Rheological and Sensory Properties of a Typical Soft Ice cream as Influenced by Selected Food Hydrocolloids

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The rheological properties of gums are important when they are used in the formulation of foods for its effect on the textural and sensory attributes. These properties should also be carefully taken into account for designing and modeling purposes of different food processes. For this purpose, we studied the effect of two novel hydrocolloids known as Balangu seed gum (BSG) and palmate-tuber salep (PTS) with corresponding CMC on the rheological characteristics of a typical soft ice cream. Balangu seed and PTS are two Iranian source of hydrocolloid. The power law model well described the flow behavior of mixes with high correlation coefficient (r). All mixes showed pseudoplastic behavior except the mix containing 0.3% PTS with a slightly dilatant characteristic. An increase in concentration was accompanied an increase in pseudoplasticity and consistency coefficient. The effect of selected gums on some sensory properties of soft ice cream has also been investigated. Generally, ice cream mixes with high consistency coefficient and low flow behavior index (means those containing BSG and CMC as stabilizers) gained better sensory scores. The correlation between apparent viscosity and sensory attributes has been determined because of importance of viscosity in quality evaluation of ice cream.

Keywords: Ice cream, flow behavior, stabilizer, sensory quality, Balangu

1 INTRODUCTION

Rheological properties of fluid and semi-fluid foods should be carefully taken into account for designing and modeling purposes of different food processes. The effect of different gums on the rheological characteristics of ice cream mix has been reported earlier [2, 3, 4], but there is no recorded data in the literature concerning the effect of two Iranian sources of hydrocolloid means palmate-tuber Salep and Balangu seed gums on the properties of a typical ice cream. Therefore, the aims of this study were: (1) to investigate the flow behavior of ice cream mixes containing BSG and PTS with corresponding CMC that is a well known commercial gum used in ice cream formulation, (2) to study the effect of these hydrocolloids on the sensory quality of a typical soft ice cream.

2 METHODOLOGIES

The standard ice cream mix formulation consisted of 10% milk fat, 15% sucrose, 11% nonfat milk solids, and 0.3, 0.4 and 0.5% stabilizers. Liquid ingredients including milk and cream were mixed together and warmed up to 50ºC at which time the pre-weighed dry ingredients (sugar, stabilizer, skim milk) were added. The mixes were pasteurized at 80°C for 25 s (HTST), cooled immediately to 5°C and then stored overnight at 5°C.
After aging, rheological properties of ice cream mixes were investigated using a rotational viscometer (Visco 88, Bohlin Instruments, Malvern, UK) equipped with a heating circulator (Model F12-MC, Julabo Labortechnik, Seelbach, Germany) at the desired temperature (5±0.5ºC) and shear rate logarithmically increasing from 14.2 to 501.7 s^{-1}. To compare the sensory and rheological data, apparent viscosity of all mixes at the shear rate 51.8 s^{-1} was recorded.
After aging, vanilla extract (0.1%) was added and freezing was done in a batch soft ice cream maker (Feller ice cream maker, Model IC 100, Feller Technologic GmbH, Dusseldorf, Germany). Required freezing time for different mixes was 25±5 min. After drawing, products were collected into 50 mL lidded plastic containers, coded and placed in a chest freezer for 1h.
Ice creams also were evaluated for sensory characteristics (viscosity, coldness, firmness, degree of coarseness, liquefying rate, body & texture and total acceptance). 10 panelists, eight females and two males, all between the ages of 23 and 30 were selected. Seven 30 min training sessions were held over a period of 1 month. Sensory evaluations were performed using the 9-point hedonic scale (1= poor, 5= average, 9= excellent). Four panel sessions were established and two or three samples were assessed in each one.

3 RESULTS AND DISCUSSION

3.1 Rheological Measurement

Power law model was adequately suitable for describing the flow behavior of ice cream mixes in this research. All samples were non-Newtonian. Flow behavior index (n) values ranged from 1.154 to 0.450 (Table 1) and were statistically different

(P<0.05) among samples. All mixes showed pseudoplastic behavior except the mix containing 0.3% PTS with a slightly dilatant characteristic.
Comparatively, the n was the lowest for ice cream mixes containing BSG and the highest for mixes with PTS within the range of concentration levels studied, while CMC produced intermediate values. An increase in gum concentration was accompanied with a decrease in flow behavior index. The results of this study agreed with former researches (Cotrell et al. 1980; Kaya and Tekin, 2001).
There was significant difference among consistency coefficient of mixes (P<0.05), which varied from 0.051 to 6.822 Pa.sn. CMC made the highest k values in ice cream mixes and difference between BSG and CMC was not significant (P>0.05) at the same concentration level. However, mixes containing PTS had the least k values and this decrease was significantly important (P<0.05).

Table 1: The power law model parameters for different ice cream mixes

Gum/Concentration	*n (-)*	*k (Pa s^n)*	*r*
CMC			
0.3%	0.744^{cd}	0.933^{c}	0.999
0.4%	0.649^{de}	2.597^{b}	0.999
0.5%	0.549^{efg}	6.822^{a}	0.999
BSG			
0.3%	0.586^{ef}	1.114^{c}	0.996
0.4%	0.520^{fg}	2.522^{b}	0.998
0.5%	0.450^{g}	6.542^{a}	0.998
PTS			
0.3%	1.154^{a}	0.051^{c}	0.996
0.4%	0.933^{b}	0.123^{c}	0.997
0.5%	0.776^{c}	0.700^{c}	0.998

3.2 Sensory Evaluation

Generally, ice cream mixes with high consistency coefficient and low flow behavior index (means those containing BSG and CMC as stabilizers) gained better sensory scores.
Sensory judges perceived ice creams containing PTS and BGS had the least and most viscosity and firmness values, respectively, but the difference between BSG and CMC was not significant (P>0.05). Coldness scores ranged from 4.9 to 6.1, but this variation was not important statistically (P>0.05). All samples had a desirable smoothness, which confirm that selected hydrocolloids act as suitable stabilizers in the term of smoothness. The liquefying rate scores, which varied from 4.3 to 6.3, were significantly different (P<0.05). Texture is directly related to the structure. Structure depends on size, number and arrangement of air cells, ice crystals and fat clumps [1]. Body and texture values ranged from 6.4 to 8.2 and were significantly different (P<0.05). Samples with BSG acquired the best body and texture scores, although the difference between CMC and BSG was not significant (P>0.05). In contrary, PTS declined the body and texture scores of ice creams significantly (P<0.05). The total acceptance of soft ice creams were assessed between 6 and 7.7, which the most acceptable ice cream was the sample containing 0.3% CMC. Total acceptance scores of all samples were higher than the average value (5) in a nine-point scale. Panelists found no differences (P>0.05) between CMC and BSG in terms of total acceptance, although significant difference observed between samples containing CMC and PTS.
Relationship between Apparent viscositiy and sensory attributes are shown in Table 2.

Table 2. Pearson coefficients indicating relationship among apparent viscosity and sensory attributes of ice cream

Variable	*Apparent viscosity*	*P value*
Apparent viscosity	1.000	0.000
Sensory viscosity	0.840	0.004
Coldness	-0.615	0.078
Firmness	0.853	0.003
Coarseness	-0.622	0.074
Liquefying rate	-0.713	0.031
Body and Texture	0.473	0.198
Total acceptance	0.559	0.117

4 REFERENCES

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