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Analytical Methods

Comprehensive studies on the trans fatty acid content of Austrian foods: Convenience products, fast food and fats

Karl-Heinz Wagner *, Elisabeth Plasser, Christiana Proell, Sonja Kanzler

Department of Nutritional Sciences, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

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Abstract

Due to reported detrimental health effects of diets high in trans fatty acids (TFA) in particular on blood lipids, convenience products, trade margarines, fats for cooking and frying and fast food products available on the Austrian market were comprehensively investigated on TFA, using gas chromatography.

About half of the tested convenience products contained less than 1% TFA, one third less than 5%, but almost 5% of the tested products more than 20% TFA. A similar allocation could be found in fast food products, with the highest TFA level of 8.9%. Total TFA of household fats were lower (1.45 ± 1.99%) than fats of industrial use (7.83 ± 10.0%, $p < 0.001$).

Compared to investigations in Austria and Germany around 10 years ago the TFA content of the tested foods had decreased significantly. About half of the investigated products contained less than 1% TFA/total fatty acids, however, very high amounts of TFA (>15%) can still be detected and an intake of more that 5 g TFA/portion, which has been shown to significantly increase the risk for cardiovascular disease, is easily possible.

Keywords: Trans fatty acids; Fast food; Margarines; Convenience products

1. Introduction

Trans fatty acids (TFA) originate in our foods mainly from industrial hydrogenation and "natural" ruminant sources. In the latter, trans-vaccenic acid (11transC18:1) accounts for over 60% of total TFA, whereas in the industrially produced TFA (IP-TFA) a broad mixture of TFA is formed with elaidic acid (9transC18:1) as the main source (EFSA, 2004; Stender, Dyerberg, & Astrup, 2006b).

Very intensive discussion on TFA in the last decade resulted in legislation to reduce the content of IP-TFA e.g. in Denmark (Astrup, 2006; Stender, Dyerberg, & Astrup, 2006a) or by declaring them on the nutrition label e.g. in Canada (Morin, 2005) or US (Satchithanandam et al., 2004).

Evidence from several controlled human intervention studies indicates that consumption of diets containing TFA, consistently results in increased serum low density lipoprotein cholesterol (LDL-C) and decreased high density lipoprotein cholesterol (HDL-C), compared with consumption of diets containing cis-monounsaturated (MUFA) or cis-polyunsaturated (PUFA) fatty acids, thereby increasing the ratio total-C:HDL-C, which is associated with an increased risk of cardiovascular disease (CVD) (EFSA, 2004). Consumption of TFA predicts higher risk of coronary heart disease, sudden death, and possibly diabetes mellitus (Mozaffarian, Katan, Ascherio, Stampfer, & Willett, 2006). These associations are greater than would be predicted by the effects of TFA on serum lipoproteins alone, suggesting that TFA intake may also influence other, non-lipid risk factors. TFA intake has also been suggested to influence inflammation, early development and fetal growth, cancer or allergies, although data are not always consistent (EFSA, 2004; Innis, 2006; Wijga et al., 2006).

* Corresponding author. Tel.: +43 1 4277 54930; fax: +43 1 4277 9549.
E-mail address: karl-heinz.wagner@univie.ac.at (K.-H. Wagner).

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Due to the public and scientific discussion, TFA content of foods has been reduced worldwide thereby also reducing the intake of TFA (Craig-Schmidt, 2006). In 1976, the average intake in Europe was 6 g/d (Stender et al., 2006b), in the TRANSFAIR study the intake varied between 1.2 and 6.7 g/d with lower intake in the south (Hulshof et al., 1999). In central Europe less data are provided, in particular in the new millennium. In Austria, which did not participate in the TRANSFAIR study, only few studies have been conducted in the nineties showing a large range of TFA in various products (Henninger & Ulberth, 1996, 1997; Wagner, Auer, & Elmadfa, 2000). Data from Germany, which has a similar eating pattern than Austria and the same nutrient recommendations (DACH: Germany–Austria–Switzerland), are more than ten years old based on the TRANSFAIR study. Only margarines, cooking fats and shortenings have been investigated in between still showing high TFA values (Precht & Molkentin, 2000). Comprehensive data from Switzerland are missing so far.

Since data from recent studies worldwide indicate very inhomogeneous data with low but also very high TFA levels in foods (Stender et al., 2006b). The aim of this study was to assess the TFA content of "high risk" food groups in Austria, which gives also basic information for other countries of Central Europe.

This part of the work will focus on the TFA in convenience products, fast food and fats, groups which have been shown to contain high TFA concentrations in previous studies.

2. Materials and methods

2.1. Reagents and solvents

All chemicals were purchased from Sigma–Aldrich (Vienna, Austria).

2.2. Instruments

A Büchi mixer B-400 (Lucerne, Switzerland) was used to homogenise the samples, while an accelerated solvent extraction system (ASE® 100, Vienna, Austria) was used for determination of the total fat content for all products after acidic pulping.

The fatty acid pattern was analysed with gas chromatography (GC) by using an Auto-System Gas Chromatograph, (Perkin Elmer, Vienna, Austria).

2.3. Samples and sample preparations

All together more than 400 food samples were purchased in Austria between April 2005 and December 2006.

Convenience products ($n = 106$) as well as trade margarines, fats for cooking and frying ($n = 20$) were purchased at different retail outlets in Vienna or in the area of Vienna. Fast food products ($n = 33$) were purchased in various fast food chains in the area of Vienna, in commercial restaurants which provide also a fast food service and in university restaurants.

The following points were considered for the choice of a sample:

Product groups: Generally product groups high in fat (10% or higher), product groups which are expected to have TFA, products which are labelled with "containing partially hydrogenated oils".

Products: Public acceptance of a product, market leading products and at the same time their cheaper alternatives, random sampling over all super markets (leading markets, discount markets and large retailers providing mainly the food industry, SMEs and most of the restaurants).

Size of the samples: Always one package, one meal or one product.

Ready to eat samples were purchased as one portion or, if larger, then one portion was calculated and prepared. They were immediately (after purchase) homogenised and frozen at −80 °C until analysis. Convenience products were purchased as one package and were always prepared according to the cooking instruction of the product (except instant soups – the dry product was investigated and the TFA content was then calculated for ready-made soups); e.g. a deep frozen product was heated in a microwave oven considering the time and the wattage instructions, or a deep frozen pizza was baked in the oven considering time and temperature requirements. If the portion was larger than one piece (e.g. pizza) then the other products were frozen for reference needs. After preparation in our experimental kitchen the samples were also weighted, immediately homogenised, and frozen at −80 °C until analysis (never longer than four weeks).

3. Methods

3.1. Fat extraction

The ASE® 100 was used for determination of the fat content for all products. Before the samples were hydrolysed with hydrochloric acid (25% w/w) by a modified method of Weibull-Stoldt (Matissek & Steiner, 2006). Depending on the fat content (final amount 0.5–1.5 g after extraction) 3 g (fat content higher than 20%) to 100 g (fat content less than 1%) of the homogenised sample was solubilised by boiling with 200 ml hydrochloric acid (12.5% v/v), whereby lipids bound to carbohydrates and proteins were hydrolysed. The fat fraction was isolated by filtration. After repeated washings of the filter until neutrality of the washing water the residue was dried and extracted with the ASE® 100. The ASE® sample cell (total volume 66 ml) was filled with cotton wool, cellulose and the dried filter and extracted with 66 ml of petroleum ether at 125 °C under pressure. The extract was evaporated on a rotary evaporator and the solvent residues removed with nitrogen. The fat fraction was quantified gravimetrically after evaporation and a further drying. For assuring the reproducibility the coefficient of variation (CV) of ten measurements of the fat content of one product (a salty snack) was acquired. The CV was 1.05%. Furthermore, the accuracy of analysis was verified by measuring food samples with standardised fat contents, e.g. margarines, milk and milk products and by using the certified standard reference material 1846 (National Institute of Standards Technology, Gaithersburg, USA), recovery was 98.6%.

3.2. TFA determination with GC–FID

Sample (1 g) was extracted with 30 ml chloroform/methanol = 2:1 (v/v, 0.005% BHT) by shaking it for two hours following an overnight extraction at 4 °C. The final extract was dried over Na_2SO_4. Approximately 18 ml of the chloroform phase were received.

Fatty acid methyl esters (FAME) were obtained using boron trifluoride (BF_3) by transesterification. The amount of extract used for transesterification was dependent on the fat content, it was calculated on approx. 10 μl oil (equivalent to 9–9.5 mg oil). Based on the latter 0.8–3 ml of each extract was boiled with 1 ml methanolic sodium hydroxide at 100 °C for 5 min. BF_3–methanol reagent (1 ml) was added and boiled for further 5 min. FAME were extracted into 1 ml hexane four times and vaporised to dryness and redissolved in 2 ml hexane for gas chromatography analysis.

FAME were separated by a 105 m × 0.25 mm ID fused silica column (RTx-2330 Restek, Bellefonte, USA) and detected with flame ionisation detector (FID), the FID temperature was set to 275 °C. Helium was used as carrier gas with the pressure of 2.8 bar, split ratio was 1:50.

The FAME extracts (1 μl) were injected at an initial injector temperature of 100 °C, which was increased after 10 min to 200 °C by 4 °C/min, from 200 °C to 220 °C by 2 °C/min and to 240 °C by 1 °C/min, with a final isothermal period of 10 min. The total period was 75 min. Peak retention times and area percentages of total fatty acids were identified by injecting known standards (SUPELCO 18919 AMP, FAME Mix, C4–C24), the following TFA were considered: 16:1n9t, 18:1n9t, 18:1n7t, 18:1n12t, 18:2n6t, 20:1n11t, 22:1n13t.

The FID signal was processed by TotalChrom Workstation 6.3.0, PE Nelson, Perkin Elmer.

A control food sample (snack) was run throughout the study. The CVs for the main fatty acids were (based on totally 34 replicates): 3.58% for 16:0, 3.19% for 18:0, 2.44% for 18:1(*n*-9), 2.44% for 18:2(*n*-6), 0.97% for 18:3(*n*-6), and 0.52% for 18:2(*n*-6)ct.

Furthermore, each day at least 1 out of 5 food samples were replicates.

Fatty acids are given in % of total fatty acids or as g/100 g of the product. Latter one is calculated on the total fat content of the sample.

4. Results and discussion

4.1. Convenience products

This group comprised of ready to eat cooled or frozen products, quick meals, desserts, pizzas, potato chips (mainly for oven preparation), pasta dishes, pre-fried products, instant products, cereal products as well as dough.

Table 1 shows a summary of the TFA contents of the individual food groups and of the total food group.

The mean TFA content of the products was 3.64 ± 5.92%/total fatty acids or 0.47 ± 0.95 g/100 g product. Main providers of TFA are cooled ready to eat products as well as dough. Although instant soups and pasta dishes (also instant products) show high TFA values in the dry product they provide less amounts in the ready to eat portion due to the lower fat content (after water addition) of the ready to eat portion. However, such high concentrations are not explainable nowadays and must be reduced (some companies have changed their recipes immediately). In these products the labelling "contains partially hydrogenated vegetable oils" can be found for almost each product.

Fig. 1 shows the distribution more detailed for the group of dough and ready to eat products (mainly cook & chill).

All dough samples were prepared according to the respective instructions on the packing without any addition of other ingredients. Depending on the kind of dough different contents of fat were obtained. Pizza bases included 4.19–11.25% fat. More fatty pastries, like puff pastry or flaky pastry dough contained fat from 26.8 to 38.87% (puff pastry) and from 27.89 to 30.37% (flaky pastry). The TFA values in all dough ranged from 0.10 to 9.91% (0.04–2.85 g/100 g dough). High amounts of TFA were found in the two investigated brands of flaky pastry dough (9.37–9.91%, 2.77–2.85 g/100 g dough) although the ingredients lists of both dough did not contain any information on the use of hydrogenated fat. Puff pastries showed a wide range of TFA values: from 0.10 to 6.57% (0.04–1.83 g/100 g dough). Four of the six puff pastries contained less than 1% of TFA, whereas the TFA values of the two other dough were in the range of 5.7–6.57%. Low amounts of TFA in puff pastries are tolerable because of the common use of butter for preparation of puff pastries. The high amounts of TFA possibly could be reduced by the use of fully hydrogenated fat instead of butter. The lowest TFA amounts (1.42–5.69%, 0.06–0.51 g/100 g product) were found in pizza bases.

Ready to eat products were cooked or heated without any further addition of fat. Fat content ranged from 2.10 to 24.61 g/100 g product, mean value was 10.98 g/100 g. Mean TFA content was 4.86%/total fatty acids but the highest amount was 33%. This product was a dried, ready to prepare dumpling, which only has to be cooked in hot water for approx. 20 min. Fortunately this product contained less fat so it provided only 2.51 g/100 g, which is, however, still too high. According to the nutritional recommendation the daily TFA intake should not exceed 2.5–3 g/d (<1% of total energy).

Table 1
TFA content (% TFA/total fatty acids (FA) and g TFA/100 g) of convenience products

Convenience products	16:1n9t	18:1n9t	18:1n7t	18:2n6t	Total (%TFA/FA)*	Total g TFA/100 g
Instant soups ($n = 7$)	0.04 ± 0.01	6.53 ± 9.35	7.04 ± 5.52	0.15 ± 0.09	13.80 ± 9.39	2.41 ± 2.00
Breakfast cereals ($n = 5$)	0.03 ± 0.01	0.03 ± 0.02	0.08 ± 0.06	0.06 ± 0.10	0.21 ± 0.19	0.02 ± 0.01
Pasta dishes ($n = 10$)	0.16 ± 0.13	1.19 ± 1.41	2.81 ± 3.33	0.12 ± 0.09	4.39 ± 4.07	0.11 ± 0.10
Pre-fried products ($n = 7$)	0.06 ± 0.04	0.02 ± 0.01	0.18 ± 0.13	0.12 ± 0.10	0.58 ± 0.40	0.07 ± 0.09
Potato chips ($n = 16$)	0.03 ± 0.01	0.75 ± 1.59	1.24 ± 2.92	0.31 ± 0.45	2.40 ± 4.20	0.18 ± 0.31
Pizzas ($n = 19$)	0.15 ± 0.06	0.25 ± 0.36	0.84 ± 0.69	0.14 ± 0.12	1.82 ± 1.33	0.17 ± 0.08
Quick meals ($n = 7$)	0.11 ± 0.07	0.09 ± 0.07	0.60 ± 0.44	0.18 ± 0.10	1.07 ± 0.62	0.12 ± 0.09
Desserts ($n = 5$)	0.09 ± 0.11	1.02 ± 2.14	1.77 ± 2.67	0.13 ± 0.09	3.41 ± 4.60	0.11 ± 0.15
Cooled ready to eat products ($n = 13$)	0.19 ± 0.11	1.55 ± 3.25	2.78 ± 5.55	0.18 ± 0.16	4.86 ± 8.86	0.33 ± 0.66
Doughs ($n = 17$)	0.05 ± 0.03	1.07 ± 1.70	2.32 ± 1.85	0.08 ± 0.06	3.78 ± 3.07	0.87 ± 0.98
Total ($n = 106$)	0.10 ± 0.09	1.29 ± 3.51	1.86 ± 3.19	0.20 ± 0.32	3.64 ± 5.92	0.47 ± 0.95

* Also containing 18:1n12t, 20:1n11t, 22:1n13t; values equal mean ± SD.

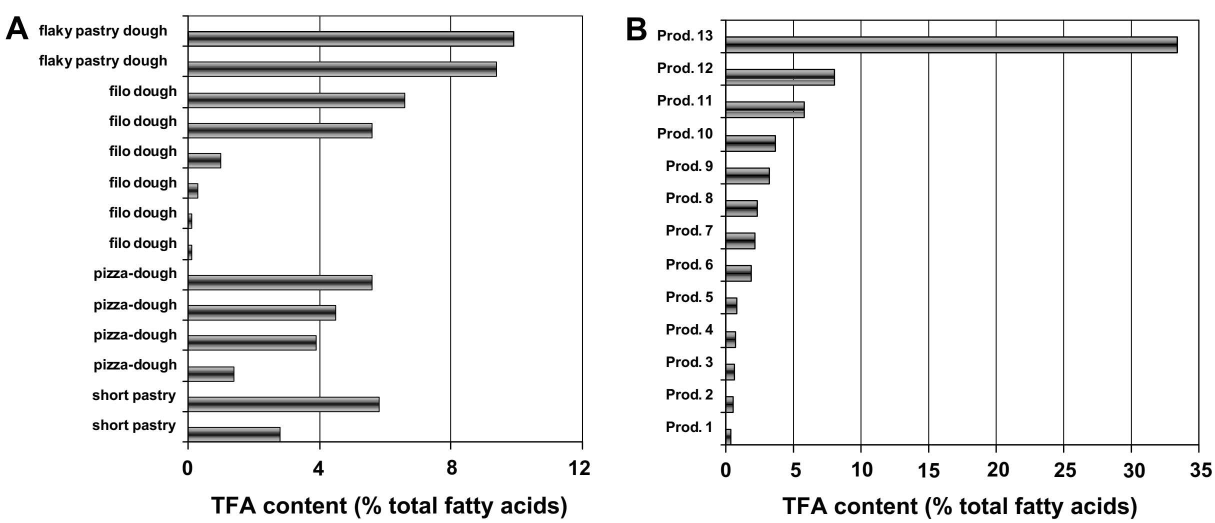

Fig. 1. TFA contents (% TFA/total fatty acids) of doughs (A) and cooled ready to eat products (B).

Different brands of frozen pizzas with similar pizza toppings, but mainly salami were selected for the determination of fat content and fatty acid pattern. All pizzas were prepared according to the producers instructions. The total fat contents ranged from 5.42 to 15.63% with a mean value of 10.76%. All investigated pizzas contained 0.75–5.04% of TFA (Fig. 2), mean value was 3.09% (stratified to the fat content 0.10–0.40 g TFA/100 g pizza, mean value 0.17 g/100 g pizza). These relatively low levels could originate from cheese used for pizza toppings since higher content of vaccenic acid was found.

Similar results were obtained in the TRANSFAIR Study. The total TFA content ranged from less than 1% up to around 5% in most pizzas, whereas higher amounts of TFA were found in Portuguese and Spanish pizza (7.9 and 10% total TFA, respectively) (Van Erp-Baart et al., 1998).

Higher amounts of TFA were found in Austrian pizzas around ten years ago. TFA contents of three investigated pizzas were in the range of 1.24–24.56% (total fat contents 6.52–7.85%) (Henninger & Ulberth, 1997).

Taking the group together about half of the tested convenience products contained less than 1% TFA, one third less than 5% but almost 5% of the tested products contained more than 20% TFA (Fig. 2).

4.2. Fast food products

This product group comprised burger, French fries, Wiener schnitzel and some other typical products from fast food restaurants (apple pies, onion rings, fried chicken; except donuts which were allocated to the group of bakery products). They were ready to eat purchased and immediately homogenised.

Table 2 gives an overview of the total food group data. The mean TFA content was 2.1 ± 2.2%, or 0.35 ± 0.43 g/100 g product, the fat content 15.1 ± 4.4 g/100 g product.

French fries were sampled in the most important fast food restaurants and snack-bars in Vienna. The TFA distribution of French fries and burger is shown in Fig. 3 ranging from 0.18 to 8.93% TFA. Compared to previous investigations the amount of TFA has been reduced (Wag-

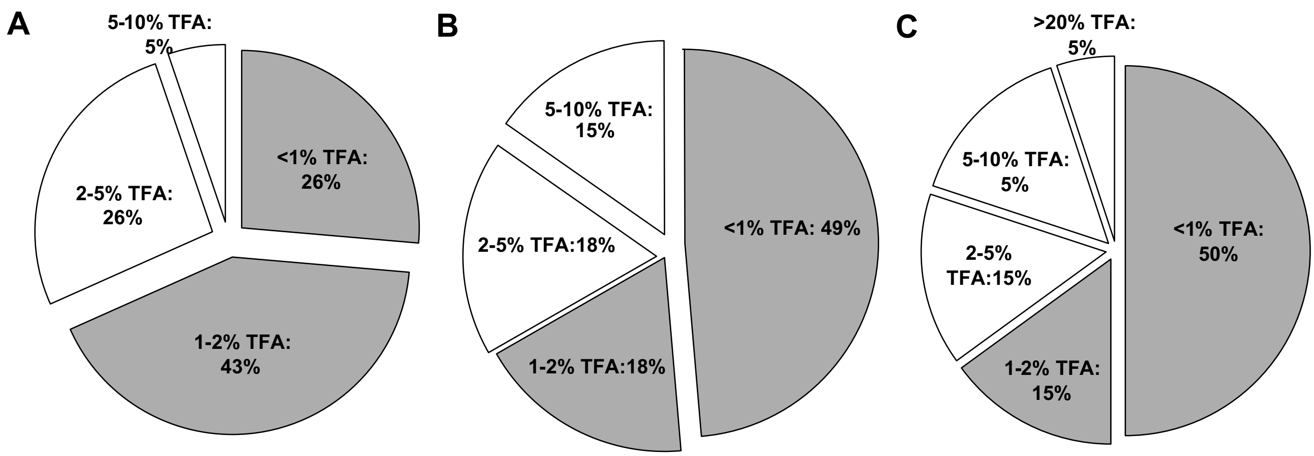

Fig. 2. Distribution of TFA (% TFA/total fatty acids) in pizzas (A), fast food (B) and margarines and fats (C).

Table 2
TFA (% TFA/total fatty acids (FA) and g TFA/100 g) content of fast food

Fast food	16:1n9t	18:1n9t	18:1n7t	18:2n6t	Total (%TFA/FA)*	Total g TFA/100 g
Hamburger ($n = 12$)	0.15 ± 0.08	1.29 ± 0.89	0.27 ± 0.62	0.25 ± 0.39	2.04 ± 1.71	0.30 ± 0.28
French fries ($n = 8$)	0.09 ± 0.12	1.38 ± 2.94	0.00 ± 0.00	0.07 ± 0.12	1.72 ± 3.04	0.30 ± 0.55
Wiener Schnitzel ($n = 6$)	0.09 ± 0.03	0.33 ± 0.29	0.04 ± 0.07	0.10 ± 0.15	0.65 ± 0.45	0.11 ± 0.10
Other products ($n = 7$)	0.18 ± 0.13	2.23 ± 1.06	0.85 ± 0.79	0.67 ± 0.27	4.20 ± 1.62	0.78 ± 0.45
Total ($n = 33$)	0.13 ± 0.10	1.34 ± 1.66	0.29 ± 0.59	0.27 ± 0.35	2.17 ± 2.22	0.36 ± 0.43

* Also containing 18:1n12t, 20:1n11t, 22:1n13t; values equal mean ± SD.

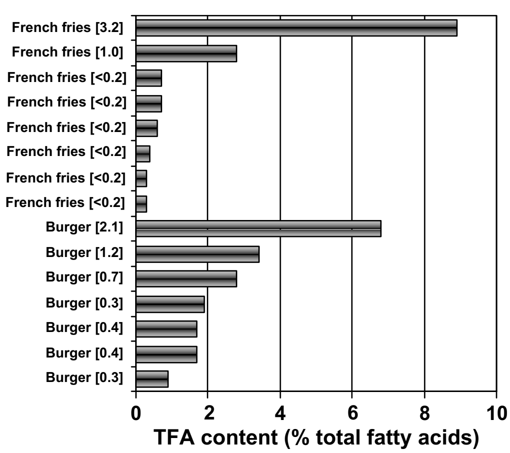

Fig. 3. Comparison of TFA concentrations of French fries and burgers. Values in parentheses are g of TFA in a 200 g portion.

ner et al., 2000), however, very high concentrations of 8.9% and 2.8% were still found.

Of the tested products 67% comprised a TFA value of less than 2%, 18% between 2 and 5% and 15% of more than 5% TFA.

Aro et al. (TRANSFAIR Study) also published strongly varying amounts of TFA contents in French fries from several fast food restaurants (0.45%–34.84%), resuming that fast food restaurants whose French fries exhibited high TFA levels used partially hydrogenated chip fats (Aro et al., 1998a). Fortunately, it seems that concentrations far higher than 10% TFA cannot be found consistently any longer. Stender et al. showed similar values for French fries of one fast food supplier in Austria and Germany (Stender, Dyerberg, Bysted, Leth, & Astrup, 2006c).

We observed around one decade ago TFA values in French fries ranging from 1.9% to 18% (Wagner et al., 2000). In all of the products from the same fast food supplier there was a significant reduction of TFA towards previous investigation.

Very similar to French fries are TFA concentrations in burgers. The mean TFA content was 2.04 ± 1.7% with highest concentrations of 6.78 and 2.80%, respectively. Both high concentrations are in the products of the same fast food brand, indicating the use of TFA containing fats.

Typical for Austria but also for parts of Germany is the consumption of Wiener schnitzel, which is pork fried within a coat of flour, egg, and breadcrumbs. It can be eaten in several restaurants but also in special take away restaurants directly in the street. Wiener schnitzel and some vegetable schnitzel (same "coat", instead of meat use of vegetable mix), all deep fried and ready to eat, were investigated. Their TFA concentrations ranged from 0.19 to 1.37% or up to 0.17 g/100 g.

These low concentrations show changes in technology and the use of alternatives to partially hydrogenated vegetable oils (Eckel, Borra, Lichtenstein, & Yin-Piazza, 2007; Tarrago-Trani, Phillips, Lemar, & Holden, 2006).

Table 3
TFA content (% TFA/total fatty acids (FA) and g TFA/100 g) of margarines ($n = 20$)

Margarines	16:1n9t	18:1n9t	18:1n7t	18:2n6t	Total (%TFA/FA)*	Total g TFA/100 g
Total ($n = 20$)	0.05 ± 0.10	1.79 ± 3.34	1.25 ± 2.65	0.23 ± 0.43	3.37 ± 6.15	2.67 ± 4.85
Household margarines ($n = 14$)	0.05 ± 0.12	0.75 ± 1.75	0.52 ± 1.06	0.10 ± 0.12	1.45 ± 1.99	1.16 ± 1.57
Industrial margarines ($n = 6$)	0.04 ± 0.03	4.24 ± 4.91	2.95 ± 4.34	0.52 ± 0.71	7.83 ± 9.97	6.21 ± 7.84

* Also containing 18:1n12t, 20:1n11t, 22:1n13t; values equal mean ± SD.

4.3. Fats and oils

Technological parameters in solid fats like spreads and baking shortenings include the melting point, lubricity, creaming ability and the moisture barrier. Fat spreads and fats used for cooking or frying were the main sources of TFA in the diet some decades ago and the discussion on TFA was also based on that product group (Ascherio, Katan, Zock, Stampfer, & Willett, 1999; Willett et al., 1993). In the development of solid shortenings without or almost without TFA functional parameters such as plasticity or creaming properties are important. Our data show that this has been successfully implemented. The mean TFA concentration of the 20 investigated products was $3.37 \pm 6.15\%$ or 2.67 ± 4.84 g/100 g product (Table 3).

However, in this product group it must be distinguished between household margarines/shortenings and industrial fats e.g. used for baking. Most of the fats used in the household contain less than 1% TFA. Only one margarine, ironically purchased in a health food shop and indicated as healthy, contained more than 6% TFA (Table 3).

The industrial margarines and shortenings which are marketed in large barrels contain in average five times more TFA than the household fats.

These results show that functionality and stability requirements can be meet in solid fats (at consumer level) thereby minimizing the content of TFA, but in the larger, industrial scale these changes have not always been made.

The trend of reduced TFA in household margarines is shown in some countries (Aro, Antoine, Pizzoferrato, Reykdal, & Van Poppel, 1998b; Brat & Pokorny, 2000; EFSA, 2004; Precht & Molkentin, 2000), or a total elimination like in Australia (Clifton, Keogh, & Noakes, 2004) but not everywhere (Baylin, Siles, Donovan-Palmer, Fernandez, & Campos, 2007).

In our investigations elaidic and vaccenic acid as the main sources for IP-TFA and ruminant TFA, respectively contributed to 75–90% of total TFA. In fast food products 62% elaidic acid and 13% vaccenic acid, in margarines/fats 53% elaidic acid and 37% vaccenic acid were found but, quite interestingly, in the convenience products 35% elaidic acid and 51% vaccenic acid were observed. This is in good accordance with previous investigations for fast food, but shows a changing trend for convenience products.

In a recent review Hunter defined, based on available studies, TFA levels which raises LDL-C and lowers HDL-C levels (Hunter, 2006).

For LDL-C a visual break point (the minimum TFA levels resulting in significant increase in LDL) was 4% of total energy, for HDL the visual break point was between 5 and 6%. Based on a total energy of 1800 kcal this means a minimum intake of approximately 8 g of TFA per day. In a meta-analysis of four large prospective studies (Mozaffarian et al., 2006) the daily intake threshold associated with increased CHD risk is 5 g TFA.

One large portion of French fries and a hamburger (200 g each) can provide TFA between less than 0.2 g up to more than 5 g, which is more than the daily recommended intake for Austria, Germany and Switzerland of <1% of total energy (approx. 2.5–3 g/d). When considering also other sources of TFA 5–8 g/day can be reached easily when choosing the "wrong" foods. Since TFA are not labelled on the products there is no possibility for the consumer to choose between products low and high in TFA. However, compared to recent findings in the USA and Eastern European countries (Stender et al., 2006c), where the consumption of more than 20 g TFA in one menu item is possible, our data indicate far lower levels.

5. Conclusion

The study confirmed the general trend towards reduced TFA content in particular "TFA risk"-food groups marketed in Austria and consumed mainly in Austria but also in other Austrian surrounding European countries (e.g. Slovakia, Hungary, Germany, Switzerland) due to the globalising market. However, these data also show that we are far away from achieving TFA free foods, in particular free of the IP-TFA. In each of the observed categories, products with high levels of TFA were found. Since there are no regulations of TFA in Austria or Germany at the moment the consumer has no possibility either to identify sources of TFA or to choose between low or high TFA options. Furthermore, the reference to partially hydrogenated vegetable oils, which must be labelled, provides no real information on TFA and in particular provides no indication of high TFA content.

A positive change observed in this study is the reduction of the elaidic acid content of foods, which is mainly formed during the partial hydrogenation process and is mainly discussed to be responsible for negative health effects.

In order to reduce the intake of TFA, we recommend the public consistently follow the general healthy eating advice provided by nutritionists and reduce their intake of high fat foods but based upon our findings it would appear difficult to selectively reduce TFA intake.

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References

Aro, A., Amaral, E., Kesteloot, H., Rimestad, A., Thamm, M., & Van Poppel, G. (1998a). Transfatty acids in French fries, soups, and snacks from 14 European Countries: The TRANSFAIR Study. *Journal of Food Composition and Analysis, 11*(2), 170–177.

Aro, A., Antoine, J. M., Pizzoferrato, L., Reykdal, O., & Van Poppel, G. (1998b). Transfatty acids in dairy and meat products from 14 European Countries: The TRANSFAIR study. *Journal of Food Composition and Analysis, 11*(2), 150–160.

Ascherio, A., Katan, M. B., Zock, P. L., Stampfer, M. J., & Willett, W. C. (1999). Trans fatty acids and coronary heart disease. *New England Journal of Medicine, 340*(25), 1994–1998.

Astrup, A. (2006). The trans fatty acid story in Denmark. *Atherosclerosis Supplements, 7*(2), 43–46.

Baylin, A., Siles, X., Donovan-Palmer, A., Fernandez, X., & Campos, H. (2007). Fatty acid composition of Costa Rican foods including trans fatty acid content. *Journal of Food Composition and Analysis, 20*(3–4), 182–192.

Brat, J., & Pokorny, J. (2000). Fatty acid composition of margarines and cooking fats available on the Czech market. *Journal of Food Composition and Analysis, 13*(4), 337–343.

Clifton, P. M., Keogh, J. B., & Noakes, M. (2004). Trans fatty acids in adipose tissue and the food supply are associated with myocardial infarction. *Journal of Nutrition, 134*(4), 874–879.

Craig-Schmidt, M. C. (2006). World-wide consumption of trans fatty acids. *Atherosclerosis Supplements, 7*(2), 1–4.

Eckel, R. H., Borra, S., Lichtenstein, A. H., & Yin-Piazza, S. Y. (2007). Understanding the complexity of trans fatty acid reduction in the American diet: American heart association trans fat conference 2006: Report of the trans fat conference planning group. *Circulation, 115*(16), 2231–2246.

EFSA (2004). Opinion of the scientific panel on dietetic products, nutrition and allergies on a request from the commission related to the presence of trans fatty acids in foods and the effect on human health of the consumption of trans fatty acids. *The EFSA Journal, 81*, 1–49.

Henninger, M., & Ulberth, F. (1996). Trans fatty acids in margarines and shortenings marketed in Austria. *Zeitschrift fur Lebensmittel-Untersuchung und -Forschung, 203*(3), 210–215.

Henninger, M., & Ulberth, F. (1997). Trans-fatty acid content of convenience food. *Zeitschrift für Ernährungswissenschaften, 36*(2), 161–168.

Hulshof, K. F. A. M., Van Erp-Baart, M. A., Anttolainen, M., Becker, W., Church, S. M., Couet, C., et al. (1999). Intake of fatty acids in Western Europe with emphasis on trans fatty acids: The TRANSFAIR study. *European Journal of Clinical Nutrition, 53*(2), 143–157.

Hunter, J. E. (2006). Dietary trans fatty acids: Review of recent human studies and food industry responses. *Lipids, 41*(11), 967–992.

Innis, S. M. (2006). Trans fatty intakes during pregnancy, infancy and early childhood. *Atherosclerosis Supplements, 7*(2), 17–20.

Matissek, R., & Steiner, G. (2006). Extraktion nach Säureaufschluß - Methode nach Weibull-Stoldt. *Lebensmittelanalytik*, 30–32.

Morin, O. (2005). Trans fatty acids: New developments. *Acides gras trans: Recent developments, 12*(5–6), 414–421.

Mozaffarian, D., Katan, M. B., Ascherio, A., Stampfer, M. J., & Willett, W. C. (2006). Trans fatty acids and cardiovascular disease. *New England Journal of Medicine, 354*(15), 1601–1613.

Precht, D., & Molkentin, J. (2000). Recent trends in the fatty acid composition of German sunflower margarines, shortenings and cooking fats with emphasis on individual C16:1, C18:1, C18:2, C18:3 and C20:1 trans isomers. *Die Nahrung, 44*(4), 222–228.

Satchithanandam, S., Oles, C. J., Spease, C. J., Brandt, M. M., Yurawecz, M. P., & Rader, J. I. (2004). Trans, saturated, and unsaturated fat in foods in the United States prior to mandatory trans-fat labeling. *Lipids, 39*(1), 11–18.

Stender, S., Dyerberg, J., & Astrup, A. (2006a). Consumer protection through a legislative ban on industrially produced trans fatty acids in foods in Denmark. *Scandinavian Journal of Food and Nutrition, 50*(4), 155–160.

Stender, S., Dyerberg, J., & Astrup, A. (2006b). High levels of industrially produced trans fat in popular fast foods. *New England Journal of Medicine, 354*(15), 1650–1651.

Stender, S., Dyerberg, J., Bysted, A., Leth, T., & Astrup, A. (2006c). A trans world journey. *Atherosclerosis Supplements, 7*(2), 47–52.

Tarrago-Trani, M. T., Phillips, K. M., Lemar, L. E., & Holden, J. M. (2006). New and existing oils and fats used in products with reduced trans-fatty acid content. *Journal of the American Dietetic Association, 106*(6), 867–880.

Van Erp-Baart, M. A., Couet, C., Cuadrado, C., Kafatos, A., Stanley, J., & Van Poppel, G. (1998). Transfatty acids in bakery products from 14 European countries: The TRANSFAIR study. *Journal of Food Composition and Analysis, 11*(2), 161–169.

Wagner, K.-H., Auer, E., & Elmadfa, I. (2000). Content of trans fatty acids in margarines, plant oils, fried products and chocolate spreads in Austria. *European Journal of Food Research and Technology, 210*, 237–243.

Wijga, A. H., Van Houwelingen, A. C., Kerkhof, M., Tabak, C., De Jongste, J. C., Gerritsen, J., et al. (2006). Breast milk fatty acids and allergic disease in preschool children: The prevention and incidence of asthma and mite allergy birth cohort study. *Journal of Allergy and Clinical Immunology, 117*(2), 440–447.

Willett, W. C., Stampfer, M. J., Manson, J. E., Colditz, G. A., Speizer, F. E., Rosner, B. A., et al. (1993). Intake of trans fatty acids and risk of coronary heart disease among women. *Lancet, 341*(8845), 581–585.