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Testing Ice Cream for Butterfat

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Butterfat is usually the most expensive ingredient of ice cream; hence, great care is necessary in controlling its use. The manufacturer of ice cream, whether doing a large or a small volume of business, must manufacture a product that will comply with the established fat standard. Some means of determining the percentage of butterfat in the product must be available in order to establish this control. The manufacturer with a large volume of business has available for this work a well-equipped laboratory containing elaborate equipment for making accurate fat tests. Since the purchase of such equipment involves considerable expense, the manufacturer with a small volume is not usually so fortunate as to own it. Babcock testing equipment is owned or can be procured by any plant regardless of size, and the cost of such equipment is negligible. The Babcock test as specified for the determination of butterfat in milk and cream is not suitable for testing ice cream for fat because of the sugar and stabilizer contained in it. Because the Babcock test is not satisfactory and because many modifications of the procedure have appeared, the author has made a critical study of these procedures and has found in most cases that the results were unsatisfactory, frequently due to charred dark-colored, or curdy light-colored, fat columns. Studies were then planned to find which of these reported procedures was most satisfactory for the determination of the percentage of fat in ice cream, using results as obtained by the Mojonnier procedure² as the standard.

CLASSIFICATION OF VARIOUS PROPOSED MODIFIED BABCOCK PROCEDURES WITH COMMENTS BASED ON EXTENSIVE TRIALS WITH THEM

In reviewing the literature on this subject, it seems desirable to classify the tests reported according to the reagents used. In most cases numerous modifications regarding the quantity and method of adding reagents are advocated for each procedure. The author has critically studied these procedures and their modifications, respectively. The results and conclusions as herewith reported are based upon more than a thousand individual tests. A classification of these tests and

¹ The author is indebted to Dr. M. J. Blish for many helpful suggestions in working out the problems confronted in this work and to Professor H. P. Davis for assistance in the preparation of the manuscript.

² The Roese-Gottlieb method of fat analysis is the official method as recognized by the Association of Official Agricultural Chemists. The Mojonnier procedure is a method of recognized accuracy and based on the same principles as the official method, but the use of electrically heated hot plates, vacuum oven, and centrifuge is incorporated to shorten the time required for the test.

the author's experience with their use may be briefly indicated as follows:

METHOD I.—Reagents: Glacial Acetic Acid and Hydrochloric Acid (1, 5, 6, 10, 11, 12, 25, 27).³

Five modifications of a procedure involving the use of these reagents were studied. These included the use of a mixture of these two acids varying from 12 to 15 c.c. to "fill the bottle almost to the neck with a mixture of the acids."

When using the modifications as suggested, results on the same sample varied as much as 2.0 per cent of fat. Most of the tests with these reagents contained either curd or charred material in the fat column of the finished test and in many cases this material made the tests practically unreadable. Variations in the length of time heated in the water bath, as well as in amounts of reagents used, failed to give satisfactory results.

METHOD II.—Reagents: Glacial Acetic Acid and Sulfuric Acid (2, 3, 4, 6, 10, 11, 12, 15, 16, 19, 20, 21, 22, 25, 26, 27).

The use of these reagents appears to be especially popular, for sixteen modifications involving their use have been reported. Procedures included almost every conceivable variation in the amounts of the two reagents, in the method of adding reagents, and in the treatment of the sample.

This method in all of its modifications failed to give entirely satisfactory results, from the standpoint of either clearness of fat column or accuracy of results. The results were greatly improved in both clearness of fat column and accuracy when 10 c.c. of water at a temperature of 180° F. was added to the test before centrifuging, altho this practice was not suggested in the published procedures. This was one of the methods by which accurate results were obtained with a selected group of samples.

The use of these reagents according to recommended procedures gave results within reasonable agreement with the Mojonnier results. The ice cream mix used was composed of sweet cream, condensed skim milk, skim milk, sugar, and gelatin and was calculated to contain 14.0 per cent butterfat, 13.0 per cent sugar, 10.0 per cent milk solids not fat, and 0.25 per cent gelatin. Incorporating what appeared to be the good points of each modification as well as those factors found desirable from experience in using these reagents, the following standard method of procedure was outlined.

³ Numbers refer to references given at end of bulletin. Each reference explains a method slightly different from any other.

The procedure was: Weigh 9 grams of the well-mixed sample into a 10-per cent, 18-gram Babcock milk test bottle. Add 10 c.c. glacial acetic acid and thoroly mix the contents of the bottle. Add 9 c.c. sulfuric acid (specific gravity 1.825) and again thoroly mix the contents. On standing, the content of the bottle changes from reddish brown to dark brown, or almost black in color. This darkening commences at the bottom and proceeds upward. Shake the bottle at frequent intervals during this period and when the entire contents have darkened in color add 10 c.c. of water at a temperature of 180° F. Mix the contents of the bottle and centrifuge at the regular speed for 5 minutes. Add water at a temperature of 180° F. until the fat column is raised to within $\frac{1}{2}$ to $\frac{1}{4}$ inch of the base of the neck. Mix the contents of the bottle and centrifuge at the regular speed for 5 minutes, and then add water at a temperature of 180° F. until the entire fat column is raised into the neck and centrifuge for 1 minute. Measure the fat column as in the Babcock milk test after the bottles have been in a water bath at a temperature of 135° to 140° F. for 5 minutes. The reading is multiplied by two to give the percentage of fat in the ice cream tested.

Results by this procedure did not prove accurate with a group of samples of varying composition.

TABLE 1.—*Sulfuric and acetic acid compared with Mojonnier*

Sample number	Flavor	Mojonnier	Sulfuric and glacial acetic acids	Variation from Mojonnier
		<i>Av. per cent</i>	<i>Av. per cent</i>	<i>Per cent</i>
1	Vanilla.....	12.60	13.20	+ .62
2	Vanilla.....	11.32	11.70	+ .38
3	Vanilla.....	13.39	15.10	+1.71
4	Vanilla.....	15.22	15.65	+ .43
5	Vanilla.....	9.41	9.85	+ .44
6	Vanilla.....	10.08	10.55	+ .47

METHOD III.—Reagents: Sulfuric Acid and Ammonium Sulfate (23).

Only one procedure was found in which a dilute solution of sulfuric acid was saturated with ammonium sulfate; and this, when added to the ice cream in the test bottle and centrifuged, caused the curd to collect in one lump. The whey was poured off, and after water was added, the test was completed as in testing cream.

With this method of procedure, it was impossible to get a test without curd or charred material below the fat column, and the results in each case were from 0.2 to 0.4 per cent low.

Possibly some of the fat was poured off with the whey, or the curd or charred material below the fat column may have contained a small amount of fat.

METHOD IV.—Reagents: Hydrochloric Acid and Sulfuric Acid (10).

A single method of procedure was suggested in which 15 c.c. of concentrated hydrochloric acid and 8 c.c. of concentrated sulfuric acid were used.

The use of the recommended procedure produced results in which there was so much charred material in the fat column that the results were rendered inaccurate. Using less than the prescribed amount of sulfuric acid did not remedy the condition.

METHOD V.—Reagents: Sulfuric Acid with Normal Butyl Alcohol, Amyl Alcohol, or Ethyl Alcohol (95 per cent) (3, 6, 7, 8, 9, 10, 11, 17, 18, 20, 22, 24).

The main variations were in the kind of alcohol used and include the use of normal butyl alcohol with two modifications, the use of amyl alcohol, and the use of ethyl alcohol.

When normal butyl alcohol was used the fat column was very clear and satisfactory in appearance, but a comparison of the results with Mojonnier results on eleven samples indicated that the normal butyl alcohol results were from 1.1 to 4.1 per cent too high. In only one of the eleven samples were the results lower than the Mojonnier results. The use of amyl alcohol in place of the normal butyl alcohol produced approximately the same results with high readings.

The use of ethyl alcohol (95 per cent) produced a fat column which in all cases was slightly charred and with results that were usually too high. The addition of water at a temperature of 180° F. before the first centrifuging improved results, altho this procedure was not suggested in the references.

Since the use of these two reagents when testing ice cream of the composition outlined under Method II produced results agreeing favorably with the percentage of fat as obtained with the Mojonnier procedure, a method of procedure was outlined incorporating the good features of the modifications studied as well as those factors found by experience to be desirable.

The method as outlined is as follows: Weigh 9 grams of the well-mixed sample into a 10-per cent, 18-gram Babcock milk test bottle. Add 10 c.c. of ethyl alcohol (95 per cent) and mix the contents of the bottle thoroly. Add 9 c.c. of sulfuric acid (specific gravity 1.825) and again thoroly mix

the contents. After a few minutes the color changes to dark brown, or almost black, at which time 10 c.c. of water at a temperature of 180° F. is added and the contents are again mixed. Centrifuge the tests at the regular speed for 5 minutes. Add water at a temperature of 180° F. until the fat is raised to within $\frac{1}{2}$ to $\frac{1}{4}$ inch of the base of the neck of the bottle and mix the contents and centrifuge for 3 minutes. Add water at a temperature of 180° F. until the fat is entirely raised into the neck and centrifuge for 1 minute. Measure the fat column as in the Babcock milk test after the bottles have been in a water bath for 5 minutes at a temperature of 135° to 140° F. The reading is multiplied by two to give the percentage of fat in the ice cream tested.

Results by this procedure did not prove accurate with a group of samples of varying composition.

TABLE 2.—*Sulfuric acid and ethyl alcohol compared with Mojonnier*

Sample number	Flavor	Mojonnier	Sulfuric acid and ethyl alcohol	Variation from Mojonnier
		<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
1	Vanilla.....	12.60	12.85	+ .25
2	Vanilla.....	11.32	11.65	+ .33
3	Vanilla.....	13.39	15.15	+1.76
4	Vanilla.....	15.22	15.70	+ .48
5	Vanilla.....	9.41	9.90	+ .49
6	Vanilla.....	10.08	10.55	+ .47

METHOD VI.—Reagents: Glacial Acetic Acid, Sulfuric Acid, and Nitric Acid (6, 13, 14, 22).

In the four variations of the procedure involving the use of these reagents the glacial acetic acid and sulfuric acid were added separately, or in combination; the nitric acid was added a few drops at a time, or in a mixture with the other acids.

Many of the tests with these reagents were clear, but bubbles arising thru the fat column interfered with the reading to such an extent as to make accurate reading impossible.

METHOD VII.—Reagent: Sulfuric Acid (1, 5, 11, 12, 27).

Three variations were found regarding the amount of sulfuric acid to be used and the method of adding the acid.

No amount, strength, or method of adding sulfuric acid alone proved satisfactory in producing a fat column that did not contain a large amount of either charred material or undissolved curd.

METHOD VIII.—Reagents: Sulfuric Acid, Nitric Acid, and Formaldehyde.⁴

The procedure consisted in using a 4.5-gram sample to which was added 1 c.c. of concentrated nitric acid and the mixture heated to boiling. To this was added 4 c.c. of sulfuric acid and a small amount of formaldehyde, after which the fat column was raised into the neck of the bottle with a mixture of equal parts of sulfuric acid and water.

In the hands of an expert this test might be operated with considerable accuracy, but as conducted by the ordinary operator, the material will probably boil out of the bottle. It has the further disadvantage of liberating nitric acid fumes that are very irritating.

METHOD IX.—Reagents: Sulfuric Acid and Ethyl Ether.⁵

A procedure was tried in which ether was added to the sample, followed by the addition of sulfuric acid.

This test was found unsatisfactory because of the excessive heat which caused the material to boil out of the bottle when the sulfuric acid was mixed with the ether.

DISCUSSION OF RESULTS OBTAINED WHEN USING MODIFIED BABCOCK TEST PROCEDURES

In many cases, the outlines of procedure given for the operation of the tests were meagre and lacking in essential details so that it was necessary to make several tests before a definite procedure giving even fairly satisfactory results could be established. All of the above tests were tried following the exact procedure as reported and were compared with results obtained with the Mojonnier used as a standard. If the test in its original form did not give satisfactory results, modifications were made endeavoring to overcome some objectionable features.

The factors considered in judging the merits of a test were in main as follows. First—clearness of fat column. A fat column that contained char (black material), curd (light-colored, undissolved material), or other foreign matter was not considered satisfactory because of the elements of uncertainty involved when reading such a test. Often this foreign material was below the fat column when the test was first removed from the centrifuge, but became incorporated with the fat column when the test was placed in the water bath before reading. Second—consistency and accuracy of results. It was considered that duplicate tests should check with each other to within 0.1 per cent, and that the average of the duplicates should check within 0.2 per cent of the average Mojonnier results. Where the recommended pro-

⁴O. Osborne was at the time that he suggested this test the chemist for the Colorado State Dairy Commission. Nothing has heretofore been published on it.

⁵While studying the literature the author decided to try these reagents.

cedure required a 9-gram, 50-per cent cream test bottle, the test was either discarded or a 10-per cent, 18-gram milk test bottle was substituted. Since the smallest graduation on the cream bottle is only 0.5 per cent this would not permit making a reading of value to the ice cream manufacturer. In order to be satisfactory, the test must also give equally reliable results with all samples, regardless of composition or flavor. Third—simplicity, rapidity of procedure, and availability of reagents. The first two factors were given the most weight.

DESCRIPTION OF THE NEBRASKA TEST

EXPERIMENTAL PROCEDURES

After these studies were completed without finding a satisfactory modification of the Babcock test procedure, efforts were made to devise a test that would give satisfactory results with all ice cream samples. It had been observed that the use of normal butyl alcohol with commercial sulfuric acid in a test produced a clear fat column, but the results were too high in practically all cases. They were not proportionately high; hence, a correction factor could not be used. After making more than two thousand tests, using various reagents singly and in combination, the following method of procedure was formulated which overcame the objection to the use of normal butyl alcohol as previously described.

Reagents used in this test are designated for convenience as A and B. Reagent A is a mixture of normal butyl alcohol and concentrated ammonium hydroxide, made up as follows: 9 parts of normal butyl alcohol and 1 part of C. P. (chemically pure) ammonium hydroxide by volume. A convenient quantity may be made by mixing 90 c.c. of normal butyl alcohol and 10 c.c. of ammonium hydroxide. This reagent is stable when kept in a tightly stoppered bottle. Reagent B is a mixture of equal parts by volume of sulfuric acid (specific gravity 1.82 to 1.83) and ethyl alcohol (95 per cent). This mixture is prepared by pouring the acid slowly into the alcohol in a glass beaker or other glass container that will withstand high temperature. The mixture will become extremely hot, and will boil, but no trouble need be experienced in preparing it if the acid *is poured carefully down the side of the beaker*, where it will run under the alcohol. After all the acid has been added, or during its addition, the mixture should be stirred with a glass rod and finally cooled to room temperature before using. Such a mixture of ethyl alcohol (95 per cent) and sulfuric acid, even after being kept as long as eight weeks in a tightly stoppered bottle, has produced satisfactory results.

In case ethyl alcohol (95 per cent) can not be procured, specially denatured alcohol (Formula Number 30)⁶ can be substituted and in the work herein reported has given as satisfactory results as ethyl alcohol (95 per cent). When the mixture of specially denatured alcohol and sulfuric acid becomes light brown in color, it should be discarded and a new supply made. This brown coloration may occur in two or three days in a warm room. If possible, it would be well to make this mixture fresh as used.

OPERATION OF THE TEST

Preparation of the sample.—Frozen ice cream should be melted in a closed jar at a temperature below 80° F. to prevent melting the fat. The sample of ice cream mix or the melted ice cream should be mixed thoroly by pouring from one vessel to another. Care should be taken not to churn the fat in the sample. It is especially easy to churn the fat in samples of melted ice cream. Fruit or nut ice cream should be strained to remove the coarser pieces of these products.

Weighing the sample.—By means of the ordinary Torsion Cream Test Balance, weigh 9 grams of ice cream mix, or melted ice cream, into a 10-per cent, 18-gram milk test bottle.⁷

Addition of reagents.—Add 5 c.c. of reagent A. Mix the contents of the bottle thoroly by shaking. Add 30 c.c. of reagent B (cooled to room temperature before using). A small variation in the amount of this reagent apparently does not affect the test. Consequently, if the capacity of the base of the bottle is small, 28 or 29 c.c. may be used to prevent the mixture from rising into the neck of the bottle while heating, which makes it difficult to mix the contents of the bottle. If possible, bottles that will hold the regulation 30 c.c. should be selected and retained for this test. After adding reagent B, again mix the contents of the bottle thoroly by shaking and continue mixing until the curd is all dissolved. The contents of the bottle should become clear and free from curd, but will not become dark until heated in the water bath.

⁶ Appendix to Regulations No. 3 (formerly 61) of the Treasury Department, Bureau of Prohibition, entitled "Formulae for Completely and Specially Denatured Alcohol," revised February, 1928, gives the following directions for Formula No. 30. "To every 100 gallons of ethyl alcohol, add ten gallons of pure methyl alcohol of specific gravity of not more than 0.810 at 60° F. The denatured alcohol may be recovered for reuse, provided such recovery is accomplished by simple distillation without the use of oxidizing agents; for example, the common laboratory practice of removing by distillation over caustic soda.

"Authorized for use in artificial musks; celluloid cement; chemical and physical laboratory purposes; dental gold; digestive ferments and similar glandular products (provided they contain no alcohol); fur dyeing; hypodermic tablets; oleo resins; photo dry plates; mercurochrome; vacuum tubes; manufacturing vegetable oils; varnish and white petroleum oils (conditional); mirrors."

This alcohol was obtained from the American Alcohol Corporation at Pekin, Illinois, after obtaining a permit from the Prohibition Administrator at Topeka, Kansas.

⁷ A milk test bottle with a large capacity below the neck is best adapted for this test. The test bottles we have used have been obtained from the Louis F. Nafis Company of Chicago.

Heating the tests.—Place the tests in a water bath at a temperature between 175° and 180° F. and heat for 15 minutes. Shake the contents of the bottles at least three times during this heating period.

Centrifuging and adding water.—Remove from water bath and centrifuge at the regular speed for 5 minutes. Shake contents of bottle thoroly. If the fat column is not up to the neck of the bottle, add water, at a temperature of not less than 180° F., until the fat column is raised to within about $\frac{1}{4}$ inch of the base of the neck. Centrifuge at the regular speed for three minutes. If any curd is apparent in the mixture at this time, shake the contents of the bottle thoroly. Add water at 180° F. until the fat column is raised so that its extremities will be between the 0 and 10 per cent graduations on the neck of the bottle. Centrifuge at the regular speed for 1 minute.

Reading the tests.—Remove from centrifuge and place bottles in a water bath for 5 minutes at a temperature of 135° to 140° F. Add glymol and read the percentage of fat with dividers as in a Babcock cream test. (Measure from bottom of lower meniscus to line between glymol and fat.) Multiply reading by two, to obtain the true percentage of fat in the ice cream sample, since only a 9-gram sample was used in an 18-gram bottle. Duplicate tests should always be made and the reading of these duplicates should check to within 0.1 per cent of each other, making a maximum variation of 0.2 per cent when the reading is doubled. The fat column in the finished tests should be clear and golden yellow in color. A small amount of fluffy brown precipitate may occur below the fat column when testing samples of fruit ice cream. This precipitate has not mixed with the fat in our studies sufficiently to hinder reading the percentage of fat.

EXPERIMENTAL RESULTS

Table 3 gives results obtained in testing ice cream samples by the above procedure. These samples were collected from different manufacturers in Nebraska and neighboring states and represent a wide range in percentage of fat, percentage of solids, and type of stabilizer. This table also shows a comparison between the use of ethyl alcohol (95 per cent) and specially denatured alcohol, Formula Number 30, as compared to the Mojonier results. Each result given is an average of at least two tests. All modified tests were made in a standard 24-bottle steam centrifuge.

TABLE 3.—*Nebraska tests compared with Mojonnier*

Sample number	Flavor	Mojonnier test for butterfat ¹	Modified Babcock tests for butterfat			
			Ethyl alcohol (95%)		Specially denatured alcohol, Formula No. 30 ²	
			Test	Variation from Mojonnier	Test	Variation from Mojonnier
		<i>Av. per cent</i>	<i>Per cent</i>	<i>Av. per cent</i>	<i>Per cent</i>	
1	Vanilla	11.53	11.4	-.13	11.4	-.13
2	Vanilla	15.04	15.0	-.04	15.0	-.04
3	Vanilla	15.82	15.8	-.02	15.6	-.22
4	Vanilla	13.01	13.0	-.01	13.0	-.01
5	Vanilla	14.03	14.0	-.03	14.0	-.03
6	Vanilla	13.44	13.2	-.24	13.2	-.24
7	Vanilla	14.70	14.6 ³	-.10	.....	.....
8	Vanilla	14.54	14.7 ³	+.16	.....	.....
9	Vanilla	13.05	13.0	-.05	13.0	-.05
10	Vanilla	13.54	13.5 ³	-.04	.....	.....
11	Vanilla	13.53	13.4	-.13	13.6	+.07
12	Vanilla	13.93	13.9 ³	-.03	.....	.....
13	Vanilla	14.00	14.0	±.00	14.2	+.20
14	Vanilla	14.56	14.5 ³	-.06	.....	.....
15	Vanilla	14.93	14.8 ³	-.13	.....	.....
16	Vanilla	14.42	14.6	+.18	14.4	-.02
17	Vanilla	14.45	14.6 ³	+.15	.....	.....
18	Vanilla	14.32	14.1 ³	-.22	.....	.....
19	Vanilla	13.45	13.3 ³	-.15	.....	.....
20	Vanilla	13.99	13.8	-.19	.....	.....
21	Vanilla	12.94	12.8	-.14	12.8	-.14
22	Vanilla	13.32	13.2	-.12	13.2	-.12
23	Vanilla	14.13	14.1 ³	-.03	.....	.....
24	Vanilla	12.78	13.0	+.22	12.8	+.02
25	Vanilla	13.05	13.0	-.05	13.0	-.05
26	Vanilla	14.92	15.0	+.08	15.0	+.08
27	Vanilla	12.85	13.0	+.15	12.8	-.05
28	Vanilla	14.89	14.8	-.09	14.8	-.09
29	Vanilla	12.98	13.0	+.02	13.0	+.02
30	Vanilla	13.75	14.0	+.25	13.8	+.05
31	Chocolate	13.66	13.8	+.14	13.8	+.14
32	Chocolate	13.65	13.8 ³	+.15	.....	.....
33	Chocolate	13.38	13.3	-.08	13.3	-.08
34	Chocolate	14.19	14.4 ³	+.21	.....	.....
35	Chocolate	12.74	12.7 ³	-.04	.....	.....
36	Chocolate	12.68	12.4	-.28	12.4	-.28
37	Chocolate	12.47	12.4	-.07	12.4	-.07
38	Chocolate	12.32	12.2	-.12	12.3	-.02
39	Chocolate	11.11	11.2	+.09	11.2	+.09
40	Chocolate	13.96	13.8 ³	-.16	.....	.....
41	Chocolate	12.59	12.4	-.19	12.5	-.09
42	Chocolate	13.51	13.6	+.09	13.6	+.09
43	Chocolate	13.40	13.3 ³	-.10	.....	.....
44	Chocolate	13.61	13.6	-.01	13.6	-.01
45	Chocolate	12.70	12.5 ³	-.20	.....	.....
46	Strawberry	11.64	11.6	-.04	11.6	-.04
47	Chocolate	12.23	12.2 ³	-.03	.....	.....
48	Strawberry	12.17	12.2 ³	+.03	.....	.....
49	Chocolate	12.78	13.0	+.22	12.8	+.02
50	Strawberry	13.35	13.5 ³	+.15	.....	.....
51	Chocolate	11.85	11.9 ³	+.05	.....	.....
52	Strawberry	12.65	12.8 ³	+.15	.....	.....
53	Chocolate	12.30	12.6	+.30	12.4	+.10
54	Chocolate	12.58	12.4	-.18	12.6	+.02
55	Strawberry	13.24	13.6	+.36	13.4	+.16
56	Strawberry	12.09	12.4	+.31	12.2	+.11
57	Chocolate	12.24	12.2	-.04	12.2	-.04
58	Strawberry	11.90	12.1	+.20	12.0	+.10
59	Vanilla	13.95	14.0	+.05	14.0	+.05
60	Chocolate	11.91	12.0	+.09	11.6	-.31
61	Vanilla	13.92	14.4	+.48	14.2	+.28
62	Chocolate	12.24	12.4	+.16	12.1	-.14
63	Strawberry	12.80	13.0	+.20	13.0	+.20
64	Strawberry	12.82	12.8	-.02	12.8	-.02

TABLE 3.—(Continued)

Sample number	Flavor	Mojonnier test for butterfat	Modified Babcock tests for butterfat			
			Ethyl alcohol (95%)		Specially denatured alcohol, Formula No. 30	
			Test	Variation from Mojonnier	Test	Variation from Mojonnier
			Av. per cent	Per cent	Av. per cent	Per cent
65	Chocolate	11.88	11.6	-.28	11.6	-.28
66	Black Walnut	13.74	13.8	+.06	14.0	+.26
67	Vanilla	15.61	15.6	-.01	15.6	-.01
68	Strawberry	13.01	13.2	+.19	13.0	-.01
69	Strawberry	11.56	11.6	+.04	11.6	+.04
70	Chocolate	12.06	12.1	+.04	12.0	-.06
71	Strawberry	11.87	11.8	-.07	11.8	-.07
72	Neapolitan	13.20	13.4	+.20	13.4	+.20
73	Vanilla	13.17	13.0	-.17	13.1	-.07
74	Chocolate	11.54	11.4	-.14	11.6	+.06
75	Vanilla	13.87	14.0	+.13	13.9	+.03
76	Strawberry	11.18	11.0	-.18	11.2	+.02
77	Strawberry	13.16	13.0	-.16	13.1	-.06
78	Chocolate	13.24	13.0	-.24	13.3	+.06
79	Vanilla	13.49	13.8	+.31	13.6	+.11
80	Vanilla	21.32	21.4 ³	+.08	.....	.....
81	Strawberry	12.60	12.6 ³	+.00	.....	.....
82	Strawberry	12.23	12.4 ³	+.17	12.4	+.17
83	Vanilla	12.76	12.6	-.16	12.6	-.16
84	Chocolate	11.02	10.7	-.32	10.9	-.12
85	Vanilla	13.07	12.9 ³	-.17	.....	.....
86	Vanilla	13.99	14.2	+.21	14.1	+.11
87	Vanilla	16.37	16.6	+.23	16.5	+.13
88	Tutti Frutti	12.66	12.4	-.26	12.4	-.26
89	Chocolate	12.16	12.2	+.04	12.0	-.16
90	Vanilla	13.55	13.6	+.05	13.6	+.05
91	Strawberry	11.02	11.0	-.02	10.8	-.22
92	Vanilla	12.64	12.6	-.04	12.4	+.24
93	Orange	12.84	12.6	-.24	12.6	-.24
94	Strawberry	14.12	14.2	+.08	14.2	+.08
95	Vanilla	12.05	12.0	-.05	11.8	-.25
96	Vanilla	13.59	13.8	+.21	13.8	+.21
97	Vanilla	15.91	16.2	+.29	15.6	-.31
98	Vanilla	14.22	14.4	+.18	14.2	-.02
99	Vanilla	12.99	12.8	-.19	13.0	+.01
100	Vanilla	18.29	18.2	-.09	18.2	-.09
101	Vanilla	10.39	10.4	+.01	10.2	-.19
102	Vanilla	14.19	.....	.....	14.4	+.21
103	Vanilla	14.41	.....	.....	14.4	+.01
104	Vanilla	12.73	.....	.....	12.8	+.07
105	Vanilla	14.01	.....	.....	14.0	-.01
106	Vanilla	14.34	.....	.....	14.4	+.06
107	Vanilla	13.96	.....	.....	14.1	+.14
108	Vanilla	14.54	.....	.....	14.8	+.02
109	Vanilla	14.78	.....	.....	14.8	+.02
110	Vanilla	13.54	.....	.....	13.4	-.14
111	Vanilla	13.85	.....	.....	14.0	+.15
112	Vanilla	13.44	.....	.....	13.2	-.24
113	Vanilla	14.14	.....	.....	14.1	-.04
114	Vanilla	13.04	.....	.....	13.1	+.06
115	Vanilla	14.19	.....	.....	14.2	+.01
116	Vanilla	13.02	.....	.....	13.0	-.02
117	Vanilla	13.53	.....	.....	13.5	-.03
118	Strawberry	12.68	.....	.....	13.0	+.32
119	Vanilla	15.82	.....	.....	15.6	-.22
120	Vanilla	13.95	.....	.....	13.7	-.25
121	Strawberry	12.15	.....	.....	12.2	+.05
122	Strawberry	13.40	.....	.....	13.5	+.10
123	Vanilla	14.60	.....	.....	14.4	-.20
124	Strawberry	11.91	.....	.....	12.0	+.09
125	Vanilla	13.81	.....	.....	13.7	-.11
126	Vanilla	14.33	.....	.....	14.3	-.03
127	Strawberry	12.90	.....	.....	13.0	+.10
128	Vanilla	14.73	.....	.....	14.7	-.03

TABLE 3.—(Concluded)

Sample number	Flavor	Mojonnier test for butterfat	Modified Babcock tests for butterfat			
			Ethyl alcohol (95%)		Specially denatured alcohol, Formula No. 30	
			Test	Variation from Mojonnier	Test	Variation from Mojonnier
		<i>Av. per cent</i>	<i>Av. per cent</i>	<i>Per cent</i>	<i>Av. per cent</i>	<i>Per cent</i>
129	Strawberry	13.35	.....	.....	13.4	+ .05
130	Strawberry	12.55	.....	.....	12.6	+ .05
131	Strawberry	13.81	.....	.....	14.0	+ .19
132	Vanilla	14.58	.....	.....	14.7	+ .12
133	Vanilla	14.43	.....	.....	14.5	+ .07
134	Vanilla	12.76	.....	.....	12.8	+ .04
135	Vanilla	13.72	.....	.....	13.7	— .02
136	Strawberry	11.99	.....	.....	12.1	+ .11
137	Strawberry	12.53	.....	.....	12.7	+ .17
138	Vanilla	13.87	.....	.....	14.1	+ .23
139	Vanilla	13.39	.....	.....	13.1	— .29
140	Strawberry	13.10	.....	.....	13.0	— .10
141	Vanilla	14.40	.....	.....	14.5	+ .10
142	Strawberry	12.45	.....	.....	12.6	+ .15
143	Vanilla	14.28	.....	.....	14.3	+ .02
144	Strawberry	12.60	.....	.....	12.5	— .10

¹Figure given is an average of at least duplicate and sometimes triplicate tests.

²Blank spaces left in the denatured alcohol results column indicate that the sample was lost before this substitution was made.

³Indicates results that were obtained with the regular procedure, except that the tests were heated 20 minutes at 130° F. before centrifuging, rather than 15 minutes. This represented the regular procedure prior to the procedure reported in this bulletin. These samples were lost due to souring, churning, or breaking of sample jar before the length of heating period was shortened. A comparison of results obtained by the 15 and 20 minute heating period, however, showed no variation. The shorter period is advisable because of the time saved.

SUMMARY OF RESULTS

A. When reagent B was composed of ethyl alcohol (95 per cent) and sulfuric acid.

The tabulation below represents results with a total of 101 samples of ice cream of which 50 were vanilla, 29 chocolate, 18 strawberry, and 4 other flavors.

16 samples or 15.84 per cent were 0.01 to 0.1% higher than the Mojonnier
 27 samples or 26.73 per cent were 0.01 to 0.1% lower than the Mojonnier
 45 samples or 44.55 per cent checked within $\pm 0.1\%$ of the Mojonnier
 16 samples or 15.84 per cent were 0.11 to 0.2% higher than the Mojonnier
 19 samples or 18.81 per cent were 0.11 to 0.2% lower than the Mojonnier
 80 samples or 79.20 per cent checked within $\pm 0.2\%$ of the Mojonnier
 9 samples or 8.91 per cent were 0.21 to 0.3% higher than the Mojonnier
 7 samples or 6.93 per cent were 0.21 to 0.3% lower than the Mojonnier
 96 samples or 95.04 per cent checked within $\pm 0.3\%$ of the Mojonnier
 3 samples or 2.97 per cent were 0.31 to 0.4% higher than the Mojonnier
 1 sample or .99 per cent was 0.31 to 0.4% lower than the Mojonnier
 100 samples or 99.00 per cent checked within $\pm 0.4\%$ of the Mojonnier.

The average variation of these results from the percentage of fat as determined by the Mojonnier procedure was ± 0.1337 per cent.

B. When reagent B was composed of specially denatured alcohol (Formula No. 30) and sulfuric acid.

The tabulation below represents results with a total of 119 ice cream samples of which 65 were vanilla, 21 chocolate, 27 strawberry, and 6 other flavors.

35 samples or 29.41 per cent	were 0.01 to 0.1% higher than the Mojonnier
35 samples or 29.41 per cent	were 0.01 to 0.1% lower than the Mojonnier
70 samples or 58.82 per cent	checked within $\pm 0.1\%$ of the Mojonnier
17 samples or 14.28 per cent	were 0.11 to 0.2% higher than the Mojonnier
11 samples or 9.32 per cent	were 0.11 to 0.2% lower than the Mojonnier
98 samples or 82.35 per cent	checked within $\pm 0.2\%$ of the Mojonnier
5 samples or 4.20 per cent	were 0.21 to 0.3% higher than the Mojonnier
13 samples or 10.92 per cent	were 0.21 to 0.3% lower than the Mojonnier
116 samples or 97.48 per cent	checked within $\pm 0.3\%$ of the Mojonnier
1 sample or .84 per cent	was 0.31 to 0.4% higher than the Mojonnier
2 samples or 1.68 per cent	were 0.31 to 0.4% lower than the Mojonnier
119 samples or 100.00 per cent	checked within $\pm 0.4\%$ of the Mojonnier

The average variation of these results from the percentage of fat as determined by the Mojonnier procedure was ± 0.1093 per cent.

Critical studies, trials, and comparisons involving proposed modified Babcock procedures for estimating butterfat in ice cream have indicated that none of the procedures thus far proposed is reliable and satisfactory for all types and flavors of ice cream, when using the approved Mojonnier method as a basis of comparison.

A new modified Babcock procedure is herewith proposed whereby the percentage of butterfat in ice cream may be determined with a degree of accuracy and reliability that should be satisfactory for almost any commercial purpose. The method is convenient, simple, inexpensive, and applicable to ice cream of all types and flavors.

The test is not presented as a replacement of ether extraction methods, but only as a procedure to be used where such methods are not available, or as a test preliminary to such procedure.

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