

Solids in Relation to Smoothness  
and Keeping Qualities of Ice Cream.

There are ~~the~~ **Presented as a Part of** ~~the~~ **Minor Thesis in Dairying.** ~~the~~ **quality of**  
ice cream, namely, flavor, smoothness, and keeping quality. The fla-  
vor of ice cream is ~~governed by the quality of the original cream and~~  
the commercial ~~flavoring added. The factors governing~~ smoothness depends  
much upon the solids the ice cream contains. ~~Solids may be in the form~~  
of butter fat, fillers, or fruits in fruit ~~creams~~, while the keeping  
quality depends upon the ingredients entering into the cream such as the  
purity of cream, ~~flavoring, filler, fruits, etc., and the conditions~~  
under which the frozen ~~products~~ are handled.

Ice Cream Formulae.

Generally speaking, ~~ice cream consists of cream 10 to 15~~  
per cent, filler (gelatin, gum tragacanth, corn starch, or various  
brands of commercial fillers) sugar, one pound per gallon, and flavor-  
ing, vanilla, being the most commonly used. In fruit creams the crush-  
ed fruit is commonly used, occasionally extracts, or a combination of  
the two.

Subject.

Solids in Relation to Smoothness and Keeping Qualities  
of Ice Cream.

1 quart of cream (the per cent fat varying.)

6 ounces of sugar.

1/2 ounce vanilla flavor

10 grams red coloring

Filler (varying) of gelatin, corn starch

and gum tragacanth  
Submitted to  
C. W. Holdaway,

Asso. Prof. in Dairy Husbandry

cream was frozen in a 4 quart hand free

Solids in Relation to Smoothness  
and Keeping Qualities of Ice Cream.

There are three factors which determine the quality of ice cream, namely, flavor, smoothness, and keeping quality. The flavor of ice cream is governed by the quality of the original cream and the commercial flavoring added. The factors governing smoothness depends much upon the solids the ice cream contains. Solids may be in the form of butter fat, fillers, or fruits in fruit cream, while the keeping quality depends upon the ingredients entering into the cream such as the purity of cream, flavoring, filler, fruits, etc., and the conditions under which the frozen products are handled.

Ice Cream Formulas.

Generally speaking, ice cream consists of cream 10 to 15 per cent, filler (gelatin, gum tragacanth, corn starch, or various brands of commercial fillers) sugar, one pound per gallon, and flavoring, vanilla, being the most commonly used. In fruit creams the crushed fruit is commonly used, occasionally extracts, or a combination of the two.

In these experimental batches of cream only a very small quantity was necessary. The formula used was as follows:

1 quart of cream (the per cent fat varying.)

6 ounces of sugar.

1/2 ounce vanilla flavor.

10 grams red coloring

Filler (varying amounts of gelatin, corn starch  
and gum tragacanth.)

Each batch of cream was frozen in a 4 quart hand freezer,



turning 60 times per minute. Ice and salt was used for freezing and packing by weight, one fifth as much salt as ice. Each batch was allowed to harden for 18 hours after freezing before being examined microscopically.

### Microscopic Examination of Ice Cream.

The essential factor governing this examination was to maintain the ice cream in its natural condition under favorable working conditions. This was accomplished most satisfactorily by using a room in which the temperature could be controlled and maintained at 35° to 40° F.

After numerous trials the following device for a freezing stage was constructed which proved very satisfactory. Fig 1.

A piece of iron pipe (C) three inches in diameter was flattened on one side, caps screwed upon the ends and ammonia passed through it by tapping these caps and connecting to ammonia system by high pressure ammonia pipe (A). The circular stage (D) was made by attaching two circular iron plates 10 inches in diameter, 1/2 inch apart and running a 3/4 inch pipe through the center. This stage proved unsatisfactory, the larger one being used.

For examination, a thickness of about 1/8 inch of frozen cream was spread on glass slides. These were placed on the chilled surface, the glass preventing the crystals which formed on the freezing stage from passing through the cream. A Leitz binocular microscope with camera attached was used throughout for making the photographs.

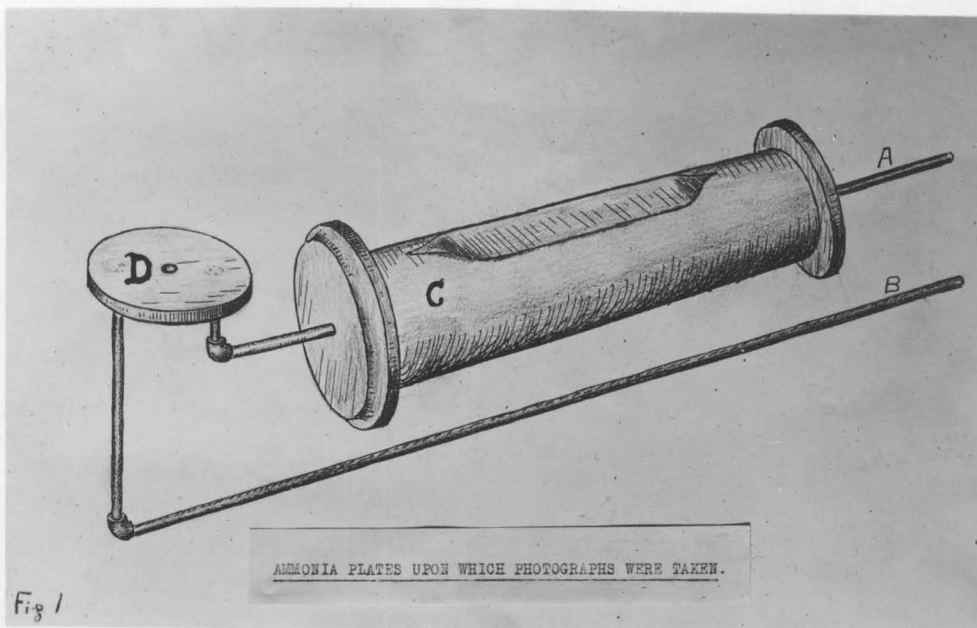


Fig 1

AMMONIA PLATES UPON WHICH PHOTOGRAPHS WERE TAKEN.

In Fig. 1. the Ammonia entered through pipe A returning through pipe B.

#### The Amount of Solids in the Cream Mixture.

Commercial ice cream makers have assumed that an increase

in the amount of milk solids tends to produce a smoother cream, and that this will apply also to an increase brought about by the addition of fillers, binders, etc.

The percentage of fat in cream is the varying factor as far as milk solids go, for creams with the same per cent fat will vary in percentage of solids - not fat - but slightly. Therefore, the assumption is that an increase in per cent fat in the cream produces a smoother texture/



The appearance of cream under the microscope of 20% and 10% fat is shown in Fig. II and III.

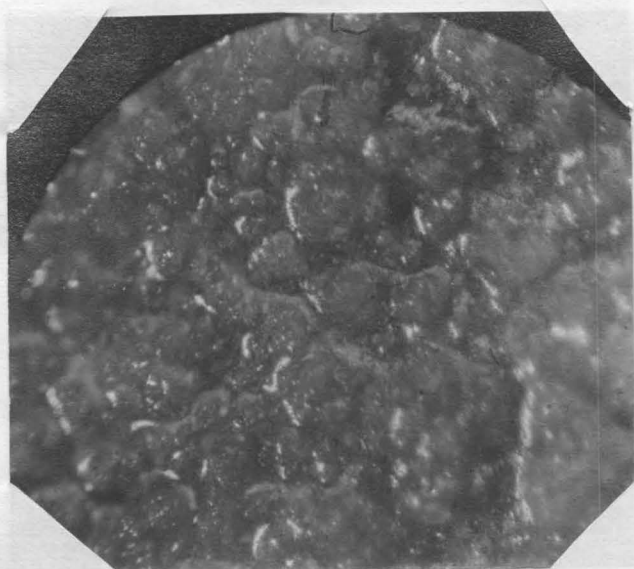


Figure II.

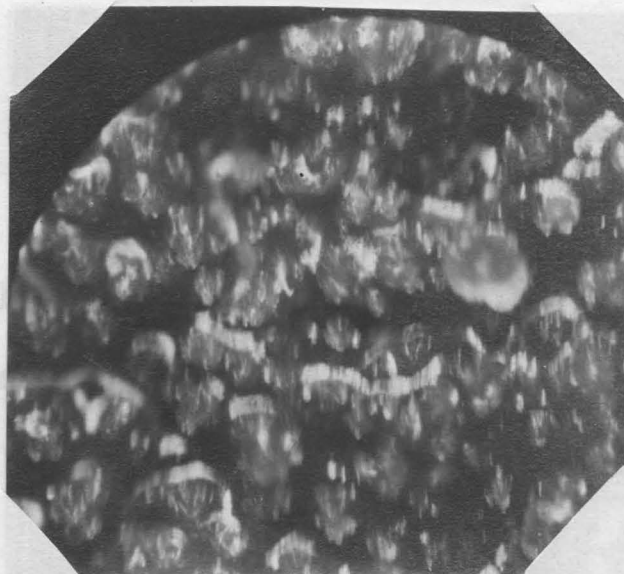


Figure III.

Figure No. II represents cream made from 20% cream without any filler. Contrast with figure No. III, which contains no filler and 10% fat. The Cream in Figure No. II has a smooth appearance, the crystals being minute and evenly distributed, while in Figure No. III the crystals are large and unevenly distributed. This difference in the ice formation may be explained as follows.

It is a well defined law of crystallography that ice freezes in a regularly formed crystals, the size depending mainly upon the rapidity of freezing. The presence of other material will naturally interfere with the formation of this regular form of crystal. The agitation of the cream while freezing causes the crystals to become irregular and much smaller. Hence the distance between the solid particles must be less in the batch which contains the greater amount of solids. Assuming that the homogeneity of the mixture remains constant

The cream in Figure IV was composed of

throughout the freezing process, the space between solid particles would be less in the batch containing the most solids.

Inasmuch as roughness in ice cream may be due to large ice crystals or ice formation, the cream having the larger amount of solids is smoother.

From the standpoint of the ice cream maker solids may be in suspension, emulsion, colloidal solution or in true solution.

Solids in Suspension. At the present time in ice cream practice solids are seldom used in the suspended form. Uncooked starch is probably one of the best illustrations of a solid in such form. This is on account of the lack of fineness of division, which will be more forcibly brought out later in this discussion.

Emulsions. The most common emulsion met with is that of fat. The importance of fineness of division of this solid in the emulsified form is shown in photographs Numbers IV and V.

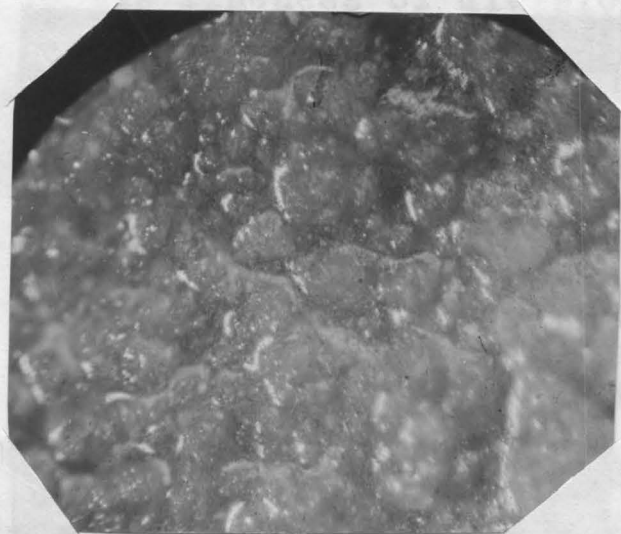


Figure No. IV

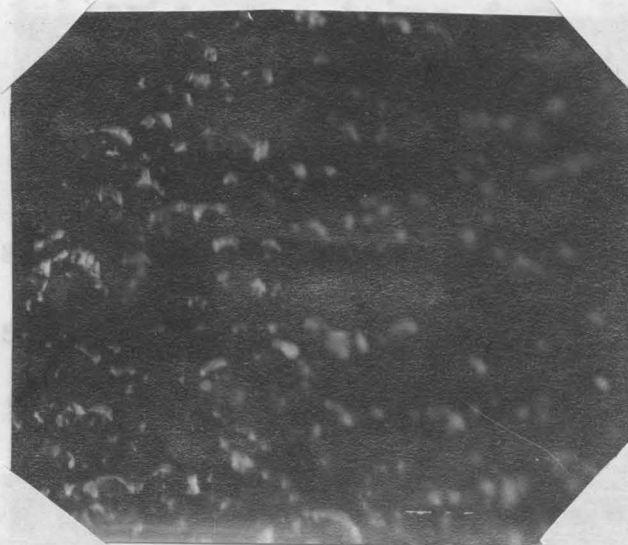


Figure No. V



The cream in Figure IV was composed of

1 quart 20% cream, unhomogenized,  
6 ounces of sugar,  
1/2 " of vanilla flavor,  
10 grams of red coloring,

The cream from which Figure No. V. was made being similar except homogenized cream used. In the process of homogenization the fat globules are divided into more minute globules which makes them more evenly distributed causing the formation of very minute crystals and a smoother cream.

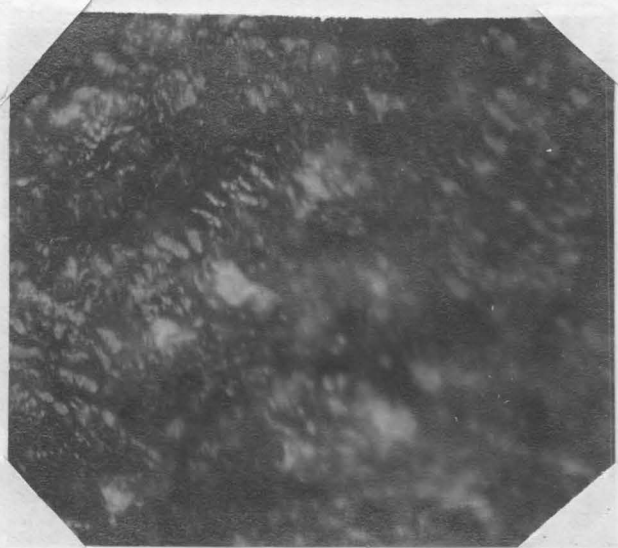
The crystals in Figure No. V are very minute and evenly distributed which is due to the evenness of the distributions and minuteness of the fat globules.

Colloidal Solutions. The solids most frequently found in ice cream in the shape of colloidal solutions are gelatin, gum tragacanth, cooked starch, eggs, etc. The chief difference between suspension colloidal solutions and true solutions is the fineness of division. The following was taken from Theoretical and Physical Chemistry as described by Bigelow:

"We are inclined to apply the term suspension if any indication of settling is perceptible after a short time, or if we think separation will eventually take place. We include under the head of colloids, substances dispersed through a solvent in particles so fine they will not settle out, and yet not so fine but what we can by experiment, form approximate estimates of their size."

Figure No. VII was made from ice cream which had been hardened for 24 hours. The following formula was used:

It will be noted that the stability of the solution depends upon fineness of the division. Ice cream is often held several days. If during this period of storage the cream is permitted to soften and later rehardened, the solids separate to a greater or less extent, permitting the water to reform in large ice crystals, thus causing a coarse cream. The one factor, therefore, in a cream of good keeping qualities is the permanency of solution of the solids in the original cream, which in turn depends mainly upon the fineness of division of the solids present. The value of fineness of division of colloidal solutions, both as to smoothness and keeping qualities of ice cream is forcibly illustrated in photographs No. VII - VIII - IX - X.



Photograph No. VII.



Photograph NO. VIII.



Figure No. VII was made from ice cream which had been hardened for 14 hours. The following formula was used:

- 1 quart of 15% cream,
- 6 ounces of sugar,
- 1/2 ounce of vanilla flavor,
- 10 grams of red coloring
- 1 ounce of gelatin,

Figure No. VIII was made from a similar cream with one ounce of cooked starch instead of the gelatin as a filler.

The division of gelatin in such a solution is much finer than starch. It will be noted that the ice crystals in the gelatin cream are smaller and more regularly distributed. These creams were held for 72 hours during which time each was permitted to soften three times and was hardened again by freezing.

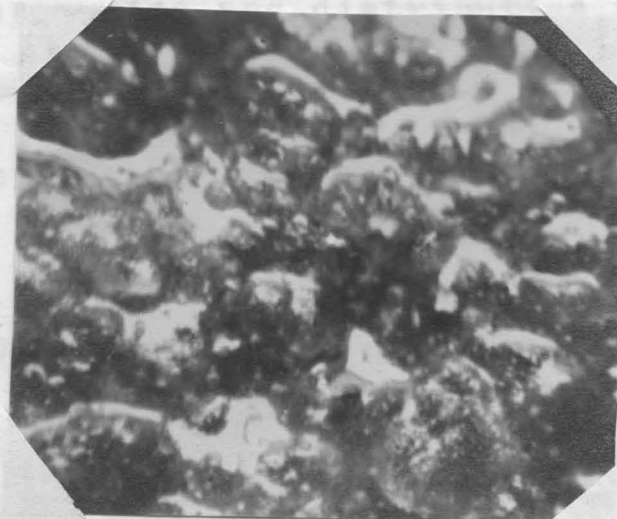


Figure No. IX.

Figure NO. X

V. The keeping qualities of ice cream depend upon the stability of the "air". That is, the keeping qualities of ice cream made from

Figure No. IX shows the form of gelatin cream found after rehardening and Figure No. X demonstrates the changes which occurred in the starch cream in the process of softening and rehardening. It will be noted that more change has occurred in the starch cream than the gelatin cream as the starch was not distributed as evenly originally and has a tendency to separate.

#### Summary.

I Smoothness and texture of ice cream are closely associated both with fresh and refrozen ice cream.

II Smoothness depends upon the amount and fineness of division of solids present other than those in true solution, within limits; that is, the smoothness depends upon size and distribution of ice crystals which in turn depend upon the number and nearness together of minute solid particles which interfere with crystallization and reduce the size of the ice crystals.

III Colloidal solutions of solids other than fat are best adapted for filler in ice cream. The finer the division the better.

IV The more complete the emulsion of the fats the better. The homogenizer has its application in this respect.

V The keeping qualities of ice cream depend upon the stability of the "mix". That is, the keeping qualities of ice cream made from



a given mixture will depend upon the disposition of the solids in that to separate from the liquid, which in turn depend upon the fineness of division of the solids. The finer the division the better the keeping qualities up to the point at which the solid merges into a true solution.