

## The Relation of Several Ingredients to the Manufacture of Commercial Ice Cream

WM. H. E. REID

The large number of different ingredients used in the preparation of an ice cream mixture has made necessary careful and organized study of the properties of each individual ingredient and the particular purpose each ingredient serves or its value in an ice cream mixture.

The butterfat of an ice cream mixture may be derived from several sources. The most common of which are as follows: whole milk, sweet cream, sweet butter, evaporated milk, and condensed milk either sweetened or unsweetened. In addition to furnishing butterfat, several of these products furnish milk solids not fat. When added to an ice cream mixture, each product should be carefully examined for its quality, as an off flavor or a high acidity of any one will reflect itself in an ice cream mixture by imparting an unpleasant flavor and may cause the entire mixture to curdle as a result of the acid reaction on the casein.

Whole milk and sweet cream free from undesirable flavors, serve as the most desirable base of the ice cream mixture. Each gives flavor, and smoothness of body to the ice cream. Milk for ice cream manufacture should have an acidity not exceeding 0.18 of 1 per cent. The acidity of the cream should not exceed 0.23 of 1 per cent. A higher acid concentration would indicate undue aging of the milk and cream or the presence of many bacteria.

The sweetness of the ice cream is usually obtained by adding cane, beet or corn sugar and sweetened evaporated milk. Honey is used to some extent by many manufacturers of ice cream.

When the mixture is properly prepared and aged, it is ready to be frozen. Unless the ice cream manufacturer is entirely familiar with what effect each ingredient may have on the temperature of the mixture during the freezing process, he is not able to meet many of the problems involved in the freezing of the mixture.

Experimental work at the Missouri Agricultural Experiment Station has furnished information as to the effect of different per-

centages of butterfat and sugar on the physical properties of ice cream and the effect of several ingredients on the change in temperature of the mixture during the freezing process. The physical properties of the finished ice cream are as follows: body, texture, hardness, overrun, and stability. The purpose of this circular is to present some practical applications of the experimental work reported in Missouri Research Bulletins Numbers 69, 70, and 71.

### EFFECT OF BUTTERFAT IN ICE CREAM

Ice cream mixtures having a butterfat of 4, 6, 8, 10, 12, 14, 16, 18, 20, and 25 per cent were prepared and standardized for fat and total solids. Four freezings of each mixture were studied.

Experimenting with these different percentages of fat, it was found that the viscosity of the mixture showed a gradual increase with each increment of fat and this increase in viscosity was more apparent when the mixture contained larger percentages of fat. Butterfat was found to have a decided influence on the viscosity of the mixture because the fat was more viscous than the water which it replaced. The viscosity of the four per cent mixture was 1.24 and in the twenty-five per cent mixture 3.50 when compared with the viscosity of the water.

It was found that the fat content of the mixture had a greater influence on the percentage of overrun than did the viscosity of the mixture. The overrun increased slightly with increased viscosity until the mixture contained ten per cent fat. When the fat content increased above ten per cent, the overrun decreased although the viscosity continued to increase.

No direct relation between the fat content of the different mixtures and the hardness of the ice cream was found to exist. The slight variation in the hardness was due entirely to variations in the temperatures of the hardened product. The temperature of the ice cream was found to exert greater influence on the hardness.

The stability of ice cream may be defined as the ability to withstand exposure to high temperature and retain a salable form and attractive appearance. This is one of the most important properties of ice cream, since it determines the length of time required for ice cream to lose its original form when exposed to average summer conditions.

Several factors such as the temperature of the ice cream, the percentage overrun, the use of binders and fillers, and different ingredients influence this property, increasing or decreasing the length of time required to melt the ice cream.

It was found that there was a direct relation between the increased fat content and the ability of the ice cream to resist summer temperatures. The four per cent ice creams lost 98.1 per cent of their total weight during three hours melting as compared with ice cream containing 25 per cent fat which lost only 39.9 per cent. This indicates the rapidity with which the ice cream containing different percentages of fat melted when exposed to summer temperatures and showed the effect of fat upon the stability of ice cream.

There was a direct relation between the fat content of the ice cream and the desirability of the flavor, body, texture, richness, appearance, and the keeping qualities of the cream. Ice creams containing less than ten per cent fat could not be classified as being rich enough to gain the approval of the average consumer. The ten and twelve per cent ice creams gave the most desirable and typical flavor, body, texture, appearance, and richness. Further increases in the fat content gave increasingly less desirable results.

#### **EFFECT OF SUGAR IN MANUFACTURE OF ICE CREAM**

Various percentages of sugar were used ranging from eight to sixteen per cent. This choice of range was based upon the average percentage of sugar recommended by the manufacturers of large quantities of ice cream. As the sugar content increased from eight to sixteen per cent the mixture became more viscous.

The overrun increased with increasing percentages of sugar up to twelve per cent and when more sugar was added the overrun decreased with the same rapidity as it had increased.

A study was made of the hardness of each mixture after the ice cream had been tempered for a given period. The results obtained show that sugar again was the important factor, as the resistance offered by each mixture became less as the sugar content was increased, the least resistance being offered by the mixture containing sixteen per cent sugar.

After exposing the bricks of ice cream containing varied amounts of sugar for four hours to a standard melting temperature of 86 degrees Fahrenheit the results obtained showed that there was a direct correlation between the percentage of sugar used and the percentage loss in weight, the loss becoming greater with the addition of each two per cent of sugar above ten per cent.

In scoring the mixtures after one-day hardening, the ice cream containing twelve per cent sugar was superior in body, texture, and flavor. The eight per cent sugar had an open texture and was

coarse while with sixteen per cent of sugar the ice cream was close in texture and had a very firm body. The flavor of the ice cream containing twelve per cent sugar was more desirable, having the desired sweetness. The ice cream containing eight per cent sugar was decidedly lacking in sweetness and when sixteen per cent sugar was added the sweetness proved excessive, making it impossible to detect the desirable ice cream flavor.

#### **EFFECT OF SEVERAL INGREDIENTS ON CHANGE OF TEMPERATURE DURING THE FREEZING PROCESS**

This investigation was made with the hope of correlating the various phases of the freezing process with the various commercial tests on the ice cream mixture. The relation of the serum solids in the mixture to the change in temperature during the freezing process was first studied. A standard set of mixtures was used in which all ingredients remained constant except the milk solids not fat, and these were used in the following amounts: 6, 10, 12, 14, and 18 per cent, these being the minimum, average, and maximum amounts used in the commercial manufacture of ice cream. To determine whether the source of milk solids not fat had any effect on the change in temperature during freezing, the following products were used as the only source of the milk solids not fat: evaporated milk, skimmed milk powder, whole milk powder, and sweetened condensed milk.

An increase in the milk solids not fat lowered the freezing point of the ice cream mixtures and produced an increase in the viscosity. A lowering of the freezing point resulted in a definite lowering of the crystallization point.

The time required to freeze was increased by an increase in the milk-solids-not-fat content and was thought to be due to the effect of the low heat conductivity of serum solids.

The rate of melting of the frozen mixture increased with an increase in the milk-solids-not-fat. This does not necessarily mean that ice cream containing a high percentage of milk solids not fat would be less stable than one with a low percentage of milk solids not fat, but that the temperature of the ice cream would rise more rapidly. An increase in the milk solids not fat increased the viscosity of the mixture, the stability of the finished ice cream, and the ability of the ice cream to rapidly absorb heat units.

An ice cream that is uniform in quality, pleasant in flavor, smooth and mellow of body can be manufactured by controlling the percentage of butterfat, the solids not fat, and the processes subsequent to the making of the mixture.