J Amer Oil Chem Soc (2007) 84:433–442
DOI 10.1007/s11746-007-1053-5

ORIGINAL PAPER

Industrially Produced *trans* Fat in Foods in Australia

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Received: 19 October 2006 / Accepted: 21 February 2007 / Published online: 3 April 2007

Abstract Selected foods sampled from Australian supermarkets and fast food outlets were analyzed for *trans* fat (TF) content. The product with the highest amount of TF (6.3 g/100 g product) was a household shortening. The TF contents in spreads were remarkably low (average 0.5, range 0.2–1.3 g/100 g product) with only 3 out of 15 exceeding the maximum level (2.0 g/100 g fat) permitted in Denmark. Ready-to-eat French fries purchased from all but one (1.5 g/100 g product) fast food outlet contained generally low levels of TF (average 0.4, range 0.3–0.7 g/100 g product), and the majority of the outlets appeared to have used non-hydrogenated vegetable oils for frying. Frozen French fries and ready-to-eat potato chips purchased from supermarkets were also low in TF (average 0.1 and 0.2 g/100 g product, respectively). So were the bakery products (biscuits, cakes, bread, cake and muffin mixes) except for croissants. However, 9 out of the 103 products tested would have been prohibited from sale in Denmark, while 25 and 12 products would have failed to qualify for '*trans* fat-free' claims according to the mandatory labeling regulations currently in force in Canada the USA, respectively.

Keywords Coronary heart disease · Foods in Australia · Labeling regulations · Saturated fatty acids · *trans* Fat

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Introduction

Partial hydrogenation is a process that has long been used by the fats and oils industry to convert liquid vegetable oils to semi-solid fats with appropriate melting properties required for the production of margarines and bakery goods. The process also improves the oxidative stability of the oil, and for this reason, partially hydrogenated vegetable oils (PHVO) have been popularly used for deep-frying applications. Unfortunately, the process of partial hydrogenation of vegetable oils also produces *trans* fats (TF) which have been shown to increase the risk of coronary heart disease [1–3]. In this respect, TF are considered worse than saturated fat [4, 5].

Prompted by the growing evidence that consumption of TF is detrimental to health, international nutrition bodies have begun advocating a reduction in TF intake. Several Western countries have already introduced legislation aimed at achieving this objective. For example, Denmark has prohibited the use of oils and fats containing more that 2.0 g TF/100 g fat (or 5.0 g TF/100 g fat when the fat is used as a food ingredient [6], and Canada has indicated its intention to impose similar restrictions. Currently, Canada [7] and USA [8] require that the TF contents exceeding 0.2 and 0.5 g respectively per serving be displayed on the product label. Although the Australian Heart Foundation recommends that TF and saturated fatty acids (SFA) together contribute no more than 8% of total energy intake, no TF regulations have been introduced in Australia, and any decision on the need for regulatory measures will hinge on how widespread high TF levels are in Australian food products.

Although recent data on TF content in food products are available for Europe [9, 10], Canada [11] and the USA [12], the last reported study on the TF content in foods in Australia was conducted more than 12 years ago [13]. The purpose of the present study was to obtain a snapshot of the current TF situation in Australia to gauge the seriousness of the problem. Here we report the TF content in selected food products generally considered to be the major sources of TF in the Western diets.

Experimental Procedures

Samples

All the products were obtained from retail or fast food outlets in Melbourne, Australia during June 2006. Within each category, products for testing were selected on the basis of their brand or corporate market share [14]. For labeled products, all the information displayed on the food labels was recorded. For products obtained from fast food outlets, the date, place, and serving size were recorded. Within each product category a single sample from each brand was analyzed with the exception of French fries from fast food outlets for which two samples were collected from the same outlets one week apart.

Sample Preparation

The French fries from the fast food outlets were analyzed immediately after purchase. The other products were analyzed within a few days after purchase and were stored at appropriate temperatures until analyzed. Fats from the spreads were separated by melting at 80 °C followed by centrifugation if required. In the case of the household shortenings, the entire block was completely melted by warming to 80 °C before a sample was withdrawn for analysis. All the other samples were snap-frozen in liquid nitrogen, converted to a fine powder by homogenizing in a laboratory blender (Waring blender, Model BB 90 E) except for the bread, dinner rolls and biscuits, which were homogenized in an industrial ball cutter (Model FC14, Lan Elec Ltd., Berks, England). The various sachets of ingredients contained in the cake, muffin, and cookie mixes were mixed together prior to snap freezing and homogenization. Two grams samples of the powders were used for fat extraction, which was performed according to the AOAC Official Method 996.06 [15]. All extractions were performed in duplicate.

Analysis of Fatty Acid Composition

The fat extracts from above were converted to FAME by treatment with potassium hydroxide and methanol [16]. The esterifications were performed in duplicate. The FAME were analyzed by capillary GC according to the operating conditions stipulated in the AOCS Official Method Ce 1h-05 [17] using an Agilent Model 6890 N GC instrument (Agilent Technologies, Melbourne, Australia) fitted with a flame ionization detector (FID). A SP-2560 fused silica capillary column (Suplelco Inc., 100 m, 0.25 mm i.d., 0.20 μm film thickness) was used with helium as the carrier gas at a flow rate of 1.0 mL/min and a split ratio of 100:1. The temperature of the GC oven was maintained at 180 °C while the injector port and the detector were both held at 250 °C. The GC/FID peaks were integrated using Chemstation software (Agilent Technologies, Melbourne, Australia). Selected samples were also analyzed by gas chromatography/mass spectrometry (GC/MS) using a system comprising an Agilent Model 6890 GC and Model 5973 MSD. The same analytical column was used for both GC and GC/MS.

The GC peaks were identified by reference to the chromatograms of PHVO shown in the AOCS Official Method Ce-1h-05 and those published in the literature [18, 19]. GC of FAME of a standard milk fat sample assisted in the classification of peaks. The GC conditions used in this study gave near baseline resolutions between the critical pairs [20] (1) 13 *trans*-18:1/14 *trans*-18:1 and 9 *cis*-18:1, (2) 16 *trans*-18:1 and 14 *cis*-18:1, and (3) 11 *cis*-20:1 and 9 *cis*, 12 *cis*, 15 *cis*-18:3 thus satisfying the conditions required for application of the AOCS standard method [17]. The *trans*-18:1 isomers were baseline-resolved from *cis*-18:1 isomers with two exceptions: (1) 13 *trans*-18:1 and 14 *trans*-18:1 co-eluted with 6 *cis*, 7 *cis*, and 8 *cis*-18:1, and (2) 15 *trans*-18:1 co-eluted with 9 *cis*-18:1 and 10 *cis*-18:1. The 13 *trans*-18:1, 14 *trans*-18:1, 15 *trans*-18:1 and 6 *cis*, 7 *cis*, and 8 *cis*-18:1 isomers are minor components in PHVO [18] and therefore for the determination of TF content in the food samples it was assumed that the peak for 13 *trans*-18:1/14 *trans*-18:1/6 *cis*, 7 *cis*, and 8 *cis*-18:1 contained only *trans* isomers and the peak for 9 *cis*-18:1/10 *cis*-18:1/15 *trans*-18:1 contained only *cis* isomers.

GC/MS analysis helped to identify any non-lipid artefacts such as small amounts furfural derivatives that can be produced during fat extraction. In some cases, the presence of small amounts of fatty acid ethyl esters was also observed. Presumably, they were derived from traces of ethanol remaining after fat extraction by Mojonnier digestion. Under the GC conditions that were used in this study, the ethyl esters of 18:0, 18:1, and 18:2 respectively eluted just in front of the *trans*-18:1, *trans*-18:2, and *trans*-18:3 regions. Although the ethyl esters did not co-elute with any of the *trans* isomers, their closeness to the *trans* regions required special care in peak allocation.

Calculations

The total content of *trans* fat (TF) in the food products (g/100 g product) was calculated according to the equation shown below. Where available, the fat content shown on the food label was used for the calculation. For others, such as bread rolls and takeaway French fries, the fat content determined according to the AOAC Official Method 996.06 [17] was used for the calculation. The results shown in Tables 1–5 are average values for duplicate analysis of single or duplicate samples.

$$\textit{trans}\text{ fat (g per 100 g test sample)} = \left(\sum \textit{trans}\ W_x\right) \times \text{fat content (g per 100 g test sample)}/\ 100,$$

where $\sum trans\ W_x$ = sum of all *trans* fatty acids in 100 g FAME excluding *trans* isomers with a conjugated double bond.

Results and Discussion

TF in foods can originate from either of two sources: (1) industrially produced during partial hydrogenation or thermal processing of vegetable or animal fats and oils, (2) naturally present in fats from ruminant animals. Current evidence suggests that public health implications of consuming TF from ruminant derived foods such as dairy products are relatively limited [2], and this study focused on the contribution to TF intake from industrially produced TF. Product categories generally expected to make major contributions to TF intake were given priority and included potato fries (both takeaway and frozen for preparation at home) (Table 1), spreads and household shortenings (Table 2), biscuits and cookies (Table 3), breads, dinner rolls, and cakes (Table 4), and cake, muffin, and cookie mixes (Table 5). Within each product category the selection of brands were based on their market share [14]. When explicit brand share data were not available the products were selected according to the corporate shares of the manufacturers of the particular product category.

As the study was conducted to obtain a general idea of the TF levels in the Australian food supply and not for regulatory purposes, a modification of the AOCS standard method was used to simplify analysis. The fat content declared by the product manufacturer was used for the calculation except for unpackaged products for which the fat content was not available. This removed the need for the use of a TAG internal standard and the FA composition was calculated as area percent. Otherwise, the GC analyses of FAME were performed strictly according to the AOCS standard method where all the requirements for peak resolution [20] were satisfied.

The AOCS official method 999.06 [15] based on Mojonnier digestion is a convenient method for extracting fat from food samples for TF analysis. However, we preferred to snap freeze in liquid nitrogen and pulverize the sample prior to fat extraction. This technique not only provided a uniform and representative sample for fat extraction but also reduced the sample bulk facilitating Mojonnier digestion of low-fat, high-volume foods such as bread and dinner rolls. The problem of preparing a representative subsample for fat extraction from products such as cake mixes containing several sachets of different ingredients with uneven particle size and consistency was also overcome by the technique of snap freezing and pulverization.

Table 1 shows the data for fried potato products. The TF content in takeaway French fries sampled from six leading fast food outlets ranged from 1.0 to 9.5 g/100 g fat which implied TF content of 0.2 to 1.5 g/100 g of fries. These values are remarkably low compared to those reported for French fries sold at fast food outlets in other countries. Stender and Dyerberg [21] recently reported the TF content in French fries sold at McDonalds and KFC outlets in 20 different countries between November 2004 and September 2005. They found that only one out of the 24 McDonald samples, and 2 out of the 19 KFC samples, contained TF below 1.0 g/100 g fries. FA profiles of the oils extracted from the French fries sampled from popular Australian fast food outlets showed that all but one of the outlets used non-hydrogenated or minimally hydrogenated vegetable oils, most probably palm and canola oil, for frying. The exception was the product with the highest amount of TF (9.5% g/100 g fat), which was probably fried in canola oil blended with a small amount of PHVO.

The results show that the majority of the popular fast food outlets in Australia have started using non-hydrogenated vegetable oils in place of PHVO and animal fats they may have previously used. The down side is that some of the outlets have replaced the PHVO and animal fat with highly saturated vegetable oils. The frying oil used by three out of the six outlets tested contained SFA in excess of 45% (w/w). The main SFA component in these oils was palmitic acid most probably resulting from the heavy use of palm oil. Although the presence of relatively high levels of palmitic acid may somewhat negate the benefits of switching to *trans*-free frying oils, overall, such a switch over should be welcomed as the detrimental effects of SFA on cardiovascular health is considered to be lower than that of TF [3].

As in the case of French fries from fast food outlets, non-hydrogenated vegetable oils (primarily canola and palm oils) also appeared to be commonly used for preparing frozen French fries. As a result, the TF contents of the oils used for preparation of the fries were relatively low (0.9–4.1 g/100 g fat). In contrast, the TF content in oils used for preparing frozen potato products prior to mandatory TF labeling in the USA ranged from 24.7 to 38.2%, w/w [12]. As the fat content of the frozen fries (3.4–7.6%,

Table 1 Total, *trans*, saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids in potato products

Product	Fat content (g/100 g) product	Serving size	*trans* fat g/serving	*trans* fat (g/100 g) product	Total *trans* fat (g/100 g fat)	*trans* 18:1 (g/100 g fat)	*trans* 18:2 (g/100 g fat)	*trans* 18:3 (g/100 g fat)	SFA (g/100 g fat)	MUFA (g/100 g fat)	PUFA (g/100 g fat)
French fries (ready to eat, fast food franchises)											
Franchise 1	21.6	NA	NA	0.2	1	0.4	0.4	0.3	51.2	38.9	9.9
Franchise 2	16.1	NA	NA	1.5	9.5	4.3	3.6	1.6	10.3	67.9	21.8
Franchise 3	18.5	NA	NA	0.3	1.6	0.9	0.5	0.2	52.0	38.5	9.5
Franchise 4	10.8	NA	NA	0.7	6.1	5.6	0.3	0.2	45.0	40.1	14.9
Franchise 5	12.5	NA	NA	0.3	2.8	1.7	0.8	0.3	26.3	51.0	22.7
Franchise 6	17.9	NA	NA	0.3	1.4	0.3	0.3	0.8	8.0	60.9	31.1
Frozen French fries and wedges (supermarket)											
Brand 1	4.6	NA	NA	0.1	2.7	1.0	0.8	0.9	10.5	61.0	28.5
Brand 2	5.2	NA	NA	0.1	2.1	0.7	0.6	0.8	9.2	61.8	29.0
Brand 3	4.7	NA	NA	0.1	1.1	0.2	0.2	0.7	7.7	61.9	30.4
Brand 4	3.4	NA	NA	0	1.2	0.3	0.2	0.7	7.9	62.4	29.7
Brand 5	7	NA	NA	0.1	0.9	0.4	0.3	0.2	50.1	39.7	10.2
Brand 6	5.4	NA	NA	0.2	4.1	3.0	0.7	0.4	38.5	47.7	11.8
Brand 7	5.5	NA	NA	0.1	1.8	0.5	0.3	1.0	10.6	61.3	28.1
Brand 8	2.9	NA	NA	0	1.2	0.3	0.2	0.7	12.8	60.0	28.2
Brand 9	3	NA	NA	0	1.5	0.2	0.3	1.0	9.8	61.0	29.2
Brand 10	7.6	NA	NA	0.7	9.8	4.5	3.7	1.6	10.9	66.7	22.4
Chips (ready to eat, supermarket)											
Brand 1	30.1	50	0.1	0.2	0.5	0.1	0.3	0.1	32.7	60.0	11.3
Brand 2	28.5	45	0.1	0.3	0.9	0.4	0.5	0.0	31.4	57.4	11.1
Brand 3	29.7	100	0.3	0.3	1	0.4	0.4	0.2	46.1	41.9	12.0
Brand 4	29.8	50	0.1	0.2	0.5	0.1	0.3	0.1	33.0	56.8	10.2
Brand 5	30.7	50	0.1	0.3	0.9	0.3	0.4	0.2	45.6	43.0	11.4
Brand 6	32.4	50	0.1	0.2	0.8	0.2	0.4	0.2	46.7	41.4	11.9
Brand 7	35.7	100	0.1	0.1	0.3	0.2	0.1	0.0	9.5	83.2	7.3
Brand 8	32.4	100	0.1	0.1	0.4	0.3	0.1	0.0	9.5	82.6	7.9
Brand 9	22.5	100	0.1	0.1	0.3	0.1	0.1	0.1	7.9	81.9	10.2
Brand 10	38.0	200	0.8	0.4	1.1	0.3	0.6	0.2	37.7	39.2	23.1

Table 2 Total, *trans*, saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids in spreads and cooking fats

Product	Fat content (g/100 g) product	Serving size (g)	*trans* fat g/serving	*trans* fat g/product	Total *trans* fat (g/100 g fat)	*trans* 18:1 (g/100 g fat)	*trans* 18:2 (g/100 g fat)	*trans* 18:3 (g/100 g fat)	SFA (g/100 g fat)	MUFA (g/100 g fat)	PUFA (g/100 g fat)
Spreads											
Brand 1	60.0	14	0.6	4.0	6.7	6.1	0.3	0.3	18.5	56.8	24.7
Brand 2	65.0	14	0.5	3.4	5.3	4.7	0.3	0.3	20.6	53.5	25.9
Brand 3	70.0	14	0.2	1.3	1.8	1.4	0.2	0.2	24.0	50.7	25.3
Brand 4	70.0	14	<0.2	0.2	0.3	0.1	0.1	0.1	23.4	32.7	43.9
Brand 5	70.0	14	<0.2	0.4	0.6	0.1	0.2	0.3	25.6	47.8	26.6
Brand 6	70.0	14	<0.2	0.4	0.5	0.2	0.0	0.3	22.4	53.9	23.7
Brand 7	59.0	14	<0.2	0.5	0.8	0.2	0.4	0.2	26.6	25.1	48.3
Brand 8	75.0	14	<0.2	0.4	0.5	0.2	0.2	0.1	26.8	25.7	47.5
Brand 9	70.0	14	<0.2	0.4	0.5	0.1	0.1	0.3	23.1	50.1	26.6
Brand 10	49.0	14	<0.2	0.4	0.9	0.4	0.1	0.4	23.6	50.3	26.1
Brand 11	70.0	14	<0.2	0.4	0.5	0.1	0.1	0.3	24.4	51.0	24.6
Brand 12	67.0	14	<0.2	0.3	0.5	0.1	0.1	0.3	23.5	49.9	26.6
Brand 13	75.0	14	<0.2	0.5	0.7	0.2	0.4	0.1	26.6	24.3	49.1
Brand 14	70.0	14	<0.2	0.4	0.6	0.1	0.2	0.3	30.0	21.9	48.1
Brand 15	57.0	14	0.6	4.6	8.1	7.3	0.3	0.5	17.0	60.2	22.8
Household shortenings											
Brand 1	100.0	14	0.2	1.7	1.7	1.4	0.3	0.0	52.8	38.6	8.6
Brand 2	100.0	14	0.9	6.3	6.3	5.5	0.6	0.2	55.0	42.3	2.7

Table 3 Total, *trans*, saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids in biscuits and cookies

Product	Fat content (g/100 g) product	Serving size (g)	*trans* fat g/serving	*trans* fat g/100 g product	Total *trans* fat (g/100 g fat)	*trans* 18:1 (g/100 g fat)	*trans* 18:2 (g/100 g fat)	*trans* 18:3 (g/100 g fat)	SFA (g/100 g fat)	MUFA (g/100 g fat)	PUFA (g/100 g fat)
Brand 1	11.3	9	0	0.1	0.5	0.2	0.2	0.1	54.0	34.5	11.5
Brand 2	25.4	15	0.1	0.5	1.9	1.4	0.4	0.1	81.1	15.4	3.5
Brand 3	20.3	35	0.2	0.7	3.7	2.8	0.7	0.2	74.2	19.3	6.5
Brand 4	15.4	19.5	0.1	0.5	3.5	2.5	0.8	0.2	59.4	31.3	9.3
Brand 5	7.6	23.2	0	0.0	0.6	0.2	0.2	0.2	12.1	60.1	27.8
Brand 6	11.1	35	0.1	0.2	1.9	1.3	0.4	0.2	49.4	37.8	12.8
Brand 7	18.8	20	0.1	0.3	1.9	1.2	0.4	0.3	52.6	35.9	11.5
Brand 8	20.2	35	0.3	0.8	3.8	3.0	0.6	0.2	49.7	39.2	11.1
Brand 9	24.8	35	0.3	1.0	4.0	2.7	1.2	0.1	56.1	34.8	9.1
Brand 10	29.1	15.4	0.1	0.6	1.9	1.3	0.4	0.2	55.9	36.6	7.5
Brand 11	27.0	18.3	0.1	0.4	1.7	1.0	0.5	0.2	57.5	35.4	7.1
Brand 12	9.2	35	0	0.1	1.6	1.1	0.4	0.1	49.5	37.8	12.7
Brand 13	14.1	30	0	0.1	1.0	0.3	0.5	0.2	47.6	37.9	14.5
Brand 14	27.2	35	0.2	0.7	2.7	2.2	0.4	0.1	50.1	40.0	9.9
Brand 15	26.7	35	0.2	0.5	1.9	1.4	0.4	0.1	52.9	39.9	7.2
Brand 16	28.6	21	0.5	2.4	8.3	6.4	1.8	0.1	57.4	35.0	7.6
Brand 17	25.5	19	0	0.2	0.7	0.2	0.3	0.2	51.5	37.5	11.0
Brand 18	20.5	35	0.1	0.2	1.0	0.5	0.3	0.2	45.1	40.8	14.1
Brand 19	11.0	35	0.1	0.2	2.0	1.4	0.4	0.2	49.1	38.0	12.9

Table 4 Total, *trans*, saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids in breads and rolls etc.

Product	Fat content (g/100) product	Serving size (g)	*trans* fat g/serving	*trans* fat (g/100 g) product	Total *trans* fat (g/100 g fat)	*trans* 18:1 (g/100 g fat)	*trans* 18:2 (g/100 g fat)	*trans* 18:3 (g/100 g fat)	SFA (g/100 g fat)	MUFA (g/100 g fat)	PUFA (g/100 g fat)
Breads											
Brand 1	2.4	80	0	0	0.7	0.6	0.1	0.0	14.4	40.8	44.8
Brand 2	1.6	80	0	0	0.9	0.8	0.1	0.0	17.3	40.1	42.6
Brand 3	3.1	80	0	0	0.0	0.0	0.1	0.0	11.2	52.5	36.3
Brand 4	2.7	80	0	0	0.6	0.5	0.1	0.0	13.4	48.0	38.6
Brand 5	2.5	80	0	0.1	2.4	1.7	0.1	0.6	17.9	41.8	40.3
Brand 6	2.3	80	0	0	1.8	1.6	0.1	0.1	14.9	45.4	39.7
Brand 7	3.0	80	0	0	0.8	0.6	0.1	0.1	16.5	43.0	40.5
Brand 8	3.1	80	0	0	0.9	0.7	0.1	0.1	15.7	37.7	46.6
Brand 9	2.1	80	0	0	1.1	0.8	0.2	0.1	21.3	21.5	57.2
Brand 10	2.6	80	0	0.1	2.6	2.0	0.2	0.4	25.2	20.4	54.4
Rolls											
Brand 1	2.2	80	0	0	1.9	1.3	0.2	0.4	21.4	20.8	57.8
Brand 2	2.2	80	0	0.1	2.7	0.7	0.4	1.6	20.4	20.7	58.9
Brand 3	2.4	80	0	0.1	2.3	0.6	0.3	1.4	21.5	20.4	58.1
Brand 4	2.2	80	0	0	1.6	0.5	0.0	1.1	21.9	38.5	39.6
Brand 5	2.2	80	0	0	1.5	0.5	0.0	0.0	31.6	29.5	38.9
Brand 6	1.8	80	0	0	0.0	0.0	0.0	0.0	39.5	11.7	48.8
Croissants											
Brand 1	17.3	80	0.7	0.9	5.3	4.5	0.8	0.0	69.6	23.6	6.8
Brand 2	17.3	80	0.6	0.7	4.1	3.1	0.8	0.2	72.8	19.7	7.5
Cakes											
Brand 1	8.5	80	0	0	0.5	0.3	0.0	0.2	36.0	43.6	20.4
Brand 2	8.5	80	0	0	0.3	0.1	0.0	0.2	23.8	52.4	3.8
Brand 3	9.0	80	0	0	0.0	0.0	0.0	0.0	64.3	25.8	9.9
Brand 4	7.9	80	0	0.1	1.4	1.4	0.0	0.0	55.1	34.4	10.5

Table 5 Total, *trans*, saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids in cake, muffin, and cookie mixes

Product	Fat Content (g/100 g) product	Serving size (g)	*trans* fat g/serving	*trans* fat (g/100 g) product	*Total trans* fat (g/100 g fat)	*trans* 18:1 (g/100 g fat)	*trans* 18:2 (g/100 g fat)	*trans* 18:3 (g/100 g fat)	SFA (g/100 g fat)	MUFA (g/100 g fat)	PUFA (g/100 g fat)
Cake mixes											
Brand 1	7.8	32	0	0	0.4	0.3	0.0	0.1	61.3	29.7	9.0
Brand 2	3.9	28	0	0	0.3	0.2	0.1	0.0	56.3	31.7	12.0
Brand 3	4.1	28	0	0.1	1.4	1.2	0.1	0.1	55.1	33.4	11.5
Brand 4	13.3	48	0.5	1.1	8.4	7.5	0.7	0.2	48.5	43.4	8.1
Brand 5	10.8	50	0	0.1	0.5	0.3	0.1	0.1	60.8	30.4	8.8
Brand 6	3.6	36	0	0	0.8	0.7	0.0	0.1	51.0	36.8	12.2
Brand 7	3.7	36	0	0	0	0.0	0.0	0.0	16.9	17.6	65.5
Muffin mixes											
Brand 1	13.9	42	0.6	1.3	9.6	9.4	0.1	0.1	47.8	44.6	7.6
Brand 2	5.9	42	0.3	0.2	3.3	2.6	0.6	0.1	52.2	36.1	11.7
Brand 3	9.1	42	0.4	0.3	3	2.7	0.0	0.3	56.8	36.2	7.0
Brand 4	4.4	50	0	0	0.6	0.3	0.3	0.0	51.5	36.6	11.9
Brand 5	9	42	0	0	0.2	0.2	0.0	0.0	77.1	17.6	5.3
Brand 6	8	50	0	0.1	0.7	0.6	0.1	0.0	77.3	17.5	5.2
Brand 7	6.2	37	0	0	0.1	0.0	0.0	0.1	49.8	32.6	17.6
Brand 8	2.7	42	0	0	0	0.0	0.0	0.0	74.7	16.7	8.6
Brand 9	2.7	42	0	0	0.1	0.0	0.0	0.1	49.5	31.4	19.1
Cookie mixes											
Brand 1	8.2	20	0.1	0	0.1	0.0	0.0	0.1	67.4	22.1	10.5
Brand 2	12	20	0	0.2	1.4	1.2	0.1	0.1	54.7	35.5	9.8

w/w) was not as high as that of ready-to-eat French fries from the fast food outlets, only two of the seven products tested had a TF content of 0.2% (g/100 g product) or more. Both these products appeared to have used a blend of beef tallow and canola oil for frying.

Non-hydrogenated vegetable oils such as palm and canola oils together with high-oleic sunflower oil (Sunola) appeared to have been widely used for the preparation of the ready-to-eat potato chips. There was no evidence for the use of PHVO in any of these products. Because of this and despite the high fat content (22.5–38.0% g/100 g product) of the products the TF content (g/100 g serving) exceeded 0.2% only for two products.

The highest TF content (6.3% g/100 g product) of all the products examined in this study was found in a sample of household shortening (Table 2). The relatively high TF content in this product appeared to be due to the use of animal fat (beef and mutton tallow) rather than PHVO.

Margarines and spreads have been a prime source of TF in the Western diets [10–12]. Although a 1993 study found high levels of TF in Australian margarines and spreads [13], the introduction of zero-TF spreads in the mid 1990s appeared to have significantly reduced the contribution from spreads to the TF intake of the Australian population. Eleven out of the fifteen spread samples tested in the present study contained less than 1.0%, w/w in the extracted oil showing that the majority of the spreads are now manufactured from non-hydrogenated vegetable oils. Canola, sunflower, and soybean were the main oils used which were generally mixed with varying amounts of other vegetable oils including palm-based oils. The SFA content of the fat component of the spreads ranged from 17.0 to 30.0 (g/100 g fat) which is considerably lower than that reported for margarines and spreads in Canada [11] and the USA [12]. The spreads contained generally high levels of monounsaturated FA (MUFA) and two thirds of the brands tested contained MUFA at levels of 45% (g/100 g fat) or greater.

Three (20%) of the spreads would have required labeling according to the regulations currently in force in the USA, and they would not have been permitted for sale in Denmark as their levels exceeded the maximum permitted level of 2.0 g/100 g fat. These products probably utilized PHVO in their manufacture.

Bakery products including biscuits and cookies make the greatest contribution to the TF intake of adults in the United States [8]. A survey of cookies and crackers in the United States found that 82% of the products tested contained in excess of 20.0% (g/100 g fat) of TF. In contrast, the highest concentration (8.3 g/100 g fat) of TF we observed was in a cookie, which used milk fat as an ingredient (Table 3). Sixty-eight percent of the products contained less than 0.2 g TF per serving and therefore would not have been subject to the labeling regulations currently in force in the USA and Canada and only one product would have been prohibited from sale in Denmark. However, the TF content in the fat used for the manufacture of the cookies and biscuits was high in SFA with 94% of the products containing greater than 45% SFA (g/100 g fat).

None of the fat ingredients used in the manufacture of breads contained TF in excess of 5.0 g/100 g fat (Table 4). This coupled with the relatively low fat content (1.6–3.1%, w/w) ensured that none of the breads contained TF at levels higher that 0.2 g/serving. A similar situation was found for the bread rolls. In contrast, the two croissants products contained significantly higher levels of TF (0.6 and 0.7 g per serving). However, the TF content in the ready-to-eat cakes was surprisingly low (0–1.4 g/100 g fat).

Only one out of the seven cake mixes and one out of the nine muffin mixes contained TF contents exceeding 5.0 g/100 g fat (0.5 g/serving) while none of the cookie mixes exceed this limit. However, SFA dominated the fat component of the mixes and seventeen out of the eighteen products contained SFA at levels higher than 45.0 g/100 g fat.

Denmark has very strict regulatory controls where oils and fats containing greater than 2.0% w/w (5.0% when the oil is used an ingredient in a product) industrially produced TF are prohibited from sale. If the Danish regulation is applied to Australia 10.7% of the products would not have been allowed for sale. While no product is prohibited from sale on the basis of TF content in Canada and the United States, it is mandatory to declare TF contents exceeding 0.2 g/serving in the case of Canada and 0.5 g/serving in the case of the United States on the product label. If the Canadian regulations were adopted in Australia at least 24.3% of the products would not have qualified for 'free of *trans* fatty acid' status, whereas if the United States regulations were adopted this number of would be at least 11.6%. It should be pointed out that the saturated fat content imposes additional restrictions on 'free of *trans* fatty acid' claims. The Canadian regulations require that a serving of a product declared to be 'free of *trans* fatty acid' contains less than 0.2 g TF, and 2 g or less of saturated fatty acids and *trans* fatty acids combined. Therefore, for example, the French fries sampled from several fast food outlets in Australia would not qualify for 'free of *trans* fatty acid' status despite their very low TF content, because of the high saturated fatty acid content in the frying oil used. Thus, the percentage of Australian products not qualifying for the 'free of *trans* fatty acid' status would have been higher if the saturated fatty acid content is also taken in to consideration.

The results of this study provide a snapshot of the content of TF in foods in Australia as at June 2006. From the results of this study it is evident that whilst TF occur in a wide range of food products in Australia, the problem is not as severe as that reported for other Western countries. This may be because food manufacturers in Australia already have implemented strategies to reduce TF content in foods in response to the recent publicity about the adverse health effects of TF and the regulatory measures introduced elsewhere. However, a more comprehensive study covering a wider range of products and more samples of each category is required before a decision can be made on the need for regulatory intervention.

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