



Scientific Research

The Study of the Effects of Replacing Date Syrup and Date Seed Powder on the Physicochemical and Sensory Properties of Diet Ice Cream

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ARTICLE INFO	ABSTRACT
<p>Article History:</p> <p>Received: 2025/03/28</p> <p>Review: 2025/10/06</p> <p>Accepted: 2025/10/19</p> <hr/> <p>Keywords:</p> <p>Diet ice cream, Date seed powder, Date syrup, Dietary fiber, Fat and sugar reduction</p>	<p>Ice cream is a widely consumed dessert, but its high sugar and fat content is associated with obesity and metabolic disorders. The use of natural and accessible substitutes can reduce calories while enhancing nutritional value. In this study, date syrup (as a sugar substitute) and date seed powder (as a fat replacer) were incorporated at different levels. Four formulations were prepared: control (without substitution), T1 (25% date syrup and 0.75% date seed powder), T2 (50% date syrup and 1.5% date seed powder), and T3 (75% date syrup and 2.25% date seed powder). Samples were stored at -18 °C and evaluated on days 1, 21, and 41 for physicochemical, sensory, and microbiological properties. Results showed that with increasing substitution levels, fat, sucrose, total sugar, Brix, pH, and dry matter significantly decreased ($p < 0.05$), while protein, acidity, viscosity, ash content, and melting point significantly increased ($p < 0.05$). The T2 sample exhibited the highest sensory acceptance in the 5-point hedonic test, with reductions of 59.54% in sucrose, 44.92% in total sugar, and 19.62% in fat compared to the control. Moreover, microbiological evaluations confirmed that all samples were within the permissible limits of the national standard. These findings suggest that date syrup and date seed powder are effective substitutes for sugar and fat in diet ice cream, producing a nutritionally improved product with good consumer acceptability.</p>
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1- Introduction

Ice cream is a delicious frozen product made from milk or dairy products, fat, and additives such as stabilizers, sweeteners, emulsifiers, and flavoring agents, and comes in various forms such as full-fat, low-fat, fat-free, and sugar-free [1,2]. After pasteurization and homogenization, this product is aerated and frozen, with an air content of 10 to 50 percent. Ice cream is composed of different components, changes in which can affect the quality properties. For example, replacing sucrose changes the taste, structure, and consistency of the product, which poses challenges for experts [1-3]. Consumers are increasingly interested in consuming healthy, nutritious, natural products without artificial additives such as colorants and flavors. Ice cream contains a high amount of fat and sugar, which causes health problems and obesity, and has increased the demand for low-calorie and high-fiber products. Functional foods have health benefits and reduce the risk of diseases, which has increased the demand for health-promoting foods with increasing consumer awareness, and food manufacturers are looking to produce new products or change the formulation with health-promoting properties [4-6]. Sugar and fat play a key role in improving the taste, texture, and quality of ice cream, but their high amounts lead to the production of a high-calorie and high-energy product and increase the risk of obesity and metabolic diseases. Fat enhances and improves taste, improves sensory properties, structure, and texture, prevents the growth of ice crystals, stabilizes air bubbles, stabilizes the foam, and is effective in melting and creating a smooth and creamy texture in ice cream [11,12].

The date palm (*Phoenix dactylifera L.*) is a tropical plant, and its kernel is known as a valuable source of fiber, minerals, and bioactive compounds. Date kernels, which are obtained from processing plant waste and contain dietary fiber, can be used as a fat substitute in the food industry, leading to the production of low-fat and healthier ice cream

[9-11]. Studies have also shown that date kernels have antioxidant, anti-inflammatory, and protective properties against heart and liver diseases, and can even be used as a flavoring similar to decaffeinated coffee [12,13]. Sucrose, a common sweetener in the food industry, is associated with problems such as diabetes, obesity, cardiovascular disease, and tooth decay, so the use of natural alternatives is important [14]. Date syrup is a valuable option due to its natural sugars, especially fructose (suitable for diabetic patients), mineral, protein and fiber compounds [15-18]. Adding date syrup to ice cream, in addition to reducing dependence on sugar, improves the texture, creates a light brown color and a desirable taste of dates. About 30% of dates are considered waste during harvesting, storage, improper transportation, and over-ripening. By producing products such as date syrup, this waste can be prevented and a product with high nutritional value can be produced that also helps the environment [17].

In a study by Ebrahimi Sarai *et al.* (2018), they investigated the replacement of sugar with two sweeteners, date liquid sugar and date syrup, at levels (0, 25, 50, 75, and 100 percent) in ice cream. The results showed that replacing syrup or date sugar by up to 50 percent increased the volume and viscosity similar to the control sample. With increasing amounts of date syrup and sugar, the melting resistance decreased, and the sensitivity to thermal shock increased. Regarding the sensory properties, replacing date sugar by up to 75 percent and date syrup by up to 50 percent had no significant effect on the sensory properties and was described as appropriate [19]. In the study by Joynipour (1400), the effect of dietary fiber of date kernel powder as a fat substitute (at levels of 0.5, 1, 1.5 and 2%) in low-calorie cream was investigated and the results showed that with increasing dietary fiber in the low-fat cream formulation, pH and acidity did not differ significantly from the control sample, but ash increased significantly and in the sensory evaluation, the 1.5% date kernel

powder sample was selected as the optimal sample due to its closeness to the control sample [20]. In another study, Mansour *et al.* (2021) investigated the replacement of date kernel powder with fat in ratios of 1.5, 2.5, and 3.5% and stated that date fiber is a valuable source and a suitable substitute for diet ice cream that also improves texture, density, and melting resistance [2]. This study aimed to investigate the effect of replacing different levels of date syrup as a sucrose substitute and date kernel powder as a fat substitute on the physicochemical, microbial, and sensory properties of diet ice cream. In this regard, an attempt was made to provide a product with higher nutritional value and appropriate sensory acceptability by utilizing by-products of the date industry and reducing the amounts of fat and sugar.

2- Experimental Section

2-1- Raw Materials

Date kernel powder (7.5% fat) and date syrup (Mana Company, Iran), dry milk with a maximum fat content of 1.5% (Pak Company, Iran), skim milk (Pak Company, Iran), sugar (Shokoeh Yas Company, Iran), oil (Golshah Naqsh-e Jahan Company, Iran), glucose (Golshah Naqsh-e Jahan Company, Iran) and stabilizer (Kale Company, Iran) were used. The chemicals and solvents used were purchased from Sigma and Merck.

2-2- Ice cream production

Using the formulation given in Table 1, ice cream samples were produced. Four ice cream samples were produced, including control, T1 (containing 25% date syrup and 0.75% date kernel powder), T2 (containing 50% date syrup and 1.5% date kernel powder), and T3 (containing 75% date syrup and 2.25% date kernel powder). In the first stage, sugar, stabilizer, and dry milk were weighed and mixed together. Then, oil, glucose, date syrup, and skim milk were added to the dry ingredients, and the resulting mixture was heated to 85°C in a bain-marie. After that, the samples were taken out, homogenized with a mixer, and heated again to 93°C in a bain-marie. Then, the samples were cooled to 4°C using ice and stored in a refrigerator at the same temperature for 24 hours. After this period, the required amount for physicochemical tests was taken, and the remaining samples were subjected to a cooling and aeration process of 15% in an ice cream maker (Carpigiani, Italy) for 6 minutes. Finally, the samples were packaged in 100 g containers and stored at -18°C for 41 days. All experiments were performed on days 1, 21, and 41 with three repetitions [20-22]. Figure 1 shows a simple overview of the production process of ice cream containing date kernel powder and date syrup.



Figure1. Steps to produce ice cream containing date kernel powder and date syrup

2-3- Physicochemical experiments

To investigate the effect of adding date juice and date kernel powder, physicochemical factors, including pH, acidity percentage, fat percentage, total sugar percentage, sucrose percentage, dry matter percentage, ash percentage, Brix, viscosity, protein, and first drop melting time, as well as sensory properties of the samples, were evaluated.

A pH meter (Methrom, Switzerland) was used to determine the pH of the samples. To measure the titratable acidity, 9 ml of the sample was mixed with 9 ml of distilled water and titrated with 0.1 normal sodium hydroxide solution until the pH reached between 2.8 and 5.8. The acidity level was calculated based on formula (1). The fat percentage of the samples was determined using a 20 butyrometer, 10 ml of 87% sulfuric acid, 1 ml of amyl alcohol, 5 g of the sample, and some water after centrifugation for 5 minutes. To measure dry matter, 0.5 g of the sample was placed in a moisture meter, and the ash content was calculated gravimetrically in an oven. Brix was measured using a refractometer. The viscosity of the samples was measured before freezing at 25°C using a Brookfield apparatus

(Model DV2T, USA). The protein content was determined by the Kjeldahl method and the sugar content by the Fehling method [21,23,24].

Formula 1 – Calculation of acidity percentage:

$$\text{Acidity (\%)} = \frac{V \times 0.009 \times 100}{W}$$

V = Volume of used profit (ml)

W = Sample weight (g).

2-4- Sensory Analysis

A group of 20 trained individuals (both sexes and between the ages of 20 and 50) participated in this test. Sensory evaluation of ice cream was performed using a five-point hedonic scale to determine the quality and acceptability; this scale ranged from “very much like” to “very much dislike”. The parameters examined included taste, smell, texture, color, and overall acceptability, which were evaluated at three time points (days 1, 21, and 41). For this purpose, 50 g of each sample was provided to the participants in numbered containers [25,26].

2-5- Microbial tests

After the ice cream samples were prepared and cooled, microbiological analysis was performed using the pure plate method on YGC¹ agar. Each sample was tested three times. For yeast and mold cultivation, 1 ml of each sample of melted and sterile ice cream was taken and poured into a plastic plate, and diluted. The cultured plates were incubated for 5 days at 25 degrees, and then the plates were examined and counted under a colony counter [2,27].

2-6- Statistical analysis

The experiment was factorial in a completely randomized design. To determine the significance of the treatments ($p < 0.05$) or the non-significance of the treatments ($p > 0.05$), one-way analysis of variance was used, and the means were compared with Duncan's test at a probability level of 5%. Table 1 shows the treatments in the study.

Table 1. Ingredients for ice cream samples

	Control	T1	T2	T3
Sugar	14%	10.5%	7%	3.5%
Milk powder	4%	4%	4%	4%
Glucose	5%	5%	5%	5%
Fat	10%	9.25%	8.5%	7.75%
Stabilizer	0.55%	0.55%	0.55%	0.55%
Date syrup	0%	3.5%	7%	10.5%
Date kernel powder	0%	0.75%	1.5%	2.25%
Skim milk	66.45%	66.45%	66.45%	66.45%

3-Results and Discussion

3-1-pH and Acidity

The results obtained in Table 2 regarding different pH and acidity levels show that with increasing storage time, pH decreases, while acidity increases. The highest pH was observed in the control sample on the first day, and the lowest acidity was observed in the control sample. The lowest pH was observed in sample T3, which contained 2.25% date kernel powder and 75% date sap with 33.6 on the first day. The highest acidity was also recorded in sample T3 in accordance with the Iranian National Standard (2450, 1386) (Figure 2). Acidity is a critical parameter for determining the quality of dairy products, and

no significant difference was observed in the samples by replacing date sap and date kernel powder. Arslaner *et al.* (2019) investigated the qualitative properties of ice cream yogurt and observed that adding honey to ice cream reduced its pH [28]. Taherian *et al.* (2021) studied the production of ice cream with date syrup and observed that with increasing date syrup, pH decreased and acidity increased. They also stated that no significant difference in acidity was observed, which is due to the lack of decomposition of sugar sources during ice cream production [23]. In another study, Hosseini and Sedaghati (2023) studied the production of a milk dessert containing date kernel powder, and the results showed that with increasing date kernel powder, pH decreased and acidity increased [29].

¹-Yeast Glucose Chloramphenicol

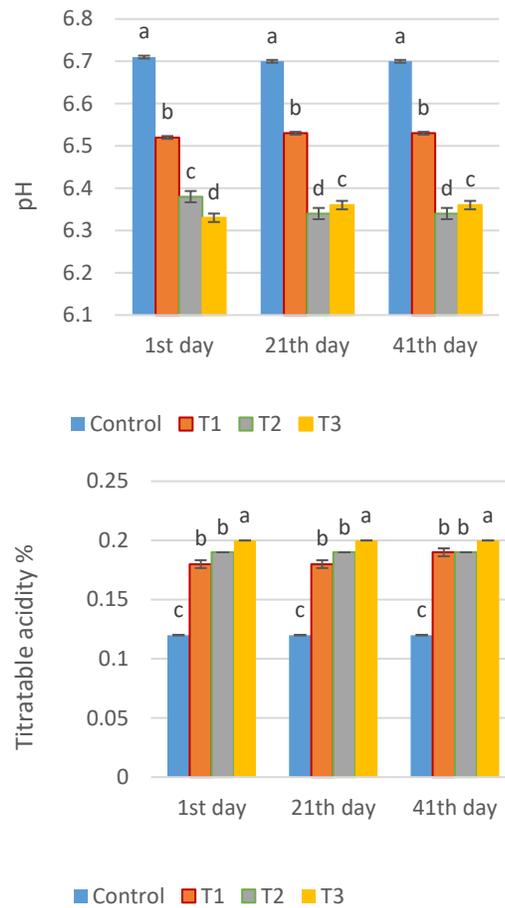


Figure 2. Changes in pH and acidity of diet ice cream

3-2- Percentage of sucrose and total sugar

The results show that with increasing the amount of date syrup, the percentage of sucrose and total sugar decreased significantly ($P < 0.05$). The highest percentage of total sugar was observed in the control sample on the first day (22.64%) and the lowest in the T3 sample on the first day (9.6%). Regarding the percentage of sucrose, the highest was observed in the control sample (15.08%) and the lowest in the T3 sample (1.5%) (Figure 3). Chamchan *et al.* (2017) investigated the properties of herbal ice cream produced with lemon balm and ginger extract along with xylitol. The results showed that replacing

xylitol can reduce up to 65% of total sugar [30]. Gheisari *et al.* (2020) stated that dates can be a suitable alternative to natural ones, which are also rich in carbohydrates and phenolic compounds [31]. Ahmed *et al.* (2023) studied the production of ice cream with stevia sweetener and stated that stevia extract contains glucose and fructose and can be a healthy and suitable alternative to sucrose [32]. Da Silva Faresin *et al.* (2022) studied the properties of ice cream containing inulin and spirulina. The results showed that the addition of inulin (2%) and spirulina (1%) reduced fat by 50% and sugar by 25% [33].

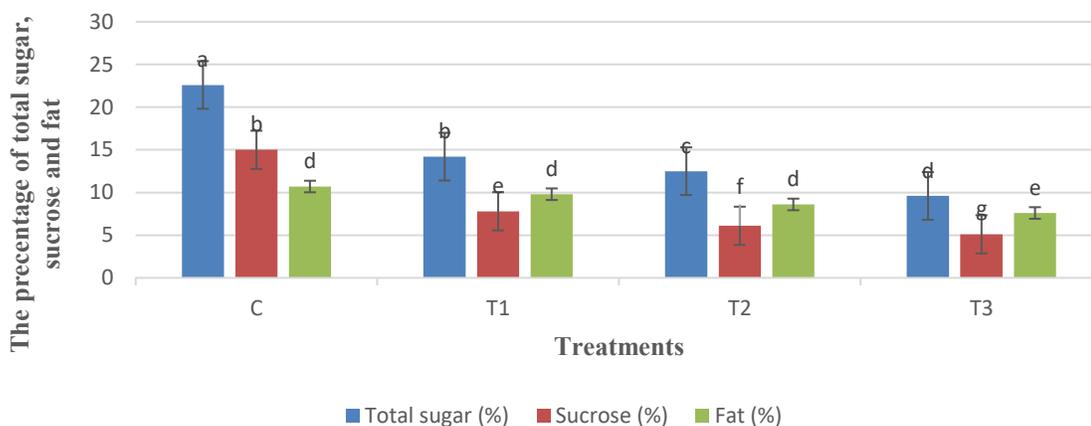


Figure 3. Changes in percentage of fat, sucrose and total sugar in ice cream samples.

3-3- Percentage of dry matter, fat, protein, and ash

According to Table 2, with increasing the amount of date sap and date kernel powder, significant changes were observed in the percentage of dry matter, fat, protein, and ash ($P < 0.05$). Regarding dry matter, with increasing the amount of date sap and date kernel powder, the percentage of dry matter decreased significantly ($P < 0.05$), and the highest amount was recorded for the control sample (38.9%) and the lowest amount was recorded for the T3 sample (35.7%). Durmaz *et al.* (2020) prepared ice cream containing natural color from dried microalgae using a spray dryer method, which led to a decrease in the amount of dry matter [34].

The results showed that the percentage of fat decreased with increasing the amount of date kernel powder. The highest amount of fat was observed in the control sample (10.7%) and the lowest in the sample containing 2.25% of date kernel powder (7.6%). Akalin *et al.* (2018) studied the enrichment of probiotic ice cream with fiber and stated that adding apple, orange, barley, bamboo, and wheat fiber reduced fat in ice cream [23]. Wang *et al.*

(2022) also stated that ice cream produced with soybean oil as a substitute for milk fat resulted in a significant reduction in fat content [35]. Mehrjoo *et al.* (1402) studied the production of yogurt containing date kernel powder and observed that with the addition of date kernel powder, the fat content of yogurt decreased significantly, with the highest amount observed in the control sample (3%) and the lowest in the sample containing 3% date kernel powder (1.55%) [36]. The results obtained from protein showed that with the increase of date syrup and date kernel powder, the percentage of protein in ice cream increased significantly ($P < 0.05$), and the lowest amount of protein was recorded in the control sample (4.10%) and the highest amount was recorded in the T3 sample (4.5%). Akalin *et al.* (2018) also stated that adding fiber to probiotic ice cream increases protein [23]. Mehrjoo *et al.* (1402) stated that a significant increase in protein was observed with increasing date kernel powder, such that the lowest value was reported for the control sample (3.58%) and the highest value was reported for the sample containing 4% date kernel powder (4.35%) [36]. The results obtained regarding ash percentage showed that with increasing the amount of date syrup and date kernel powder, the ash percentage

increased significantly ($P < 0.05$). The lowest ash content was recorded in the control sample (1.3%) and the highest in the T3 sample (3.3%) [34]. Elkot *et al.* (2022) investigated the properties of synbiotic ice cream using black rice and *Lactobacillus acidophilus*, and the results showed that with increasing the amount of black rice, the ash percentage increased significantly [37]. Saadi *et al.* (2022) investigated the properties of low-fat ice cream containing maple syrup, and the results showed that with increasing maple syrup, the ash percentage also increased [38].

3-4- Brix

The results showed that the Brix degree decreased significantly with the increase in date sap and date kernel powder ($P < 0.05$). The highest Brix level was observed in the control sample (38.9%) and the lowest in the T3 sample (28.9%). Rahim *et al.* (2019) investigated the physicochemical properties of acacia honey lemon ice cream with different hydrocolloids and observed that the Brix level decreased with the addition of acacia honey [39].

3-5- Viscosity

Viscosity is a measure of the resistance of a fluid to flow. With increasing viscosity, the energy required for aeration and freezing increases. The most important factors affecting viscosity are fat content, stabilizers, and casein. Viscosity is also an important factor in the speed of creaming, mass and heat transfer, and has a great impact on the sensory quality of the product. Increasing viscosity delays ice crystal formation and growth and improves appearance, air composition, and texture [21,40]. Table 2 shows the changes in

viscosity, and Figure 4 shows the changes in viscosity and shear rate. After preliminary tests, spindle 2 was selected as the most suitable for the experiment. The results show that with the increase of date sap and date kernel powder, a significant difference in viscosity was observed ($P < 0.05$). The lowest viscosity was recorded in the control sample at 196.2 cP, and the highest was recorded in the sample containing 75% and 2.25% date kernel powder at 246 cP (Figure 4). The changes in viscosity with shear rate are attributed to the decrease in sucrose and the increase in monosaccharides and fiber. Milani and Koocheki (2011) observed that viscosity increased in a low-fat frozen yogurt dessert containing date syrup and guar gum with an increase in date syrup and guar gum [40]. Moriano and Alamprese (2017) reported that ice cream with honey replacing sucrose showed a decrease in viscosity, which was due to the substitution of honey and a decrease in solid content [41]. Silva Avellaneda *et al.* (2021) noted that the production of whey protein-based ice cream increased density and viscosity [42]. Gheisari *et al.* (2020) investigated the properties of ice cream containing date syrup, and the results showed that viscosity also increased with the increase in date syrup. They also stated that date syrup contains a large amount of phenolic compounds, anthocyanins, and carbohydrates, and is a good source of energy [31]. Hajian *et al.* (2020) investigated the properties of low-fat ice cream produced with camel milk casein and antioxidant hydrolysates. The results showed that viscosity increased with the addition of protein [43]. Tolve *et al.* (2024) stated that the addition of dietary fibers such as inulin, acacia, oat, and apple to low-fat ice cream significantly increased viscosity [44].

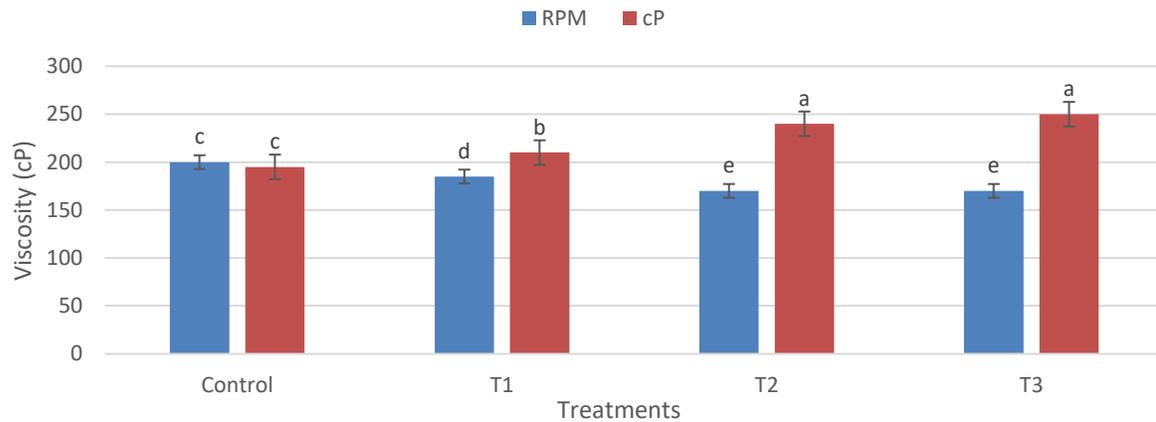


Figure 4. Changes in viscosity (cP) of diet ice cream samples containing different levels of date syrup and date kernel powder at 25°C and different shear rates (rpm)

* cP = Centipoise (unit of viscosity), rpm = revolutions per minute

3-6- Mold and Yeast

The results indicate that ice cream produced with date syrup and date kernel powder was free of mold and yeast, which could be due to the antimicrobial and antioxidant properties of date syrup and date kernel powder. The results obtained are in accordance with the results of Ismail (2020) regarding ice cream enriched with pomegranate syrup and peel [45]. Taleb

et al. (2016) investigated the antibacterial effect of date syrup polyphenols on a variety of bacteria and found that antioxidants such as tannins, flavonoids, and phenols present in date syrup, along with its relatively acidic pH, help reduce bacterial growth. In addition, high concentrations of fructose and glucose create high osmotic pressure in the product, which reduces water activity and inhibits the growth of microorganisms [27].

Table 2. The effect of date syrup and date kernel powder replacement ratio on the physicochemical and microbial properties of ice cream samples during storage

Treatments	pH (\pm SD)			Titratable Acidity (%) (\pm SD)		
	1 st day	21th day	41th day	1 st day	21th day	41th day
Control	6.71 \pm 0.05 ^a	6.70 \pm 0.04 ^a	6.70 \pm 0.04 ^a	0.12 \pm 0.01 ^c	0.12 \pm 0.01 ^c	0.12 \pm 0.01 ^c
T1	6.52 \pm 0.06 ^b	6.53 \pm 0.05 ^b	6.53 \pm 0.05 ^b	0.18 \pm 0.01 ^b	0.18 \pm 0.01 ^b	0.19 \pm 0.01 ^b
T2	6.38 \pm 0.04 ^c	6.34 \pm 0.05 ^c	6.34 \pm 0.05 ^c	0.19 \pm 0.01 ^b	0.19 \pm 0.01 ^b	0.19 \pm 0.01 ^b
T3	6.33 \pm 0.04 ^c	6.36 \pm 0.04 ^c	6.36 \pm 0.04 ^c	0.20 \pm 0.01 ^a	0.20 \pm 0.01 ^a	0.20 \pm 0.01 ^a
	Sugars (%) (\pm SD)			Total sugar (%) (\pm SD)		
	1 st day	21th day	41h day	1 st day	21th day	41th day

Control	15.03 ± 0.10 ^a	15.08 ± 0.12 ^a	15.08 ± 0.11 ^a	22.64 ± 0.15 ^a	22.24 ± 0.16 ^a	22.24 ± 0.15 ^a
T1	7.79 ± 0.08 ^b	7.76 ± 0.09 ^b	7.76 ± 0.08 ^b	14.20 ± 0.12 ^b	14.50 ± 0.13 ^b	14.50 ± 0.14 ^b
T2	6.08 ± 0.07 ^c	6.02 ± 0.06 ^c	6.02 ± 0.06 ^c	12.47 ± 0.11 ^c	12.47 ± 0.10 ^c	12.63 ± 0.11 ^c
T3	5.13 ± 0.05 ^d	5.10 ± 0.06 ^d	5.10 ± 0.06 ^d	9.60 ± 0.09 ^d	9.80 ± 0.09 ^d	9.80 ± 0.10 ^d
	Protein (%) (±SD)			Fat (%) (±SD)		
	1 st day	21th day	41th day	1 st day	21th day	41th day
Control	4.10 ± 0.05 ^d	4.15 ± 0.04 ^d	4.15 ± 0.04 ^d	10.70 ± 0.10 ^a	10.60 ± 0.10 ^a	10.60 ± 0.11 ^a
T1	4.18 ± 0.05 ^c	4.18 ± 0.05 ^c	4.21 ± 0.05 ^c	9.80 ± 0.09 ^b	9.90 ± 0.09 ^b	9.80 ± 0.09 ^b
T2	4.30 ± 0.04 ^b	4.30 ± 0.05 ^b	4.40 ± 0.05 ^b	8.60 ± 0.08 ^c	8.70 ± 0.08 ^c	8.80 ± 0.08 ^c
T3	4.40 ± 0.05 ^a	4.40 ± 0.04 ^a	4.50 ± 0.05 ^a	7.60 ± 0.07 ^d	7.70 ± 0.07 ^d	7.70 ± 0.07 ^d
	Dry matter (%) (±SD)			°Brix (±SD)		
	1 st day	21thday	41th day	1 st day	21thday	41th day
Control	38.90 ± 0.20 ^a	38.40 ± 0.20 ^a	38.80 ± 0.21 ^a	38.90 ± 0.20 ^a	38.50 ± 0.21 ^a	38.50 ± 0.20 ^a
T1	36.30 ± 0.18 ^b	36.10 ± 0.18 ^b	36.50 ± 0.18 ^b	35.70 ± 0.18 ^b	35.50 ± 0.18 ^b	36.80 ± 0.18 ^b
T2	36.00 ± 0.18 ^b	36.40 ± 0.18 ^b	36.40 ± 0.19 ^b	32.40 ± 0.17 ^c	32.60 ± 0.17 ^c	32.60 ± 0.18 ^c
T3	35.70 ± 0.17 ^c	35.10 ± 0.17 ^c	35.10 ± 0.17 ^c	28.90 ± 0.16 ^d	28.80 ± 0.16 ^d	28.80 ± 0.16 ^d
	Ash (g/100) (±SD)			Mold and yeast (CFU/ml)		
	1 st day	21thday	41th day	1 st day	21th day	41th day
Control	1.30 ± 0.05 ^d	1.20 ± 0.05 ^d	1.30 ± 0.05 ^d	Not detected	ND	ND
T1	2.10 ± 0.06 ^c	2.30 ± 0.06 ^c	2.30 ± 0.06 ^c	ND	ND	ND
T2	2.70 ± 0.07 ^b	2.40 ± 0.07 ^b	2.50 ± 0.07 ^b	ND	ND	ND
T3	3.30 ± 0.08 ^a	3.00 ± 0.08 ^a	3.00 ± 0.08 ^a	ND	ND	ND
	Viscosity(cP) (±SD)					
	cP	RPM	%			
Control	196.2 ± 2.0 ^d	200	98/1			
T1	221.1 ± 2.1 ^c	180	99/5			
T2	248.8 ± 2.2 ^a	160	99/5			
T3	246.0 ± 2.2 ^b	160	98/4			

Values are expressed as mean \pm standard deviation (n=3). Different lowercase letters within each column indicate significant differences at $p < 0.05$ according to LSD test

3-7- Melting resistance

One of the important indicators for measuring the quality of ice cream is its melting resistance, which is measured by the melting speed of the ice cream [46]. The melting process involves heat transfer from the environment to the interior of the ice cream, which causes the ice crystals to melt. Factors affecting melting include the size and structure of ice crystals, the increase in volume, and the network of fat globules. The binding of water reduces its accessibility, which leads to an increase in the freezing point and a decrease in the melting point [21,47]. Ice cream samples stored at -18 degrees Celsius were placed on a stainless-steel grid with a pore diameter of 2 mm after being removed from the container, and the time of the first, second, third, fourth drop, and the drop of ice cream at 25 degrees Celsius was recorded according to Chart 5. The results showed that with increasing the amount of date syrup and date kernel powder, due to the presence of

moisture-absorbing compounds, polysaccharides, viscosities, and various sugars, it can absorb water and increase the gelling property and reduce the melting intensity. Milani and Koocheki (2011) studied the physicochemical properties of ice cream containing date syrup and guar gum in a low-fat frozen yogurt dessert, and the results showed that melting stability increased with increasing date syrup and guar gum [40]. Mir-Arab-Rezi *et al.* (2016) stated regarding the melting resistance of ice cream containing malt extract that with increasing the amount of malt, the melting intensity decreased, which was due to the presence of viscosity and moisture absorption in malt. They also recorded the melting time of the first drop in the control sample as 12.3 minutes and the sample containing 50% malt extract as 15.03 minutes [48]. Sang Sefidi *et al.* (2018) also stated that adding banana puree increased the melting resistance of ice cream [49]. Airoldi *et al.* (2022) stated that replacing fat with carnauba wax oleogel reduced the melting speed of ice cream [50].

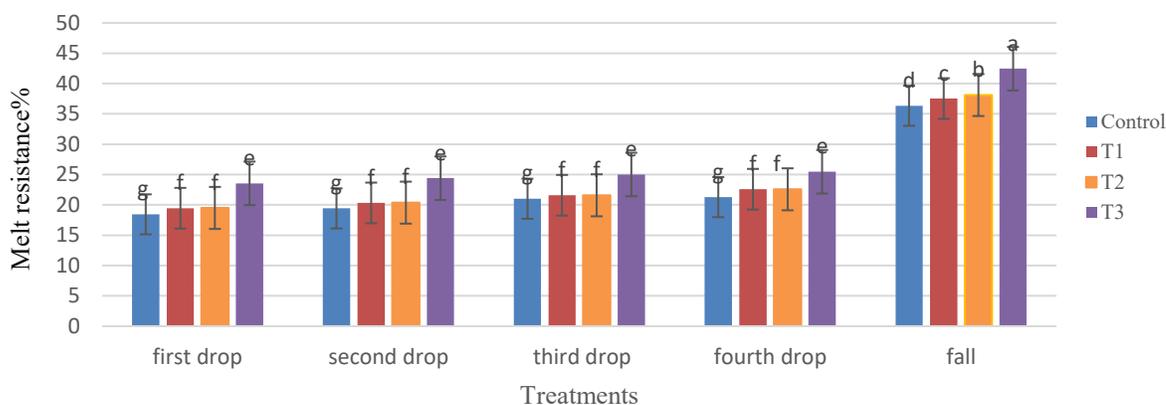


Figure 5. Changes in melting resistance of diet ice cream

3-8- Sensory evaluation

The results of the data comparison were carried out by trained members during 41 days of ice cream storage to evaluate texture, taste, odor, color, and overall acceptance using a

five-point hedonic scale. The results obtained are shown in Figure 6. No significant changes were observed in the results with increasing storage time. In terms of texture, there was no significant difference between the control, T1, and T2 samples, and the highest score was

given to sample T2 (score 4.6), and sample T3 had the lowest score (score 3.8) due to its coarse sand-like texture. Regarding taste, no significant difference was observed between samples T1 and T2, and the highest score was given to the sample containing 1.5% date kernel powder and 50% date juice (score 4.65), and the lowest scores were given to the control sample and T3 (score 3.8) due to the absence of any flavoring in the control sample and the increase in the taste of additives. In terms of color, no significant difference was observed between the control sample, T1, and T2, and they obtained scores of 4.35 and 4.65, respectively, but sample T3 obtained the lowest score (score 4.2) due to the darkness of the product. Product evaluation regarding smell showed that there was no significant difference between samples T1, T2, and T3, and they were accepted (scores 4.6, 4.6, and 4.65, respectively), but due to the absence of additives in the control sample, the product obtained the lowest score (3.8). The highest overall acceptance was obtained by T2 (score 4.6) and then by T1 (score 4.35), which

indicated that the texture, taste, flavor, and smell were desirable and liked by consumers, and the lowest acceptance was obtained by the sample containing 25.2% date kernel powder and 75% date syrup due to its sandy texture, sweet taste, and dark color with a score of 8.3. In a study, Hashim *et al.* (2016) investigated the acceptance of ice cream produced with date syrup. The results obtained from one hundred consumers who consume ice cream at least once a week showed that ice cream has similar and higher sensory properties and a softer texture, and consumers were willing to consume this product again. Also, 79% of the participants were willing to pay the same or higher price for this product [17]. In another study, Suleiman *et al.* (2022) investigated the sensory evaluation of ice cream with date syrup, and the results showed that ice cream was liked by consumers. They also stated that it was welcomed for reasons such as the absence of artificial flavors and colors and the presence of natural sugars such as glucose and fructose, which are suitable for energy absorption [15].

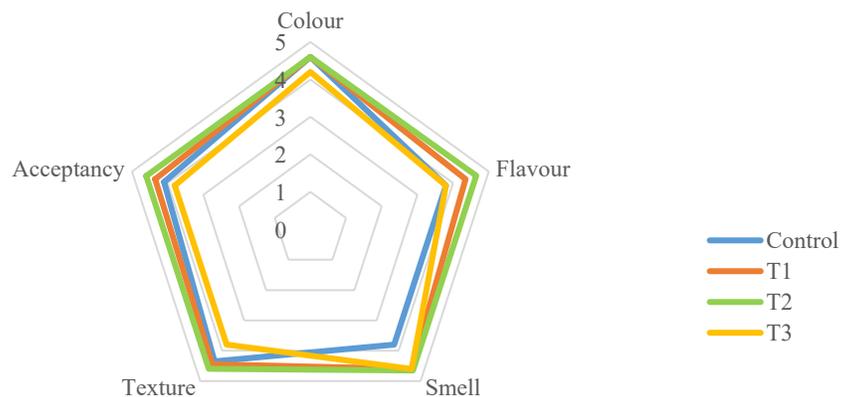


Figure 6. Sensory evaluation of ice cream samples with date syrup and date kernel powder

4-General Conclusion

The results indicate that sample T2, containing 1.5% date kernel powder and 50% date syrup, has higher

physicochemical and sensory acceptability compared to other samples. In addition, it is also nutritionally significant due to the significant reduction in sugar and fat content. Also, considering

the widespread popularity of ice cream in all age groups and the high prevalence of diabetes and obesity in society, products with reduced fat and sugar can be produced by using appropriate alternatives such as date syrup and date kernel powder. Considering the use of food waste in this product, it is also significant from an environmental perspective.

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Data Availability

The data used to support the finding of this study are available from the corresponding author upon request.

Conflict Of Interest

The authors have no conflicts interest to report.

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مقاله علمی-پژوهشی

بررسی اثر جایگزینی شیره و پودر هسته خرما بر ویژگی های فیزیکی شیمیایی و حسی بستنی رژیمی

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اطلاعات مقاله	چکیده
<p>تاریخ های مقاله :</p> <p>تاریخ دریافت: ۱۴۰۴/۰۱/۰۸</p> <p>تاریخ داوری: ۱۴۰۴/۰۷/۱۴</p> <p>تاریخ پذیرش: ۱۴۰۴/۰۷/۲۷</p>	<p>بستنی یکی از دسرهای پر مصرف است که به دلیل دارا بودن مقادیر بالای قند و چربی می تواند زمینه ساز مشکلات متابولیکی و چاقی شود. استفاده از جایگزین های طبیعی و در دسترس، ضمن کاهش کالری، ارزش تغذیه ای محصول را ارتقا می دهد. در این پژوهش از شیره خرما (به عنوان جایگزین شکر) و پودر هسته خرما (به عنوان جایگزین چربی) در سطوح مختلف استفاده شد. چهار فرمولاسیون بستنی شامل شاهد (بدون جایگزین)، T1 (۲۵٪ شیره خرما و ۰/۷۵٪ پودر هسته خرما)، T2 (۵۰٪ شیره خرما و ۱/۵٪ پودر هسته خرما) و T3 (۷۵٪ شیره خرما و ۲/۲۵٪ پودر هسته خرما) تهیه و در روزهای ۱، ۲۱ و ۴۱ در دمای ۱۸- درجه سانتی گراد از نظر ویژگی های فیزیکی شیمیایی، حسی و میکروبی مورد ارزیابی قرار گرفتند. نتایج نشان داد با افزایش میزان جایگزینی، درصد چربی، ساکارز، قند کل، بریکس، pH و ماده خشک به طور معنی داری کاهش یافت ($p < 0.05$)، در حالی که مقدار پروتئین، اسیدیته، ویسکوزیته، خاکستر و نقطه ذوب افزایش معنی داری داشت ($p < 0.05$). نمونه T2 بالاترین پذیرش حسی را در آزمون هدونیک پنج نقطه ای به دست آورد و نسبت به نمونه شاهد کاهش ۵۹/۵۴٪ در ساکارز، ۴۴/۹۲٪ در قند کل و ۱۹/۶۲٪ در چربی نشان داد. همچنین بررسی های میکروبی بیانگر آن بود که تمامی نمونه ها در محدوده مجاز استاندارد ملی قرار داشتند. یافته ها حاکی از آن است که شیره خرما و پودر هسته خرما می توانند جایگزین های مناسبی برای قند و چربی در تولید بستنی رژیمی باشند و محصولی با کیفیت تغذیه ای و پذیرش مطلوب ارائه دهند.</p>
<p>کلمات کلیدی:</p> <p>بستنی رژیمی، پودر هسته خرما، شیره خرما، فیبر غذایی، کاهش چربی و قند</p> <p>DOI: 10.48311/fsct.2026.84015.0</p> <p>* مسئول مکاتبات: alireza_shahablavasani@iaui.ac.ir</p>	