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Effects of the addition of rose hip on various nutritional and quality properties of ice cream

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In this study, the effects of rose hip (*Rosa* L.) on the physical, chemical and sensory characteristics, antioxidant activity and mineral contents of ice cream were investigated. Four different proportions (0, 5%, 10% and 15%) of rose hip were used in ice cream production. The sample containing 15% rose hip had the highest antioxidant activity (DPPH and total phenolic content, 28.71 mg sample mg^{-1} DPPH and 1555 mg GAE g^{-1} extract, respectively) and vitamin C (246.50 mg 100 g^{-1}) among all ice cream samples. The L^* and White Index values of the samples decreased significantly with the increment of rose hip concentration while the a^* and b^* values increased. The calcium, magnesium, sulfur, potassium, manganese, iron and zinc values increased with the addition of rose hip. Sensory results showed that the ice cream sample containing 15% rose hip had lower score than the control sample in terms of color, appearance, gumming structure, flavor and general acceptability.

Keywords: Antioxidant activity, Ice cream, Mineral composition, Rose hip, Vitamin C
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Ice cream is one of the most known and consumed frozen dairy desserts around the world[1]. Ice cream, a complex dairy product, consists of a mix of milk, fat, sweeteners, emulsifiers, stabilizers and other ingredients[2]. Ice cream contains nutritional and caloric compounds such as proteins, fats, carbohydrates, various minerals and vitamins. However, many bioactive compounds such as vitamin C, carotenoids, pigments and polyphenols are insufficient in dairy products[2].

In recent years, consumer demands have increased towards natural, healthy, nutritious and functional foods[3,4]. Food products containing fruits and vegetables are preferred by consumers who are health-conscious[4]. For this reason, different fruits are used in the recipes of ice cream. Fruits are rich in minerals, vitamins, fiber, natural antioxidants and various bioactive compounds. Therefore, the functional and nutritional properties of ice cream can be improved with the addition of fruits[5].

Rose hip (RH) is a widely consumed fruit both worldwide and in Turkey due to its nutritional and functional properties[3,6]. RH belongs to the *Rosa* genius. The *Rosa* genius consists of approximately 200 species and they are grown in different parts of the world including Europe, Africa, Asia and the Middle East. There are 25 species of *Rosa* in Turkey[3].

RH can be consumed in many different forms such as marmalade, tea, pulp, jam or fruit juice[4,7] on the other hand its consumption as fresh is extremely rare[7]. RH is known to be rich in vitamin C and also contains high concentrations of polyphenols, fatty acids, vitamins A and E, various minerals (Ca, K, Mg, S, Si, Se, Fe and Mn), natural antioxidants and other bioactive compounds[3,8,9]. RH has antioxidant, anti-inflammatory, cardioprotective, anticancer, antidiabetic, neuroprotective, immunomodulation and antimicrobial properties[3,6,7]. RH has therapeutic effects on many health problems such as kidney stones, obesity, liver disease, rheumatoid arthritis, osteoarthritis, cancer, depression and dermatological issues. Consequently, rose hip can be used as a good nutritive ingredient, natural antioxidant source and colorant in addition to improving many properties of ice cream[6,10].

Usage of RH in some foods such as probiotic drinks, soups and yoghurts has increased over the last decades[10]. This study aimed to create a new ice cream formulation improving nutritious and functional characteristics, to evaluate the possibility of using RH in ice cream as a nutritive ingredient and to determine the effects of the addition of RH on physicochemical and sensorial properties, mineral

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and vitamin C contents and antioxidant activity of ice cream samples.

Materials and Methods

Materials

The cows' milk and butter were obtained from the Şiran Dairy Products Factory in Gümüşhane, Turkey. The RHs were collected from the district of Şiran in Gümüşhane. The salep (stabilizer), sugar and emulsifier were obtained from local markets. The skim milk powder was purchased from Aynes Dairy Products Co. (Turkey).

Ice cream manufacturing

The ice cream was manufactured in a local patisserie in Şiran, Gümüşhane. The fat ratio of the ice cream mixture was set as 8% (w/w) using butter. The ice cream was divided into four portions with each portion weighing 2 kg. 16% (w/w) sugar, 3.75% (w/w) skim milk powder, 0.7% (w/w) salep (as stabilizer), and 0.2% (w/w) emulsifier (mono- and di-glycerides) were added to the mixture of each portion. The mixtures were pasteurized at 85°C for 25 s. The mixes were immediately cooled to 4°C and kept in refrigerator (4ºC) for 24 h to be matured. The RHs were washed with water, and their seeds were separated by hand. The fruits were then crushed using a blender. The dry matter, ash, pH and protein values of RH were determined as 37.33%, 2.12%, 3.76, 1.46% (fresh weight), respectively. The crushed fruits were added to the mixtures at three different concentrations (5%, 10% and 15%). The samples were coded as C (without RH), RH5 (containing 5%), RH10 (containing 10%) and RH15 (containin 15%). RH was added to mixes in the freezing stage to produce ice cream containing RH. Ice cream machine (Ugur Cooling Machineries Co., Nazilli Turkey) was used for freezing of the samples (-5°C). Samples were hardened in a deep freezer at -22°C for 24 h and stored at -18°C.

Methods

Physical and chemical analyses

The dry matter (%), ash (%), fat (%), protein (%), acidity (SH) and pH of the ice cream samples were determined as described by AOAC[11]. The gravimetric method was used to determine the dry matter (%) and ash (%) contents. The fat (%) contents of the samples were determined using the Gerber method and the Kjeldahl method was used to determine the protein contents of the samples. pH measurements were performed with a pH meter (Crison model Basic 20, Alella, Spain). The following equation was used to determine the overrun values of the samples[12].

$$Overrun\ (\%) = \frac{(\text{weight of mix}) - (\text{weight of ice cream})}{\text{weight of ice cream}} \times 100$$

The first dripping time was determined according to the method described by Güven & Karaca[13]. The ice cream samples were weighted as 25 g and kept on a mesh (2 mm) above a flask in an air-conditioned room (20°C) to melt. The dripping times were recorded as seconds. The melting rate of the samples was determined according to the method of Innocente *et al.*[14] and stated as g min^{-1}.

RQ Flex plus10 reflectometer (Merck, Darmstadt, Germany) was used for the determination of the vitamin C content of the ice cream samples. The vitamin C analysis was performed according to the protocol described on the prospectus. Test kits (1.16981.0001; Merck, Darmstadt, Germany) compatible with the reflectometer were used for measurements.

A digital Brookfield Viscometer, Model DV-II (Brookfield Engineering Laboratories, Stoughton, MA, USA) was used to determine the viscosity values of the ice cream samples. Before the analysis, the samples were stirred gently to remove any air bubbles[15]. The measurements to determine the rheological behavior of the ice cream samples were performed with spindle number 4 at different rpm (from 2.5 rpm to 100 rpm) at 4°C. The power law model was used in the calculation of rheological behavior. In the following equation, the apparent viscosity, the flow behavior index, the consistency coefficient and the shear rate were indicated with η (Pa s), *n*, *K* and γ (rpm), respectively[16].

$$\eta = K\gamma^{(n-1)}$$

Color measurements

The color parameters were measured with a CR-200 Minolta colorimeter (Minolta Camera Co., Osaka, Japan). The measured color parameters were L*-value (lightness), *a**-value (redness/greenness) and *b**-value (yellowness/blueness). The colorimeter was calibrated using the standard white plate. The hue angle (*H*) value was calculated using the equation defined by McLellan *et al.*[17]. The red, yellow, green, blue and red colors demonstrated 0°, 90°, 180°, 270° and 360° according to Hue angel values, respectively. The difference between two colors was explained with the ΔE. The saturation (C^*) and ΔE values were determined according to the method described by Cecchini *et al.*[18]. The differences of colors were determined as imperceptible ($\Delta E^*<1$), minimal ($1\leq\Delta E^*<2$), just perceptible ($2\leq\Delta E^*<3$), perceptible ($3\leq\Delta E^*<5$), strong difference ($5\leq\Delta E^*<12$) and different color ($\Delta E^*\geq 12$)[18]. The White Index (WI) was determined according to the method defined by Kurt and Atalar[19].

Mineral analysis

The mineral composition of the samples was determined at the Gümüşhane University Central Research and Application Centre for Central Research Laboratory. The method defined by Güler[20] was used in the mineral analyses. The wet burning method was used for the digestion of the ice cream samples. The mineral composition was detected using an Agilent 7700 inductively coupled plasma mass spectrometry (ICP-MS, Japan).

Antioxidant analysis

Extraction method

For the analysis of the samples, 25 g was weighted from each sample and diluted with ethanol (90%). The mixtures were shaken at 200 rpm for 6 h. Then, to filter the samples, Whatman 1 paper was used. For the measurements, the UV visible spectrophotometer (DU 730 Beckman Coulter Inc.) was used.

DPPH assay

1,1-diphenyl-2-picrylhydrazyl (DPPH) radical was used to determine the antioxidant activity of the samples. The extracted samples of different concentrations were added on the DPPH radical and the DPPH radical scavenging measured absorbance as 517 nm[21]. The IC_{50} value was calculated using the linear regression. Butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), trolox and α-tocopherol were used as the reference antioxidants in the DPPH test.

Total phenolic content

The total phenolic content (TPC) of the samples was detected with the Folin–Ciocalteu colorimetric method and gallic acid was used as standard in this analysis[22,23]. Briefly, 46 mL distilled water was added to 1 mL extract, to which 1 mL Folin–Ciocalteu reagent was added. This solution was stirred for 3 min and then 3 mL sodium carbonate (2% w/v) was transferred onto the solution. The solutions were kept in a dark place for 2 h and the measurements of the mixtures were carried out at 760 nm against blank (distilled water). The TPCs of the mixtures were calculated with standard curve obtained from different concentrations of gallic acid.

Sensory analysis

The sensory properties such as color, appearance, texture, gumming structure, flavor, resistance to melting and general acceptability tests were used for the evaluation of the samples and were performed[24] by 10 volunteer panelists. The panelists consisted of two males and eight females and their ages were between 20 and 40. They were all academic staff members that had received sensorial analysis education and had experience regarding the sensorial analysis of dairy products. The panelists evaluated the sensorial properties of the samples on a scale between 1 (poor) and 9 (excellent).

Statistical analysis

The statistical analysis of all data was carried out using the SPSS statistical software program version 17 (SPSS Inc., Chicago, IL, USA). Analysis of variance (ANOVA) and the Duncan's multiple range tests were used to determine the significant differences among the results of the present study.

Results and Discussion

Physical and chemical properties

The chemical (dry matter, ash, protein, titratable acidity, pH, fat, vitamin C) and physical (overrun, first dripping time, meltdown rations) data of the ice cream samples are presented in Table 1. The ash, titratable acidity, pH and fat values of the samples were significantly affected ($p<0.01$) by the addition of RH and but only dry matter values were not affected ($p>0.05$). The addition of RH had a significant effect on the melting rate ($p<0.01$) and overrun ($p<0.05$) values of the samples, while it did not have any significant effect on the first dripping times ($p>0.05$).

The dry matter content of the samples increased depending on the increment of fruit concentration. However, these changes were not statistically significant ($p>0.05$). The ash values of samples C and RH5 were lower than the other samples ($p<0.05$). The differences between the C and RH5 samples were not significant ($p>0.05$) and the ash values of samples RH10 and RH15 were statistically similar ($p>0.05$). Dervisoglu and Yazici[25] found that the dry matter values of the ice cream samples to which citrus fiber was added did not show a significant change, while

Table 1 — Effect of the addition of rose hip on the physicochemical characteristics of ice creams

Parameters	C	RH5	RH10	RH15
Dry matter (%)	28.99±0.00a	29.63±0.03a	29.25±1.36a	30.75±0.18a
Fat (%)	6.70±0.42c	5.30±0.42b	4.70±0.14ab	3.90±0.14a
Protein (%)	3.60±0.28a	3.49±0.10a	3.40±0.05a	3.19±0.15a
Ash (%)	0.62±0.01a	0.63±0.02a	0.76±0.02b	0.78±0.01b
Titratable acidity (°SH)	14.62±0.52a	21.40±0.27b	27.86±0.91c	31.65±0.79d
pH	6.33±0.01d	5.33±0.01c	4.91±0.03b	4.67±0.01a
Overrun (%)	33.04±1.10a	34.72±0.21a	36.68±0.33b	37.20±0.76b
First dripping time (s)	1620±84.85a	1530±42.43a	1830±127.28a	1740±254.56a
Melting rate (g min^{-1})	0.32±0.03c	0.27±0.01c	0.17±0.04b	0.10±0.01a
Vitamin C (mg 100 g^{-1})	<25a	71.00±1.41b	200.00±7.07c	246.50±0.71d

The significantly changes in same row were shown by different lower case letter. C: control without rose hip, RH5: 5% (w/w) rose hip added, RH10: 10% (w/w) rose hip added, RH15: 15% (w/w) rose hip added.

citrus fiber had significant effect on the ash values of the samples. Their results are in similar with the results of the present study.

The fat values of the ice cream samples are shown in Table 1. The fat value was found as the highest in the C sample (6.70%) and the lowest in the RH15 sample (3.90%). The fat values of all samples decreased with the increasing concentration of RH. These results are in agreement with those of Erkaya *et al.*[26] and Kavaz Yuksel[5] who reported that the fat values in the ice cream were the highest in the samples did not contain fruit. It could be concluded that the fat content of the fruit is not contributed fat content of the dairy products.

The protein values varied from 3.19% to 3.60% (Table 1). The protein values of the ice cream samples did not show any significant changes (p>0.05) with the addition of RH. The protein values found in the present study were lower than those reported by Kavaz Yuksel [5] for blackthorn added ice cream, and by Erkaya *et al.*[26] for cape gooseberry added ice cream. However, it should be noted that the protein values of the ice cream used in these studies decreased in all samples. Some researchers found similar results[2,5,26].

The titratable acidity values of the samples varied between 14.62% and 31.65% (Table 1). The RH15 sample had the highest acidity (31.65%) and the lowest pH value (4.67), while the control sample had the lowest acidity (14.62%) and the highest pH value (6.33). RH is known to have high contents of organic acids and phenolic acids[10]. The changes in the acidity and pH values may be a result of the organic acids found in the fruit. Similar results were reported by Erkaya *et al.*[26] and Kavaz Yuksel[5].

The overrun values of the samples varied between 33.04% and 37.20% (Table 1). The overrun values of the C and RH5 samples were statistically similar however these values were lower than the values of the other samples. El-Samahy *et al.*[27] determined that the overrun values of the ice cream samples to which cactus pear pulp was added varied between 43.11% and 55.11%. Erkaya Kotan[28] found that the overrun values of blueberry added ice cream changed from 20.33% to 25.61%. The present study found the overrun values to be higher than those reported by Erkaya Kotan[28] and lower than those reported by El-Samahy *et al.*[27]. The overrun value is inversely proportional to the mean ice crystal size. The increasing overrun causes a decrease in the mean ice crystal size[29]. High aeration may also have an effect on the ice crystal size due to the decrease in heat transfer rate[30].

The first dripping times of the samples used in the present study ranged from 1530 s to 1830 s. The first dripping time decreased in the sample containing 5% RH compared to the C sample and then increased. But these changes were not statistically significant (p>0.05). These results are in agreement with the data reported by Erkaya Kotan[28]. The melting rate of the samples varied from 0.10 g min^{-1} to 0.32 g min^{-1}. The rate decreased depending on the increase in RH level in all samples (Table 1). The melting rates of the C and RH5 samples, which were similar (p>0.05), had the highest rate. In contrast, the R15 sample had the lowest rate. Fruits are known to have high dietary fiber contents. The dietary fiber has positive effects on texture properties and high water holding capacity[5,25]. The lower melting rate values in the RH added samples may be resulted from the dietary fibers in the fruit.

Many factors such as overrun, emulsifying characteristics, and the concentration of proteins and lipids have an effect on the melting rate values of ice cream[2]. Sofjan and Hartel[30] found that lower melting rates with higher overrun. Muse and Hartel[31] reported that melting rate decreased as the fat destabilization level and the consistency coefficient increased while the ice crystal size has shrank. The results of the studies conducted by Sofjan and Hartel[30] and Muse and Hartel[31] were similar with the results of the present study.

Vitamin C content

Vitamin C, one of the most important bioactive compounds, that is necessary for iron absorption. For this reason, vitamin C is generally used as an ingredient to improve the quality of food[32]. Vitamin C is found in very low levels in milk. It has low stability and is more sensitive against oxidation compared to other vitamins. Vitamin C has antioxidant property which prevents oxidation[32,33]. Heat, metal ions and light have a negative effect on vitamin C stability as they can cause the acceleration of oxidation. Consequently, the vitamin C amount in dairy products is low in the final product due to technological processes such as pasteurization[32].

The vitamin C content of the samples was significantly affected by RH concentration ($p<0.01$). The vitamin C values increased in accordance with the increment of the RH ratio in the samples. The C sample (<25 mg 100 g^{-1}) had the lowest vitamin C content, while the RH15 sample (246.50 mg 100 g^{-1}) had the highest content (Table 1). These values were higher than those reported by Topdaş *et al.*[34] and Çakmakçı *et al.*[35]. RH is one of the richest fruits in terms of vitamin C. For this reason, RH is consumed widely by people as marmalade and herbal tea to protect against diseases such as infection, flu and the common cold[9,36]. The intake of vitamin C for male and female adults is recommeded as 90 mg/day and 75 mg/day, resectively[36].

Mineral contents

Minerals are one of the most important nutritional substances as they have many functions in human health such as physiological, structural, hormonal, enzymatic reactions and regulatory. Various minerals such as Na and Ca are especially important for bone structure. Minerals are divided into two groups as major and micro elements according to their amounts[37]. The major element values of the ice cream samples are presented in Table 2. The addition of RH significantly affected the Mg ($p<0.05$) and S ($p<0.05$) contents, while its effect on other major elements (Ca, Na, P and K) was not statistically significant ($p>0.05$).

K content was significantly lower in the C sample compared to the other samples ($p<0.05$). The Na, Mg, Ca, P and S contents changed with the addition of RH, however these changes were not statistically significant. The Ca and K contents of the RH15 sample were higher compared to the C sample ($p<0.05$). The Na and P contents showed irregular changes, however these changes were not significant ($p>0.05$). Mg content varied from 160.43 mg kg^{-1} to 314.47 mg kg^{-1}. The highest Mg content was determined in the RH15 sample. S content of the C sample (146.32 mg kg^{-1}) was the lowest among all ice cream samples. In the literature, different results were found depending on added fruits[26,28,38].

The micro element contents of the samples can be seen in Table 2. Mn and Zn contents of the samples were significantly affected ($p<0.01$) by the addition of RH, while Fe and Ni contents were not affected ($p>0.05$). The highest Mn, Fe and Zn contents were obtained in the RH15 sample. Fe contents of the samples varied between 6.15 mg kg^{-1} and 16.12 mg kg^{-1}. Ni contents of the samples showed changes with the addition of RH, however, no significant change was

Table 2 — Effect of the addition of rose hip on the mineral composition of ice cream samples

Minerals	C	RH5	RH10	RH15
Major elements (mg kg^{-1})				
Ca	1166.03±208.43a	1375.45±26.87ab	1204.80±15.48ab	1482.23±62.98b
Na	543.11±34.27a	527.21±10.63a	540.36±16.74a	494.89±8.87a
Mg	160.43±13.62a	267.61±1.96c	220.83±6.69b	314.47±3.55d
P	724.34±8.34a	768.76±8.21a	711.64±7.17a	710.73±86.69a
S	146.32±5.19a	161.96±2.12b	155.93±3.03b	164.90±2.23b
K	1309.13±82.26a	1706.34±55.64ab	1728.21±356.95ab	1838.99±25.57b
Micro elements (mg kg^{-1})				
Mn	0.85±0.25a	3.39±0.28b	2.06±0.13a	4.94±0.83c
Fe	6.15±0.29a	8.76±0.83ab	10.15±2.02ab	16.12±5.20b
Ni	0.31±0.28a	0.33±0.14a	0.52±0.19a	0.37±0.18a
Zn	12.00±3.89a	17.14±8.35a	17.61±2.50a	96.48±25.32b

The significantly changes in same row were shown by different lower case letter. C: control without rose hip, RH5: 5% (w/w) rose hip added, RH10: 10% (w/w) rose hip added, RH15: 15% (w/w) rose hip added.

observed ($p>0.05$) in the samples. Zn and Mn play vital roles in various functions of human body such as enzymatic activity, growth and other much vital metabolism. Zn is known to have antioxidant properties[37]. Anemia is known to be a common disorder around the world[39]. The iron deficiency anemia is a common but important type of anemia[37,39]. The inadequate intake and absorption of iron are the main causes of iron deficiency[39].

Kizil *et al.*[9] investigated the mineral contents of RH and found that the Ca, Mg, K, Fe and Zn levels in RH were 3351.0 mg kg^{-1}, 1435.0 mg kg^{-1}, 6258.3 mg kg^{-1}, 117.5 mg kg^{-1} and 16.5 mg kg^{-1}, respectively. The mineral contents of the ice cream samples may have been affected by the mineral content of RH.

Rheological properties

The viscosity is one of the most important indicators of texture and characteristics of ice cream[14]. The effect of RH on the apparent viscosity (20 and 50 rpm) values of the samples was not statistically significant ($p>0.05$). The viscosity values (20 and 50 rpm) of the ice cream samples exhibited irregular changes with the addition of RH, however, these changes were not statistically significant ($p>0.05$).

The consistency coefficient (*K*) of the samples ranged from 17.06 to 25.08 $Pa.s^n$ (Table 3). The consistency coefficient of the RH15 sample (25.08) was higher than the other samples ($p<0.05$). There were no significant changes ($p>0.05$) among other samples. The increase in the consistency coefficient may have been caused by the dietary fiber content of RH.

Fluids can be classified as follows: $n=1$ as Newtonian fluid, $0<n<1$ as pseudoplastic fluid and $n>1$ as dilatant fluid[16]. In the present study, the *n* (Flow behavior index) values were found to be between 0 and 1, thus all samples showed pseudoplastic behavior. Similar results were determined by Akalın *et al.*[40] and Erkaya Kotan[28]. Goff *et al.*[41] defined the flow behavior index of an ice cream mix at pasteurization temperatures as pseudoplastic behavior. Goff *et al.*[41] stated that stabilizers are expected to show pseudoplastic behavior as they affect the rheological and textural properties of ice creams.

Color properties of ice creams

The color of a product is one of the most important parameters of choice for consumers[38]. In this study, the L^*, a^*, b^*, H, C^* and ΔE^* values were affected significantly ($p<0.01$) by the addition of RH. The color properties (L^*, a^*, b^*, H, C^* and ΔE^* values) of the samples are presented in Table 4. The brightness of the samples decreased with the decrease in the RH concentration. The highest lightness value was observed in the C sample (85.09), while the lowest value was in the RH15 sample (61.28). These results correlate with those of Kavaz Yuksel[5] and Topdaş *et al.*[34]. The a^* and b^* values increased with the increment of the RH ratio. The C sample had the lowest a* (-5.44) and b* (14.29) values, while the RH15 sample had the highest values (12.69 and 25.93).

The intensity and saturation of a color are indicated with C*. Hue angles (*H)* are described as 0 and 360° for red, 90° for yellow, 180° for green and 270° for blue. The C* and H^o values were calculated using a^* and b^*[17]. In the H^o values of the ice cream samples, a significant decrease was observed ($p<0.05$) with the increment of the RH ratio, while the C^* and ΔE^* values increased. The C sample had the lowest C^* value and the highest H^o value, while the C^* value of the RH15 sample was found to be the highest (Table 4). The redness and color

Table 4 — Effect of the addition of rose hip on colour parameters of ice cream samples

Parameters	C	RH5	RH10	RH15
L^*	85.09±0.62c	73.49±2.31b	70.32±3.95b	61.28±0.08a
a^*	-5.44±0.12a	5.20±0.28b	10.86±0.59c	12.69±0.32d
b^*	14.29±0.55a	22.76±0.08b	23.54±0.46b	25.93±0.12c
H^o	110.83±0.31c	77.15±0.62b	65.23±1.62a	63.93±0.47a
C^*	15.29±0.56a	23.35±0.15b	25.92±0.16c	28.86±0.25d
ΔE*	-	17.91±0.71a	23.94±2.15b	32.11±0.87c
WI	78.64±0.83c	64.65±1.64b	60.54±2.86b	51.70±51.70a

The significantly changes in same row were shown by different lower case letter. WI: white index; C: control without rose hip, RH5: 5% (w/w) rose hip added, RH10: 10% (w/w) rose hip added, RH15: 15% (w/w) rose hip added.

Table 3 — Effect of the addition of rose hip on rheological properties of ice cream samples

Parameters	C	RH5	RH10	RH15
Viscosity 20 rpm	4130±326.68a	4362±16.26a	3866±711.35a	4263±74.95a
Viscosity 50 rpm	2633±260.22a	2849±26.87a	2549±266.58a	2856±205.06a
K (Consistency coefficient) ($Pa.s^n$)	17.66±1.74a	21.04±0.66a	20.09±0.37a	25.08±1.82b
n (Flow behaviour index)	0.50±0.00a	0.48±0.02a	0.46±0.04a	0.44±0.02a

The significantly changes in same row were shown by different lower case letter. C: control without rose hip, RH5: 5% (w/w) rose hip added, RH10: 10% (w/w) rose hip added, RH15: 15% (w/w) rose hip added.

saturation of the RH15 sample was higher than the other samples. This may have resulted from the red color of RH. The ΔE^* values of the RH added samples varied between 17.91 and 32.11. The RH5 sample had the lowest ΔE^* value (17.91), while the RH15 sample had the highest ΔE^* value (32.11). Similarly Ürkek *et al.*[38] reported an increase in ΔE^* values in the sloe berry added ice cream samples. The color differences (ΔE^*) among the RH added samples were statistically significant ($p<0.05$). Whiteness index (WI) is an important criterion that affects consumers in choosing dairy products[19]. The WI of the RH15 sample was found to be the lowest and the WI values of the RH5 and RH10 samples were statistically similar ($p>0.05$). However, significant changes were observed among the other samples ($p<0.05$). These results are in compliance with those reported by Kurt and Atalar[19]. RH has many natural colorant compounds such as diverse carotenoids[42] and anthocyanins[43]. Therefore, the differences in color parameters may be a result of its natural colorant compounds[25].

DPPH radical scavenging activity

DPPH assay is accepted as a method used to indicate total antioxidant capacity. It is frequently used in the determination of the antioxidant activity of foods. The DPPH radical scavenging values were expressed as IC_{50}. The low IC_{50} value indicates high antioxidant activity. The antioxidant activity of the reference antioxidants was higher than RH and the ice cream samples. The DPPH IC_{50} values are given in Table 5. The highest antioxidant activity (28.71 mg sample mg^{-1} DPPH) was found in the RH15 sample, while the lowest activity (143.19 mg sample mg^{-1} DPPH) was found in the C sample. The antioxidant activity of the RH15 sample was almost similar to the antioxidant activity of BHA and BHT (Table 5). The antioxidant activity of the samples increased depending on the increment of RH concentration. These results are in agreement with the results of Ullah *et al.*[44] and Çakmakçi *et al.*[35] who reported that the antioxidant activity of ice cream increased depending on the concentration of the added sugarcane (*Saccharum officinarum* L.) juice and kumquat (*Fortunella margarita*), respectively. RH is rich in bioactive compounds such as phenolics, ascorbic acid, and carotenoids[3,8]. The increase of antioxidant activity in the samples containing RH could be a result of these bioactive compounds.

Table 5 — DPPH (IC_{50}) and total phenolic content (TPC) values of RH (fruit), ice cream samples and reference antioxidants

Samples	DPPH (mg sample mg^{-1} DPPH)	Phenolic (mg GAE g^{-1} extract)
BHA	26.51±0.26	-
BHT	25.36±1.26	-
Trolox	18.34±0.22	-
α-tocopherol	20.96±0.38	-
RH (fruit)	44.04±1.49	4440.08±62.88
C	143.19±3.25	149.48±73.03
RH5	33.44±0.34	516.79±48.76
RH10	29.18±1.01	1264.39±31.35
RH15	28.71±0.34	1555.30±29.66

C: control without rose hip, RH5: 5% (w/w) rose hip added, RH10: 10% (w/w) rose hip added, RH15: 15% (w/w) rose hip added.

TPC of the samples

Most plants have phenolic compounds such as secondary metabolites which are beneficial for human health. Phenolic compounds are one of the most important natural antioxidants[45]. Table 5 indicates the TPC of the samples. The TPC of RH (4440.08 mg GAE g^{-1} extract) was found to be higher than that of the ice cream samples. TPC of the C sample was found to be the lowest, while the TPC of the RH15 sample was the highest (1555.30 mg GAE g^{-1} extract). Similar to the DPPH value, the TPC of the samples increased with the increment of RH concentration. The results were similar to those reported by Ullah *et al.*[44] and Çakmakçi *et al.*[35] who found that the TPC of the fruit added ice cream also increased.

RH has rich content in terms of antioxidant compounds such as phenolic compounds, vitamin C, flavonoids and carotenoids[8,10]. Therefore, the antioxidant activity of the RH added ice cream samples was quite high in the present study. In addition, the antioxidant activity of the samples was similar to their vitamin C content (Table 1).

Sensorial properties

The sensory assessment scores are shown in the radar plots in Figure 1. The addition of RH had a significant effect on the color and appearance, general acceptability ($p<0.05$) and flavor ($p<0.01$) scores. However, the gumming structure, texture and resistance to melting scores were not affected by the addition of RH ($p>0.05$). The most desirable samples in terms of the sensory properties except for gumming structure and texture were reported to be the control and RH5 samples by the panelists.

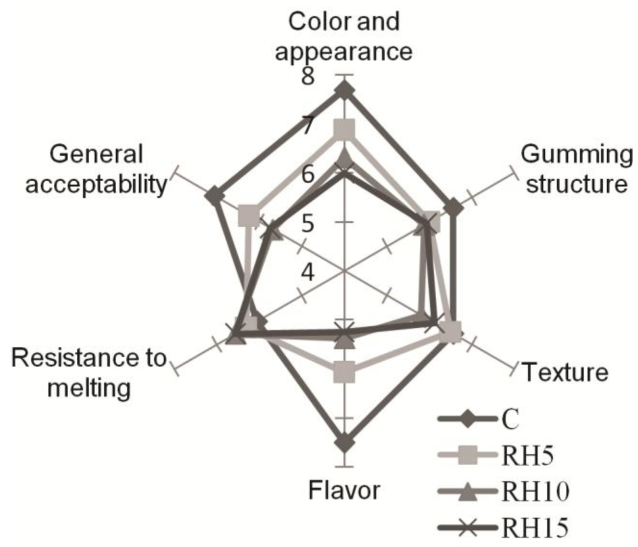

Fig. 1 — Effect of the addition of rose hips on the sensory properties of ice cream samples (C: control without rose hips, RH5: 5% (w/w) rose hips added, RH10: 10% (w/w) rose hips added, RH15: 15% (w/w) rose hips added)

Conclusion

The results of the present study demonstrated that the addition of RH to ice cream had significant effects on physicochemical properties such as ash, acidity, pH, fat, melting ratios ($p<0.01$) and overrun values ($p<0.05$), while dry matter, first dripping times and protein values were not affected ($p>0.05$). RH addition increased the vitamin C amount of the samples compared to the C sample. The colorimetric values (L^*, a^*, b^*, $H°$, C^*, ΔE^* and WI values) significantly differed in all samples. The viscosity (at 20 and 50 rpm) values did not show a significant change. Consistency coefficient (K) value of the RH15 sample increased compared to the other samples. The Ca, Mg, S, K, Mn, Fe and Zn contents increased in accordance with the increment of RH concentration. Similarly, the antioxidant activity of the samples also increased with the increment of RH concentration. The RH15 sample had the lowest IC_{50} and the highest TPC. The addition of RH had a negative effect on the color and appearance, flavor and general acceptability scores of the samples, while it had a positive effect on resistance to melting. The general acceptability score of the RH5 sample was higher than other ice cream samples.

In brief, RH can be successfully used to improve the ash, overrun, melting ratios and consistency properties of ice cream and to enrich its antioxidant activity and the vitamin C, Ca, Mg, S, K, Mn, Fe and Zn contents. In addition, RH can be used as a beneficial nutritional ingredient. It can be a source of natural antioxidants and colorant. However, it significantly lowers flavour and general acceptability scores which are very important to consumers.

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The sensory evaluation of the research was reviewed and approved by the Research Ethics Committee of Gümüşhane University (No: 95674917-108.99-E.7081).

Conflict of Interest

The author declares that there is no conflict of interest.

References

1 Balthazar C F, Silva H L A, Vieira A H, Neto R P C, Cappato L P*et al*., Assessing the effects of different prebiotic dietary oligosaccharides in sheep milk ice cream, *Food Res Int*, 91 (2017) 38–46.

2 dos Santos Cruxen C E, Hoffmann J F, Zandona G P, Fiorentini A M, Rombaldi C V *et al*., Probiotic buti a (*Butia odorata*) ice cream : Development, characterization, stability of bioactive compounds and viability of *Bifidobacterium lactis* during storage, *LWT - Food Sci Technol*, 75 (2017) 379–385.

3 Ercisli S, Chemical composition of fruits in some rose (*Rosa* spp.) species. *Food Chem*, 104 (4) (2007) 1379–1384.

4 Sagdic O, Toker O S, Polat B, Arici M & Yilmaz M T, Bioactive and rheological properties of rose hip marmalade, *J Food Sci Technol*, 52 (10) (2015) 6465–6474.

5 Kavaz Yuksel A, The effects of blackthorn (*Prunus spinosa* L.) addition on certain quality characteristics of ice cream, *J Food Qual*, 38 (6) (2015) 413–421.

6 Patel S, Rose hip as an underutilized functional food: Evidence-based review, *Trends Food Sci Technol*, 63 (2017) 29–38.

7 Yildiz O & Alpaslan M, Properties of rose hip marmalades, *Food Technol Biotechnol*, 50 (1) (2012) 98–106.

8 Alp S, Ercisli S, Jurikova T, Cakir O & Gozlekci S, Bioactive content of rose hips of different wildly grown *Rosa dumalis* genotypes, *Not Bot Horti Agrobot Cluj-Napoca*, 44 (2016) 472–476.

9 Kizil S, Toncer O & Sogut T, Mineral content and fatty acid compositions of wild and cultivated rose hip mneral contents and fatty acid compositions of wild and cultivated rose hip (*Rosa canina* L.), *Fresenius Environ Bull*, 27 (2) (2018) 744–748.

10 Demir N, Yildiz O, Alpaslan M & Hayaloglu A A, Evaluation of volatiles, phenolic compounds and antioxidant activities of rose hip (*Rosa* L.) fruits in Turkey, *LWT - Food Sci Technol*, 57 (1) (2014) 126–133.

11 AOAC, *Official Methods of Analysis of the AOAC (18th ed.)*, 2005.

12 Akbari M, Eskandari M H, Niakosari M & Bedeltavana A, The effect of inulin on the physicochemical properties and sensory attributes of low-fat ice cream, *Int Dairy J*, 57 (2016) 52–55.

13 Güven M & Karaca O B, The effects of varying sugar content and fruit concentration on the physical properties of vanilla and fruit ice-cream-type frozen yogurts, *Int J Dairy Technol*, 55 (1) (2002) 27–31.
14 Innocente N, Comparin D & Corradini C, Proteose-peptone whey fraction as emulsifier in ice-cream preparation, *Int Dairy J*, 12 (1) (2002) 69–74.
15 Ozer B H, Bell A E, Grandison A S & Robinson R K, Rheological properties of concentrated yoghurt (labneh), *J Texture Stud* 29 (1) (1998) 67–79.
16 Steffe J F, *Rheological methods in food process engineering*, Freeman Press, East Lansing, MI, USA, 1967 1-428.
17 McLellan M R, Lind L R & Kime R W, Hue angle determinations and statistical analysis for multiquadrant Hunter L, a, b data, *J Food Qual*, 18 (3) (1995) 235–40.
18 Cecchini M, Contini M, Massantini R, Monarca D & Moscetti R, Effects of controlled atmospheres and low temperature on storability of chestnuts manually and mechanically harvested, *Postharvest Biol Technol*, 61 (2–3) (2011) 131–136.
19 Kurt A & Atalar I, Effects of quince seed on the rheological, structural and sensory characteristics of ice cream, *Food Hydrocoll*, 82 (2018) 186–195.
20 Güler Z, Levels of 24 minerals in local goat milk, its strained yoghurt and salted yoghurt (tuzlu yoğurt), *Small Rumin Res*, 71 (1–3) (2007) 130–137.
21 Balaydin H T, Gulcin I, Menzek A, Goksu S & Sahin E, Synthesis and antioxidant properties of diphenylmethane derivative bromophenols including a natural product, *J Enzym Inhib Med Chem*, 25 (2010) 685–695.
22 Fogliano V, Verde V, Randazzo G & Ritieni A, Method for measuring antioxidant activity and its application to monitoring the antioxidant capacity of wines, *J Agric Food Chem*, 47 (1999) 1035–1040.
23 Gülçin I, Antioxidant activity of food constituents: An overview, *Arch Toxicol*, 86 (2012) 345–391.
24 Roland A M, Phillips L G & Boor K J, Effects of fat content on the sensory properties, melting, color, and hardness of ice cream, *J Dairy Sci*, 82 (1) (1999) 32–38.
25 Dervisoglu M & Yazici F, Note. The effect of citrus fibre on the physical, chemical and sensory properties of ice cream, *Food Sci Technol Int*, 12 (2) (2006) 159–164.
26 Erkaya T, Dağdemir E & Sengül M, Influence of Cape gooseberry (*Physalis peruviana* L.) addition on the chemical and sensory characteristics and mineral concentrations of ice cream, *Food Res Int*, 45 (1) (2012) 331–335.
27 El-Samahy S K, Youssef K M & Moussa-Ayoub T E, Producing ice cream with concentrated cactus pear pulp: a preliminary study, *J Pacd*, 11 (2009) 1–12.
28 Erkaya Kotan T, Mineral composition and some quality characteristics of ice creams manufactured with the addition of blueberry, *Gida / J Food*, 43 (2018) 635–643.
29 Flores A A & Goff H D, Recrystallization in ice cream after constant and cycling temperature storage conditions as affected by stabilizers, *J Dairy Sci*, 82 (1999) 1408–1415.
30 Sofjan R P & Hartel R W, Effects of overrun on structural and physical characteristics of ice cream, *Int Dairy J*, 14 (2004) 255–262.
31 Muse M R & Hartel R W, Ice cream structural elements that affect melting rate and hardness, *J Dairy Sci*, 87 (2004) 1–10.
32 Bai Y, Saren G & Huo W, Response surface methodology (RSM) in evaluation of the vitamin C concentrations in microwave treated milk, *J Food Sci Technol*, 52 (7) (2014) 4647–51.
33 Padayatty S J, Katz A, Wang Y, Eck P, Kwon O *et al*., Vitamin C as an antioxidant: Evaluation of its role in disease prevention, *J Am Coll Nutr*, 22 (1) (2003) 18–35.
34 Topdaş E F, Çakmakçı S & Çakıroğlu K, The antioxidant activity, vitamin C contents, physical, chemical and sensory properties of ice cream supplemented with cornelian cherry (*Cornus mas* L.) paste, *Kafkas Univ Vet Fak Derg*, 23 (5) (2017) 691–697.
35 Çakmakçi S, Topdaş E F, Çakir Y & Kalin P, Functionality of kumquat (*Fortunella margarita*) in the production of fruity ice cream, *J Sci Food Agric*, 96 (5) (2016) 1451–1458.
36 Fan C & Pacier C, Martirosyan DM & Martirosyan D, Rose hip (*Rosa canina* L): A functional food perspective, *Funct Foods Heal Dis*, 4 (2014) 493–509.
37 McDowell L R, *Minerals in animal and human nutrition*, Elsevier Science, Amsterdam, The Netherlands, 2003 33-100.
38 Ürkek B, Şengül M, Akgül H I & Kotan T E, Antioxidant activity, physiochemical and sensory characteristics of ice cream incorporated with sloe berry (*Prunus spinosa* L.), *Int J Food Eng*, 15 (11–12) (2019) 1–9
39 Pasricha S, Drakesmith H, Black J, Hipgrave D & Biggs B, Control of iron deficiency anemia in low- and middle-income countries, *Blood*, 121 (2013) 2607–2617.
40 Akalın A S, Karagözlü C & Ünal G, Rheological properties of reduced-fat and low-fat ice cream containing whey protein isolate and inulin, *Eur Food Res Technol*, 227 (3) (2008) 889–895.
41 Goff H D, Davidson V J & Cappi E, Viscosity of ice cream mix at pasteurization temperatures, *J Dairy Sci*, **77** (1994) 2207–2213.
42 Mármol I, Sánchez-De-Diego C, Jiménez-Moreno N, Ancín-Azpilicueta C & Rodríguez-Yoldi M, Therapeutic applications of rose hips from different Rosa species, *Int J Mol Sci*, 18 (2017) 1–37.
43 Stănilă A, Diaconeasa Z, Roman I, Sima N, Măniuţiu D, *et al*., Extraction and characterization of phenolic compounds from rose hip (*Rosa canina* L.) using liquid chromatography coupled with electrospray ionization - mass spectrometry, *Not Bot Horti Agrobot Cluj-Napoca*, 43 (2015) 349–354.
44 Ullah R, Nadeem M, Ayaz M, Tayyab M, Imran M, *et al*., Antioxidant characteristics of ice cream supplemented with sugarcane (*Saccharum officinarum* L.) juice, *Food Sci Biotechnol*, 24 (2015) 1227–1232.
45 Gülçin I, Antioxidant activity of food constituents: An overview, *Arch Toxicol*, 86 (2012) 345–391.