

Trans fatty acids levels of puff pastry products marketed in the central region of Portugal

Níveis de ácidos graxos trans em produtos folhados comercializados na região central de Portugal

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Resumo

Portugal tem um elevado consumo de produtos de massa folhada, altamente apreciados localmente e cuja produção pode envolver a utilização de gordura vegetal parcialmente hidrogenada (PHVF). A ingestão de ácidos gordos *trans* (TFA) é uma preocupação crescente para a saúde, uma vez que existem fortes evidências entre sua ingestão e o aumento da lipoproteína de baixa densidade (LDL) /diminuição do colesterol de lipoproteína de alta densidade (HDL), respostas metabólicas relacionadas com um maior risco de doença coronária. Para avaliar os níveis de ácidos gordos trans em produtos de confeitaria populares na região centro de Portugal, cinquenta amostras destes produtos foram coletadas e analisadas por cromatografia gasosa de alta resolução (HRGC). Os resultados mostram um teor médio de ácidos gordos trans de $1,88 \pm 0,60\%$ (intervalo de confiança de 95%) nos lípidos combinados totais. A maior parte das amostras analisadas (54%) apresentou um teor muito baixo de ácidos gordos *trans*, menor que 1,00%.

Abstract

Portugal has a high consume of puff pastries products, highly appreciated locally and whose production may involve the use of partially hydrogenated vegetable fat (PHVF). The intake of trans fatty acids (TFA) is a growing health concern since strong evidence exists between their ingestion and the increase of low density lipoprotein (LDL)/decrease of high-density lipoprotein(HDL) cholesterol, metabolic responses which are related to a higher risk of coronary heart disease. To access the levels of *trans* fatty acids in popular pastry products in the center region of Portugal, fifty samples of these products were collected and analyzed using high-resolution gas chromatography (HRGC). Results show a mean content of *trans* fatty acids of $1.88 \pm 0.60\%$ (95% confidence interval) from total combined lipid fatty acids. The major part of the examined samples (54%) showed very low trans fatty acid content, lesser than 1.00%.

Keywords: Coronary heart disease, Fat, Portuguese puff pastry, *Trans* fatty acids.

1. Introduction

Portugal has a rich heritage of pastry products very appreciated locally as well as in Portuguese influence countries. From central Europe to Asia is possible to find on sale “pastel de nata” a typical example of a Portuguese puff pastry product. This and other variants of puff pastries require fat to make the outer multilayered structure when cooked. Industrial fat such margarines and “shortenings” are available from different local sources, some of them involving partially hydrogenated vegetable fat.

Cardiovascular diseases account for more than half of all deaths in Europe [1] (WHO, 2013). Different studies agree that *trans* fatty acid intake in diet, originated from hydrogenated fats, leads to inflammatory markers associated with a higher production of reactive oxygen species (ROS). [2] Their cumulative effects may lead to low density lipoprotein (LDL) raising and high density lipoprotein cholesterol (HDL) lowering [3,4,5], factors associated with the increased risk of coronary heart disease [2,3,5]. *Trans* fats are originated in the fat hydrogenation process and are often found in foods like bakery products, snack foods, margarine/“shortenings”. [6] For this reason is of great interest to know their content and then frequently to access their levels in bakery and pastry products.

The hydrogenation of fat is an industrial process in which liquid fatty oils are converted into a most desirable solid fat. However as the result of a secondary reaction, the natural *cis* fatty acids may be isomerized to the *trans* configuration. This depends on the type of catalyst used in the hydrogenation step [7,8] existing those that do not produce significant *trans* fat derivatives. Recommendations to the producers may be emitted if the information of *trans* fatty acid levels turn available. Common fat materials are often rich in oleic acid, 18:1(Δ 9c), being elaidic acid 18:1(Δ 9t) its isomerization product most frequently found after the hydrogenation process. [5] Other *trans* fatty acid found is that derived from the isomerization of one double bond of linoleic acid, 18:2(Δ 9c,12c). *Trans* fatty acids derived from the

isomerization of linolenic acid, 18:3(Δ 9c,12c,15c) were not determined in this work, since its content is very low in pastry fat.

Denmark was among the first countries to be concerned with the ingestion of high levels of *trans* fat; there, in 2004, was imposed a maximum limit of 2.00% of *trans* fatty acids in all oils and fats intended for food, thus driving the law to the sources rather than to the final products [10]. Other countries such as Canada and the United States of America have also implemented legislation aiming to control *trans* fatty acid content in food. [11,12, 13].

The evaluation of *trans* fat at European level started in 1998 by the TRANSFAIR study [14] in which the content in food samples from 14 different countries were accessed. Results had shown values ranging from 15.20 to 46.10% for the presence of total *trans* fatty acids for European food with the presence of partially hydrogenated vegetable oils indicated in their label.[15] For In Portugal, the results showed the presence of some high values of *trans* fatty acid in “croissants” (8.64%) and in “donuts” (6.00%) while in cakes, and pastries and biscuits, in general, the percentage of *trans* fatty acids varied between 0.21 to 6.78%. [16] According to the same study, the consumption of *trans* fatty acids, on average, per person in Portugal was 1.60 g/day. Other studies accessed the levels of *trans* fatty acids in vegetable spread creams from the Portuguese market, giving an average value of 2.60% from total fatty acids [17] (Torres et al., 2002). In pastries less evaluations were made along the years but one work found levels higher than 5.00% in a few samples. [18] This study involved 16 pastries, from which 7 had a high content of *trans* fatty acids. One of the samples, a French type croissant reached a value as high as 15.00%. [18] For other foodstuffs like chips it appears that their levels are very low, with *trans* fatty acids in the range of 0.01 to 0.28% relatively to total fat. [19]

The food industry has several options to produce products with lower content of *trans* fatty acids. [20-21] Interesterified fat (chemical or enzymatic) or catalyst change in the chemical fat hydrogenation process are solutions that decrease their content in the final products.

These technologies are available to the food industry but the lack of information may prevent their implementation. [22] With this goal in mind a population of fifty popular pastries products marketed in the center region of Portugal have been sampled and analyzed by us.

2. Materials and methods

2.1. Sampling

The samples were collected between the months of February to July 2014 in several locations of Coimbra, Aveiro and Viseu districts (Portugal), in different types of commercial establishments, grouped in supermarket and hypermarkets (assigned with an *s* in Table 1) including traditional pastry shops and café's (assigned with an *t* in Table 1). Both samples of the whole pastry products or components namely puff pastry were collected. The products selection took in account their level of appreciation in Portuguese diet. The samples included different pastries like cream cake ("Pastel de Nata" in Portuguese), custard tart, pies, croissants and cookies, reaching a total of fifty different samples.

2.2. Sample preparation

The samples containing high percentage of moisture were previously dried in a vacuum oven at a pressure of 10^{-4} atm. at 40 °C for 4 hours. Dried samples were weighed (approximately 1.0g) and placed in a 15mL glass tube and rod crushed in heptane (6mL). To each solution 400µL of fresh 0.2M sodium methoxide was added. The solution was vigorously stirred in vortex for 1-2 minutes. The formation of fatty acids methyl esters (FAME) from triglycerides takes place at room temperature by simple strong agitation. After decanting sample supernatants were injected in the gas chromatography system.

2.3. Gas chromatography and combined fatty acids profiles

Fatty acid methyl esters (FAME) profiles were determined using a gas chromatograph Agilent 6890 series, equipped with a split/splitless injector and a flame ionization detector. The capillary column was a Tracer CN100 (Spain, 60m x 0.25 mm; stationary phase thickness of 0.2 µm). Injection mode was splitless ($t=45s$) with helium as carrier gas (Injector head pressure=150KPa). Injector and detector temperatures were 270°C. The column heating program was: initial temperature of 90°C for 7 minutes followed by a heating ramp at 5°C/min. to 220°C, then isotherm for 17 minutes, giving a run total time of 50 min. FAME solutions were injected (0.5µL) using a Hamilton #7102 2µL micro syringe. Chromatographic data was acquired through a Hercule Lite digital analogic interface connected to a PC running the Jasco-Borwin software version 5.1. The identification of FAMES was made by comparison of each fatty acid relative retention time (RRT, oleic acid as reference) to those obtained with authentic standards (Supelco FAME™ C14-C22 MIX reference 18917-1AMP and Sigma L8404 linoleic acid mix). Results are expressed as a relative percentage of total fatty acids (Table 1).

3. Results

3.1. Fatty acid composition of the pastry products lipid

Combined fatty acid composition profiles from pastry lipid population are shown in Table 1. Profile result analysis of the fatty acids suggest that they can be grouped in two classes – those rich in palmitic acid alluding palm oil as main fat origin and the group of oleic acid rich fat profile which provenience may come from sources such as olive, soy or rapeseed oils. A few samples contained higher level of linoleic relatively to oleic acid suggesting sources such as soybean or corn oils. [24]

4. Discussion

As expected the predominant *trans* fatty acid determined was elaidic acid C18:1 Δ^9t , with an average content of $1.67 \pm 0.67\%$, followed by the derivatives of

Table 1. Fatty acid composition profiles¹ of the pastry sample lipid.

Fatty acid	Saturated fatty acids (%)			Monounsaturated fatty acids (%)				Polyunsaturated fatty acids (%)						Trans (total)	
	C14	C16	C18	C20	C16:1	C9-C18:1	T9-C18:1	C9,12-C18:2	C18:2 Δ 9t,12r	C18:2 Δ 9c,12r	C18:2 Δ 9t,12c	C18:3	other		
Sample n. ^o	Cake type														
1	Bean cake, t*	2,78 ± 1,28	37,47 ± 3,61	3,94 ± 0,35	0,24 ± 0,08	0,06 ± 0,04	28,94 ± 2,72	0,11 ± 0,04	14,3 ± 1,18	n.d.	0,22 ± 0,09	0,18 ± 0,07	0,74 ± 0,06	11,00 ± 3,66	0,49 ± 0,09
2	Bean cake, t	1,78 ± 1,11	35,19 ± 3,44	6,21 ± 0,61	n.d.	0,46 ± 0,03	29,07 ± 1,58	0,36 ± 0,18	16,14 ± 0,83	n.d.	n.d.	n.d.	0,70 ± 0,43	9,99 ± 5,72	0,70 ± 0,26
3	Pizza Dough, s	n.d.	34,98 ± 0,83	12,4 ± 5,51	0,40 ± 0,03	n.d.	35,19 ± 7,99	0,93 ± 0,66	13,04 ± 3,44	n.d.	n.d.	n.d.	0,87 ± 0,21	2,63 ± 1,21	0,62 ± 0,77
4	Orange Cupcake, s	n.d.	29,53 ± 1,26	8,12 ± 1,37	n.d.	0,11 ± 0,09	27,53 ± 15,45	1,24 ± 1,47	23,14 ± 11,63	n.d.	n.d.	n.d.	1,07 ± 0,58	9,19 ± 2,39	1,20 ± 1,42
5	Croissant Brioche, t	1,48 ± 0,18	53,13 ± 1,55	3,49 ± 0,63	0,35 ± 0,21	0,04 ± 0,00	25,32 ± 0,66	1,17 ± 0,26	12,18 ± 0,52	n.d.	0,14 ± 0,02	0,11 ± 0,02	0,25 ± 0,07	2,30 ± 0,79	1,42 ± 0,25
6	Apple/coconut pie, t	2,79 ± 0,93	46,43 ± 7,51	3,37 ± 0,61	0,06 ± 0,07	0,04 ± 0,01	23,36 ± 7,18	0,21 ± 0,26	16,17 ± 4,52	0,01 ± 0,00	0,33 ± 0,11	0,25 ± 0,03	0,21 ± 0,02	6,75 ± 3,24	0,79 ± 0,38
7	Cake, s	1,23 ± 0,21	47,72 ± 4,02	3,52 ± 0,74	0,41 ± 0,06	0,06 ± 0,01	30,37 ± 2,39	0,28 ± 0,16	12,59 ± 0,71	n.d.	0,13 ± 0,01	0,13 ± 0,02	0,58 ± 0,02	2,92 ± 0,63	0,53 ± 0,17
8	Chicken Pie, s*	1,05 ± 0,57	37,99 ± 4,54	8,90 ± 1,05	0,36 ± 0,16	n.d.	26,65 ± 1,82	2,20 ± 0,65	15,64 ± 0,62	n.d.	0,19 ± 0,12	0,20 ± 0,10	0,66 ± 0,19	6,16 ± 1,85	2,59 ± 0,75
9	Cream Cake (Nata), t*	1,16 ± 0,57	42,87 ± 0,52	4,55 ± 0,52	0,45 ± 0,25	0,05 ± 0,01	32,26 ± 1,39	2,75 ± 0,38	11,6 ± 0,48	0,05 ± 0,02	0,21 ± 0,00	0,18 ± 0,01	0,6 ± 0,08	3,21 ± 0,42	3,19 ± 0,40
10	Chocolate cookie, s	0,28 ± 0,24	9,92 ± 2,26	3,25 ± 0,38	0,49 ± 0,38	0,04 ± 0,03	67,4 ± 1,77	0,44 ± 0,32	12,78 ± 0,65	n.d.	0,07 ± 0,01	0,1 ± 0,09	0,57 ± 0,12	4,58 ± 3,25	0,57 ± 0,40
11	Chocolate cookie, s	0,75 ± 0,24	30,17 ± 3,1	4,85 ± 0,57	0,52 ± 0,33	0,04 ± 0,02	47,05 ± 2,46	0,33 ± 0,34	12,49 ± 0,53	n.d.	0,13 ± 0,08	0,14 ± 0,12	0,54 ± 0,05	2,95 ± 0,36	0,60 ± 0,56
12	Cream Cake (Nata), t*	0,84 ± 0,70	29,03 ± 5,35	12,64 ± 3,02	0,48 ± 0,35	0,03 ± 0,02	24,19 ± 2,24	2,18 ± 0,34	26,57 ± 0,81	n.d.	0,12 ± 0,00	0,13 ± 0,05	0,51 ± 0,16	3,24 ± 0,56	2,43 ± 0,28
13	Stuffed Palmier, s*	0,8 ± 0,49	34,6 ± 4,28	13,28 ± 3,26	0,44 ± 0,35	n.d.	27,31 ± 1,20	0,64 ± 0,44	17,77 ± 0,84	n.d.	0,11 ± 0,02	0,2 ± 0,23	1,95 ± 0,34	2,91 ± 1,24	0,95 ± 0,69
14	Fried cake, s	1,07 ± 0,46	31,73 ± 4,70	17,36 ± 6,23	0,31 ± 0,21	0,17 ± 0,06	19,33 ± 7,07	2,65 ± 1,32	20,51 ± 2,44	n.d.	n.d.	0,67 ± 0,89	1,30 ± 0,15	6,26 ± 0,33	2,15 ± 2,79
15	strawberry cake, t	0,73 ± 0,22	25,37 ± 6,91	7,92 ± 2,88	n.d.	0,67 ± 0,50	29,62 ± 5,23	3,95 ± 0,74	21,03 ± 4,60	n.d.	0,22 ± 0,17	0,47 ± 0,14	0,93 ± 0,31	9,12 ± 1,82	4,18 ± 0,62
16	Rice cake, t	0,46 ± 0,13	19,92 ± 2,67	9,08 ± 0,34	0,34 ± 0,13	0,12 ± 0,02	24,47 ± 0,6	0,16 ± 0,06	37,09 ± 0,36	n.d.	0,16 ± 0,08	0,17 ± 0,18	0,36 ± 0,03	7,56 ± 2,25	0,49 ± 0,32
17	Margarine (in bread), s	1,46 ± 0,30	19,47 ± 1,08	7,70 ± 0,71	0,63 ± 0,09	n.d.	31,07 ± 1,48	0,66 ± 0,44	28,81 ± 2,01	n.d.	0,2 ± 0,04	0,14 ± 0,06	1,48 ± 0,09	8,48 ± 2,34	0,89 ± 0,47
18	Vanilla wafer, s	6,95 ± 1,59	34,61 ± 1,44	6,29 ± 2,24	0,50 ± 0,19	0,03 ± 0,01	24,99 ± 3,55	0,91 ± 0,21	5,98 ± 0,61	n.d.	0,08 ± 0,05	0,08 ± 0,03	0,14 ± 0,01	19,43 ± 3,70	1,06 ± 0,23
19	Cake, s	0,54 ± 0,14	27,01 ± 1,05	10,04 ± 0,17	0,44 ± 0,09	0,11 ± 0,03	26,77 ± 1,59	0,50 ± 0,13	21,22 ± 0,80	n.d.	n.d.	n.d.	1,46 ± 0,12	11,80 ± 0,67	0,50 ± 0,16
20	Chocolate cake, s	1,86 ± 0,66	38,22 ± 2,70	18,45 ± 2,17	1,19 ± 0,32	0,04 ± 0,01	31,13 ± 1,48	0,25 ± 0,24	4,70 ± 0,15	0,01 ± 0,00	0,06 ± 0,01	0,07 ± 0,04	0,22 ± 0,05	3,79 ± 0,76	0,38 ± 0,27
21	Rice cake, t	0,17 ± 0,09	18,68 ± 1,25	9,77 ± 0,36	0,43 ± 0,36	0,11 ± 0,06	24,38 ± 1,03	0,72 ± 0,76	32,43 ± 7,10	n.d.	0,07 ± 0,03	0,05 ± 0,01	2,79 ± 0,51	10,20 ± 6,36	0,73 ± 0,68
22	Cookie, s	1,19 ± 0,17	28,52 ± 2,95	4,47 ± 0,39	0,40 ± 0,08	0,03 ± 0,00	33,47 ± 2,03	0,10 ± 0,02	25,68 ± 1,07	n.d.	0,21 ± 0,00	0,16 ± 0,04	2,40 ± 0,11	3,34 ± 0,66	0,47 ± 0,05
23	Chocolate cake, s*	8,56 ± 1,27	28,48 ± 1,33	12,44 ± 1,08	0,21 ± 0,04	0,17 ± 0,02	24,47 ± 1,38	1,88 ± 0,14	5,82 ± 0,29	0,24 ± 0,03	0,40 ± 0,05	0,21 ± 0,03	0,95 ± 0,07	16,01 ± 0,43	2,72 ± 0,17
24	Cream Cake (Nata), t	0,56 ± 0,14	32,71 ± 3,50	5,62 ± 0,75	0,53 ± 0,13	0,02 ± 0,00	41,79 ± 2,67	0,46 ± 0,13	12,99 ± 0,87	n.d.	0,12 ± 0,01	0,12 ± 0,03	2,73 ± 0,08	2,31 ± 0,37	0,70 ± 0,15
25	Sponge cake, s	0,12 ± 0,01	22,27 ± 1,61	15,54 ± 0,51	0,04 ± 0,01	0,27 ± 0,02	27,73 ± 0,54	0,19 ± 0,03	18,85 ± 0,33	n.d.	0,07 ± 0,01	0,03 ± 0,00	0,44 ± 0,01	14,19 ± 1,71	0,39 ± 0,04
26	Puff pastry (Tentugal), t	0,74 ± 0,01	26,46 ± 0,74	12,05 ± 0,23	0,22 ± 0,05	0,23 ± 0,01	30,39 ± 0,21	0,36 ± 0,07	16,75 ± 0,24	n.d.	0,16 ± 0,06	0,12 ± 0,04	0,73 ± 0,01	11,55 ± 1,02	0,64 ± 0,17
27	Chicken pie, s*	1,43 ± 0,74	40,72 ± 5,48	5,99 ± 1,34	0,26 ± 0,08	0,04 ± 0,00	32,40 ± 2,93	2,56 ± 0,69	13,45 ± 1,08	n.d.	0,19 ± 0,04	0,24 ± 0,1	0,62 ± 0,23	2,07 ± 0,25	2,99 ± 0,83

Table 1. Fatty acid composition profiles¹ of the pastry sample lipid (continuation).

Fatty acid	Saturated fatty acids (%)			Monounsaturated fatty acids (%)				Polyunsaturated fatty acids (%)					Trans (total)		
	C14	C16	C18	C20	C16:1	C18:1	C18:1t	C18:2	C18:2 Δ 9t,12t	C18:2 Δ 9c,12t	C18:2 Δ 9t,12c	C18:3		other	
Sample n. ^o															
28	Stuffed Palmier, t*	1,16 ± 0,83	33,04 ± 5,07	10,8 ± 1,02	0,30 ± 0,13	0,02 ± 0,00	22,55 ± 2,89	1,75 ± 0,16	26,94 ± 3,44	n.d.	0,09 ± 0,00	0,08 ± 0,02	0,27 ± 0,05	3,00 ± 1,71	1,90 ± 0,16
29	Chicken pie, t*	1,28 ± 0,54	39,17 ± 5,03	9,92 ± 1,97	0,30 ± 0,12	0,02 ± 0,00	27,54 ± 2,60	4,09 ± 0,37	14,03 ± 0,74	0,04 ± 0,02	0,15 ± 0,05	0,18 ± 0,02	0,89 ± 0,09	2,37 ± 0,22	4,46 ± 0,41
30	Cream Cake (Nata), s*	1,36 ± 1,13	20,98 ± 1,25	14 ± 4,33	0,47 ± 0,27	0,06 ± 0,02	23,49 ± 3,49	6,73 ± 2,61	22,07 ± 4,52	n.d.	n.d.	n.d.	2,03 ± 0,25	8,75 ± 5,57	6,73 ± 2,62
31	Bean cake, t*	3,01 ± 1,65	23,81 ± 1,72	10,64 ± 1,96	0,46 ± 0,28	0,06 ± 0,02	27,17 ± 5,01	9,74 ± 2,47	6,36 ± 1,29	0,09 ± 0,03	0,10 ± 0,05	0,52 ± 0,82	1,52 ± 0,39	16,46 ± 8,68	10,44 ± 3,25
32	Puff pastry/strawberry ¹	3,98 ± 1,85	38,32 ± 3,70	4,08 ± 1,66	0,22 ± 0,12	0,06 ± 0,01	27,32 ± 10,13	0,25 ± 0,14	8,84 ± 2,91	0,02 ± 0,00	0,12 ± 0,04	0,10 ± 0,03	1,08 ± 0,38	15,55 ± 13,18	0,48 ± 0,17
33	Cream Cake (Nata), t*	1,15 ± 0,61	30,79 ± 3,79	12,01 ± 3,01	0,24 ± 0,11	n.d.	20,84 ± 2,20	2,78 ± 1,42	27,6 ± 2,3	n.d.	0,15 ± 0,01	0,43 ± 0,55	1,09 ± 0,12	2,92 ± 1,02	3,36 ± 1,97
34	Vegetable cream, s	0,91 ± 0,37	25,87 ± 2,22	7,18 ± 4,19	0,14 ± 0,03	0,03 ± 0,00	27,14 ± 0,89	0,18 ± 0,06	28,05 ± 3,49	n.d.	0,2 ± 0,02	0,17 ± 0,02	6,01 ± 0,07	4,12 ± 1,73	0,53 ± 0,01
35	Chicken pie, s*	1,31 ± 0,61	40,18 ± 5,55	6,03 ± 1,33	0,24 ± 0,18	0,04 ± 0,01	34,48 ± 3,65	2,34 ± 0,24	12,59 ± 0,87	n.d.	0,15 ± 0,03	0,13 ± 0,02	0,53 ± 0,12	1,96 ± 0,28	2,61 ± 0,26
36	Cereal bar, s	0,41 ± 0,26	20,79 ± 5,64	8,04 ± 0,83	0,63 ± 0,30	0,05 ± 0,02	56,97 ± 3,36	0,03 ± 0,01	8,34 ± 0,54	n.d.	0,01 ± 0,00	0,00 ± 0,00	1,6 ± 0,58	3,07 ± 0,67	0,04 ± 0,03
37	Cream Cake (Nata), t	1,50 ± 0,82	43,69 ± 5,90	6,29 ± 1,23	0,31 ± 0,16	n.d.	31,73 ± 3,85	0,93 ± 0,14	12,02 ± 1,1	n.d.	0,23 ± 0,04	0,2 ± 0,03	0,59 ± 0,12	2,50 ± 0,08	1,36 ± 0,2
38	puff pastry cake, s	1,32 ± 0,81	39,95 ± 5,66	6,48 ± 1,22	0,21 ± 0,07	n.d.	32,14 ± 3,79	0,15 ± 0,05	16,46 ± 1,4	n.d.	0,11 ± 0,02	0,09 ± 0,02	0,52 ± 0,06	2,57 ± 0,20	0,35 ± 0,09
39	Veg. fat (in bread), s	1,08 ± 0,64	24,35 ± 2,05	8,36 ± 3,84	0,22 ± 0,06	n.d.	29,96 ± 1,19	0,3 ± 0,13	32,73 ± 0,22	n.d.	0,32 ± 0,03	0,29 ± 0,03	0,37 ± 0,1	2,03 ± 0,4	0,91 ± 0,09
40	Margarine (in bread), s	1,84 ± 0,96	46,83 ± 8,25	7 ± 2,86	0,28 ± 0,15	0,04 ± 0,00	31,24 ± 5,56	0,15 ± 0,03	9,58 ± 1,86	n.d.	0,14 ± 0,01	0,13 ± 0,01	0,34 ± 0,15	2,45 ± 1,36	0,44 ± 0,03
41	Birthday Cake, s	1,2 ± 0,46	31,06 ± 3,55	6,27 ± 0,68	0,12 ± 0,04	0,07 ± 0,01	29,12 ± 2,41	0,09 ± 0,03	28,16 ± 2,04	n.d.	0,27 ± 0,04	0,23 ± 0,02	0,25 ± 0,02	3,12 ± 1,20	0,53 ± 0,02
42	Chicken pie, s*	1,98 ± 0,79	54,11 ± 4,57	3,97 ± 0,63	0,16 ± 0,02	0,06 ± 0,02	28,47 ± 4,51	1,51 ± 0,06	7,31 ± 0,92	0,02 ± 0,00	0,11 ± 0,02	0,09 ± 0,01	0,33 ± 0,04	1,83 ± 0,83	1,72 ± 0,05
43	Cake (Bouleima), t	1,45 ± 1,12	21,80 ± 6,12	7,67 ± 1,25	n.d.	0,31 ± 0,14	32,04 ± 0,57	0,2 ± 0,02	30,68 ± 6,08	n.d.	n.d.	n.d.	1,25 ± 0,5	4,29 ± 0,98	0,20 ± 0,13
44	Ançã cake, t	n.d.	29,54 ± 1,7	6,7 ± 0,26	n.d.	n.d.	16,61 ± 0,18	n.d.	39,96 ± 1,5	n.d.	n.d.	n.d.	2,5 ± 0,52	4,69 ± 0,25	-
45	Chocolate Croissant, t*	3,12 ± 0,17	39,67 ± 1,38	7,45 ± 0,25	0,28 ± 0,04	0,09 ± 0,02	29,27 ± 0,71	6,19 ± 0,15	6,85 ± 0,16	0,06 ± 0,01	0,12 ± 0,02	0,09 ± 0,01	1,63 ± 0,06	5,08 ± 0,34	6,46 ± 0,16
46	Cream Cake (Nata), t*	1,18 ± 0,61	29,58 ± 5,28	9,98 ± 1,84	0,32 ± 0,16	n.d.	26,17 ± 1,96	3,46 ± 0,30	25,77 ± 1,52	0,02 ± 0,01	0,22 ± 0,02	0,2 ± 0,04	0,38 ± 0,07	2,74 ± 0,54	3,89 ± 0,35
47	Chocolate Croissant, t	2,9 ± 0,22	31,06 ± 2,08	7,62 ± 1,27	n.d.	n.d.	19,32 ± 5,76	2,06 ± 0,29	23,61 ± 4,88	n.d.	n.d.	n.d.	0,96 ± 0,41	12,48 ± 3,48	2,06 ± 0,29
48	Bean cake, t*	1,66 ± 0,13	37,42 ± 3,05	5,93 ± 0,92	0,37 ± 0,07	0,04 ± 0,01	33,02 ± 0,83	7,25 ± 0,71	7,75 ± 0,24	0,02 ± 0,01	0,15 ± 0,02	0,17 ± 0,14	2,26 ± 0,06	3,94 ± 1,06	7,59 ± 0,85
49	Stuffed palmier, t*	3,83 ± 0,44	35,36 ± 4,67	3,71 ± 0,19	0,2 ± 0,03	0,02 ± 0,00	22,5 ± 1,21	0,44 ± 0,49	6,65 ± 0,31	n.d.	0,06 ± 0,02	0,12 ± 0,12	0,91 ± 0,03	26,19 ± 6,06	0,62 ± 0,57
50	Meat patty, t*	1,82 ± 0,43	44,83 ± 2,97	6,09 ± 0,58	0,19 ± 0,04	0,05 ± 0,01	30,66 ± 2,39	3,03 ± 0,24	10,57 ± 0,97	n.d.	0,12 ± 0,02	0,19 ± 0,12	0,39 ± 0,06	2,00 ± 0,66	3,34 ± 0,36
Maximum		8,56 ± 1,27	54,11 ± 4,57	18,45 ± 2,17	1,19 ± 0,32	0,67 ± 0,50	67,4 ± 1,77	9,74 ± 2,47	39,96 ± 1,5	0,24 ± 0,03	0,40 ± 0,05	0,67 ± 0,89	6,01 ± 0,07	26,19 ± 6,06	10,50 ± 3,25
Minimum		0,12 ± 0,01	9,92 ± 2,26	3,25 ± 0,38	0,04 ± 0,01	0,02 ± 0,00	16,61 ± 0,18	0,03 ± 0,01	4,70 ± 0,15	0,01 ± 0,00	0,01 ± 0,00	0,00 ± 0,00	0,14 ± 0,01	1,83 ± 0,83	0,09 ± 0,03
Mean		1,71 ± 0,44	32,91 ± 2,58	8,15 ± 1,02	0,35 ± 0,05	0,1 ± 0,04	29,73 ± 2,38	1,67 ± 0,58	17,65 ± 2,48	0,05 ± 0,02	0,16 ± 0,02	0,18 ± 0,04	1,07 ± 0,28	6,56 ± 1,48	1,88 ± 0,59

1. Relative percentage of each fatty acid in relation to total fatty acid. The values were obtained by averaging the three replicates injections made for each sample. Results expressed as confidence interval (95%). Group of pastry product acquired in supermarket and hypermarkets assigned with an s; Group of pastry product acquired in traditional pastry shops and café's assigned with an t; Samples of puff pastry component are assigned with an asterisk; n.d.- not detectable.

linoleic acid with one of the double bonds isomerized, with a content of $0.16 \pm 0.02\%$ for the isomer $C18:2\Delta^{9t,12c}$ and $0.18\% \pm 0.02\%$ and the isomer $C18:2\Delta^{9c,12t}$. The double isomerized derivative $C18:2\Delta^{9t,12t}$ was found with an average of $0.05 \pm 0.02\%$. The distribution of the total *trans* fatty acid levels found in the population is shown in Figure 1.

While *trans* fatty acids were detected in all samples with only one exception (sample 44) for more than half of the population ($n=27$, 54%) their level is below 1.00% and this may indicate the absence of use of hydrogenated fat in confectioning. Vegetable fat samples show low levels of *trans* fatty acids. [24] The samples with higher content in the total *trans* fatty acids suggest the use of industrial hydrogenated fat. Denmark stated to be acceptable in foodstuffs the presence of *trans* fatty acids at levels lower than 2.00%. [10] In the group of 1-2%, the present study results found 6 samples (12%). With higher content, the range of 2-4% there were found 11 samples (22%), for the 4-6% range 2 samples (4%) and higher than 6% 4 samples (8%). The total population medium value was $1.88 \pm 0.59\%$. The sample number 31 (puff of bean pastry) (puff pastry component) showed the highest content of *trans* fatty acids, a value of $10.44 \pm 3.25\%$.

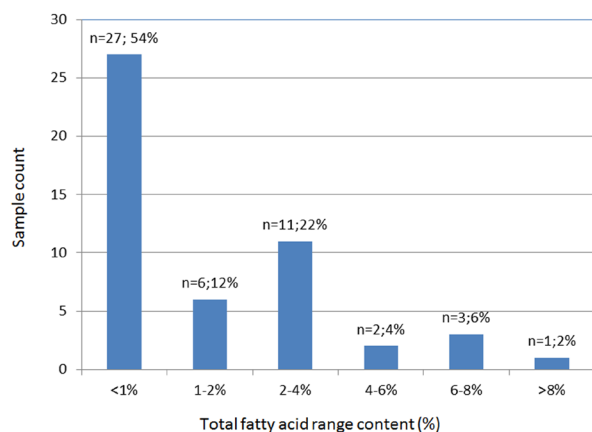


Figure 1. Distribution count for the levels of total *trans* fatty acids found in puff pastry products marketed in the Central region of Portugal.

For vegetable creams, the percentage of *trans* fatty acids to total fatty acids ranged from 0.44 to 0.89%, a very low value, similar to that found in a 2002 study [17], in which a range of 0.2-0.5% levels was obtained in that time.

Looking at particular cases of the Table 1 the same type of product can show very different levels of *trans* fat. For example samples 1, 31 and 48 (Puff from bean pastry, see Table 1) are the same product but were acquired from different sources and the values detected are significantly different: 0.55%, 10.5% and 7.63% respectively. The same occurs with samples 9, 30, 33 and 46 (Puff from cream cake) which values are respectively 3.24%; 6.79%; 3.36% and 3.89%.

Table 2 presents an analysis of *trans* fat data sorted by the main establishment considered in the sampling program: one group including the traditional pastry house including traditional cafe's (referred as *t* in Table 1 and 2) and the other acquired in supermarket or hypermarket (referred as *s* in Table 1 and 2). Analysis of both pastries puff component or the whole pastry were made. Results showed that the levels of *trans* fat when considering the whole pastry are moderately low but higher in traditional shops (1.56%) relatively to those buy in super/hypermarket (0.65%).

The highest levels of *trans* fatty acids is found predominantly in products made of puff dough and acquired in pastry shop's, as can be seen in samples 31, 45 and 48, mainly puff pastry cakes or puff component, with respectively values of 10.50%, 6.55% and 7.63% of *trans* fatty acids. Table 2 results yields a mean value of 3.74% for *trans* fat in traditional commerce samples and 2.90% for those coming from super/ hypermarkets. It should be emphasized that the sampling method was specifically directed to the puff pastry, a component which seems to be more susceptible to the presence of hydrogenated fat (samples assigned with an asterisk in Table 1).

Comparing these results with previous studies [14], [17-18], there are a clear reduction in the absolute

Table 2. Comparison of trans fat in different pastry products and from different provenience.

Trans fatty acid content (%) from total fat				
Type of sample	Whole pastry		Puff pastry	
Provenience	Traditional (t)	Super/hypermarket (s)	Traditional (t)	Super/hypermarket (s)
Number of samples	13	9	12	16
Mean	1.56	0.65	3.74	2.90
Standard deviation	2.08	0.45	2.83	1.69

values of trans fat found in pastry products as also in the medium value. This tendency follows that observed in other EU countries, where there is, in recent years, a clear reduction in the levels of trans fatty acids, although in some of them, Government or laws, do not impose any obligation to contribute to this reduction. [25]

5. Conclusions

Evidence exists and also literature reports a correlation between the intake of trans fatty acids and increased incidence of various coronary heart diseases. The relevance of frequent analysis of their content as a source of indicators to the producers is unquestionable. In this work, a population of pastry products – whole or puff - were analyzed and 54% of the samples showed very low trans fatty acid content (< 1.00%). The mean content value of trans fatty acids present was 1.88% ± 0.59% relativity to the content total fatty acids. The

results obtained are significantly lower than those found in earlier studies carried out in pastry products in Portugal [14], [17-18]. This seems to indicate a reduction tendency of use of hydrogenated fat or the modification of the techniques used by the specific industry along the time. The values here presented in foodstuffs may be even lower. However this study showed that even better results can be achieved with benefits on public health if pastry high trans fat content could be eradicated or at least, if Government Public Health services impose more severe rules on, in order to guarantee the actually seen progressive reduction.

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