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Investigation of the Chemical, Textural and Sensory Properties of Some Fruit Puree Added Ice Cream

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ABSTRACT

Introduction: The aim of this study was to investigate the chemical, textural and sensory properties of some fruit-added ice creams.

Methods: For this purpose, 6% fruit puree (blackberry, raspberry, kiwi, banana, and sour cherry) added to the ice cream formulation and the produced ice creams were stored at -18°C for 60 days.

Results: Titration acidity, pH, colour (*L**, *a**, *b**), first drip time, melting rate, overrun, viscosity, texture, total phenolic content (TPC) values were determined. Fruit-added ice creams had significantly higher dry matter content than control samples (p<0.05). The overrun rate of ice creams decreased with the addition of fruit although the difference between ice cream varieties was insignificant (p>0.05). It was observed that titration acidity and stickiness values of ice creams generally increased while pH and hardness values decreased with fruit addition (p<0.05). At the end of the storage period, the first drip time of the ice creams decreased and the melting rates increased. However, no statistically significant difference was observed between the storage periods (p>0.05). Although the viscosity values of ice cream mixes showed variability, no significant difference was determined between ice cream samples (p>0.05). Compared to the plain ice cream (DS), the addition of fruit puree to the ice cream increased the TPC (p<0.05). No statistically significant difference was found between storage times of ice cream samples in terms of pH, titration acidity, colour values, first drip time, melting rate, viscosity, and TPC (p>0.05). Sensory analyses indicated that banana (DM) and blackberry (DB) added ice creams were the most popular varieties in terms of general acceptability.

Conclusions: Current study suggests that the natural antioxidants, minerals, vitamins, nutritional fibers and natural color ingredient in fruits increase the nutritional values of ice cream as well as its attractiveness to people.

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Introduction

Ice cream is a mixture of milk, fat, sugar, emulsifiers, stabilisers, fruits, and flavouring agents. Ice cream is produced and consumed frequently worldwide, especially during the summer months due to its refreshing effect and pleasing taste and aroma (1). People tend to consume ice creams with natural additives such as fruits and dietary fibres since these additives can provide health benefits, especially for children, while enhancing its nutritional value and organoleptic quality (2, 3) . The inclusion of natural additives in ice cream has shown an increase due to the increasing demand for functional and flavoured ice creams by consumers (4). Therefore, in addition to the chocolate, vanilla, and caramel flavoured ice creams a variety of fruit-flavoured products (such as strawberry, raspberry, blueberry, cherry, melon, peach, and lemon) have taken place in market shelves recently (1).

The fruits added to the ice cream provide some nutritional benefits owing to their natural antioxidants, minerals, vitamins, fiber, natural colorants, together with a low amount of cholesterol and fat. Furthermore, fruits are valuable sources of anti-carcinogens and anti-mutagens and they improve the organoleptic characteristics (such as appearance, colour and flavour) of the food products (5). Therefore, more studies on the enrichment of ice creams with natural ingredients and development of functional ice creams are required (6). The Effects on physical, chemical, and sensory properties of ice creams have been studied following the addition of a variety of fruit types and their products into ice cream (7,8,9,10). In this study, the chemical, textural, and sensory properties of ice creams produced using kiwi, banana, blackberry, raspberry, and sour cherry purees were investigated. In addition, the total

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phenolic contents and antioxidant activities of ice creams were determined.

Materials and Methods

Pasteurized Cream (Rama Food, Istanbul), skim milk powder (Izi milk), beet sugar (Torku, Konya), and pasteurized milk (Ak Food, Sakarya) containing 11% dry matter, 3% protein, and 3% fat was used in the ice cream production. Purees of kiwi, banana, blackberry, raspberry, and sour cherry (Mec3, Gelato, Italy), emulsifiers, and stabilizers provided by Pastarom Food Company (Izmir, Turkey).

Preparation of Ice Creams

Ice cream mixes contained 56% milk, 22.4% cream, 10.5% milk powder, 10.5% sugar, 0.3% stabilizer, and 0.3% emulsifier. Following the homogenization of the ingredients, the ice cream mix subjected to pasteurization process at 75-80°C for 10-12 minutes. The pasteurized mix was aged at 4ºC for 1 day to ensure complete hydration of all ingredients. Fruit puree concentrations in the ice creams optimized and set to 6% based on pre-trials. Then, fruit purees were added to the aged ice-cream mixes and ice-creams were produced using a home scale ice cream machine (II Gelataio ICK5000, Delonghi, Italy) and stored in a freezer (-18ºC). The blackberry (DB), raspberry (DF), kiwi (DK), banana (DM), plain (DS), and sour cherry (DV) ice creams were subjected to physical, chemical, and sensory analyses on the 1, 30, and 60 days of storage. Ice creams produced at two replicates.

Physicochemical analysis

For dry matter, 5 g of the ice cream samples was placed in the drying pans and allowed to dry in an oven at 105°C until it reached a constant weight and the results were expressed as the percentage of sample weight (11). The 10 g samples weighed and homogenized in 100 ml of purified water and pH value was determined using a pH meter (Ohaus, USA). Subsequently, this solution filtered and 25 mL of the filtrate was titrated with 0.1 N NaOH solution along with the phenolphthalein indicator until a stable pink colour was formed. Titration acidity calculated as lactic acid equivalent (11). A colorimeter (Minolta, CR-400, Osaka, Japan) was used for the determination of L^* (100 = white; 0 = black), a^* (+, red; -, green) and b^* (+, yellow; -, blue) values of ice cream samples. The overrun rate was detected by weighing the same volume of ice cream after and before freezing in the same volumetric cylinder. The overrun was measured by the formula given by Ahmad et al. (12). The ice creams were transferred to the specific container of the viscometer (AND, SV-10, Tokyo, Japan) and the viscosity values were determined as centipoise (cp) at 8°C. Ice cream samples of 15 g were placed on a strainer and kept at 24±1°C for determination of melting rate and first drip time. The time required for observation of first drop (sec) is recorded as the first drip time and melting rate was calculated as the percentage of the initial weigh of ice cream that melted after 30 minutes (3).

Texture analysis

The hardness and stickiness of ice creams were evaluated at room temperature using a texture analyser (Stable Microsystem, Reading, UK), which was equipped with a 2.5 mm radius stainless steel cylinder probe (P/5), and operated under conditions of load cell (5 kg), test speed (1.00 mm/s), and distance (15 mm). Ice cream hardness was defined as the peak force attained during the penetration and the stickiness was considered as the maximum negative force on the graph during withdrawal.

Total Phenolic Content

Bioactive compounds were extracted from fruit purees and ice cream samples (20 g) by mixing them with 30 mL of acidified methanol (0.1% HCI), and the mixture was kept at 4°C overnight. The solution was filtered through Whatman No.1 filter paper under vacuum. The TPC method is based on spectrophotometric measurement of the blue colour produced by the redox reaction in which the phenolic compounds are reduced by the Folin-Ciocalteu reagent under basic conditions (13).

Sensory Analysis

A panel consisting of 10 faculty members carried out sensory evaluations of ice cream samples. Six ice cream samples, five fruity and one plain, served with a cup of water for mouth rinsing between sample transitions. The panellists evaluated the ice cream samples based on colour-appearance, structure-texture, taste-aroma, and general acceptability criteria on a 10 point hedonic scale (1: unacceptable; 10: very good).

Statistical analysis

All analyses were performed in duplicate. The data were analyzed statistically using Minitab®

17.0 statistical software and the results were presented as “mean ± standard deviation”. Analysis of variance was performed (ANOVA) for determination of statistical differences between ice cream types and storage periods. Subsequently, Tukey's Multiple Range Test was applied for differences that were found statistically significant (α=0.05).

Results and discussion

Analysis Results of Fruit Purees

Analysis results of fruit purees used in ice cream production are given in Table 1. The pH values of fruit purees were in the range of 2.46-3.77, while banana puree had the highest value. When the colour values were examined, the *L** value of banana puree was found to be the highest while blackberry possessed the highest *a** value. In terms of *b** value, indicating yellow and blue colour intensity, banana and kiwi puree had higher values than raspberry, cherry, and blackberry purees. The highest TPC was determined in blackberry puree (591.38±13.06 mg GAE/g) while the lowest one was in banana puree (163.55±22.81 mg GAE/g). Accordingly, the highest and lowest groups in terms of antioxidant capacity were blackberry (6528.99±378.14 mg TE/g) and banana (2366.63±126.65 mg TE/g) purees, respectively. A correlation was found between the TPC content of fruit purees; thereby the antioxidant capacity increased in the groups that are rich in phenolic compounds.

Table 1. Some Analysis Results of Fruit Purees

Fruit pulp	pH value	Colour values			TPC (mg GAE/g)	Antioxidant Activity (mg TE/g)
		*L**	*a**	*b**		
Blackberry	2.71±0.01^{b}	21.69±1.83^{b}	2.01±0.41^{a}	-0.12±0.54^{b}	591.38±13.06^{a}	6528.99±378.14^{a}
Raspberry	2.61±0.01^{c}	20.39±1.14^{b}	1.37±0.13^{bc}	0.39±0.27^{b}	469.36±30.38^{b}	5149.39±376.27^{b}
Kiwi	2.46±0.05^{d}	19.73±0.40^{c}	1.26±0.11^{c}	2.13±0.15^{a}	164.92±6.03^{d}	2484.49±90.66^{c}
Banana	3.77±0.01^{a}	22.41±0.31^{a}	1.90±0.06^{ab}	2.29±0.38^{a}	163.55±22.81^{d}	2366.63±126.65^{c}
Sour cherry	2.65±0.01^{bc}	21.86±0.68^{b}	1.81±0.08^{ab}	0.01±0.64^{b}	340.94±177.87^{c}	4034.48±282.94^{b}

Results are expressed as mean±standard deviation (n=5x2). Capital letters in the same column indicate significant differences (p<0.05).

Table 2. Acidity and pH values of ice cream samples during storage

	Ice Cream Type	Storage Time (day) 1	30	60
pH value	**DS**	6.81±0.01^{Aab}	6.73±0.05^{Ab}	6.89±0.05^{Aa}
	DB	5.77±0.18^{Ba}	5.65±0.01^{Bb}	5.68±0.01^{Bb}
	DF	5.19±0.38^{Ba}	5.33±0.35^{BCa}	5.38±0.35^{BCa}
	DK	4.91±0.02^{Ba}	4.88±0.07^{Ca}	4.70±0.01^{Cb}
	DM	6.82±0.02^{Aa}	6.62±0.01^{Ab}	6.72±0.04^{Ab}
	DV	5.44±0.38^{Ba}	5.45±0.28^{BCa}	5.59±0.33^{Ba}
Titration acidity (l.a. %)	**DS**	0.10±0.01^{Ba}	0.03±0.00^{Cb}	0.04±0.00^{Cb}
	DB	0.11±0.00^{Ba}	0.08±0.01^{Bb}	0.08±0.01^{Bb}
	DF	0.12±0.01^{Ba}	0.12±0.01^{Aa}	0.13±0.02^{Aa}
	DK	0.32±0.01^{Aa}	0.12±0.00^{Ab}	0.12±0.01^{ABb}
	DM	0.05±0.00^{Ca}	0.04±0.00^{Cb}	0.04±0.01^{Cab}
	DV	0.11±0.01^{Ba}	0.10±0.01^{Aa}	0.12±0.01^{ABa}

Results are expressed as mean±standard deviation (n=5x2). DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry. Capital letters in the same column indicate significant differences (p<0.05). Lowercase letters on the same line indicate significant differences (p<0.05).

Physicochemical analyses

The pH values of ice cream samples are shown in Table 2. The fruit variety and storage time significantly affected the pH and titratable acidity of the samples (p<0.05). The pH values generally decreased significantly at the end of the first week of storage, except the DF and DV ice creams (p<0.05). Aliyev (14) reported that the pH values of blueberry-supplemented ice cream were between 4.18 and 6.16 and Uğurlu (9) reported that the pH values of blueberry, blackberry, and strawberry supplemented ice cream were between 5.61 and 6.56. Kavaz Yuksel (5) found that pH value of 6.60 in control ice cream samples decreased to 5.07 with increasing concentrations of plum addition. This situation is probably due to the organic acids that are naturally found in all fruit additives. Our results comply with those found in similar studies by Güven and Karaca (15) and Murtaza et al. (16).

Titration acidity values of ice cream samples during storage are given in Table 2. The lowest titration acidity value was found to be 0.03% on day 30 in DS samples and the highest one was 0.32% in DK sample on the first day. In terms of titration acidity, there were similarities between DS and DM; and between DF and DV ice creams. Çakmakçı et al. (7) determined titration acidity values of ice creams produced by using kumquat fruit in the range of 0.25-0.49%. Kavaz Yuksel (5) determined titration acidity as 0.17-0.87% in ice cream samples with jackal plum additive. Similar with our results, Uğurlu (9) reported that the addition of fruit to ice cream causes an increase in titration acidity levels and the titration acidity value increases as the fruit rate increases.

Table 3. The initial viscosity, overrun and dry matter properties of ice cream samples

Ice Cream Type	Viscosity (cp)	Overrun (%)	Dry matter (%)
DS	83.10±22.9^{A}	73.94±6.11^{A}	36.69±0.33^{B}
DB	65.33±12.41^{B}	44.10±3.30^{A}	39.08±0.42^{A}
DF	87.78±13.39^{A}	42.69±3.23^{A}	38.06±0.39^{A}
DK	82.10±18.90^{A}	54.79±5.05^{A}	38.66±0.23^{A}
DM	64.77±3.95^{B}	36.81±4.99^{A}	38.93±0.29^{A}
DV	89.90±19.2^{A}	61.40±2.22^{A}	38.37±0.02^{A}

Results are expressed as mean±standard deviation (n=5x2). DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry. Capital letters in the same column indicate significant differences (p<0.05)

The lowest dry matter content (36.69±0.33) was found in the control ice cream (DS) and it was significantly different from the others (p<0.05). There was no significant difference in dry matter concentrations among the fruit-added ice creams (p>0.05). The increase of viscosity may be due to the increase of the total solid content in the ice creams with addition of fruit purees. Increasing the viscosity of the of ice cream mixes has been reported by adding various substance such as gooseberry (17), minced blackthorn (5) and besnigrape (3). As shown in Table 3, viscosity and overrun values of ice creams ranged 64.77-89.90 cp. and 36.81-73.94%, respectively. Our results indicated that addition of fruit puree had an insignificant effect on overrun and viscosity values of the ice cream samples (p<0.05).

Table 4. Colour values of ice cream samples during storage

	Ice Cream Type	Storage Time (days)		
		1	30	60
L*	**DS**	80.89±0.53^{Aa}	80.86±0.31^{Aa}	81.70±0.97^{Aa}
	DB	66.96±0.01^{Da}	67.97±1.40^{Ca}	70.09±0.85^{Ba}
	DF	71.52±0.71^{BCa}	72.12±0.66^{Ba}	72.89±1.02^{Ba}
	DK	73.12±1.25^{Ba}	73.75±1.41^{Ba}	75.76±3.65^{ABa}
	DM	79.99±0.92^{Aa}	80.53±0.35^{Aa}	80.95±0.54^{Aa}
	DV	69.77±0.94^{CDa}	70.37±0.37^{BCa}	72.56±2.42^{Ba}
a*	**DS**	1.16±0.04^{Da}	1.23±0.05^{Ca}	1.30±0.05^{Ca}
	DB	9.73±0.05^{Aa}	9.60±0.21^{Aa}	9.91±0.29^{Aa}
	DF	8.07±0.05^{Ba}	8.10±0.05^{Ba}	8.12±0.04^{Ba}
	DK	-1.13±0.00^{Ea}	-1.11±0.01^{Da}	-1.11±0.01^{Da}
	DM	1.38±0.05^{Ca}	1.41±0.06^{Ca}	1.57±0.12^{Ca}
	DV	8.18±0.04^{Ba}	8.27±0.07^{Ba}	8.35±0.17^{Ba}
b*	**DS**	2.61±0.02^{Ca}	2.63±0.10^{Ca}	2.69±0.08^{Ba}
	DB	-4.46±0.04^{Fa}	-4.55±0.16^{Fa}	-4.67±0.42^{Ea}
	DF	0.43±0.02^{Da}	0.46±0.01^{Da}	0.49±0.03^{Ca}
	DK	9.11±0.11^{Aa}	9.16±0.01^{Aa}	9.41±0.22^{Aa}
	DM	3.32±0.01^{Ba}	3.32±0.03^{Ba}	3.36±0.06^{Ba}
	DV	-0.79±0.02^{Ea}	-0.80±0.06^{Ea}	-0.86±0.08^{Da}

Results are expressed as mean±standard deviation (n=5x2). DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry. Capital letters in the same column indicate significant differences (p <0.05). Lowercase letters on the same line indicate significant differences (p <0.05).

Colour Values

Colour changes are dependent on the colour of the added compounds. For example, due to the colour of the pistachio peel extract, which was almost green, the greenness of the ice cream increased (18). Current colour values of ice creams were determined on the days 1, 30, and 60 of storage (Table 4). The highest *L** value was found in DS samples (81.70±0.97) on the day of

60 while the lowest value was found in the DB ice cream on the first day (66.96±0.01).

During 60 days of storage, there was no significant change observed in the L^* values of the ice cream samples (p>0.05). However, differences in L^* values were observed in ice cream regarding fruit type. Lower L^* values in fruit added ice creams can be explained by the low L^* values of the fruit purees (19.73-22.41). Similar to our findings, Durak (19) stated that the higher concentration of blueberry pulp the lower L^* values of the yogurt ice creams. Kavaz Yuksel (5) reported that L^* value gradually decreased with increasing concentrations of fruit in coyote plum added ice creams.

The change in a^* values of ice cream samples during storage is given in Table 4. The lowest a^* value was determined in DK sample (-1.13±0.00) on the first day, while the highest a^* value was determined in DB sample (9.91±0.29) on the 60th day. The effect of fruit variety and storage time on a^* values were significant (p<0.05). Açu (20) produced functional ice cream samples using fruit sauces and a^* values were varied between -2.57 and -11.60 during 120 days of storage. Topdaş et al. (10) reported that a^* value in the ice cream produced using cranberry paste varied between -2.77 and -9.08.

Changes in b^* values of ice cream samples during storage are given in Table 4. The lowest b^* value was found on the 60th day in the DB sample (-4.67±0.42), while the highest value was determined on the 60th day in the DK sample (9.41±0.22). The effect of fruit addition on b^* values is significantly important (p<0.05). Kavaz et al. (3) determined the b^* value of the grape-added ice cream as 1.50-10.70 and Salık (21) determined the b^* value of ice creams with grape and walnut addition in the range of 1.09-13.01. Furthermore, Goraya and Bajwa (22) indicated that the addition of amla resulted in a significant decrease of L^* and b^* values in ice cream samples.

First Drip Time

When determining the melting rate of the ice cream samples, the first consideration is to determine the time that the first drip occurs. The first drip time is a criterion that gives information about the structure and the durability of ice cream. The changes in first drip time during storage is given in Table 5. The highest mean first drip time was in the DM ice cream with 1395±134.4 sec and the lowest value was found to be in the DK sample (409±49.5 sec) on the 30th day. In DB, DF, and DV ice cream varieties, during the storage period, the first drip times decreased, after the 30th day increase in DK, DM and DS samples, a decrease occurred at the end of storage. The effect of fruit variety and storage time on the first drip time of ice cream samples was insignificant (p>0.05). Uğurlu (9) reported that compared to the control sample, the first drip time increased with increasing concentrations of strawberry, blackberry, and blueberry added to the ice creams and the most increase was observed in blackberry ice cream. Salık (21) has determined that grape and grape seeds addition to ice creams increased the first drip time. In general, ice creams with high dry matter content are more resistant to melting, while fruit ice creams with low dry matter have shorter melting times. It is known that factors that increase the water holding capacity of the ingredients added to the ice cream mix have an effect on the first drip time. Melting time and melting rate are inversely proportional. Confirming this phenomenon, analyses indicated that the fruit type affects the first drip time in ice cream and increases it in general. Similarly, Marshall et al. (23) stated that the fruit additive increases the water retention capacity, viscosity and melting time of ice cream.

Melting Rate

The melting rates mostly depend on the composition of ice cream mix, more specifically the additives and fruit type. Salık (21) stated that the probiotic ice cream samples produced with currant and walnut mixture decreased the melting rate, the samples containing 10% fruit started to melt later than the control groups and complete melting process took relatively more time. On the other hand, ice creams with inulin showed low melting rates due to the potential ability of inulin for reducing the free movement of water molecules (24). Melting rate was calculated by determining the melting amount after 30 minutes waiting at room temperature. Melting rates of ice cream varieties during storage are given in Table 5. Overall, the highest mean melting rate (92.57 ± 3.05%) was detected in the DB sample, while the lowest melting rate (46.50 ± 3.0%) was in the DK ice cream which was significantly different than others (p<0.05, data not shown). Neither fruit type nor storage time had significant effect on melting rate ($p>0.05$).

Table 5. First drip times and melting rates of ice cream samples during storage

	Ice Cream Type	Storage Time (days) 1	30	60
First drip time (s)	DS	641.00±144^{Aa}	776.5±132^{ABa}	562.5±77.1^{Aa}
	DB	710.50±0.71^{Aa}	688.0±134^{ABa}	494.0±128.7^{Aa}
	DF	1023.0±528^{Aa}	796.0±69^{ABa}	770.0 ±216^{Aa}
	DK	896 ±72.1^{Ab}	1395.0±134^{Ab}	861.5±72.8^{Ab}
	DM	652.5±13.44^{Aa}	551.0±182^{Ba}	409.0±49.5^{Aa}
	DV	812.0 ±221^{Aa}	772.0±330^{ABa}	581.5±87^{Aa}
Melting rate (%)	DS	88.47±6.32^{Aa}	86.97±1.74^{Aa}	97.57±0.14^{Aa}
	DB	91.33±3.11^{Aa}	95.00±2.26^{Aa}	91.37±3.72^{Aa}
	DF	49.6±6.52^{Aa}	93.10±2.22^{Aa}	82.2±19.3^{Aa}
	DK	66.7±18.6^{Aa}	23.8±2.64^{Ba}	49.0±3.98^{Aa}
	DM	87.60±2.83^{Aa}	89.67±2.92^{Aa}	85.60±0.57^{Aa}
	DV	86.40±7.54^{Aa}	90.37±1.37^{Aa}	89.50±6.84^{Aa}

Results are expressed as mean±standard deviation (n=5x2). DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry. Capital letters in the same column indicate significant differences ($p<0.05$). Lowercase letters on the same line indicate significant differences ($p<0.05$).

Texture Analysis

The change in hardness values of ice cream samples during storage is given in Table 6. The hardest ice cream was found to be the DS sample (11.13±6.05 kg) on the 60 day, while the lowest hardness value was determined in the DF sample (1.59±1.34 kg) on the first day. The effect of fruit variety and storage time on the hardness values of ice cream samples was significant ($p<0.05$). The change of stickiness values of ice cream samples during storage is given in Table 6. The highest stickiness value was determined in the DF sample (-0.42±0.27) on day 1 while the lowest stickiness value was determined on day 60 in the DS sample (-0.75±0.01). The effect of storage time on the stickiness values of ice cream samples was insignificant ($p>0.05$). It was observed that the hardness value decreased by the addition of fruit puree to ice cream samples ($p<0.05$). Muse and Hartel (25) suggested that the hardness of ice cream depends on the ice phase volume, ice crystal size, overrun, fat destabilization, and the rheological characteristics of the mix.

Table 6. Hardness and Stickiness values of ice cream samples during storage (kg)

	Ice Cream Type	Storage Time (day) 1	30	60
Hardness values	DS	7.62±3.36^{Aa}	5.22±2.51^{Aa}	11.13±6.05^{Aa}
	DB	2.96±0.03^{ABab}	2.31±0.21^{Ab}	3.60±0.39^{Aa}
	DF	1.59±1.34^{Ba}	3.48±0.71^{Aa}	3.53±0.61^{Aa}
	DK	2.69±0.57^{ABab}	1.88±0.32^{Ab}	6.12±1.27^{Aa}
	DM	3.15±0.17^{ABa}	3.24±1.91^{Aa}	5.69±2.50^{Aa}
	DV	2.14±0.27^{ABab}	1.64±0.70^{Ab}	5.22±1.25^{Aa}
Stickiness Values	DS	-0.56±0.16^{Aa}	-0.54±0.06^{Aa}	-0.75±0.01^{Aa}
	DB	-0.61±0.04^{Aa}	-0.54±0.05^{Aa}	-0.65±0.02^{Aa}
	DF	-0.42±0.27^{Aa}	-0.67±0.12^{Aa}	-0.64±0.02^{Aa}
	DK	-0.57±0.10^{Aa}	-0.45±0.08^{Aa}	-0.65±0.04^{Aa}
	DM	-0.67±0.05^{Aa}	-0.55±0.18^{Aa}	-0.65±0.04^{Aa}
	DV	-0.46±0.03^{Aa}	-0.46±0.21^{Aa}	-0.74±0.02^{Aa}

Results are expressed as mean±standard deviation (n=5x2). DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry. Capital letters in the same column indicate significant differences ($p<0.05$). Lowercase letters on the same line indicate significant differences ($p<0.05$).

Total Phenolic Content (TPC)

The TPC values determined during storage of ice cream samples are given in Table 7. On the first day of storage, the highest amount of TPC was found in the DB with 269.47±8.58 mg GAE/g while the lowest one was 158.64±10.51 mg GAE/g in the DS samples. At the end of storage period, the highest and lowest TPC levels were observed in DF (249.0±16.30 mg GAE/g) and DS (122.46±12.56 mg GAE/g), respectively. During storage, there was no significant change observed in the TPC values of the samples ($p>0.05$). Kavaz et al. (3) reported the TPC content of grape added ice cream was 42.20-187.50 mg GAE/g. It has been reported that the addition of grape wine lee, kiwi fruit, and pomegranate peel caused an increment in the total phenols of ice cream (6). The processed amla (Indian gooseberry) ice cream samples were also found to have higher antioxidant activity, total phenols, and tannins than controls due to the higher concentrations of total phenols and tannins, which are infused from the amla into the ice cream matrix Goraya and Bajwa (22).

Table 7. Total phenolic content of ice cream samples during storage

	Ice Cream Type	Storage Time (day)		
		1	30	60
Total phenolic (mg GAE/g)	**DS**	158.64 ± 10.51^{Ba}	150.26 ± 13.38^{BCa}	122.46 ± 12.56^{Da}
	DB	269.47 ± 8.58^{Aa}	224.6 ± 32.10^{ABa}	212.50 ± 24.0^{ABCa}
	DF	237.26 ± 11.83^{Aa}	234.20 ± 14.90^{Aa}	249.0 ± 16.30^{Aa}
	DK	167.27 ± 1.14^{Ba}	137.10 ± 26.90^{Ca}	164.03 ± 8.50^{CDa}
	DM	177.20 ± 16.70^{Ba}	151.06 ± 9.62^{BCa}	$183.20\pm19.20B^{CDa}$
	DV	240.31 ± 10.29^{Aa}	225.10 ± 17.50^{ABa}	238.42 ± 8.86^{Aba}

Results are expressed as mean±standard deviation (n=5x2).DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry. Capital letters in the same column indicate significant differences ($p < 0.05$). Lowercase letters on the same line indicate significant differences ($p < 0.05$).

Sensory Analysis

According to the sensory evaluations made by panellists on colour and appearance, the differences between ice cream types were found to be insignificant ($p>0.05$) although DK had the lowest score in this category. In terms of taste-aroma, DM sample received the highest mean score (8.95±0.96) while DF received the lowest (7.25±1.18). Considering the general acceptability scores, the highest mean score (8.90±0.84) was determined for DM variety and the lowest mean score (7.72±0.94) was for DF samples (Fig. 1). In a similar study, it was reported that the amount of grape juice residue did not significantly affect the colour, aroma, taste, texture, and overall appearance of the ice cream (26). Contrary to these results, Karaman and Kayacier (27) showed that the addition of black tea and herbal tea, except for chamomile, significantly decreased the sensory scores of ice creams.

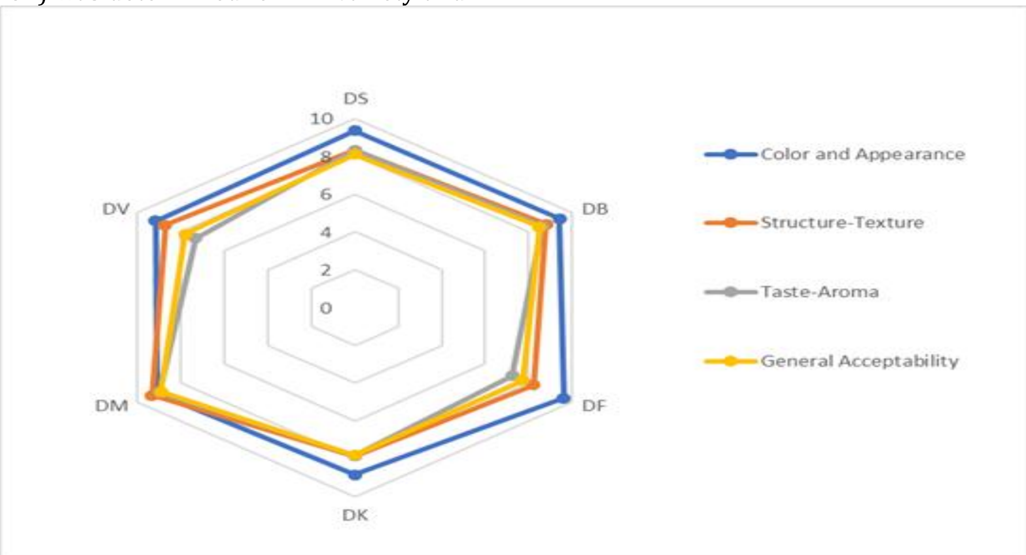

Figure 1. Sensory test scores for ice cream samples during storage. DS; control, DB; blackberry, DF; raspberry, DK; kiwi, DM; banana, DV; sour cherry (n=5x10).

Conclusions

The plain ice cream and the ice creams produced by adding blackberry, raspberry, kiwi, banana, and sour cherry puree were compared in terms of some quality characteristics. Fruit ice creams had higher dry matter content than control samples. It was observed that titration acidity and stickiness values of fruit added ice creams increased, pH and hardness values decreased. With storage, the first drip time of ice creams decreased and their melting rate increased. The addition of fruit puree increased the phenolic content. The sensory feature showed that banana and blackberry added ice creams are the most popular varieties in terms of general acceptability.

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