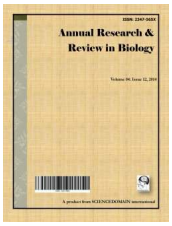

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Chemical Quality and Fatty Acid Profile of Zanjan Traditional Butter

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Authors' contributions

This work was carried out in collaboration between all authors. Authors HH and AS planed and designed of the study. Author AS performed the tests and wrote a part of manuscript. Authors MF and MA shared in performance of tests. Author HH analyzed the data, achieved statistical analysis, drafted, wrote and revised the manuscript. Author MA revised the manuscript. Finally all authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aimed to evaluate chemical quality and fatty acid profile of traditional butter samples in Zanjan, Iran.
Study Design: Quantitative determination of chemical quality and fatty acid profiles of 30 samples of Traditional cows' butter was carried out from market of Zanjan, Iran.
Place and Duration of Study: Department of food safety and hygiene in school of Health, Zanjan University of Medical Sciences, Zanjan, Iran during spring in 2016.
Methodology: Chemical quality of butter samples was evaluated using measurement of moisture, peroxide value, saponification value and Iodine value according to standard protocols of the national institute of standards and industrial research of Iran, No. 8381-1, 4179, 10501 and 4888, respectively. Determination of fatty acid composition was in accordance with Iranian national

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standard No. 8818 (Preparation of fatty acid methyl esters) and 8819 (measuring of fatty acids) using a gas chromatography.
Results: Total moisture of all samples varied from 17.3% to 22.3%. Peroxide value of butter samples changed from 0.4-3.2 mEq/ kg. Average saponification value and Iodine value of the samples were 178.02±14.8 mg/g and 27±1.41%, respectively. The results of Fatty acid profile showed the total of short-chain fatty acid contents of butter samples varied from 0.38% to 1.14%, while medium-chain fatty acid levels ranged from 0.44% to 12.88%. Minimum and maximum contents of long-chain fatty acids of butter samples were 0.52% and 29.39%.
Conclusion: The present study, investigation of chemical quality and fatty acids profile showed that moisture content of all butter samples were higher than standard range and both palmitic acid and oleic acid were most predominant saturated and monounsaturated fatty acids, respectively. Chemical quality of butter samples can be protected by control of hygienic conditions in production process and keeping the cold chain until the consumption.

Keywords: Fatty acid; Iodine value; moisture; peroxide value, saponification value; Zanjan.

1. INTRODUCTION

Milk and dairy products are major sources of dietary vital components of nutrition (energy, protein and fat) for people [1]. Milk fat is the second largest component of milk, a source of energy and essential fatty acids as well as liposoluble vitamins which has major commercial value [2,3].

Butter is recognized as the oldest dairy product and composed of milk fat which has been separated from other milk components [4]. Worldwide, it is commonly made from different milk sources including cow, sheep, goat, buffalo, camel and yak [5]. Butter is made of fermented or unfermented milk or cream industrially and traditionally. By churning the cream or milk, coalescence of fat globules happens and larger clusters is formed which is finally separated from the liquid portion and forms a semisolid phase called butter [6]. Traditionally, fermented milk used in making butter [7]. Butter may be washed, salted or colored and then packaged in different sizes and shapes. This dairy product consists of butterfat, water, and milk proteins. Through the world in some areas including turkey, Jordan, India and Iran, traditionally butter sample is made from shaking up mixture of yogurt with cold water in a wood or metal container having spinning paddles. Butter fat has been separated from water mixture with a spoon after half an hour and then washed and cooled. In this step, maybe some salt (almost 1%) was added to butter. Remained mixture is called Doogh or Ayran [8]. Produced butter was wrapped in a clean cotton cloth and pressed to forming solid butter and separation the moisture by hands. Usually butter packaged in a plastic container without a protective cover, even in retail markets and then stored in cool place.

Approximately 81 percent of butter consists of fat [5]. Milk fat almost contains 400 different fatty acids that differentiate it from all natural fats [8]. Two main sources of fatty acids (FAs) in the milk are the microbial activity of present microorganisms in the rumen and the feed of the animal [5]. Approximately 60 percent of the fatty acids (FA) in milk are saturated of which butyric and palmitic acid are the most abundant among them. Fatty acids in milk are classified according to carbon chain length to short chain (SCFA) (C4-C6), medium chain (MCFA) (C8-C14), long chain (LCFA) (C16-C18) and very long chain (VLCFA) (C20-C24) including both saturated (SFAs) and unsaturated fatty acids (USFAs) [3]. Butyric acid as main short chain and some MCFAs are synthesized in rumen that enters to bloodstream and then to mammary glands. Biosynthesis process of FAs in the mammary gland of the cow or other domestic dairies produces FAs with even number of C4-C16 in chain length. About half of the C16:0 and the LCFAs emanate of dietary lipids and lipolysis of triacylglycerols present in adipose tissue. Possible desaturation of saturated MCFAs and LCFAs in the mammary gland, particularly C18:0 cause formation of mono unsaturated fatty acids [9].

The FA composition of butter and other dairy products can impress on their oxidative stability, physical properties and organoleptic quality and also on human health [3]. Many studies have focused on functional properties of various saturated or unsaturated fatty acids emanated from dairy products including short, medium, branched, odd chain FAs and conjugated linoleic acid (CLA) on prevention of diseases such as type 2 diabetes, cardiovascular diseases, cancer, skeletal disorders and etc. [10-12]. Regardless of

the milk type and breeding management of animal, methods of butter production and environmental conditions of processing, storage and distribution can influence butter chemical quality. Several studies were conducted on chemical composition and FA profiles of butter samples using classic and modern methods through the world including Iran [3,13-16].

Gaining popularity among people to consume butter in diet and being common dairy product of breakfast lead researches and authorities to control this product's quality. Variations in quality attributes due to bad processing and maintenance or any adulteration by adding non-edible oils, plant oils, old used oils or industrial cream to both industrial or traditional produced butters have negative affect on consumer acceptability and health that lead to low marketability and economic losses of product. Due to high consumption of produced traditional butters in Zanjan province and different conditions of storage and supplying of this product, this study aims to evaluate chemical quality and fatty acid profile of traditional butter samples in Zanjan, Iran.

2. MATERIALS AND METHODS

2.1 Sampling

Thirty samples of locally produced cows' butter produced by native people of yogurt were purchased from supermarkets, randomly, according to cluster sampling plan of the city at retail market in Zanjan, Iran, and were taken to lab in ice-box and frozen at -30ºC till to analyzing the samples during spring in 2016.

2.2 Chemical Analysis

Chemical quality of butter samples was evaluated using measurement of moisture, peroxide value, saponification value and Iodine value according to standard protocols of the national institute of standards and industrial research of Iran, No. 8381-1, 4179, 10501 and 4888, respectively [17-20].

2.3 Analysis of Fatty Acids

Determination of FA composition was in accordance with Iranian national standard No. 8818 (Preparation of fatty acid methyl esters) and 8819 (measuring of fatty acids) using a gas chromatography (Agilent 6890 N Hewlett-Packard Co., Avondale, PA, USA) equipped with flame ionization detector (FID) and BPX70 capillary column, N2carrier gas, with 1 microliter volume injection [21-22]. The peaks were identified by retention times and comparing them with authentic standards under the same conditions.

2.4 Statistical Analysis

Data is expressed as mean ± standard deviation of 3 replicates. Statistical analysis of all samples was performed using SPSS software (Ver. 16.0, SPSS Inc., Chicago, USA).

3. RESULTS AND DISCUSSION

3.1 Results

Chemical quality and FA profile of butter samples are shown in Table 1 and Table 2, respectively. Total moisture of all samples varied from 17.3% to 22.3%. Peroxide value of butter samples varied from 0.4-3.2 mEq/ kg. Saponification value and Iodine value variation of the samples were 176-189 mg/g and 25.4 to 29.2%, respectively.

The results of fatty acid profile showed the total of SCFA (C4-C6) contents of butter samples varied from 0.38% to 1.14%, while MCFAs (C8-C14) ranged from 0.44% to 12.88%. Minimum and maximum contents of LCFAs (C16-C18) of butter samples were 0.52% and 29.39%.

3.2 Discussion

According to obtained results, chemical quality of the butter samples was not in normal standard range in some samples (Table 1). Moisture content, peroxide value (PV),

Table 1. Chemical quality of Zanjan butter samples

	Mean±SD	Minimum	Maximum	Standard range
Moisture (%)	20.54±2.15	17.30	22.30	Up to 16 [17]
Peroxide value (mEq/kg)	2.26±0.92	0.40	3.20	Up to 1.7 [18]
Saponification value (mg/g)	178.02±14.8	176.00	189.00	225-235 [19]
Iodine value (%)	27.15±1.41	25.40	29.20	26-40 [20]

Table 2. Fatty acid profile of Zanjan butter samples

Fatty acids	Mean ± SD (%)	Minimum (%)	Maximum (%)	Standard range [22]
SCFA				
Butyric acid (C4:0)	0.69±0.20	0.38	1.14	1-5
Caproic acid (C6:0)	0.75±0.17	0.47	1.09	0.80-3.60
MCFA				
Caprylic acid (C8:0)	0.63±0.12	0.44	0.84	0.50-1.8
Capric acid (C10:0)	1.81±0.34	1.31	2.46	1.9-3.70
Lauric acid (C12:0)	2.57±0.47	1.80	3.50	2.20-4.50
Myristic acid (C14:0)	10.24±1.84	7.46	12.88	5.40-14.60
Myristoleic acid (C14:1)	1.33±0.27	0.97	1.88	0.50-1.85
LCFA				
Palmitic acid (C16:0)	36.5±2.00	33.40	41.60	22-41
Palmitoleic acid (C16:1)	2.09±0.40	1.49	2.75	0.70-6.00
Stearic acid (C18:0)	9.33±1.14	7.60	12.09	6-15
Oleic acid (C18:1)	25.61±2.43	19.46	29.39	18.26-38.20
Linoleic acid (C18:2)	4.69±3.59	1.20	10.09	0.68-5.50
Linolenic acid (C18:3)	0.88±0.26	0.52	1.25	0.90-1.20
VLCFA				
Eicosanoic acid (C20:1)	0.67±0.17	0.46	0.93	0.05-1.00

saponification value (SV), iodine value (IV) are the main tests used for evaluation of butter chemical quality.

Presence of USFAs in fats and oils has the main role in autoxidation (oxidative rancidity). High degree of unsaturation increase susceptibility to autoxidation. The PV is the best test for determination of autoxidation [18]. A good measure for chain length evaluation of all present FAs in fats and oils such as butter is SV [19]. The amount of unsaturation in FAs is determined by measurement of IV [19]. Therefore, these values were measured as an indicator of fat oxidation, presence of long-chain fatty acids and unsaturated fatty acids content, respectively [18-20]. Iran national standard limits for moisture, PV, SV and IV in butter samples are up to 16%, up to 1.7 mEq/kg, 225-235 mg/g and 26-40%, respectively [17-20]. In this study, all samples had high moisture content that is justified in this traditional butter due to their producing method, not complete removing of fat and water substitution in butter composition as fat replacer [15,23]. Ghasemloy Incheh et al., (2017) indicated high moisture in 100% of butter samples, being quite similar to the data of present study [15]. High content of moisture predispose butter samples to spoilage due to stimulating the growth of microorganisms, lipase activity and hydrolysis of the triglycerides [24]. PV, SV and also IV were not within standard range in some samples. Any change in the USFAs profile will cause alteration in these indexes [15]. As shown in Table 1, High PV gives a measure of the extent to which some butter samples in this study has undergone primary oxidation. SV has been lower and higher than standard range in some samples. The SCFAs have high SV due to their relatively high numbers of carboxylic functional groups per unit mass of the fat [25]. Therefore low or high SV shows higher or lower content of LCFAs in butter samples and vice versa, respectively which IV content confirms it.

FA profile of butter samples showed in Table 2. Fourteen FAs are evaluated in this study. As shown in Table 2, butyric acid, caproic acid, caprylic acid and capric acid are the main short chain to medium fatty acids. It is demonstrated that presence of short and some of medium chain fatty acids particularly, butyric acid (C4:0) can influence on some characteristics of butter including: body resorption and turning speed to energy, melting point, *In-vitro* and *In-vivo* antimicrobial and antiviral activities and inhibition of human cancer cell lines [3,26,27].

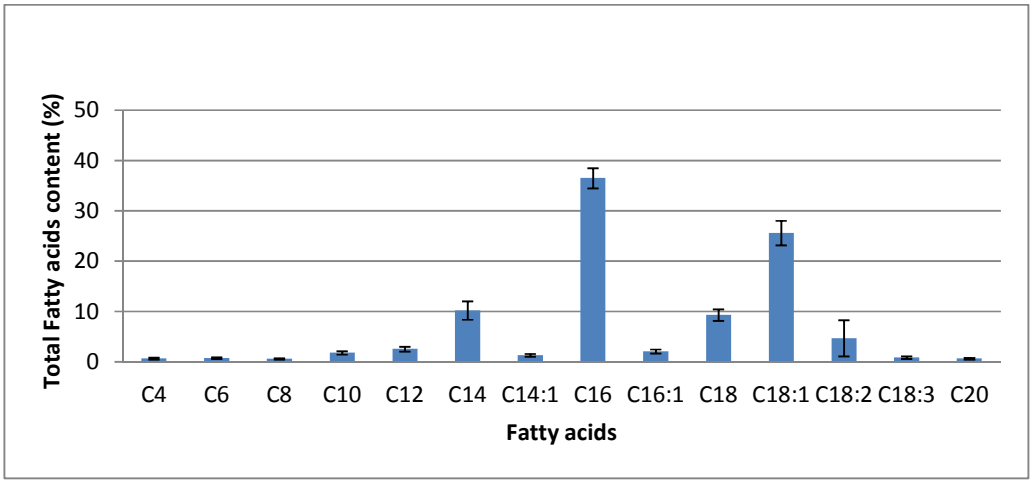

Fig. 1. Fatty acids content of traditional butter samples from Zanjan (Means with SD error bars)

The SFAs were the most dominant in the butter samples and their content varied from 0.63%-41.6%. While USFAs ranged from 0.46 to 29.39%. Most predominant FAs were palmitic acid (36.5%), myristic acid (10.24%) and stearic acid (9.33%) (Fig. 1). This result is consistent with Ozcan et al. (2016) showed that these FAs were 32.65%, 11.48% and 11.38%, respectively in Trabzon Butter [3]. Several researchers stated the predominance of these SFAs particularly palmitic acid in butter samples and being quite consistent to the present data [15,23,28].

Oleic acid was the main USFA in butter samples of this study followed by linoleic and linolenic acids, respectively (Table 2). Obtained result is in agreement with those reported by Ghasemloy Incheh et al., Ozcan et al., Idoui et al. and Rady and Badr [3,15,24,29]. Presence of long chain USFAs especially oleic acid and linoleic acid in dairy products including butter are essential in human nutrition because of their effects on health promoting and functional properties [3]. Oleic acid is recognized as a source of energy, one of the precursors of other LCFAs used in brain tissue structure especially in myelin, and their beneficial in reducing levels of bad cholesterol (LDL) in blood [3]. Presence of specific FAs differentiated animal butter of plant oils. Linolenic acid content as a poly USFA in butter fat is very low (0.9-1.2%0), therefore detection of higher amount of linolenic acid in dairy products can be a sign of adulteration with plant oils [30].

USFA in butter samples increases likelihood of rancidity, especially when oxidants (metal ions, oxygen and light) are present and the hygiene of production, maintenance and supply of butter are not considered particularly in traditionally produced butter samples [15,16]. Synthetic or natural antioxidants are used to prevent rancidity in oily food and butter samples industrially [31,32]. Hence in comparison with locally produced butter samples, all above mentioned tests maybe were within standard range in industrially produced butter samples.

4. CONCLUSION

Considering to growing demand for traditional dairy products due to being nutritious and providing other benefits for human health, continuous monitoring of their quality is necessary. In present study, investigation of chemical quality and FAs profile showed that moisture of all butter samples and PV, SV and IV in some butter samples were not within standard range. Presence of USFAs in butter predisposed the samples to oxidative rancidity. Many factors can influence chemical composition of butter samples that can be listed as traditional production methods, environmental conditions and all parameters that affect the composition of milk such as animal species, stage of lactation and geographical location. Therefore, chemical quality of butter samples can be protected by control of hygienic conditions in production process and keeping the cold chain until the consumption.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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