Effect of *Salvia macrosiphon* seed gum as a fat replacer on physicochemical and sensory characteristics of lowfat ice cream

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**ABSTRACT**

Elimination or reduction the amount of dietary fat in ice cream is of special importance. Application of either protein or carbohydrate based fat replacers can improve the properties of these products. The aim of this research was to develop a functional low fat ice cream by the use of modified *Salvia macrosiphon* seed gum as a fat mimetic. For this purpose, *Salvia* seed gum as a native fat replacer and stabilizer was used at three levels: 0.05%, 0.1%, 0.2% w/w. Also conventional stabilizer (Salep) was used as control treatment. After treatments, physicochemical tests including melting resistance, pH, overrun, specific gravity and sensory tests including measurement of flavor, intensity of coldness, viscosity, degree of smoothness, liquefiying rate and total acceptance were analyzed. Results showed no significant differences between physicochemical and sensory properties of the samples *(p<0.0.5).*

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**KEYWORDS**

Low fat ice cream;
Salvia macrosiphon seed gum;
Salep;
Fat replacer.

**INTRODUCTION**

Ice cream is constituted of a complex multilayer system consisting of ice crystals air cells and fat globules embedded in a high viscous freeze concentrated matrix phase[12, 4]. Also, ice cream is characterized by countless interfaces between its different constituents. Milk fat has been recognized as a critical parameter for the formation and support of structural characteristics of ice cream as well as for the perceived textural quality e.g. lubrication of tongue, richness of mouth-feel, enhancement of creaminess, thickness and flavor perception[24]. Typically, ice cream contains 10-16% fat but recently some ice cream manufactures have attempted to lower the level of fat fraction due to health concerns and have replaced the fat with either carbohydrates or proteins[11, 14]. High intake of fat is considered a risk factor in nutrition related diseases, such as obesity, cardiovascular diseases, such as types of cancer. Therefore, nutritionists recommend that dietary fats should contribute less than 30% of total energy intake. Ice cream is very popular food, but consumers prefer to avoid its consumption due to the high fat content of ice cream[11, 18].

The structure of ice cream has been identified as three-component foam, made up of a network of fat
globules and ice crystals dispersed in a high-viscosity aqueous phase. The challenge in working with low-fat ice creams is related to the fact that the fat globule network would either be disrupted or be absent, and this could seriously impact the texture of the product.[25]

Milk fat is the main contributor to the rich flavor and mouth feel associated of ice cream[20]. Reduction the fat content of ice cream led to high melting rate, more icy and watery body, inferior texture with fewer visible air bubbles and lower richness in taste as compared to full fat ice cream.[4]. Several strategies have been suggested to overcome these defects such as using emulsifiers,[6], using fat replacers,[3], using practically hydrolysescasein micelles,[8], using of high pressure homogenization,[13] and using whey protein concentrate treated by hydrostatic pressure[19,9]. The genus Salvia (Labiateae) contains more than 700 species, which about 200 out of them exist in Iran and is probably found in neighboring countries. Wild sage seed (Salvia macrosiphon) is a small, rounded seed, which readily swells in water to give mucilage[21,7].

The aim of this research was to develop low fat ice cream using Salvia macrosiphon seed gum as a fat mimetic.

MATERIALS AND METHODS

Materials

Pasteurized milk (1% fat) was purchased from Kanyar Industry Co (Quchan), Iran. Homogenized and pasteurized cream (30% fat) purchased from Pegah dairy Industry Co Mashhad, Iran. Sugar, Vanilla, Salep and Salvia seed were obtained from a local confectionery market, Gonbad Kavus, Iran. Salvia macrosiphon seed gum was prepared on the basis of Bostan et al, 2010.[7]

Ice cream formulation and processing

Ice cream mix was formulated to contain 3% cream, 15% sugar, 12% milk solid nonfat (MSNF), 0.05-0.2% stabilizers and 0.1% vanilla. Formula for all the mixes summarized in TABLE 1. Liquid ingredients including milk and cream were mixed together and warmed up to 50°C. Dry ingredients were mixed thoroughly and then added to the liquid ingredients using a mixer (Model B.G300P; Parskhazar, Iran). The mixes were pasteurized at 80°C for 25 seconds, cooled immediately to 5°C and aged at 4-5°C for 24 hours. After aging, vanilla extract was added and the freezing was carried out in a batch ice cream maker (Feller ice cream maker, Model IC 100, Feller, China) for about 30 minutes. Samples were packed in 50mL plastic cups and placed in a freezer at -12°C (Electrosteel, Model ES.453, Mashhad, Iran) for hardening.

Physicochemical analysis

pH

pH was tested with a pH meter at 5°C (Model, Gp353, UK). Each sample was mixed thoroughly and the pH was noted.[21]

Melting resistance

A 30g sample of ice cream poured in a Buchner funnel on the top of a flask and allowed to melt at room temperature (24 ± 1°C) for 15 min. Then the dipped volume was weighed and melting resistance was obtained using the following equation: Equation 1

\[
\text{Melting resistance} = \frac{A_1 - A_2}{A_1} \times 100
\]

Where \(A_1\) and \(A_2\) are the weight of initial and melted samples respectively.[20]

| TABLE 1 : Formulation of ice cream mixes containing different levels of gum |
|-----------------|------|------|------|------|------|------|
| Ingredient      | Mix 1 | Mix 2 | Mix 3 | Mix 4 | Mix 5 | Mix 6 |
| Cream           | 5.025%| 5.025%| 5.021%| 5.021%| 5.014%| 5.014%|
| Salvia macrosiphon| 0.05%| -     | 0.1%  | -     | 0.2%  | -     |
| Salep           | -     | 0.05% | -     | 0.1%  | -     | 0.2%  |
| Vanilla         | 15%   | 15%   | 15%   | 15%   | 15%   | 15%   |
| MSNF            | 12%   | 12%   | 12%   | 12%   | 12%   | 12%   |
| Milk            | 67.825%| 67.825%| 67.779%| 67.779%| 67.686%| 67.686%|
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Specific gravity

In order to measure the specific gravity, an apicnometer (empty, filled with distilled water at 25°C and filled with ice cream mixture) was weighted. Bulk density was calculated from the following equation:

Equation 2

$$SG = \frac{G_3 - G_2}{G_2 - G_1}$$

Where $G_1$ is the weight of the empty apicnometer, $G_2$ weight of the apicnometer with distilled water and $G_3$ weight of apicnometer with ice cream mixture$^{[20]}$.

Overrun

According to equation 3 overrun was calculated by comparing the weight of a known volume of ice cream ($M_1$) to the weight of the same volume of unfrozen ice cream mix ($M_2$)$^{[20]}$.

Equation 3

$$\%Overrun = \frac{M_1 - M_2}{M_2} \times 100$$

Sensory evaluation

The ice creams were evaluated for sensory characteristics (viscosity, coldness, firmness, degree of smoothness, liquefying rate and total acceptance. All the samples were served in 50 ml plastic containers.

Figure 1: Effect of type and concentration of the Salvia gum and Salep on the physicochemical properties of low-fat ice cream.
with lids and the evaluation was done at 24±1°C under white lights. Panelists were selected from the student population. In order to test panelists from the first training session, three coded samples were given which two of them were alike. Finally, 8 panelists, six females and two males, all between the ages of 26 and 40 were selected. One 30 min training sessions was held. In these sessions, definition of attributes and assessment techniques were introduced and the sample evaluation was done practically. Sensory evaluations of appearance, flavor, body and texture, and total acceptance were performed using the 9-point scale (1=poor, 5=average, 9=excellent). Other attributes were assessed using 9-point scale too, according their definitions. The ballot is shown in Figure 1[4]. Four panel sessions were established and foursamples were assessed in each one. The samples were tempered in a batch freezer for 10 days after production and presented at the same time in a random order. In this study, sensory analyses were performed in 2 replications.

Statistical analysis

The experimental design was a completely random-ized, performed intwice on separate days. Data was subjected to ANOVA analysis using SAS(version 9/1) statistical analysis system program. Means were sepa-rated using Duncan’s Multiple Range Test and results were considered significant for p<0.05. Curves fitting was done by Microsoft Excel (2010).

RESULTS AND DISCUSSION

Physicochemical properties

The data are given in TABLE 2 which shows that the physicochemical properties for almost all the treatments are significantly different (p<0.01).

Melting resistance

The mean values of melting resistance (MR) are presented in Figure 1 which shows significant differences between the treatments (p<0.01), ranging from 42.5-85.45%. In all cases, melting resistance increased as gum concentration increased.

In a study done by Kunna and Abdel Razig(2013) the effect of some additives on the rheological and sen-
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investigated. Results showed that pectin induced the
lowest melting rate (7.3%) followed by WP
(9.0%), lecithin (10.0%) and control sample
(11.3%). Francyet al(2012) found that the melting
rate and structure of ice cream were not affected
markedly by differences in the protein content.
Soukouliset al (2010) found that in- creased
viscosity and foamy appearance, increased
resistance to melting the ice cream. The contribution
of fat to the structural characteristics of ice cream as
well as its reduced heat conductivity can explain the
former effects[22].

pH

According to Figure 1, the pH values show differ-
ence between samples containing Salvia seed
gum and Salep (p< 0.01). Khalil and
Embaby(2012) produced low fat ice cream with
powderedJambul fruit which exhibited
significantly lower pH value than the full fat ice
cream.

Overrun

The overrun of low fat ice cream samples was sig-
ificantly affected by using additive[18].
The re-
sults of the comparison test for overrun is
shown in Figure 1 which shows significant
difference (p<0.01). According to the results,
increasing the amount of stabilizer increased the
overrun. Overrun was at the highest rate for
sample containing 0.2%Salvia seed gum.
Kirchhubeland Rot (1978), reported that an
overrun of 60% was necessary for good quality
of ice cream, and different overrun val-
ues might be obtained according to the type of emul-
sifier used. Kunna and Abdel Razig(2013), reported
the highest overrun of low fat ice cream
containing pectinat 49%, followed by the
formulation contain- ing whey protein (48%),
lecithin (40%) and control sample (38%).
According to a study conducted by Khalil
andBlassy(2011), adding date pulp enhanced the
overrun in low fat ice cream.

Specific gravity

Ice cream specific gravity varies depending on the
constituents between 1.0544and 1.1232[20]. Our finding
in Figure 1 indicate that the difference is not significant
(p>0.05), except for the samples containing Salep
(p<0.01). Khalil and Blassy (2011), reported that the
Incorporation of air into ice cream mix during the pre-
TABLE 2: The results of physicochemical tests of samples of low-fat ice cream

<table>
<thead>
<tr>
<th>Formulation</th>
<th>pH</th>
<th>Overrun</th>
<th>Specific gravity</th>
<th>Melting resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05%</td>
<td>6.260**</td>
<td>17.350**</td>
<td>1.06145**</td>
<td>42.0500**</td>
</tr>
<tr>
<td>Salviamacrospohon</td>
<td>0.1%</td>
<td>6.2200**</td>
<td>18.1500**</td>
<td>1.02740**</td>
</tr>
<tr>
<td>0.2%</td>
<td>6.33500**</td>
<td>25.0250**</td>
<td>1.13805**</td>
<td>85.4500**</td>
</tr>
<tr>
<td>0.05%</td>
<td>6.2900**</td>
<td>11.1500**</td>
<td>1.105900**</td>
<td>42.0500**</td>
</tr>
<tr>
<td>Salep</td>
<td>0.1%</td>
<td>6.2400**</td>
<td>17.500**</td>
<td>1.018300**</td>
</tr>
<tr>
<td>0.2%</td>
<td>6.4400**</td>
<td>23.8500**</td>
<td>1.037550**</td>
<td>48.700**</td>
</tr>
</tbody>
</table>

*: p<0.05 (95%), **: p<0.01 (99%), ns: p>0.05 (95%).

TABLE 3: The results of sensory tests of low-fat ice cream

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Intensity of coldness</th>
<th>Viscosity</th>
<th>Flavor</th>
<th>Degree of smoothness</th>
<th>Liquefying rate</th>
<th>Total Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05%</td>
<td>8.3500**</td>
<td>6.1500**</td>
<td>5.7500**</td>
<td>6.1500**</td>
<td>6.8500**</td>
<td>5.6500**</td>
</tr>
<tr>
<td>Salvia macrospohon</td>
<td>0.1%</td>
<td>6.7000**</td>
<td>5.9500**</td>
<td>5.7500**</td>
<td>6.8500**</td>
<td>6.2500**</td>
</tr>
<tr>
<td>0.2%</td>
<td>5.4500**</td>
<td>7.9000**</td>
<td>4.8500**</td>
<td>7.6500**</td>
<td>6.0500**</td>
<td>8.0000**</td>
</tr>
<tr>
<td>0.05%</td>
<td>7.5500**</td>
<td>5.5500**</td>
<td>4.2000**</td>
<td>5.6500**</td>
<td>6.4500**</td>
<td>4.5000**</td>
</tr>
<tr>
<td>Salep</td>
<td>1.1%</td>
<td>7.150**</td>
<td>5.3000**</td>
<td>5.7500**</td>
<td>7.1500**</td>
<td>6.1500**</td>
</tr>
<tr>
<td>0.2%</td>
<td>6.800**</td>
<td>6.7500**</td>
<td>5.0500**</td>
<td>7.4000**</td>
<td>5.4500**</td>
<td>6.1000**</td>
</tr>
</tbody>
</table>

*: p<0.05 (95%), **: p<0.01 (99%), ns: p>0.05 (95%).

The freezing process causes a decrease in ice cream specific gravity and consequently to its weight per gallon. It was noticed that the specific gravity of ice cream, weight per gallon of T1 were lower than T2. This may be due to the higher overrun of full fat ice cream than control (low fat one without modified date pulp). Ashishet al (2010) reported that the inclusion of sago in low fat mango ice cream did not adversely affect the overrun in ice cream.

Sensory properties

The data are given in TABLE 3 which shows that the sensory properties for almost all the treatments are significantly different.

Flavor

Milk fat has been recognized as a critical parameter for the formation and support of structural characteristics of ice cream. According to the results shown in Figure 2, the lowest score was obtained for the sample containing Salep at 0.05% and overall, marve improved the flavor.

Degree of smoothness

Reducing fat in ice cream and frozen tissue, causes more water and air bubbles in ice cream. The difference between different concentrations of stabilizers was statistically significant (p<0.05). The Degree of smoothness increased by increasing stabilizer content and was at the high rate at 0.2% concentration. The highest (7.65) and lowest (5.65) points, was respectively gained for the samples containing Salvia seed gum and Salep.

Intensity of coldness

According to Figure 2, increasing the stabilizer concentration decrease the intensity of coldness. The highest score was obtained for the sample containing Salvia seed gum at 0.05%.

Viscosity

The results showed that the samples containing Salvia gum samples (p<0.01) and Salep (p<0.05), differences were significant. According to Figure 3, the lowest (5.3) and highest (7.9) points of viscosity of ice cream containing Salep 0.1% and 0.2% Salvia gum is.

Liquefying rate

According to the results shown in TABLE 3, there are significant differences for samples Salvia (p<0.01) and Salep (p<0.05). Highest score (6.85) containing 0.05% Salvia seed gum ice cream and lowest (5.45) for the ice cream containing Salep 0.2%. score liquefying rate with increase the rate of condensation of stabilizers used in ice cream, low fat, reduced (Figure 2).
Figure 2: Effect of type and concentration of the Salvia gum and Salep on the sensory properties of low-fat ice cream.

According to the results shown in TABLE 3, no significant differences for samples (Salvia $p<0.01$).
Salvia seed gum as a stabilizer and in three levels 0.05, 0.1 and 0.2 percent in the preparation of low fat ice cream, low fat ice cream has been used to improve the quality and sensory characteristics. The overall results of the physicochemical and sensory tests were significant differences (p<0.05) for samples showed low fat ice cream. The results showed that the use of Salvia seed gum in the low fat ice cream formulation as stabilizer and substitutes fat have positive effects on physicochemical and sensory properties of products. Considering to the positive effects of Salvia seed gum users in low fat ice cream and good functioning characteristics of the gum as stabilizer and fat substitutes, and also because of the expensive cost of production of fat substitutes used in the food industry, the gum was extracted and effect in different food products seem important. This gum is used as a fat substitute because the stabilizing role and the role fat plays an economical alternative.

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