Asian Journal of Chemistry; Vol. 26, No. 15 (2014), 4871-4874

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2014.16323

Evaluation of Fatty Acid Compositions of Yogurts in Turkey

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Received: 10 September 2013; *Accepted*: 19 November 2013; *Published online*: 16 July 2014; AJC-15589

In this study, fatty acid composition and conjugated linoleic acid content of some yogurts in Turkey were determined. Total 50 yogurt samples belonging to 16 different national yogurt brands were analyzed by using GC. These samples categorized as whole yogurts, light yogurts, probiotic yogurts and fruity yogurts. Generally, palmitic acid (28.840-30.160 %), oleic acid (26.003-27.533 %) and stearic acid (11.413-12.077 %) were major fatty acids. Total conjugated linoleic acid percentages varied between 0.790 and 0.862 %. The results have shown that fatty acids compositions of yogurts have a desirable characteristic for healthy diet when their levels of conjugated linoleic acid contents are considered.

Keywords: Conjugated linoleic acid, Fatty acid composition, Probiotic dairy product, Turkey, Yogurt.

INTRODUCTION

Milk is generally recognized as being a component of good nutrition. It is supersaturated with equimolar amounts of calcium and phosphate, stabilized as colloidal calcium phosphate. Therefore, dairy products are important in the prevention of osteoporosis. Milk products have a high nutrient density and thus contribute significantly to the daily intake of several nutrients. They may improve intestinal health by means of cytoprotective effects of their high calcium phosphate (CaPi) content[1]. Yogurt has been defined as a coagulation of milk by *Lactobacillus L. delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*[2]. It is unique in that its dietary components present in the food matrix provide certain protection to probiotics and nutrients during passage through the stomach[3]. It is also the perfect delivery vehicle for added vitamins, fiber, essential fatty acids and antioxidants[4]. Probiotic dairy products are considered to have functional properties because the probiotic bacteria added to the regular fermentation cultures provide therapeutic benefits[5]. There are more than 500 different species of bacteria in a human intestinal tract, many of which have a beneficial role[6]. Some of dairy products that have the potential to carry probiotic bacteria are milk, yogurt and ice cream. Especially, dairy products such as yogurt are a good resource to transfer these useful microorganisms to consumer. Several health benefits are attributed to the ingestion of probiotic-containing foods, some of them have scientifically been proven. The main science-based benefits related to probiotics are: antimicrobial and antimutagenic activities[7], anticarcinogenic properties[8], antihypertension properties[9], beneficial effects on mineral metabolism[10], attenuation of symptoms of bowel disease and Crohn's syndrome[8]. Epidemiological studies indicated the reducing effect of probiotic yogurt on total cholesterol and LDL levels and the raising effect on HDL[11]. Some studies have attributed the hypocholesterolaemic effects of fermented milk to the sphingolipids present in yogurt and the fatty acids in milk fat[12,13]. The fat content of yogurt is approximately 1.7 and 3.3 % if made from low-fat and whole milk, respectively[14]. Milk and dairy products are the richest sources of conjugated linoleic acid in our diet. Conjugated linoleic acid is described as a group of positional and geometric isomers of linoleic acid. It shows anticancerogenic, anticholesterolemic and immunomodulating properties as well as protection from osteoporosis[15]. Processing and production methods contribute to the wide variability in the conjugated linoleic acid content of processed dairy products[16,17]. In the manufacture of yogurt, however, production practices do not contribute to significantly increases in conjugated linoleic acid content[18]. However, the scientific literature characterizing the fatty acid compositions and conjugated linoleic acid contents of different yogurt types (whole yogurts, light yogurts, probiotic yogurts and fruity yogurts) in Turkish are nonexistent. Therefore, the aim of present study was to determine fatty acid composition and conjugated linoleic acid content of yogurts belonging to some brands in Turkey.

EXPERIMENTAL

In this study, 50 yogurt samples belonging to 16 different national yogurt brands were analyzed. Yogurt samples were collected from stores in Konya, Turkey. These samples categorized as whole yogurts (n = 17), light yogurts (n = 2), probiotic yogurts (n = 6) and fruity yogurts (n = 25). Yogurt samples were frozen and stored at -27 °C for fatty acid composition analysis.

Fatty acid analysis: Yogurt fat was extracted by slight modifications of the method of Erickson and Dunkley[19] with hexane as the extraction solvent. Yogurt samples (20 g) were put into glass screw top culture tubes and 1 mL of saturated sodium chloride and 18 mL of 0.0625 M HCl in ethanol were added. Tubes were sealed with Teflon lined caps and shaken by hand for 1 min. This was followed by addition of 10 mL of hexane and shaking on a Burrell wrist action shaker for 10 min. To separate phases, tubes were centrifuged for 5 min at 500 × g and using a Pasteur pipette, the upper hexane layer was removed and washed with 20 mL of double deionized water. After shaking and recentrifuging at the same g force, the hexane layer was transferred to a vial containing 1.2 g of anhydrous sodium sulfate and allowed to dry for 15 min. The fatty acids in the fat have been esterified according to AOCS[20]. The fatty acid methyl esters were analyzed on a HP (Hewlett Packard) Agilent 6890N model gas chromatograph (GC), equipped with a flame ionization detector (FID) and fitted with a HP-88 capillary column (100 m, 0.25 mm ID and 0.2 μm). Chromatographic conditions were performed according to method modified as follows: Injector and detector temperatures were 250 and 280 °C, respectively. The oven was programmed at 60 °C initial temperature and 1 min initial time. Thereafter the temperature increased 20 °C/min to 190 °C held for 60 min then increased at 1 °C/min to 220 °C and held for 10 min at 220 °C. Total run time was 107.5 min. Carrier gas was helium (1 mL/min). Identification of fatty acids and *trans* isomers were carried out by comparing sample fatty acid methyl ester peak relative retention times with those obtained for Alltech standards. Linoleic acid conjugated methyl ester (mixture of *cis*-and *trans*-9,11- and -10,12-octadecadienoic acid methyl esters, catalog number O5632) was purchased from Sigma-Aldrich (St. Louis, MO, USA). Results were expressed as FID response area relative percentages. Each reported result is the average value of three GC analyses. The results are offered as mean ± SD.

RESULTS AND DISCUSSION

As stated from the GC analysis, 36 fatty acids were identified in fat of 50 yogurt samples. Table-1 shows the fatty acid compositions and conjugated linoleic acid contents in the analyzed yogurt samples, commercially available in Turkey. All milks were standardized to 2 % milk fat prior to yogurt production. Total lipid content increased significantly, from 1.94 to 2.25 %, during the processing of milk into yogurt, through the loss of water during heat treatment[21]. The composition of the main fatty acids in yogurt samples was C16:0 palmitic acid (28.840-30.160 %), C18:1 ω9 oleic acid (26.003-27.533 %), C18:0 stearic acid (11.413-12.077 %) and C14:0 myristic acid (9.273-10.036 %). Dairy fat contains a high proportion of saturated fatty acids (SFAs). Saturated fatty acids, as compared to unsaturated fatty acids, may increase the incidences of atherogenicity[22]. In present study, saturated fatty acids were higher than monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) and varied from 59.315 to 63.155 %. The highest amounts of saturated fatty acids were found in light yogurt. There are correlations between the fatty acids characteristic of dairy fat (14:0, 14:1, 15:0, 17:0 and 17:1) in adipose tissue, serum lipid fractions and the estimated intake of dairy fat[23]. Monounsaturated fatty acids ranged from 30.503 to 31.965 % and oleic acid was the major monounsaturated fatty acid in all samples. Oleic acid was found to be 27.383, 26.003, 27.278 and 27.533 % of total fatty acids in whole yogurt, light yogurt, probiotic yogurt and fruity yogurt, respectively. C16:1 ω7 palmitoleic acid and C14:1 ω5 miristoleic acid were other predominant monounsaturated fatty acids. These fatty acids were 2.248-2.349 and 1.388-1.518 %, respectively. Seckin *et al.*[24] determined that oleic acid was predominant monounsaturated fatty acid and ranged from 23.12 to 32.78 g/100 g total fatty acid in some dairy products in Turkey. The polyunsaturated fatty acid contents were determined in whole yogurt, light yogurt, probiotic yogurt and fruity yogurt 3.052, 3.303, 3.349 and 5.975 %, respectively. C18:2 ω6 linoleic acid was found as major polyunsaturated fatty acids. The linoleic acid varied from 2.188 to 4.522 %. Similarly, Boylston and Beitz[21], Prandini *et al.*[25] and Florence *et al.*[26] found that yogurts had high amounts of C18:2 ω6 in comparison with other polyunsaturated fatty acids.

trans-Vaccenic acid (C18:1 *t*11) was found to be the highest *trans* fatty acid (1.266-1.470 %) in all samples and C 14:1 *t*9, C 16:1 *t*9, C 18:2 *t*9*t*12 and C 18:2 *t*9*c*12 were other *trans* fatty acids in yogurts. The highest level of vaccenic acid was observed in light yogurts. The main *trans* 18:1 isomer is vaccenic acid in milk fat, but *trans* double bounds are also observed in low concentrations in milk fat[27]. Vaccenic acid constitutes approximately 2.7 % of the total fatty acid content and varies with season. Vaccenic acid which is an intermediate in the rumen biohydrogenation of both linoleic and linolenic acid, is converted to rumenic acid by Δ^9-desaturase, an enzyme present in the mammary gland[28].

The observed variability in the conjugated linoleic acid (CLA) content of processed dairy products[16] has been correlated to quantity of the conjugated linoleic acid content of raw milk[17]. In terms of biological activity, *c*9*t*11 octadecadienoic acid has been seen as the most important conjugated linoleic acid isomer[29]. Therefore, the *c*9*t*11 octadecadienoic acid was researched in this study.

Conjugated linoleic acid is found primarily in milk, dairy product and the meat of ruminant animals[30]. Conjugated linoleic acid content in milk fat can be affected from diet, breed and age of animals[31]. Some researchers have demonstrated that the conjugated linoleic acid content of milk and meat increased in animals which feed on fresh grass[32-36]. Guler *et al.*[37] indicated that the total conjugated linoleic acid content of Turkish commercial milks were between 0.961-1.020 % of total fatty acids in whole milk, light milk and fruity milk. We also found that the total conjugated linoleic acid percentages were 0.51, 0.47-0.64, 0.52-0.70 and 0.57-0.60 % in raw milk, in heat-treated milk, in salt-free and salt cheeses made from raw milk at different temperatures, respectively[38].

TABLE-1
MEAN VALUE OF FATTY ACID COMPOSITION AND CONJUGATED LINOLEIC ACID ANALYZED YOGURT IN DIFFERENT CATEGORY (%)

Fatty acids	Whole yogurt (n = 17)	Light yogurt (n = 2)	Probiotic yogurt (n = 6)	Fruity yogurt (n = 25)
C 4:0	0.811 ± 0.38[a]	0.528 ± 0.07	0.673 ± 0.15	0.653 ± 0.29
C 6:0	1.428 ± 0.41	5.750 ± 1.97	1.357 ± 0.18	1.292 ± 0.22
C 8:0	0.813 ± 0.10	0.743 ± 0.07	0.748 ± 0.04	0.719 ± 0.10
C 10:0	2.024 ± 0.13	1.830 ± 0.11	1.913 ± 0.07	1.806 ± 0.25
C 11:0	0.204 ± 0.03	0.365 ± 0.02	0.184 ± 0.02	0.176 ± 0.03
C 12:0	2.634 ± 0.21	2.405 ± 0.11	2.490 ± 0.08	2.318 ± 0.31
C 13:0	0.094 ± 0.02	0.128 ± 0.02	0.092 ± 0.02	0.076 ± 0.02
C 14:0	10.036 ± 0.36	9.345 ± 0.14	9.978 ± 0.14	9.273 ± 1.15
C 15:0	1.093 ± 0.11	1.013 ± 0.05	1.142 ± 0.04	1.020 ± 0.16
C 16:0	30.160 ± 1.23	28.840 ± 0.88	30.157 ± 0.41	29.537 ± 2.90
C 17:0	0.560 ± 0.05	0.550 ± 0.02	0.610 ± 0.02	0.531 ± 0.07
C 18:0	11.959 ± 0.73	11.413 ± 0.53	12.077 ± 0.42	11.689 ± 1.27
C 19:0	0.021 ± 0.01	0.025 ± 0.01	0.030 ± 0.01	0.026 ± 0.01
C 20:0	0.046 ± 0.02	0.073 ± 0.06	0.068 ± 0.04	0.068 ± 0.04
C 21:0	0.045 ± 0.10	0.043 ± 0.04	0.032 ± 0.01	0.027 ± 0.02
C 22:0	0.089 ± 0.03	0.108 ± 0.05	0.122 ± 0.03	0.102 ± 0.02
Σ SFA[b]	62.017 ± 1.27	63.155 ± 0.19	61.673 ± 0.49	59.315 ± 5.62
C 14:1 ω5	1.490 ± 0.07	1.395 ± 0.05	1.518 ± 0.09	1.388 ± 0.24
C 15:1 ω5	0.325 ± 0.03	0.353 ± 0.03	0.343 ± 0.02	0.308 ± 0.05
C 16:1 ω7	2.311 ± 0.14	2.248 ± 0.05	2.349 ± 0.09	2.235 ± 0.25
C 17:1 ω8	0.397 ± 0.04	0.428 ± 0.03	0.393 ± 0.05	0.387 ± 0.05
C 18:1 ω9	27.383 ± 1.27	26.003 ± 0.25	27.278 ± 0.67	27.533 ± 1.90
C 20:1 ω9	0.058 ± 0.03	0.078 ± 0.05	0.079 ± 0.02	0.070 ± 0.02
Σ MUFA[b]	31.965 ± 1.28	30.503 ± 0.30	31.959 ± 0.55	31.920 ± 2.26
C 18:2 ω6	2.234 ± 0.12	2.188 ± 0.10	2.261 ± 0.11	4.522 ± 5.36
C 18:3 ω6	0.119 ± 0.02	0.145 ± 0.05	0.144 ± 0.02	0.126 ± 0.04
C 18:3 ω3	0.353 ± 0.05	0.378 ± 0.05	0.426 ± 0.04	0.655 ± 0.65
C 20:2 ω6	0.042 ± 0.02	0.085 ± 0.09	0.058 ± 0.02	0.051 ± 0.02
C 20:4 ω6	0.176 ± 0.03	0.193 ± 0.01	0.227 ± 0.12	0.175 ± 0.02
C 20:5 ω3	0.066 ± 0.03	0.198 ± 0.16	0.144 ± 0.09	0.256 ± 0.36
C 22:6 ω3	0.062 ± 0.02	0.118 ± 0.07	0.090 ± 0.03	0.190 ± 0.27
Σ PUFA[b]	3.052 ± 0.14	3.303 ± 0.32	3.349 ± 0.15	5.975 ± 6.60
C 14:1 t9	0.268 ± 0.03	0.213 ± 0.10	0.271 ± 0.03	0.247 ± 0.04
C 16:1 t9	0.413 ± 0.09	0.448 ± 0.02	0.452± 0.04	0.367 ± 0.08
C 18:1 t11	1.330 ± 0.28	1.470 ± 0.30	1.313 ± 0.14	1.266 ± 0.25
C 18:2 *t*9*t*12	0.076 ± 0.02	0.080 ± 0.01	0.086 ± 0.01	0.079 ± 0.02
C 18:2 *t*9*c*12	0.032 ± 0.01	0.040 ± 0.01	0.035 ± 0.01	0.033 ± 0.01
Σ TFA[b]	2.121 ± 0.31	2.250 ± 0.40	2.156 ± 0.15	1.992 ± 0.31
C 18:2 *c*9*t*11	0.800 ± 0.11	0.698 ± 0.14	0.793 ± 0.10	0.743 ± 0.15
C 18:2 *t*10*c*12	0.044 ± 0.03	0.093 ± 0.06	0.069 ± 0.02	0.052 ± 0.02
Σ CLA[b]	0.844 ± 0.10	0.790 ± 0.20	0.862 ± 0.12	0.796 ± 0.15

[a]Values reported are means ± S.D [b]SFA: Saturated fatty acid, MUFA: Monounsaturated fatty acid, PUFA: Polyunsaturated fatty acid, TFA: *Trans* fatty acid; CLA: Conjugated linoleic acid.

In the current study, conjugated linoleic acid contents of yogurts were found as 0.790-0.862 %, which have demonstrated that conjugated linoleic acid levels in the yogurt were higher than the raw milk and cheese.

Turkish yogurts are important sources of conjugated linoleic acid. As expected, yogurt is one of the most interesting dairy products for the consumer, containing relatively high contents of total conjugated linoleic acid and its *c*9*t*11 isomer. The results of this study have shown that fatty acids compositions of yogurts have a desirable characteristic for healthy diet when their levels of conjugated linoleic acid contents are considered.

ACKNOWLEDGEMENTS

The authors acknowledged the financial support by Selcuk University, Scientific Research Foundation (BAP).

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