Effect of date syrup as a substitute for sugar on physicochemical and sensory properties of ice cream

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Key words: Date syrup, ice cream, viscosity, overrun and freezing point.

Abstract

Sugar as a usual sweetener added to formulation of different food stuff, but it is associated with diabetic problems. On the other hand date syrup is natural sweetener that contains a low percentage of sugar. In this study, date syrup at different concentrations (25, 50, 75, and 100%) was substitute for sugar in the formulation of two different ice cream which contained alginate and taragacanth as stabilizer. The different properties were investigated. The results showed that addition of date syrup significantly increased viscosity and ash content and reduced solid matters and freezing point; however, it did not have any significant effect on acidity and pH value. To comparing two different hydrocolloids alginate and taragacanth caused greater viscosity in both date syrup and sugar – contained samples.

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**Introduction**

Ice cream as a complex multi-phase system consists of a viscous frozen matrix in which ice crystals and fat globules are included (Arbuckle, 1977). In addition to the components of milk, sugar, hydrocolloids, and various flavorings are always included in the formulation of ice cream in order to improve its texture and flavor. A wide range of hydrocolloids include alginate, gelatin, and guar as stabilizers have been used in the formulation of ice cream. Hydrocolloids are actually a group of carbohydrates which mainly function to increase the viscosity of the unfrozen part of water and maintain it so that water is prevented from moving into the ice cream. This inhibits the formation of large crystals during storage making the texture of ice cream softer. In the absence of stabilizers, ice cream develops a coarse and icy texture because free water moves and joins the ice crystals making them to grow (Goff and Sahagian, 1996). One of the less widely used stabilizers is tragacanth gum. Tragacanth gum is naturally dried exuded gum from some species of astragalus being widely applied in food industries as a stabilizer, emulsifier, thickening agent and fat substitute. Sugar as a natural sweetener has superior functional properties, however it is associated with some health problems such as hypertension, cardiovascular diseases, teeth decay obesity increased level of glucose and insulin that is especially harmful to diabetic patients. Thus research is being conducted on the substitution of other sweeteners for sugar (Foulkes, 1977). Date syrup one of the most valuable date secondary products being rich in natural sugars such as fructose and glucose but it contains a low percentage of sugar. Fructose physiologically, requires no insulin for its absorption thus it is a suitable sugar for diabetic patients providing a high amount of energy. Also date syrup contains high amounts of potassium, calcium phosphorous and iron which make it suitable for children, nursing mothers, and the elderly (Gohariardebili et al., 1984). In the present study, date syrup, in replace of sugar, was included in the formulation of two types of ice cream which containing alginate and tragacanth and different physicochemical properties were examined.

**Materials and methods**

**Ice-cream preparation**

For ice cream preparation, its ingredient was mixed and pasteurized at 80 °C, after that by salt and ice bath, its temperature was reduced and reached to 5 °C and for 4 h storage in refrigerator. After this period 100cc of samples was removed for physicochemical analyses (pH, acidity, ash, total solid) and 900cc infuse in ice cream maker machine (Geepas) and freezing process was done for 20 min (Goff and Sahagian, 1996). Vanilla – flavored ice cream with 18% sugar served as the control and the formulation was as below; cream: 8.26%, gum (tragacanth or alginate):0.4%, milk with 2.5% fat: 69.3%, dry milk: 4.04. For other samples, date syrup at four levels (25, 50, 75, and 100%) was included in the formulation as a substitute for sugar. Ten ice cream samples were prepared following the formulation given in Table 1.

**Physicochemical analyses**

The test for pH, acidity, ash and solid matters determination was used as per Iranian national standard method No. 2450 (ISIRI, 2000).

**Viscosity**

The viscosity was measured by viscometer (Bruckfield model RV-DVII, USA) at 50°C. In order to find the best spindle a preliminary test was conducted and spindle No. 2 was selected as the best spindle for measurements. The viscosity was measured at 140 rpm (Bahram Parvar et al., 2010).

**Overrun**

Comparison of a certain volume of ice cream was performed in order to measure volume increase. To do so a sample of ice cream mixture was prepared before and after freezing and weighed. The overrun or volume increase was calculated using the following relation:

\[
\text{Volume increase} = \frac{\text{sample weight before freezing} - \text{sample weight after freezing}}{\text{sample weight after freezing}} \times 100
\]

**Freezing point**
In order to measure the freezing point temperature, the temperature of ice cream was measured by thermometer that is special for temperature below (Marshall and Arbuckle, 1996).

Sensory evaluation
Sensory evaluation was performed according to Iranian National standard No. 4937, as the panelists were asked to score the texture and flavor of ice cream, 5 and 1 represented the highest and the lowest scores, respectively.

Statistical Analysis
Software MINITAB 14 was used for data statistical analysis. The analyses were performed in completely randomized design with probability level being 0.05.

Results and discussion
Acidity and pH
The results of acidity and pH measurements are presented in Table 2. As shown in the Table 2 the produced ice cream samples have no significant (P<0.05) difference in acidity however, as the concentration of date syrup increased from 0 to 100%, the acidity showed a rising trend in both taragacanth – and alginate – contained samples. For instance the control sample has an acidity value of 0.20% whereas it increased to 0.24%, in samples H4 and H9 containing 100% date syrup. pH also showed insignificant variations supporting the results obtained for acidity. The highest pH value was observed for the control (6.5) and the lowest value (6.06) was found for H4. These differences also were not significant (p<0.05). As determined by Iranian national standard No. 2450, the acidity of ice cream should not exceed 0.2%. The acidity of all samples falls within the standard range. In all samples acidity increased steadily as the concentration of date syrup increased. This may be explained by the fact that sugar or simply sugar does not have any acid property by itself, while in water phase due to the presence of pectin compounds, date syrup may exhibit acid property, i.e. it may convert to pectic or pectinic acids. However, these are weak acids as they are hardly ionized with low P<sub>k</sub>a and the reactions become balanced upon ionization. This is why insignificant decrease in acidity was observed for the samples. On the other hand the acidity of ice cream is affected by solid matters (Hagen and Narvhus, 1999). As shown in the Table 2 total solid matters content did not much change thus the results of acidity measurement support the results of total solid matters content. pH value of the date syrup used in this study was 5.5 which is somewhat acidic resulting in increased acidity and reduced pH. Amir oghdaeis et al. (2012) reported a pH value of 6.2 for their produced ice cream being near the value found in this work (Amir oghdaeis et al, 2012).

Table 1. Different Ice-cream samples formulation.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Milk (2.55% fat)</th>
<th>Dried milk</th>
<th>Cream</th>
<th>Sugar</th>
<th>Date syrup</th>
<th>Alginate</th>
<th>Taragacanth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>18</td>
<td>0</td>
<td>0.40</td>
<td>0</td>
</tr>
<tr>
<td>H1</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>13.50</td>
<td>4.50</td>
<td>0.40</td>
<td>0</td>
</tr>
<tr>
<td>H2</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>9</td>
<td>9</td>
<td>0.40</td>
<td>0</td>
</tr>
<tr>
<td>H3</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>4.50</td>
<td>13.50</td>
<td>0.40</td>
<td>0</td>
</tr>
<tr>
<td>H4</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>0</td>
<td>18</td>
<td>0.40</td>
<td>0</td>
</tr>
<tr>
<td>H5</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0.40</td>
</tr>
<tr>
<td>H6</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>13.50</td>
<td>4.50</td>
<td>0</td>
<td>0.40</td>
</tr>
<tr>
<td>H7</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0.40</td>
</tr>
<tr>
<td>H8</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>4.50</td>
<td>13.50</td>
<td>0</td>
<td>0.40</td>
</tr>
<tr>
<td>H9</td>
<td>69.30</td>
<td>4.04</td>
<td>8.26</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Ash
The results of ash measurement are presented in Table 2. As the content of date syrup increased in both types of ice cream ash content showed a significant increase ($p<0.05$) such that the control had the smallest amount of ash (0.45%) and the samples containing alginate and taragacanth had ash contents of 1.03 and 1% respectively. Interestingly, at the same concentration of date syrup there was no significant difference between two ice cream containing two different hydrocolloids. For example samples H1 and H6 (contained 25% date syrup) and H9 and H4 (contained 100%) had the same ash contents ($p<0.05$). Ash indicates minerals content in the product. Its higher amount contributes to higher nutritional value of final product. According to Hooti et al. (2002), ash constitutes about 2% of wet weight of ripe dates. It consists of calcium potassium phosphorous. Chlorine, sulphur magnesium, iron, copper, etc. During date syrup production these compounds totally enter into the syrup. Date syrup applied in this formulation contained 5.2% ash. So, it is reasonable that ash content shows an increase as the amount of date syrup increased. Since at the same concentration of date syrup as content in both types of ice cream with two different hydrocolloids did not show any significant difference it may concluded that both hydrocolloids (alginate and taragacanth) have similar ash content. El owni and khater (2009) reported an ash content of 0.39 – 0.64% for their produced ice cream being consistent with our results.

Table 2. Physicochemical properties of different Ice-cream samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Acidity (%)</th>
<th>pH</th>
<th>Ash (%)</th>
<th>Dry matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.20±0.02 *</td>
<td>6.50±0.00 *</td>
<td>0.45±0.01 d</td>
<td>39.15±1.20 a</td>
</tr>
<tr>
<td>H1</td>
<td>0.21±0.01 a</td>
<td>6.25±0.02 a</td>
<td>0.55±0.03 c</td>
<td>38.66±1.45 ab</td>
</tr>
<tr>
<td>H2</td>
<td>0.21±0.05 a</td>
<td>6.15±0.12 a</td>
<td>0.67±0.01 b</td>
<td>38.02±0.80 b</td>
</tr>
<tr>
<td>H3</td>
<td>0.22±0.03 a</td>
<td>6.10±0.10 a</td>
<td>0.78±0.02 b</td>
<td>37.52±2.30 b</td>
</tr>
<tr>
<td>H4</td>
<td>0.24±0.08 a</td>
<td>6.06±0.13 a</td>
<td>1.03±0.04 a</td>
<td>37.11±1.17</td>
</tr>
<tr>
<td>H5</td>
<td>0.21±0.03 a</td>
<td>6.30±0.05 a</td>
<td>0.43±0.02 a</td>
<td>38.92±1.25 a</td>
</tr>
<tr>
<td>H6</td>
<td>0.23±0.02 a</td>
<td>6.50±0.00 a</td>
<td>0.50±0.03 c</td>
<td>38.12±0.85 a</td>
</tr>
<tr>
<td>H7</td>
<td>0.22±0.03 a</td>
<td>6.26±0.03 a</td>
<td>0.65±0.08 b</td>
<td>37.52±2.30 ab</td>
</tr>
<tr>
<td>H8</td>
<td>0.23±0.02 a</td>
<td>6.08±0.10 a</td>
<td>0.75±0.02 b</td>
<td>37.76±1.45 b</td>
</tr>
<tr>
<td>H9</td>
<td>0.24±0.04 a</td>
<td>6.09±0.04 a</td>
<td>1.00±0.01 a</td>
<td>37.64±1.67 b</td>
</tr>
</tbody>
</table>

Results are expressed as mean ± standard deviation.

Values with similar superscript letters represent no significant difference ($p<0.05$).

Total solid
The results of solid matters measurement are presented in Table 2. Increased date syrup and reduced sugar content have caused a significant falling trend for solid matters ($p<0.05$). Solids contents in the control sample containing taragacanth and alginate are 39.14% and 38.92% respectively being statistically similar ($p<0.05$). In the samples containing alginate, solids contents are 38.66%, 38.02, 37.52 and 37.11 respectively as the concentration of date syrup increased to 25%, 50%, 75% and 100%. Taragacanth – contained samples also showed a falling trend as solids content in sugar – free sample decreased to 37.64%. According to Iranian national standard No. 2450 minimum permitted solid matters in ice cream is 28% so all produced samples comply with the standard. One of parameters that directly affect the quality of foods is total solid matters. As total solids increased in food systems the fluidity of food decreases namely an increase in viscosity occurs. This is true for ice cream. Total solid matters directly and effectively affect the texture of ice cream resulting in firm texture and improved mouth feel. In this study there were no significant differences among ice cream samples despite the fact that sugar content was reduced and it
was replaced by date syrup. However total solids significantly decreased which seems reasonable, because sugar omitted from the formulation contains no moisture i.e. sugar reduction directly results in decreased total solids content and since the same amount of date syrup is added total solids content should decline ultimately because date syrup contains water (date syrup used here contained 14% moisture) exerting less effect that sugar. Bernard et al., (1984) reported total solids content of 37-40% for their traditional made samples being in agreement with our results.

Table 3. Physicochemical properties of different ice cream samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Viscosity(cp)</th>
<th>Overrun (%)</th>
<th>Freezing point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>160±7.08&lt;sup&gt;1&lt;/sup&gt;</td>
<td>51±1.32&lt;sup&gt;4&lt;/sup&gt;</td>
<td>-3.80±0.36&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>H1</td>
<td>181±5.12&lt;sup&gt;4&lt;/sup&gt;</td>
<td>62±1.15&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>-4.00±0.89&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>196±6.57&lt;sup&gt;5&lt;/sup&gt;</td>
<td>65±3.54&lt;sup&gt;4&lt;/sup&gt;</td>
<td>-4.60±0.53&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>230±4.18&lt;sup&gt;6&lt;/sup&gt;</td>
<td>60±2.38&lt;sup&gt;8&lt;/sup&gt;</td>
<td>-5.00±1.09&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>311±6.42&lt;sup&gt;7&lt;/sup&gt;</td>
<td>52±1.57&lt;sup&gt;8&lt;/sup&gt;</td>
<td>-5.50±0.82&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>190±3.19&lt;sup&gt;9&lt;/sup&gt;</td>
<td>42±1.12&lt;sup&gt;4&lt;/sup&gt;</td>
<td>-4.00±0.17&lt;sup&gt;9&lt;/sup&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>210±7.15&lt;sup&gt;1&lt;/sup&gt;</td>
<td>52±2.38&lt;sup&gt;4&lt;/sup&gt;</td>
<td>-4.30±0.52&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H7</td>
<td>254±5.38&lt;sup&gt;4&lt;/sup&gt;</td>
<td>57±1.18&lt;sup&gt;7&lt;/sup&gt;</td>
<td>-5.00±0.12&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td>H8</td>
<td>322±4.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>52±3.02&lt;sup&gt;7&lt;/sup&gt;</td>
<td>-6.20±0.67&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>H9</td>
<td>341±6.71&lt;sup&gt;c&lt;/sup&gt;</td>
<td>44±2.56&lt;sup&gt;7&lt;/sup&gt;</td>
<td>-6.50±0.59&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Results are expressed as mean ± standard deviation.
Values with similar superscript letters represent no significant difference (p<0.05).

Viscosity

Viscosity, resistance to flowing, is one of the most important characteristics of ice cream of which a certain amount is required for proper mixing and holding air in the ice cream. The results of viscosity measurement are presented in Table 3. The viscosity values of the control sample containing alginate and the control sample containing taragacanth were 160 and 190 cp, respectively implying that taragacanth, alone play a more significant role in increasing viscosity as compared to alginate. In both samples viscosity showed a significant increase as the amount of date syrup increased (p<0.05), for example, viscosity values of samples H1, H2, H3 and H4 were 203, 181, 230 and 315 cp, respectively. Also in the samples containing taragacanth, as the concentration of date syrup increased to 25, 50, 75 and 100% the viscosity reached 210, 254, 322 and 341 cp respectively. It should be noted that at equal concentrations of date syrup, the viscosity of the samples containing taragacanth has been always significantly higher than that of alginate – contained samples (p<0.05).

Table 4. Sensory properties of produced samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Flavor</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.02±0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.80±0.35&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H1</td>
<td>4.00±0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.30±0.80&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>4.80±6.57&lt;sup&gt;5&lt;/sup&gt;</td>
<td>4.30±0.51&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>4.70±0.19&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.50±0.15&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>4.10±0.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.20±0.72&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>4.00±0.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.10±0.17&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>4.30±0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.30±0.51&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H7</td>
<td>4.60±0.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.40±0.67&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H8</td>
<td>4.20±0.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.80±0.35&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>H9</td>
<td>4.02±0.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.10±0.59&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Results are expressed as mean ± standard deviation.
Values with similar superscript letters represent no significant difference (p<0.05).
In all samples the viscosity of the final product increased as the amount of date syrup was increased. The observed increase in viscosity is due to two reasons. The first reason is the carbohydrate compounds of date syrup itself. These compounds comprise 75% of date components of which 63% consists of sugars and 13% includes fibrous compounds such as pectin. The lower molecular weight saccharides tend to absorb more water resulting in increased viscosity. Date syrup, contains more simple sugars as compared to sugar because it mainly consists of fructose and glucose. In general most sugars produce high viscous solution due to their great hydrophilic tendency and solubility. Sugars bind water molecules through hydrogen bonds by their hydrogen bonds via increasing active groups with respect to the molecular structure thereby declining free water movement and increasing viscosity of ice cream mixture. The second reason for increased viscosity is the pectin contained in date syrup which acts as hydrocolloids with the liquid part of ice cream and water absorption may explain the increase observed in viscosity (Akin et al., 2007). Hydrocolloids inherently absorb water and form a gel network thereby changing the rheological properties given the crucial role of viscosity in the quality of ice cream, using different hydrocolloids such as alginate, taragacanth and / or pectin contained in date syrup may cause significant variations in the quality of ice cream. Despite various researches on the effects of viscosity on the quality of ice cream there is not conclusive report on its proper accurate amount in ice cream yet. In addition alginate and taragacanth are present in the system exerting a synergistic effect with hydrocarbon compounds of date syrup more increasing the viscosity since in food system this component and hydrocolloids are always competing for water absorption ultimately resulting in increased viscosity. To comparing two different hydrocolloids alginate and taragacanth, taragacanth caused greater viscosity in both date syrup – contained samples and the control ones and this is because of the difference in molecular structure of these two gums. The molecular weight of alginate (Ca. 10000-600000 Da) is lower than that of taragacanth (Ca. 840000 Da). As the higher molecular weight of hydrocolloids has the greater viscosity of the product, therefore it is reasonable that taragacanth produces greater viscosity in food systems.

Finally it may be said that the viscosity of ice cream mixture is affected by the ingredients especially stabilizers. Raw materials and their quality the processing method and handling also affect the viscosity. Also knowing the values of viscosity enables us to determine the best formulation of ice cream and also to select proper pumps for transport and designing the equipment’s. On the other hand; viscosity plays a crucial role in the rate of creaming mass and temperature transport and flowing conditions of food products (BahramParvar et al., 2010).

Bahramparvar et al., (2010) added different concentrations of gum to icecream mixture and reported that the viscosity of ice-cream was 100-120 mps. Amiroghdaei et al., (2012) reported that the viscosity of their produced ice cream was about 46-155 mps. The viscosity found in these two studies is less than that of this product because in this study a great amount of date syrup was used in the formulation of ice cream.

Overrun
The results of measuring overrun of the ice cream samples are presented in Table 3. The overrun values of the control samples containing alginate and taragacanth were 51 and 42 respectively. In both samples, as the concentration of date syrup increased the amount of sugar decreased and the overrun value increased initially and then showed a falling trend. It should be noted that these variations are statistically significant (p<0.05). For example for samples H1 and H2 that containing 25% and 75% date syrup the overrun values have increased and reached 62% and 65%, respectively however as the amount of date syrup further increased the overrun values were decreased to 60 and 52% ,so, being still higher than that of the control sample. A similar trend was observed for the taragacanth – contained sample. For
the samples containing taragacanth the highest values of overrun (57%) was found in the sample containing 50% date syrup. As the concentration of date syrup increased the overrun value has significantly \((p<0.05)\) decreased and reached 44%. Alginate produced greater overrun when compared to taragacanth as the statistical analyses demonstrated that this difference was significant \((p<0.05)\). For instance, in the samples containing 25% date syrup alginate and taragacanth produced the overrun values of 62% and 52% respectively. The observed variations of overrun seem to be related to the mechanisms that change the viscosity of the system. Overrun is directly as the viscosity of ice cream as the viscosity of ice-cream mixture increased the overrun value increased and when the viscosity decreased, the overrun value diminished. Another mechanism involved in dependency of overrun on viscosity is more air entrapment between the molecules. However, it should be bear in mind that if the viscosity exceed the limits its mechanism will change. During the freezing process, viscosity increases steadily because of ice crystals formation caused by the phenomenon of freezing concentration of unfrozen phase consequently water movement from the unfrozen liquid part, required for crystals formation, becomes very difficult, so the crystallization and ice volume reduced and overrun value will be diminished. Various studies have shown an inverse relationship between viscosity and overrun which is in agreement with this results. On the other hand, overrun decrease seems to be attributed to molecular weight. Since the molecular weight of saccharose is lower than that of date syrup, it is able to hold more air cells there by increasing the overrun value (Nazari et al., 2013). They also stated that the type and concentration of the stabilizer have significant effect on the aeration. The ingredients of ice cream especially hydrocolloids have significant effects on overrun. Other factors including the type of aeration including the type of aeration system as well as total solid matters content may affect the ice cream volume increase. Volume increase is of enormous importance due to its relationship with the output and profitability and also its effect on the texture properties of ice cream.

Saleem et al., (1989) reported that volume increase of ice cream was 38-70% among others. Nazari et al., (2013) added sucralse in the formulation of ice cream in replace of sugar and investigated different properties of the product. The results showed that initially increase in the concentration of sucralse did not change the overrun value however as the content of sucralse further increased the value of overrun showed a significant decrease.

Freezing point

The results of measuring freezing point value are shown in Table 3.

Freezing points of the control samples containing alginate and tragacanth were -3.8 and -4 respectively meaning that tragacanth lower the freezing point more than alginate, however this difference is not statistically significant \((p<0.05)\). Also when comparing these two gums in other treatments the sample containing alginate has higher freezing point. Addition of date syrup to ice cream results in lower freezing point. For ice cream containing alginate and up to 50% date syrup freezing point did not show any significant changes just decreased from -3.8°C (control) to -4.6°C (H2), however, it decreased significantly as the concentration of date syrup further increased as the samples containing 75% and 100% date syrup showed freezing points of -5 and -5.5°C, respectively. There was no significant difference between these two samples \((p<0.05)\). The samples containing taragacanth showed a more evident drop freezing point with a significant difference from the sample containing 50% date syrup \((p<0.05)\). Ice cream samples without date syrup and sugar showed freezing points of -4°C and -6.5°C respectively. All sugars play an important role in lowering freezing point. The more simple sugars cause lower freezing point and the sugars of date syrup is simpler than sugar. The reason for this drop is the difference in the sugars between honey (mainly glucose and fructose) and sugar. Addition of date syrup to ice cream increases the content of non-fat solid matters (NSMs). NSMs have high nutritional value improve the texture of ice cream by binding
water molecules contained in the mixture and affect the dispersion and distribution of air during freezing. Also they lower freezing point of ice cream through water absorption. In other words more heat and energy is required for melting and formation of liquid phase. Thus ice cream and other similar products contain some unfrozen water even at very low temperate. Otherwise ice cream becomes so firm that cutting would be impossible. If the absorbent and hydrocolloids are used in excess amounts, freezing point will be lowered and viscosity and stickiness will be greatly reduced which will not be much desirable. Saleem et al., (1998) investigated the application of soy milk in ice cream mix and showed that as the concentration of soy milk increased the viscosity increased and the freezing point declined. Our results are in consistent in their findings.

Sensory evaluation
The results of sensory tests on the produced ice cream samples are presented in Table 4. There is no significant difference in flavor and texture between the samples (p<0.05) implying that the consumers perceived date syrup contained product the same as the product containing sugar however the control sample (without date syrup) and the sugar – free sample were not much acceptable regarding texture and flavor. For instance, the sample containing 0% and 100% sugar was given the lowest score (4.1) for taste, and for texture the sample containing 50% date syrup was given the highest scores for taragacanth and alginate – contained samples being 4.8 and 4.6 respectively. The reason for texture loss is convicting for the consumers because at high concentrations of date syrup increased viscosity and reduced overrun make the ice cream moist and heavy which is not desirable. Two hydrocolloids used in this study i.e. the sample containing taragacanth and alginate without date syrup, did not cause any significant changes in the sensory properties because the gums including taragacanth have no distinct aroma and flavor however they improve the texture and mouth feel via water absorption. Amirioghdaei et al., (2011) included different gum in the formulation of ice-cream containing alginate their results revealed no significant effects on the properties of the produced ice cream.

Conclusion
Iran is one of the main producers of date worldwide of which a considerable amount is lost annually due to high amounts of wastes and lack of adequate transformational industries on the other hand there is a growing tendency towards healthy natural foods with reduced sugar content using date syrup in ice cream the nutritional value but it may be recommended as a dietary product for diabetic patients. The results of this study showed that a high amount of date syrup had no good effect on the quality of product as it increased the viscosity to an undesirable level. Since the sensory test revealed that as the concentration of date syrup increased organoleptic quality of product diminished high concentration of date syrup is not proper to include in the formulation of ice cream and a concentration up to 50% is recommended.

References


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