

The survey of trans fatty acid content in a selection of margarines sourced from a local market in Thailand

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Abstract

In 2018, the Thai Food and Drug Administration (Thai FDA) amended its rules to prohibit the use of partial hydrogenated ingredients containing trans fatty acids (TFAs) in foodstuffs. The ruling was based upon several studies, each of which had noted a discernible link between the consumption of trans fatty acids and a rise in the levels of cardiovascular disease (CVD). For this study, 11 commercial spreads, shortenings and margarines were examined for their fatty acid content. The products were both locally produced (Thai) and international brands. Total fat, saturated fatty acids and the trans fatty acid as trans-Elaidic acid and natural trans fatty acid as trans-Linolelaidic acid were all measured separately. It was found that 3 local, budget-priced brands, none of which carried any TFAs declaration, contained approximately 6–10% TFAs in the form of trans-Elaidic acid. A further 6 local brands which all carried a TFAs declaration were found to typically contain between 4–7% TFAs. The remaining two imported products, neither of which carried a TFAs declaration, both contained between 4–5% of TFAs. When comparisons were made drawing upon data on similar products from other countries, it was noted that locally produced (Thai) margarines and spreads in this study contained a higher TFAS content. Considering the high occurrence of CVD in Thailand, it is self-evident that the increase in risk resulting from a high intake of TFAs should not be ignored.

Keywords: Trans fatty acids, Margarine, Survey, Thailand

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1. Introduction

The prohibition of the use of partial hydrogenation ingredients introduced in 2018 by the Thai FDA was brought in to serve consumers, giving them further additional information about ingredients, so that they could make informed choices hopefully leading to an eventual overall reduction in their intake of trans fat one example of this would be bakery products. Trans fatty acids (TFAs) are monounsaturated fatty acids (MUFAs) or polyunsaturated fatty acids (PUFAs), containing at least one double bond in the trans configuration, as opposed to the more usual cis configuration appearing in most lipids. This configuration may occur one of either two ways – as a result of micro fermentation in the rumen (leading to the presence of TFAs in dairy products or in the meat of ruminants), or as a result of the process of hydrogenation (creating TFAs in spreadable fats used commonly in the baking industry) (Ledoux *et al.*, 2007).

In natural TFAs, the predominant isomer is vaccenic acid (t18:1n-7), whereas industrial TFAs generally has a distribution of trans 18:1 isomers with highest levels of elaidic acid (t18:1n-9) (Wolff *et al.*, 1998). The biochemistry of TFAs is not yet fully understood. However, it can be said that excessive amounts of unnatural TFAs can significantly alter many physiological functions of biological membranes, which are known to be important for cell homeostasis.

Concerns about diets high in TFAs were first raised in the 1990s, following reports that they were becoming more and more associated with the increased risks of coronary heart disease, caused by the increase in serum low density lipoprotein cholesterol (LDL-C) and the decrease in high density lipoprotein cholesterol (HDL-C) (Mozaffarian *et al.*, 2006). Reviews of studies revealed an intake increase of TFAs between 2.8 to 10 g per day equated to a 22% increase in risk of coronary heart disease (CHD) events and the same percentage increase was applicable to cases of fatal CHD events. (Gebauer *et al.*, 2011). A positive association between the intake of TFAs and the prevalence of risks of diabetes, asthma, allergic and cancer was found in childhood and adult (Stender and Dyerberg, 2004). The current review offers a revised valuation of the strength of the evidence relating to any alleged relationship between TFAs intake and increase in body weight in addition to attempting to contextualise the scope of any effect. (Mozaffarian *et al.*, 2006 and Micha and Mozaffarian, 2009).

Whereas the fatty acid composition in shortening or frying fats used by the fast-food industry is quite well researched and understood, the fatty acidic composition of shortenings margarine and locally produced spreads used by bakery manufacturers is far less studied. Hydrogenated fats represent a significant proportion of dietary fat intake so it is imperative to possess detailed knowledge of the composition of these foods in order to be able to share

conclusions clearly and precisely with the consumer, in respect of adhering to a healthy diet. This study examined the fatty acid content including TFAs of 11 shortening, margarine and spreadable products, either local or imported brands marketed in Thailand.

2. Materials and Methods

2.1 Sample

Two samples each of 11 different brands of spreadable fats (Table 1) were purchased from several local supermarkets in Muang Chiang Mai District, Chiang Mai province, Thailand. 9 brands were manufactured in Thailand, while 2 other brands were produced outside Thailand (imported products). One product was manufactured in the United Kingdom and the other one in Australia.

2.2 Preparations of fat solutions.

Approximately 20 g of each sample were heated (50 °C) in an oven for about 20 min in order to destabilise the emulsion. The lipidic phase was then decanted and filtered through filter paper with anhydrous NaSO₄ (Christopherson and Glass, 1969).

2.3 Preparation of fatty acid methyl esters (FAMES).

The following procedure was based on the method proposed by Christopherson and Glass (1969). Approximately 0.1 mg margarine was weighed and dissolved in 3 mL of hexane. 0.1 mL of 2 N Methanolic potassium hydroxide was then added and the mixture was stirred for 1 min and left to rest for 15 min. The hexane layer was then separated, and 0.2 µL of the hexane fraction was injected into the Gas Chromatography (GC). For recovery analysis of the Silver ion Thin Layer Chromatography (Ag-TLC) fractions and direct GC systems, 1 mL of heptadecanoic acid methyl ester (11 mg/5 mL hexane) was added to margarine oil as internal standard before transesterification.

2.4 Fatty acid composition by using gas liquid chromatography analysis.

The FAMES were analysed using a GC FID Agilent model 6890 N. Separations were obtained on a fused-silica capillary column (100 m × 0.25 mm i.d., 0.20 µm film; Supelco). For the separation and quantification of the total FAME amounts, the column temperature was hold from 140 °C for 5 min and raised 3 °C per min to 250 °C hold for 17 min during the chromatographic run for 55 min. The inlet temperature of the carrier gas (helium) was 140 kPa. The injector and the detector were held at 250 °C (Boatella, *et al.*, 1993).

2.5 Statistical analysis

Three individual samples from each treatment were acquired and an analysis on each sample was conducted. Results were shown in the means ± standard deviation of three parallel measurements.

3. Results and Discussion

In the western and developed nations of America and Europe, instances of death from diet-related chronic diseases are on the increase. The major dietary causes of CHD are undoubtedly dietary total fat and saturated fat, owing to their effects on serum total cholesterol and LDL-C concentrations. Governments have made strenuous efforts to educate and persuade consumers to lower their intake of saturated fat. In tandem with these efforts, food manufacturers have moved to replace animal fat with hydrogenated vegetable oils. Products manufactured with hydrogenated vegetable oils may claim a low saturated fat and low or no cholesterol content, attracting customers trying to reduce their fat intake (Willett and Ascherio, 1994).

However, the unique adverse effects of TFAs on health issue have been documented in numerous human metabolic studies. Isocaloric replacement of either saturated or cis unsaturated fats with TFAs also raises LDL-C and reduces HDL-C. This is similar to observational studies of habitual TFAs consumption. In one study, higher TFAs consumption (habitual intake of 2.5–3.6 g/day) was associated with higher LDL-C, lower HDL-C and a higher LDL-C to HDL-C ratio. Similarly, dietary TFAs also increase serum triglycerides compared with unsaturated fats. Each of these changes in serum lipids is independently associated with higher CHD risk (Micha and Mozaffarian, 2008).

Fatty acid composition of a representative collection of margarines, spreadable and shortening in Thai market was shown in Table 1. Whereas trans-octadecenoic acid in milk fats results from biohydrogenation in the rumen, the isomeric pattern of C18:1 TFA (trans-9-Eladic acid) in margarines and oils is formed by technical hydrogenation. All the margarines were mixtures of a number of oils in their native state with fat and oils hydrogenated or partially hydrogenated. As a consequence, the amounts of trans-18:1 isomers in the samples ranged from 3.92 to 10.13%.

None of the margarines analysed was fat reduced, the average fat content being about 80%. The total TFAs contents of the margarines varied between 12% and 21% (% of total fatty acids, w/w) including the natural TFAs and TFAs from the food processing. Three local budget price brands without any TFAs declaration (sample 1–3) were characterised by a 6-10% approximately while six local brands with TFAs declaration (sample 4-9) on the packaging were characterised by a slightly high TFAs content of 4–7% approximately. All other tested margarines were still containing 4–5% of TFAs.

Table 1 Fatty acid composition (%fatty acids, g/100g) in margarines, spreadable and shortening products marketed in Thailand

Fatty acid	Sample										
	1	2	3	4	5	6	7	8	9	10	11
C4:0(Butyric acid)	ND	ND	ND	0.46 ± 0.00	0.77 ± 0.01	1.57 ± 0.01	1.49 ± 0.01	0.31 ± 0.00	0.20 ± 0.00	0.95 ± 0.00	ND
C6:0(Caproic acid)	0.18 ± 0.00	0.17 ± 0.00	0.03 ± 0.00	0.68 ± 0.01	0.88 ± 0.01	1.55 ± 0.01	1.42 ± 0.00	0.30 ± 0.00	0.24 ± 0.00	1.08 ± 0.00	0.07 ± 0.00
C8:0(Caprylic acid)	1.38 ± 0.01	0.90 ± 0.01	0.80 ± 0.01	1.86 ± 0.01	1.46 ± 0.01	0.99 ± 0.01	0.92 ± 0.00	0.16 ± 0.00	0.24 ± 0.00	0.55 ± 0.00	0.20 ± 0.00
C10:0(Capric acid)	1.10 ± 0.01	0.72 ± 0.01	0.76 ± 0.01	2.41 ± 0.01	2.04 ± 0.01	2.42 ± 0.01	2.22 ± 0.01	0.43 ± 0.01	0.46 ± 0.00	1.37 ± 0.01	0.19 ± 0.00
C11:0(Undecanoic acid)	ND	ND	ND	0.12 ± 0.00	0.13 ± 0.00	0.27 ± 0.01	0.25 ± 0.00	0.04 ± 0.00	0.03 ± 0.00	0.15 ± 0.00	ND
C12:0(Lauric acid)	9.27 ± 0.01	6.15 ± 0.01	10.93 ± 0.01	21.18 ± 0.01	15.28 ± 0.01	3.03 ± 0.00	2.98 ± 0.01	0.66 ± 0.00	1.96 ± 0.01	1.71 ± 0.01	2.90 ± 0.00
C13:0(Tridecanoic acid)	ND	ND	ND	0.08 ± 0.00	0.08 ± 0.00	0.15 ± 0.00	0.14 ± 0.01	0.03 ± 0.00	0.02 ± 0.00	0.09 ± 0.00	ND
C14:0(Myristic acid)	4.32 ± 0.01	2.96 ± 0.01	4.30 ± 0.01	10.46 ± 0.01	9.52 ± 0.01	8.62 ± 0.01	8.00 ± 0.01	2.29 ± 0.01	2.45 ± 0.01	5.43 ± 0.01	1.09 ± 0.00
C15:0(Pentadecanoic acid)	ND	ND	ND	0.29 ± 0.00	0.40 ± 0.00	0.92 ± 0.00	0.85 ± 0.00	0.14 ± 0.00	0.01 ± 0.00	0.46 ± 0.00	ND
C16:0(Palmitic acid)	ND	ND	ND	ND	ND	ND	0.01 ± 0.00	ND	ND	ND	ND
C17:0(Heptadecanoic acid)	0.08 ± 0.00	0.08 ± 0.00	0.08 ± 0.00	0.53 ± 0.00	0.77 ± 0.01	1.74 ± 0.00	1.62 ± 0.00	0.37 ± 0.00	0.29 ± 0.00	0.91 ± 0.00	0.10 ± 0.00
C18:0 (Stearic acid)	ND	ND	ND	0.09 ± 0.00	0.11 ± 0.00	ND	ND	ND	ND	ND	0.04 ± 0.00
C20:0 (Arachidic acid)	5.32 ± 0.01	4.56 ± 0.01	4.70 ± 0.00	2.19 ± 0.01	2.13 ± 0.00	3.69 ± 0.01	3.52 ± 0.00	16.95 ± 0.01	16.07 ± 0.01	5.70 ± 0.01	9.53 ± 0.01
C21:0(Heneicosanoic acid)	0.11 ± 0.00	0.09 ± 0.00	0.09 ± 0.00	0.21 ± 0.00	0.24 ± 0.00	0.61 ± 0.00	0.57 ± 0.00	2.53 ± 0.00	2.38 ± 0.00	2.21 ± 0.00	3.48 ± 0.00
C22:0(Behenic acid)	ND	ND	ND	ND	ND	ND	ND	0.03 ± 0.00	0.02 ± 0.00	ND	ND
C23:0 (Tricosanoic acid)	ND	ND	0.01 ± 0.00	0.03 ± 0.00	0.05 ± 0.00	0.11 ± 0.00	0.15 ± 0.00	0.04 ± 0.00	0.03 ± 0.00	0.06 ± 0.00	0.01 ± 0.00
C24:0(Lignoceric acid)	0.05 ± 0.00	0.04 ± 0.00	0.05 ± 0.00	0.03 ± 0.00	0.04 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.07 ± 0.00	0.06 ± 0.00	0.04 ± 0.00	0.07 ± 0.00
C14:1(Myristoleic acid)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C15:1n10(cis-10-Pentadecenoic acid)	0.03 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.44 ± 0.00	0.50 ± 0.00	0.83 ± 0.00	0.76 ± 0.00	0.22 ± 0.00	0.19 ± 0.00	0.57 ± 0.00	0.01 ± 0.00

Note: mean ± SD; ND is not detected; TSFA is total saturated fatty acid; TMUFA is total monounsaturated fatty acid; TPUFA is total polyunsaturated fatty acid; TPUFA/TSFA is the ratio of total polyunsaturated fatty acid and saturated fatty acid; Trans-fat is total trans fatty acid

Table 1 Fatty acid composition (%fatty acids, g/100g) in margarines, spreadable and shortening products marketed in Thailand (continue)

Fatty acid	Sample										
	1	2	3	4	5	6	7	8	9	10	11
C17:1n10(cis-10-Heptadecenoic acid)	0.06 ± 0.00	0.05 ± 0.00	0.06 ± 0.00	0.28 ± 0.00	0.33 ± 0.00	0.50 ± 0.00	0.47 ± 0.00	0.19 ± 0.00	0.16 ± 0.00	0.35 ± 0.00	0.03 ± 0.00
C18:1n9t (Trans-9-Eladic acid)	8.10 ± 0.01	6.41 ± 0.01	10.13 ± 0.01	4.92 ± 0.01	5.49 ± 0.01	6.84 ± 0.01	6.36 ± 0.00	4.22 ± 0.00	3.92 ± 0.01	5.38 ± 0.01	4.20 ± 0.00
C18:1n9c(cis-9-Oleic acid)	0.05 ± 0.00	0.06 ± 0.00	0.26 ± 0.00	0.97 ± 0.00	0.96 ± 0.00	1.58 ± 0.00	1.52 ± 0.00	0.39 ± 0.00	0.34 ± 0.00	1.10 ± 0.00	0.09 ± 0.00
C20:1n11 (cis-11-Eicosenoic acid)	ND	ND	ND	0.01 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	ND	ND	0.10 ± 0.00	0.13 ± 0.00
C22:1n9 (Erucic acid)	ND	ND	ND	0.02 ± 0.00	0.03 ± 0.00	0.07 ± 0.00	0.06 ± 0.00	0.01 ± 0.00	ND	0.04 ± 0.00	ND
C24:1n9 (Nervonic acid)	ND	ND	ND	ND	ND	0.01 ± 0.00	ND	0.02 ± 0.00	0.02 ± 0.00	0.04 ± 0.00	0.05 ± 0.00
C18:2n6t (trans-Linolelaidic acid)	11.03 ± 0.01	9.98 ± 0.00	10.70 ± 0.01	7.12 ± 0.00	7.87 ± 0.00	10.90 ± 0.01	10.22 ± 0.00	12.55 ± 0.01	11.68 ± 0.01	12.67 ± 0.01	14.56 ± 0.00
C18:2n6c (cis-9,12-Linoleic acid)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C18:3n6c (gamma-Linolenic acid)	0.23 ± 0.00	0.19 ± 0.00	0.26 ± 0.00	0.11 ± 0.00	0.13 ± 0.00	0.12 ± 0.00	0.12 ± 0.00	0.26 ± 0.00	0.25 ± 0.00	0.21 ± 0.00	0.29 ± 0.00
C18:3n3c (alpha-Linolenic acid)	0.09 ± 0.00	0.07 ± 0.00	0.09 ± 0.00	0.06 ± 0.00	0.07 ± 0.00	0.09 ± 0.00	0.09 ± 0.00	0.46 ± 0.00	0.39 ± 0.00	0.41 ± 0.00	0.59 ± 0.00
C20:3n6(cis-8,11,14-Eicosatrienoic acid)	0.04 ± 0.00	0.03 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.06 ± 0.00	0.08 ± 0.00	0.08 ± 0.00	0.18 ± 0.00	0.16 ± 0.00	0.12 ± 0.00	0.14 ± 0.00
C20:3n3(cis-11,14,17Eicosatrienoic acid)	ND	ND	ND	ND	ND	0.01 ± 0.00	0.02 ± 0.00	0.07 ± 0.00	0.06 ± 0.00	0.04 ± 0.00	ND

Note: mean ± SD; ND is not detected; TSFA is total saturated fatty acid; TMUFA is total monounsaturated fatty acid; TPUFA is total polyunsaturated fatty acid; TPUFA/TSFA is the ratio of total polyunsaturated fatty acid and saturated fatty acid; Trans-fat is total trans fatty acid

Table 1 Fatty acid composition (%fatty acids, g/100g) in margarines, spreadable and shortening products marketed in Thailand (continue)

Fatty acid	Sample										
	1	2	3	4	5	6	7	8	9	10	11
C20:4n6(Arachidonic acid)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
C22:2 (cis-13,16-Docosadienoic acid)	ND	ND	ND	0.03 ± 0.00	0.03 ± 0.00	0.04 ± 0.00	0.04 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.03 ± 0.00	ND
C20:5n3(cis-5,8,11,14,17- Eicosapentaenoic acid)	ND	ND	ND	0.02 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.02 ± 0.00	ND	ND	0.02± 0.00	ND
C22:6n3(cis-4,7,10,13,16,19- Docosahexaenoic acid)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TSFA	21.83	15.66	21.77	40.62	33.90	25.71	24.16	24.34	24.56	20.72	17.67
TMUFA	33.71	28.05	37.15	24.67	27.49	32.57	32.24	23.72	22.82	23.94	9.80
TPUFA	11.40	10.28	11.08	7.38	8.18	11.27	10.58	13.54	12.55	13.49	15.59
TPUFA/TSFA	0.52	0.65	0.51	0.18	0.24	0.44	0.44	0.56	0.51	0.65	0.88
Trans fat	19.13	16.39	20.82	12.04	13.26	17.74	16.58	16.77	15.60	18.05	18.76
Omega 3 (mg/100g)	90.86	70.73	88.52	77.97	88.50	126.79	129.96	534.76	453.67	468.46	600.25
Omega 6 (mg/100g)	296.76	227.31	299.69	158.96	195.58	201.89	196.41	443.09	406.67	328.79	439.85
Omega 9 (mg/100g)	50.46	56.29	261.99	988.21	982.61	1662.07	1581.09	420.15	363.89	1179.23	142.25

Note: mean ± SD; ND is not detected; TSFA is total saturated fatty acid; TMUFA is total monounsaturated fatty acid; TPUFA is total polyunsaturated fatty acid;

TPUFA/TSFA is the ratio of total polyunsaturated fatty acid and saturated fatty acid; Trans-fat is total trans fatty acid

4. Conclusions

Overall TFAs consumption can be reduced in several ways – by education and persuading consumers of the health merits of their avoidance, by food producers and manufacturers exploring alternative oils and fats, as well through more prominent labelling coupled government-led policies and initiatives. The Thai FDA, for example, has banned totally from 2018 the use of products containing TFAs in the food industry. This report found a remarkably higher level of TFAs in 9 margarine locally and slightly high in 2 of imported margarine in Thailand market. Three local budget price brands without any TFAs declaration (sample 1–3) were characterised by a 6-10% approximately while six local brands with TFAs declaration (sample 4–9) on the packaging were characterised by a slightly high TFAs content of 4–7% approximately. All other tested margarines still contained 4–5% of TFAs. Given the high prevalence of cardiovascular diseases in Thailand, the possible increase in risk for those diseases caused by a high TFAs consumption should be carefully considered.

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