Research Article

Fatty Acid Profile of Some Fat Rich Foods with Special Reference to their Trans Fatty Acids Content

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ABSTRACT

The main concern of our study was to determine the fatty acids profile of various fat rich food products collected from Giza and Qalyubiah Governorates, Egypt. One hundred and twenty random samples of cooking butter, margarine, ghee, and shortenings were collected from dairy shops and street vendors. Fat was extracted via the modified Bligh and Dyer method, and the fatty acid profiles were assessed using gas chromatography. The mean values of saturated fatty acids were 67.22±3.74, 56.44±1.04, 66.36±7.72 and 51.29±2.44 respectively. Palmitic acid was the most abundant saturated fatty acid (SFA) in the examined products. The polyunsaturated fatty acids content was present with a mean value of 2.31 ± 0.19, 6.88 ±0.30, 4.37± 1.8, and 10.59 ± 0.88 respectively. There was a significant difference in both mono and polyunsaturated fatty acids between cooking butter and the other food product (P<0.05). Trans fatty acids and monounsaturated fatty acids were estimated.

Key words: Fatty acid Profile, oleic acid, palmitic acid, cooking butter, margarine, ghee, shortenings.

1. INTRODUCTION

Fats are an irreplaceable part of the everyday human dietplaying a crucial role in human nutrition. All natural fats are a combination of monounsaturated, polyunsaturated and saturated fatty acids. Fatty acids are carbon chains with a methyl group at one end of the molecule and a carboxyl group at the other end, It can be saturated or unsaturated. Saturated fatty acids are "filled" (saturated) with hydrogen.Unsaturated fatty acids are divided into monounsaturated fatty acids having one carbon-carbon double bond, which can occur in different positions and polyunsaturated fatty acids (PUFAs) having more than one carbon-carbon double bond **(Rustan and Drevon, 2005 and Meremae et al., 2012).**

Trans fatty acids (TFAs) are unsaturated fatty acids that contain at least one double bond in the trans configuration. They are formed during industrial partial hydrogenation of vegetable oils, a process widely commercialized to produce solid fats. The TFA content of partially hydrogenated vegetable oils (PHVO) depends on the variables of the hydrogenation process, i.e. time, catalyst, temperature, and hydrogen pressure. The major dietary sources of trans fats are margarine and shortenings **(Vandana et al., 2011 and Liu, et al., 2017).**

Butter and dairy spreads are members of food commonly identified as "yellow fat spreads" The term also encompasses margarine and other products used for a similar purpose and which are emulsions of water and oil/fat derived from milk or different animal and/or plant sources **(Anna and Matthew, 2008*).***

Dietary fatty acids with trans double bond have a significant high levels of serum cholesterol. it also responsible of a high prevalence of coronary heart disease, breast cancer, shortening of pregnancy period, risks of preeclampsia, nervous, vision disorders in infants, colon cancer, diabetes, obesity, and allergy **(Schaefer, 2002 and Vandana et al., 2011).**

Globally, WHO 2003, announced that one third of all deaths attributed to coronary heart diseases. In this regard, there is an international consensus to reduce the uptake of saturated fatty acids to less than 10 % and 15 % of total daily energy should be supplied in the form of monounsaturated fatty acids **(AHA, 2000 and ITFPCHD, 2003).**

The USDA Dietary Guidelines in (2005) recommended that trans fatty acid intake should be less than 1% of total calories. Since hydrogenated fats comprise a major portion of dietary fat and involved in various health- related issues, it is important to have detailed information of fatty acids composition in Egyptian food **(USDA, 2005).** Therefore our work was aimed to study the fatty acids profile in Egyptian fat rich food products (cooking butter, margarine, ghee, and shortenings).

2. MATERIALS AND METHODS

2.1. Collection of samples

One hundred and twenty random samples of fat- rich food products (30 of each cooking butter, margarine, ghee and shortenings) were collected in their natural packages from dairy shops, supermarkets and street vendors in Cairo, Giza and Qalyubiah governorate. Transferred to the laboratory in an insulated icebox (-20 ^{o}C) to be examined for fatty acid profile.

2.2. Fatty acid extractionaccording to AOAC, (2002)

Fatty acids are extracted from examined samples by hydrolytic methods (alkaline hydrolysis) for dairy products. Pyrogallic acid is added to minimize oxidative degradation of fatty acids during analysis. Triglyceride, Triundecanoin (C11:0), is added as internal standard. Fat is extracted into ether, then methylated to fatty acid methyl esters (FAMEs) using BF3 in methanol.

2.3. Gas Chromatography (GC) Analysis of FAMEs according to AOAC, (2002)

FAMEs are quantitatively measured 50 by capillary gas chromatography (GC) against C11:0 internal standards. Total fat is calculated as the sum of individual fatty acids expressed as triglyceride equivalents. Saturated and monounsaturated fats are calculated as the sum of particular fatty acids.

Statistical Analysis

Statistical analysis was performed using STATISTICA v.10 (StatSoft.Inc, 2010, Tulsa, USA) software. The relationships between the variables tested by means of linear correlation. The correlations were considered statistically significant if P<0.05.

3. RESULTS

Table 1: Statistical analytical results of saturated fatty acids in the examined samples

Fatty acids	Cooking Butter	Margarine	Ghee	Shortenings
C4:0 Butyric acid	0.62±0.10	0.00	0.80±0.24	0.00
C6:0 Caproic acid	0.61±0.05	0.00	1.18±0.18	0.00
C8:0 Caprylic acid	0.46±0.06	0.038±0.008	1.00±0.14	0.02±0.003
C10:0 Capric acid	1.22±0.18	0.04±0.004	2.90±0.45	0.02±0.004
C11:0 Undecenoic acid	0.02±0.003	0.00	0.046±0.007	0.00
C12:0 Lauric acid	2.00±0.29	0.51±0.08	4.67±0.79	0.27±0.05
C14:0 Myristic acid	11.88±0.98	1.23±0.14	12.48±1.72	1.19±0.04
C15:0 Pentadecanoic acid	1.45±0.12	0.04±0.006	1.34±0.20	0.04±0.003
C16:0 Palmitic acid	33.7±0.95	41.51±0.52	29.42±2.45	41.97±0.69
C17:0 Margaric acid	0.72±0.04	0.094±0.008	0.84±0.12	0.09±0.004
C18:0 Stearic acid	14.2±0.94	12.51±0.25	11.42±1.31	7.24±1.62
C20:0 Arachidic acid	0.00	0.35±0.01	0.10±0.10	0.33±0.017
C21:0 Heneicosanoic acid	0.10±0.01	0.00	0.04±0.005	0.00
C22:0 Behenic acid	0.10±0.01	0.058±0.009	0.038±0.002	0.03±0.002
C23:0 Tricosanic acid	0.09±0.01	0.026±0.006	0.042±0.006	0.044±0.01
C24:0 Lignoceric acid	0.05±0.002	0.042±0.006	0.046±0.005	0.046±0.005
Total	67.22±3.74	56.44±1.04	66.36±7.72	51.29±2.44

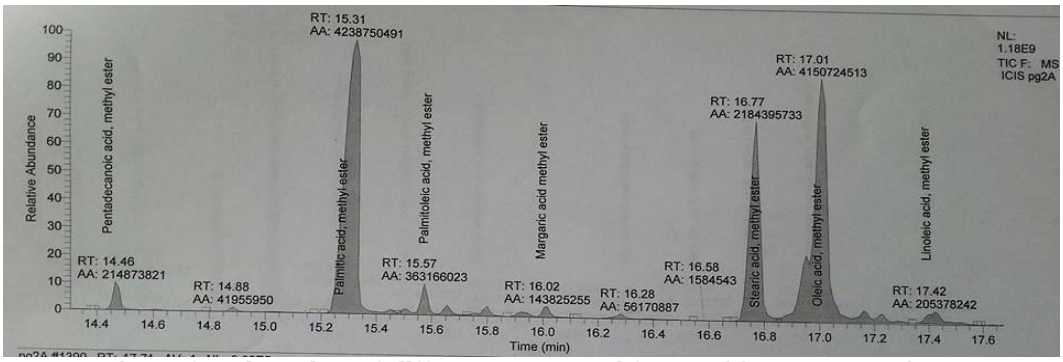

Fig. 1: fractionation of different saturated fatty acids concentrations of cooking butter sample using Gas Chromatography (GC) expressed as (%)

Table 2: Statistical analytical results of Monounsaturated fatty acids in the examined samples

Fatty acids	Cooking butter	Margarine	Ghee	Shortenings
4 Decenoic acid	0.05±0.01	0.00	0.21±0.03	0.00
C16:1 Palmitoliec acid	2.58±0.20b	0.18±0.02	2.11±0.35	0.21±0.02
C18:1 Oleic acid	27.26±1.37	36.34±0.73*	26.72±1.81	37.74±0.65*
C19:1 10 Nonadecenoic acid	0.14±0.008b	0.00	0.10±0.02	0.00
C20:1 11- Eicosenoic acid	0.20±0.01b	0.11±0.007	0.21±0.033	0.11±0.007
Total	30.23±1.59	36.63±0.75	29.35±2.24	38.06±0.67

* Significant difference P<0.05

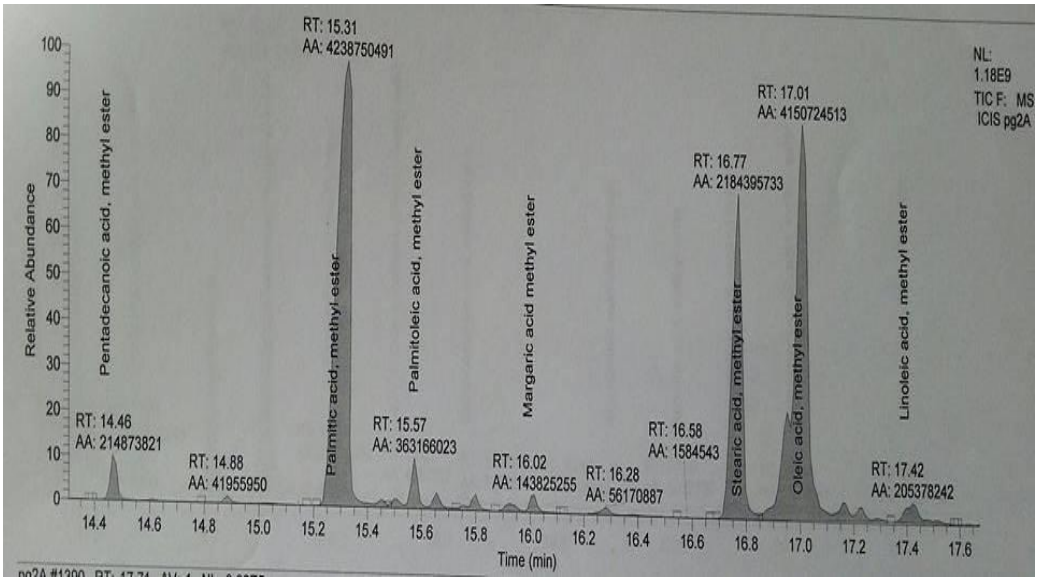

Fig. 2: fractionation of different mono unsaturated fatty acids concentrations of shortenings sample using Gas Chromatography (GC) expressed as (%)

Table 3: Statistical analytical results of Polyunsaturated fatty acids in the examined samples

Fatty acids	Cooking butter	Margarine	Ghee	Shortenings
C18:2 Linoleic acid	0.03±0.008	0.00	0.00	0.00
C18:3 α-Linolenic acid	1.34±0.12	6.80±0.30	2.94±1.45	10.47±0.87*
Linoeliadic acid	0.098±0.01	0.08±0.008	0.42±0.07	0.12±0.015
C20:4 Arachidonic acid	0.76±0.04	0.00	0.71±0.22	0.00
C18:4 6,9,12-Octadecatrienoic acid	0.048±0.005	0.00	0.02±0.003	0.00
C20:3 8,11,14-Eicosatrienoic acid	0.00	0.00	0.21±0.03	0.00
7,10,13- Eicosatrienoic acid	0.04±0.005	0.00	0.02±0.01	0.00
(C20:5) EPA	0.00	0.00	0.03±0.007	0.00
(C22:6) DHA	0.002±0.002	0.00	0.02±0.01	0.00
Total	2.31±0.19	6.88±0.30	4.37±1.8	10.59±0.88

* Significant difference P< 0.05

Table 4: Statistical analytical results of Trans fatty acids in the examined samples

Fatty acids	Cooking butter	Margarine	Ghee	Shortenings
4-Decenoic acid , methyl ester	0.05±0.01	0.00	0.21±0.03	0.00
10- Nonadecenoic acid , methyl ester	0.14±0.008	0.00	0.10±0.02	0.00
11-Eicosenoic acid, methyl ester	0.20±0.01	0.11±0.007	0.21±0.03	0.11±0.007
C18:2 Linolelaidic acid , methyl ester	0.098±0.01	0.08±.008	0.42±0.07	0.12±0.015
6,9,12-Octadecatrienoic acid, methyl ester (gamma linolenic acid methyl ester)	0.048±0.005	0.00	0.02±0.003	0.00
8,11,14-Eicosatrienoic acid, methyl ester	0.00	0.00	0.03±0.008	0.001
7,10,13-Eicosatrienoic acid, methyl ester	0.044±0.005	0.00	0.02±0.01	0.00
Total	0.58±0.048	0.19±0.015	1.01±0.17	0.23±0.022

4. DISCUSSION

As shown in Table (1) the mean values of total saturated fatty acids in examined cooking butter, margarine, ghee and shortenings samples were 67.22±3.74, 56.44±1.04, 66.36±7.72 and 51.29±2.44, respectively. The most predominant saturated fatty acid in all inspected products was palmitic acid (C16:0) followed by Stearic acid (C18:0), then Myristic acid (C14:0). Saturated acids are known to increase the risk for cardiovascular diseases **(Sacks &Katan, 2002)**. Early studies have all demonstrated a positive relationship between saturated fat intake and CHD risk through the elevation of total and LDL-C cholesterol. It's indicated that saturated fatty acids are possible the most damaging dietary factors in terms of the fact that when compared to carbohydrate on an energy equivalent basis, saturated fatty acids (SFA) raise total and LDL- cholesterol levels **(Hu et al., 2001).** NearlySimilar results were obtained by **Anwar et al. (2006); Dolezal and Dostalova (2012) and Idoui et al. (2013).**

The mean values of total monounsaturated fatty acids were 30.23±1.59, 36.63±0.75, 29.35±2.24 and 38.06±0.67, respectively with a relatively higher amount in margarine and shortenings. The predominant monounsaturated fatty acid in all examined product was oleic acid (C18:1). There was a significant difference (P< 0.05) between oleic acid and Palmitoleic acid, Nonadecenoic acid & Eicosenoic acid (Table 2).

Oleic acid was the most predominant in margarine and shortenings than other examined products. Nearly similar findings were reported **by Wagner et al. (2000); Bhanger& Anwar (2004); Hoffmann (2007); Kroustallaki et al. (2011); Meremae et al. (2012), and Bakeet et al. (2013).**Oleic acid has a favorable effect on plasma lipids and mortality rates for chronic heart diseases (CHD) **(Hu et al., 2001 and Willet, 2006a).** Monounsaturated fatty acids (MUFA) have been shown to increase HDL-C concentrations and decrease plasma triglycerides without affecting LDL-C concentrations. Additionally, a further postulated benefit of substitution of MUFA for saturated fat is that MUFA have been recently shown to offer some protection against the oxidative damage caused to LDL-C. Based on the numerous favorable effects there is a consensus on the following recommendation: up to 15 % of total daily energy should be supplied in the form of monounsaturated fatty acids **(AHA, 2000 and ITFPCHD, 2003).**

Table (3) revealed that the mean values of total polyunsaturated fatty acids in the examined cooking butter, margarine, ghee and shortenings samples were 2.31±0.19, 6.88±0.30, 4.37±1.8 and 10.59±0.88, respectively. The most predominant fatty acid in all analyzed samples was α-Linolenic acid (C18:3), while EPA and DHA (N-3) fatty acids were nearly absent in all products. Comparatively similar results were obtained by **Anwar et al. (2006); Dixit & Das (2012)** while lower values in shortenings were obtained by **Bhanger&Anwar (2004)** and **Zbikowska and Krygier (2011).** Linoleic acid demonstrates a significant lowering effect on both total and LDL-C cholesterol. Additionally, n-6 PUFA above 10% of total energy intake lowers HDL-C concentrations **(Wahrburg, 2004).**Alpha-Linolenic acid (C18:3) considered one of essential fatty acidswhichhas a major biological importance but are not synthesized by the body thus it must obtained through dietary intake which is mainly founded in margarine samples according to our study as it mainly produced from vegetable oils

(soybean oil mainly) which is one of the main source of this fatty acid. According to **Fitzgerald& Brasher (2007)** soybeans are the main source of edible oils in the U.S., and 40% of soy oil production is partially hydrogenatedandNational Health and Nutrition Examination Survey 2005-2006 already listed margarine as the thirteen contributed intake source of α-Linolenic acid (C18:3).

The mean values of trans fatty acids in the examined cooking butter, margarine, ghee and shortenings samples were 0.58±0.048, 0.19±0.015, 1.01±0.17 and 0.23±0.022, respectively (**Table 4**). There was a significant difference in ghee P< 0.05 than other examined samples. Which implicated in cardiovascular and coronary diseases.

Although little information's available on the specific effects of individual trans fatty acids, multiple studies have demonstrated adverse effects on blood lipid profiles**(Asherio, 2006 and Willet, 2006b).** Relative to cis- unsaturated fatty acids, increase levels of transfats raise LDL-cholesterol and lower HDL-cholesterol. Additionally, the increase in the total: HDL- cholesterol ratio is approximate twice the response seen with saturated fatty acids **(Vermunt et al., 2001 and Ascherio, 2006).**

The American Heart Association recommends **(Lichtenstein et al., 2006)** a healthy dietary pattern and lifestyle to combat heart disease, limiting *trans*-fat consumption to less than 1% (or approximately 2 g on a 2,000-calorie diet) and saturated fat to less than 7% of total daily calories. Similar results were obtained by **Huang et al. (2006)** and **Kroustallaki et al. (2011)**, while lower values were obtained by**Albers et al. (2008)**; **Leth et al. (2006)** and **Ritvanen et al. (2012)**.

5. CONCLUSION

It is crucial to increase consumer awareness of the health implications of Trans fatty acids present in fatty food and state efforts to limit their use by restaurants and food service establishments. Also, the national government agencies should aid these efforts by enforcing Egyptian legislation and laws that legislate trans fat legal percentage use in Egypt.

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