Evaluation of Fatty Acid Profile of Trabzon Butter

Tulay Ozcan, Arzu Akpinar-Bayizit, Lutfiye Yilmaz-Ersan, Kader Cetin, and Berrak Delikanli

***Abstract*—Trabzon butter, a dairy product with its unique flavor, aroma and color, is produced with traditional methods in Black sea region/Turkey. In the present study, the types and amounts of short, medium and long-chain saturated and unsaturated fatty acids of Trabzon butter sold in Bursa retail markets from different geographical origin were determined by gas chromatography. The total of short-chain fatty acid levels of Trabzon butter samples were 1.43% to 2.17%, while medium-chain fatty acid levels ranged from 0.09% to 12.00%. Minimum and maximum levels of long-chain fatty acids of samples were determined as 0.01% and 34.24%. The fatty acid profile showed that palmitic, stearic and myristic acids were dominant as saturated fatty acids whereas oleic was the major monounsaturated fatty acid in butter. It could be concluded that the fatty acid content of butter can be affected by raw milk quality, the breed type and the genetic and physiological factors of the animals, geographical location and the production practices.**

***Index Terms*—Trabzon butter, fatty acids.**

I. Introduction

Milk has been a part of the human diets for centuries and consumed either in fresh milk or fermented or soured forms. The demand for milk and dairy products depends on many factors including sex, age, ethnicity, cultural factors and consumer preferences. Whole milk is composed of 88% water, 3.3% fat, 3.3% protein, 4.8% carbohydrate, and some other minor constituents such as vitamins and minerals [1]–[3]. Milk lipids represent a good dietary source of the essential fatty acids as well as liposoluble vitamins such as retinol, α-tocopherol and β-carotene. Due to the presence of various microorganisms in the rumen, over 400 fatty acids have been determined in milk [4]. The fatty acid composition of milk is not only effective on physical properties, oxidative stability and organoleptic quality of dairy products, but also has positive effects on human health.

The most abundant fatty acids in milk are butyric, palmitic and oleic acid. Recent studies have focused on the functional fatty acids such as short chain, medium chain, branched chain and odd chain fatty acids and conjugated linoleic acid (CLA) which may play a key role in the prevention of certain diseases [5]–[7] such as cancer, atherosclerosis, cardiovascular disease.

Traditions, religious beliefs or ancient views integrate with eating-drinking habits and shape it. Since traditional foods are known to be the reflection of cultural inheritance, the diversity of Turkish dairy products reflects the cultures of the populations living in highly dissimilar in geographically and climatically regions [8].

Trabzon (Trebizond, Trebizond, Trapezund, Tribisonde, or Trapezus) is a city on the Black Sea coast of northeastern Turkey (Fig. 1). It is located on the historical Silk Road and became a trade gateway to Iran in the southeast and the Caucasus to the northeast. Trabzon's regional cuisine is a feast in itself due to being a melting pot of religions, languages and culture for centuries and traditionally reliant on fish, especially hamsi. Other local delicacies are stuffed collards, kaygana, corn bread and Trabzon butter.

Fig. 1. Location of Trabzon within Turkey.

Butter is produced by churning either fresh or fermented cream/milk which is obtained by separation of milk fat from milk or yogurt [9]. Flavor or taste quality attributes are the key factors to determine the consumption of butter. Flavor and texture properties of butter are influenced by milk type obtained from the different dairy animals, diets, stages of lactation, seasons of the year and processing conditions [10], [11].

Butter making processes and its consumption levels are quite different in many countries [12]. In Black Sea region, traditional Trabzon butter, also known as *sari yağ* (yellow fat/oil), is produced from raw goat or sheep milk or mixed with cow milk. To make this butter, milk is collected in a wooden storage vessel called "*kulek"*. When the amount is sufficient, it is put into a barrel called "*yayik*" and churned. After churning the butter begins to separate into clumps, and the butter/milk mixture in yayik is the emptied into a pot. The butter, which collects on the surface, is removed with a spoon and put into a pan. When all the butter is collected, it is washed until the water flows transparent. This is unsalted butter, and is generally consumed for traditional Turkish breakfast. If it is to be stored for long periods, it must be appropriately salted. This salted butter is preferential for cooking.

Trabzon butter has individual characteristics like its taste, odor and color. Furthermore, processing and storage conditions contribute to the diverse flavor and texture

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characteristics of butter [13]. Original taste/flavor of Trabzon butter comes from the milk of goat, sheep and cows grown in natural habitats around Black Sea region that use plants and water resources of this specific area In addition, Trabzon butter is ripened in wooden barrels or earthenware jugs for characteristic flavor. This butter is originated from Vakfikebir and Tonya districts of this region [14], [15].

Traditional Trabzon butter is mainly manufactured at small-scale family-owned plants by traditional methods. The information in literature regarding the standard manufacturing process, composition and quality characteristics of this butter are very limited [12], [14], [16]. Hence, this study aims to determine the fatty acid profile, an important consumer preference parameter of taste and flavor of Trabzon butter.

II. Materials and Methods

In study, butter samples were obtained from various markets in Bursa and stored in ice-box until taken to the lab and frozen at -20 ℃ up to the analyses. Milk fat was extracted according to Bligh and Dyer [17], and cold esterification was carried out to obtain fatty acids methyl esters (FAMEs) according to IUPAC (International Union of Applied and Pure Chemistry) method (Commission Regulation (EC) No 796/2002 of 6 May 2002). The FAMEs were analyzed using a gas chromatograph (Agilent 6890N Series, Hewlett-Packard Co., Avondale, PA, USA) equipped with flame ionization detector and a capillary column (Agilent DB23 column; 60 m, 0.25 mm i.d, J&W Scientific Co., Folsom, CA, USA) on a split mode. The oven temperature was programmed as follows: the initial temperature of 130 ℃ was raised to 170 ℃ at a rate of 6.5 ℃/min and was held at this temperature for 1 min, then was increased at 2.15 ℃/min to 215 ℃, and was held at this temperature for 12 min. and thereafter was increased to 230 ℃ and held at this temperature for 3 min. Nitrogen was the carrier gas and sample injection volume was 1 μL.

The identification of the peaks was achieved by retention times and by comparing them with authentic standards analyzed under the same conditions. Peak areas of triplicate injections were measured with an HP computing integrator. Results were expressed as (%) total fatty acids.

III. Results and Discussion

Fatty acids composition of milk can vary due to the quality of farming practices, the breed type, the genetic and physiological factors of the animals, lactation, season, feed and geographical location [18]–[21]. Thus, the fatty acid content of butter, like any other milk product, is highly affected by these factors. In addition, further milk processing conditions such as the heat treatment, starter culture, ripening period and the storage temperature also affect the fatty acid composition [22]–[27].

Saturated fatty acids are classified according to their chain length into short (C_4 to C_6), medium (C_8 to C_{14}), long (C_{16} to C_{18}) and very long chain fatty acids (longer than 19 carbons) chain. There is considerable interest in dairy products rich in long chain fatty acids (LCFA) due to their beneficial effects on human health. As shown in Table I, the total of short-chain fatty acid levels of butter samples changed from 1.43% to 2.17%, while medium-chain fatty acid levels ranged from 0.09% to 12.00%. Minimum and maximum levels of long-chain fatty acids of Trabzon butter were determined as 0.01% and 34.24%.

TABLE I: Fatty Acid Composition of Trabzon Butter

Fatty Acids	Min. (%)	Max. (%)	Mean ± SD (%)
SCFA			
Butyric acid ($C_{4:0}$)	1.81	2.17	1.94±0.131
Caproic acid ($C_{6:0}$)	1.43	1.66	1.52±0.089
MCFA			
Caprylic acid ($C_{8:0}$)	0.94	1.1	1.01±0.078
Capric acid ($C_{10:0}$)	2.15	2.63	2.43±0.201
Lauric acid ($C_{12:0}$)	2.79	3.32	3.05±0.219
Tridecanoic acid ($C_{13:0}$)	0.09	0.09	0.05±0.052
Myristic acid ($C_{14:0}$)	10.75	12.0	11.38±0.480
Pentadecanoic acid ($C_{15:0}$)	1.07	1.46	1.23±0.149
Myristoleic acid ($C_{14:1}$)	1.49	1.82	1.62±0.116
LCFA			
Palmitic acid ($C_{16:0}$)	30.43	34.24	32.65±1.322
Palmitoleic acid ($C_{16:1}$)	1.16	1.67	1.39±0.206
Heptadecanoic acid ($C_{17:0}$)	0.51	0.87	0.68±0.121
Heptadecenoic *(cis)* ($C_{17:1}$)	0.24	0.85	0.45±0.229
Stearic acid ($C_{18:0}$)	10.60	12.7	11.48±0.839
Oleic acid ($C_{18:1}$)	23.87	27.1	25.70±1.076
Linoelaidic acid (9,12-$C_{18:2}$)	0.00	0.11	0.02±0.044
Linoleic acid ($C_{18:2}$)	1.39	2.31	1.99±0.326
Gamma-Linolenic acid (6,9,12-$C_{18:3}$)	0.00	0.08	0.01±0.032
Linolenic acid (9,12,15-$C_{18:3}$)	0.00	0.45	0.25±0.187
VLCFA			
Eicosanoic acid *(cis)* ($C_{20:1}$)	0.70	1.28	1.01±0.238
Eicosadienoic acid *(cis)* ($C_{20:2}$)	0.00	0.12	0.02±0.004
Heneicosanoic acid ($C_{21:0}$)	0.00	0.09	0.02±0.003
Tricosanoic acid ($C_{23:0}$)	0.00	0.06	0.00±0.000
Behenic acid ($C_{24:0}$)	0.00	0.30	0.11±0.001

Abbreviations: Short-chain fatty acids (SCFA, C_4:0 to C_6:0); Medium-chain fatty acids (MCFA; C_8:0 to $C_{15:1}$); Long-chain fatty acids (LCFA; $C_{16:0}$ to $C_{18:3}$); Very long chain fatty acids (VLCFA, longer than 19 carbons)

The concentration of the short chain fatty acids such as butyric, caproic, caprylic and capric acids may be influential on flavor characteristics for butter. The butters have high resorption rates due to high digestibility of short-chain fatty acids (SCFA, C_4:0 to C_6:0) and melting point below body temperature. At the same time, these fatty acids (C_4 to C_6) are easily digested and rapidly turned to energy. Neyts et al. [28] reported that the short and medium chain fatty acids can exert antimicrobial and antiviral activities both in vitro and in animal studies. Particularly, butyric acid (C_4:0) has been suggested to inhibit human cancer cell lines even at low concentrations [29]. We found butyric acid to be present in Trabzon butter between 1.81 and 2.17%. The level of capric acid (2.43%) was significantly higher than caproic acid (1.52%) and caprylic acid (1.01%) (see Table I).

The data concerning mean values of saturated and unsaturated fatty acid as degree of saturation of carbon chain were presented in Fig. 2 and Fig. 3. Among these fatty acids classes, the saturated ones were predominating. Obtained results demonstrate that total saturated fatty acid levels changed from 0.02 to 32.65%, while total unsaturated fatty acids ranged from 0.02 to 25.70%. Palmitic acid, stearic acid

and their derivatives are essential to the controlled development of the brain in children [30]. The most abundant saturated fatty acids determined in Trabzon butter were palmitic acid (32.65%), stearic acid (11.48%) and myristic acid (11.38%) (see Fig. 2). Seckin [31] indicated that these saturated fatty acids were 34.6%, 12.16% and 11.45% in cream butter, being quite similar to the present data obtained from Trabzon butter.

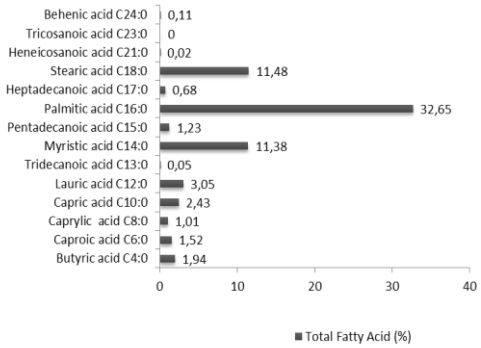

Fig. 2. Saturated fatty acids of Trabzon butter (%).

Idoui *et al.* [32] prepared butter in the laboratory from cows' milk according to the traditional method used by people in the Jijel areas (Eastern Algeria), and found important differences in fatty acid compositions. The butter samples contained a high percentage of saturated fatty acids and palmitic acid was the major SFA (24.33–36.95%) followed by myristic acid (18.49–27.35 %) and stearic acid (7.68–14.05%).

Rady and Badr [33] reported that cows' butter contained 49.43% saturated fatty acids (SFA) and palmitic acid was the major SFA (22.81%) followed by stearic (10.21%) and myristic (6.79%), respectively. Several researchers stated the predominance of palmitic acid [34]–[36].

The unsaturated fatty acids with multiple double bounds are essential components for human nutrition because of their valuable functional and health promoting properties. Oleic acid (C18:1, n-9), the principal unsaturated fatty acid in milk, is used as a source of energy and in the reserves of body fat. It is one of the precursors of very long-chain fatty acids used in the structure of brain tissue, especially in myelin, and relatively neutral in cardiovascular terms. Consumption of monounsaturated fatty acids such as oleic acid is believed to be beneficial in reducing levels of low-density lipoprotein (LDL) (bad cholesterol) in blood [37], [38].

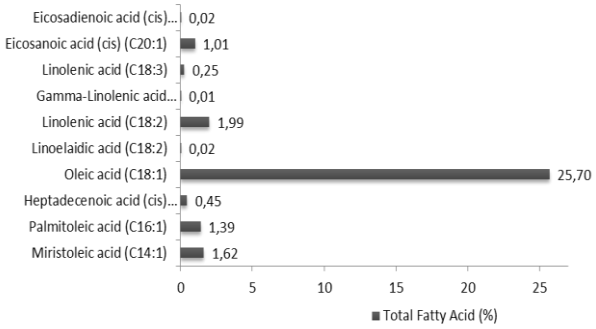

Fig. 3. Unsaturated fatty acids of Trabzon butter (%).

Oleic acid contents of Trabzon butter were significantly high (25.70%) among all unsaturated fatty acids. The presence of linoleic (18:2) and linolenic acids (18:3) in amounts of 1.99-0.25%, respectively, in butter samples was also interesting since these fatty acids are generally recognized to display positive effect on cholesterol-lowering and cardiovascular health (see Fig. 3).

Sagdic *et al.* [12] determined the contents of saturated, monounsaturated and polyunsaturated fatty acids as 73.88±0.62, 21.20±0.94 and 1.44±0.01% in goats' yayik butter, 69.10±-0.36, 20.22±0.76 and 2.96±0.06 in ewes' yayik butter, 67.06±0.30, 24.01±0.84 and 1.34±0.01 in cows' yayik butter, respectively. They stated that the traditional yayik butter made from goats' milk had the most acceptable organoleptic characteristics.

Salomon *et al.* [39] analyzed the effect of heat on fatty acid composition of milk and foodstuff with high fat content (i.e. cheese, butter, margarine). Oleic acid was the major fatty acid with 93.63%, however, with heat treatment was decreased to 90.49%, and cis-configurated oleic acid turns to trans-configurated form (as elaidic acid).

Kamleh *et al.* [40] found that the general fat content average of butter produced in the Bekaa Valley over a one year period was 82.10±5.40%, higher than the value cited 80% as minimal fat content in butter. The averages of fat % in butters produced in cold seasons were higher than in hot seasons.

IV. Conclusion

There is a growing demand for traditional dairy foods in that it can provide other benefits for human health in addition to being nutritious. In this study, the fatty acid profiles of Trabzon butter were investigated. The fatty acid profile of butter showed that palmitic acid was predominant; and oleic acid was the major monounsaturated fatty acid. Fatty acid composition of the butter is mainly influenced by the type of animal species and the composition of milk, growth conditions, traditional production methods and geographical location due to the fact that the each region consists of different meadow and pastures flora.

A geographical indication (GI) is the name or sign used for certain products corresponding to a specific geographical location or origin (e.g. a town, region, or country) or products that possess certain qualities and made according to traditional methods. The recognition and protection of traditional products, produced by rural communities over generations and that have gained a reputation on the markets for their specific qualities, forces the producers to invest in maintaining the recognized qualities of the product. In addition, it may also promote the reputation of the product. Therefore, GI for Trabzon butter will increase the revenues for local producers, satisfy the needs of more conscious customers and improve the economy of the country creating employment in the devoted area.

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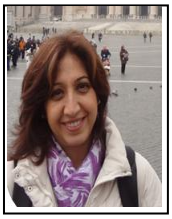

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