Research Note

Effect of Composition and Temperature on the Scooping Qualities of Ice Cream

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Uniform portion dispensing can be maintained in the scooping of ice cream only when certain factors are controlled. It has been recognized in the industry for many years that the ideal scooping temperature ranges between -13.5°C and -11°C. The most desirable temperature within this range will depend upon the quantities and types of the various ingredients used in the ice cream coupled with the percentage of overrun.

In order to quantify the amount of force required to be exerted in the attainment of optimum scooping conditions, an ice cream scoop was modified and fitted with a strain gauge (Figure 1). The strain gauge was, in turn, connected through a transducer amplifier to a recorder (Figure 2).

Several ice cream mixes containing similar amounts of fat, stabilizer, and emulsifier, but varying amounts of serum solids and sucrose were prepared. The ranges in percentages of serum solids and sucrose were 7% to 15% and 13% to 19% respectively. The mixes were frozen to different percentages of overrun ranging from 50% to 150%. They were scooped at cabinet temperatures ranging from -8°C to -16°C. Mix compositions, percentages of overrun and scooping temperatures were pre-selected statistically using a response surface block design.

The optimum scooping force was determined by using an ice cream of accepted normal composition, namely 12.0% fat, 11.0% serum solids, 15.0% sucrose, 0.25% stabilizer, and 0.15% emulsifier. It was frozen to 100% overrun in a continuous ice cream freezer and scooped at a temperature of -12°C. The scooping force required under these conditions was approximately 3 kg and was selected as the basis upon which all future comparisons were made.

A multiple regression analysis was conducted on the data resulting in the equation:

\[ F = 4.1044 + 0.8195 T^2 + 0.0000548 (OR \times S) + 0.00043375 OR^2 + 0.01148 (T \times OR) - 0.3133838 S \]

where:
- \( F \) = Force, kg
- \( T \) = Temp. °C
- \( OR \) = % overrun
- \( S \) = % sucrose

Coefficient of determination = 0.96
Standard error of estimate = ± 0.5 kg

Effects of serum solids content were not included in the equation, since they were found to be insignificant.

From the regression equation, the data in Table 1 were compiled showing the relationship of force to overrun, and temperature at a sucrose level of 15%.

Using the regression equation and the data presented in Table 1, it is possible to state that within the accepted limits for normal ice cream composition and scooping conditions:

- a) An increase of 1% sucrose decreases the force by approximately 0.3 kg.
- b) An increase of 1°C in temperature decreases the force by approximately 1 kg.
- c) An increase of 10% overrun decreases the force by approximately 0.5 kg.

Further use of Table 1 is facilitated by the application of the following formula to calculate overrun percentage:

\[ \frac{Wt. \ of \ mix - Wt. \ of \ the \ same \ volume \ of \ ice \ cream}{Wt. \ of \ mix} \times 100 = \% \ OR \]

* Ice cream mix weighs 11 pounds per gal.

In this report, the effects of mix composition with respect to quantity of sucrose and serum solids only have been recorded. Types of sweeteners, i.e. corn syrup and dextrose, will undoubtedly have some bearing on scooping force as will the amounts and types of fats, stabilizers and emulsifiers. These factors have yet to be studied.

Acknowledgement

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Fig. 1. Modified ice cream scoop with strain gauge attached.
Fig. 2. Strain gauge on ice cream scoop, transducer amplifier and recorder.

Table 1. Calculated effect of temperature and overrun on scooping force of ice cream at a constant sucrose level (15%).

<table>
<thead>
<tr>
<th>Overrun (%)</th>
<th>Force (kg)</th>
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<tbody>
<tr>
<td></td>
<td>-8.00</td>
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<tr>
<td>50</td>
<td>1.56</td>
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