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Plastic cream as an ingredient of ice cream

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by

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PLASTIC CREAM AS AN INGREDIENT OF ICE CREAM

INTRODUCTION

Plastic cream is a product of recent development; it represents the highest practical fat concentration as a cream, the fat content varying from 65 to 85 per cent. Plastic cream with a content of 80 per cent fat is considered standard in commercial work. Cream of this fat content was used throughout this experiment. In spite of this high concentration, the fat remains in substantially its original emulsion with the milk solids not fat present in the serum. Due to the high concentration of fat, plastic cream is not in the fluid state at ordinary temperatures but is plastic in form much the same as butter.

The commercial production of plastic cream is described by Wendt[20] as follows: "In creameries, there is first the separation, according to the preferred method, of a cream from whole sweet milk, or sweet farm separated cream may be used, standardized not to exceed 40 per cent fat. This cream is then heated to pasteurizing temperature by either the flash or holding method. If the holding method is used, the cream should be heated to 165° F. for thirty minutes, and to 185° F. if flashed.

"When desired, the cream may be precooled to as low as 100° F. or it may be passed directly at pasteurizing temperature, through the special 'Creamer', adjusted and operated to centrifugally produce a cream containing from 70 to 85 per cent of milk fat as may be desired.---- As the cream issues from the 'Creamer' cover in a fluid condition it is directed to flow continuously to the feeding hopper of an especially designed drum type cooler, through which chilled sweet water or brine is circulated. ----The cooling of the cream, with a temperature drop of as much as 100° F. in nine seconds, is accomplished with a minimum of handling or agitation. The product, cooled to around 47° F., at this point has become plastic, like freshly made butter, and is carried away by a sterilized belt and conveyed directly to the package.

"At the present time, the plain product is being packaged in 60 pound butter tubs lined with sterilized parchment liners."

Plastic cream may also be produced by a second method using a regular cream separator equipped by the manufacturers with special cream covers and milk flow regulators. The author found that this method could be used successfully. In order to uniformly secure plastic cream testing 80 per cent butterfat without undue fat losses in the skim milk, it seems advisable that fresh whole milk be separated at the pasteurizing temperature.

Plastic cream should be stored at temperatures of approximately -10° to 10° F. It was found in this investigation that storage at 40° F. for only a short period resulted in the development of tallowy and other off flavors, thereby making the product unfit for use.

The use of plastic cream in ice cream has become a relatively common practice within the past year or two. The ice cream industry has long felt the need of a source of butterfat which could be stored during periods of surplus milk production for use during months when demand is greater than supply. Frozen cream and unsalted butter have been and are being used for this purpose. That plastic cream should be well adapted for such a practice seems logical. Much less handling and storage space would be required as compared with frozen cream. Furthermore, plastic cream should be more suitable than unsalted butter for ice cream manufacture because the original emulsion of the butterfat is not materially changed and a higher percentage of solids not fat are present. In churning butter, the emulsion of fat in serum is changed to an emulsion of water in fat which is attended by a loss of milk solids not fat in the buttermilk and wash water.

The fact that up to the present time no experimental work has been reported regarding the use of plastic cream in ice cream indicated a need for a study of this product as an ice cream ingredient. Hence, this work was carried out having in mind the following objectives:

1. To determine the various effects obtained by using plastic cream in the ice cream mix.
2. To compare the properties of ice cream mixes containing plastic cream, with the properties of mixes in which the fat is derived from other sources.
3. To determine the suitability of plastic cream as a source of fat for ice cream mixes of varying fat and serum solids content.
4. To determine the effects of differences in the age and source of plastic cream.
5. To determine the advisability of using corrective means of overcoming any undesirable effects of plastic cream on the properties of ice cream mixes.

REVIEW OF PREVIOUS WORK

Although some literature has been published regarding the manufacture and uses of plastic cream, to date no data have been reported regarding its use as an ice cream ingredient.

Wendt[20] describes the manufacture of plastic cream for use in butter and ice cream. He says, "When this cream (plastic cream) is used in place of fluid cream, in the manufacture of ice cream, the same identical results are obtained, from a flavour, freezing and overrun standpoint as when fluid cream, heretofore regarded as the ideal source of cream in the manufacture of ice cream, is used". However, Wendt fails to give any data to substantiate his assertions.

Tracy[18] worked with plastic cream in the manufacture of 'honey cream'. Using both factory and farm size De Laval separators, he found that the highest testing cream was secured by:

a. Setting the bowl adjustment for a high test cream.
b. Reducing the rate of inflow normally secured with the special cream cover and milk flow regulator.
c. Raising the temperature of the milk to 140° F.

Tracy also reports that even at 40° F. there is a danger of plastic cream becoming tallowy. Rancidity is another defect which he recognizes and as a preventative measure he recommends the pasteurization of milk at 145° F., thereby destroying fat-splitting enzymes.

Linneboe and Jackson[7] found butter freshly made from plastic cream would score as high as butter churned in the usual manner as a control lot. The relationship remained the same during the first three weeks in storage at refrigerator temperature. After that the butter made from plastic cream deteriorated more rapidly than the control.

EXPERIMENTAL PROCEDURE

In order to attack the problem systematically, the various mixes made during the investigation were classed in series as follows:

Series I. Standard mixes were made containing 14 per cent fat, 10 per cent serum solids, 15 per cent sugar and 0.35 per cent gelatin. A plastic cream mix was compared with mixes of the same composition in which the sources of fat were frozen cream, unsalted butter, and sweet cream, respectively. The plastic cream mix in this series will hereafter be referred to as the standard plastic cream mix.

Series II. Low fat, high serum solids mixes were made containing 10 per cent fat, 11 per cent serum solids, 15 per cent sugar, and 0.35 per cent gelatin. These mixes were made from the same products as those in Series I.

Series III. High fat, low serum solids mixes were made containing 18 per cent fat, 8 per cent serum solids, 15 per cent sugar, and 0.35 per cent gelatin. These mixes were made from the same sources of fat as those in Series I and II.

Series IV. The standard plastic cream mix as in Series I was used in this series. Mixes in which the source of fat was a commercial grade of plastic cream manufactured some months previously, were compared with mixes in which the source of fat was plastic cream which had been prepared in the college plant and held in storage for approximately one week.

Series V. The standard plastic cream mix was compared with plastic cream mixes of the same composition but to which dried egg yolk, lecithin, sodium citrate and di-sodium phosphate had been added.

Series VI. The standard plastic cream mix was compared with plastic cream mixes of the same composition but which had been subjected to double stage homogenization.

Series VII. The standard plastic cream mix was compared with a mix of the same composition but in which 50 per cent of the fat was supplied by plastic cream, the remainder being supplied by sweet cream.

All ingredients used were of good quality. The plastic cream was of commercial source except in Series IV where plastic cream was prepared in the college plant for comparison. The sweet cream used was fresh and of good quality, testing from 40 to 48 per cent fat. The frozen cream used was first pasteurized and then held in storage at 0° F. for two months before use. The unsalted butter was manufactured in the college plant from fresh sweet cream. Skim milk powder testing 95.6 per cent total solids was used as a concentrated source of serum solids. A gelatin testing 225 Bloom was used.

All mixes were pasteurized at 150° F. for thirty minutes. The mixes were homogenized at the pasteurization temperature at a pressure of 2500 pounds per square inch except those in Series II, III and VI. Those in Series II and Series III were homogenized at 3000 pounds pressure and 1500 pounds pressure, respectively. Some of the mixes in Series VI were subjected to double stage homogenization. From the homogenizer the mixes were run over a surface cooler, using water and brine as the cooling media, and were cooled to 45° F. or below. All mixes were aged for twenty-four hours at 40° F. before freezing.

The mixes were tested for fat by the Minnesota method and for total solids by the Mojonnier method.

Viscosity readings were made with 100 c.c. samples of the mix after 24 hours, using the MacMichael viscosimeter. Readings were made with a No. 30 wire and the disc bob. The cup was rotated at the rate of 14.9 r.p.m. Readings were taken when the mix temperature in the cup reached 68° F. All readings are stated in degrees M.

The fat globules and clumps were measured using an ocular micrometer disc standardized with the microscope so adjusted that each of the smallest divisions represented 0.63 microns. One c.c. of the mix was diluted with 99 c.c. of distilled water and mounted as a hanging drop preparation.

One set of mixes from each series was frozen in a 40-quart standard motor driven brine freezer. Several runs of each series were frozen in a small experimental brine freezer, motor driven, and of one gallon capacity. A brine varying from -10° F. to 5° F. was employed.

A definite procedure was followed in freezing. The freezer 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. Immediately thereafter, the hopper was opened, the brine was turned on and the stop watch started. At the end of two minutes a sample was drawn to determine the overrun present and immediately following this, another sample was taken to determine the temperature of the ice cream in the freezer. These samples were returned to the freezer after the readings were taken. Overrun and temperature determinations were made in this manner at intervals of one minute, until the maximum overrun was obtained. The brine was shut off at such a time that all batches were frozen to approximately 23.5° F. except those in Series III. The mixes in this series were frozen to approximately 25.5° F. in order to prevent excessive stiffness due to the high fat content. Duplicate samples for observation were taken at 85 per cent overrun. These samples were held in the hardening room for one week. After one week one set of samples was judged for flavor and the remaining set was used in melting tests.

All data discussed under experimental results represent freezings made with the 40-quart brine freezer. Data from the small experimental freezer which substantiates the results on the larger freezer are listed on pages 37 - 51.

EXPERIMENTAL RESULTS

I. A Comparison of Plastic Cream with Other Sources of Fat in Ice Cream Mixes Containing Fourteen Per Cent Fat

Ice cream mixes in which plastic cream is the source of fat exhibit different properties than do mixes made with frozen cream, butter, or sweet cream. This is brought out by an examination of Table I and Graph I. As compared with mixes made from frozen cream and sweet cream, plastic cream mixes had a higher viscosity, showed more clumping of fat globules and whipped more slowly in the freezer. Plastic cream mixes did, however, show a marked improvement over mixes in which butter was used as the source of fat. Compared with plastic cream mixes, butter mixes were more viscous, exhibited a greater degree of fat clumping and whipped more slowly. Since ice cream is usually drawn from the freezer at an overrun of 80 - 100 per cent, it is interesting to note the time required in the freezer for the ice cream to reach an overrun of 90 per cent. The plastic cream mix in Series I required approximately one and a half more minutes to reach 90 per cent overrun than did the mixes made from frozen cream or sweet cream. However, the butter mix was nearly two minutes slower than the plastic cream mix in reaching this overrun.

Microscopic examination of the various mixes showed a tendency for plastic cream mixes to contain slightly larger fat globules than mixes made from frozen cream or sweet cream. Oftentimes a deformation of some of the larger fat globules was observed in plastic cream mixes. Fat globule clumping, although present to a medium degree, was never excessive in the mixes containing plastic cream.

The ice cream made from plastic cream was slightly inferior in flavor to that made from frozen cream or sweet cream. There was no objectionable flavor present but the samples lacked the fresh, creamy flavor characteristic of ice cream which has been made from good quality sweet cream. No doubt, the fact that the plastic cream had been in storage for some time was an important factor here. Even though fresh butter was used in preparing the butter mixes, the ice cream containing butter had an inferior flavor which is characteristic of butter mixes.

There was no appreciable difference in melting appearance of the various samples.

TABLE I

The Effect of Source of Fat on Viscosity, Size of Fat Globules, Size of Fat Globule Clumps and Amount of Clumping in Ice Cream Mixes.*

Source of Fat	Viscosity of Mix °M	Average Size of Globules microns	Average Size of Clumps microns	Degree of Clumping
Series I. (14% fat)				
Plastic Cream	134	1.57	2.52 X 3.78	Med.
Frozen Cream	90	1.26	2.52 X 2.52	Med.
Unsalted Butter	246	1.60	3.15 X 4.61	Med.+
Sweet Cream	79	1.15	1.89 X 2.52	Very Little
Series II. (10% fat)				
Plastic Cream	80	1.25	1.89 X 2.52	Very Little
Frozen Cream	90	1.26	2.52 X 3.78	Little
Unsalted Butter	121	1.30	2.52 X 5.04	Med.
Sweet Cream	88	1.12	2.21 X 3.46	Little
Series III. (18% fat)				
Plastic Cream	225	1.89	4.41 X 6.30	Excessive
Frozen Cream	217	1.68	3.78 X 5.67	Med.
Unsalted Butter	278	2.21	3.78 X 6.30	Excessive
Sweet Cream	203	1.42	2.52 X 3.78	Med.

* Comparisons should be made only within each series

II. The Use of Plastic Cream in Ice Cream Mixes Varying in Fat and Serum Solids Content

The suitability of plastic cream for ice cream depends to a marked degree upon the per cent of fat and serum solids in the ice cream mix. In Series II and III, the data show that plastic cream is much more suitable for use as a source of fat in low fat, high serum solids mixes than in mixes high in fat content and low in serum solids.

A. In Series II, mixes were made containing 10 per cent fat and 11 per cent serum solids. In mixes of this composition, plastic cream was very suitable as a source of fat. The plastic cream mixes in this series showed very little fat globule clumping, exhibited a low viscosity and whipped very well in the freezer.

Ice cream from this series was judged for flavor and texture. The ice cream containing sweet cream was placed first, with that from frozen cream a close second. The plastic cream and butter samples were about equal, both having a very slight old or storage flavor.

Melting tests failed to reveal any significant difference in the appearance of the various samples upon melting.

B. Series III was made up of mixes containing 18 per cent fat and 8 per cent serum solids. The superiority of sweet cream over other sources of fat as an ingredient of ice cream high in fat content was demonstrated. Sweet cream mixes showed a lower viscosity, whipped to the desired overrun of 90 per cent in less time and reached the maximum overrun much sooner. Frozen cream mixes ranked second to sweet cream mixes in the above respects. The plastic cream mixes and butter mixes both whipped much more slowly. While an overrun greater than 100 per cent is usually of no direct commercial significance, it is interesting to note in Graph III that an overrun above 122 per cent could not be secured when plastic cream was used as the source of fat for high fat ice cream. Both the plastic cream mixes and the butter mixes in this series showed excessive fat globule clumping when observed under the microscope.

The ice cream made from plastic cream was inferior in flavor to that made from sweet cream. The plastic cream imparted an old, storage flavor to the ice cream. However, this off flavor was less noticeable in the plastic cream sample than in that made from butter.

All the ice creams melted uniformly, with the exception of that made from butter. This sample remained stiff and resisted melting for a much longer period than the others in the series.

III. The Effect of Age and Source of Plastic Cream

A study of the data in Series IV shows little difference in properties of plastic cream mixes due to differences in the age of the plastic cream and the source from which it was obtained. The differences, as shown in Graph IV, were small. The slight difference in whipping ability of the ice cream containing plastic cream of commercial source over that made in the college plant could be attributed to a possible difference in citrate content. Commercial plastic cream is put up for storage during the seasons of high milk production when the cows are on pasture. Increases of from 0.03 to 0.06 per cent in the citric acid content of milk have been reported as a result of green feed or pasture feeding.[6,17] Sommer and Young[16] and Hening and Dahlberg[5] found that the addition of citrates to ice cream mixes increased the whipping ability. Thus the improved whipping ability of commercial plastic cream put into storage during the early summer months, over that made during the winter season from milk produced by stall fed cows, may be attributed to an increased citrate content.

The length of time plastic cream remained in storage had no appreciable effect on the whipping ability of the mixes made from it. The difference in favor of the plastic cream stored for a period of months over that stored for approximately one week is no doubt a seasonal one and is perhaps due to an increased citrate content. Mack[8], working with frozen cream, found that the length of time frozen cream remained in storage had no apparent effect on the whipping time of mixes made from it.

Microscopic examination of the mixes made from the two different plastic creams showed little difference in properties, other than that the mix made from the commercial plastic cream exhibited slightly less fat globule clumping, due possibly to an increased amount of citrates.[5,16]

There was no noticeable difference in flavor or in melting characteristics of the two ice creams.

IV. Corrective Means of Overcoming Undesirable Effects of Plastic Cream on the Properties of Ice Cream Mixes

It is evident from a study of the data presented in Series I and III that plastic cream does have an undesirable effect upon some of the properties of ice cream mixes, especially when compared with sweet cream. Chief among these undesirable effects are a slower rate of whipping, and a slightly inferior flavor. With this in mind, Series V, VI, and VII were run in an effort to find some means of making plastic cream more suitable for use in ice cream.

A. The addition of 0.3 per cent dried egg yolk to plastic cream mixes was found to increase markedly whipping ability, increase the maximum overrun obtainable, and lower the viscosity. The mix containing egg yolk reached an overrun of 90 per cent approximately two and a half minutes sooner than the control mix which contained no egg yolk. The addition of egg yolk was found to decrease clumping slightly, and to result in an ice cream of improved melting appearance. These results are in agreement with previous findings regarding the use of egg

TABLE II

The Effect of Various Treatments of Plastic Cream Mixes on Viscosity, Size of Fat Globules, Size of Fat Globule Clumps, and Amount of Clumping.*

Treatment	Viscosity of Mix °M	Average Size of Globules microns	Average Size of Clumps microns	Degree of Clumping
Series V.				
Control	115	1.26	2.52 X 3.15	Med.
Dried Egg Yolk	75	1.26	2.52 X 2.52	Little +
Lecithin	70	1.26	1.89 X 3.15	Med.
Sodium Citrate	61	1.26	1.89 X 1.89	Very Little
Di-sodium Phosphate	68	1.26	1.89 X 2.52	Little
Series VI.				
Control (2500 lbs.)	134	1.57	2.52 X 3.78	Med.
2000 - 500 lbs.	33	1.52	1.89 X 3.15	Little
2500 - 500 lbs.	30	1.57	1.89 X 3.15	Little
Series VII.				
Control (plastic cream)	122	1.57	3.15 X 5.04	Med.
Plastic Cream & Sweet Cream	85	1.26	2.52 X 3.78	Little

* Comparisons should be made only within each series

solids in mixes containing other sources of fat.[2,9,11,12,13,14]

According to Haas and Hill[3], egg yolk contains 9.4 per cent lecithin. With this in mind, an attempt was made to overcome the undesirable effects of plastic cream on the ice cream mix, by the addition of lecithin. Soybean lecithin was first dispersed in hot water, and then added to the mix before homogenizing, at the rate of 0.2 per cent. Throughout the experiment, it was found that lecithin repressed the overrun during the early stages of whipping but increased whipping ability slightly, once this initial depression had been overcome. Whitaker[21] suggests that lecithin incorporated in ice cream with cream, buttermilk, or egg yolk might be responsible for the differences in the freezing properties observed when this material is partially lacking in the ice cream mix. Wright[22] found that when lecithin was incorporated into the ice cream mix in a favorable manner, so as to be adsorbed on the surface of the fat globules, an improvement in whipping of butter mixes resulted. However, Sommer and Horrall[15], Martin and Caulfield[9], and Tracy and Ruehe[19] found that the addition of lecithin to mixes did not improve whipping. Button[1] found that egg lecithin and egg oil were responsible for the initial lowering of overrun in egg yolk mixes. Sommer[15] suggests that the lecithin-protein combination may be responsible for the better whipping of mixes containing egg yolk. This suggestion is worthy of consideration.

In a comparison of the results secured in this experiment with the use of lecithin and the results of others[1,9,15,19,22], the disagreement can probably be attributed to one of the following factors: (1) plastic cream was not used as a source of fat in previous experiments; (2) the efficiency of the freezers used in the different trials varied; and (3) the lecithin must be incorporated into the mix in a careful manner in order to be adsorbed on the surface of the fat globules.

The addition of sodium citrate or di-sodium phosphate to plastic cream mixes at the rate of 0.1 per cent was found to result in an improvement in whipping ability. There was also a significant decrease in fat globule clumping. The addition of sodium citrate did not affect the flavor of the ice cream but when di-sodium phosphate was added there was a slight salty taste. Previously, Sommer and Young[16], and Hening and Dahlberg[5] demonstrated that additions of sodium citrate and di-sodium phosphate to ice cream mixes containing sweet cream before homogenization, decreased the clumping, decreased the viscosity and increased the whipping ability.

B. Double stage homogenization of mixes containing plastic cream was found to be of little value. Fat clumping was decreased and viscosity was lowered, but whipping ability was improved only slightly. After seven minutes in the freezer, the control mix whipped as well as the mixes which had been subjected to double-stage homogenization. Martin and Dahle[10], Hening[4], and others report that double-stage homogenization reduces the clumping, decreases the viscosity, and increases the whipping ability of ice cream mixes.

Double-stage homogenization resulted in an ice cream which melted more quickly and with a smoother appearance. There was no noticeable difference in the texture of the samples.

There is reason to believe that in the case of high fat mixes, mixes high in acidity, or a freezer in poor condition, double-stage homogenization of plastic cream mixes would be more effective in increasing whipping ability.

C. In Series VII the practice of deriving 50 per cent of the fat from sweet cream was found beneficial with mixes containing plastic cream. Incidentally, this is a common practice with butter mixes.

The substitution of sweet cream for a part of the plastic cream in the mix resulted in decreased fat globule clumping, lowered viscosity, and improved whipping ability. There was also a noticeable improvement in the flavor of the ice cream.

This practice is particularly recommended when the slow whipping and inferior flavor of plastic cream mixes of a reasonably high fat content must be overcome.

SUMMARY AND CONCLUSIONS

1. Ice cream mixes in which plastic cream is the source of fat show more clumping of fat globules, exhibit a higher viscosity, whip more slowly in the freezer and have a poorer flavor than mixes made from frozen cream or sweet cream.

2. Plastic cream mixes show less clumping of fat globules, a lower viscosity, and better whipping ability than butter mixes. Ice cream made from plastic cream is superior in flavor and melting characteristics to that made from butter.

3. Plastic cream is best suited for use as a source of fat in ice cream mixes of a relatively low fat content. Its use as the entire source of fat for mixes of a high fat content is not recommended.

4. The age and source of plastic cream for ice cream are not of great importance. Plas-

tic cream put into storage during the summer months is preferable, due possibly to higher citrate content.

5. The addition of dried egg yolk, lecithin, sodium citrate and di-sodium phosphate to plastic cream mixes results in improved whipping ability. The use of dried egg yolk is recommended as being most satisfactory from a practical standpoint.

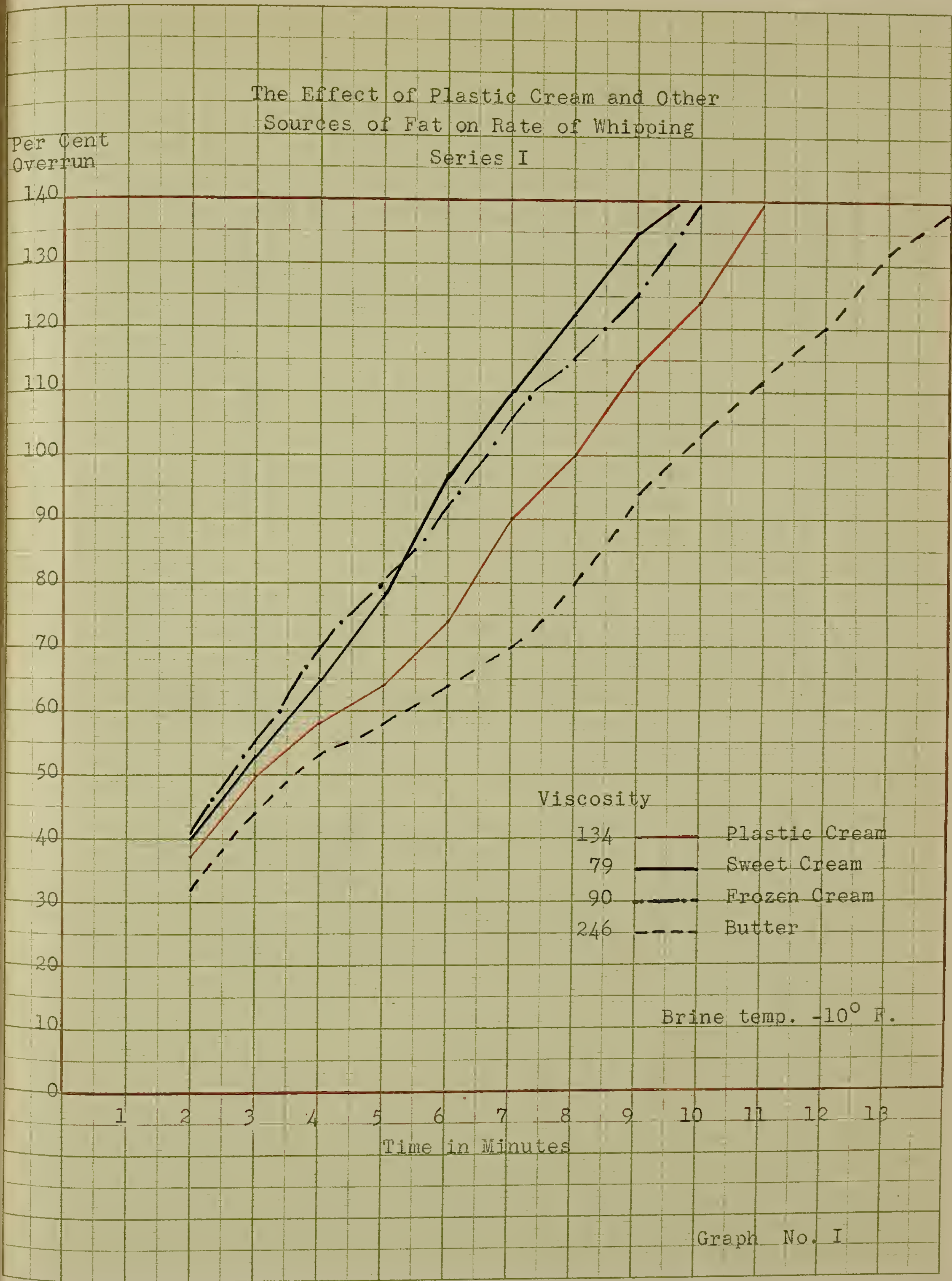
6. Double-stage homogenization of plastic cream mixes seems best adapted for mixes of a high fat content or mixes made or frozen under adverse conditions.

7. The use of sweet cream in conjunction with plastic cream is recommended where difficulty is experienced with the use of plastic cream as the only source of fat. This combination results in less viscosity and fat globule clumping, more rapid whipping, and an improved flavor.

The following section contains the graphs and freezing data referred to in the discussion of experimental results.

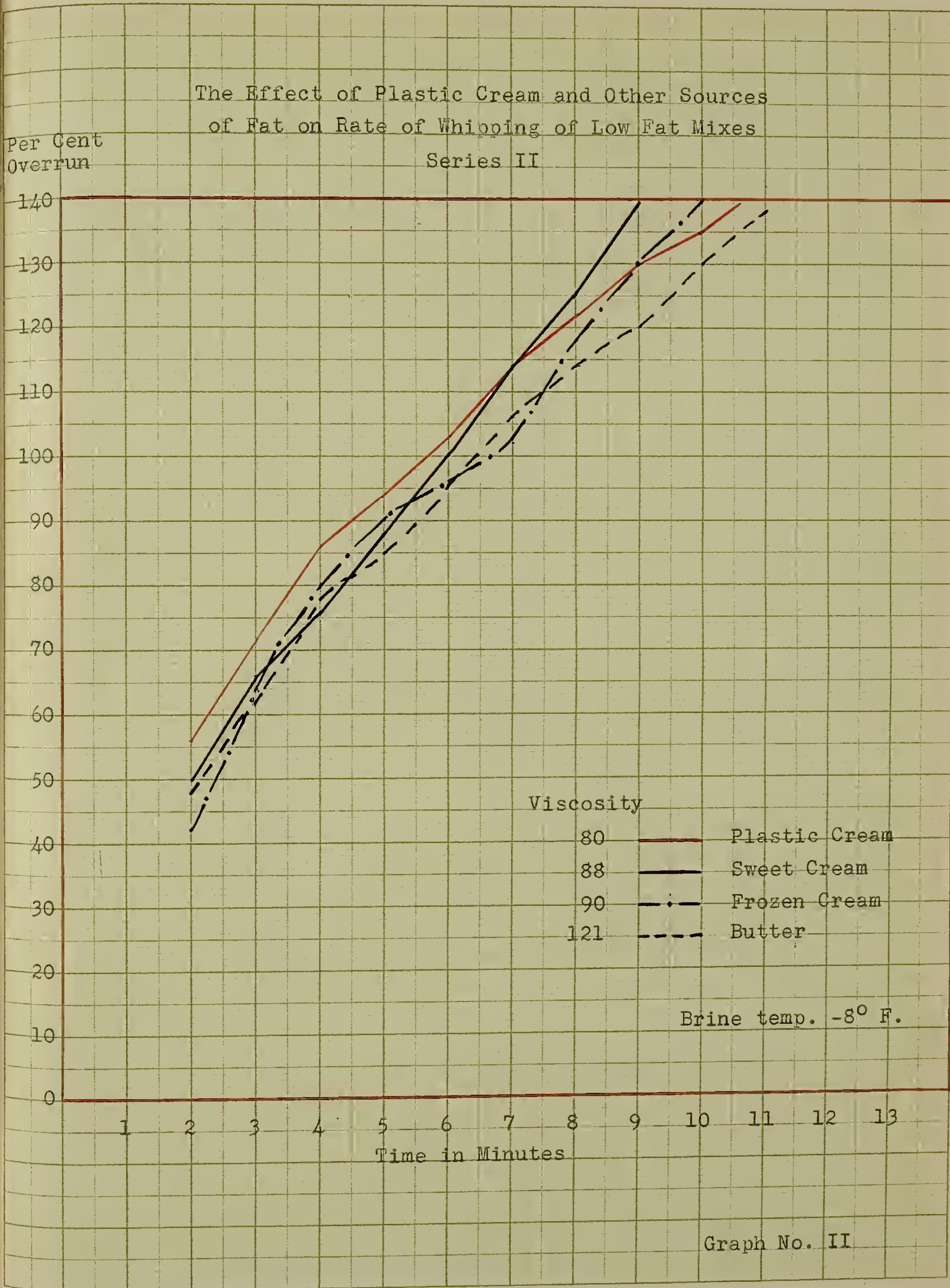
FREEZING DATA FOR GRAPH NO. I

Min.	Plastic Cream		Sweet Cream		Frozen Cream		Butter	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	25.8	37	25.8	40	25.8	40	25.9	32
3	25.1	50	25.2	53	25.1	55	25.3	44
4	24.6	58	24.6	65	24.7	70	24.6	53
5	23.8	64	23.7	78	23.6	80	23.7	58
6	23.5	74	23.5	97	23.4	92	23.4	64
7	23.4	90	23.4	110	23.3	106	23.3	70
8	23.5	100	23.4	122	23.4	115	23.4	80
9	23.7	114	23.6	135	23.6	125	23.6	94
10	23.8	124	23.8	142	23.8	140	23.7	103
11	24.1	140					23.9	112
12							24.1	120
13							24.4	132
14							24.6	138
15							24.8	142


The Effect of Plastic Cream and Other
Sources of Fat on Rate of Whipping
Series I
Per Cent
Overrun
140
130
120
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
Time in Minutes
Viscosity
134 Plastic Cream
79 Sweet Cream
90 Frozen Cream
246 Butter
Brine temp. -10° F.
Graph No. I

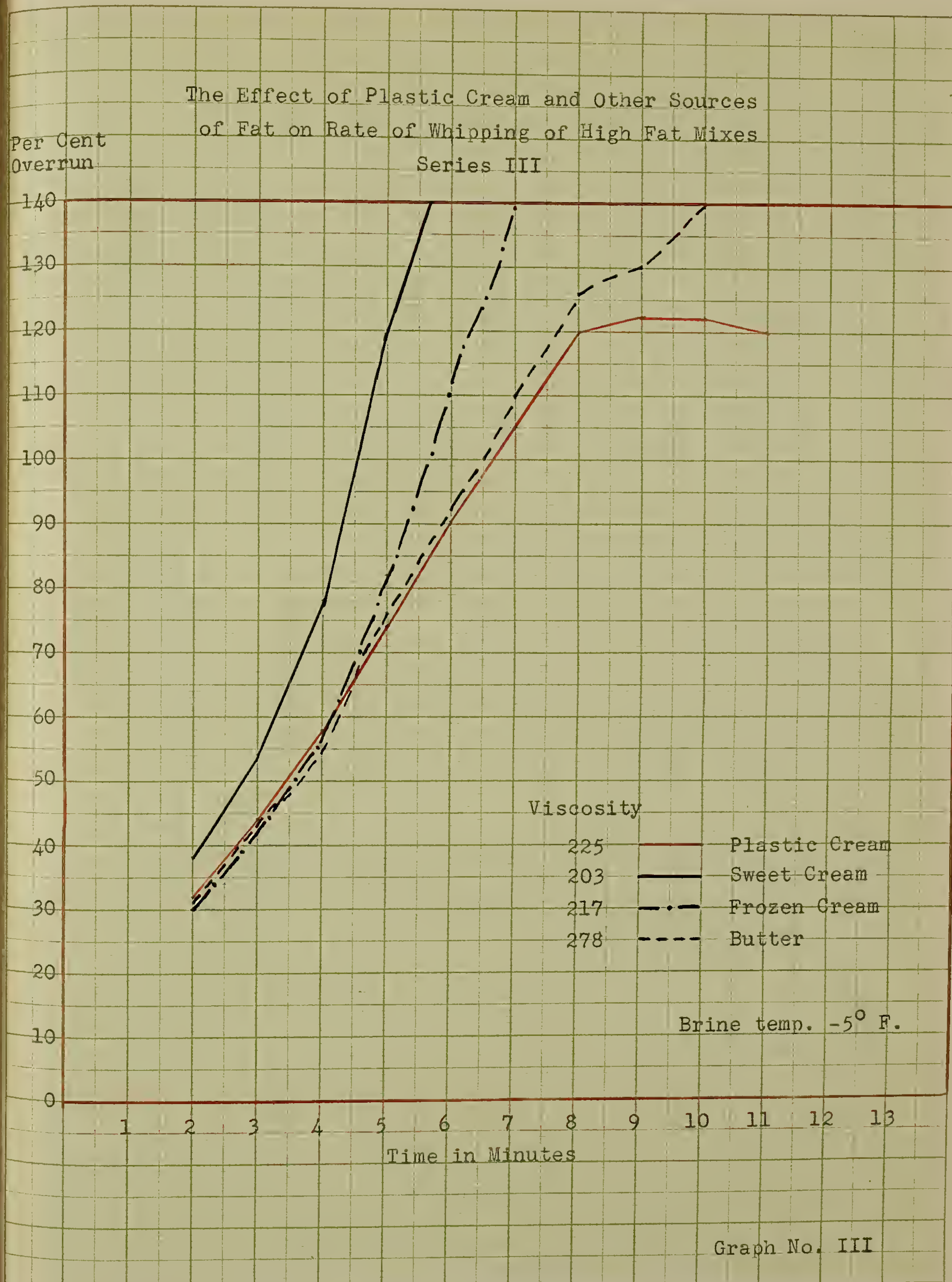
FREEZING DATA FOR GRAPH NO. II

Min.	Plastic Cream		Sweet Cream		Frozen Cream		Butter	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.6	56	27.0	50	26.5	42	26.6	48
3	25.7	72	26.0	66	25.7	64	25.5	64
4	25.0	86	25.3	76	25.1	80	25.0	78
5	24.3	94	24.6	88	24.2	90	24.2	85
6	23.8	103	23.8	100	23.8	96	23.8	96
7	23.6	114	23.6	114	23.6	102	23.7	106
8	23.6	122	23.8	125	23.6	118	23.7	114
9	23.7	130	23.8	140	23.8	130	23.8	120
10	23.8	135			24.0	140	24.0	130
11	24.0	142					24.2	138


The Effect of Plastic Cream and Other Sources
of Fat on Rate of Whipping of Low Fat Mixes
Series II
Per Cent
Overrun
140
130
120
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
Time in Minutes
Viscosity
80 Plastic Cream
88 Sweet Cream
90 Frozen Cream
121 Butter
Brine temp. -8° F.
Graph No. II

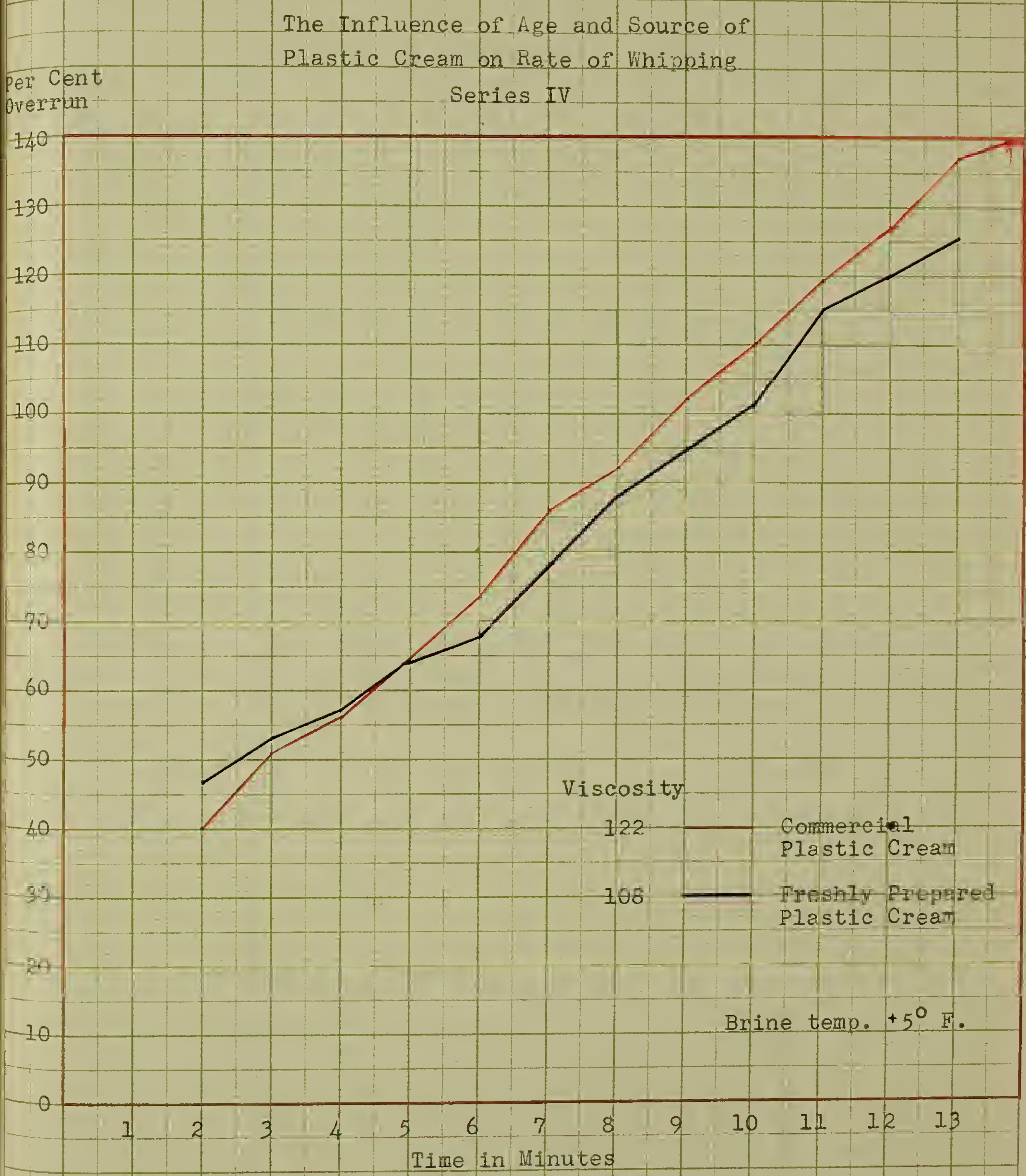
FREEZING DATA FOR GRAPH NO. III

	Plastic Cream		Sweet Cream		Frozen Cream		Butter	
Min.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.7	32	26.6	38	26.7	30	26.5	32
3	25.8	44	25.8	54	25.9	42	26.0	43
4	25.5	58	25.5	78	25.5	57	25.6	55
5	25.4	74	25.4	120	25.5	82	25.5	76
6	25.4	90	25.4	150+	25.5	112	25.5	92
7	25.5	105			25.6	140	25.6	110
8	25.5	120					25.6	126
9	25.6	122					25.7	130
10	25.6	122					25.7	140
11	25.8	120						


The Effect of Plastic Cream and Other Sources
of Fat on Rate of Whipping of High Fat Mixes
Series III
Per Cent
Overrun
140
130
120
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
Time in Minutes
Viscosity
225
203
217
278
Plastic Cream
Sweet Cream
Frozen Cream
Butter
Brine temp. -5° F.
Graph No. III

FREEZING DATA FOR GRAPH NO. IV

Min.	Commercial Plastic Cream		Freshly Prepared Plastic Cream	
	Temp.	O.R.	Temp.	O.R.
2	26.2	40	26.0	47
3	25.7	51	25.5	53
4	25.2	56	25.0	57
5	24.8	64	24.6	64
6	24.8	73	24.6	68
7	24.9	86	24.6	78
8	25.0	92	24.8	88
9	25.1	102	24.9	95
10	25.2	110	25.0	101
11	25.4	119	25.2	115
12	25.6	127	25.3	120
13	25.8	137	25.5	125
14	25.9	140		

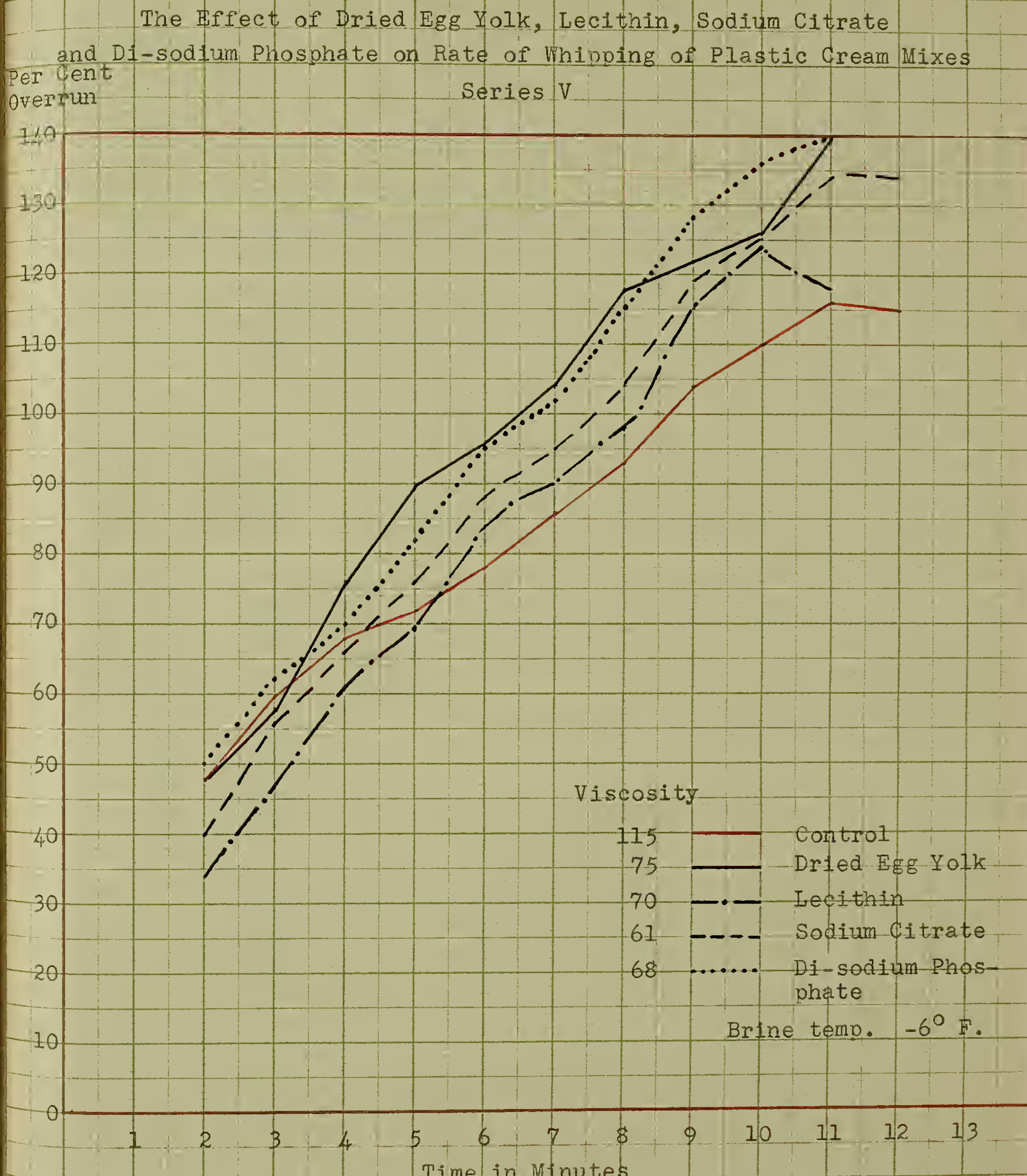


The Influence of Age and Source of
Plastic Cream on Rate of Whipping
Series IV
Per Cent
Overrun
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Time in Minutes
Viscosity
122
Commercial
Plastic Cream
108
Freshly Prepared
Plastic Cream
Brine temp. +5° F.

Graph No. IV

FREEZING DATA FOR GRAPH NO. V

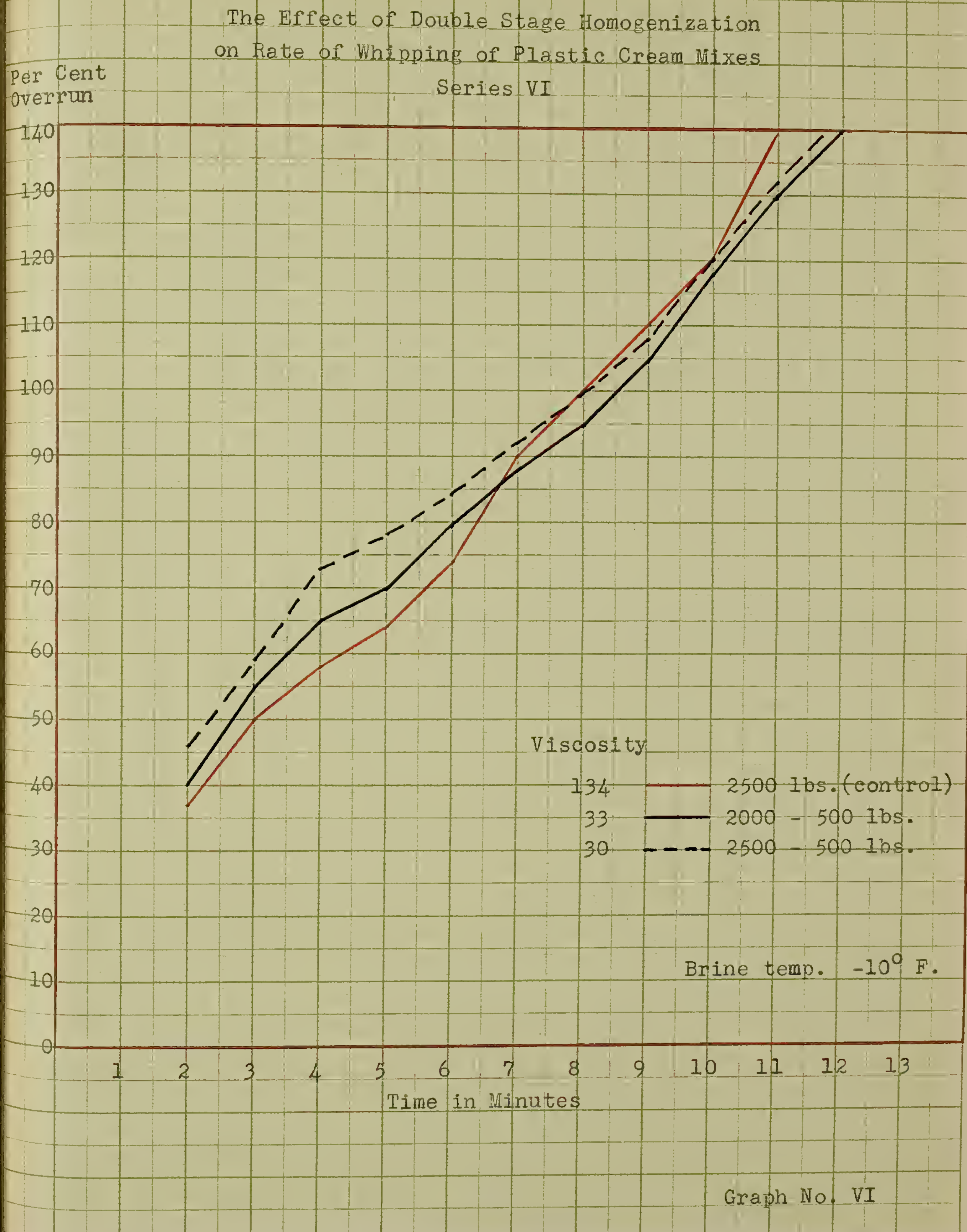
Min.	Plastic Cream (Control)		Dried Egg Yolk		Lecithin		Sodium Citrate		Di-sodium Phosphate	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.0	48	25.8	48	26.0	34	25.7	40	25.8	50
3	25.4	60	25.2	58	25.4	47	25.4	56	25.4	62
4	24.7	68	24.8	76	24.7	61	24.7	66	25.0	70
5	24.0	72	24.0	90	23.8	69	24.2	76	24.8	82
6	23.5	78	23.4	96	23.2	84	23.5	88	23.8	96
7	23.2	86	23.3	104	23.0	90	23.2	95	23.6	102
8	23.3	93	23.4	118	23.2	98	23.4	104	23.8	115
9	23.5	104	23.6	122	23.4	115	23.6	119	24.0	128
10	23.8	110	23.8	126	23.6	124	23.8	125	24.2	136
11	24.0	116	24.2	140	24.0	118	24.1	134	24.2	140
12	24.2	115					24.2	134		


The Effect of Dried Egg Yolk, Lecithin, Sodium Citrate
and Di-sodium Phosphate on Rate of Whipping of Plastic Cream Mixes
Series V
Per Cent
Overrun
140
130
120
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
Time in Minutes
Viscosity
115
75
70
61
68
Control
Dried Egg Yolk
Lecithin
Sodium Citrate
Di-sodium Phosphate
Brine temp. -6° F.

Graph No. V

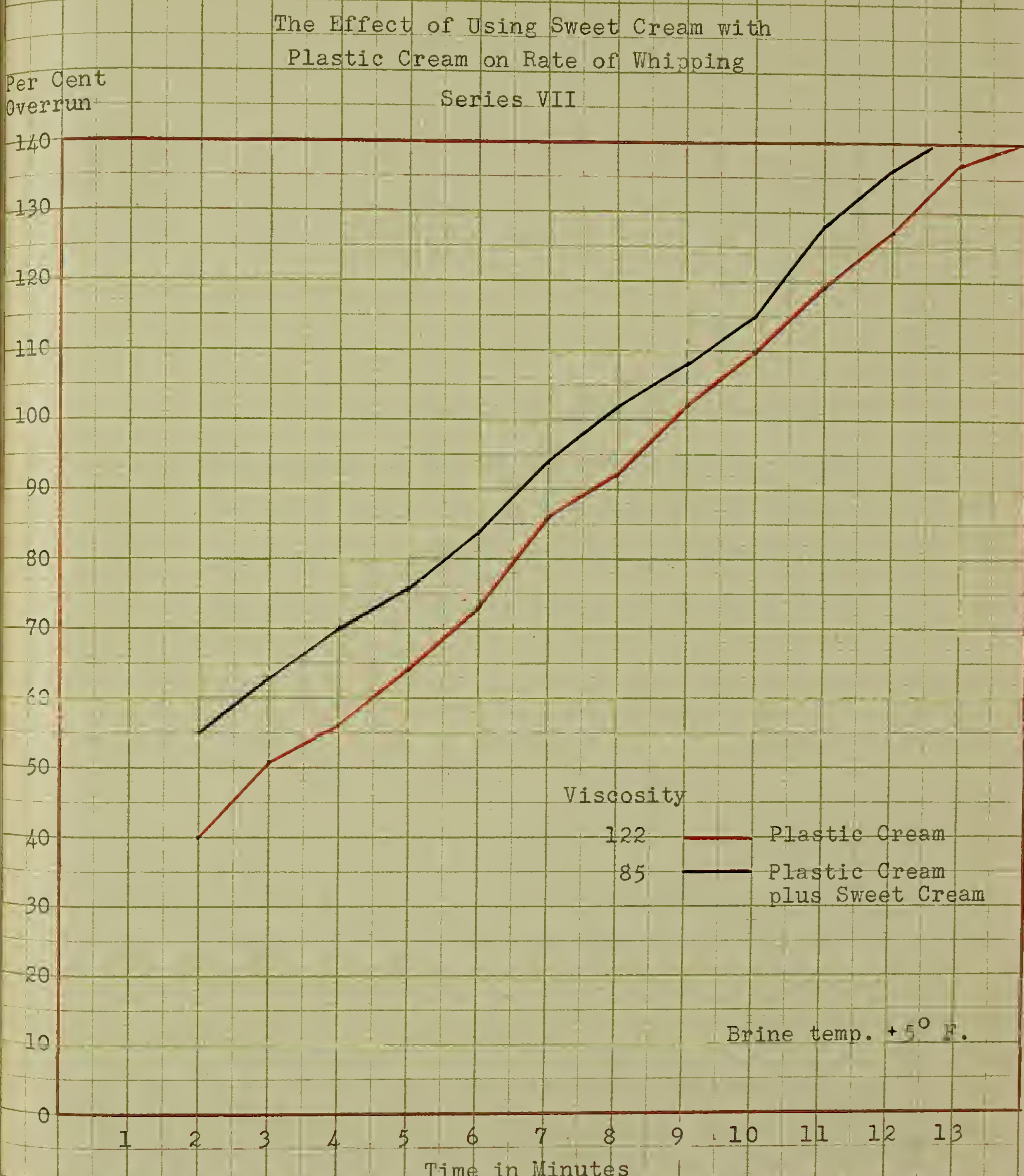
FREEZING DATA FOR GRAPH NO. VI

Min.	2500 lbs. (control) Temp.	O.R.	2000 - 500 lbs. Temp.	O.R.	2500 - 500 lbs. Temp.	O.R.
2	25.8	37	25.6	40	25.8	46
3	25.1	50	25.0	55	25.1	59
4	24.6	58	24.2	65	24.5	73
5	23.8	64	23.6	70	23.8	78
6	23.5	74	23.5	80	23.4	84
7	23.4	90	23.5	88	23.4	92
8	23.5	100	23.6	95	23.5	100
9	23.7	110	23.8	105	23.6	108
10	23.8	120	23.9	118	23.8	120
11	24.1	140	24.2	130	24.2	132
12			24.3	140	24.4	142


The Effect of Double Stage Homogenization
on Rate of Whipping of Plastic Cream Mixes
Series VI
Per Cent Overrun
140
130
120
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
Time in Minutes
Viscosity
134 2500 lbs.(control)
33 2000 - 500 lbs.
30 2500 - 500 lbs.
Brine temp. -10° F.
Graph No. VI

FREEZING DATA FOR GRAPH NO. VII

Min.	Plastic Cream Temp.	Plastic Cream O.R.	Plastic Cream plus Sweet Cream Temp.	Plastic Cream plus Sweet Cream O.R.
2	26.2	40	26.0	55
3	25.7	51	25.5	63
4	25.2	56	25.2	70
5	24.8	64	24.8	76
6	24.8	73	24.6	84
7	24.9	86	24.7	94
8	25.0	92	24.8	102
9	25.1	102	25.0	108
10	25.2	110	25.0	115
11	25.4	119	25.2	128
12	25.6	127	25.4	136
13	25.8	137	25.6	142
14	25.9	140		


The Effect of Using Sweet Cream with
Plastic Cream on Rate of Whipping
Series VII
Per Cent
Overrun
140
130
120
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
Time in Minutes
Viscosity
122
Plastic Cream
85
Plastic Cream
plus Sweet Cream
Brine temp. + 5° F.

Graph No. VII

The section which follows contains the balance of the freezing data secured during the experiment. These data were secured with the small experimental freezer and substantiate the results previously tabulated in graph form.

SERIES I

The Whipping Ability of Plastic Cream, Frozen Cream, Butter, and Sweet Cream Mixes Containing 14 Per Cent Fat.

Min.	Plastic Cream		Frozen Cream		Butter		Sweet Cream	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
3	26.0	33	26.0	45	26.4	38	26.0	42
4	25.0	42	25.4	48	25.6	40	25.0	47
5	24.5	48	25.0	54	24.0	42	24.3	53
6	24.3	52	24.5	60	23.8	43	24.2	56
7	24.3	54	24.0	64	23.6	46	24.3	63
8	24.2	60	24.2	70	23.6	55	24.4	68
9	24.5	64	24.2	72	23.5	64	24.6	72
10	25.0	68	24.6	74	23.6	67	24.8	75
Viscosity	147		135		132		115	

Brine Temp. 0^{o} F.

SERIES I

The Whipping Ability of Plastic Cream, Frozen Cream, Butter, and Sweet Cream Mixes Containing 14 Per Cent Fat.

Min.	Plastic Cream		Butter		Sweet Cream	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.8	64	26.2	52	26.8	60
3	26.0	66	25.8	54	26.0	68
4	25.1	68	24.8	60	25.2	78
5	24.7	73	24.6	67	24.8	86
6	24.7	82	24.6	70	25.0	92
7	24.9	87	24.9	80	25.2	98
8	25.1	92	25.0	86	25.4	106
9	25.4	100	25.5	90	25.6	113
10	25.7	104	25.8	93	26.0	116
11	26.0	110	26.1	96	26.3	120
12	26.2	115				
Viscosity	73		118		62	

Brine Temp. -10° F.

SERIES II

The Whipping Ability of Plastic Cream, Frozen Cream, Butter, and Sweet Cream Mixes Containing 10 Per Cent Fat.

	Plastic Cream		Frozen Cream		Butter		Sweet Cream	
Min.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
3	26.0	78	26.2	74	26.2	72	26.2	70
4	25.6	80	25.6	78	25.5	74	25.5	74
5	25.2	84	25.4	84	25.2	78	25.0	80
6	25.0	90	25.2	86	24.9	82	24.8	88
7	25.0	95	25.2	92	24.8	84	24.8	94
8	25.2	100	25.5	96	25.0	86	24.9	100
9	25.5	102	25.8	100	25.4	90	25.2	106
10	26.0	106	26.2	100	25.8	92	25.6	110
11	26.4	106			26.2	92	26.0	110
Viscosity	80		90		121		88	

Brine Temp. 0° F.

SERIES II

The Whipping Ability of Plastic Cream, Frozen Cream, Butter, and Sweet Cream Mixes Containing 10 Per Cent Fat.

	Plastic Cream		Frozen Cream		Butter		Sweet Cream	
Min.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
3	25.8	68	26.2	64	26.0	65	26.2	65
4	25.0	76	25.4	72	25.2	68	25.4	68
5	24.7	80	25.0	78	24.9	74	25.0	73
6	24.8	83	25.2	82	24.9	78	24.9	80
7	25.1	88	25.4	86	25.2	79	25.2	83
8	25.5	90	25.6	90	25.5	82	25.5	89
9	25.8	91	26.0	90	25.8	85	25.8	92
10	26.2	93			26.2	85	26.2	96
11	26.3	92			26.4	82	26.4	97
Viscosity	137				205		146	

Brine Temp. 0^{o} F.

SERIES III

The Whipping Ability of Plastic Cream, Frozen Cream, Butter, and Sweet Cream Mixes Containing 18 Per Cent Fat.

Min.	Plastic Cream		Frozen Cream		Butter		Sweet Cream	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
3	26.2	30	26.2	30	26.9	29	26.6	42
4	25.8	42	25.3	44	26.2	41	26.1	50
5	25.4	53	25.1	60	25.8	54	26.0	70
6	25.5	58	25.3	74	26.0	60	26.0	82
7	25.7	66	25.6	80	26.2	66		
8	26.2	70	25.8	84	26.5	71		
9	26.5	74			26.8	75		
10	26.8	76			27.0	74		
11	27.0	78						
Viscosity	225		217		278		203	

Brine Temp. 0° F.

SERIES III

The Whipping Ability of Plastic Cream, Frozen Cream, Butter, and Sweet Cream Mixes Containing 18 Per Cent Fat.

	Plastic Cream		Butter		Sweet Cream	
Min.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.2	32	26.4	30	26.4	40
3	25.8	40	25.9	38	26.0	48
4	25.2	52	25.4	50	25.4	60
5	25.0	58	25.0	60	25.2	72
6	25.0	65	25.2	66	25.2	86
7	25.2	68	25.2	70	25.4	88

Brine Temp. 0° F.

SERIES IV

The Effect of Age and Source of Plastic Cream
on Whipping Ability of Ice Cream Mixes.

Min.	Commercial Plastic Cream		M.S.C. Plastic Cream	
	Temp.	O.R.	Temp.	O.R.
3	26.0	64	26.0	64
4	25.6	68	25.4	70
5	25.2	72	25.0	75
6	24.8	78	24.8	80
7	24.8	80	24.8	84
8	25.0	88	25.0	90
9	25.2	96	25.2	98
10	25.5	102	25.6	100
11	25.8	105	25.9	106
12	26.0	105	26.2	108
Viscosity	132		125	

Brine Temp. +5° F.

SERIES IV

The Effect of Age and Source of Plastic Cream on Whipping Ability of Ice Cream Mixes.

	Commercial Plastic Cream		M.S.C. Plastic Cream	
Min.	Temp.	O.R.	Temp.	O.R.
2	26.6	60	26.4	58
3	26.0	64	25.8	64
4	25.4	69	25.0	66
5	24.8	74	24.8	70
6	24.6	80	24.6	78
7	24.8	86	24.8	88
8	25.0	94	25.0	94
9	25.2	100	25.5	102
10	25.5	106	25.8	108
11	25.8	110	26.0	110
12	26.0	112	26.4	110
Viscosity	75		80	

Brine Temp. -8° F.

SERIES V

The Effect of Dried Egg Yolk, Lecithin, and Sodium Citrate on Whipping Ability of Plastic Cream Mixes.

Min.	Control Temp.	Control O.R.	Control + Egg Yolk Temp.	Control + Egg Yolk O.R.	Control + Lecithin Temp.	Control + Lecithin O.R.	Control + Sodium Citrate Temp.	Control + Sodium Citrate O.R.
3	25.8	50	26.0	48	25.7	40	25.8	54
4	25.3	54	25.5	52	25.2	48	25.2	58
5	25.3	60	25.4	60	25.0	54	25.0	64
6	25.0	68	25.2	64	24.8	62	25.0	70
7	25.2	72	25.2	70	24.8	70	25.2	80
8	25.5	76	25.5	80	25.2	75	25.4	84
9	25.8	80	25.6	86	25.5	84	25.7	92
10	26.0	90	25.6	94	25.8	92	26.0	100
11	26.2	96	25.8	104	26.0	98	26.2	108
12	26.4	96	26.0	106	26.2	98		
Viscosity	120		110		116		84	

Brine Temp. 0° F.

SERIES V

The Effect of Dried Egg Yolk, Lecithin, Sodium Citrate, and Di-sodium Phosphate on Whipping Ability of Plastic Cream Mixes.

	Control		Dried Egg Yolk		Lecithin		Sodium Citrate		Di-sodium Phosphate	
Min.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.0	57	26.2	50	25.8	50	26.0	54	25.8	52
3	25.0	58	25.4	60	24.8	56	25.0	58	24.8	58
4	24.5	60	24.4	62	24.0	60	24.3	64	24.2	66
5	24.5	63	24.2	65	23.9	64	24.1	68	24.1	72
6	24.2	68	23.9	70	23.9	70	24.1	74	24.3	76
7	24.4	72	24.2	80	24.2	72	24.3	82	24.5	80
8	24.7	76	24.3	83	24.5	80	24.4	88	24.6	84
9	25.0	81	24.5	94	24.8	85	24.7	96	24.9	95
10	25.1	87	24.6	98	25.0	90	25.0	104	25.4	103
11	25.4	93	24.8	102	25.4	98	25.4	106	25.8	110
12	25.6	96			25.6	96				
Viscosity	102		115		100		89		91	

Brine Temp. -6^{o} F.

SERIES VI

The Effect of Double Stage Homogenization on
Whipping Ability of Plastic Cream Mixes.

Min.	2500 lbs. Pressure		2000 - 500 lbs. Pressure		2500 - 500 lbs. Pressure	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
3	26.0	---	26.1	---	26.0	---
4	25.6	---	25.3	---	25.2	---
5	24.6	65	24.5	68	24.5	70
6	23.8	66	23.8	68	23.9	72
7	23.8	72	23.9	76	23.9	75
8	23.9	83	24.2	85	24.2	84
9	24.0	88	24.5	90	24.6	90
10	24.5	98	25.0	98	25.0	100
11	25.2	109	25.3	102	25.2	108
12	25.3	111	25.6	109	25.4	110

Brine Temp. -6° F.

SERIES VI

The Effect of Double Stage Homogenization on Whipping Ability of Plastic Cream Mixes.

Min.	2500 lbs. Pressure		2000 - 500 lbs. Pressure		2500 - 500 lbs. Pressure	
	Temp.	O.R.	Temp.	O.R.	Temp.	O.R.
2	26.2	60	26.2	57	26.0	62
3	25.4	66	25.4	63	25.2	67
4	24.6	72	24.6	69	24.0	70
5	23.8	78	24.0	74	23.8	76
6	23.6	80	23.8	77	23.6	82
7	23.6	86	23.9	83	23.8	90
8	24.0	94	24.2	90	24.2	96
9	24.2	98	24.6	96	24.3	100
10	24.6	103	24.8	102	24.6	104
11	24.8	110	25.0	105	25.0	111
12	25.0	112	25.2	110	25.4	114

Brine Temp. -6° F.

SERIES VI

The Effect of Double Stage Homogenization on Whipping Ability of Plastic Cream Mixes.

Min.	2500 lbs. Pressure Temp.	2500 lbs. Pressure O.R.	2000 - 500 lbs. Pressure Temp.	2000 - 500 lbs. Pressure O.R.	2500 - 500 lbs. Pressure Temp.	2500 - 500 lbs. Pressure O.R.
2	26.8	64	26.8	75	26.8	75
3	26.2	66	26.2	80	26.0	77
4	25.1	70	25.1	82	25.1	83
5	24.7	75	24.8	87	24.8	87
6	24.7	82	24.6	90	24.8	94
7	24.9	88	24.8	94	25.0	96
8	25.1	94	25.0	98	25.3	100
9	25.4	100	25.2	106	25.5	106
10	25.7	106	25.5	110	25.8	108
11	26.0	110	25.8	114	26.0	112
12	26.2	116	26.0	116		
Viscosity	48		34		33	

Brine Temp. -10° F.

SERIES VII

The Effect on Whipping Ability of Using Sweet Cream in Conjunction with Plastic Cream.

Min.	Plastic Cream Temp.	Plastic Cream O.R.	Plastic Cream + Sweet Cream Temp.	Plastic Cream + Sweet Cream O.R.
3	26.0	64	26.2	68
4	25.6	68	25.5	72
5	25.2	72	25.2	75
6	24.8	78	24.8	82
7	24.8	80	24.6	86
8	25.0	88	24.6	96
9	25.2	96	24.8	98
10	25.5	102	25.2	105
11	25.8	105	25.5	110
12	26.0	105	25.8	112
Viscosity	132		110	

Brine Temp. 45° F.

SERIES VII

The Effect on Whipping Ability of Using Sweet Cream in Conjunction with Plastic Cream.

Min.	Plastic Cream Temp.	Plastic Cream O.R.	Plastic Cream + Sweet Cream Temp.	Plastic Cream + Sweet Cream O.R.
2	26.6	60	26.4	68
3	26.0	64	25.9	72
4	25.4	69	25.2	74
5	24.8	74	25.0	78
6	24.6	80	24.8	85
7	24.8	86	24.8	92
8	25.0	94	25.0	98
9	25.2	100	25.0	108
10	25.5	106	25.5	112
11	25.8	110	26.0	118
12	26.0	112	26.0	118
Viscosity	75		68	

Brine Temp. -8° F.

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