 4)	14.2(0.8) (13.1–14.9)	2.5(1.4) (1.0–4.2)	43.1(1.4) (41.5–44.6)	45.7(0.2) (45.4–45.9)	0.2(0.0) (0.2–0.3)	0.8(0.0) (0.8–0.8)	36.7(1.6) (34.7–38.2)	4.7(0.2) (4.6–5.0)	38.6(0.4) (38.2–38.9)	12.5(0.2) (12.2–12.7)	3.2(0.3) (2.8–2.4)
Garlic bread >5% TFA (n = 5)	59.1(6.1) (52.0–68.4)	17.5(5.2) (11.5–25.1)	19.4(1.4) (17.3–21.1)	36.9(6.5) (28.8–46.2)	0.5(0.1) (0.4–0.7)	0.1(0.0) (0.1–0.1)	10.9(0.6) (9.9–11.4)	7.0(0.9) (5.8–8.3)	26.7(3.5) (23.4–30.8)	31.1(3.4) (24.6–33.7)	4.8(1.2) (3.3–6.3)
Garlic bread $\leq$ 5% TFA (n = 6)	49.7(9.1) (34.4–57.3)	1.8(1.4) (0.9–4.3)	35.5(17.6) (24.7–66.9)	37.4(19.1) (26.4–71.6)	1.2(1.7) (0.1–4.3)	2.9(5.4) (0.4–12.6)	24.0(5.9) (17.6–33.8)	5.9(3.2) (4.1–11.6)	24.4(0.6) (24.0–25.4)	32.9(17.1) (2.3–43.2)	5.3(2.6) (0.6–6.6)
Pies >5% TFA (n = 7)	12.9(4.3) (7.6–17.8)	22.3(8.0) (5.5–29.0)	37.0(15.7) (21.0–61.6)	59.3(8.7) (47.9–68.6)	4.5(7.5) (0–16.2)	3.1(4.1) (0.2–10.8)	13.4(8.6) (6.9–30.4)	13.4(1.7) (10.1–16.0)	34.5(7.3) (27.8–44.0)	4.0(2.9) (2.3–10.0)	0.6(0.5) (0.1–1.4)
Pies $\leq$ 5% TFA (n = 4)	15.5(4.0) (8.1–21.4)	1.9(1.1) (0.7–4.2)	42.9(5.7) (28.0–56.3)	44.8(5.6) (31.0–57.8)	4.1(4.1) (0.1–14.1)	3.2(3.3) (0.4–7.7)	27.8(5.7) (14.5–40.4)	6.3(2.0) (4.5–11.0)	34.3(5.7) (22.0–40.0)	17.9(7.9) (10.0–17.4)	3.0(1.2) (1.4–45.7)
Tarts >5% TFA (n = 5)	17.1(8.3) (7.3–27.6)	13.8(7.2) (5.4–23.0)	42.4(15.2) (23.3–59.0)	56.1(11.6) (42.8–66.7)	4.8(4.5) (0.1–9.3)	3.9(3.7) (0.6–9.8)	21.3(10.2) (11.7–35.7)	10.6(2.3) (9.3–13.4)	33.6(8.3) (27.1–43.0)	8.9(3.4) (4.7–13.1)	0.8(0.4) (0.5–1.3)
Tarts $\leq$ 5% TFA (n = 10)	16.0(5.7) (13.1–18.9)	1.7(1.1) (0.9–3.2)	40.3(10.0) (27.4–63.3)	42.0(10.7) (29.1–67.4)	3.3(4.8) (0.6–14.2)	3.7(3.4) (0.9–6.1)	25.7(7.8) (15.1–34.8)	5.8(2.5) (3.0–8.8)	37.9(5.9) (27.1–46.8)	16.6(5.4) (4.5–23.5)	3.4(1.9) (0.8–7.4)

<sup>a</sup> The values are given as mean and SD (in parentheses) for all the samples for each food category collected from 2005 to 2009. The ranges are given in parentheses.

tritridecanoin or triheneicosanoin in 1 mL CHCl<sub>3</sub>, 2.0 mL ethanol, and 10.0 mL 8.3 M HCl were added and mixed well until the entire product was dispersed. The test tube was heated for 60 min at 80°C, and the contents of the test tube were thoroughly mixed using a vortex mixer every 10 min to incorporate into solution particulates adhering to the sides of the test tube. After 60 min for digestion, the test tube was removed from the bath, allowed to cool to room temperature, and mixed with 2.0 mL ethanol and 5.0 mL diethyl ether. The contents of the tube were transferred to a separatory funnel. To ensure quantitative transfer, the tube was rinsed with 2 × 10 mL diethyl ether and 2 × 10 mL hexane twice. These rinses were transferred to the separatory funnel. Then 50 mL diethyl ether and 50 mL hexane were added the separatory funnel, and mixed briefly; the layers were allowed to settle, and the top organic layer was collected into a flask. The aqueous layer was extracted with 2 × 25 mL diethyl ether and 25 mL hexane. These extracts were combined with the previously collected organic layer, dried for 15 min with sodium sulfate, and filtered; the solvent was evaporated to dryness in a Rotovap.

#### *Methylation*

The fat was dissolved in 2 mL toluene, mixed with 1 mL methanol and converted to fatty acid methyl esters (FAMES) by heating at 100°C with 1 mL 14% BF<sub>3</sub>-methanol (SUPELCO, Bellefonte, PA).

#### *GC Analysis*

The FAMES were recovered by using hexane and analyzed according to the AOCS Official Method Ce 1h-05 (31) with an SP-2560 capillary column (100 m × 0.25 mm id, 20 μm film thickness, SUPELCO) in a GC system (Agilent 6890 GC was used in Ottawa and Toronto laboratories, and a Varian GC was used in the Winnipeg laboratory) equipped with a flame ionization detector (FID) and a chromatographic software. The column oven temperature was 180°C isothermal. Ultrahigh purity hydrogen (Ottawa laboratory) or helium (Toronto and Winnipeg laboratories) were the carrier gases and were run at a constant flow rate of 1.0 mL/min. The injector and detector temperatures were 250°C. The injector was set up for a split ratio of 100:1.

The FAME peaks on the GC trace were identified by comparison with the published traces in the AOCS Official Method Ce 1h-05 (31) and with traces published by Ratnayake et al. (32–34). Identifications were further established by comparison of retention times using standard FAME standards purchased from Nu Check Prep, Inc. (GLC-463) and Sigma, St. Louis, MO. The fatty acid composition (as % total fatty acids and corrected for the FID response) and the total fat content expressed as triglyceride equivalents were calculated according to the AOCS Official Method Ce 1h-05 (31).

#### *Label Review of Nutritional Facts Table*

In early 2008, it was recognized that the total fat content and the *trans* and SFA values from laboratory analyses matched values declared in the Nutrition Facts table of most

prepackaged foods. Thus, in 2008, for some prepackaged foods data on total fat, TFAs and SFAs, which are given as grams per serving, were taken from the Nutrition Facts table. The data were then converted to express the fat content per 100 g food, and TFAs and SFAs per 100 g total fatty acids. For the label review, the food categories (cookies, crackers, instant noodles, snack puddings, coffee whiteners, frozen potato products, baked prepackaged desserts, frozen prepackaged desserts, snacks, and popcorn) were chosen because they represented foods that were previously significant sources of TFAs. The individual products within each category were selected on the basis of market share data. Collectively, products represented more than 99% of the market share, as volume share. The food labels were collected in March and October 2008 from major grocery stores in Toronto and Scarborough (Ontario), Vancouver (British Columbia), Halifax (Nova Scotia), and Montreal (Quebec).

#### *Estimates of TFA and SFA Intake Levels for the Canadian Population for 2004 and 2008*

The dietary intake data required for the estimations of TFA and SFA intakes were from the 2004 Canadian Community Health Survey 2.2 of Statistics Canada (35). This was a 24 h food recall survey performed in 2004, and involved over 33 000 respondents from all provinces of Canada, excluding the two territories, with a repeat recall done on a subset of 10 000 respondents. Respondents with null or invalid recalls, children under 1 year of age, and breast-fed children were excluded. The required TFA and SFA composition values in foods required for the intake estimation for 2004 were from the Canadian Nutrient File version 2.2 of Health Canada (36). For the 2008 estimation, the TFA and SFA composition values were from the Trans Fat Monitoring Program (26–28).

Intake distributions were estimated using the Software for Intake Distribution Estimations (37). Population weightings were applied to obtain representative estimates, and the Bootstrap method was used to calculate standard errors for the TFA and SFA estimates (38). Reliability rules based on the CV were applied to identify estimates of marginal reliability (16.6% < CV ≤ 33.3%).

## **Results**

A total of 1120 food samples in 31 different food categories were analyzed from 2005 to April 2009. Of this, 672 samples were laboratory analyses, and for the balance of 448 samples, the data were from the label review of the Nutrition Facts table. The number of samples analyzed and the progress made in meeting the 2% (for soft or tub-margarines and other spreads) or 5% (for all other foods) for each year are summarized in Table 1. This table also includes a cumulative summary of the results from 2005–2009, which represent results for those foods that were analyzed more than once. This summary shows that in 2005, 58% of the samples met the 2% or 5% TFA limit. This percentage remained the same in 2006, but gradually increased to 68% in 2007 and 77% in 2008. In 2009 (up to April), 78% of the samples met the limit.

**Table 4. Fat content (g/100 g food) and fatty acid composition (g/100 g total fatty acids) for fast foods from restaurants with TFA level above and below 5% limit<sup>a</sup>**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Chicken products >5% TFA (n=25)	14.6(3.6) (9.2–21.0)	18.0(7.4) (5.3–38.5)	17.2(5.1) (8.0–26.6)	35.2(10.4) (14.4–58.4)	0(0)	0.2(0.1) (0.1–0.3)	10.4(3.3) (6.1–16.0)	5.9(1.7) (2.3–10.8)	46.3(10.2) (33.1–69.0)	14.6(7.3) (5.2–31.8)	1.6(0.7) (0.4–3.3)
Chicken products ≤5% TFA (n=77)	14.6(3.6) (7.6–25.8)	1.4(0.6) (0.6–4.8)	13.1(4.7) (8.0–25.6)	14.5(4.6) (8.6–26.4)	0(0)	0.2(0.2) (0.1–1.0)	8.4(3.6) (5.2–18.0)	2.8(1.1) (2.0–7.7)	60.0(9.4) (29.3–72.4)	21.9(6.6) (14.0–47.3)	3.5(1.8) (0.4–7.0)
French fries >5% TFA (n=19)	14.3(2.4) (8.6–22.3)	21.8(10.1) (5.7–46.0)	15.4(3.7) (9.4–13.0)	37.0(12.0) (15.1–66.4)	0(0)	0.1(0.1) (0.1–0.4)	8.2(2.4) (4.9–10.8)	6.0(2.0) (2.8–10.8)	47.1(10.9) (26.0–63.8)	13.7(10.0) (0.8–37.9)	1.6(0.9) (0.1–6.9)
French fries ≤5% TFA (n=71)	15.1(4.0) (2.7–25.0)	1.4(0.8) (0.7–4.3)	9.7(2.5) (7.2–24.8)	11.2(2.8) (7.9–28.5)	0(0)	0.1(0.1) (0.1–0.8)	5.9(1.8) (3.6–13.1)	2.4(0.8) (1.7–8.7)	63.3(10.1) (26.2–84.3)	21.0(7.5) (5.6–49.9)	4.4(2.2) (0.3–8.4)
Onion rings >5% TFA (n=3)	18.8(5.8) (13.0–30.2)	24.1(1.6) (6.5–37.1)	15.9(4.7) (10.4–21.0)	40.0(15.7) (17.5–57.0)	0(0)	0.1(0)	9.0(2.5) (5.7–11.7)	6.2(2.5) (3.2–9.5)	44.0(14.1) (30.8–65.0)	14.5(6.7) (9.9–31.4)	1.5(0.6) (0.9–2.8)
Onion rings ≤5% TFA (n=12)	20.7(5.6) (16.1–33.0)	1.2(0.7) (0.7–3.0)	10.5(2.7) (8.1–16.7)	11.7(3.3) (8.7–19.7)	0(0)	0.2(0.3) (0.1–1.2)	6.6(1.9) (4.8–9.0)	2.7(0.8) (1.8–4.3)	60.9(10.2) (37.4–61.7)	26.1(10.3) (17.5–49.4)	3.0(0.9) (1.6–3.2)
Fish products >5% TFA (n=6)	9.3(2.9) (4.7–12.5)	27(15.1) (5.4–42.4)	18.3(5.3) (10.1–23.3)	45.3(20.2) (15.4–65.7)	0(0)	0.1(0.1) (0.1–0.3)	9.9(2.3) (6.3–11.7)	7.0(3.0) (3.0–10.3)	39.4(15.9) (29.2–65.0)	11.6(12.2) (4.0–35.0)	3.1(2.7) (0.3–6.6)
Fish products ≤5% TFA (n=19)	14.3(5.2) (6.9–24.4)	1.3(0.6) (0.7–3.0)	9.8(2.6) (8.0–14.6)	11.1(2.6) (8.9–16.4)	0(0)	0.1(0)	6.1(1.7) (4.7–9.0)	2.5(1.1) (1.8–3.0)	62.9(11.1) (33.7–69.7)	20.7(7.7) (14.9–43.2)	5.2(3.0) (2.6–12.0)
Pizzas ≤5% TFA (n=13)	5.3(3.4) (1.2–9.6)	2.4(1.3) (1.0–3.7)	34.6(10.5) (19.3–46.8)	37.0(11.2) (20.9–50.5)	1.2(1.2)	2.9(3.1) (0.4–6.1)	21.0(4.4) (12.5–25.2)	7.9(2.9) (3.1–11.1)	34.8(7.2) (20.1–45.5)	24.9(12.7) (11.3–50.4)	3.2(2.0) (2.1–6.1)
Donuts >5% TFA (n=25)	20.7(6.8) (7.4–31.2)	32.0(7.7) (5.4–56.0)	24.5(5.5) (14.0–45.4)	56.4(5.7) (34.1–72.3)	0.2(0.6)	0.2(0.3) (0.0–1.1)	10.8(6.1) (5.1–37.7)	12.5(2.4) (6.3–15.7)	35.9(5.3) (25.1–50.2)	6.6(3.3) (2.7–14.6)	0.9(0.8) (0.1–3.4)
Donuts ≤5% trans (n=10)	19.0(5.3) (9.5–29.0)	1.5(1.1) (0.2–3.1)	48.1(2.3) (43.2–51.4)	49.7(2.6) (45.9–52.2)	0.3(0.1)	0.9(0.1) (0.7–1.3)	39.7(4.0) (32.0–45.2)	6.5(2.2) (4.8–11.2)	33.4(1.4) (30.8–35.0)	15.7(3.0) (11.8–16.6)	1.2(0.4) (0–1.5)
Muffins >5% trans (n=3)	9.7(1.5) (8.5–11.4)	20.8(5.8) (16.6–27.4)	19.5(4.6) (16.7–27.4)	40.3(10.3) (33.3–52.2)	0(0)	0.1(0.1) (0.1–0.2)	9.3(3.5) (7.2–13.3)	9.1(1.2) (8.4–10.5)	45.0(6.1) (37.9–48.9)	11.8(2.2) (9.3–12.4)	3.0(2.1) (0.6–4.0)
Muffins ≤5% TFA (n=25)	14.1(4.1) (8.0–25.1)	0.9(0.4) (0.5–1.9)	15.1(5.4) (8.4–31.9)	15.9(5.4) (9.0–32.4)	0.3(0.4)	0.2(0.3) (0.1–1.3)	7.5(2.8) (5.0–16.6)	3.9(2.8) (1.9–12.0)	32.9(11.3) (25.7–70.0)	28.9(5.5) (18.0–50.6)	5.9(1.9) (1.9–10.8)
Miscellaneous fast foods >5% TFA (n=2)	17.7(8.9) (11.4–24.0)	26.9(23.1) (10.5–43.3)	27.2(23.5) (10.6–43.8)	55.0(23.8) (38.2–71.8)	0.5(0.5)	1.2(1.2) (0.0–2.4)	13.7(12.5) (4.8–22.6)	10.8(10.1) (3.6–18.0)	33.0(12.7) (24.0–42.0)	10.6(6.1) (3.6–17.6)	1.1(0.9) (0.2–2.0)
Miscellaneous fast foods ≤5% TFA (n=9)	17.2(7.9) (1.2–33.1)	1.8(1.3) (0.5–4.4)	29.8(20.0) (8.1–88.3)	31.5(21.0) (2.4–90.1)	2.5(6.4)	2.8(3.7) (0–16.0)	16.8(10.4) (4.3–39.9)	15.8(11.6) (1.8–26.1)	45.6(18.0) (4.0–73.9)	20.5(12.9) (9.7–53.7)	2.7(2.0) (0.3–6.4)
Pizza dipping sauces ≤5% TFA (n=8)	26.4(21.3) (0.1–52.2)	1.5(1.0) (0.9–2.0)	15.6(11.7) (7.9–43.3)	17.2(12.6) (9.6–46.9)	1.0(2.5)	0.2(0.4) (0.0–0.6)	8.8(3.8) (4.6–16.9)	3.0(0.9) (2.2–4.4)	51.0(22.8) (15.8–68.5)	26.6(15.2) (11.1–53.3)	5.2(3.3) (1.2–8.0)

<sup>a</sup> The values are given as mean and SD (in parentheses) for all the samples for each food category collected from 2005 to 2009. The ranges are given in parentheses.

In 2009 the focus was only on foods served in cafeterias of hospitals, universities, and colleges; other samples were not collected. In total, from 2005 to April 2009, 1120 samples were analyzed, and 852 (or 76%) met the TFA limits recommended by the Trans Fat Task Force.

The fat content and fatty acid composition details obtained by actual laboratory analysis for prepackaged foods, bakery products, fast foods from restaurants, ethnic foods, and foods from institutions are shown in Tables 2–6. The data derived from the food label review are shown in Table 7. In the fatty acid data tables, the samples in each food category are placed into one of two groups: samples that were above the TFA limits and samples that were below the TFA limits. The mean, SD, and the range for the two groups are given.

### *Prepackaged Foods*

Previous data have shown that prepackaged foods sold in Canada could contain large amounts of TFAs (18, 19). The fatty acid data of Tables 1, 2, and 7 show that in many prepackaged food categories a number of food manufacturers have successfully decreased the level of TFAs in their products by reformulating to the levels recommended by the Trans Fat Task Force. For example, 83% of frozen chicken products, 94% of crackers, 71% of frozen prepackaged desserts, 84% of baked prepackaged desserts, 80% of granola bars, 86% of instant noodles, 90% of frozen potato products, 100% of lard-shortening, 92% of snacks, 78% of snack puddings, and 82% of popcorn sampled contained <5% TFAs. However, the progress made in several other prepackaged food categories was much lower. For example, only 68% of cookies, 53% of coffee whiteners, 62% of tub-margarines, 0% of print-margarines, and 50% of vegetable shortening samples met the 2% (spreads) or 5% (foods other than spreads) TFA limits.

The fatty acid data (Tables 2 and 7) also show that in many cases where there was a reduction of TFA, these decreases resulted in TFA levels that were much lower than the 2% limit for tub-margarines or 5% limit for all the other foods. The small amounts of TFAs present in the reformulated products are the *trans* geometric isomers of linoleic and  $\alpha$ -linolenic acids (detailed TFA isomer data are not shown in Tables) and have most likely originated from the liquid vegetable oils used in the reformulated products. It is known that liquid vegetable oils, such as canola and soybean oils, can contain small amounts (0.2–2%) of *trans* isomers of linoleic and  $\alpha$ -linolenic acids, which are formed during the deodorization step of the refining process (1, 3).

The fatty acid data also show that the reductions of TFAs in many brands of granola bars, frozen potato products, tub-margarines, frozen pizzas, and vegetable shortenings were achieved by not increasing the levels of SFAs, but by increasing the levels of *cis*-unsaturated fatty acids. Several manufacturers have increased oleic acid levels, and in some products, both linoleic and  $\alpha$ -linolenic acids increased (Table 2). In crackers, cookies, frozen chicken products, and garlic spreads, TFA reductions were associated with an increase in the level of SFAs and unsaturated fatty acids.

Although there was an increase in SFAs in these four food categories, the sum of TFAs and SFAs did not increase, which suggests that the reduction of TFAs in these prepackaged foods was achieved primarily by increasing the unsaturated fatty acids. In other words, PHVOs were replaced by an oil blend containing a small proportion of saturated oil and a high proportion of high-oleic oil or moderately high-linoleic and  $\alpha$ -linolenic acid oil. In most of the reformulated products where the SFA content increased, the primary SFA that was increased was palmitic acid (Table 2), which indicated that the source of palmitic acid in many of the reformulated products with high SFA content was palm oil.

The progress in reducing the TFA content of tub-margarines in Canada is slow and has lagged behind Europe (39). Furthermore, none of the Canadian print-margarines sampled met the 5% TFA limit (Tables 1 and 2). The average TFA content for the six brands analyzed in 2005 and 2007 was 39.3%, which is similar to the levels reported in previous studies for Canadian margarines (15–17).

### *Bakery Products*

Foods in this category were previously known to contribute large amounts of TFA (18, 19). The fatty acid data suggest that the progress in this category is extremely poor, where 45% of brownies, 43% of cakes, 25% of croissants, 45% of danishes, 55% of garlic breads, 36% of pies, and 67% of tarts sampled contained <5% TFAs (Table 3). However, the good news is that in most of the bakery products, the reduction was achieved by an increase in the oleic, linoleic, and  $\alpha$ -linolenic acids, and no increase in SFAs. Overall, the reformulated bakery products had a nutritionally improved fatty acid profile compared to those prepared using PHVOs (Table 3).

### *Fast Foods from Restaurant Establishments*

Because PHVOs are traditionally used as commercial shortenings for frying in fast-food establishments and other restaurants, fast foods are known to contain relatively high levels of TFAs (1, 18, 19, 40) and they can be a significant source of TFAs in the diet (39). The fatty acid data of the present study show that a significant number of popular fast-food and family restaurant chains in Canada have been successful in decreasing TFA levels in menu items that had previously been high in TFAs, such as chicken products, fish products, French fries, miscellaneous foods (hash browns, apple turnovers, etc.), muffins, onion rings, and pizzas (Tables 1 and 2). For example, 100% of pizzas, 79% of chicken products, 83% of fish products, 79% of French fries, 89% of muffins, and 75% of onion rings sampled contained <5% TFAs (Table 1). In all the fast-food items, except donuts and miscellaneous foods, the reductions were achieved by using healthier alternatives containing high levels of oleic acid or linoleic/ $\alpha$ -linolenic acids and by not increasing the levels of SFAs (Table 4). The fatty acid results suggest that the high-oleic oils are predominantly used in fast-food establishments in Canada for frying chicken products, French fries, onion rings, and fish products. For making pizzas and

**Table 5. Fat content (g/100 g food) and fatty acid composition (g/100 g total fatty acids) for ethnic foods with TFA level above and below 5% limit<sup>a</sup>**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Indian											
Finger foods <sup>b</sup> ≤5% TFA (n = 12)	14.5(6.5) (5.2–26.1)	1.8(0.7) (0.9–3.0)	15.3(7.2) (8.9–24.8)	17.0(7.8) (9.8–26.3)	0.1(0.2) (0–0.8)	0.5(0.8) (0.1–1.4)	9.9(5.3) (5.6–23.0)	4.2(2.2) (2.0–7.1)	47.2(13.6) (25.2–59.5)	29.2(10.7) (21.6–50.7)	6.5(1.5) (4.1–8.2)
Breads >% TFA (n = 1)	10.7	8.5	18.7	0	0.2	12.0	5.6	24.3	43.2	5.2	27.2
Breads ≤5% TFA (n = 5)	12.9(5.2) (7.7–18.1)	0.8(0.5) (0.3–1.2)	33.2(25.9) (14.6–62.8)	34.0(25.4) (15.5–63.1)	0.1(0.1) (0–0.2)	0.8(0.4) (0.4–1.2)	26.2(24.6) (9.6–54.4)	5.3(2.1) (2.9–6.6)	36.5(14.4) (28.0–53.1)	25.3(17.5) (8.4–43.4)	4.1(3.5) (0.2–7.0)
Dessert ≤5% TFA (n = 1)	15.1	0.8	17.0	17.8	0	0.3	12.4	3.5	57.7	18.9	5.6
Jamaican											
Curry chicken >5% TFA (n = 1)	4.1	5.4	30.1	35.5	0	0.7	22.6	6.4	47.3	16.0	1.2
Chinese											
Fried meat products >5% TFA (n = 1)	25.7	5.4	30.7	36.1	0.1	1.0	19.4	9.7	40.1	22.4	1.4
Fried meat products ≤5% TFA (n = 10)	12.8(5.4) (7.6–22.0)	1.9(1.5) (1.0–4.9)	22.3(11.0) (10.6–39.2)	24.3(12.1) (11.6–42.2)	0(0) (0–0.1)	0.5(0.4) (0–1.2)	14.4(7.5) (6.5–23.8)	6.6(4.1) (2.8–13.7)	53.5(8.5) (41.5–61.4)	18.0(2.5) (14.6–20.7)	4.3(2.7) (0.9–7.0)
Fried rice ≤5% TFA (n = 6)	6.0(1.1) (5.0–7.7)	0.9(0.3) (0.4–1.1)	18.5(4.1) (12.9–23.9)	19.4(4.0) (14.0–24.8)	0.2(0.6) (0–1.4)	0.3(0.2) (0.2–0.7)	12.3(2.6) (8.6–15.9)	4.8(1.4) (2.9–6.7)	39.8(14.1) (28.1–54.9)	35.0(11.6) (19.8–46.8)	5.8(0.8) (4.9–7.1)
Fried noodles ≤5% TFA (n = 2)	16.0(3.7) (13.3–18.6)	0.8(0.1) (0.8–0.9)	25.3(19.1) (11.7–38.8)	26.1(19.2) (12.5–39.7)	0.1(0.1) (0–0.1)	0.7(0.5) (0.2–1.2)	15.7(11.0) (7.9–23.5)	8.1(7.8) (2.5–13.6)	47.7(14.4) (37.5–57.9)	21.5(0.9) (20.8–22.1)	4.7(3.8) (2.0–7.4)
Spring rolls ≤5% TFA (n = 3)	14.3(5.1) (11.0–20.2)	0.9(0.3) (0.7–1.3)	33.6(13.5) (23.0–48.9)	34.6(13.3) (24.3–49.6)	2.4(4.1) (0–7.1)	1.7(1.8) (0.7–3.8)	18.1(4.0) (14.5–22.4)	10.1(3.0) (7.1–13.1)	39.2(13.0) (30.8–54.2)	22.9(10.5) (16.3–35.0)	3.4(1.7) (1.4–4.6)
Instant noodles ≤5% TFA (n = 1)	18.5	0.7	47.8	48.5	0.1	0.1	42.9	4.0	37.9	13.2	0.3
Crackers, biscuits >5% TFA (n = 3)	23.2(12.5) (9.5–34.1)	22.4(17.9) (10.1–43.0)	44.4(9.8) (33.2–50.9)	66.9(8.6) (59.3–76.2)	3.0(2.5) (0.3–5.3)	1.8(0.9) (0.9–2.6)	27.9(5.5) (22.0–32.8)	10.3(1.5) (8.9–11.9)	27.2(5.8) (20.9–32.3)	5.6(2.7) (2.7–8.0)	0.3(0.1) (0.2–0.3)
Crackers, biscuits ≤5% TFA (n = 6)	18.5(6.1) (9.1–25.2)	1.0(0.4) (0.6–1.5)	31.1(15.7) (9.6–50.6)	32.0(15.8) (10.5–52.1)	0.8(1.4) (0.1–3.5)	1.0(0.8) (0.1–1.9)	23.0(12.8) (9.8–42.4)	5.3(4.1) (2.0–13.3)	40.0(9.4) (25.2–55.3)	22.8(8.1) (12.2–34.4)	2.7(3.1) (0.4–8.0)
Thai											
Spring rolls ≤5% TFA (n = 4)	13.2(5.0) (8.6–18.6)	1.1(0.1) (1.0–1.2)	17.0(8.7) (11.0–2.7)	9.5(2.1) (7.2–11.4)	3.0(3.4) (0–6.6)	1.3(1.3) (0.1–2.6)	9.5(2.1) (7.2–11.4)	3.7(1.0) (2.5–4.3)	45.1(20.5) (21.5–59.0)	28.7(14.4) (19.2–45.2)	6.0(0.9) (5.4–7.1)
Fried meat products ≤5% TFA (n = 4)	8.7(8.5) (3.0–21.1)	1.0(0.4) (0.7–1.5)	20.9(3.8) (16.8–25.5)	21.9(4.6) (17.6–26.5)	0(0) (0–0)	0.3(0.1) (0.2–0.4)	13.9(2.6) (12.0–17.7)	5.6(1.7) (3.7–7.5)	38.3(17.5) (26.3–64.0)	35.4(14.1) (15.6–46.8)	4.5(1.5) (2.6–6.0)

**Table 5. (continued)**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
<b>Lebanon</b>											
Shawarma ≤5% TFA (n = 2)	15.6(1.3) (13.6–15.5)	1.5(0.6) (1.0–1.9)	14.1(0.8) (13.6–14.7)	15.6(1.4) (14.6–16.6)	0(0) (0–0)	0.2(0.1) (0.2–0.3)	9.3(0.5) (8.9–9.6)	3.3(0.8) (2.7–3.9)	66.8(11.1) (58.9–74.6)	9.7(13.6) (0.1–19.3)	8.0(1.0) (7.3–8.7)
Dessert >5% TFA (n = 1)	30.9	13.2	23.9	0	0.2	15.0	7.6	49.1	13.1	0.3	37.1
<b>Japanese</b>											
Tempura ≤5% TFA (n = 1)	16.2	1.3	11.3	12.6	0	0.1	7.3	2.7	52.2	27.9	7.1

<sup>a</sup> The values are given as mean and SD (in parentheses) for all the samples for each food category collected from 2005 to 2009. The ranges are given in parentheses.  
<sup>b</sup> Finger foods: pakora, samosa, vada; breads: naan, rotli, paratha; fried meat products: chicken, beef, pork.

muffins, liquid oils containing high levels of linoleic acid and moderate levels of  $\alpha$ -linolenic acid appear to be predominantly used.

The reduction of TFAs in donuts is unsatisfactory; only 29% of the samples analyzed from 2005 to 2009 contained <5% TFA (Table 1), which may suggest a difficulty in finding suitable healthy alternatives for replacing PHVOs in donut preparation. This is evident from the relatively high SFA content (48% of total fatty acids) of donut samples with <5% TFAs (Table 4). The SFA content is almost double, compared to donuts with >5% TFA. Nevertheless, this large increase of SFA level did not result in an increase in the sum of TFAs and SFAs, which suggests that healthier alternatives have been used in reducing TFA in donuts.

The progress of TFA reduction in miscellaneous foods (hash browns, apple turnovers, etc.) was also unsatisfactory (Table 1). In 2007, 78% of the samples met the 5% TFA limit, but in a different set of samples examined in 2008, only 50% met the limits. Nevertheless, it is encouraging to note a substantial improvement in the nutritional quality of those samples that contained <5% TFAs (Table 4). The only negative aspect was the slightly higher SFA content (29.8 versus 27.2%), but this is offset by the very high levels of oleic (45.6 versus 33.0%), linoleic (20.5 versus 10.6%), and  $\alpha$ -linolenic (2.7 versus 1.1%) acids. This clearly demonstrates that miscellaneous fast foods as well as other fast foods can be prepared using healthier alternatives.

**Ethnic Foods**

Because of the large ethnic population in Canada and the increasing popularity of ethnic foods among all Canadians, our study included some of the popular ethnic foods of Indian, Chinese, Thai, Lebanese, Caribbean, and Japanese origin. The fatty acid results show that, of the 63 foods sampled, 56 (or 89%) meet the 5% TFA limit (Table 1). The fatty acid data also suggest that unsaturated oils have been primarily used in ethnic food preparations (Table 5).

**Foods from Cafeterias in Institutions**

Our study included foods served in cafeterias of hospitals, universities, and colleges. Most (>70%) of the chicken products (primarily fried-battered chicken and chicken fingers), cookies, French fries, and muffin samples analyzed met the 5% limit (Tables 1 and 6). However, some other foods sold (fried onion rings, fish products) or used (margarines) in institutions did not meet the 5 or 2% limit. The fatty acid data suggest that unsaturated oils have been used in frying fast foods, and saturated fats have been used in the preparation of cookies (Table 6).

**Estimated TFA and SFA Levels for the Canadian Population**

The estimated average TFA and SFA intakes, expressed in two different formats (g/day and % of total energy) by age-sex group for 2004 and 2008 are shown in Table 8. All standard errors were low, indicating an adequate level of reliability. All CVs were below the marginal reliability threshold of 16.6%.

**Table 6. Fat content (g/100 g food) and fatty acid composition (g/100 g total fatty acids) for foods from cafeterias in institutions (hospitals, universities, and colleges) with TFA level above and below 2% (tub-margarines) or 5% (all foods except tub-margarines) limit<sup>a</sup>**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	12:0	14:0	16:0	18:0	18:1	18:2	18:3
Chicken products >5% TFA (n=3)	10.9(2.9)	25.5(18.6)	14.4(3.1)	39.9(19.5)	0(0)	0.1(0)	8.8(2.5)	3.9(0.8)	45.4(15.0)	13.1(6.3)	1.6(1.1)
Chicken products >5% TFA (n=11)	7.6–13.0	(14.0–47.0)	(11.0–17.2)	(25.0–62.0)	(0–0)	0.1–0.1	(6.0–11.0)	(3.5–4.8)	(31.0–61.0)	(7.5–20.0)	(0.3–2.2)
Cookie products >5% TFA (n=7)	14.2 (4.6)	2.0(1.3)	12.2(3.6)	14.3(4.5)	0(0)	0.1(0.0)	7.9(2.8)	3.1(1.0)	59.9(16.8)	23.0(11.5)	2.8(1.6)
Cookie products >5% TFA (n=7)	(9.0–19.7)	(1.0–4.6)	(9.0–18.0)	(9.8–22.0)	(0–0)	(0.1–0.2)	(5.3–13.0)	(2.2–4.7)	(26.3–73.6)	(14.0–48.0)	(1.6–5.9)
Cookie products ≤5% TFA (n=22)	21.4(3.1)	21.8(5.5)	29.1(9.0)	50.9(7.9)	1.3(3.0)	0.8(1.3)	13.2(2.3)	12.3(3.7)	39.4(5.7)	8.3(4.0)	0.8(0.6)
Cookie products ≤5% TFA (n=22)	(17.5–25.6)	(13.7–29.0)	(19.0–35.7)	(39.0–60.9)	(0–8.6)	(0.2–3.9)	(10.0–17.2)	(7.7–16.3)	(28.7–47.0)	(4.5–16.0)	(0.4–0.6)
Desserts >5% TFA (n=3)	20.7(4.3)	1.2(0.8)	46.8(10.6)	48.0(10.6)	3.2(3.7)	2.7(1.9)	30.0(7.7)	9.6(3.7)	38.5(7.0)	11.8(4.1)	1.7(1.8)
Desserts >5% TFA (n=3)	(12.7–30.0)	(0.4–4.2)	(10.6–60.8)	(11.5–61.9)	(0–12.0)	(0.1–6.5)	(7.5–39.7)	(2.0–14.3)	(30.8–52.0)	(8.0–24.0)	(0.3–4.6)
Desserts ≤5% TFA (n=5)	11.8(3.0)	17.4(10.1)	23.0(4.0)	40.4(13.1)	0.1(0.2)	0.2(0.1)	12.5(3.1)	9.0(1.3)	35.4(12.8)	20.6(14.7)	3.1(2.2)
Desserts ≤5% TFA (n=5)	(9.9–15.3)	(8.9–28.6)	(19.0–26.9)	(31.9–55.5)	(0.0–0.3)	(0.2–0.3)	(9.5–15.6)	(7.6–9.9)	(25.1–49.8)	(13.0–37.6)	(0.6–5.0)
Desserts ≤5% TFA (n=5)	16.7(4.4)	0.7(0.2)	34.0(23.1)	34.7(23.0)	4.1(9.0)	2.0(3.2)	21.5(17.1)	4.3(4.7)	45.9(15.1)	15.0(5.3)	4.3(3.3)
Desserts ≤5% TFA (n=5)	(12.6–23.3)	(0.6–1.0)	(8.6–59.8)	(11.0–60.4)	(0–20.2)	(0.1–7.6)	(5.4–40.5)	(0.2–12.3)	(26.8–60.7)	(9.5–22.4)	(0.3–8.1)
Fish products >5% TFA (n=1)	12.4	13.4	12.1	25.5	0	0.1	8.1	2.9	50.0	21.0	2.9
Fish products ≤5% TFA (n=1)	18.4	0.6	10.4	11.0	0	0.1	5.1	3.7	61.9	26.0	1.0
French fries >5% TFA (n=6)	14.4(3.2)	13.7(3.7)	14.7(3.0)	28.4(6.4)	0.1(0.1)	0.1(0.1)	9.0(1.9)	4.4(1.3)	43.9(11.1)	21.7(10.4)	2.7(0.6)
French fries >5% TFA (n=6)	(10.9–18.2)	(6.7–16.8)	(10.0–16.9)	(16.7–33.7)	(0.0–0.3)	(0.1–0.2)	(5.7–11.0)	(2.9–5.9)	(33.6–63.0)	(19.0–28.0)	(2.1–3.7)
French fries ≤5% TFA (n=15)	14.0(4.2)	1.6(1.2)	9.0(2.1)	10.5(3.2)	0.0(0)	0.1(0)	5.2(1.6)	2.5(0.7)	66.7(10.3)	19.3(6.7)	3.4(1.9)
French fries ≤5% TFA (n=15)	(5.0–23.7)	(0.8–5.0)	(7.0–15.1)	(7.8–13.0)	(0–0)	(0.1–0.1)	(3.7–9.7)	(1.9–4.2)	(38.1–76.5)	(13.7–36.0)	(1.5–8.1)
Fried onion rings >5% TFA (n=1)	26.1	5.3	16.8	22.1	0	0.1	11.0	4.9	28.3	43.0	6.0
Fried onion rings ≤5% TFA (n=2)	19.1(0.1)	0.8(0.3)	10.2(1.0)	10.9(0.6)	0(0)	0.1(0)	5.7(0)	3.1(0.8)	63.3(7.7)	24.0(8.0)	1.7(0.8)
Fried onion rings ≤5% TFA (n=2)	(19.0–19.2)	(1.0–0.6)	(9.5–10.9)	(10.3–11.5)	(0–0)	(0.1–0.1)	(5.7–5.7)	(2.5–3.7)	(57.8–68.7)	(18.3–29.6)	(1.1–2.3)
Tub-margarines >2% TFA (n=2)	76.0(3.0)	25.0(1.0)	17.0(0)	42.0(1.0)	0(0)	0.2(0)	7.3(0.0)	8.1(0)	49.5(0.5)	6.9(0.5)	1.3(0)
Tub-margarines >2% TFA (n=2)	73–79	(24.0–26.0)	(17.0–17.0)	(41.0–43.0)	(0.0)	(0.2–0.2)	(7.3–7.3)	(8.0–8.1)	(49.0–50.0)	(6.5–7.2)	(1.3–1.3)
Tub-margarines ≤2% TFA (n=2)	80.0(1.0)	2.6(2.5)	15.0(0)	17.6(2.5)	1.1(0.1)	0.8(0.0)	9.2(0.3)	2.4(0)	52.0(2.0)	24.5(0.5)	6.3(0.6)
Tub-margarines ≤2% TFA (n=2)	(79.0–81.0)	(0.8–4.4)	(15.0–15.0)	(15.8–19.4)	(1.1–1.2)	(0.8–0.8)	(8.9–9.5)	(2.4–2.4)	(50.0–54.0)	(24.0–25.0)	(5.9–6.7)
Muffins ≤5% TFA (n=22)	11.8(4.0)	0.9(1.0)	15.9(6.0)	16.8(7.0)	0.3(1.0)	0.6(1.0)	9.5(4.0)	4.4(2.0)	51.7(19.0)	27.1(14.0)	4.4(3.0)
Muffins ≤5% TFA (n=22)	(2.0–18.8)	(0.2–3.0)	(9.6–28.0)	(10.3–24.3)	(0.0–2.1)	(0.0–4.5)	(4.6–19.0)	(1.8–8.1)	(23.0–72.8)	(14.0–15.0)	(0.9–7.6)

<sup>a</sup> The values are given as mean and SD (in parentheses) for all the samples for each food category collected from 2005 to 2009. The ranges are given in parentheses.

**Table 7. Fat content (g/100 g food) and fatty acid composition (g/100 g total fatty acids) for prepackaged foods from grocery stores sold in Canada in 2008 with TFA level above and below 5% limit<sup>a</sup>**

Food item (No. of samples)	Fat content (g/100 g food)	TFA	SFA	TFA+SFA	Unsaturated fat
Coffee whiteners >5% TFA (n=9)	19.8 (7.5) (10.0–33.3)	54.8(16.9) (13.3–66.7)	30.9(8.3) (20.0–40.0)	81.3(23.6) (33.3–100)	18.7(23.6) (0–66.7)
Coffee whiteners ≤5% TFA (n=8)	12.4(12.6) (0.0–33.3)	0 (0) (0.0–0)	50.0(53.4) (0.0–100)	50(53.4) (0.0–100)	50.0(53.4) (0–100)
Cookies >5% TFA (n=24)	20.3(7.8) (8.3–33.3)	18.5(8.2) (6.7–33.3)	41.7(18.6) (21.4–75.0)	60.2(12.9) (36.0–78.5)	39.8(12.9) (16.6–55.6)
Cookies ≤5% TFA (n=46)	18.9(6.1) (4.9–33.3)	0.9(1.3) (0–4.0)	46.1(17.7) (8.0–90.0)	47.0(18.2) (8–90.0)	53.0(18.2) (10.0–92.0)
Crackers >5% TFA (n=7)	16.5(9.2) (1.0–30.0)	18.1(12.6) (5.0–33.3)	23.0(10.2) (11.1–42.9)	42.5(11.0) (20.0–55.5)	57.5(11.0) (44.5–80.0)
Crackers <5% TFA (n=7)	18.7(6.7) (5.0–31.6)	0.2(0.7) (0.0–2.2)	30.0(18.8) (10–100)	31.2(18.5) (10–100)	68.8(18.5) (0–90)
Instant noodles >5% TFA (n=3)	18.7(0.2) (18.5–18.8)	0.2(0.7) (41.7–43.8)	30.0(18.8) (16.7–18.8)	31.2(18.5) (58.4–62.6)	68.8(18.5) (27.4–41.6)
Instant noodles ≤5% TFA (n=19)	13.0(9.2) (1.5–23.4)	0.2(0.3) (0–0.9)	40.1(14.8) (10.0–63.6)	40.3(15.1) (10.0–63.6)	59.7(15.1) (36.4–90.0)
Frozen potato products >5% TFA (n=1)	7.1	41.3	16.7	58.4	41.6
Frozen potato products ≤5% TFA (n=10)	4.7(2.6) (0.4–9.4)	0(0) (0–0)	12.2(3.6) (6.7–16.7)	12.2(3.6) (6.7–16.7)	87.8(3.6) (83.3–93.3)
Desserts, baked prepackaged >5% TFA (n=14)	18.0(3.7) (7.5–20.7)	17.8(8.5) (6.7–28.6)	28.6(10.6) (15.0–55.0)	46.4(10.7) (25.0–62.5)	53.6(10.7) (37.5–75.0)
Desserts, baked prepackaged ≤5% TFA (n=73)	19.3(6.9) (2.9–44.6)	1.3(1.2) (0–4.3)	36.3(17.9) (11.1–88.9)	37.6(18.1) (13.3–88.9)	62.4(18.1) (11.1–86.7)
Desserts, frozen prepackaged >5% TFA (n=13)	16.4(6.8) (4.2–28.0)	11.7(5.0) (6.5–12.5)	47.7(14.2) (21.1–68.2)	58.8(10.4) (42.1–75.0)	41.2(10.4) (25.0–57.9)
Desserts, frozen packaged ≤5% TFA (n=36)	17.3(6.4) (5.8–33.9)	2.1(1.4) (0–4.5)	54.3(17.0) (20.8–90.9)	55.5(16.9) (21.7–95.5)	44.5(16.9) (4.5–78.3)
Snacks >5% TFA (n=7)	19.6(11.5) (2.5–29.2)	22.4(13.9) (10.0–50.0)	21.5(15.6) (11.1–50.0)	43.9(27.7) (23.0–100)	54.9(26.8) (0–76.6)
Snacks ≤5% TFA (n=85)	24.9(9.5) (6.0–40.0)	0.1(0.1) (0.0–2.0)	20.3(18.9) (0.0–92.3)	20.5(19.1) (0–92.3)	79.5(19.1) (7.7–100)
Snack pudding >5% TFA (n=6)	3.4(1.6) (1.5–6.1)	22.5(9.3) (16.0–33.3)	48.6(16.3) (25.0–66.7)	71.2(16.6) (50.0–100)	28.8(16.6) (0–50.0)
Snack pudding ≤5% TFA (n=21)	1.2(1.0) (0–3.5)	0.2(0.7) (0–3.3)	53.1(35.8) (0–100)	53.4(35.9) (0–100)	46.6(35.9) (0–100)
Popcorn >5% TFA (n=4)	19.8(10.5) (6.0–32.0)	33.0(10.0) (20.0–34.6)	25.4(9.8) (16.7–50.0)	58.4(18.1) (40.0–100.0)	41.6(18.1) (0.0–60.0)
Popcorn ≤5% TFA (n=18)	16.2(13.5) (4.0–42.5)	0.2(0.4) (0.0–1.0)	32.6(20.5) (0.0–66.7)	32.8(20.6) (0.0–66.7)	67.2(20.6) (33.3–100)

<sup>a</sup> The fatty acid data were calculated from the nutrition information (fat content, saturated fat and *trans* fat given as grams per serving) obtained from the Nutrition Facts table from food labels. The calculated values are given as mean and SD (in parentheses) for the two groups in each food category. The ranges are given in parentheses.

Table 8. Estimated average TFA and SFA intakes by Canadians in 2004 and 2008 by age-sex group<sup>a</sup>

Age-sex group, years	Sample size	TFA g/day				SFA g/day				TFA % of energy			
		2004		2008		2004		2008		2004		2008	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Children 1–3	2117	3.52	0.07	2.62	0.06	20.55	0.41	20.73	0.41	2.07	0.03	1.55	0.03
Children 4–8	3235	5.00	0.09	3.39	0.06	23.89	0.41	24.11	0.40	2.31	0.03	1.57	0.02
Boys 9–13	2080	6.49	0.16	4.32	0.12	30.14	0.58	30.43	0.58	2.31	0.03	1.54	0.03
Boys 14–18	2288	7.28	0.17	4.97	0.13	35.02	0.78	35.31	0.79	2.25	0.04	1.53	0.03
Boys 9–18	4368	6.88	0.12	4.64	0.09	32.60	0.49	32.89	0.49	2.28	0.03	1.53	0.02
Girls 9–13	1980	5.36	0.13	3.56	0.10	24.65	0.57	24.85	0.57	2.32	0.04	1.54	0.03
Girls 14–18	2277	5.08	0.12	3.54	0.09	23.95	0.55	24.07	0.55	2.17	0.04	1.52	0.03
Girls 9–18	4257	5.22	0.09	3.55	0.07	24.29	0.38	24.45	0.38	2.24	0.03	1.53	0.02
Males 19–30	1804	6.22	0.19	4.33	0.13	30.45	0.79	30.48	0.81	2.01	0.04	1.40	0.03
Males 31–50	2596	5.65	0.17	4.00	0.12	29.53	0.75	29.59	0.75	1.94	0.04	1.38	0.03
Males 19–50	4400	5.85	0.13	4.11	0.09	29.85	0.56	29.90	0.57	1.96	0.03	1.39	0.02
Males 51–70	2550	4.86	0.14	3.50	0.10	25.90	0.67	26.12	0.68	1.89	0.04	1.36	0.03
Males 71+	1520	4.14	0.14	3.14	0.11	21.72	0.71	21.90	0.71	1.92	0.05	1.44	0.03
Males 51+	4070	4.68	0.11	3.41	0.08	24.85	0.52	25.06	0.53	1.90	0.03	1.38	0.02
Males 19+	8470	5.43	0.09	3.86	0.07	28.05	0.40	28.16	0.41	1.94	0.02	1.39	0.02
Females 19–30	2017	4.54	0.12	3.10	0.10	22.21	0.66	22.26	0.66	2.05	0.04	1.39	0.03
Females 31–50	2755	4.15	0.11	2.95	0.08	22.32	0.59	22.40	0.60	1.94	0.04	1.39	0.03
Females 19–50	4772	4.28	0.09	3.00	0.07	22.28	0.46	22.35	0.46	1.98	0.03	1.39	0.02
Females 51–70	3201	3.71	0.10	2.70	0.07	19.40	0.39	19.53	0.39	1.87	0.03	1.36	0.02
Females 71+	2610	3.40	0.10	2.57	0.08	17.39	0.45	17.56	0.46	1.96	0.04	1.47	0.03
Females 51+	5811	3.62	0.07	2.66	0.05	18.79	0.30	18.93	0.30	1.90	0.03	1.39	0.02
Females 19+	10583	4.02	0.06	2.87	0.04	20.92	0.30	21.02	0.30	1.95	0.02	1.39	0.01
All adults 19+	19053	4.71	0.06	3.36	0.04	24.42	0.26	24.52	0.27	1.94	0.02	1.39	0.01
All persons 1+	33030	4.87	0.06	3.44	0.04	24.83	0.21	24.95	0.22	2.01	0.01	1.42	0.01

<sup>a</sup> The results in this table were obtained on the basis of dietary pattern data reported in the Canadian Community Health Survey-Cycle 2.2, Statistics Canada (35) and by using SFA and TFA composition data of foods reported in (a) the Canadian Nutrient File (36) for the 2004 estimates and (b) The Trans Fat Monitoring Program (26–28) for the 2008 estimates.

In 2004, the highest intakes of TFAs were among 14–18 year-old boys, with an average intake of 7.3 g/day, and lowest among females 71 years and over, with an average intake of 3.4 g/day. Expressed as a percentage of energy, there was no clear highest or lowest between the various age-sex groups (Table 8). However, the youth group 18 years and under, had the highest intake of TFAs, whereas both male and female adults (19+ years) had the lowest intakes.

For all age-sex groups, the TFA average intake levels for 2008 are significantly lower than the estimates for 2004. On average, the levels have dropped by 30% between 2004 and 2008. The TFAs as a percentage of energy for the combined ages and sexes show average intake levels of 2.0 and 1.4% for 2004 and 2008, respectively.

Table 8 data show that for all age-sex groups, SFA intakes have not increased from 2004 to 2008. The data for the combined ages and sexes show an SFA intake of 24.8 g for 2004 and 25.0 g for 2008. Expressed as % energy, SFA intakes would be 10.2 and 10.3% for 2004 and 2008, respectively (% energy data for SFAs are not shown in Table 8).

Table 9 presents the intake averages and distributions of TFA for males and females for age groups above 9 years. The corresponding data for SFAs are not shown because there was no difference between 2004 and 2008 in the level of intake. The decrease in average TFA levels observed in Table 8 can also be seen in the extremities of the TFA distribution shown in Table 9. The highest 95th percentile in 2004 was among boys aged 9 to 18 years at 11.6 g, falling to 7.8 g in 2008. The lowest 95th percentile in 2004, at 7.4 g among females aged 51 years and above, dropped to 4.8 g in 2008. As a percentage of energy, the 95th percentiles for all age-sex groups have dropped from approximately 3 to 2%.

## Discussion

The data presented in this study demonstrate that the periodic Web publication of the results of Health Canada's Trans Fat Monitoring Program (25–28), at least in part, have helped to reduce TFAs in prepackaged foods, bakery products, and fast foods.

The most striking finding of this study is that many fast-food and family restaurant chains in Canada have been successful in decreasing TFAs in menu items that were previously high in TFAs, such as French fries, chicken products, fish products, and pizzas. This is especially important given that the nutrition labeling regulations do not apply to foods sold in restaurants and food service establishments. At the end of 2008, more than 82% of the fast-food and family restaurants targeted in our study have reduced the TFAs to <5% limit by eliminating the use of PHVOs as the frying medium. Most importantly, this led to significant improvement in the nutritional quality of the fatty acid profile of most of the fast foods, except in donuts. In particular, the levels of oleic acid and linoleic and  $\alpha$ -linolenic acids have increased while the level of SFAs has decreased. The fatty acid data presented here suggests that a majority of

the restaurant establishments have replaced PHVOs with high-oleic oils or with a blend of high-oleic oil and a liquid oil, such as canola, containing both linoleic and  $\alpha$ -linolenic acids. This change in the frying oil of restaurant establishments from PHVO to unsaturated liquid oils, will increase the levels of oleic acid, and linoleic and  $\alpha$ -linolenic acids in the diets of some Canadians, which may have a positive health impact, because n-3 and n-6 fatty acids are known to provide cardiovascular health benefits (41, 42).

The prepackaged food industry in Canada has also been successful in reducing the TFA content in most foods that were previously high in TFAs, such as crackers, frozen desserts, breads and buns, granola bars, instant noodles, frozen potato products, snacks, and popcorn to levels below 5% TFA limits. However, there are still some poor performers in the prepackaged food category, notably the tub-margarines. The percentage of brands that were meeting the 2% TFA limit was low and some tub-margarines still contain high levels of TFAs, reaching 21% of total fat. An observation worth noting from the monitoring data is that, despite having reformulated some of their products to be low in TFAs, some tub-margarine producers were keeping their high TFA product on the market. For example, one particular company was selling a "hydrogenated" tub-margarine with 17.8% TFAs and a "nonhydrogenated" tub-margarine with 1.4% TFAs. This approach may be contributing to the low percentage of tub-margarines that were meeting the TFA limits.

Similar to fast foods, the reduction of TFAs in some of the reformulated prepackaged foods, in particular in tub-margarines, frozen desserts, snacks, and frozen pizzas, was achieved by replacing PHVO with high-oleic oils or blends of high-oleic oils and liquid oils containing both linoleic and  $\alpha$ -linolenic acids.

In contrast to the fast-food and prepackaged food industries, the baking industry is not performing well in reducing the TFA levels in its products. This might be attributed to the difficulty of finding suitable alternatives to PHVOs for reformulation of the bakery products. But on the other hand, it should be noted that a number of bakery products analyzed in this study contained <5% TFAs, which clearly demonstrates that the technology is available for the baking industry to prepare products without PHVOs.

Overall, the Canadian food industry has made significant progress in reformulating and decreasing the TFA content in many food products. This is reflected by the fact that 76% of all the foods originally recognized as contributors of TFA met the 2 or 5% TFA limits. Although reductions have occurred, the TFA levels in Canadian foods are nowhere near as low as those of foods sold in Denmark (43, 44). Danish margarines, in contrast to some Canadian margarines, contain no TFAs. Also, the TFA content has been reduced or removed from the products that were previously known to contain high levels of TFAs, like French fries, popcorn, and various bakery products. The successful elimination of TFAs in Denmark was a direct result of the regulations passed in 2003 to ban the sale of products containing >2% TFA/100 g fat (44).

Table 9. Estimated TFA intake distributions in Canada for 2004 and 2008 by age-sex group<sup>a</sup>

Age-sex, years	Sample size	Year (unit)	TFA intake percentiles												
			5th	10th	25th	50th	75th	90th	95th	Estimate	SE	Estimate	SE		
Boys 9–18	4368	2004 (g/day)	3.90	4.45	5.50	6.89	8.57	10.36	11.58	0.17	0.16	0.16	0.19	0.27	0.34
		2008 (g/day)	2.65	3.00	3.68	4.58	5.69	6.91	7.75	0.14	0.13	0.13	0.15	0.22	0.28
Girls 9–18	4257	2004 (% energy)	1.55	1.70	1.96	2.27	2.62	2.96	3.18	0.05	0.04	0.04	0.04	0.06	0.07
		2008 (% energy)	1.22	1.20	1.34	1.51	1.71	1.91	2.04	0.05	0.04	0.03	0.04	0.07	0.09
Males 19–50	4400	2004 (g/day)	2.75	3.18	4.01	5.09	6.37	7.71	8.60	0.12	0.11	0.11	0.14	0.19	0.23
		2008 (g/day)	1.86	2.14	2.68	3.42	4.33	5.34	6.03	0.08	0.08	0.08	0.10	0.15	0.19
Males 51+	4070	2004 (% energy)	1.58	1.71	1.94	2.22	2.53	2.82	3.00	0.07	0.05	0.04	0.04	0.06	0.08
		2008 (% energy)	1.06	1.15	1.30	1.49	1.73	1.96	2.12	0.05	0.04	0.03	0.04	0.06	0.08
Males 19+	8470	2004 (g/day)	2.61	3.12	4.17	5.58	7.29	9.14	10.42	0.16	0.15	0.16	0.21	0.32	0.41
		2008 (g/day)	2.02	2.36	3.02	3.93	5.04	6.23	7.05	0.13	0.12	0.12	0.16	0.24	0.31
Females 19–50	4772	2004 (% energy)	1.16	1.31	1.58	1.92	2.29	2.67	2.91	0.05	0.04	0.03	0.04	0.07	0.08
		2008 (% energy)	0.90	0.99	1.15	1.36	1.59	1.81	1.96	0.05	0.03	0.03	0.03	0.05	0.07
Females 51+	5811	2004 (g/day)	1.87	2.27	3.10	4.27	5.84	7.66	8.97	0.10	0.11	0.13	0.17	0.25	0.32
		2008 (g/day)	1.37	1.66	2.25	3.12	4.26	5.62	6.61	0.08	0.08	0.10	0.12	0.18	0.24
Females 19–50	4772	2004 (% energy)	0.96	1.11	1.40	1.80	2.27	2.78	3.12	0.04	0.04	0.04	0.05	0.06	0.08
		2008 (% energy)	0.71	0.82	1.03	1.31	1.66	2.04	2.30	0.03	0.03	0.03	0.03	0.05	0.06
Females 51+	5811	2004 (g/day)	2.23	2.70	3.68	5.08	6.83	8.77	10.13	0.09	0.10	0.11	0.15	0.22	0.28
		2008 (g/day)	1.67	2.00	2.66	3.60	4.82	6.17	7.13	0.07	0.08	0.08	0.11	0.16	0.21
Females 19–50	4772	2004 (% energy)	1.05	1.21	1.50	1.87	2.30	2.74	3.03	0.03	0.03	0.03	0.03	0.05	0.06
		2008 (% energy)	0.80	0.90	1.09	1.34	1.63	1.92	2.13	0.03	0.02	0.02	0.02	0.04	0.05
Females 51+	5811	2004 (g/day)	2.01	2.39	3.13	4.08	5.31	6.66	7.59	0.10	0.10	0.10	0.14	0.20	0.27
		2008 (g/day)	1.39	1.64	2.16	2.86	3.73	4.68	5.35	0.06	0.07	0.08	0.10	0.14	0.18
Females 19–50	4772	2004 (% energy)	1.27	1.40	1.65	1.95	2.30	2.64	2.85	0.05	0.04	0.04	0.05	0.07	0.09
		2008 (% energy)	0.92	1.00	1.16	1.36	1.59	1.82	1.97	0.04	0.03	0.03	0.04	0.06	0.07
Females 51+	5811	2004 (g/day)	1.70	2.00	2.59	3.42	4.45	5.59	6.39	0.08	0.08	0.09	0.11	0.15	0.20
		2008 (g/day)	1.21	1.43	1.87	2.49	3.29	4.20	4.84	0.06	0.06	0.07	0.08	0.12	0.16
Females 19–50	4772	2004 (% energy)	1.10	1.24	1.50	1.84	2.23	2.63	2.89	0.04	0.03	0.03	0.04	0.05	0.07
		2008 (% energy)	0.79	0.89	1.08	1.33	1.64	1.96	2.18	0.03	0.03	0.02	0.03	0.04	0.05

Table 9. (continued)

Age-sex, years	Sample size	Year (unit)	TFA intake percentiles													
			5th	10th	25th	50th	75th	90th	95th	Estimate	SE					
Females 19+	10583	2004 (g/day)	1.87	2.23	2.91	3.82	4.99	6.27	7.17	0.07	0.07	0.07	0.07	0.09	0.14	0.18
		2008 (g/day)	1.31	1.55	2.04	2.72	3.57	4.51	5.17	5.17	0.05	0.05	0.05	0.07	0.10	0.12
All persons 1+	33030	2004 (% energy)	1.19	1.33	1.58	1.90	2.28	2.65	2.89	0.03	0.03	0.03	0.03	0.05	0.06	
		2008 (% energy)	0.85	0.94	1.12	1.34	1.61	1.89	2.08	0.02	0.02	0.02	0.02	0.03	0.04	
		2004 (g/day)	2.06	2.48	3.35	4.58	6.14	7.89	9.13	0.05	0.05	0.05	0.07	0.10	0.13	
		2008 (g/day)	1.49	1.78	2.38	3.21	4.29	5.53	6.41	0.03	0.04	0.05	0.07	0.10		
		2004 (% energy)	1.19	1.34	1.62	1.96	2.35	2.75	3.00	0.02	0.02	0.02	0.03	0.03	0.03	
		2008 (% energy)	0.87	0.97	1.15	1.38	1.65	1.93	2.12	0.01	0.01	0.01	0.02	0.02	0.03	

<sup>a</sup> The results in this table were obtained on the basis of dietary pattern data reported in the Canadian Community Health Survey-Cycle 2.2, Statistics Canada (35) and by using SFA and TFA composition data of foods reported in (a) the Canadian Nutrient File (36) for the 2004 estimates and (b) The Trans Fat Monitoring Program (26–28) for the 2008 estimates.

<sup>b</sup> SE = Standard error of the mean.

Parallel with the reduction of TFA levels in Canadian foods, the average TFA intake has declined from the high value of 8.4 g/day (3.7% of energy) in the mid-1990s (20) to 4.8 g/day (2.0% of energy) in 2004, and to 3.4 g/day (1.4% of energy) in 2008. In addition, our analyses show that even within the highest intakes (i.e., within the 95th percentile), the maximum TFA levels were about 2.1% of total energy. However, this most current average estimate of TFA intake (i.e., for 2008) of 1.4% energy for the Canadian population is still above the WHO recommended limit of TFA intake of <1% of energy. All children and adolescents, especially, exceed the WHO recommended limit. This is a very vulnerable group for high TFA intakes, because they are easily attracted to eating high-density foods such as donuts and fried foods. The food industry needs to put more effort into reducing the TFA content in its products, especially in some of the prepackaged foods such as tub-margarines and fast foods such as donuts and bakery products, some of which are consumed in high volumes by many Canadians. Alternatively, Canadian consumers should select foods that are labeled to contain low TFAs or made with nonhydrogenated oils.

One of the major concerns of the Trans Fat Task Force (23) was that reformulations to reduce the TFA content might lead to substitution of PHVOs with saturated oils, such as coconut oil, palm oil, palm kernel oil and its fractions or fully hydrogenated oils containing tristearin and would result in an elevation of the SFA content in the Canadian diet. The fatty acid results of this study clearly show that this was not the case. In some products, especially in donuts, cookies, and crackers there was an increase in the SFA content with reformulation. However, for the majority of the other products, the reformulation did not cause an increase in the SFA content and the SFA + TFA content. In some food reformulations, there was even a significant reduction of SFAs. The overall effect of the reformulation was that there was no change in the average SFA intake of Canadians between 2004 and 2008. The estimated value of 10.4% energy for SFAs is very much in line with the WHO recommendation to limit SFAs to 10% of total energy.

The Canadian experience indicates that success can be achieved in the reduction of the TFA content of foods and in the decrease of TFA intakes by Canadians. The monitoring results indicate that further reductions in Canada are needed to fully meet the public health objectives and reduce the risk of coronary heart disease.

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