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DEPARTMENT OF DAIRY HUSBANDRY

A SIMPLIFIED METHOD OF STANDARDIZING THE ICE-CREAM MIX.

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The information contained in this circular is offered to beginners in ice-cream manufacture in the hope that what seems to them a rather puzzling and complicated process may be made simple and easily understandable. It is purposely made intensely practical in order to be simple. Technical phraseology is avoided as much as possible.

One of the most important and difficult qualities to attain in the manufacture of ice cream is uniformity. In order to sell well ice cream should be of essentially the same composition from day to day. The raw materials which are available at any time must be used and these may vary considerably from day to day. While this makes standardization more difficult it is by no means impossible, and it is hoped that the method and formulas presented in this circular will aid somewhat in this respect as well as assist the maker in putting out a better product.

THE QUALITIES OF GOOD ICE CREAM.

The Kansas ice-cream law reads, in part, as follows: "Ice cream is a frozen product containing not less than 10 per cent milk fat, and not less than a total of 20 per cent milk solids; said product consisting of a flavored, sugar-sweetened mixture of cream or cream and milk, or the sweet pure products of cream and milk, with or without the addition to gelatin, vegetable gums, or such other wholesome

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stabilizers as may be approved by the State Dairy Commissioner, to which mixture may be added pure, fresh, sweet, wholesome eggs, fruit or fruit juice, cocoa, chocolate, or nuts."

It will be noted that the law specifically requires 10 per cent of milk fat and 20 per cent total milk solids. This means that the mix must contain 10 per cent of milk solids not fat or serum solids.

Since the fat requirement for fruit ice cream is the same as for plain ice cream, it is necessary either to make separate mixes for plain and for fruit ice cream or carry about 12 per cent of fat in the plain ice cream.

The sugar content of a good mix varies from about 11 per cent to as high as 16 per cent, according to the requirements of the trade. In most cases 12 per cent sugar is sufficiently sweet.

Gelatin is the best stabilizer; one-half of 1 per cent of a high-grade gelatin is sufficient. More is required if the cheaper grades are used.

The following explanation of terms used in this discussion may promote clearness:

Total solids refers to the solids which would remain if the mix was evaporated to dryness.

Milk solids refers to solids obtained from milk.

Serum solids refers to milk solids minus the butter fat.

The approximate average per cent of solids in materials ordinarily used in the manufacture of ice cream is given in the following table:

Skim milk—9 per cent serum solids.

4-per-cent milk—4 per cent fat, 8.64 per cent serum solids.

35-per-cent cream—35 per cent fat, 5.85 per cent serum solids.

Skim-milk powder—95 per cent serum solids.

Plain condensed skim milk—20 per cent serum solids.

Sweetened condensed skim milk-40 per cent cane sugar, 28 per cent serum solids.

Unsalted butter—1 per cent casein, moisture variable.

Sugar—100 per cent total solids.

Gelatin—100 per cent total solids.

The moisture content of the butter should always be determined by test.

When purchasing condensed products it is always desirable to request an analysis of each shipment.

The moisture content of sugar and gelatin are purposely ignored as is also the small solids content of the vanilla.

STANDARDIZING THE MIX.

In this method a basic formula is adopted which gives the composition of the mix. For example, a mix is adopted with the following composition: Fat, 12 per cent; serum solids, 10 per cent; sugar, 12 per cent; and stabilizer, one-half of 1 per cent. This constitutes our basic formula as shown below.

BASIC FORMULA.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
Fat	12.0	12	..	..	12.0
Serum solids	10.0	..	10	..	10.0
Sugar	12.0	..	..	12	12.0
Gelatin	.5	..	..	..	.5
					34.5

Case No. 1.

Skim-milk powder furnishes the serum solids and pure milk fat the necessary butter fat in this case.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
Pure milk fat	12.0	12	..	..	12.0
Skim-milk powder	10.5	..	10	..	10.0
Sugar	12.0	..	..	12	12.0
Gelatin	.5	..	..	..	.5
Water	65.0	..	..	..	....
	100.0	12	10	12	34.5

Skim-milk powder on the average consists of 95 per cent serum solids (total solids) and is so calculated. The amount necessary to supply 10 pounds of serum solids is then $\frac{10}{95} \times 100 = 10.5$ pounds. Enough water is added to bring the total mix up to 100 pounds.

Case No. 2.

In this case unsalted butter is substituted for pure milk fat.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
Unsalted butter (84 per cent fat)	14.3	12	..	..	12.0
Skim-milk powder	10.5	..	10	..	10.0
Sugar	12.0	..	..	12	12.0
Gelatin	.5	..	..	..	.5
Water	62.7	..	..	..	....
	100.0	12	10	12	34.5

In this formula it will be noted that but one ingredient is different from the preceding (Case No. 1); that is, the butter-fat carrier. Unsalted butter contains moisture and curd in addition to the butter

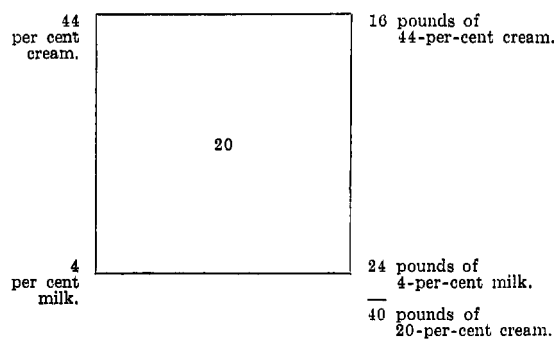
fat. The curd averages about 1 per cent. The butter must be tested for moisture. In this case the moisture is assumed to amount to 15 per cent. This makes 16 per cent to be subtracted, leaving 84 per cent of the unsalted butter as butter fat.

The butter required to furnish the desired 12 pounds of fat is then $\frac{12}{84} \times 100 = 14.3$ pounds. Water is then added to bring the total to 100 pounds.

THE PEARSON SQUARE METHOD OF STANDARDIZATION.

This method can best be explained by a simple example. Suppose one wishes to mix 44-per-cent cream and 4-per-cent milk in such proportions as to make 100 pounds of 20-per-cent cream.

First draw a square and place inside the square the desired per cent—in this case 20. At the upper left-hand corner of the square place the test of the cream on hand—in this case 44. At the lower left-hand corner place the test of



the milk—in this case 4 per cent. Now subtract diagonally 20 from 44 and place the result 24 in the lower right-hand corner. Similarly 4 from 20 leaves 16. This figure is placed in the upper right-hand corner. Adding 24 pounds and 16 pounds gives 40 pounds of 20-per-cent cream.

Suppose, however, that in place of 40 pounds one wants 100 pounds of 20-per-cent cream. This may be obtained by means of a simple proportion.

$$100 : 40 :: x : 16 \quad \text{or} \quad 40 : 16 :: 100 : x$$

$$40x = 100 \times 16 = 1600$$

$$x = \frac{1,600}{40} = 40 \text{ pounds of 44-per-cent cream}$$

$$100 - 40 = 60 \text{ pounds of 4-per-cent milk}$$

Therefore, 40 pounds of 44-per-cent cream and 60 pounds of 4-per-cent milk will make 100 pounds of 20-per-cent cream.

Case No. 3.

Fresh skim milk is used in this formula in place of the water and part of the skim-milk powder, some of the latter still being retained to bring the serum solids to the desired 10 per cent.

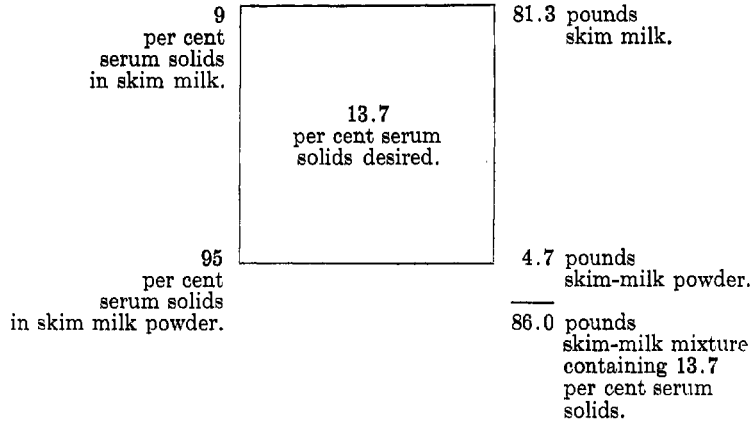
Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
Unsalted butter	14.3	12	....	..	12.00
Fresh skim milk	69.2	..	6.22	..	6.22
Skim-milk powder	4.0	..	3.80	..	3.80
Sugar	12.0	..	....	12	12.00
Gelatin	.5	..	....	..	.50
	100.0	12	10.02	12	34.52

Referring to Case No. 2 we find:

Skim-milk powder	10.5 pounds
Water	62.7 pounds
Total	73.2 pounds

That is, 73.2 pounds of skim milk or serum solids mixture are required to supply 10 pounds of serum solids. In order to determine the amounts of fresh skim milk and skim-milk powder for our new mixture it is necessary to know what per cent 10 pounds is of 73.2 pounds. Or $\frac{10}{73.2} \times 100 = 13.7$ per cent serum solids.

By the Pearson Square Method of Standardization we can obtain the desired parts of fresh skim milk and skim-milk powder necessary to make 73.2 pounds of skim mixture containing 13.7 per cent of 10 pounds of serum solids.



The desired proportion then is:

Mixture from square.		Mixture desired.		Skim-milk powder from square.		Skim-milk powder desired.
86 pounds	:	73.2 pounds	::	4.7 pounds	:	x

$$86x = 73.2 \times 4.7 = 344.04$$

$$x = \frac{344.04}{86} \text{ or 4 pounds skim-milk powder}$$

Subtracting 4 pounds of skim-milk powder from 73.2 pounds leaves 69.2 pounds fresh skim milk.

The results agree with those shown in Case No. 3 and hence prove the calculation.

Case No. 4.

In this case whole milk testing 4 per cent fat is substituted for the skim milk and part of the unsalted butter. The calculation will be similar with milk of any other fat percentage. Since the whole milk will carry practically the same amount of serum solids as the skim milk no calculation is necessary for serum solids except to prove the correctness of the formula.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
Unsalted butter	10.85	9.15	....	....	9.15
Whole milk (4 per cent fat)	72.65	2.90	6.27	....	9.17
Skim-milk powder	4.00	....	3.80	....	3.80
Sugar	12.00	....	....	12	12.00
Gelatin	.50	....	....	....	.50
	100.00	12.05	10.07	12	34.62

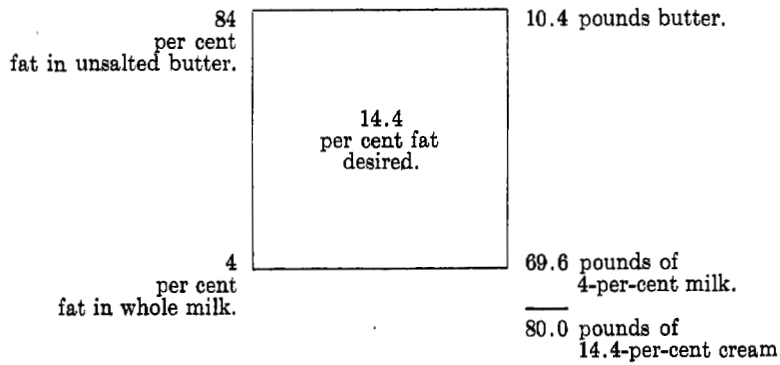
Referring to Case No. 3 we find:

Unsalted butter	14.3 pounds
Skim milk	69.2 pounds
Total	83.5 pounds

That is, we have a total of 83.5 pounds of butter fat mixture or cream containing 12 pounds of butter fat. In order to standardize our new mixture of unsalted butter and 4-per-cent milk it is necessary to know what per cent 12 pounds is of 83.5 pounds. Or

$$\frac{12}{83.5} \times 100 = \text{approximately } 14.4 \text{ per cent fat.}$$

Again by the Pearson Square Method of Standardization we can obtain the desired parts of unsalted butter and 4-per-cent milk to make 83.5 pounds of cream containing 14.4 per cent or 12 pounds of butter fat, thus:



Our proportion then is:

$$80 : 83.5 :: 10.4 : x$$

$$80x = 83.5 \times 10.4 = 868.40$$

$$x = \frac{868.40}{80} \text{ or } 10.85 \text{ pounds}$$

This is the required amount of butter. Subtracting 10.85 pounds from 83.5 pounds of cream leaves 72.65 pounds of 4-per-cent milk. The results, as shown in Case No. 4, prove the calculation to be correct.

In calculating the pounds of serum solids in whole milk or cream of any fat content, if the fat is subtracted from the total milk, the balance may be figured as skim milk containing 9 per cent serum solids.

Example:

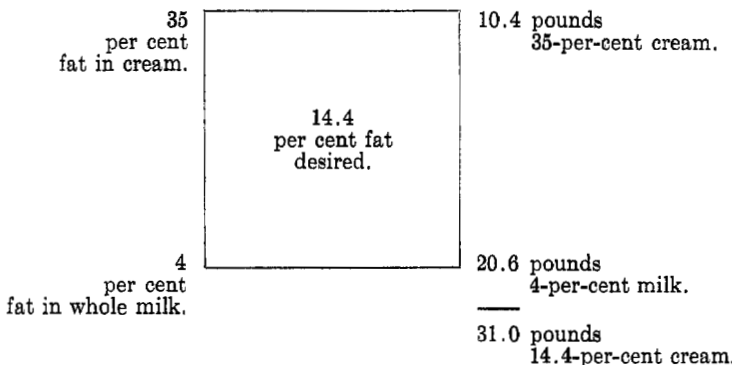
4 per cent of 72.65 = 2.90 pounds fat
72.65 — 2.90 = 69.75 pounds skim milk
9 per cent of 69.75 = 6.27 pounds serum solids

Case No. 5.

In this case cream testing 35 per cent is substituted for the unsalted butter and a part of the 4-per-cent milk. The calculation will be similar with cream or milk of any other fat per cent. Since the cream will carry practically the same amount of serum solids as we have in Case No. 4, no calculation is necessary for serum solids except to prove the correctness of the formula.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
35-per-cent cream	28.0	9.80	1.64	....	11.44
4-per-cent milk	55.5	2.22	4.79	....	7.01
Skim-milk powder	4.0	....	3.80	....	3.80
Sugar	12.0	....	....	12	12.00
Gelatin	.5	....	....	....	.50
	100.0	12.02	10.23	12	34.75

Referring to Case No. 4 we find that 83.5 pounds of 14.4-per-cent cream is required. Then by the square method of standardization we have:



Our proportion then is:

$$83.5 : 31 :: x : 10.4$$

$$31x = 83.5 \times 10.4 = 868.40$$

$$x = \frac{868.40}{31} \text{ or } 28 \text{ pounds of 35-per-cent cream}$$

Subtracting 28 pounds of 35-per-cent cream from 83.5 pounds of 14.4-per-cent cream leaves 55.5 pounds of 4-per-cent milk. The results, as shown in the formula, prove the calculation to be correct.

Case No. 6.

Plain condensed skim milk furnishes a part of the serum solids in this case, replacing the skim-milk powder and a part of the milk.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
20.6-per-cent cream	58.3	12	4.16	....	16.16
Plain condensed skim	29.2	....	5.84	....	5.84
Sugar	12.0	....	....	12	12.00
Gelatin	.5	....	....	....	.50
	100.0	12	10.00	12	34.50

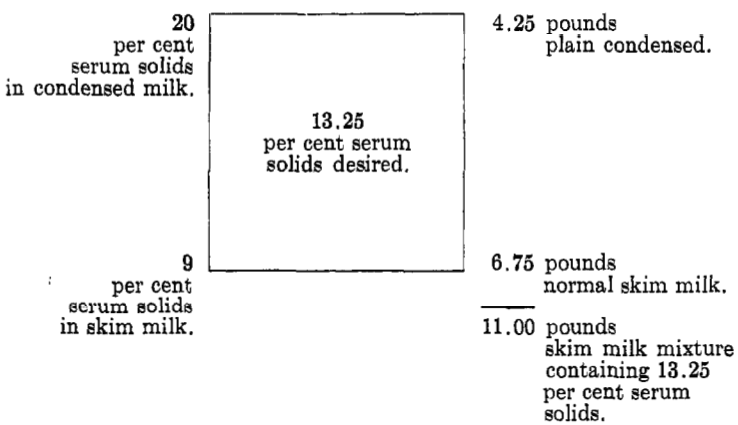
Referring again to Case No. 1 we find that there is required:

Water ..... 65.0 pounds
Skim-milk powder.... 10.5 pounds

Total ..... 75.5 pounds of skim-milk mixture

This is the amount necessary to contain 10 pounds of serum solids. In order to standardize the new mixture of plain condensed skim milk and normal skim milk for serum solids it is necessary to know what per cent 10 pounds is of 75.5 pounds. Or $\frac{10}{75.5} \times 100 = 13.25$ per cent serum solids.

Then by means of Pearson's square and assuming plain condensed skim milk to contain 20 per cent serum solids, we have:



Our proportion then is:

$$75.5 : 11 :: x : 4.25$$
$$11x = 75.5 \times 4.25 = 320.875$$
$$x = \frac{320.875}{11} = 29.2 \text{ pounds of condensed skim milk}$$

Subtracting 29.2 pounds from 75.5 pounds leaves 46.3 pounds of skim milk.

Now since this formula is to be made with cream, 12 pounds of butter fat must be added to the 46.3 pounds of skim milk which will give 58.3 pounds of cream testing $\frac{12}{58.3} \times 100 = 20.6$ per cent butter fat. Cream testing 20.6 per cent can then be standardized by the square method.

Case No. 7.

In Case No. 7 sweetened condensed skim milk furnishes a part of the serum solids and a part of the sugar.

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
35-per-cent cream	34.30	12	2.007	....	14.007
Skim milk	44.68	....	4.026	....	4.026
Sweetened condensed ..	14.20	....	3.970	5.68	9.650
Sugar	6.32	....	.....	6.32	6.320
Gelatin	.50	....	.....	....	.500
	100.00	12	10.003	12.00	34.503

Sweetened condensed skim milk is taken as containing 28 per cent serum solids and 40 per cent cane sugar. It is impossible to make a simple calculation of this mix except by means of higher mathematics (algebra) since we have too many unknowns for ordinary arithmetic. The above formula was calculated in that manner but the method is obviously not given here. It is suggested that for practical purposes the worker use the trial mix system which though cumbersome is the only one which a student lacking a knowledge of algebra can use.

A good general rule to follow in the making of a formula containing sweetened condensed skim milk is as follows: If it is desired that the mix contain 12 percent of sugar, use 15 pounds of condensed milk, while if 14 per cent of sugar is desired as much as 20 pounds of condensed milk may be used.

Suppose in the present case 15 pounds of sweetened condensed skim milk be used. This would contain 40 per cent of 15 pounds or 6 pounds of sugar and 28 per cent of 15 pounds or 4.21 pounds of serum solids. Since the mix must contain 12 per cent of sugar and 10 per cent serum solids it is necessary to add 6 pounds more of sugar and 5.8 pounds of serum solids, which must come from the sweet milk and cream.

Our formula now stands:

Sweetened condensed skim milk.....	15.0 pounds
Sugar	6.0 pounds
Gelatin	.5 pounds
Total	21.5 pounds

Subtracting 21.5 pounds from 100 pounds leaves 78.5 pounds to be supplied as cream containing 12 pounds of butter fat.

The necessary cream would test $\frac{12}{78.5} \times 100 = 15.3$ per cent, or, say 15.5 per cent for convenience. The cream can be made up in the usual way by the method heretofore given.

Subtracting 12 pounds from 78.5 pounds leaves 65.5 pounds. Nine per cent of 65.5 pounds = 5.98 pounds of serum solids which result appears to be satisfactory. The formula then is as follows:

Ingredients.	Pounds per 100.	Per cent fat.	Per cent serum solids.	Per cent sugar.	Per cent total solids.
15.3-per-cent cream	78.5	12	5.98	....	17.98
Sweetened condensed skim,	15.0	....	4.20	6	10.20
Sugar	6.0	....	....	6	6.00
Gelatin	.5	....	....	....	.50
	100.0	12	10.18	12	34.68

Having adopted a formula and standardized according to the ingredients on hands one can make up any quantity of mix simply by multiplying all weights by the following factor:

$$\frac{\text{Pounds of mix desired}}{100} = \text{Factor}$$

For example, $\frac{\text{1,200 pounds of mix desired}}{100} = 12$

Pasteurize the entire mix at 145° to 150° F. and emulsify, viscolize, or homogenize hot, cooling preferably over a cooler down to 35° or 40° F. Age for 24 to 48 hours in order to restore the viscosity before freezing.

APPLICATION.

After having acquired a perfect understanding of the detailed process of standardization as given in this circular it is possible for the maker to adopt short cuts, an example of which is given below:

Suppose that 2,000 pounds of mix is desired with the composition shown in the basic formula.

Multiply by the factor, which in this case would be 20, the necessary ingredients are found to be:

$20 \times 12 = 240$ pounds of butter fat
$20 \times 10 = 200$ pounds of serum solids
$20 \times 12 = 240$ pounds of sugar
$20 \times 0.5 = 10$ pounds of gelatin.

After the morning's sweet cream deliveries are received it is found that there are 500 pounds of cream on hand in small lots of varying fat content. The easiest method of handling odd lots of cream is to dump it all in the mixing vat and mix thoroughly. A sample can

then be taken and tested for fat. Suppose in this case the cream test is 33 per cent and that there are 602 pounds of skim milk on hand. By calculation it is found that if the skim milk is added to the cream the result will be 1,102 pounds of 14.9-per-cent cream.

Thus: 33 per cent of 500 pounds = 165 pounds of fat
500 pounds plus 602 pounds = 1,102 pounds of cream

$$\frac{165}{1{,}102} \times 100 = 14.9\text{-per cent cream.}$$

It is assumed that there is plenty of unsalted butter (84 per cent butter fat) and skim-milk powder on hand. Of 14.9-per-cent cream, 1,102 pounds contains 165 pounds of fat. The proposed mix requires 240 pounds of fat. Or, 240 pounds minus 165 pounds = 75 pounds of fat to be supplied by unsalted butter. Since the unsalted butter contains only 84 per cent of butter fat, $\frac{75}{84} \times 100 = 89.5$ pounds of butter will be required.

The next step is to determine the pounds of serum solids in the cream.

Or, 1,102 — 165 = 937 pounds
9 per cent of 937 pounds = 84.33 pounds of serum solids
200 pounds of serum solids is required
200 pounds — 84.33 pounds = 115.67 pounds of serum solids to be supplied by the addition of skim-milk powder containing 95 per cent serum solids

Or, $\frac{115.67}{95} \times 100 = 127.5$ pounds of skim-milk powder

Set down the figures obtained in a table as shown in Case No. 9. Add the sugar and gelatin and total the columns. It is found that the mix weighs 1,569 pounds. Therefore, the balance of the 2,000 pounds or 431 pounds must be made up with water.

Ingredients.	Pounds.	Pounds fat.	Pounds serum solids.	Pounds sugar.	Pounds total solids.
14.9-per-cent cream ...	1,102.0	165	84.33	....	249.33
Unsalted butter (84 per cent fat).....	89.5	75	....	....	75.00
Skim-milk powder	127.5	....	115.67	....	115.67
Sugar	240.0	....	....	240	240.00
Gelatin	10.0	....	....	....	10.00
	1,569.0	240	200.00	240	690.00
Water	431.0				
Total	2,000.0				

This 2,000 pounds of mix contains: 12 per cent butter fat; 10 per cent serum solids; 12 per cent sugar; one-half of 1 per cent gelatin; and 34.5 per cent total solids.

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