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Research Article

Effects of Extra Virgin Olive and Riviera Olive Oil Addition on the Properties of Butter: an Optimization Study Based on D-Optimal Mixture Design

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Abstract

Increased consumption of butter is associated with high blood pressure and serum cholesterol level for humans. Therefore, we aimed to form a functional butter by blending it with vegetable oils. In this study, butter was mixed with both extra virgin olive oil (EVOO) and riviera olive oil at different concentrations (20%, 30%, 35% and 40%). D-optimal mixture design, having two mixtures (EVOO and butter, riviera and butter) was used to see the effects and to have the optimum mixing level. Physicochemical analysis (moisture, fat content, color and viscosity), sensory analysis were conducted. In addition, major fatty acid compositions of the samples were characterized. Also, the effect of oil concentration on the texture of butter was evaluated. It was observed that viscosity of butter was decreased 104.2 mPa.s to 28.75 mPa.s by blending with vegetable oil. Addition of riviera olive oil increased L^* values, but decreased a^* and b^* values. Vegetable oil additions led to significant reduction in total saturated fatty acid levels and a significant increase in the levels of total unsaturated fatty acid ($p<0.05$). In sensory evaluations, the samples blended with 20% extra virgin olive oil and riviera olive oil received the highest rating. The results show that addition of vegetable oil improved the spreadability of butter and may be used as a functional fat.

Keywords: Butter, Extra virgin olive oil, Riviera olive oil, Health, Spreadability

Ekstra Sızma Zeytinyağı ve Riviera Zeytinyağı İlavesinin Tereyağının Özellikleri Üzerine Etkileri: D-Optimal Dizayna Dayalı Optimizasyon Çalışması

Öz

İnsanların fazla tereyağı yağ tüketimi, yüksek kan basıncı ve serum kolesterol seviyesini etkilemektedir. Bu yüzden, bu çalışma ile tereyağı, bitkisel yağlar ile karıştırılarak fonksiyonel bir yağ elde edilmesi amaçlanmıştır. Çalışmada tereyağı, ekstra sızma zeytinyağı ve Riviera zeytin yağı ile belirli konsantrasyonlarda (20%, 30%, 35% and 40%) karıştırılmıştır. D- optimal dizayn kullanılarak iki karışımın (ekstra sızma zeytinyağı ve tereyağı, Riviera zeytin yağı ve tereyağı) optimum karıştırma seviyesi ve etkileri incenlenmiştir.

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Fizikokimyasal analizler (nem, yağ miktarı, renk, viskozite), duyusal analiz yapılmıştır. Buna ilave olarak, yağ asitleri kompozisyonları karakterize edilmiştir. Ayrıca eklenen bitkisel yağ miktarının tereyağının tekstürü üzerindeki etkisi değerlendirilmiştir. Bitkisel yağ ilavesi ile tereyağının viskozitesi 104.2 mPA.s'den 28.75 mPa.s'ye kadar düşmüştür. Riviera zeytinyağı eklenmesi, *L** değerini artırmış fakat *a** ve *b** değerlerini azaltmıştır. Bitkisel yağ eklenmesi toplam doymamış yağ asiti içeriğinde önemli derecede azalmaya ve toplam doymamış yağ asiti içeriğinde önemli derecede artmaya sebep olmuştur ($p<0.05$). Duyusal analiz sonuçlarına göre, %20 riviera ve %20 ekstra sızma zeytinyağı eklenmiş tereyağı örnekleri en yüksek beğeniyi almıştır. Sonuçlar, bitkisel yağ ilavesinin tereyağın sürülebilirliğini arttırdığını ve karışımın fonksiyonel bir yağ olarak kullanılabileceğini göstermektedir.

Anahtar Kelimeler: Tereyağı, ekstra sızma zeytinyağı, Riviera zeytinyağı, sağlık, sürülebilirlik

1. Introduction

Texture and hardness of the butter are related to the levels of saturated and unsaturated fatty acids. Unsaturated fatty acids form a less firm and more spreadable butter due to their lower melting point (Hurtaud et al., 2007). Epidemiological studies have revealed that consumption of olive oil, which is a major part of the Mediterranean diet, has very positive health effects. It may have health benefits which include reduction of risk factors of coronary heart disease, prevention of several types of cancers, and modification of immune and inflammatory responses. (Covas et al., 2015; Martín-Peláez et al., 2017). Previous studies show that monounsaturated fatty acid (MUFA) consumption is positively related to many risk factors linked to coronary heart disease. MUFAs reduces total plasma triacylglycerol and LDL cholesterol levels and increases HDL cholesterol levels (Bellido et al., 2004).
The health benefits of olive oil is mainly related to its oleic acid content, which represents 55% to 83% of total fatty acids (Covas et al., 2015). Extra virgin olive oil is also rich in various additional bioactive compounds such as squalene, tocopherols, and hydrophilic compounds such as polyphenols, which may show favorable effects on insulin sensitivity. The content of these compounds of olive oil differs being contingent on the cultivation, climate, time of harvest as well as the extraction process of production.

Growing consumer demand for health has become a driving force for the increased levels of manufacturing of modified butter and butter-based spreads. Blending butter with vegetable oils contributes to spreads that improve nutritional value, offers advantageous organoleptic attributes and decreases production costs (Rousseau & Marangoni, 1998).
Butter's cold, difficult to spread consistency is its disadvantage. Margarines can be easily spread after being removed from the refrigerator, but butter cannot be spread easily. The consistency of butter could be changed by blending vegetable oils. Several modifications were suggested to get softer and more spreadable butter (Litz et al., 2006; Mortensen, 2011). Spreadability of butter can be modified by changing the physical properties of butter, which is dependent on factors such as solid fat content, melting point (Buldo et al., 2013), changes in cooling rates (Ronholt et al., 2012) as well as storage conditions of the finished product (Krause et al., 2008). More softer and spreadable butter can be also obtained by modifying the milk fat composition by changing animal feeding (Bayourthe et al., 2000), adding unsaturated fatty acids (Mallia et al., 2008), blending milk fat and vegetable oil (Lai et al., 2000; Rodrigues & Gioielli, 2003) or fractionating milk fat (Fatouh et al., 2003).

The purpose of this study was to produce a butter with an increased nutritional value, a reduced firmness and an improved spreadability. For this aim, butter was blended with riviera olive oil and extra virgin olive oil at concentration levels of 25, 30, 35 and 40 %. The viscosity, color, fatty acid composition, sensory analysis and texture analysis results were compared with control butter sample.

2. Material and Method

2.1. Material

Both extra virgin and riviera olive oil were obtained from retailers in Kayseri, Turkey. Butter samples were produced at the food processing and development lab (pilot plant) of Erciyes University. Solvents and reagents were analytical grade and were purchased from Sigma Aldrich and Merck.

2.2. Method

Oil samples were mixed along concentrations shown in Table 1. Butter was mixed with the 20, 30, and 40% of extra virgin olive oil and Riviera olive oil.

Table 1. Parameters studied in mixture optimization of butter

Design Constraints

Low	Constraint	High
0.60	A:butter	0.80
0.20	B:riviera oilve oil	0.40
	A+B	1.00
0.60	A:butter	0.80
0.20	B:extra virgin olive oil	0.40
	A+B	1.00

2.2.1. Viscosity

The viscosity values of the samples were determined at 25 °C employing a strain/stress controlled rheometer (RheoStress 1; Thermo Scientific Haake, Karlsruhe, Germany) furnished with a temperature-control unit (Haake, Karlsruhe, Germany), and a cone-plate configuration with a cone radius of 35 mm and a gap of 1.00 mm between the cone and the plate. The measurement of viscosity was repeated 5 times.

2.2.2. Color measurements

The oil samples' color values were analyzed by employing an automatic colorimeter (Lovibond RT Series Reflectance Tintometer; Lovibond, Amesbury, UK). The Lovibond tintometer provides values for *L*, a*, b**. The *L** values measure the level of black to white (0-100), *a** shows the degree of red to green (+ = red and − = green), and *b** shows the degree of yellow to blue (+ = yellow and − = blue). The samples' color measurement was redone for 5 times.

2.2.3. Fatty acid (FA) composition

3 ml of hexane was used for the dissolving of 100 mg oil sample of each oil type. Then, 100 µl 2 N KOH was added for saponification. The mixture was shaken with a vortex for 1 min and then centrifuged at 6.000 rpm for 5 min. The fatty acids compositions were analyzed by gas chromatograph (6890 N, Agilent Technologies, Palo Alto, USA), equipped with a Supelco HP 88 capillary column (100 mm x 0.25 mm ID, 0.2 µm HP 88) and a flame ionization detector. The temperature was selected 250 °C for injection. The oven temperature was kept at 103 °C for 1 min and then programmed from 103 to 170 °C at 6.5°C/min, from 170 to 215 °C for 12 min at 2.75 °C /min and finally at 230 °C for 5 min. The carrier gas helium with a flow rate of 2 ml/min, the split rate was 1/50 (Capar and Yalcin, 2017).

FA was established by retention times in comparison to accepted standards. The FAs were shown as percent of total fatty acid weight (Yalcin et al., 2012). The analyses of each sample were done in duplicate.

2.2.4. Sensory analysis

Sensorial properties of the blended samples were tested by semi-trained panelists. The panelist used the hedonic sensory analysis form, which ranged from a scale of 1-9, where 1 represented the lowest acceptability while 9 represented the highest acceptability, respectively. Ten panelists who were used to do the ratings were trained for a total of 10 hours. Their training lasted for 5 weeks and consisted of two 1-hour session per week. Their training consisted of evaluating butter and the blended samples for perception of taste and flavor characteristics. Training sessions were conducted as a group by tasting and describing the tastes and flavors of butter and its blended samples. A panel leader working with the panelists created descriptors in order to define the butter and its blended samples being tested. Afterwards, each of the panelists were supplied with examples of each descriptor and was asked to evaluate the butter and its blended samples for those descriptors. Several characteristics of the samples such as texture, taste, flavor and odor, color and overall visual and flavor acceptance were evaluated by the panelists during the storage.

2.2.5. Textural analysis

Textural analysis of butter samples was performed for effects of blending concentration on the spreadability. The texture profile analysis (TPA) was determined with a Texture Analyzer TA-XT2i (Stable Microsystems, Surrey, England) equipped with TTC Spreadability Rig probe supplied with Texture Exponent Programs. 5mm/s test speed, 10mm/s post-test speed, 60% strain, 70mm probe return distance, 10mm/s return speed and 5g contact force were selected as test parameters. 5 replicates were carried out for texture analysis.

2.2.6. Experimental design and Statistical analysis

In the current study, Combined D-optimal mixture design (Design Expert Software 8.0.7.1, State-Ease Inc., Minneapolis, USA) approach has been employed to determine optimum levels of the two variables (butter-riviera olive oil, butter-EVOO) regarding six responses; viscosity, *L** value, *b** value, total saturated fatty acids, total unsaturated fatty acids and general acceptability. Experimental runs for the D-optimal mixture design were shown in Table 2. The statistical parameters used in evaluating and selecting

the best-fitted model are coefficient of determination (R^2), coefficient of variation (C.V.), standard deviation (SD) and lack of fit. The statistical analysis also constructs an equation from the best fitted model.

Table 2. Percentage composition of butter-riviera mixture

	Component 1	**Component 2**
Run	A:butter	B: riviera
1	0.700	0.300
2	0.700	0.300
3	0.800	0.200
4	0.600	0.400
5	0.800	0.200
6	0.700	0.300
7	0.600	0.400
8	0.650	0.350
9	0.800	0.200
10	0.600	0.400
11	0.800	0.200
12	0.700	0.300
13	0.600	0.400
	Component 1	**Component 2**
Run	A:butter	B: EVOO
1	0.600	0.400
2	0.700	0.300
3	0.700	0.300
4	0.600	0.400
5	0.800	0.200
6	0.800	0.200
7	0.650	0.350
8	0.800	0.200
9	0.600	0.400
10	0.600	0.400
11	0.700	0.300
12	0.650	0.350
13	0.800	0.200

3. Results and Discussion

In this study, butter was blended with riviera and extra virgin olive oil at different concentrations in order to see the effects on certain quality parameters. Control butter sample's properties were given in Table 3. Also, the values obtained for the tested samples were presented in Table 4.

Table 3. Control butter sample properties

Butter	**Properties**
Viscosity	104.2 mPa.s
*L** value	84.60
*b** value	20.86
Total saturated fatty acids	66.86 %
Total unsaturated fatty acids	33.14 %
General acceptability	5.65

Table 4. Change in the quality parameters of the butter-riviera olive oil samples

Butter %	***Riviera %***	***Viscosity (mPa.s)***	***L* values***	***b* values***	***Total saturated fatty acid (%)***	***Total unsaturated fatty acid (%)***	***General acceptability***
0.70	0.30	53.45	88.41	14.31	50.1	50.34	6.55
0.70	0.30	53.45	88.41	14.31	50.1	50.34	6.55
0.80	0.20	73.15	87.81	14.14	54.12	45.88	6.65
0.60	0.40	43.35	90.56	12.05	45.04	54.96	6.2
0.80	0.20	73.15	87.81	14.14	54.12	45.88	6.65
0.70	0.30	53.45	88.41	14.31	50.1	50.34	6.55
0.60	0.40	43.35	90.56	12.05	45.04	54.96	6.2
0.65	0.35	43.7	89.29	13.58	47.64	52.92	4.95
0.80	0.20	73.15	87.81	14.14	54.12	45.88	6.65
0.60	0.40	43.35	90.56	12.05	45.04	54.96	6.2
0.80	0.20	73.15	87.81	14.14	54.12	45.88	6.65
0.70	0.30	53.45	88.41	14.31	50.1	50.34	6.55
0.60	0.40	43.35	90.56	12.05	45.04	54.96	6.2
Butter %	***EVOO%***	***Viscosity (mPa.s)***	***L* values***	***b* values***	***Total saturated fatty acid (%)***	***Total unsaturated fatty acid (%)***	***General acceptability***
0.60	0.40	28.75	85.18	28.49	43.63	56.37	4.9
0.70	0.30	48.75	87.34	22.79	48.74	51.26	5.84
0.70	0.30	48.75	87.34	22.79	48.74	51.26	5.84
0.60	0.40	28.75	85.18	28.49	43.63	56.37	4.9
0.80	0.20	78.3	88.7	19.43	53.96	46.04	6.85
0.80	0.20	78.3	88.7	19.43	53.96	46.04	6.85
0.65	0.35	42.95	86.47	25.37	45.13	54.88	5.1
0.80	0.20	78.3	88.7	19.43	53.96	46.04	6.85
0.60	0.40	28.75	85.18	28.49	43.63	56.37	4.9
0.60	0.40	28.75	85.18	28.49	43.63	56.37	4.9
0.70	0.30	48.75	87.34	22.79	48.74	51.26	5.84
0.65	0.35	42.95	86.47	25.37	45.13	54.88	5.1
0.80	0.20	78.3	88.7	19.43	53.96	46.04	6.85

Addition of riviera and EVOO into butter decreased the viscosity of the samples. The viscosity of the control sample (butter) was found 104.2 mPa.s (Fig 1). However, addition of riviera decreased butter mix viscosity 73.15 and 43.7 mPa.s in 20% and 35% samples, respectively. EVOO addition also decreased butter mix viscosity 78.3 and 28.75 mPa.s in 20% and 40% samples, respectively (Fig 1).

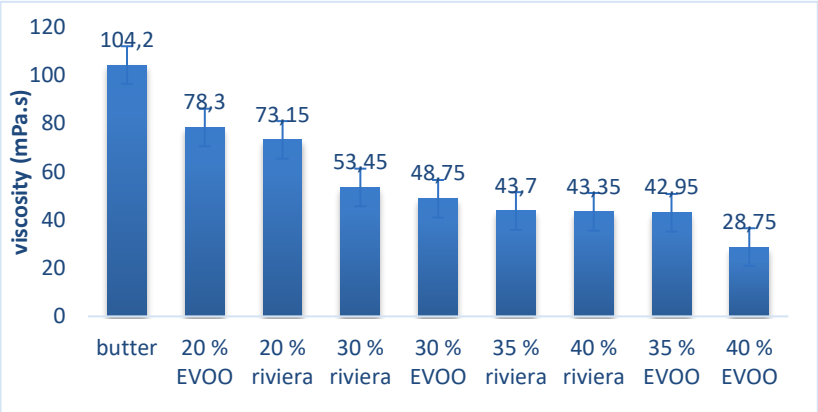

Figure 1. Viscosity of the samples

The highest viscosity was observed in control butter sample which can be due to the existence of high amounts of saturated fatty acid and relatively low amounts of unsaturated fatty acids. Addition of riviera and EVOO decreased the viscosity because of the high level

of unsaturated fatty acid compared to control butter sample. Statistical analysis showed that viscosity of the samples was significantly affected by riviera and EVOO concentrations (Table 5). The mean viscosity for all samples was calculated as 54.22 mPa.s.

Table 5. Significance of the regression models (F values) and the effects of variables on physicochemical properties of blended samples

	df	**Physicochemical properties**					
		Viscosity	*L** value	*b** value	Total saturated fatty acids	Total unsaturated fatty acids	General acceptability
Butter-riviera olive oil							
Linear mixture	1	509.83[a]	48.97[a]	271.01[a]	4491.83[a]	4491.83[a]	1662.08[a]
Lack of fit	1	2.28	0.06	0.46	0.34	0.34	
Pure error	9						0.015
Corr total	12	2251.60	13.14	11.80	176.19	176.19	3.85
Model	2	274.12[a]	30.21[a]	195.69[a]	2253.78[a]	2253.78[a]	628.39[a]
SD		2.01	0.43	0.17	0.20	0.20	0.039
Mean		54.22	88.72	13.39	49.39	50.61	6.23
C.V %		3.70	4.09	1.28	0.40	0.39	0.62
R^2		0.98	0.85	0.97	0.99	0.99	0.99
Butter-EVOO							
Linear mixture	1	5040.32 [a]	25.20 [a]	168.77 [a]	234.13 [a]	234.22 [a]	8.47 [a]
Lack of fit	1	32.67	0.25	1.72	0.92	0.94	0.063
Pure error	9						
Corr total	12	5105.66	25.70	172.21	235.97	236.09	8.60
Model	2	5040.32 [a]	25.20 [a]	168.77 [a]	234.13 [a]	234.22 [a]	8.47 [a]
SD		2.44	0.21	0.56	0.41	0.41	0.11
Mean		50.80	86.96	23.91	48.22	51.78	5.75
C.V %		4.80	0.24	2.34	0.85	0.80	1.87
R^2		0.9872	0.9808	0.9800	0.9922	0.9921	0.9852

[a] $P<0.01$

Table 6 displays the regression equations for the parameters under study. These would be useful in estimating the parameters for different concentrations of butter and riviera olive oil or EVOO. As can be seen, the regression coefficients for the tested parameters were very high and acceptable.

Table 6. Effect of each mixture component[a] and their interactions on studied parameters of oil samples predicted by model Equations

Parameters (Y)	**Predicted model equations[b]**	**R^2**
Butter-Riviera olive oil		
Viscosity	*Y = 161.99366 A + 298.69582B –724.22126 AB*	0.9803
L value*	*Y = 92.53315 A + 137.04823 B – 84.54885AB*	0.8460
b value*	*Y = 7.33134 A – 46.59582 B + 109.38793 AB*	0.9727
Total saturated fatty acids	*Y = 59.62366 A – 4.39918 B + 45.61207 AB*	0.9976
Total unsaturated fatty acids	*Y = 40.37634 A +104.39918 B –45.61207AB*	0.9976
General acceptability	*Y = -13.60250 A + 248.26 B –434.125 AB +389.58 AB (A-B)*	0.9947
Butter-EVOO		
Viscosity	*Y = 126.0642A – 118.5567 B*	0.9872
L value*	*Y = 92.2824 A + 74.9847 B*	0.9808
b value*	*Y = 10.134A + 54.8958 B*	0.9800
Total saturated fatty acids	*Y = 64.4407 A – 11.7184 B*	0.9922
Total unsaturated fatty acids	*Y = 35.5577 A +88.2901 B*	0.9921
General acceptability	*Y = 8.8337 A – 1.1956 B*	0.9852

[a] A, and B were the mixture components; butter and riviera olive oil or EVOO, respectively.
[b] Final equations were constructed in terms of real components and actual factors.

Oil color changes from light yellow to dark green or brown, due to the type and concentration of the color pigments. The natural yellow color of butter results from presence of carotenoids, vitamin A and other pigments. A uniform light, pale yellow color seems to most often meet the consumer preferences. *L** value of the samples range between 85.18 and 90.56. *L** value of the control sample was found as 84.60. The lowest *L** value was observed in the control sample whereas the highest value was observed in riviera olive oil blended at 40% concentration. *L** value of the sample was affected by mixture component significantly ($P<0.01$). The lighter yellow color of butter blended with riviera in comparison to the control group might be caused by the presence of higher levels of carotenoids in riviera. *b** value of the samples was found as 12.05 and 28.49 riviera and EVOO samples at the 40% concentrations, respectively. *b** value of the control sample was found as 20.86. Riviera addition caused a decrement in *b** value of the samples. As the concentration of riviera increased, *b** value decreased. EVOO addition caused an increment *L** and *b** values in the samples (Table 4). The regression model shows that *L** and *b** values can be used to predict the unknown *L** and *b** values given the high levels of the coefficient of determination (Table 6, $R^2 = 0.8460$ and $R^2=0.9727$, respectively). Besides the color changes, positive changes in the nutritional and sensory aspects have been observed in the product due to the addition of Riviera and EVOO to butter.
Studies in recent years have focused on increasing the level of unsaturated fatty acid in dairy and milk products (Marius Collomb et al., 2006; Jones et al., 2005) due to their beneficial health effects. Butter naturally contains 25-35% unsaturated fatty acids which changes due to feeding regimen, season, breed and period of lactation (M. Collomb et al., 2004). According to our results, unsaturated fatty acids level of the control sample was found as 33.14% which is in good agreement with literature. Increasing the riviera or EVOO addition to butter, increases the total unsaturated fatty acid concentration in blended samples. Total unsaturated fatty acid level in EVOO blended samples were higher than riviera at all concentrations. Major fatty acids of control butter sample were found as palmitic (33.39%), oleic (30.94%), stearic (12.73%) and myristic (11.50%). These results shows similarity with previous literature (Seçkin et al., 2005).

Sensory analysis become a necessity in food industry due to the fact that today's consumers are more aware and expect products not only safe and nutritious but also with a high organoleptic quality to satisfy their senses. Sensory analysis results showed that general acceptability was in the range between 4.9 and 6.85. General acceptability of the samples decreases as the EVOO or riviera concentration increases except 40% riviera blended sample. The highest score was found in the 20% EVOO blended samples whereas lowest was observed in the 40% EVOO blended samples. General acceptability of control sample was found as 5.65. Addition of EVOO or riviera at the concentration of 20%, increased the general acceptability of the samples.

The texture is important for the spreadability of butter. Blending butter with EVOO and riviera increased the spreadability of the butter (Figure 2). Results showed that the mixing level of the vegetable oil changed the spreadability rating as a textural property. As the concentration of the riviera and EVOO increased the firmness of butter samples decreased. The firmness value of the samples varied between 7662.88 g and 764.15 g. The highest firmness value was obtained in control butter sample and lowest value was obtained in 40% riviera blended sample.

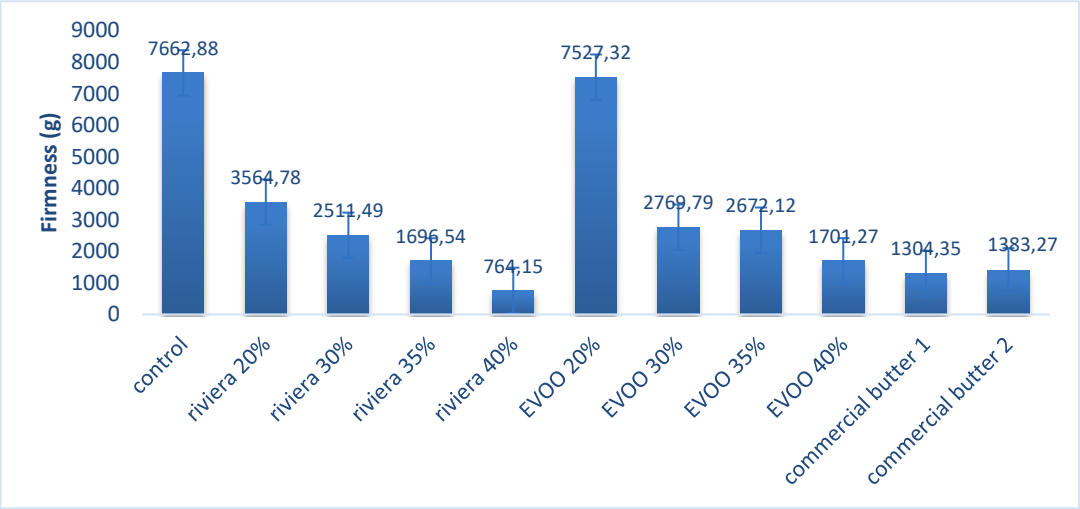

Figure 2. Firmness of butter and vegetable oil blended butter samples

3.1. Optimization of parameters

Table 7 presents the multiple response optimization results. Maximization and minimization of the processed variables are also given. Maximization was performed to determine the maximum butter concentration in the mixture without any quality disorder. Similarly, minimization was performed to determine the ideal blending ratio of the oils for the consumers.

Table 7. Multiple response optimization procedures applied to find optimum values of the parameters of

Parameters	**Multiple response optimization**							
	Minimization				Maximization			
	Minimum levels	Butter (%)	Riviera oil (%)	Desirability	Maximum levels	Butter (%)	Riviera oil (%)	Desirability
butter- riviera olive oil mixture		64	36	0.565		72	28	0.495
Viscosity (mPa.s)	44.31				54.25			
L value*	89.09				87.95			
b value*	13.11				14.28			
Total saturated fatty acids	47.06				50.89			
Total unsaturated fatty acids	52.94				49.11			
General acceptability	5.78				6.76			

Parameters	**Multiple response optimization**							
	Minimization				Maximization			
	Minimum levels	Butter (%)	EVOO (%)	Desirability	Maximum levels	Butter (%)	EVOO (%)	Desirability
Viscosity(mPa.s)	53.26	67	33	0.522	58.14	72	28	0.516
L value*	86.65				87.75			
b value*	24.71				22.56			
Total saturated fatty acids	47.27				49.80			
Total unsaturated fatty acids	52.73				50.20			
General acceptability	5.57				6.05			

The minimization process for riviera blended samples showed that minimum viscosity (44.31 mPa.s), *L** value (89.09), *b** value (13.11), total saturated fatty acids (47.06%), total unsaturated fatty acids (52.94%) and general acceptability (5.77) values would be

obtained by adding butter and riviera at the concentration of 64% and 36%, respectively. The desirability of these parameters was found as 0.565. With regard to the maximum values of the parameters under study, blending butter with riviera at the levels of 72% and 28 % resulted in viscosity, *L** value, *b** value, total saturated fatty acids, total unsaturated fatty acids and general acceptability to be 54.25 mPa.s, 87.95, 14.28, 50.89%, 49.11% and 6.76, respectively. The desirability function was determined to be 0.495 for these parameters. Optimization results indicate that butter blended with 20% riviera would have viscosity, *L** value, *b** value, total saturated fatty acids, total unsaturated fatty acids and general acceptability to be 73.45 mPa.s, 87.91, 14.05, 54.12%, 45.88% and 6.71, respectively. For providing better spreadability of butter, it should be blended with riviera to decrease its viscosity. Blending with riviera would cause a lower viscosity, higher total unsaturated fatty acids and general acceptability at the concentration of 63% butter blended with 37% of riviera. This mixture desirability would be 0.726.

Minimization process for the EVOO blended samples showed that minimum viscosity 53.26 mPa.s, *L** value 86.65, *b** value 24.71, total saturated fatty acids 47.27%, total unsaturated fatty acids 52.73% and general acceptability 5.57 values were obtained for the sample prepared with the addition of butter and EVOO at the concentration of 67% and 33 %. The desirability for these parameters was found as 0.522. According to maximization process results, the viscosity, *L** value, *b** value, total unsaturated fatty acids, total unsaturated fatty acids and general acceptability were found as 58.14 mPa.s, 87.75, 22.56, 49.80%, 50.20% and 6.05, respectively. The desirability function was found as 0.516 for these parameters. Optimization results for EVOO showed that butter blended with 20% EVOO would have viscosity, *L** value, *b** value, total saturated fatty acids, total unsaturated fatty acids and general acceptability to be 77.14 mPa.s, 88.70, 19.09, 53.89%, 46.10% and 6.83, respectively. For providing better spreadability of butter, it should be blended with EVOO to decrease the viscosity. Blending with EVOO would cause a lower viscosity, 65% of butter could be blended with 35% of EVOO. The desirability of this mixture would be 0.586.

4. Conclusions and Recommendations

Due to their beneficial health effects, consumers have increasingly come to prefer dairy products enhanced with unsaturated fatty acids. Butter is rich in saturated fatty acid whereas EVOO and riviera olive oil rich in unsaturated fatty acids. Blending butter with vegetable oils decreases the saturated fatty acid level, which in turn reduces many associated risk factors related to coronary heart disease. Furthermore, blending butter with vegetable oils decreases firmness that is important for the spreadability of butter. The addition of EVOO and riviera to butter positively affects the physicochemical characteristic of butter. Results have shown that 30 % riviera blended butter samples presented more intense yellow color, high level of unsaturated fatty acids, higher general acceptability and lower firmness compared to control sample. The results of this study shed light on obtaining an optimal butter mix that has better spreadability and higher nutritional value and less harmful health effects.

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