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Studies on the use of egg in plain ice cream

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Studies on the Use of Egg in Plain Ice Cream

by

Donald A. Pettee

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Studies on the Use of Egg in Plain Ice Cream

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INTRODUCTION

Some form of egg yolk is used by a large majority of ice cream manufacturers. This ingredient may be added in the form of dehydrated, frozen or fresh egg yolk. Because of convenience and comparative cheapness the dehydrated form is most generally used.

The consumption of ice cream in 1928 is reported as 340,000,000 gallons. If 60 per cent of the product contained 0.3 per cent powdered egg yolk, the amount used would then be approximately 9,200,000 pounds. At a cost of 70 cents per pound this represents an investment in egg alone of more than $6,400,000.

It is generally believed that the egg which is added performs three roles:

1st. It gives the product greater uniformity.

2nd. It improves the texture.

3rd. It hastens the freezing process by allowing the mix to whip more rapidly.

Eggs have long been recognized as effective emulsifying agents. Since this is true it is natural to expect that the product containing egg would have greater uniformity and improved texture. Doubtless chefs and connoisseurs in years past realized this fact because they invariably included eggs in their recipes for ice cream. Home-made ice cream usually contains eggs, "to make it smoother" or, in more scientific terms, to emulsify the fat. In the case of the home-made product, the egg flavor is apt to be quite apparent but is not looked upon as objectionable. In reality such a product is a "French" ice cream which is in no way comparable with the commercial plain ice cream. When ice cream was first made commercially, it was natural to use as a basis formulas in general use by the better chefs. These recipes called for eggs. It is natural to believe that partly because of custom and because of the now generally recognized whipping quality inherent in egg yolk its use has always been universal.

With the general adoption of the homogenizer or viscolizer, however, the amount of egg used is so small that it is hardly correct to think of eggs as active emulsors. Homogenization is the term applied to a mechanical process whereby, under the influence of pressure, the fat globules of the fat are greatly reduced in size and further dispersed. Therefore, since the fat is emulsified mechanically, some other justification must be found for the use of egg in the ice cream mix.

Some investigators feel that the addition of egg improves the texture of the ice cream. Others feel that there is no improvement and if any improvement is manifest it would pass unnoticed by the consumer. Just what influence the egg may exert upon the whipping ability of the mix has not been established beyond question. The industry is hardly out of its infancy and many phases have not as yet been comprehensively investigated. The influence exerted by the addition of eggs on the ice cream mix is no exception.

In developing this problem the following factors have been given consideration:

1st. To ascertain what influence the various forms of eggs have upon the whipping ability of plain ice cream.

2nd. To discover if certain stages in the preparation of the mix are better than others for the incorporation of this ingredient.

3rd. To ascertain whether the so-called improved quality and rate of whipping justify the amount of money expended for this ingredient.

4th. To determine what effect the mineral salts found in egg yolk have upon the whipping ability of plain ice cream.

REVIEW OF PREVIOUS WORK

The role which egg performs in the ice cream mix and the freezing process has not been comprehensively investigated and for this reason very little previous work has a bearing on the problem. Consequently a review of the literature cannot be comprehensive;neither can it be used, except in a limited way, as a basis for developing this work.

Tracy[1] concludes that a small amount of powdered egg yolk tends to improve the body and also increases the richness of the ice cream. He also states that the ice cream manufacturer should not lose sight of the fact that the same thing can be accomplished by the use of additional milk solids. The use of a filler is justified only when it has food value and can be economically used without detracting from the quality of the ice cream. He found that an objectionable flavor was imparted when the egg content was high; that is, when as much as 8 ounces was added to a 45 pound batch. This, of course, is a reflection on the quality. Since powdered egg yolk contains an average of 45 per cent fat, the product which contains egg should appear richer. This would be more noticeable in the product with a low fat content. The amount of egg added in any case, however, is so small that whatever influence might be exerted upon the final richness of the product would go unnoticed by the average consumer or observer.

Turnbow and Raffetto[2] found that ice cream containing egg had a smooth, velvety appearance when drawn from the freezer but observed that the texture of the product when hardened might not be smooth if the composition of the original mix was incorrect.

Price[3] takes exception to some of Tracy's work and contends that the use of powdered egg yolk results in an ice cream with a stronger consistency, improved texture, and better flavor.

Reid[4] believes that the use of dehydrated egg yolk tends to improve flavor and body. He also contends that the manufacturer may obtain the same effect by using extra serum solids. This substantiates the statement by Tracy. In Reid's experimental work three different amounts of egg; namely, 4, 6, and 8 ounces to a 50 pound batch, were used in medium, low, and high butterfat mixes.

He observed the effect of these additions upon the viscosity and overrun of the mix. Observations on texture, resistance, and flavor were noted from the frozen product. If the egg was added previous to homogenizing, the viscosity was usually reduced. Egg powder added previous to homogenizing yielded a higher maximum overrun than the control or those which were treated by adding the egg following the homogenization process. If the egg added was not homogenized with the mix, the maximum overrun was highest in the control. Many of Reid's statements have been substantiated in this work.

Dahle and Caulfield[5] found that dehydrated egg yolk gave better results than any other product added for the purpose of aiding the yield. It saved time in freezing in all instances. They call attention to the fact that the best results were obtained with mixes which contained no gelatin, but when egg yolk was used with the usual amount of gelatin a saving in time was observed over the control which contained no egg. They state further that egg yolk should not be considered a stabilizer but rather an emulsifying agent, because it cannot be substituted for gelatin. It is superior to milk solids as an emulsifying agent. A more stable fat emulsion exists when egg yolk is used than is the case with skim milk powder, if used in equal amounts determined on a dry basis.

In the work cited the manner in which the egg has been added to the mix has not been clearly defined. This factor may be more influential on the results obtained than is generally recognized.

A nation-wide survey[6] shows that different manufacturers follow many different procedures in adding the egg to the mix. Some add the dry powder with the sugar; others sift the egg in while the mix is heating. Some mix the egg powder with a small amount of warm water. This results in a smooth paste which is then added with the other liquid ingredients. This same procedure is also followed by others who make the egg paste but do not add it to the mix until just previous to the homogenizing process. In several instances it was noted that the egg paste was added at the freezer. If equally good results can be obtained by adding the dry egg powder either alone or with the sugar, it would appear that this is the best method to use. If an egg paste is made with water the addition of this water tends to reduce the total solids content of the mix. If the maximum good is obtained from the egg when added in the form of a paste or custard, then it would seem advisable to make the paste from whole or skim milk. The use of either is not reported, however.

Some concerns use fresh egg yolk. The use of four dozen yolks to every 50 pounds of mix is reported. These are added to the mix with the sugar and cream before pasteurizing. Another adds two quarts of yolks to six gallons of homogenized mix and then heats the mixture for ten minutes. This latter method would appear very impracticable since the mix would have to be cooled again before freezing. This method could not be used in a plant where the gallonage is large.

It is interesting to note what these same manufacturers have to say in regard to the use of eggs in their product. The following statements appear in the September 1925 issue of the Ice Cream Trade Journal[6]. The statement that the texture is improved is one that is repeated in varying phraseology,"Better emulsification produced, resulting in a smoother product". "Seems to give the product more viscosity and makes a velvety finished ice cream". "We feel that the egg yolk gives us a smoother, better and more palatable product with better texture, flavor, and color". Another emphasizes the fact that the egg yolk causes the ice cream to be more uniform from day to day, and as a result causes it to dish out better. One declares that its use saves him time in freezing while another says, "With it we can freeze ice cream more easily and with a greater variation in brine temperature". Only two seem to be impressed with the fact that they are apparently able to freeze the product more quickly.

Sommer[7] has shown that the salts normally present in the dairy products used in ice cream may have a marked influence on the whipping ability of the mix. These salts are the chlorides, citrates and phosphates of sodium, potassium, calcium, and magnesium. It has been observed that neutralized mix whips less readily than a fresh or sweet mix. This is due in part to the destruction of citrates in the fermentation that occurs during souring. When lime is added to correct this acid condition, calcium lactate is formed in the mix. He found that if 0.1 per cent calcium lactate was added to a fresh mix the ease of whipping was reduced, whereas the addition of disodium phosphate and sodium citrate greatly increased the whipping ability over that of the control. In this work the salts were homogenized and aged with the mix since it was found that if they were added at the freezer their influence could hardly be detected. It is generally recognized that the viscosity influences the whipping ability of the mix. The influence on the viscosity is not reported. This factor will be considered later.

Hening and Dahlberg[8] have reported the influence of adding sodium and calcium salts to the mix as related to viscosity, ease of whipping, and fat globule clumping. Sodium citrate, disodium phosphate and calcium lactate were the salts used. If added before homogenizing the sodium salts reduced the viscosity and the ease of whipping was increased over that of the control. The calcium lactate increased the viscosity and made a slow or hard whipping mix. If the salts were added after homogenizing, no noticeable effect was apparent in the viscosity. The sodium salts, however, improved the whipping while the calcium salts exerted no influence. The viscosity change was attributed in part to the action of the salts. In those cases where the viscosity was reduced, the fat globule clumps were smaller. This was true only where the salts were homogenized with the mix as there was no marked effect in those cases where the salts were added after this process. The calcium salts increased the viscosity and the size of fat globule clumps.

From this work and that of Sommer it is doubtless true that there is enough variation in the sodium and calcium salt content in the ice cream mix from day to day to cause a variation in the whipping properties of the mix.

Turnbow and Raffetto[2] state that the salts present in eggs may have a bearing upon the whipping ability of the mix. This assertion together with the work cited above has been the underlying motive for endeavoring to determine what influence the salts present in egg yolk exert upon the whipping ability of ice cream mix.

EXPERIMENTAL PROCEDURE

In order to attack the problem systematically, a standard mix was selected and made under a definite procedure. The mix meeting the requirements contained 14 per cent butterfat, 10 per cent serum solids, 15 per cent sugar, and 0.35 per cent gelatin. This will be referred to as the standard mix. From this standard mix the numerous variables were introduced.

An endeavor was made to determine what influence fresh egg yolk, fresh egg white or albumin, frozen egg yolk, and dehydrated egg yolk had upon the whipping ability of the standard mix. The study was continued by varying the amount of fat as well as the serum solids of the mix..Later an attempt was made to see how the source of these ingredients; that is, butter or cream as the fat source and skim milk powder or condensed skim milk as the source of serum solids, reacted to the addition of egg yolk in its various forms. A variation in the sugar content of the mix and maximum overrun determinations made up a part of the study.

The final part of the work deals with the phosphates present in egg yolk and the possible influence they exert upon the whipping ability of an ice cream mix.

All batches were mixed and pasteurized in a glass lined holding tank. The liquid ingredients were added first, after which the skim milk powder, gelatin in dry form, and sugar were added in the order named. Live steam and cold water were used to control the heating and holding processes. In all cases the mix was heated to 145° F. - 150° F. and held for thirty minutes.

After pasteurizing, the mix was homogenized at a pressure of 2500 pounds per square inch unless otherwise noted.

From the homogenizer the mix was run over a surface cooler where the cooling process was completed. Water and brine are used in this cooler as the cooling media. The mix was cooled to 50° F. or slightly lower by this method.

In this work 45 pound batches were selected as the most desirable, therefore the mix was divided into 45 pound batches at the cooler.

The time of adding the egg varied in the study. It was added either with the sugar and processed, just previous to homogenizing, as the mix was taken from the cooler, or at the freezer. The amount added and the manner of adding is dealt with under experimental results.

The mix was aged for at least sixteen hours in a refrigerator where a temperature of 40° F. - 45° F. is maintained.

Previous to freezing an index of the viscosities of all the batches was determined. This was accomplished by timing the flow from a 17.5 c.c. volumetric pipette. Briefly this consists of filling a pipette to the etched line above the bulb. The mix is then allowed to flow from the pipette until the upper level of the out flowing mix reaches the constriction below the bulb. The time of outflow is determined by a stopwatch. The number of seconds taken is used as the index. In these studies an average of three trials was taken as the index value. These trials were taken at a temperature of 40° F. - 45° F. after the mixes had been given the same amount of agitation (approximately) with a stirring rod.

A definite procedure was followed in freezing. The machine was first cooled by a batch which was frozen without taking any data. The control batch was then placed in the hopper and the freezer started. Next the hopper was opened while at the same time the brine was turned on and the stop-watch started. At the end of one minute a sample was drawn to determine the overrun present, and immediately following this another sample was taken to determine the temperature of the mix. Overrun and temperature determinations were made in this manner until the necessary data had been obtained. All mixes were frozen to an overrun of 100 per cent since in commercial practice ice cream is seldom whipped beyond this point.

A Mojonnier Junior overrun tester was used in making the overrun determinations. Temperatures were read with an indicating thermometer graduated from 0° F. to 50° F. with 0.2° intervals.

Samples for observation were taken at 85 per cent overrun. These samples were placed in pint Sealright containers and held in the hardening room until ready for observation.

The make and capacity of the machines used in carrying out this work follow. They are named in order of their use.

Pfaudler Glass Lined Holding Tank - 150 gallon capacity.

Gaulin Homogenizer (Two Stage) - 1000 pounds per hour.

Simplex Surface Cooler - Capacity determined by amount fed to machine.

Fort Atkinson Brine Freezer - 40 quarts.

Method of Determining Amount of Phosphates in Egg Yolk

Leach[9] gives the composition of the ash of eggs as follows: (This ash represents 2.91 per cent of the dry substance of the yolk.)

	Per Cent		Per Cent
Potassium	9.29	Iron Oxide	1.65
Sodium	5.87	Phosphoric Acid	65.46
Calcium	13.04	Silica	0.86
Magnesium	2.13	Chlorine	1.95

Assuming that the phosphoric acid is combined in the form of the phosphates of potassium, sodium, calcium, and magnesium, a mixture was made up to approximate that given above.

Hydrogen potassium phosphate, mono basic sodium phosphate, mono calcium phosphate, magnesium sulfate and sodium chloride were used to supply the materials present in the ash of egg. They were combined in a single molecular weight ratio except the mono calcium phosphate of which two parts were used.

The following figures will make the above statement clear.

Ingredient	Mol. Wt.	Gms. Used
K_2HPO_4	176	17.6
NaH_2PO_4	143	14.3
2 Ca H $(PO_4)_2$	468	46.8
MgSO4	120	12.0
NaCl	58	5.8

The table below gives the percentage composition of the mixture used and the percentage composition of the egg yolk ash as given by Leach.

Phosphate Mixture

	Per Cent Supplied	Per Cent Desired
PO_4	59.15	65.46
K	8.1	9.29
Na	4.77	5.87
Ca	8.31	13.04
Mg	2.49	2.13
S	3.32	0.00
Cl	3.63	1.95

Since there is a tendency for the salts to deteriorate when in combination with one another, the mixture was made just previous to being used. The desired amount, 6.5 gms., was dissolved in 50 c.c. of water and stirred with the mix after it had been cooled.

It requires on the average six dozen egg yolks to make one pound of dehydrated product. Leach[9] gives the weight of one fresh egg yolk as 19 grams. By using this value (19 grams) it will be found that approximately eleven egg yolks or 214.4 grams of the fresh egg yolks should yield 2.5 ounces of the dehydrated product. Leach states that the ash of egg repsents 2.91 per cent of dry substance. This being the case 1.96 grams of the ash mixture would be introduced into a mix if 2.5 ounces of dehydrated egg yolk were used. For simplicity 2.0 grams of the mixture were actually used.

EXPERIMENTAL RESULTS

Influence of the Various Forms of Egg on Rate of Whipping

a. Fresh Egg Yolk

By figures gained from the survey mentioned in the introduction and partly for convenience, one pound of the raw egg yolk was used to every 45 pounds of mix. This gives 2.2 per cent egg figured on a total weight basis. Since egg yolk contains approximately 50 per cent water, this would give 1.1 per cent of egg yolk ingredient actually added.

An endeavor was made to determine at what stage in the process the egg should be added to obtain the greatest overrun in the shortest time. Accordingly the stated amount was added to one batch of the mix after it had been cooled. This was done in order that the egg might age in the mix. The yolks were beaten in order that they might be stirred into the mix more evenly. To a second batch one pound of the egg was added and homogenized with the mix then cooled as in the regular procedure. The third batch was completed by adding the egg at the freezer so that the egg was neither homogenized nor aged with the mix.

If the egg is homogenized with the mix, the viscosity is usually reduced. If the egg is added at the cooler and aged with the mix, a marked increase in the viscosity results. The freezing data obtained indicate that the greatest benefit can be derived from the raw egg yolk if the yolk is added after the mix is cooled. (See accompanying graph No. I.) Under the conditions existing at this laboratory, the investigation indicates that the greatest benefit from the standpoint of aiding the yield can be obtained from raw egg yolk if it is aged with the mix but not homogenized. On the other hand, from a commercial point of view as well as to insure thorough incorporation of the egg, it should be homogenized with the mix.

b. Frozen Egg Yolk

The frozen egg yolk which was used differed slightly in composition from the fresh shell eggs in that it contained a small amount of sugar. Since the amount is negligible (1 per cent) one pound of the raw yolk was used in this work. This would tend to keep the comparison between the shell and frozen egg yolk the same.

As far as possible the same conditions apply in this study as were outlined in the discussion given under "Fresh Egg Yolk". The viscosity relationship was the same as in the case of fresh eggs. New factors seemed to become evident in this series. First, the initial whip of the mixes containing egg was slower than the control. This was particularly noticeable in the homogenized product. However, all of the mixes seemed to incorporate 65 - 70 per cent overrun at approximately the same time. From this point on to 100 per cent the egg mixes whipped more rapidly than the control. In this series there was no noticeable difference between the unhomogenized egg mixes, both arriving at 100 per cent two and one-half minutes sooner than the control. This was one minute faster than the homogenized egg mix. This makes the latter one and one-half minutes faster than the control.

Reference to graph No.II will substantiate these statements.

This again indicates that the fastest whip can be obtained from raw egg by adding to the mix and permitting the egg to pass through the normal aging period with the rest of the mix.

c. Dehydrated Egg Yolk

As a custard:- Powdered egg yolk may be added to the mix in various ways. It may be added dry with the sugar or sifted into the liquid mixture during the heating process or just previous to homogenizing. Some prefer to make a thin paste with water and add with the rest of the liquid ingredients. The most convenient method is to add with the sugar, since it is somewhat difficult to get a satisfactory mixture of the egg and water.

In this study several methods were employed to incorporate the powder but in this particular instance that of adding in the form of a water paste is reported.

In making up the water egg mixture seven pounds of yolk and 21 pounds of water were used. This was heated to 180° F. and held for ten minutes to make a smooth mixture and to remove the danger of egg flavor. A stock mix which could be used as needed was thus made. One pound of this mixture was used for each batch. This was the equivalent of adding 0.417 per cent egg yolk.

The three general procedures previously outlined for incorporating the egg yolk were employed in this study.

It appears that this method cannot be used if the egg is to be added for whipping purposes alone. In fact, the egg retarded the whip. Graph No.III indicates the results obtained in this work. There was a retardation of one minute in the homogenized mix and one and a quarter and one and a half minutes respectively when added at the cooler and freezer. This seemed to apply not only on the standard mix, but in all trials.

<u>In dry form</u>:- Commercial ice cream makers usually add from 0.2 to 0.5 per cent of powdered egg yolk to their plain mix. The amount which is most commonly used is 0.3 per cent. For convenience 2.5 ounces or 0.277 per cent were used in this study. When the powder is added to the mix in a dry form, the two methods most generally used are; first, by mixing and adding with the sugar; and second, by sifting into the hot mix just previous to homogenizing. An attempt was made to see if one method was superior to the other from the standpoint of obtaining overrun.

The results obtained indicate that there is a slight advantage to be gained by sifting the egg powder into the mix just previous to homogenizing. (See graph No.IV). In one trial there was a difference of one minute in favor of this method. This may have been due to the fact that certain of the phosphates in the egg yolk tend to be broken down by heat. It is possible that during the heating and pasteurizing process this may happen and thereby cut down the effectiveness of the phosphates on the whipping. In addition there is possibly a breaking down of the egg protein or coagulation which may influence the whipping properties. In support of the above it has been found in this work that a more rapid and also higher maximum overrun can be obtained from the use of raw egg yolk than from the dehydrated form. The addition of powdered egg yolk aided the yield in every instance. The greatest good can be obtained from the use of egg where the freezer is in poor condition.

d. Different Forms of Egg Yolk Compared

Since it takes approximately six dozen egg yolks to make one pound of dehydrated egg yolk powder, eleven fresh yolks may be considered equal to 2.5 ounces of the dehydrated product. Eight ounces of the frozen egg were used since the fresh yolks weighed between seven and eight ounces, and thus the same relative amounts of the various forms were used.

In this particular instance the egg ingredients were added just previous to homogenizing, the fresh and frozen eggs being raw.

The mixes containing the fresh yolk were found to whip most rapidly. The egg powder mixes whipped more rapidly than those containing the frozen egg but were slower than the fresh yolk mixes. This seems to demonstrate that the whipping constituents of the egg are most active in the fresh product. Graph No. V supplements this statement.

e. Egg White (Albumin)

It is a matter of common observation that the white of egg will take on air readily when beaten sufficiently. This property makes it adaptable to many uses in cooking.

It might be reasonable to expect that the egg white would exert some influence on the ease with which ice cream can be whipped. From this study there was no indication whatever of any improvement in whipping. Typical freezing data are shown in graph No. VI .

The egg albumin was not heated and pasteurized with the mix because of possible danger of coagulation in which case any benefit might be destroyed. One pound of the material was added previous to homogenizing, at the cooler, and at the freezer. In some of the trials only 12 ounces were used. There was practically no change in the viscosity of the mix containing the egg albumin. The freezing process could not be completed any more quickly by the incorporation of this ingredient. In a study of maximum overrun the same condition prevailed, in that the control and the mix containing the albumin whipped to the same maximum.

f. Influence of Egg Yolk on Mixes Varying in Source of Fat

In studying this phase of the problem, cream, butter, and a combination of sweet butter and cream were used because these materials supply by far the greatest amount of fat in the commercial product. In the latter case 50 per cent of the butterfat was supplied from each of the products.

It is generally recognized that a so-called butter mix whips more slowly than a mix of the same fat content made from cream. Other things being equal, the butter mixes were found to whip more slowly than the cream although this difference was not as marked as many would expect. In general the butter mixes had a more rapid initial whip but lost this advantage from 60 per cent on and were finally passed by the cream and the butter and cream mixes. This study indicates that a butter mix in which the serum solids are supplied from super heated skim condensed milk whips more easily than where skim milk powder is used as the source of extra serum solids. (See graph No. VII). Egg powder added at the rate of 0.277 per cent caused a marked improvement in the ease of obtaining overrun in all cases. Its greatest influence, however, was exerted upon the butter mixes. In one case where skim condensed was used as the source of serum solids, the whipping time was shortened three minutes over that of the control. Another trial on a butter-cream mix showed an improvement of one and one-half minutes. Placing the egg powder under the severest conditions with an unaged butter mix, it was found that an improvement of over four minutes in whipping time could be gained by the addition of only 0.277 per cent. Under the existing conditions the egg powder caused cream mixes to whip about one minute faster than the control.

g. Influence of Egg Yolk on Low and High Butterfat Mixes

This study indicates that a high fat content does not appreciably retard the whipping qualities of a mix over the whole freezing period. This is perhaps in contradiction to general belief. The initial whip of a high butterfat mix is slower than that of a low butterfat mix. However, the rate of whipping after reaching 65 - 80 per cent overrun is more rapid than a mix where the opposite condition prevails; namely, one of a lower fat content. Two mixes containing 11 per cent and 17 per cent respectively were frozen under identically the same conditions with regard to brine flow and temperature. This represents a variation of approximately 33 per cent in butterfat content yet both arrived at 102 per cent overrun at the same time. From these results it appears that egg yolk creates a better whipping condition within the low butterfat mix; that is, the yield is hastened more than is the case with a high butterfat mix. This is demonstrated by graph No. VIII.

h. Influence of Egg Yolk on Low and High Serum Solids Mixes

This study indicates that there is only a slight tendency for a low serum solids mix to whip more readily than when the opposite condition exists. This is more apparent where the condition of a low serum solids content exists in combination with high butterfat content.

When egg is used in a high serum solids mix it exerts a greater influence upon the whipping than will an equal amount used in a low serum solids mix of otherwise same composition. (See accompanying graph No. IX).

i. Influence of the Mineral Salts in Egg Yolk

Sommer[7] as well as Hening and Dahlberg[8] have shown that the salt balance within a dairy product may very markedly determine its behavior with reference to added salts and in the case of ice cream influence its whipping ability. It has been stated that certain citrates and phosphates may retard or hasten the freezing process.

In order to discover whether the salts, largely phosphates, in the egg yolk were in any way responsible for the increased ease with which mixes containing egg could be frozen, the mixture of phosphates described under experimental procedure was used on mixes of varying composition.

There may be considerable variation in the salt balance of any particular dairy product from time to time. This may explain the failure of the salts to have any appreciable influence at certain times while at others there is a marked difference in the whipping time. In this particular study the most satisfactory results were obtained when the salt mixture was added at the cooler and aged with the mix.

Two grams of the salt mixture, which would be the equivalent of 2.5 ounces of the egg powder, failed to appreciably influence the whipability. This amount was increased to 6.5 grams and in most instances there was a decrease in the viscosity. A decrease in whipping time was noted in nearly every instance. Graph No. X is typical of the results obtained.

Doubling the amount of mineral salts from 6.5 to 13.0 grams did not cause any marked difference in the rate of whipping.

In this study the phosphates were slightly less effective on the butter mixes than on the cream mixes.

From the results of this work it is believed that a part of the whipping ability attributed to eggs can be traced to their phosphate content. Since better results were obtained by adding the salt mixture to the cold mix than was the case where it was added to the hot mix and homogenized, it tends to further the argument that possibly some of the effectiveness of the egg is lost on long continued heating;

for example, during the pasteurizing process. There was no improvement in whipping time when the mixture was added at the freezer.

j. Influence of Egg Yolk on the Quality of Ice Cream

Quality is a broad term. When used in reference to ice cream it usually refers to body and texture or flavor. If the body is weak and the texture is coarse, the product may be spoken of as poor in quality. Obviously, if the flavor is unnatural or false, it is a reflection on the quality of the product. From this standpoint the conclusions in regard to quality have been made.

The addition of 0.277 per cent egg yolk in any of the various forms studied exerted but little influence on the quality of the frozen ice cream. There was a tendency for such a product to be somewhat smoother but this was not constantly noted, and would, it is believed, be unnoticed by the general consumer. This small amount of egg did, however, make the ice cream more resistant to melting. If allowed to melt, the product containing the egg appeared smoother than the control. Since ice cream is not eaten in the melted condition this is of little value.

If the amount of egg added was under 0.3 per cent it was rather difficult to detect in all instances. Above this amount the egg flavor became obvious varying in intensity with the amount added.

If the product was to be scored it is believed that it would be classed as "egg flavor" or "objectionable." This would perhaps apply only to the quality of egg used. In this study, however, a product of recognized quality was used.

This work indicates that the dehydrated form is more easily detected than either the frozen or fresh yolk.

The flavor of the egg was in no instance pronounced where the amount added did not exceed 0.3 per cent. The product containing the egg powder, however, left an unnatural after taste.

Egg powder used in excess of 0.3 per cent is apt to impart an egg flavor. This is not considered desirable. The smallest amount which aids the yield should be used since this relieves the danger of any pronounced egg flavor.

CONCLUSIONS

1. All forms of egg yolk will decrease the freezing time of ice cream mix.
2. If equal amounts of raw, frozen, and dehydrated egg yolk are compared, raw egg yolk is the most effective.
3. The greatest benefit can be obtained from fresh egg yolk and frozen egg yolk if it is added after the mix has been cooled, or aged with the mix.
4. Slightly greater benefit will be obtained if dehydrated egg yolk is sifted into the mix just previous to homogenizing.
5. From the standpoint of improved quality, added egg does not justify the amount of money expended.
6. If enough egg is added to materially cut down the whipping time of a fresh cream mix, there is danger of a pronounced egg flavor which impairs the quality.
7. Egg yolk shortens the whipping time of a butter mix more than a cream or a cream and butter mix.
8. The whipping time of a high serum solids mix is decreased more by the addition of egg than is that of a low serum solids mix.
9. Egg yolk shortens the whipping time of a low butterfat mix more than that of a mix of higher butterfat content.
10. Egg white or albumin does not influence the whipping ability of ice cream mix.
11. The mineral salts present in egg yolk are probably responsible for a part of the whipping ability attributed

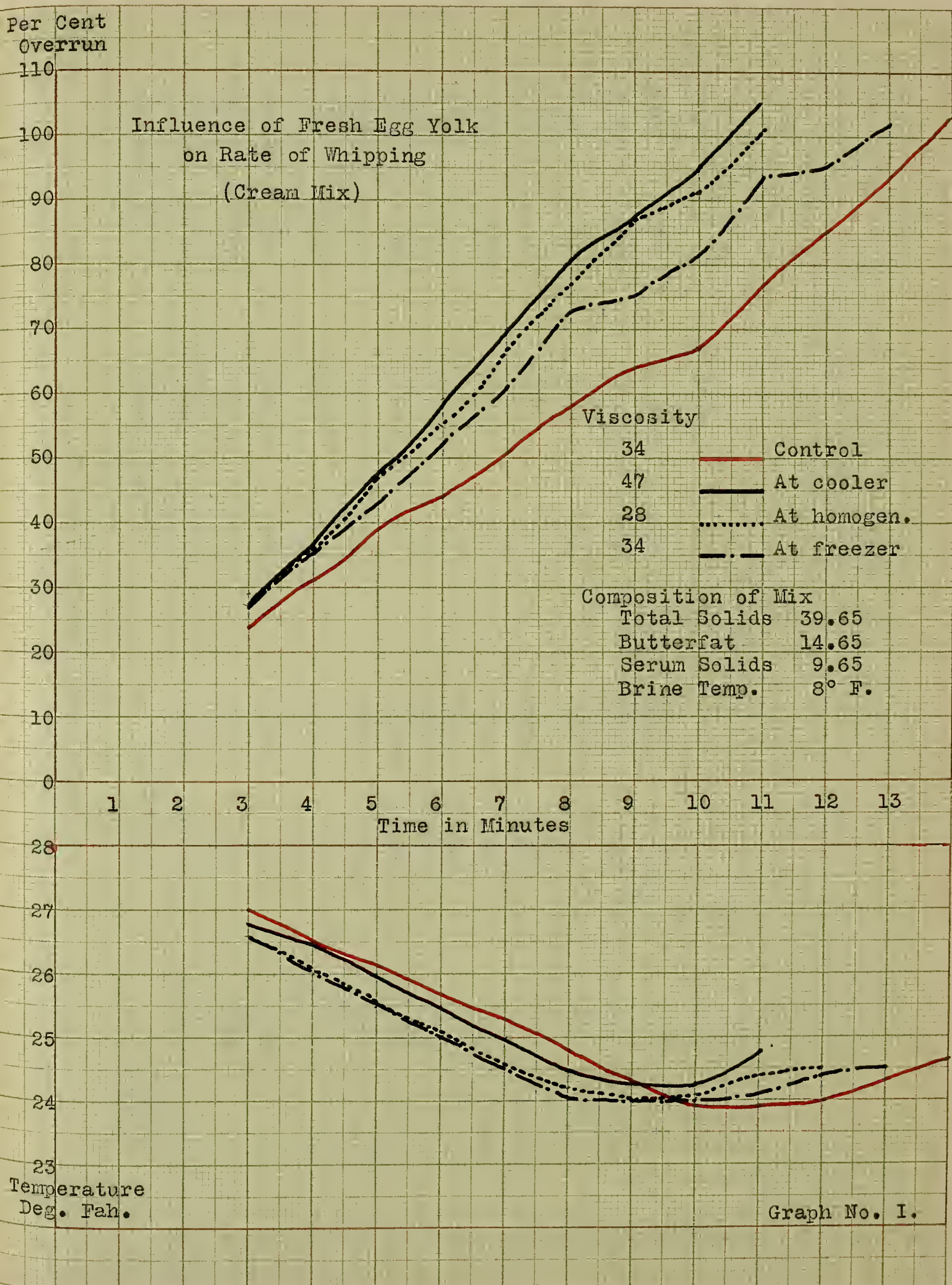
to eggs.

12. The composition of the mix, the source of the ingredients, the condition of the freezer and the brine flow should determine the advisability of using egg to decrease the whipping time.

The section which follows includes the graphs and freezing data referred to in the discussion of experimental results.

Freezing Data for Graph No. I

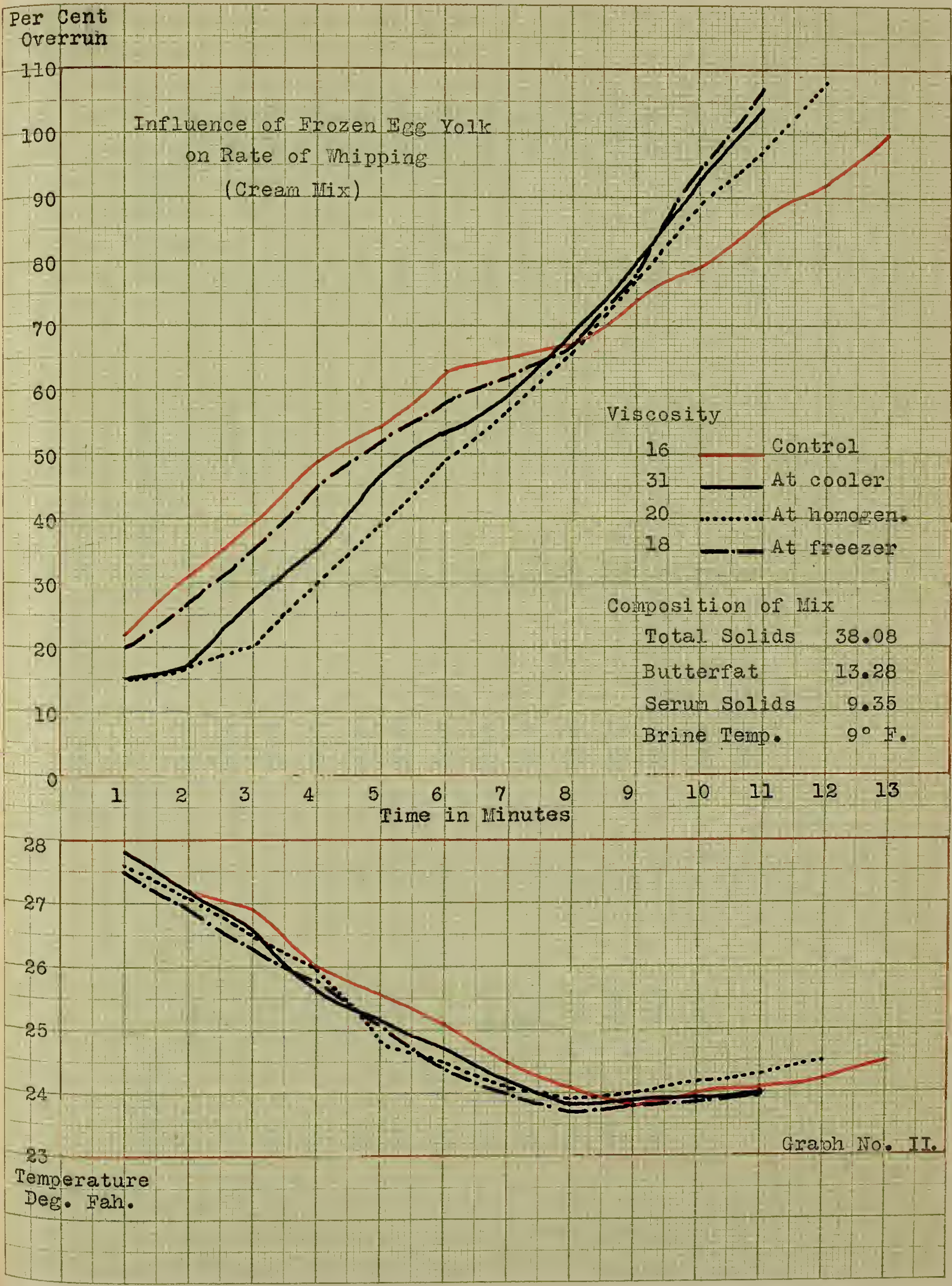
	Control		At cooler		At homogenizer		At freezer	
Min.	O. R.	Mix. T.	O. R.	Mix. T.	O. R.	Mix. T.	O. R.	Mix. T.
1	-	-	15	30.4	14	29.5	12	30.9
2	-	-	25	27.0	19	27.0	19	27.0
3	24	27.0	29	26.8	27	26.5	27	26.6
4	31	26.5	37	26.5	35	26.1	35	26.0
5	39	26.1	47	26.0	47	25.5	43	25.5
6	44	25.7	59	25.5	55	25.1	52	25.0
7	51	25.3	70	25.0	67	24.6	61	24.5
8	58	24.8	81	24.5	77	24.2	73	24.0
9	64	24.3	87	24.3	87	24.0	75	24.0
10	67	23.9	95	24.3	91	24.1	82	24.0
11	77	23.9	105	24.8	101	24.4	94	24.1
12	85	24.0					95	24.4
13	94	24.3					102	24.5
14	103	24.6						


Per Cent Overrun
Influence of Fresh Egg Yolk on Rate of Whipping (Cream Mix)
Viscosity
34 Control
47 At cooler
28 At homogen.
34 At freezer
Composition of Mix
Total Solids 39.65
Butterfat 14.65
Serum Solids 9.65
Brine Temp. 8° F.
Time in Minutes
Temperature Deg. Fah.
110
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13
28
27
26
25
24
23

Graph No. I.

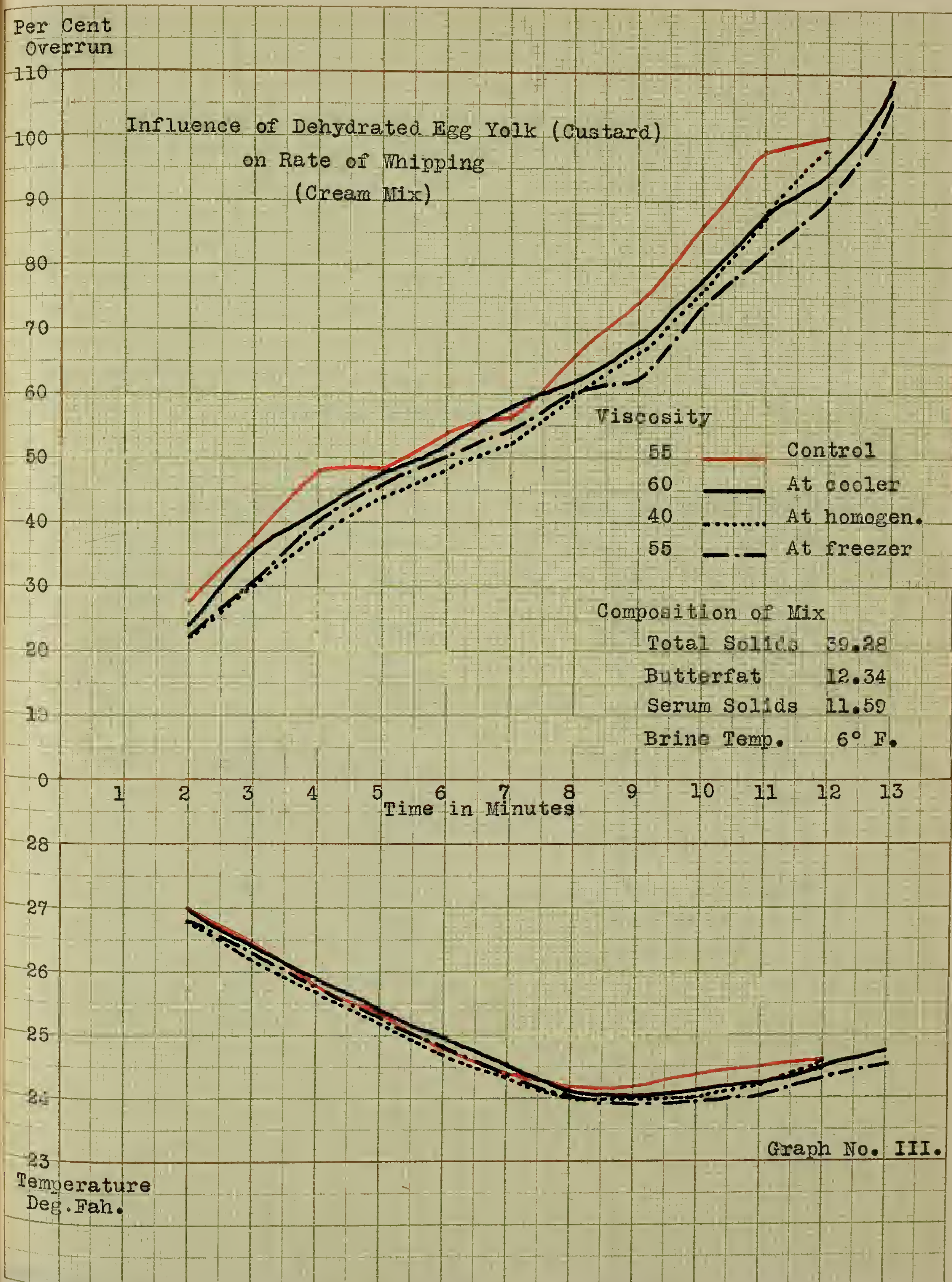
Freezing Data for Graph No. II

	Control		At cooler		At homogenizer		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix.T.	O. R.	Mix. T.	O. R.	Mix. T.
1	22	28.4	15	27.8	15	27.6	20	27.5
2	31	27.3	17	27.1	17	27.2	27	26.9
3	39	26.9	27	26.6	20	26.5	35	26.3
4	49	26.0	35	25.6	30	26.0	45	25.8
5	54	25.6	47	25.2	39	24.8	52	25.1
6	63	25.1	53	24.7	49	24.5	58	27.4
7	65	24.5	59	24.2	57	24.1	62	24.0
8	67	24.1	69	23.8	66	23.9	67	23.7
9	74	23.8	80	23.9	77	24.0	78	23.8
10	79	24.0	93	23.9	89	24.2	94	23.9
11	87	24.1	104	24.0	97	24.3	107	24.0
12	92	24.2			108	24.5		
13	100	24.5						


Per Cent
Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Frozen Egg Yolk
on Rate of Whipping
(Cream Mix)
Viscosity
16 Control
31 At cooler
20 At homogen.
18 At freezer
Composition of Mix
Total Solids 38.08
Butterfat 13.28
Serum Solids 9.35
Brine Temp. 9° F.
1
2
3
4
5
6
7
8
9
10
11
12
13
Time in Minutes
28
27
26
25
24
23
Graph No. II.
Temperature
Deg. Fah.

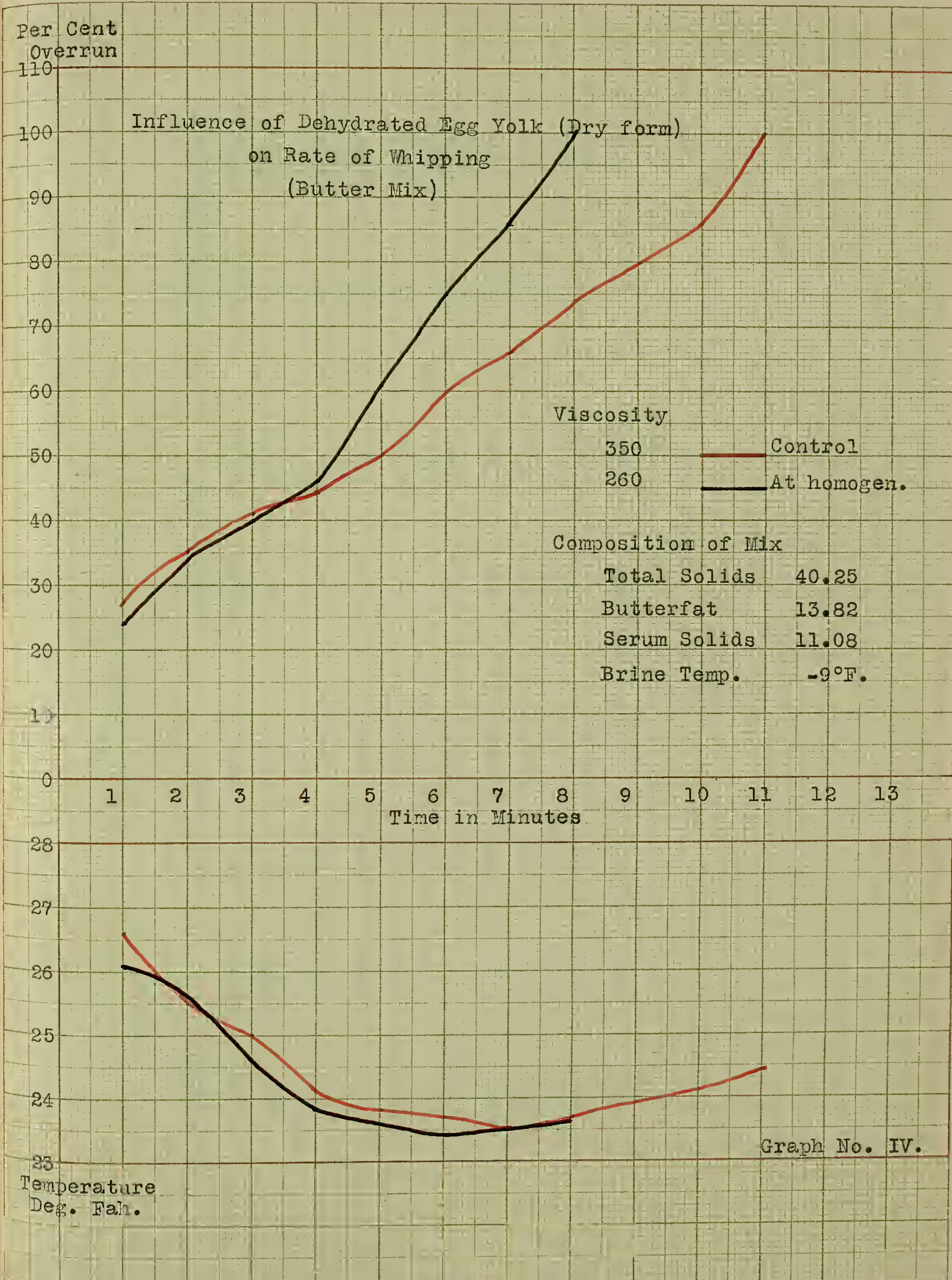
Freezing Data for Graph No. III

Min.	Control O. R.	Control Mix T.	At cooler O. R.	At cooler Mix T.	At homogenizer O. R.	At homogenizer Mix T.	At freezer O. R.	At freezer Mix T.
1	-	-	12	27.8	12	27.8	12	27.4
2	28	27.0	24	27.0	22	26.8	22	26.8
3	38	26.5	36	26.4	30	26.2	30	26.4
4	48	25.8	42	25.9	38	25.7	40	25.8
5	48	25.4	48	25.4	44	25.2	46	25.4
6	54	24.8	52	25.0	48	24.7	50	24.8
7	56	24.4	58	24.6	52	24.4	54	24.4
8	66	24.2	62	24.1	60	24.0	60	24.0
9	74	24.2	68	24.0	76	24.0	62	23.9
10	86	24.4	78	24.1	76	24.0	74	23.9
11	98	24.5	88	24.2	88	24.2	82	24.0
12	100	24.6	94	24.5	98	24.5	90	24.3
13			110	24.7			106	24.5


Per Cent
Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Dehydrated Egg Yolk (Custard)
on Rate of Whipping
(Cream Mix)
Viscosity
55 Control
60 At cooler
40 At homogen.
55 At freezer
Composition of Mix
Total Solids 39.28
Butterfat 12.34
Serum Solids 11.59
Brine Temp. 6° F.
1 2 3 4 5 6 7 8 9 10 11 12 13
Time in Minutes
28
27
26
25
23
Graph No. III.
Temperature
Deg. Fah.

Freezing Data for Graph No. IV

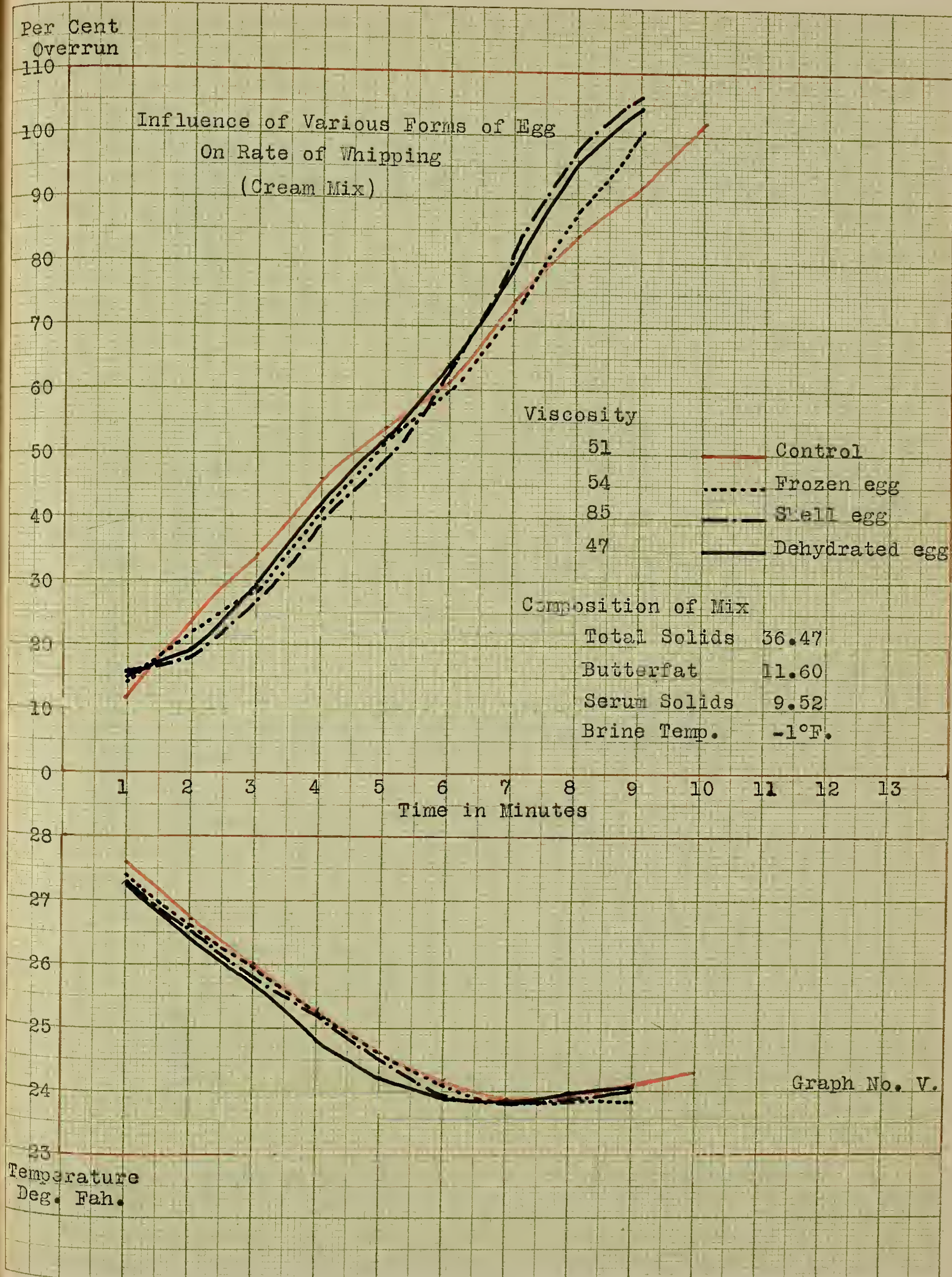
	Control		Deh. Egg at homogenizer	
Min.	O. R.	Mix T.	O. R.	Mix T.
1	27	26.6	24	26.1
2	35	25.5	34	25.6
3	41	25.0	40	24.6
4	44	24.1	46	23.8
5	50	23.8	61	23.6
6	60	23.7	75	23.4
7	66	23.5	86	23.5
8	74	23.7	100	23.6
9	80	23.9		
10	86	24.1		
11	100	24.4		


Per Cent
Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Dehydrated Egg Yolk (Dry form)
on Rate of Whipping
(Butter Mix)
Viscosity
350 Control
260 At homogen.
Composition of Mix
Total Solids 40.25
Butterfat 13.82
Serum Solids 11.08
Brine Temp. -9°F.
1 2 3 4 5 6 7 8 9 10 11 12 13
Time in Minutes
28
27
26
25
24
23
Temperature
Deg. Fah.

Graph No. IV.

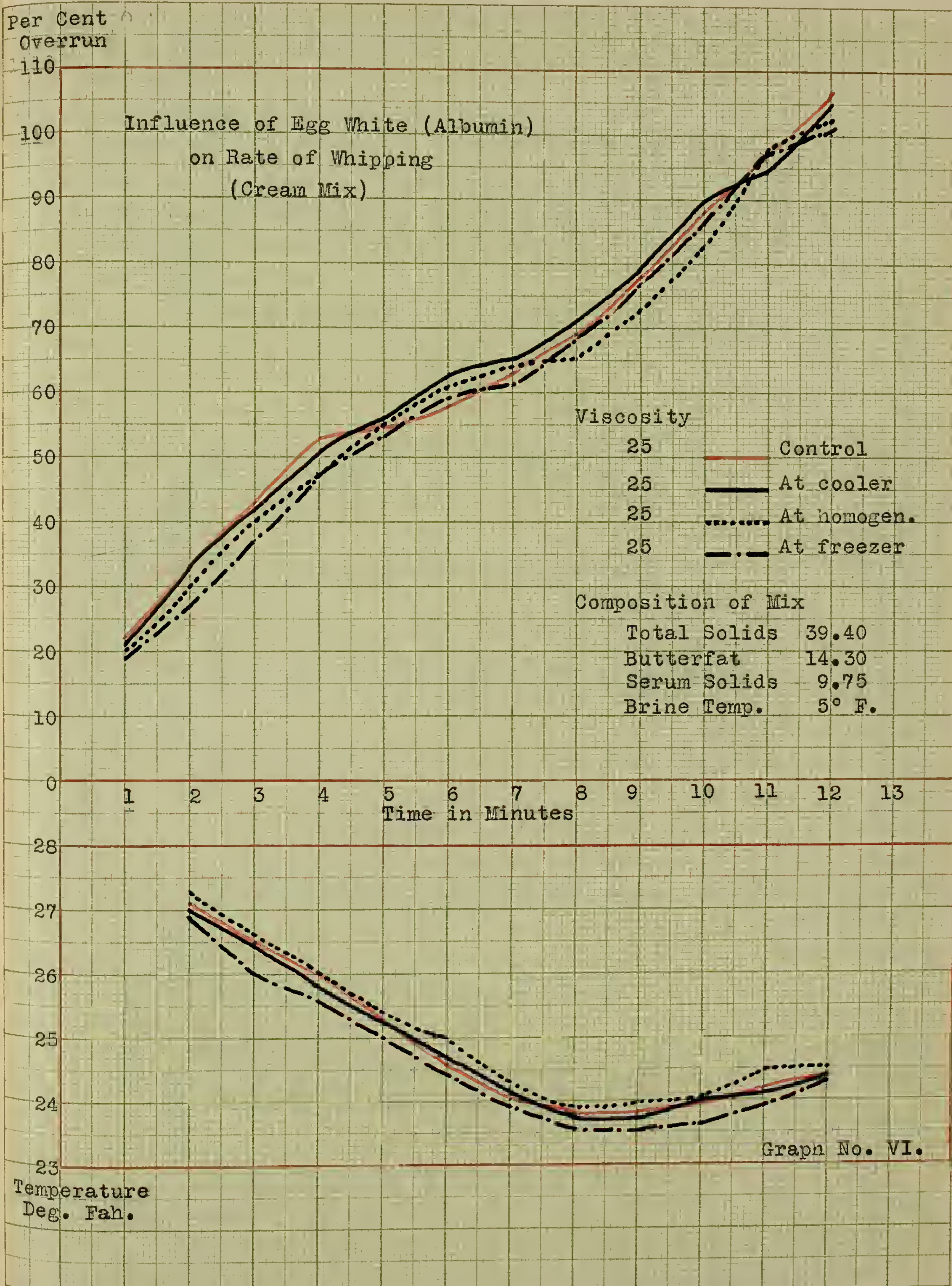
Freezing Data for Graph No. V.

	Control		Frozen Egg		Shell Egg		Dehydrated Egg	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	12	27.6	14	27.4	16	27.3	15	27.3
2	24	26.7	22	26.6	18	26.6	19	26.4
3	34	26.0	28	26.0	27	25.8	29	25.7
4	46	25.3	41	25.3	40	25.3	42	24.8
5	54	24.6	52	24.6	49	24.5	52	24.2
6	61	24.2	60	24.1	63	23.9	64	23.9
7	74	23.9	72	23.8	82	23.8	79	23.8
8	84	23.9	88	23.8	98	23.8	96	24.0
9	92	24.1	102	23.8	106	24.0	104	24.1
10	102	24.3						


Per Cent Overrun
Influence of Various Forms of Egg
On Rate of Whipping
(Cream Mix)
Viscosity
51 Control
54 Frozen egg
85 Shell egg
47 Dehydrated egg
Composition of Mix
Total Solids 36.47
Butterfat 11.60
Serum Solids 9.52
Brine Temp. -1°F.
Time in Minutes
Graph No. V.
Temperature Deg. Fah.

Freezing Data for Graph No. VI.

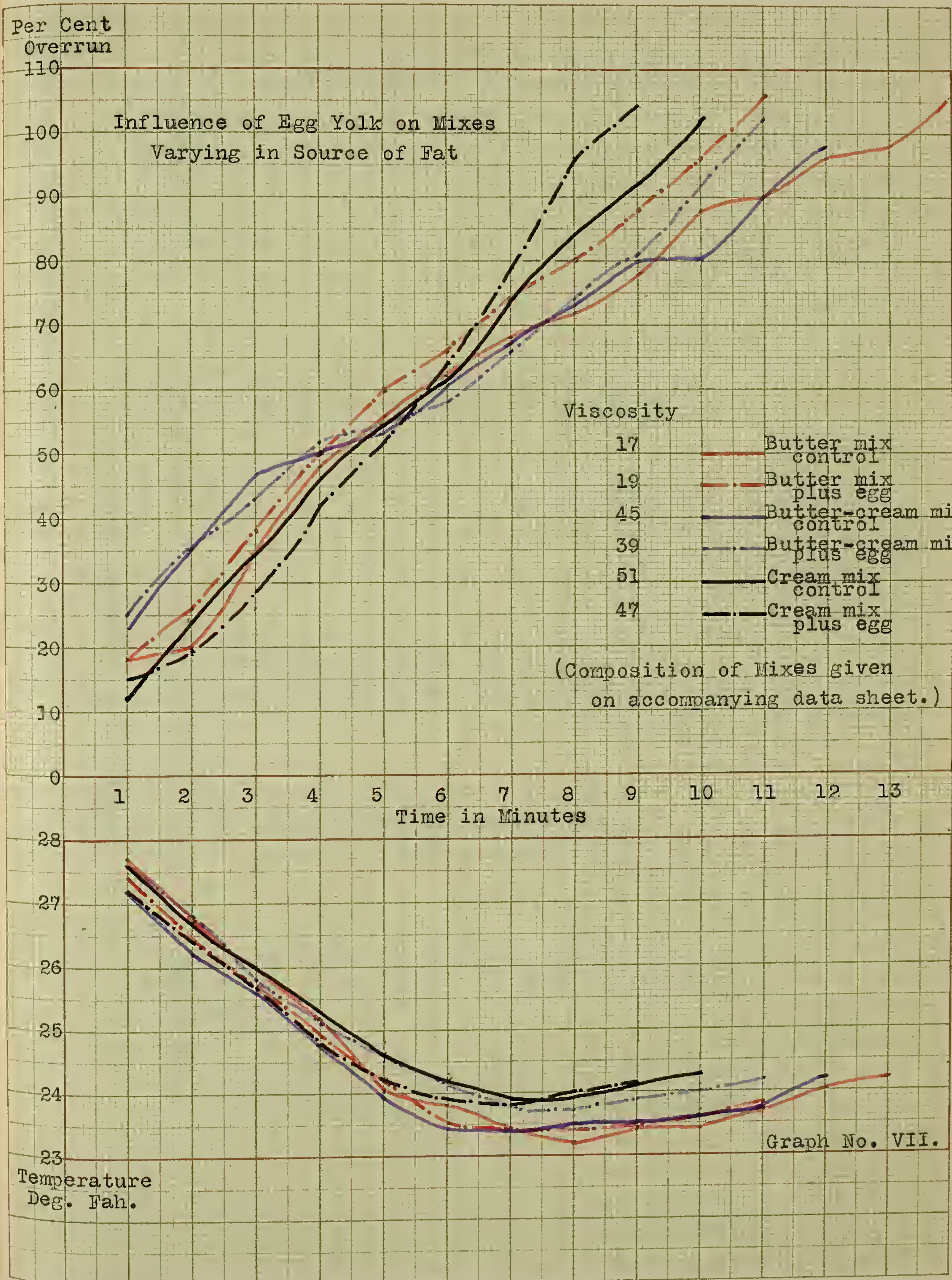
	Control		At Cooler		At homogenizer		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	-	-	21	28.0	19	27.6	20	27.9
2	33	27.1	33	27.0	27	26.9	30	27.3
3	43	26.5	42	26.5	37	26.0	40	26.6
4	53	26.0	51	25.8	47	25.6	47	26.0
5	55	25.3	56	25.3	53	25.0	55	25.4
6	58	24.6	63	24.7	59	24.4	61	25.0
7	63	24.0	65	24.1	61	23.9	64	24.3
8	69	23.8	71	23.7	69	23.5	65	23.9
9	78	23.8	79	23.7	77	23.5	73	24.0
10	88	23.9	90	24.0	86	23.6	83	24.0
11	97	24.2	94	24.1	97	23.9	98	24.5
12	107	24.4	105	24.4	100	24.3	102	24.5


Per Cent Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Egg White (Albumin)
on Rate of Whipping
(Cream Mix)
Viscosity
25 Control
25 At cooler
25 At homogen.
25 At freezer
Composition of Mix
Total Solids 39.40
Butterfat 14.30
Serum Solids 9.75
Brine Temp. 5° F.
1 2 3 4 5 6 7 8 9 10 11 12 13
Time in Minutes
28
27
26
25
24
23
Graph No. VI.
Temperature
Deg. Fah.

Freezing Data for Graph No. VII

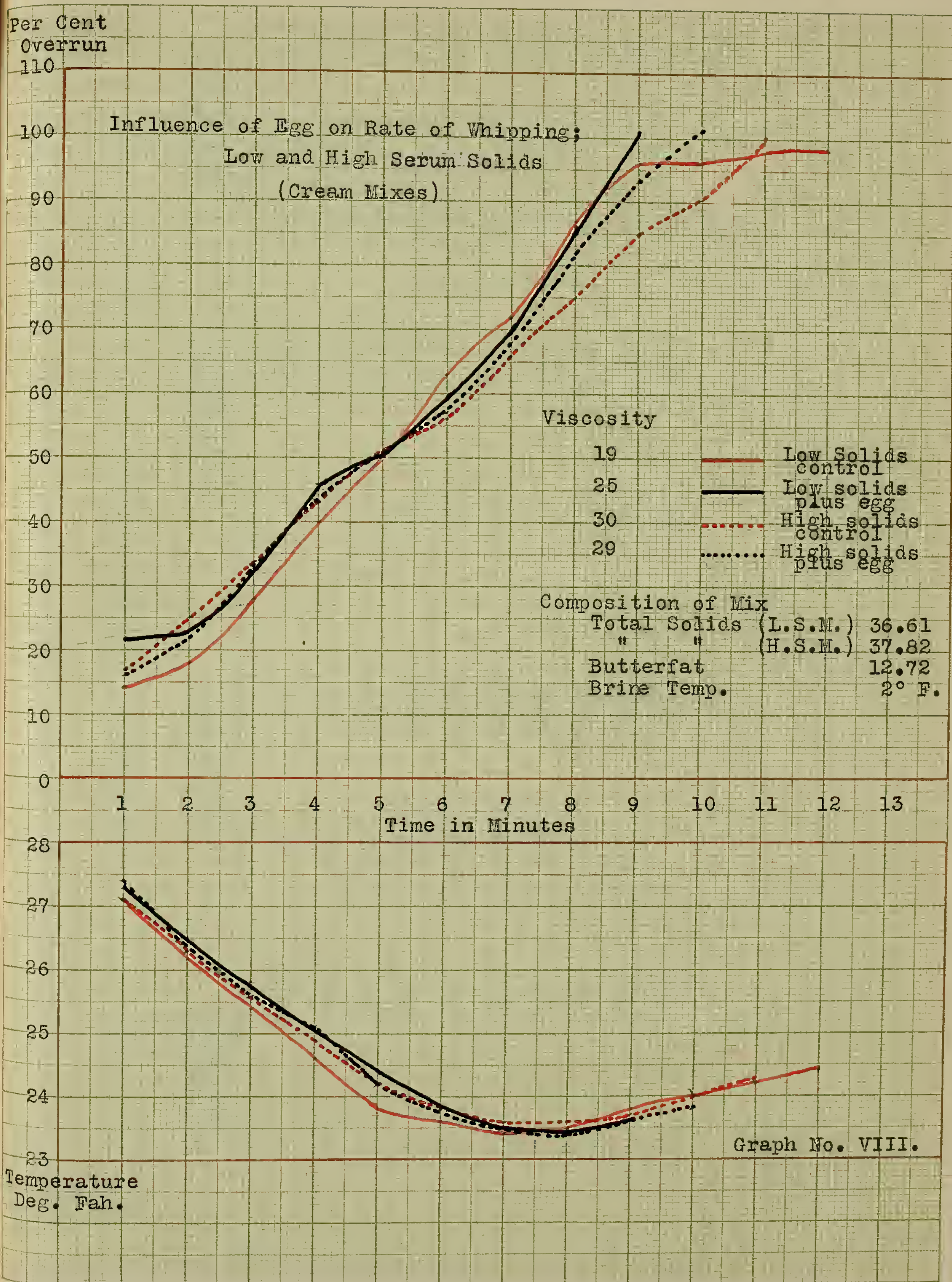
	Cream Mix				Butter-cream Mix				Butter Mix			
	Control		Plus Egg		Control		Plus Egg		Control		Plus Egg	
Min.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.
1	12	27.6	15	27.2	23	27.2	25	27.6	18	27.7	18	27.4
2	24	26.7	19	26.4	35	26.2	33	26.8	20	26.7	26	26.4
3	34	26.0	29	25.7	47	25.6	43	25.8	34	26.0	38	25.7
4	46	25.3	42	24.8	50	24.8	52	25.2	48	25.2	50	24.9
5	54	24.6	52	24.2	53	23.9	54	24.6	56	24.0	60	24.2
6	61	24.2	64	23.9	61	23.4	58	24.2	62	23.8	66	23.5
7	74	23.9	79	23.8	67	23.4	66	23.8	68	23.4	74	23.4
8	84	23.9	96	24.0	73	23.5	74	23.7	72	23.2	80	23.4
9	92	24.1	104	24.1	80	23.5	81	23.9	78	23.4	88	23.4
10	102	24.3			80	23.7	92	24.0	88	23.4	96	23.6
11					90	23.6	102	24.2	90	23.7	106	23.8
12					98	24.2			96	24.0		
13									98	24.2		
14									106	24.4		

Composition of Cream Mix - T.S. 36.47; B.F. 11.60; Brine Temp. -1°F.
" " Butter-cream Mix - T.S. 39.27; B.F. 13.91; Brine Temp. -3°F.
" " Butter Mix - T.S. 34.26; B.F. 8.18; Brine Temp. -3° F.


Per Cent
Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Egg Yolk on Mixes
Varying in Source of Fat
Viscosity
17 Butter mix control
19 Butter mix plus egg
45 Butter-cream mix control
39 Butter-cream mix plus egg
51 Cream mix control
47 Cream mix plus egg
(Composition of Mixes given
on accompanying data sheet.)
1 2 3 4 5 6 7 8 9 10 11 12 13
Time in Minutes
28
27
26
25
24
23
Temperature
Deg. Fah.
Graph No. VII.

Freezing Data for Graph No. VIII

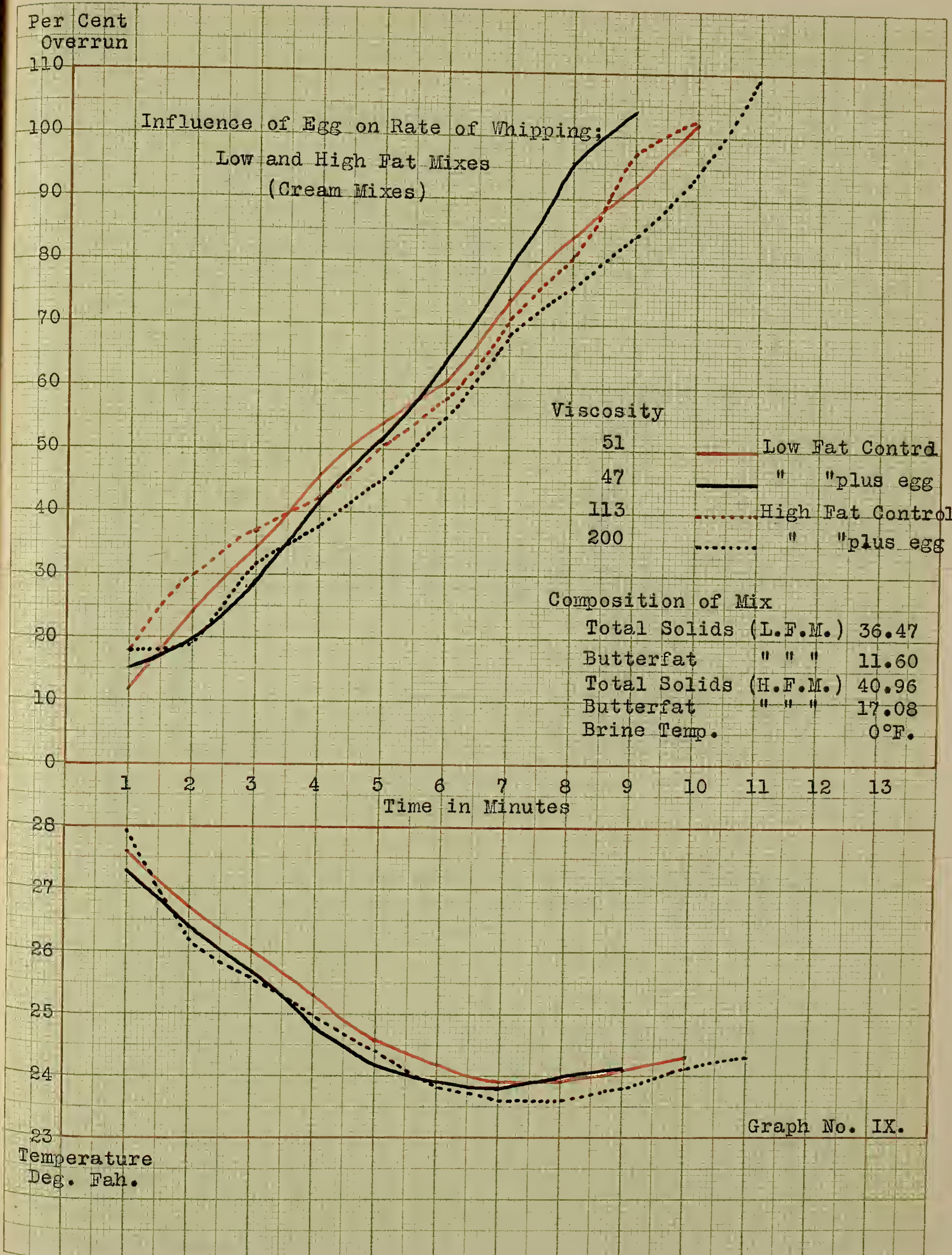
	Low Solids		Low Solids Plus Egg		High Solids		High Solids Plus Egg	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	14	27.1	22	27.3	17	27.1	26	27.4
2	18	26.2	23	26.5	25	26.3	22	26.3
3	28	25.4	33	25.8	34	25.6	33	25.6
4	40	24.6	46	25.1	43	24.9	43	25.1
5	50	23.8	50	24.4	51	24.2	50	24.2
6	63	23.6	59	23.7	56	23.8	57	23.8
7	72	23.4	70	23.5	66	23.6	68	23.5
8	87	23.5	86	23.4	75	23.6	82	23.4
9	96	23.8	101	23.6	85	23.7	93	23.6
10	96	24.0			90	24.0	101	23.8
11	98	24.2			100	24.2		
12	98	24.4						



Graph No. VIII.

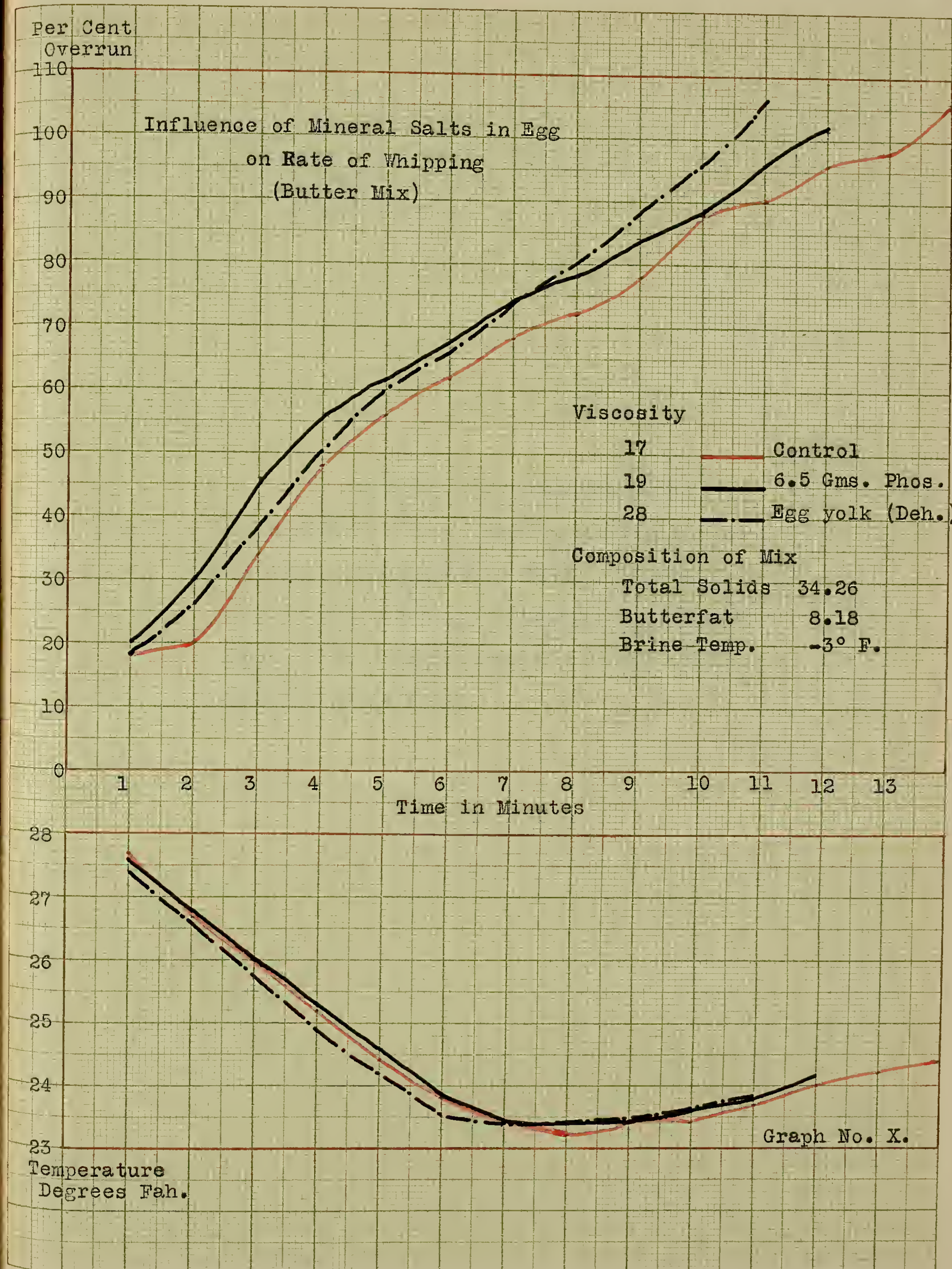
Freezing Data for Graph No. IX

Min.	Low Butterfat (Control) O. R.	Low Butterfat (Control) Mix T.	Low Butterfat (Plus Egg) O. R.	Low Butterfat (Plus Egg) Mix T.	High Butterfat (Control) O. R.	High Butterfat (Control) Mix T.	High Butterfat (Plus Egg) O. R.	High Butterfat (Plus Egg) Mix T.
1	12	27.6	15	27.3	18	27.8	18	28.0
2	24	26.7	19	26.4	30	26.1	19	26.2
3	34	26.0	29	25.7	37	25.4	32	25.6
4	46	25.3	42	24.8	42	24.6	38	25.0
5	54	24.6	52	24.2	51	23.9	45	24.4
6	61	24.2	64	23.9	58	23.8	55	23.8
7	74	23.9	79	23.8	71	23.8	68	23.6
8	84	23.9	96	24.0	82	23.9	76	23.6
9	92	24.1	104	24.1	97	24.0	84	23.8
10	102	24.3			102	24.2	94	24.1
11							110	24.3


Per Cent
Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Egg on Rate of Whipping;
Low and High Fat Mixes
(Cream Mixes)
Viscosity
51 Low Fat Contrd
47 " "plus egg
113 High Fat Control
200 " "plus egg
Composition of Mix
Total Solids (L.F.M.) 36.47
Butterfat " " " 11.60
Total Solids (H.F.M.) 40.96
Butterfat " " " 17.08
Brine Temp. 0°F.
1 2 3 4 5 6 7 8 9 10 11 12 13
Time in Minutes
28
27
26
25
24
23
Temperature
Deg. Fah.
Graph No. IX.

Freezing Data for Graph No. X

	Control		Egg Yolk (Deh.)		6.5 Grams Phos.	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	18	27.7	18	27.4	20	27.6
2	20	26.7	26	26.6	30	26.8
3	34	26.0	38	25.7	46	26.0
4	48	25.2	50	24.9	56	25.3
5	56	24.4	60	24.2	62	24.6
6	62	24.8	66	23.5	68	23.8
7	68	23.4	74	23.4	74	23.4
8	72	23.2	80	23.4	78	23.4
9	78	23.4	88	23.4	84	23.4
10	88	23.4	96	23.6	88	23.6
11	90	23.7	106	23.8	96	23.8
12	96	24.0			102	24.2
13	98	24.2				
14	106	24.4				


Per Cent
Overrun
110
100
90
80
70
60
50
40
30
20
10
0
Influence of Mineral Salts in Egg
on Rate of Whipping
(Butter Mix)
Viscosity
17 Control
19 6.5 Gms. Phos.
28 Egg yolk (Deh.)
Composition of Mix
Total Solids 34.26
Butterfat 8.18
Brine Temp. -3° F.
1 2 3 4 5 6 7 8 9 10 11 12 13
Time in Minutes
28
27
26
25
24
23
Temperature
Degrees Fah.
Graph No. X.

The following section includes the balance of the freezing data secured during the experimental work. Although none of the tables are referred to specifically, they substantiate the results tabulated in graph form.

Whipping Ability of Powdered Egg Yolk (Custard)

	Control		.50#		.75#		1.00#		1.25#	
Min.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.
1	27	27.9	30	27.6	24	28.4	22	27.8	20	28.1
2	40	27.3	37	27.2	30	27.2	28	27.3	26	27.3
3	48	26.8	46	26.8	40	26.8	38	26.9	36	26.8
4	58	26.3	59	27.3	50	26.4	50	26.2	48	26.2
5	68	25.8	67	25.9	58	25.8	58	25.6	58	25.5
6	72	25.4	68	25.4	62	25.3	64	25.2	64	25.2
7	70	24.8	67	24.8	66	24.8	64	24.8	64	24.8
8	74	24.4	69	24.8	68	24.5	68	24.4	70	24.4
9	76	24.2	70	24.2	70	24.2	70	24.1	72	24.2
10	80	24.2	76	24.2	78	24.1	78	24.1	82	24.2
11	86	24.4	83	24.4	80	24.2	84	24.2	90	24.3
12	94	24.6	86	24.5	88	24.4	94	24.4	100	24.5
13	98	24.8	93	24.6	98	24.5	102	24.6		
14			101	24.9	102	24.7				

Viscosity 35
Composition of Mix - T.S. 38.61; B.F. 13.37; Brine Temp. 9°F.

Note: A custard added at freezer.

Whipping Ability of Frozen Egg

	Control		At cooler		Homogenized		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	11	32.6	11	30.4	13	27.4	10	31.7
2	18	26.4	20	26.6	20	26.4	19	26.2
3	26	25.9	28	26.1	28	25.9	24	26.0
4	32	25.4	38	25.6	39	25.4	32	25.4
5	38	24.9	47	25.3	48	24.9	42	25.0
6	44	24.6	54	24.8	56	24.5	48	24.5
7	48	24.3	59	24.4	60	24.1	53	24.2
8	56	24.1	68	24.1	74	24.0	65	24.2
9	63	24.1	84	24.0	88	24.0	76	24.0
10	70	24.1	96	24.1	88	24.2	86	24.2
11	79	24.2	104	24.2			97	24.3
12	87	24.3					104	24.5
13	96	24.5						
14	102	24.6						
Viscosity	209		210		74		209	

Composition of Mix - T.S. 38.28; B.F. 14.42; Brine Temp. 9.5°F. (1# egg used)

Note: Extra serum solids from super heated skim condensed milk.

Whipping Ability of Frozen Egg

	Control		At cooler		Homogenized		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	32	27.8	18	27.7	18	27.2	19	27.7
2	50	26.8	30	26.8	28	26.0	23	26.8
3	58	26.1	44	26.1	40	25.5	39	26.0
4	66	25.3	54	25.3	52	24.5	50	25.2
5	70	24.5	62	24.5	60	23.8	59	24.5
6	78	24.1	68	24.0	64	23.1	62	24.1
7	88	24.1	74	24.0	68	23.0	63	24.0
8	92	24.5	80	24.1	72	23.0	76	24.0
9	96	24.5	86	24.1	82	23.1	80	24.0
10	102	24.7	94	24.4	90	23.5	91	24.4
11			105	24.4	100	23.7	97	24.5
12							104	24.8
Viscosity	29		24		27		29	

Composition of Mix - T.S. 35.72; B.F. 10.90; Brine Temp. -2°F. (1#egg used)

Whipping Ability of Frozen Egg (Re-run mix)

	Control		At cooler		Homogenized		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	20	27.5	20	27.8	20	26.6	20	27.1
2	28	26.3	22	26.0	28	25.5	26	26.0
3	40	25.5	32	25.2	42	24.8	38	25.3
4	50	24.8	44	24.5	50	23.9	48	24.5
5	56	23.9	52	23.8	56	23.3	52	23.8
6	62	23.2	60	23.3	64	23.0	60	23.3
7	70	23.0	70	23.2	72	23.0	70	23.2
8	76	23.1	80	23.3	78	23.0	78	23.3
9	86	23.2	90	23.5	85	23.3	90	23.4
10	94	23.4	98	23.7	88	23.5	100	23.8
11	100	23.7	110	23.9	98	23.8		
12					108	23.9		
Viscosity	36		43		64		38	

Composition of Mix - T.S. 38.89; B. F. 13.60; Brine Temp. -3°F. (1#egg used)

Whipping Ability of Frozen Egg

	Control		At cooler		Homogenized		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	21	31.2	15	27.4	14	27.5	14	27.8
2	30	26.6	22	27.0	23	26.8	20	27.0
3	37	26.4	29	26.6	34	26.2	27	26.5
4	45	26.0	36	26.0	47	25.4	37	25.8
5	53	25.4	47	25.2	55	24.8	47	25.2
6	62	24.6	53	24.6	64	24.2	56	24.6
7	65	24.2	59	24.0	67	23.5	65	24.0
8	68	23.8	66	23.7	72	23.2	74	23.6
9	77	23.8	77	23.8	79	23.3	80	23.7
10	89	23.9	85	23.9	83	23.5	88	23.8
11	98	24.1	90	24.0	96	23.8	92	24.2
12	102	24.4	102	24.4	102	24.0	100	24.4
Viscosity	94		300		80		94	

Composition of Mix - T.S. 38.76; B.F. 14.55; Brine Temp. 2°F. (1# egg used)

Whipping Ability of Shell Egg (Re-run mix)

	Control		At cooler		Homogenized		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	32	27.4	31	28.5	20	27.3	14	27.4
2	44	26.7	45	26.9	25	26.7	17	26.9
3	57	26.2	59	26.4	35	26.3	21	26.3
4	70	25.8	71	26.0	41	25.9	30	25.9
5	79	25.3	81	25.4	53	25.3	42	25.3
6	84	24.9	85	25.0	61	25.0	54	24.9
7	84	24.2	86	24.6	66	24.5	61	24.6
8	82	23.8	84	24.1	69	24.0	64	24.0
9	80	23.3	83	23.7	71	23.5	68	23.5
10	84	23.0	85	23.4	75	23.4	72	23.3
11	85	23.1	88	23.5	78	23.5	81	23.5
12	92	23.3	90	23.6	84	23.5	90	23.5
13	100	23.8	93	23.8	88	23.6	93	23.7
14			97	24.0	95	23.9	103	24.0
15			101	24.2	101	24.1		
Viscosity	14		$13\frac{1}{2}$		$13\frac{1}{2}$		19	

Composition of Mix - T.S. 39.24; B.F. 13.86; Brine Temp. $8\frac{1}{2}$°F.

Whipping Ability of Frozen Egg Yolk (Varying amounts)

	Control		At cooler (.75#)		At cooler (1.0#)		At cooler (1.50#)	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	20	27.4	17	27.5	19	27.5	18	27.5
2	27	26.6	24	26.8	24	26.7	24	27.0
3	39	26.1	33	26.4	33	26.3	33	26.5
4	47	26.6	44	25.8	45	25.6	43	25.8
5	57	25.0	53	25.1	53	25.2	55	25.3
6	65	25.4	61	24.5	63	24.3	67	24.6
7	76	24.0	71	24.0	73	23.9	82	24.2
8	86	24.0	92	24.0	88	24.0	93	24.2
9	97	24.2	99	24.3	99	24.1	110	24.5
10	117	24.5						
Viscosity	73		80		83		97	

Composition of Mix - T.S. 37.75; B.F. 14.91; Brine Temp. 2°F.

Whipping Ability of Shell Egg

	Control		At cooler		Homogenized		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	15	36.1	12	35.3	16	32.5	14	34.5
2	26	27.8	24	27.5	22	27.5	22	27.5
3	39	27.5	30	27.0	26	26.8	22	26.8
4	44	27.0	32	26.5	38	26.3	34	26.4
5	56	26.5	40	26.0	46	25.8	44	25.9
6	62	26.2	48	25.4	52	25.3	50	25.5
7	64	25.9	56	25.0	56	24.8	56	25.0
8	66	25.4	62	24.5	64	24.6	60	24.5
9	67	25.0	70	24.2	72	24.1	64	24.2
10	66	24.5	84	24.3	80	24.1	74	24.0
11	69	24.5	94	24.4	94	24.0	84	24.2
12	76	25.7	102	24.6	104	24.3	92	24.3
13	82	25.8					102	24.5
14	89	25.0						
15	94	25.2						
16	102	25.4						
Viscosity	30		45		21		30	

Composition of Mix - T.S. 39.24; B.F. 13.91; Brine Temp. 9°F.

Whipping Ability of Dehydrated Egg Yolk

	Control		Homogenized #		At freezer	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	22	27.7	18	27.2	20	27.5
2	30	27.1	30	26.8	26	26.8
3	38	26.5	38	26.3	34	26.4
4	48	25.9	48	25.7	46	25.8
5	54	25.4	58	25.1	52	25.3
6	60	24.8	62	24.7	60	24.8
7	66	24.4	70	24.3	66	24.4
8	74	24.1	80	24.0	76	24.0
9	86	24.2	92	24.0	86	24.0
10	100	24.3	108	24.2	100	24.2
Viscosity	66		63		66	

Composition of Mix - T.S. 39.64; B.F. 15.36; Brine Temp. 6°F. (2.5 oz. egg used)

Note: Egg powder added with sugar and homogenized. #
Dry egg added at freezer.

Preliminary Trials with Phosphate Mixture

	Control		6.5 gms.		13.0 gms.	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	22	26.7	20	27.8	22	28.3
2	24	25.2	26	27.0	32	27.2
3	30	24.8	34	26.4	40	26.7
4	38	24.4	44	26.1	46	26.2
5	46	24.1	52	25.8	58	25.9
6	54	23.7	60	25.4	62	25.5
7	62	23.6	64	25.2	66	25.2
8	68	23.6	68	24.9	70	24.8
9	70	23.7	70	24.6	70	24.6
10	80	23.8	76	24.2	74	24.3
11	82	23.9	82	24.0	80	24.1
12	86	24.0	86	24.2	88	24.0
13	86	24.1	94	24.3	94	24.2
14			110	24.5	100	24.3
Viscosity	60		75		51	

Composition of Mix - T.S. 39.64; B.F. 15.36; Brine Temp. 13°F.

Note: Salts added to mix after aging 4 hours.

Comparison of Powdered egg Yolk and Phosphate Mixture

	Control		Egg Yolk		6.5 gms.		13.0 gms.	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	22	27.3	30	27.5	28	28.0	32	27.3
2	34	26.9	38	26.9	38	27.0	40	26.8
3	42	26.5	46	26.5	50	26.4	50	26.3
4	54	25.8	54	26.0	60	26.0	62	25.8
5	58	25.5	62	25.6	66	25.6	68	25.4
6	66	25.2	64	24.9	68	25.1	70	24.6
7	68	24.7	68	24.7	70	24.5	70	24.4
8	72	24.3	72	24.2	72	24.2	72	24.2
9	70	23.9	72	23.9	78	24.0	78	23.8
10	74	23.7	80	23.8	82	24.0	80	23.9
11	84	24.1	90	24.1	88	24.4	90	24.1
12	86	24.1	106	24.2	98	24.3	96	24.5
13	94	24.2			102	24.6	104	24.5
Viscosity	52		37		64		50	

Composition of Mix - T.S. 39.02; B.F. 14.14; Brine Temp. 9°F. (2.5 oz. egg used)

Note: Egg yolk added with sugar and processed.
Phosphate mixture added at cooler.

Comparison of Powdered Egg Yolk and Phosphate Mixture

	Control		Egg Yolk		6.5 gms.		13.0 gms.	
Min.	O.R.	Mix T.	O. R.	Mix T.	O.R.	Mix T.	O. R.	Mix T.
1	20	27.0	22	27.4	21	27.4	25	27.5
2	33	26.3	27	27.0	33	26.4	34	26.4
3	49	25.6	39	26.4	46	25.8	42	25.6
4	57	25.0	52	25.9	54	25.2	49	25.0
5	61	24.4	60	25.4	60	24.6	56	24.4
6	63	23.8	64	24.8	64	24.0	59	23.9
7	68	23.4	69	24.3	70	23.7	66	23.6
8	75	23.4	74	24.0	77	23.6	73	23.4
9	79	23.6	84	24.0	82	23.8	79	23.6
10	86	23.7	90	24.0	85	23.9	87	23.6
11	88	23.8	101	24.2	89	24.0	91	23.8
12	97	24.0			96	24.2	100	24.0
13	102	24.2			99	24.3		
Viscosity	76		23		41		34	

Composition of Mix - T.S. 34.65; B.F. 11.21; Brine Temp. 8°F. (2.5 oz. egg used)

Note: Egg sifted into hot mix just previous to homogenizing.
Phosphates added to hot mix and homogonized.

Comparison of Egg Yolk (Deh.) and Phosphate Mixture (Butter - Powder - Water Mix)

	Control		Egg Yolk		6.5 gms.		13.0 gms.	
Min.	O.R.	Mix T.	O.R.	Mix T.	O.R.	Mix T.	O.R.	Mix T.
1	39	27.4	21	27.4	35	27.4	33	27.5
2	57	27.0	37	26.5	52	26.7	50	26.8
3	64	26.4	45	26.2	61	26.1	58	26.2
4	66	25.8	50	25.6	61	25.7	62	25.5
5	63	25.2	55	25.0	61	25.2	64	25.0
6	59	24.6	58	24.5	60	24.6	64	24.2
7	60	24.2	64	24.1	61	24.1	64	23.8
8	61	24.1	71	24.0	63	24.2	67	23.8
9	63	24.1	78	24.1	63	24.2	69	23.8
10	67	24.3	87	24.2	66	24.3	73	24.0
11	69	24.5	97	24.4	71	24.7	76	24.1
12	76	24.7			74	24.6	80	24.3
13	81	24.8			78	24.8	82	24.5
14	81	25.0			82	25.0	86	24.7
15	84	25.2			87	25.2	90	25.0
16	91	25.4			87	25.2	92	25.0
17	81	25.6			87	25.3	96	25.0
Viscosity	53		75		40		32	

Composition of Mix - T.S 38.50; B.F. 13.80; Brine Temp. -1°F.

Comparison of Egg Yolk (Deh.) and Phosphate Mixture (Unaged Butter Mix)

	Control		Egg Yolk		6.5 gms.		13.0 gms.	
Min.	O.R.	Mix T.	O.R.	Mix T.	O. R.	Mix T.	O.R.	Mix T.
1	26	24.6	19	33.8	24	32.0	31	34.3
2	43	26.7	30	26.4	43	26.5	47	26.5
3	53	26.1	36	25.8	57	25.9	57	25.8
4	61	25.5	44	25.2	63	25.3	65	25.1
5	60	24.7	47	24.5	60	24.5	63	24.2
6	58	24.0	49	23.8	57	23.8	59	23.5
7	59	23.6	57	23.6	61	23.5	63	23.3
8	60	23.6	63	23.5	61	23.5	66	23.3
9	63	23.7	67	23.6	63	23.5	69	23.4
10	67	23.9	75	23.7	67	23.7	71	23.5
11	72	24.0	80	23.9	73	23.8	75	23.7
12	75	24.2	87	24.0	74	24.0	78	23.9
13	80	24.4	93	24.2	77	24.2	80	24.1
14	82	24.5			83	24.4	85	24.4
15	86	24.8			84	24.6	87	24.5
16	89	24.9			87	24.8	89	24.6
17					91	24.9		
Viscosity	42		44		43		40	

Composition of Mix - T.S. 41.65; B.F. 15.33; Brine Temp. 2°F.
Note: Phosphates added at cooler.

Comparison of Egg Yolk (Deh.) and Phosphate Mixture (Butter-cream Mix)

	Control		Egg Yolk		6.5 gms.		13.0 gms.	
Min.	O.R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	23	27.2	19	27.8	-	-	30	27.3
2	35	26.2	31	27.0	24	26.1	40	26.5
3	47	25.6	42	26.3	34	25.3	48	25.5
4	50	24.8	52	25.6	41	24.7	51	24.8
5	53	23.9	58	24.9	47	23.8	55	24.3
6	61	23.4	64	24.2	51	23.4	61	23.9
7	67	23.4	69	24.1	57	23.2	66	23.8
8	73	23.5	74	23.8	64	23.2	76	23.8
9	80	23.5	80	24.0	71	23.2	79	23.9
10	80	23.7	88	24.1	77	23.4	84	24.2
11	90	23.9	93	24.3	87	23.6	86	24.2
12	98	24.2	102	24.6	94	23.9	92	24.4
13					96	24.1	96	24.6
14					103	24.3	102	24.8
Viscosity	45		39		210		47	

Composition of Mix - T.S. 39.27; B.F. 13.91; Brine Temp. -3°F.

Note: Egg added with sugar and processed.
Phosphates added at cooler.

Whipping Ability of Dehydrated Egg Yolk (Butter Cream Mix)

	Control		Egg Yolk (a)		Egg Yolk (b)	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	23	27.2	19	27.8	25	27.6
2	35	26.2	31	27.0	33	26.8
3	47	25.6	42	26.3	43	25.8
4	50	24.8	52	25.6	52	25.2
5	53	23.9	58	24.9	54	24.6
6	61	23.4	64	24.2	58	24.2
7	67	23.4	69	24.1	66	23.8
8	73	23.5	74	23.8	74	23.7
9	80	23.5	80	24.0	81	23.9
10	80	23.7	88	24.1	92	24.0
11	90	23.9	93	24.3	102	24.2
12	98	24.2	102	24.6		
Viscosity	45		39		31	

Composition of Mix - T.S. 39.27; B.F. 13.91; Brine Temp. -3°F.

Note: (a) Egg added with sugar and processed.
(b) Egg sifted into hot mix just previous to homogenizing.

Whipping Ability of Phosphate Mixtures

	Control		13.0 gms.		26.0 gms.	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	-	-	-	-	-	-
2	26	30.0	25	28.3	40	29.0
3	40	28.0	39	28.0	47	28.2
4	45	27.6	49	27.6	54	28.0
5	52	27.4	69	27.4	70	27.8
6	65	27.3	84	27.0	82	27.4
7	86	26.9	87	26.7	89	27.0
8	91	26.8	87	26.5	90	27.0
9	88	26.4	80	26.2	87	26.6
10	85	26.2	75	26.0	83	26.2
11	80	25.7	79	26.0	80	26.2
12	77	25.5	85	26.0		
13	74	25.0	93	26.1		
14	78	25.0	99	26.2		
15	85	25.1				
16	90	25.5				
17	97	25.6				

Note: Freezing data taken at Bushway Ice Cream Co.

Composition of Mix - T.S. 36.3; B.F. 12.2; Sugar 12.0.
Butter-cream Mix; Serum Solids from cond. skim.

Whipping Ability of Egg Yolk; Variation in Sugar Content

Min.	14.0 Sugar Control O.R.	14.0 Sugar Control M.T.	14.0 Sugar Egg O.R.	14.0 Sugar Egg M.T.	16.0 Sugar Control O. R.	16.0 Sugar Control M.T.	16.0 Sugar Egg O.R.	16.0 Sugar Egg M.T.	18.0 Sugar Control O.R.	18.0 Sugar Control M.T.	18.0 Sugar Egg O.R.	18.0 Sugar Egg M.T.
1	22	27.4	19	27.2	21	27.2	15	27.1	21	26.2	15	27.2
2	32	26.8	20	26.4	21	26.4	22	26.0	24	25.6	16	25.5
3	41	25.8	29	25.5	28	25.5	31	25.2	35	25.0	26	24.7
4	49	25.0	37	24.8	40	24.5	40	24.5	44	24.0	35	24.0
5	56	24.0	46	24.1	48	24.0	49	23.9	52	23.4	47	23.4
6	65	23.9	59	23.7	59	23.5	60	23.6	60	23.2	58	23.2
7	74	23.6	70	23.5	71	23.6	77	23.4	70	23.2	72	23.2
8	84	23.6	84	23.6	81	23.6	90	23.5	80	23.4	86	23.3
9	90	23.8	90	23.7	96	23.7	95	23.8	84	23.6	100	23.4
10	110	24.2	96	24.1	100	23.8	103	24.0	93	23.7		
11			101	24.2					101	23.9		
Viscosity	32		22		26		30		34		26	

Composition of Mix - T.S. 36.76; B.F. 13.31 (T.S. represents 14.0 per cent mix.); Brine Temp. -1°F.

Note: Egg powder sifted into mix just previous to homogenizing.

Whipping Ability of Egg Yolk and Phosphate Mixture

	Control		13.0 gms.		26.0 gms.		Egg Yolk	
Min.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.	O. R.	Mix T.
1	-	-	-	-	-	-	-	-
2	35	27.0	37	27.0	35	27.0	30	27.0
3	41	26.8	47	26.6	38	26.7	40	26.8
4	57	26.6	58	26.8	53	26.3	43	26.4
5	70	26.2	72	25.9	66	25.9	54	25.9
6	79	25.6	78	25.5	78	25.5	63	25.6
7	84	25.4	84	25.1	83	25.0	70	25.2
8	85	25.0	85	24.8	84	24.7	73	24.9
9	85	24.8	86	24.2	87	24.3	77	24.4
10	85	24.2	90	23.8	91	23.9	78	24.1
11	85	23.8	101	24.1	103	24.1	83	23.8
12	89	23.7					92	23.8
13	95	24.1					100	24.0

Note: Egg added in paste form (5 oz.).
90 lb. batches.

Composition of Mix - T.S. 37.70; B.F. 11.50; Sugar 15.70; gel. .40.

Whipping Ability of Individual Phosphates

	Control		PO_4 Mixture		Sodium		Calcium		Potassium		Mg Sulphate	
Min.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M. T.
1	25	26.8	-	-	-	-	-	-	-	-	-	-
2	29	26.2	20	26.8	22	26.7	25	26.7	23	26.8	24	26.7
3	40	26.0	29	26.2	31	26.3	30	26.4	29	26.4	31	26.3
4	55	25.5	37	26.0	29	26.0	42	25.9	39	26.0	43	26.0
5	-	-	53	25.5	53	25.5	55	25.4	53	25.6	53	25.5
6	65	24.8	63	25.0	64	25.0	67	24.9	63	25.0	63	25.0
7	75	24.6	71	24.4	70	24.4	70	24.6	68	24.5	68	24.5
8	76	24.1	73	24.0	75	24.0	73	23.9	71	24.0	71	24.0
9	81	23.8	82	23.8	79	23.8	78	23.7	78	23.8	75	23.7
10	88	23.9	91	23.9	90	23.8	85	23.7	86	23.9	82	23.7
11	97	24.0	99	24.0	96	24.0	95	23.8	97	24.0	92	23.8

Note: Phosphate salts added at freezer (Unaged with mix).
90 lb. batches.

Composition of Mix - T.S. 37.70; B.F. 11.50; Sugar 15.70; gel. .40.

Whipping Ability of Various Forms of Egg

	Control		PO_4 Mixture		Shell Egg		Frozen Egg		Dch. Egg	
Min.	O.R.	M.T.	O. R.	M. T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.
1	18	28.4	19	28.5	20	27.8	-	-	18	28.0
2	30	26.1	27	26.2	24	26.4	20	26.4	19	26.2
3	37	25.4	35	25.4	32	25.6	29	25.6	32	25.6
4	24	24.6	44	24.7	40	24.8	37	24.8	38	25.0
5	51	23.9	49	24.1	48	24.2	43	24.2	45	24.4
6	58	23.8	57	23.7	63	23.8	54	27.3	55	23.8
7	71	23.8	65	23.6	74	23.7	54	23.6	68	23.6
8	82	23.9	74	23.6	87	23.8	73	23.6	76	23.6
9	97	24.0	82	23.8	101	24.1	83	23.8	84	23.8
10	102	24.2	95	24.0			90	24.0	94	24.1
11			98	24.2			100	24.2	110	24.3
12			104	24.4						
Viscosity	113		96		126		300		200	

Composition of Mix - T.S. 40.96; B.F. 17.08; Brine Temp. 0°F.

Note: All forms of egg homogenized but not pasteurized with mix.

Whipping Ability of Egg Yolk (Deh.); Variation in Amount

	Control		Egg White		2.5 oz.		5.0 oz.		7.5 oz.	
Min.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.	O.R.	M.T.
1	22	27.6	25	27.8	19	28.6	20	27.4	18	27.8
2	30	26.8	28	26.6	24	26.7	20	26.5	19	26.8
3	37	26.1	36	26.0	28	26.0	26	25.8	27	26.2
4	45	25.4	43	25.4	38	25.3	38	25.1	40	25.2
5	50	24.8	48	24.7	47	24.6	49	24.5	51	24.5
6	58	24.1	55	24.2	54	23.9	60	23.8	62	24.0
7	67	23.8	64	23.8	66	23.6	79	23.8	80	23.8
8	80	23.7	77	23.7	78	23.6	96	23.6	100	23.9
9	90	23.8	85	23.8	96	23.7	100	23.8		
10	96	24.0	95	24.0	100	23.8				
11	106	24.2	103	24.2						
Viscosity	64		65		35		40		53	

Composition of Mix - T.S. 38.66; B.F. 14.63; Brine Temp. 2°F.

Note: Egg yolk sifted into hot mix previous to homogenizing.
Egg white (12 oz.) homogenized with mix.

Study of Egg White, Phosphate Mixture, and Egg Yolk (Deh.)

Min.	Control O.R.	Control M.T.	Egg White O. R.	Egg White M.T.	Phos. Mixture O. R.	Phos. Mixture M. T.	Egg Yolk O. R.	Egg Yolk M. T.
1	19	26.7	18	27.7	18	27.2	16	27.0
2	14	26.2	25	26.7	24	26.4	24	26.0
3	33	25.5	29	25.5	32	26.1	34	25.2
4	42	24.9	39	24.8	41	25.4	43	24.6
5	53	24.3	46	24.4	52	24.8	54	24.0
6	60	23.8	55	23.9	55	24.2	62	24.0
7	72	23.6	62	23.7	60	23.7	82	23.8
8	80	23.6	73	24.8	70	23.7	90	23.7
9	90	23.8	88	23.9	74	23.8	97	23.8
10	96	24.1	90	24.2	88	24.1	98	24.0
11	106	24.3	98	24.4	84	24.4	104	24.2
12			106	24.6	92	24.6		
13					98	24.7		
Viscosity - 47			40		45		32	

Composition of Mix - T.S. 40.82; B.F. 17.45; Brine Temp. 1°F.

Note: Egg white added at cooler.

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