

Characteristics of Cookies Supplemented with Oleaster (*Elaeagnus angustifolia* L.) Flour. I Physicochemical, Sensorial and Textural Properties

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Received: November 6, 2012 Accepted: November 20, 2012 Online Published: January 15, 2013

doi:10.5539/jas.v5n2p160

URL: <http://dx.doi.org/10.5539/jas.v5n2p160>

Abstract

Oleaster flours (OFs) were produced from two different genotypes (G1 and G2) by two different methods (oleaster mesocarp flour: OMF and oleaster mesocarp flour with pericarp: OMFP). In this study, OFs were used to replace wheat flour in the cookie formulation (control) at the levels of 5,10,15,20 and 25% (w/w). OFs supplementation increased total dietary fiber (TDF) contents and decreased caloric contents of cookies compared to the control. Spread ratio (SR) values of cookies with OFs increased. Cookies with OFs were found to be larger in diameter than control cookies. Increasing of OMF and OMFP levels in the cookies led to darker appearance of the cookies than the control. In general, hardness tends to increase as the level of OMFs and OMFPs increased in the cookies. According to sensory analysis, overall acceptance of cookies were found the best at control sample. However, panelists liked all cookies with OFs moderately or slightly. Especially, the usage of 5% for OMFs and OMFPs in cookie formulation gave satisfactory results in terms of acceptability. The present study demonstrated that considerable nutritive and functional improvement could be attained by the addition of OFs to cookie formulation.

Keywords: oleaster, oleaster flour, cookie

1. Introduction

Oleaster (*Elaeagnus angustifolia*, Russian olive) belongs to *Elaeagnus* L. genus and *Elaeagnaceae* family. *Elaeagnus angustifolia* L. is a shrub or tree with a height of up to 7 m and a capacity to grow under a wide range of environmental conditions (Klich, 2000). This species shows a broad geographical range, occurring widely in Asia and Europe, particularly in Turkey, Caucasia and Central Asia (Aksoy & Sahin, 1999). It is widely cultivated for its edible fruits in Middle and East Anatolia. The fruits are reddish-brown, elliptic, 9-12 mm long and 6-10 mm wide and they mature in September. It is consumed either freshly or in dried form. The fruits are used as diuretic, tonic, antipyretic, antidiarrheal and as a medication against kidney disorders (inflammatory or to pass kidney stone) in traditional Turkish medicine (Ayaz & Bertoft, 2001; Gurbuz et al., 2003), against dysentery and diarrhea in Kingdom of Jordan (Lev & Amar, 2002) and for its anti-inflammatory, antinociceptive and analgesic effects in Iranian folk medicine. Decoction and infusion of its fruits is considered to be a good remedy for fever, jaundice, asthma, tetanus and rheumatoid arthritis (Ahmadiani et al., 2000).

Oleaster flour may be obtained from dried fruits and used as a functional ingredient in the production of bakery products, yoghurt, ice cream, infant food, chocolate, confectionery etc. due to its floury structure, specific taste and functional properties like dietary fibre, mineral content and phenolic compounds etc. Because of the increasing demand for healthy, functional products have been used to improve functionality of foods by

modifying their nutritive composition. However, the use of oleaster flour as a functional ingredient in cookies have not been investigated. Hence, the aim of this study was to evaluate the physicochemical, sensorial and textural properties of cookies supplemented with various levels and compositions of oleaster flour.

2. Material and Methods

2.1 Materials

Two different genotypes were used as oleaster fruit samples. These genotypes were supplied from 2 different regions GO1 (40°11'19.60"N - 26°06'09.16"E) and GO2 (39°34'01.48"N - 26°51'02.90"E) of Turkey. The fruits had approximately same maturity (almost reddish) with uniform shape and size and healthy. Mature fruits were harvested and randomly collected. Harvested fruits were dried at 50°C for 20 hours in a hot air oven dryer.

2.2 Preparation of Oleaster Flour (OF)

Oleaster flours were produced by two different methods. In the first method; the fruit pericarp and seeds of dry samples were removed using a plastic knife, and then the mesocarp was ground in a coffee grinder and sieved through a standard sieve (mesh size 60). The flour samples were stored in an air tight container at 4°C until experiment. This product is called "oleaster mesocarp flour" (OMF). In the second method; only seeds of dry samples were removed using a plastic knife, and then the mesocarp and pericarp were ground together in a coffee grinder and sieved through a standard sieve (mesh size 60). Samples were stored in an air tight container at 4°C until experiment. This product is called "oleaster mesocarp flour with pericarp" (OMFP). Sample codes are shown in Table 1.

Table 1. Sample codes

Codes	Sample
G1-OMF	Genotype 1, oleaster mesocarp flour
G1-OMFP	Genotype 1, oleaster mesocarp flour with pericarp
G2-OMF	Genotype 2, oleaster mesocarp flour
G2-OMFP	Genotype 2, oleaster mesocarp flour with pericarp

2.3 Analytical Methods

Moisture, ash, protein and wet gluten contents were determined according to AACCI Approved Methods 44-15.02, 08-01.01, 46-12.01 and 38-10.01, respectively (AACCI, 1999). Oleaster flours (OFs) were analyzed for moisture (Metod No: 925.40), protein (Metod No:950.48) and ash (Metod No: 950.49) (AOAC, 1990). Dietary fiber contents of flours and cookies were also determined according to AACCI Approved Methods 32-05.01 (AACCI, 1999). Fat contents of cookies were also carried out according to AOAC Metod No: 948.22 (AOAC, 1990). The tests were performed at least in triplicate and mean values are reported.

2.4 Production of Cookies

Cookies were prepared using the American Association of Cereal Chemists International (AACCI) method 10-54.01 (AACCI, 1999). The dough was formulated in Table 2. All purpose of shortening added into mixing bowl then added dry ingredients on top of shortening. These ingredients mixed for 3 min stir speed (Electrolux Ditomix 5, EU), scraping every minute. High-fructose corn syrup, appropriate amount of water, ammonium bicarbonate, sodium bicarbonate added into 100 ml beaker and swirl to dissolve. Liquid to creamed mass added and mixed 1 min, scraping every 15 sec. Finally calculated amount of flour added and mixed 10 sec while tapping side of bowl, scraped dough from mixer and bowl pins; scrape outer edge and bottom of bowl. Dough was divided into two relatively equal portions and made into oblong shape having approximately 5 cm length. Both portions placed on ungreased baking sheet. Dough was cut with cookie cutter, discarded excess dough, and remove cutter. Oleaster flours (OMFs and OMFPs) were used to replace wheat flour in the formulation at the levels of 5, 10, 15, 20 and 25% (w/w) (Table 2). Control sample including no oleaster flour was also prepared. Baking was performed in a convection oven (Inoksan FKE 006, TR) at 175 °C for 10 min. The baked cookies were left to cool for 30 min and then they were wrapped in aluminum foil and stored for 24 h at room temperature prior to analyses. The baked cookies were left to be cool, wrapped and allowed to stand at room temperature prior to analyses. Each batch yielded 4 cookies.

Table 2. Formulation of cookies

Ingredients ¹	Proportion (g)
Wheat Flour ²	100
Sucrose	32
Brownulated granulated sucrose	10
Nonfat dry milk	1.0
Salt	1.25
Sodium bicarbonate	1.0
All-purpose shortening (fat)	40
High-fructose corn syrup	1.5
Ammonium bicarbonate	0.5
Deionized water	Variable

¹ Ingredients at 21±1°C, ² 13% moisture basis.

2.5 Physical Evaluation of Cookie

The physical parameters of the cookies were evaluated in terms of diameter (D), thickness (T), and spread ratio (D/T) values. After cooling of the cookies for 30 min, diameter and thickness measurements were taken using a caliper. Spread ratio was calculated from the ratio of diameter and thickness.

2.6 Colour Analysis

The colours of the cookies were measured with a Minolta Spectrophotometer CM-3600d (Osaka, Japan). The Colourimeter was calibrated using a standard white plate. The dimension L^* means lightness, with 100 for white, 0 for black; a^* indicates redness when high positive and greenness when high negative, b^* indicates yellowness when high positive and blueness when negative.

2.7 Texture Analysis

A texture analyzer (TA-XT PLUS, Stable Microsystems, UK), equipped with a 50 kg load cell was used for cookie texture evaluation 24 h after baking. The fracture force test was conducted on the cookies using a 'measure force in compression' test with 3-point bending jig and heavy duty platform (HDP/90). The hardness of the cookies was indicated by the maximum peak force required to break the cookies. The texture analyzer was set to 'return to start' cycle, a pretest speed of 1.0 mm s⁻¹, test speed of 3.0 mm s⁻¹, post-test speed of 10 mm s⁻¹, and a distance of 5.0 mm and data acquisition rate, 500 pps. The trigger type for cookies was set at 50 g. A force/penetration plot was made for every test. Measurements were conducted three times and results are expressed as mean±S.D values.

2.8 Sensory Analysis

The sensory characteristics of cookies were screened by an untrained consumer panel with 20 panelists. The instructions were given in full to panelists beforehand. The samples were labeled randomly with 3-digit numbers and evaluated under incandescent light in terms of appearance, taste-flavor, mouthfeel and overall acceptability of the cookies. Samples were served to the panelists in random order to guard against any bias. Water at room temperature was used to clear the mouth before the each test sample. A 9-point hedonic scale with 9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like or dislike, 4-dislike slightly, 3-dislike moderately, 2-dislike very much, and 1-dislike extremely was used. Final judgment was obtained by averaging the scores given by all panelists.

2.9 Statistical Analysis

Data were analyzed for variance using the one-way analysis of variance (ANOVA) using the program SPSS 20. When significant differences were found ($P < 0.05$), the least significant difference (LSD) test was used to determine the differences among means. Paired t-test was carried out to compare the properties G1OMF-G2OMF, G1OMFP-G2OMFP.

3. Results

3.1 Chemical Compositions of Wheat Flour and Oleaster Flours

Chemical compositions of flour samples are presented in Table 3. The commercial soft wheat flour used in this study consisted of 13.99% moisture, 0.60% ash, 9.0% protein, 29% wet gluten and 1.69% total dietary fiber (TDF). The protein contents of the OF samples varied between 3.74 and 4.65%. The protein contents of OFs were significantly ($P<0.05$) lower than that of soft wheat flour. On the contrary, TDF contents of OFs were significantly ($P<0.05$) higher than that of the soft wheat flour. Thus, oleaster flour is a good source in TDF, it might be important from the nutrition point of view. The TDF contents of OMF samples were significantly ($P<0.05$) lower than those of OMFP samples. The higher TDF levels observed for OMFP samples are possibly related to pericarp contents.

Table 3. Chemical compositions of wheat flour and oleaster flours[†]

Sample	Moisture* (g/100 g)	Ash* (g/100 g)	Protein* (g/100 g)	Wet Gluten (g/100 g)	Total Dietary Fiber (g/100 g)
Wheat flour	13.99±0.95 ^b	0.60±0.07 ^c	9.00±0.25 ^a	29	1.69±0.07 ^c
G1-OMF	18.99 ±1.05 ^a	2.46±0.22 ^a	3.74±0.26 ^c	---	23.55±0.07 ^c
G1-OMFP	18.43±1.13 ^a	2.57±0.17 ^a	4.49±0.17 ^b	---	30.65±0.16 ^a
G2-OMF	19.78±1.11 ^a	1.87±0.15 ^b	4.51±0.24 ^b	---	20.67±0.21 ^d
G2-OMFP	20.20±0.96 ^a	1.87±0.21 ^b	4.65±0.19 ^b	---	25.44±0.44 ^b

*Means with different superscripts in columns indicate significant difference ($P<0.05$).

[†]Data are expressed as means ± standard deviations.

Table 4. Chemical compositions of cookies*

Sample code	OF Level (%)	Dry Matter (g/100 g)	Protein (g/100g)	Fat (g/100 g)	TDF (g/100g)	Calories (kcal)
Control	0	93.40±0.58a	5.74±0.04a	22.97±0.88a	2.76±0.02h	452.77
	5	93.06±0.08a	5.51±0.02a	21.20±0.04b	4.75± 0.42g	438.48
	10	91.69±0.83b	5.48±0.05a	21.42±0.05b	6.01± 0.42f	429.34
G1-OMF	15	91.39±0.43bc	5.36±0.02ab	21.57±0.02b	6.92± 0.34de	438.72
	20	90.55±0.27cd	5.05±0.07abc	21.62±0.06b	7.64± 0.11c	439.05
	25	90.58±0.30cd	4.63±0.67c	21.74±0.04b	8.42±0.37b	424.60
	5	91.85±0.28b	5.45±0.10a	21.39±0.02b	4.99± 0.30g	427.70
	10	91.57±0.03b	5.41±0.05ab	21.47±0.08b	6.29±0.39ef	411.67
G1-OMFP	15	90.54±0.65cd	5.39±0.01ab	21.62±0.04b	7.17± 0.36cd	412.18
	20	90.62±0.24cd	5.13±0.06abc	21.62±0.01b	8.41± 0.22b	402.55
	25	90.36±0.05d	4.69±0.85bc	21.72±0.06b	9.34± 0.13a	398.71
	5	90.93±1.20b	5.60±0.18ab	21.94±0.05bc	3.91± 0.01i	428.63
	10	89.39±0.74bc	5.01±0.15abcd	22.07±0.04bc	4.94± 0.10g	416.93
G2-OMF	15	88.88±0.20c	5.32±0.13bcde	22.19±0.06bc	5.89± 0.09e	418.53
	20	86.62±0.46d	5.25±0.21cde	22.21±0.06bc	6.84± 0.11c	411.93
	25	86.08±1.25d	5.22±0.14de	22.29±0.25bc	7.49± 0.05b	409.50
	5	91.08±0.45b	5.55±0.21abc	21.89±0.04c	4.07± 0.06	423.42
	10	88.95±1.20c	5.42±0.12bcde	22.02±0.05bc	5.18±0.08f	406.52
G2-OMFP	15	86.55±1.02d	5.30±0.13bcde	22.13±0.05bc	6.06± 0.04d	416.28
	20	86.01±0.5d	5.24±0.05de	22.37±0.06abc	6.98± 0.04c	399.30
	25	85.64±0.32d	5.14±0.06e	22.51±0.08ab	7.85± 0.10a	398.93

*Means with different superscripts in columns indicate significant difference ($P<0.05$). Data are expressed as means ± standard deviations.

3.2 Chemical Properties of Cookies

Table 4 shows the chemical composition of cookies made with OMFs and OMFPs. The protein and fat contents of the cookies containing OMFs and OMFPs showed change compared to the control. OF addition reduced protein and fat contents of cookies. However, replacement of wheat flour with oleaster flour increased dietary fiber contents of cookies compared to the control. Increasing OFs addition levels significantly ($P<0.05$) enhanced the TDF contents of cookies. Therefore, these cookies with OMFs and OMFPs can claim to be a source of dietary fiber. Cookies made with OMFs and OMFPs have lower energy values compared to control. Oleaster flour supplementantion led to a decrease in caloric content of cookies. The TDF and caloric contents in the cookies with OMFs and OMFPs showed a significant change, which is important for the nutritional effects of oleaster flour. Ajila et al. (2008) reported a increase in TDF of biscuits upon addition of mango peel powder. Seker et al. (2010) also reported that TDF content of the cookies supplemented with apricot kernel flour (AKF) increased significantly as the AKF concentration increased.

3.3 Physical Characteristics and Texture Properties of Cookies

The diameter and spread ratio of cookies supplemented with varying levels of OMF and OMFP are presented in Table 5. Spread ratio (diameter/thickness) is one of the most important properties in evaluating the quality of cookies. Greater spread ratios are desirable and indicate a better cookie quality (Seker et al., 2010). Spread ratio (SR) values of OFs supplemented cookies increased significantly ($P<0.05$) in both genotypes (G1, G2) and in both flour types (OMF, OMFP) at all levels. Control had the lowest SR (3.64) value while the 25% G1-OMF and G1-OMFP had the highest SR (6.23 and 6.20%, respectively) values. The SR value, ranging from 3.94 to 6.23, increased with the increase in the level of OF products. In our study, the substitution of wheat flour with oleaster flour (OF) led to a significant increase in spread ratio.

Table 5. Physical characteristics of cookies*

Sample code	OF Level (%)	Diameter (cm)	Spread Ratio	Hardness (Peak force) (g)
Control	0	5,70±0,15c	3,64±0,35c	39,06±3,41de
	5	6,60±0,02a	5,14±0,20b	40,47±1,36cde
	10	6,54±0,02ab	5,34±0,18b	42,06±9,51bcde
G1-OMF	15	6,53±0,02ab	5,60±0,28b	42,07±13,27 bcde
	20	6,32±0,07b	6,18±0,23a	45,57±11,58bcde
	25	6,33±0,02b	6,23±0,42a	55,30±11,24abc
G1-OMFP	5	6,64±0,16a	5,25±0,28b	39,51±7,02de
	10	6,52±0,12ab	5,48±0,16b	50,86± 10,25bcd
	15	6,30±0,01b	5,55±0,07b	55,72±12,65abc
G1-OMFP	20	6,33±0,07b	5,65±0,27ab	56,07±8,43ab
	25	6,34±0,02b	6,20±0,72a	66,98±8,33a
	5	5,96±0,03b	3,94±0,34c	41,18±14,58bcd
G2-OMF	10	6,01±0,07b	4,46±0,17c	43,95±7,73abc
	15	6,16±0,10a	4,78±0,54b	48,67±9,69bc
	20	6,17±0,03a	4,80±0,43b	50,22±3,52ab
G2-OMF	25	6,28±0,10a	5,53±0,10a	50,92±5,42a
	5	6,05±0,01b	4,26±0,01c	39,31±1,85bcd
	10	6,11±0,03b	4,56±0,02c	42,54±4,96abcd
G2-OMFP	15	6,27±0,06a	5,08±0,17b	45,42±3,87abc
	20	6,27±0,07a	5,15±0,29ab	47,71±2,74ab
	25	6,33±0,06a	5,77±0,07a	52,47±2,79a

*Means with different superscripts in columns indicate significant difference ($P<0.05$). Data are expressed as means ± standard deviations.

Diameter values of the cookies generally followed a similar trend with the SR values. Cookies with oleaster flours were found to be larger in diameter than control cookies. Control had the lowest diameter (5.70 cm) while the 5% G1-OMFP and 5% G1-OMF had the highest diameter (6.64 and 6.60 %, respectively). Cookie diameter was found to be significantly ($P<0.05$) affected by adding OF samples (Table 5). Cookies of enriched with OMFs and OMPFs showed higher diameter and spread ratio values than the control.

Table 5 shows the hardness of cookies made with different percentages of oleaster flours. Among the G1-OMF supplemented samples, only 25% supplementation significantly ($P<0.05$) increased the hardness values of the cookies. Other G1-OMF levels had no significant effect on the hardness values of cookies. Cookies made with all G1-OMFP levels except 5 and 10% had significantly ($P<0.05$) higher hardness as compared to control cookie. Cookies prepared from G2-OMF containing except 5% level had significantly ($P<0.05$) harder than control. The G2-OMFP levels except 5 and 10% had significant effect on the hardness values of cookies. In general, hardness tends to increase as the amount of OMFs and OMPFs increased in the cookies. Since oleaster flour (OF) contains dietary fiber, water absorption capacity of dough is high. For this reason, an extensive gluten structure occurs. As a result, doughs provide the harder cookies formation. Similar results were reported by Sudha et al. (2007). These researchers reported that a increase in diameter and in breaking strength of cookies upon addition of oat bran.

Table 6. Colour properties of cookies[†]

Sample code	OF Level (%)	Colour		
		L^*	a^*	b^*
Control	0	72.66±1.22a	4.86±1.13h	30.95±1.43ab
	5	64.95±0.87b	7.45±0.24g	29.69±0.10bc
	10	58.46±1.97c	10.58±0.71f	31.67±0.60a
G1-OMF	15	55.37±1.29d	11.42±0.78de	29.81±0.13bc
	20	49.96±1.99e	13.15±0.39ab	29.39±0.95c
	25	44.32±0.93f	13.80±0.39a	26.36±0.91e
G1-OMFP	5	60.02±1.42c	10.31±0.49f	31.02±0.63ab
	10	60.20±0.15c	9.80±0.13f	30.41±0.40abc
	15	52.98±1.93d	11.65±0.29cd	29.97±1.01bc
G2-OMF	20	48.83±1.90e	12.59±0.56bc	27.96±0.22d
	25	48.75±1.57e	13.26±0.33ab	29.15±1.23cd
	5	61.01±1.74b	8.75±0.86e	30.10±0.65a
G2-OMFP	10	41.79±1.70d	11.50±0.49bc	29.19±0.64b
	15	50.31±2.25d	11.97±0.70ab	28.89±1.12bc
	20	45.43±1.33f	12.10±0.50a	25.44±0.72d
G2-OMFP	25	40.08±0.50h	12.46±0.70a	22.86±0.35f
	5	59.68±2.34b	9.18±0.66e	30.56±0.60a
	10	55.20±2.26c	9.91±0.47d	28.13±0.62c
G2-OMFP	15	51.45±1.40d	11.35±0.32c	28.66±0.84bc
	20	47.42±2.96e	11.41±0.36bc	25.59±1.90d
	25	41.94±0.93g	12.48±0.36a	24.03±0.56e

[†] Means with different superscripts in columns indicate significant difference ($P<0.05$). Data are expressed as means ± standard deviations.

L^* : lightness of the sample, 100=white, 0=black; a^* : redness when the values are positive and greenness when the values are negative; b^* : yellowness when the values are positive and blueness when the values are negative.

3.4 Colour Characteristics

The colour of the cookies affects the consumers' perception and acceptability of the product. The Colour parameters L^* , a^* , b^* are shown in Table 6. The addition of OMFs and OMFPs had significant ($P < 0.05$) effects on L^* , a^* , and b^* values of cookies.

L^* value is a measure of the brightness of cookie surface colour. In general, increasing of OMF and OMFP level in the cookies led to significantly ($P < 0.05$) darker appearance of the cookies than the control as indicated by lower L^* values due to the possibility of Maillard reactions. Control cookie had the highest brightness compared to the OMFs and OMFPs enriched cookies.

The differences in redness (a^*) and yellowness (b^*) values were also statistically significant ($P < 0.05$). Increase in redness was observed as the OMF and OMFP level increased from 0% to 25%. Cookies with OMFs and OMFPs were redder than the control. The ' b^* ' value, which indicates the yellowness, significantly ($P < 0.05$) decreased with increase in OMF and OMFP level.

Similar changes in colour values were also observed by other investigators who supplemented wheat flour with sugar beet fiber (Koksel & Ozboy, 1999; Ozturk et al., 2008), flaxseed flour (Khouryeh & Aramouni, 2012), brewers' spent grain (Ozturk et al., 2002), wheat bran, rice bran, oat bran, and barley bran (Sudha et al., 2007). Due to the enzymatic browning, brightness (L^*) and yellowness (b^*) of the cookies may be decreased.

Table 7. Sensorial characteristics of cookies*

Sample code	OF Level (%)	Appearance	Taste/Flavor	Mouthfeel	Overall Acceptability
Control	0	7.21±1.62	7.42±2.17	7.00±1.63	7.48±1.51
	5	7.97±1.22	7.34±1.64	6.37±1.59	7.33±1.18
	10	7.29±1.95	6.26±1.88	5.97±1.96	6.61±1.73
G1-OMF	15	6.31±1.94	6.14±1.96	5.06±1.91	5.98±1.54
	20	5.86±2.34	5.69±2.00	4.89±1.81	5.82±1.85
	25	4.54±2.62	4.66±2.76	5.23±2.26	5.61±1.95
G1-OMFP	5	7.80±1.55	7.34±1.41	7.74±1.38	7.29±1.42
	10	7.86±1.40	6.43±1.91	5.63±1.73	6.99±1.81
	15	6.20±2.44	6.77±1.73	6.77±1.73	6.88±1.87
G2-OMF	20	6.71±2.57	6.14±2.29	6.60±2.26	6.76±2.00
	25	5.69±2.78	5.74±2.28	6.09±1.63	6.64±1.99
	5	7.21±1.62	6.68±1.53	6.05±1.68	7.23±1.59
G2-OMFP	10	7.84±1.68	6.58±2.06	6.68±1.92	6.75±1.67
	15	7.21±1.32	6.16±1.80	5.53±1.61	6.30±1.66
	20	6.79±1.47	5.53±1.74	4.68±1.67	5.97±1.83
G2-OMFP	25	6.26±2.02	3.74±1.91	5.53±1.61	5.88±1.85
	5	7.21±1.88	7.00±1.89	6.47±1.47	7.22±1.57
	10	7.42±1.57	7.21±1.89	5.84±2.70	6.81±1.92
G2-OMFP	15	7.74±1.66	6.58±2.06	6.58±1.71	6.72±2.11
	20	7.32±1.38	6.72±2.06	5.42±1.57	6.59±1.97
	25	6.68±1.38	5.31±2.20	5.95±1.81	6.48±1.81

*Means with different superscripts in columns indicate significant difference ($P < 0.05$). Data are expressed as means ± standard deviations. 9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like or dislike, 4-dislike slightly, 3-dislike moderately, 2-dislike very much, and 1-dislike extremely

3.5 Sensory Evaluation

Sensorial characteristics of cookies are presented in Table 7. Cookies with 5% G1-OMF received the highest appearance score in all samples containing OF. According to appearance scores, all cookies prepared with OFs, except 25% G1-OMF, were liked moderately and liked slightly by panelists. Oleaster flour addition increased the darkness. Above 20% supplementation of OMFs and OMFP in the cookie formulation had dark crumb colour. Increasing addition levels of OFs slightly decreased taste/flavor score. The highest taste/ flavor score also belongs to the cookie with 5% G1-OMF. According to sensory analysis, overall acceptance of cookies were found the best at control sample. All cookies prepared with OFs were liked moderately and like slightly by panelists. Cookies prepared with OMFs and OMFPs at 5% substitution levels produced cookies close to the control in overall acceptability, as evaluated by a panel of twenty judges. As a result, the usage of 5% OFs in cookie formulation gave satisfactory results in terms of acceptability.

4. Discussion

In accordance with the results oleaster flour (OF) supplementation to cookie formulation increased dietary fiber contents of cookies compared to the control. One serving of cookies (=30 g) provided 1.8 g to 2.8 g total dietary fiber including 10-25% OFs, which met the US FDA definition of a 'Good Source' of dietary fiber. The physical properties of the OFs enriched cookies were affected in a positive way by demonstrating a decrease in height, an increase in diameter, a higher spread ratio. Despite the significant differences determined between control and OFs added cookies, our results show that it is possible to use OFs to partially substitute for wheat flour in the production of cookies with acceptable physical characteristics. Increasing of OMF and OMFP levels in the cookies led to significantly darker appearance of the cookies than the control due to the possibility of Maillard reactions. According to sensory analysis, overall acceptance of cookies were found the best at control sample. However, panelists liked all cookies with OFs moderately or slightly. Considering the overall acceptance attributes, it can be say that 5% level of OMF and OMFP was suitable for cookie production. Thus, oleaster, growing almost everywhere naturally in Turkey, could be utilized for the preparation of cookies and other bakery products due to its floury structure, specific taste and functional properties like dietary fibre. The present study demonstrated that considerable nutritive and functional improvement could be attained by the addition of OFs. Further studies could investigate the antioxidant properties and total phenolics of the OFs cookies.

Acknowledgments

The authors would like to thank the The Scientific and Technological Research Council of Turkey (TUBITAK) for financially support this research project (Project No: TOVAG 110 O 060).

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