A COMPARISON OF METHODS OF INCORPORATING DRIED WHOLE EGGS INTO CAKES CONTAINING FAT

by

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TABLE OF CONTENTS

INTRODUCTION

Present world conditions have increased the demand for eggs. The use of dried eggs for human consumption has helped relieve the shortages of fresh eggs. Dried eggs can be used satisfactorily in most products where fresh or frozen eggs are used. At certain times dried eggs would be more economical to use than either of the others. Wider use of dried eggs is forecast but more information regarding their use is needed.

Little work has been done on methods of incorporating the eggs into food. Quick, easy and convenient methods of incorporating the eggs into a product should be of value to all interested in using them.

The present study was undertaken to determine: (a) the effect of different methods of incorporating dried eggs into a cake containing fat, and (b) acceptable methods of incorporating dried eggs into the cake to obtain a standard product.

PROCEDURE

The work was divided into two series. In Series I, the cakes were mixed with a KitchenAid household mixer and in Series II, they were mixed with a Hamilton Beach household mixer.

One hundred twenty cakes were made in each series. Six cakes were baked to be judged at the same time, one being a frozen egg cake used as the control or standard. The methods of incorporating the eggs into the cakes varied, 20 different methods being used. Each method was checked four times in each series.

The ingredients were as nearly identical as possible. Swans Down cake flour; finely granulated sugar; Calumet baking powder; Sweetex, a

"high ratio" shortening; salt; Schilling's vanilla and distilled water were used in all cakes.

Grade A pasteurized whole milk was obtained daily from the College Dairy. Dried and frozen whole eggs were supplied by the Seymour packing Company of Philadelphia through their plant in Topeka, Kansas, and brought to Calvin Hall as needed. The dried eggs were prepared from fresh shell eggs November 8, 1943. They were packed in 15-pound cartons lined with double vapor-moisture-proof cellophane bags and closed with the confectioner's seal. The first carton was brought to the laboratory soon after drying. The remainder were stored in Topeka at -5° F. until needed. When brought to Calvin Hall they were stored at approximately 40° F. A quart carton was filled from the large carton and eggs were used from the smaller one; thus the major portion of the eggs remained in the cold room until ready to weigh.

The frozen eggs were packed in tin cans weighing approximately 390 g and were stored at 0° F. or less. About 48 hours before they were to be used, the cans were placed in the refrigerator to thaw, then removed, stirred thoroughly, weighed, and allowed to stand at room temperature for at least one hour before being combined with the other ingredients.

All work was done in the foods research laboratory in Calvin Hall.

The equipment used included a torsion balance for weighing all ingredients, the foam or creamed mix and the batter; a KitchenAid electric mixer with two bowls of five-quart capacity; a Model C Hamilton Beach electric mixer with two bowls, one of one-quart capacity and one of three-quart capacity; two Centigrade chemical thermometers; three Eastman timers; a small aluminum cup with straight sides in which the foam or creamed mix and the batter were weighed in order that the specific gravity of each could be computed; a funnel for determining consistency of the batter; and aluminum cake

cake pans 7 3/4 inches square and 1 7/8 inches deep for baking the cakes. All cakes were baked in a gas oven equipped with a revolving hearth and an accurate thermostatic heat control. Three Taylor oven thermometers were used to check the oven temperature.

Tests and determinations made for each cake were as follows: the temperatures of the room during mixing and during testing; the time of creaming; the specific gravity and temperature of the creamed mix; the specific gravity and temperature of the batter; consistency of the batter; height of the finished cake; shortness; compressibility; and quality as determined by a palatability committee. One slice from each cake was preserved to be used for final check at the completion of the study.

The specific gravity determinations were made by filling a 57 cc cup, weighing it, and recording the weight in grams. The specific gravity was obtained by dividing the weight of the sample by the weight of an equal volume of water. The specific gravity was computed for both the first creamed mixture and for the finished batter.

Consistency of the batter was determined by putting the sample used in the specific gravity determination into a glass funnel, on the stem of which were two marks two inches apart. The bore of the stem was approximately eight millimeters in diameter. The time necessary for the batter to move from the upper mark to the lower one was recorded as the consistency.

Approximately 20 hours after baking, the cakes were cut. Four uniform slices were cut, using an apparatus similar to a mitre box, made of hardwood, closed at both sides and one end with a kerf on each side one inch from the closed end into which fitted a long knife. The first slice was not used for testing because of the crust on one side.

The height of each cake was determined by measuring in centimeters the fourth slice at the center, at the outer edges, and at points one-half the distance from the center to each edge. The average of the five measurements was recorded as the standing height of the cake.

A gram shortometer, an apparatus consisting of a modified spring balance and a remodeled laboratory balance as described by Kramer (1935) and by Fulks (1936) was used to measure in grams the force necessary to break a slice of cake one inch in thickness. On the weighing pan of the spring balance were two parallel bars three inches apart, used to support the slice of cake to be tested. A third bar, suspended from the right-hand pan of the remodeled laboratory balance was adjusted to apply pressure on the cake at a point midway between the two parallel bars and the dial of the balance turned to zero. On the right-hand pan was placed a 250 cc glass beaker. Water was syphoned into this at a constant rate. The force necessary to break the cake was indicated by two movable hands rotating on the face of the spring balance. Upon breaking, one hand remained stationary for reading the breaking force; the other returned to zero. The three one-inch slices were tested on the shortometer and an average of these readings recorded as shortness of the cake.

After testing for shortness, one-half of each broken slice was used to test for compressibility. The apparatus for this test, similar to that described by Platt and Kratz (1933) and used by Fulks (1936), Miller (1942), and Buck (1943), consisted of a remodeled laboratory balance and an Eastman timer. Beneath the right-hand pan of the balance was fastened a metal plunger 31 mm in diameter. The cake sample was placed on an adjustable platform just below the plunger so that the plunger rested easily upon it. A 10 g weight placed on the pan above held the plunger to the surface of the

cake. The left-hand pan held a linked chain which exactly balanced the 200 g weight on the right-hand pan. A wooden drum extended over the left-hand pan so that the chain could easily be wound from the pan to the drum by means of a handle, thus allowing the weight to act upon the plunger. A pointer suspended from the cross arm of the balance to a scale at the lower part of the balance indicated the millimeters compressed. The average reading for the three samples was recorded as compressibility of the cake.

Two of the broken pieces not used for mechanical tests and five other pieces cut from the remainder of the cake were numbered, wrapped, and given to the palatability committee to score according to Form I (Appendix). The test piece for each committee member was a slice from the same relative position in the cake. The personnel of the palatability committee consisted of five members of the staff of the Department of Food Economics and Nutrition and two graduate students in the department.

One-half of the center slice of each cake was preserved by saturating it with a formaldehyde-glycerin-water solution as suggested by Markley (1934). Each slice was numbered and stored for later comparisons.

All data were recorded according to Form 2 (Appendix).

A basic recipe widely used at Kansas State College was taken for the foundation recipe. Jordan and Sisson (1943) suggested that 13.5 g whole egg powder was equivalent to 48 g liquid egg. Preliminary work on the above mentioned recipe showed that 100 g water with 27 g dried whole eggs could replace two fresh eggs in making a satisfactory cake. However, when frozen eggs were substituted for fresh eggs it was found that an increase of 15.3 g or approximately one tablespoon of milk gave better results. As a result of this, the following basic recipe was worked out:

Ingredients	Weights (g)	Approximate measure
Fat	75	3/8 cup
Sugar	200	1 cup
Cake flour	168	1 3/4 cups
Baking powder	10	2 1/2 teaspoons
Salt	1.5	1/4 teaspoon
Vanilla		1 teaspoon
and		
Frozen whole eggs	96	1/3 cup
Milk	178	2/3 cup, 1 tablespoon
or		
Dried whole eggs	27	6 tablespoons
Water	100	6 2/3 tablespoons
Milk	162.7	2/3 cup

The standard procedure for the experimental work was as follows:

The ingredients, except vanilla, for the six cakes were weighed on a torsion balance before beginning to mix.

The dry ingredients were sifted once before weighing.

All ingredients were used at room temperature unless otherwise stated.

Vanilla was measured and added to the milk.

Room temperature was recorded each time before mixing.

The mixing procedure varied with each method.

The temperature and weight of the foam or the first creamed mix, depending upon method of mixing, were recorded at the designated time.

After completing the mixing, the bowl was removed from the mixer.

The temperature of the batter was recorded.

A 57 cc cup of batter was weighed, recorded, and saved to test for consistency.

The remaining batter was poured into a cake pan lined on the bottom with waxed paper.

The batter was cut with a spatula 12 times in each direction to expel large air bubbles.

The batter was placed in a preheated oven and baked at 365° F. for 43 minutes.

The consistency of the batter was determined and recorded.

After baking, the cake was removed from the oven and cooled three minutes.

A spatula was used to loosen the cake from the sides of pan.

The pan was inverted on a wire rack and the cake allowed to fall from the pan.

Waxed paper which adhered to the bottom of the cake was removed and the cake turned to an upright position.

The cake was cooled on a rack, then placed on a cookie sheet and covered with a larger cake pan until the following morning when tests were made.

METHODS OF MIXING

The methods chosen for each series were as follows:

1. Cake-Mixer Method

Eggs reconstituted in 100 g water at 68° C.

Series I. KitchenAid mixer.

a. Sift baking powder and flour together three times.
Divide into halves.
Add vanilla to milk.
Sift sugar and salt together three times.

b. Beat eggs, high speed, three minutes.

c. Change to medium speed.
Add fat and sugar-salt mixture. Cream two minutes. Scrape.
Continue to cream to desired specific gravity. Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mixture.

d. Change to low speed.
Add one-half flour and baking powder. Mix 30 seconds. Scrape.
Mix one minute. Scrape.
Add one-half milk-vanilla mixture and mix 30 seconds. Scrape.
Add remaining flour and baking powder. Mix 30 seconds. Scrape.
Mix 30 seconds. Scrape. Mix one minute. Scrape.
Add remaining milk. Mix 30 seconds. Scrape.
Mix 30 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.
Beat, high speed, four minutes.

c. Same as Series I except change to large bowl.

d. Same as Series I.

2. Cake-Mixer Method, Variation of 1

Eggs reconstituted in 75 g water at 68° C.; 25 g water added with milk.

Series I. KitchenAid mixer.

Steps same as Method 1 except as indicated.

a. Same as Method 1, Series I.

b. Eggs reconstituted in 75 g water at 68° C.

c. Same as Method 1, Series I.

d. 25 g water added to milk-vanilla mixture.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.
Beat, high speed, four minutes.

c. Same as Series I except change to large bowl.

d. Same as Series I.

3. Cake-Mixer Method

Eggs reconstituted in 100 g water. Water bath 65° to 70° C.

Series I. KitchenAid mixer.

a. Sift baking powder and flour together three times.
Divide into halves.
Add vanilla to milk.
Sift sugar and salt together three times.

b. Beat eggs, high speed, three minutes while using hot-water bath of 65° to 70° C. Water was kept at this temperature by adding hot water as needed and removing the cool by means of a syphon.

c. Remove from hot-water bath.
Change to medium speed.
Add fat and sugar-salt mixture. Cream two minutes.
Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

d. Change to low speed.
Add one-half flour-baking powder mixture. Mix 30 seconds. Scrape.
Mix one minute. Scrape.
Add one-half milk-vanilla mixture and mix 30 seconds. Scrape.
Add remaining flour-baking powder mixture. Mix 30 seconds. Scrape.
Mix 30 seconds. Scrape. Mix one minute. Scrape.
Add remaining milk. Mix 30 seconds. Scrape. Mix 30 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use large bowl for water bath, small bowl for mixing. Beat, high speed, four minutes.

c. Same as Series I except transfer mix to large bowl after removing water bath.

d. Same as Series I.

4. Cake-Mixer Method, Variation of 3

Eggs reconstituted in 75 g water; 25 g water added with milk. Water bath at 65° to 70° C.

Series I. KitchenAid mixer.

Steps same as Method 3 except as indicated.

a. Same as Method 3.

b. Eggs reconstituted in 75 g water.

c. Same as Method 3.

d. 25 g water added to the milk-vanilla mixture.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I.

c. Same as Series I.

d. Same as Series I.

5. Modified Cake-Mixer Method

Eggs sifted with flour and baking powder; 100 g water added with milk, none with creamed mixture.

Series I. KitchenAid mixer.

a. Sift eggs, flour, and baking powder together four times.
Divide into fourths.
Add water and vanilla to milk.
Sift sugar and salt together three times.

b. Cream fat, medium speed, five minutes. Scrape.
Gradually add sugar-salt mixture during next five minutes, approximately one tablespoon every 15 seconds. Scrape.
Cream to desired specific gravity. Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add remaining milk mixture. Mix 30 seconds. Scrape.
Add remaining flour mixture. Mix one minute. Remove bowl. Scrape.
Replace bowl. Mix one minute. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

6. Modified Cake-Mixer Method, Variation of 5

Eggs sifted with flour and baking powder; 75 g water added with milk, 25 g with creamed mixture.

Series I. KitchenAid mixer.

Steps same as Method 5 except as indicated.

a. Add 75 g water to milk-vanilla mixture.

b. After 10 minutes creaming as in Method 5, add 25 g water in two additions, taking 30 seconds. Continue the same.

c. Same as Method 5.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

7. Modified Cake-Mixer Method, Variation of 5

Eggs sifted with flour and baking powder; 50 g water added with milk, 50 g with creamed mixture.

Series I. KitchenAid mixer.

Steps same as Method 5 except as indicated.

a. Add 50 g water to milk-vanilla mixture.

b. After 10 minutes creaming as in Method 5, add 50 g water in four additions, taking one minute. Continue the same.

c. Same as Method 5.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

8. Modified Cake-Mixer Method, Variation of 5

Eggs sifted with flour and baking powder; 25 g water added with milk, 75 g with creamed mixture.

Series I. KitchenAid mixer.

Steps same as Method 5 except as indicated.

a. Add 25 g water to milk-vanilla mixture.

b. After 10 minutes creaming as in Method 5, add 75 g water in five additions, taking 75 seconds. Continue the same.

c. Same as Method 5.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

9. Modified Cake-Mixer Method, Variation of 5

Eggs sifted with flour and baking powder; no water added with milk, 100 g with creamed mixture.

Series I. KitchenAid mixer.

Steps same as Method 5 except as indicated.

a. Add no water to milk-vanilla mixture.

b. After 10 minutes creaming as in Method 5, add 100 g water during the next two and one-half minutes. Continue the same.

c. Same as Method 5.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

10. Modified Cake-Mixer Method

Eggs made into paste with 50 g water; 50 g water added with milk.

Series I. KitchenAid mixer.

a. Sift flour and baking powder together three times.
Divide into fourths.
Sift sugar and salt together three times.
Make paste of eggs and 50 g water.
Add 50 g water and vanilla to milk.

b. Cream fat, sugar, and salt, medium speed, two minutes. Scrape.
Add egg paste and continue creaming to desired specific gravity.
Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add remaining milk mixture. Mix 30 seconds. Scrape.
Add remaining flour mixture. Mix one minute. Remove bowl. Scrape.
Replace bowl. Mix one minute. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl. Scrape sides of bowl with small spatula during first two minutes.

c. Same as Series I except change to large bowl.

11. Modified Cake-Mixer Method

Eggs, sugar, and salt sifted together; 100 g water added with creamed mixture.

Series I. KitchenAid mixer.

a. Sift eggs, sugar, and salt together four times.
Sift flour and baking powder together three times.

b. Cream fat and sugar mixture, medium speed, two minutes. Scrape.
Add 100 g water to creamed mixture during next two and one-half minutes.
Continue creaming to desired specific gravity.
Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add remaining milk mixture. Mix 30 seconds. Scrape.
Add remaining flour mixture. Mix one minute. Remove bowl. Scrape.
Replace bowl. Mix one minute. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

12. Modified Cake-Mixer Method, Variation of 11

Eggs, sugar, and salt sifted together; 75 g water added with creamed mixture, 25 g with milk.

Series I. KitchenAid mixer.

Steps same as Method 11 except as indicated.

a. Add 25 g water to milk-vanilla mixture.

b. Cream eggs, sugar, salt, and fat two minutes. Add 75 g water to creamed mixture during next two and one-fourth minutes. Continue the same.

c. Same as Method 11.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

13. Modified Cake-Mixer Method

Eggs reconstituted with 75 g water, then added with milk; 25 g water added with creamed mixture.

Series I. KitchenAid mixer.

a. Sift flour and baking powder together three times.
Divide into fourths.
Reconstitute eggs with 75 g water and add to milk-vanilla mixture.
Sift sugar and salt together three times.

b. Cream fat, medium speed, five minutes. Scrape.
Gradually add sugar-salt mixture during next five minutes, adding approximately one tablespoon every 15 seconds. Scrape.
Add 25 g water in two additions during next 30 seconds. Scrape.
Cream to desired specific gravity. Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add remaining milk mixture. Mix 30 seconds. Scrape.
Add remaining flour mixture. Mix one minute. Remove bowl. Scrape.
Replace bowl. Mix one minute. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

14. Modified Cake-Mixer Method

Eggs sifted with sugar, salt, and 68 g flour; 100 g water added with creamed mixture.

Series I. KitchenAid mixer.

a. Sift eggs, sugar, and salt and 68 g flour together four times.
Sift remaining flour and baking powder together three times.
Divide into fourths.

b. Cream egg mixture with fat two minutes, medium speed. Scrape.
Add 100 g water during the next two and one-half minutes. Scrape.
Continue creaming to desired specific gravity.
Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add one-third milk mixture. Mix 30 seconds. Scrape.
Add one-fourth flour mixture. Mix 30 seconds. Scrape. Mix one minute.
Add remaining milk mixture. Mix 30 seconds. Scrape.
Add remaining flour mixture. Mix one minute. Remove bowl. Scrape.
Replace bowl. Mix one minute. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except stir down constantly.

c. Same as Series I.

15. Four-Minute Method

Eggs reconstituted in 75 g water; 25 g water added with milk.

Series I. KitchenAid mixer.

a. Sift flour, baking powder, salt, and sugar together three times.
Add 25 g water to milk-vanilla mixture.
Reconstitute eggs in 75 g water.

b. Add shortening and two-thirds milk mixture to dry ingredients.
Mix, low speed, one minute. Scrape.
Change to medium speed. Mix 45 seconds. Scrape. Mix 15 seconds. Scrape.

c. Add remaining milk mixture and reconstituted egg.
Change to low speed. Mix 30 seconds. Scrape. Mix 30 seconds. Scrape.
Change to medium speed. Mix 30 seconds. Remove bowl. Scrape.
Replace bowl. Mix 30 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I.

c. Same as Series I.

16. Modified Conventional Sponge Method

Eggs reconstituted in 100 g water at 68° C.

Series I. KitchenAid mixer.

a. Divide sugar into halves.
Sift baking powder, salt, and one tablespoon flour together three times.
Divide remaining flour into halves.

b. Cream fat and half the sugar, low speed, 20 minutes.
Scrape at five-minute intervals.
Remove bowl at end of 20 minutes and replace with bowl containing 100 g sugar and eggs reconstituted in 100 g water at 68° C.
Beat, low speed, one minute. Scrape.
Change to high speed. Beat four minutes. Scrape.
Record time of mixing, specific gravity, and temperature of mix.
Change to low speed.

c. Replace bowl containing fat-sugar mixture and add baking powder mixture. Mix 25 seconds. Scrape.
Add one tablespoon milk. Beat 25 seconds. Scrape.
Add one-half remaining flour. Beat 25 seconds. Scrape.
Add one-half remaining milk-vanilla mixture. Beat 25 seconds. Scrape.
Add remaining flour. Beat 25 seconds. Scrape.
Add remaining milk. Beat 25 seconds. Remove bowl. Scrape.
Add beaten egg-sugar mixture. Replace bowl. Beat 10 seconds. Scrape. Beat 45 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except cream fat and sugar in small bowl. Change to large bowl. Scrape. Beat egg mixture in small bowl one minute, low speed, and six minutes, high speed. Scrape.

c. Same as Series I except use medium speed until last 45 seconds when change to low speed.

17. Conventional Method

Eggs reconstituted in 100 g water.

Series I. KitchenAid mixer.

a. Reconstitute eggs in 100 g water.
   Sift flour and baking powder together three times.
   Divide into thirds.
   Sift sugar and salt together three times.

b. Cream fat, high speed, two minutes. Scrape.
   Add sugar mixture and cream five minutes, medium speed. Scrape.
   Add reconstituted eggs gradually during next two and one-half minutes. Scrape.
   Cream to desired specific gravity.
   Scrape at two-minute intervals.
   Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
   Add one-third flour mixture. Mix 30 seconds. Scrape.
   Add one-half milk-vanilla mixture. Mix five seconds. Scrape.
   Add one-third flour mixture. Mix 30 seconds. Scrape.
   Add remaining milk. Mix five seconds. Scrape.
   Add remaining flour. Mix 30 seconds. Remove bowl. Scrape.
   Replace bowl. Mix one minute. Scrape.
   Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl.

c. Same as Series I except change to large bowl.

18. Modified Conventional Method

Eggs sifted with sugar and salt; 100 g water added with creamed mixture.

Series I. KitchenAid mixer.

a. Sift eggs, sugar, and salt together four times.
Sift flour and baking powder together three times.
Divide into thirds.

b. Cream sugar mixture and fat, medium speed, two minutes. Scrape.
Add 100 g water during the next two and one-half minutes.
Continue creaming to desired specific gravity.
Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

c. Change to low speed.
Add one-third flour mixture. Mix 30 seconds. Scrape.
Add one-half milk-vanilla mixture. Mix five seconds. Scrape.
Add one-third flour mixture. Mix 30 seconds. Scrape.
Add remaining milk. Mix five seconds. Scrape.
Add remaining flour. Mix 30 seconds. Remove bowl. Scrape.
Replace bowl. Mix one minute. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use small bowl. Stir down constantly.

c. Same as Series I except change to large bowl.

19. Flour-Batter Method

Eggs reconstituted in 100 g water at 68° C.

Series I. KitchenAid mixer.

a. Sift flour, salt, and baking powder together three times.
Add vanilla to milk.

b. Put flour mixture and fat into mixing bowl.
Beat, low speed, two and one-half minutes. Scrape.
Continue to beat for two and one-half minutes. Scrape. Remove bowl.

c. Heat 100 g water to 68° C. and pour into another bowl. Add egg immediately and allow to reconstitute while beating, high speed, one minute.
Add sugar, approximately one tablespoon at a time, to egg mixture while continuing the beating for next two and one-half minutes. Scrape.
Continue beating to desired specific gravity.
Scrape at two-minute intervals.
Record time of creaming, specific gravity, and temperature of mix.

d. Change to low speed.
Replace meringue bowl with bowl containing fat-flour mixture.
Add one-half the meringue and beat one minute. Scrape.
Add remainder and beat one minute. Scrape.
Beat two minutes. Scrape.

e. Add one-half milk-vanilla mixture. Beat 30 seconds. Scrape.
Beat 30 seconds.
Add remainder of milk-vanilla mixture.
Beat 30 seconds. Scrape.
Beat 30 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I.

c. Same as Series I except use small bowl.

d. Same as Series I except change to medium speed.

e. Same as Series I except change to low speed.

20. Dough-Batter Method (Dried Egg)

Eggs sifted with flour, salt, and baking powder; 100 g water added with milk.

Series I. KitchenAid mixer.

a. Sift eggs, flour, salt, and baking powder together four times.
Put flour mixture and fat into mixing bowl.
Beat on low speed for two and one-half minutes. Scrape.
Continue to beat for two and one-half minutes. Scrape.

b. Mix sugar and one-half liquid.
Add one-third sugar mixture to flour mixture. Beat one minute. Scrape.
Add one-third sugar mixture to flour mixture. Beat one minute. Scrape.
Add remaining sugar mixture to flour mixture. Beat one minute. Scrape.
Beat one minute. Scrape.

c. Add one-half of remaining liquid and flavoring. Beat 35 seconds. Scrape.
Add the remainder. Beat one minute. Remove from mixer. Scrape.
Replace. Beat one minute, 25 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use medium speed.

c. Same as Series I except change to low speed.

21. Dough-Batter Method (Frozen Egg)

Eggs added with last 83 g of milk-vanilla mixture.

Series I. KitchenAid mixer.

a. Sift flour, salt, and baking powder together three times.

b. Put flour mixture and fat into mixing bowl.
Beat, low speed, for two and one-half minutes. Scrape.
Continue to beat for two and one-half minutes. Scrape.
Add 100 g milk-vanilla to sugar.

c. Add one-half sugar-milk-vanilla mixture.
Beat one minute. Scrape.
Add remaining sugar mixture and beat one minute. Scrape.
Beat two minutes. Scrape.

d. Add one-half of remaining eggs and milk-vanilla mixture which have been stirred together 40 times. Beat 35 seconds. Scrape.
Add remainder. Beat one minute. Remove bowl. Scrape.
Replace. Beat two minutes, 25 seconds. Scrape.
Remove from mixer and finish according to standard procedure.

Series II. Hamilton Beach mixer.

a. Same as Series I.

b. Same as Series I except use medium speed.

c. Same as Series I except use medium speed for one minute, 35 seconds. Finish on low speed.

REVIEW OF LITERATURE

Production of dried eggs is not new but dates back to the drying of eggs in China a great many years ago. Johnson (1942) stated that up to about 1925 nearly all of the dried eggs used in this country came from China. In 1940 and 1941 production in the United States began to increase when government agencies became interested. The tentative production schedule for 1944, according to a report from the Swift and Company Research Laboratory and Home Economics Kitchens (1944) calls for between 250 and 275 million pounds of dried eggs or the equivalent of eight to nine billion shell eggs.

Dried eggs have been prepared by different methods, many of which are patented processes. Johnson (1942) pointed out that the methods used included spray-drying, pan-drying, belt-drying, vacuum-drying, and drum-drying, with spray-drying being used almost exclusively for the drying of whole eggs.

In spray-drying the liquid eggs are forced by powerful pumps through fine nozzles under a pressure of 1,500 to 3,000 pounds per square inch into a drying chamber where they are reduced to a fine mist in the presence of filtered heated air at 160° to 220° F. The liquid product is dried almost instantaneously and collected from the bottom of the chamber as it drops down. As it is collected, it is often necessary to shake or stir it in order to have a cool, uniform product. Gorseline (1943) recommended cooling the powder to 85° F. or less before packaging. He also stated that reducing the moisture level to 0.5 to 1.0 percent improved the keeping quality of the dried whole eggs. The work of Stewart, Best, and Lowe (1943) agreed with this. Bate-Smith, Brooks, and Hawthorne (1943) also found that the rate of deterioration was a function of temperature and water content. The Quartermaster Corps of

the army now specifies two percent as the maximum acceptable moisture content, according to Burton (1944).

Vickery (1943) found that deterioration of dried eggs did not become serious during storage at a temperature of 68° F. for about six months, but storage at 86° F. reduced the length of keeping before deterioration began to six weeks. He did not state the moisture content of the egg powder studied.

Reasons often given for the restricted use of dried eggs as reviewed by Bate-Smith, Brooks, and Hawthorne (1943) were: (a) lack of quality and uniformity, and (b) variation in keeping properties. Quality as defined by these workers includes flavor, solubility, and aërating power. Flavor is very important if the product is to be appealing. Solubility indicates the measure of physical deterioration suffered during drying and/or storage. Aërating power is considered the most essential property of eggs in the production of sponge goods, according to these authors.

Vickery (1943) pointed out that first-grade egg powder could be used for any purpose for which eggs in the shell were used. Simpich (1943) reported that dried eggs yield a food so good that they have come to stay even for home use in peace time. However, Johnson (1942) believed that only in an emergency would dried egg products be likely to replace shell eggs for home use.

Bennion, Hawthorne, and Bate-Smith (1942) found in their work with spray-dried eggs that as a whole all samples of dried eggs were inferior in baking quality to fresh or frozen eggs in sponge cakes, but when a secondary aërating agent was used, as in cakes containing fat, cakes similar to those made with fresh or frozen eggs could be made. Dried eggs to be used successfully in making cakes containing fat should accomplish the same functions attributed to fresh eggs. Certain changes which occur in eggs during drying may affect their reaction with other cake ingredients.

Stuart, Grewe, and Dicks (1942) in work done on pound cakes, found it was generally true that the higher the solubility index of egg powder used the greater the volume of the cake. LeClerc and Bailey (1940) pointed out that solubility and leavening power of the eggs were decreased if too high a temperature was used in drying. Bennion, Hawthorne, and Bate-Smith (1942) found that batters made with dried eggs appeared to have more oven spring than those made with frozen eggs.

For 48 g of liquid whole egg in experimental work, 13.5 g of spray-dried whole egg powder may be substituted, according to Jordan and Sisson (1943). Bate-Smith, Brooks, and Hawthorne (1943) found that three parts of water by weight was satisfactory for reconstituting one part of whole egg powder.

Work in the laboratory of Procter and Gamble Company (1929) indicated that dried eggs may be either incorporated dry with the other ingredients or reconstituted and added as liquid egg.

Since eggs are one of the most important ingredients in a cake containing fat, many factors need consideration.

Nason (1939) stated that eggs are emulsifying agents which bring about an even distribution of fat. The proteins of the eggs coagulate with heat, thus aiding the flour in forming the structural part of the dough during the baking process. Eggs also make the gluten more elastic. Milam (1913) concluded that eggs served as a partial leavening agent in cake making. She also believed they influenced flavor, texture, grain, and food value of the cake. Bailey and LeClerc (1935) agreed that eggs improve the texture and grain and also the flavor and general appearance of a cake.

Lowe and Nelson (1939) stated that best results could be obtained when the eggs were added late in the combining process but, according to work done

by the bakery research department of the Procter and Gamble Company (1929), better results were obtained by adding the eggs fairly early in the creaming process. According to Lowe (1943), a cake batter may be either a water-in-oil type of emulsion, an oil-in-water type, or both may be present. The bakery research department of Procter and Gamble Company (1929) also found that freshness and tenderness of the finished cake were due to the fat, which has the property of keeping wet particles of dough apart. Egg emulsifies the fat. Egg yolk contains an unstable complex, "lecitho-protein", which contains both lecithin and protein, making it a good emulsifier, according to the work of Sell, Olsen, and Kremers (1935). Lowe (1943) pointed out that lecithin favors the formation of oil-in-water emulsions.

Other ingredients also affect the quality of the finished cake. A liquid content greater than 110 percent on the flour basis, was found by Pyke and Johnson (1940) to give a batter which would curdle and become so unstable that separation into two distinct layers might occur during the baking process.

Bailey and LeClerc (1935) pointed out that the fat used in cakes made a tender product with improved grain, texture, and keeping quality. In an attempt to improve the baking quality of fats, shortening manufacturers have produced a special product which contains a small amount of emulsifying agent. Such shortenings Pyke and Johnson (1940) found produced smoother but heavier batters than ordinary fats. Cakes made from these special fats were of smaller volume.

The importance of temperature and proper mixing of a cake containing fat was discussed by several authors. Work was cited by Lowe and Nelson (1939) which favored the use of 25° C. for mixing cakes containing fat rather than higher temperatures. It was found that as the temperature of the ingredients

at the time of mixing was raised, the oil-in-water emulsion increased and the quality of the cake decreased. They cited two reasons for the increase of temperature during creaming, (a) friction during that time and (b) the production of heat because of adsorption of fat by the sugar. They observed a close relationship between viscosity of the batter and cake quality. They concluded that the two things having an effect on viscosity of batter were temperature of the batter and technique of mixing. Work by Buel was also cited which showed that with increased mixing temperature there was a decrease in volume.

The optimum amount of mixing according to Nason (1939) depended upon proportions of ingredients and kind of baking powder used. Lowe (1943) pointed out that with the right amount of mixing the ingredients were well blended; the grain of the cake was finer and cell walls thinner than when either insufficiently- or over-mixed, and the crumb was smooth and velvety when tasted.

Mixing at low speed after the flour was added was suggested by the Bakery Research Department of the Procter and Gamble Company (1929) as being a factor in producing cakes of fine grain. It was found that poor volume and large holes may be caused by creaming at too high a speed and that the speed of the mixing machine played an important part in controlling cake quality. It was also found that the quality of the finished cake depended upon the creaming process. The work showed best results when creaming was carried on until the maximum amount of air had been incorporated. It also showed that with the methods used cakes with extremely coarse grain were improved when mixed on low speed from two to five minutes after the flour was added. According to Lowe and Nelson (1939), maximum volume during the creaming process was maintained for a varying period, after which the volume gradually decreased.

They cited work done by Martin where she found that the creamed mixture seemed to reach a maximum volume as quickly with slow speed as at high and to hold the volume longer. Later, Lowe (1943) cites the work of Farnham which showed the maximum volume of creamed fat and sugar less at low than at medium speed. A tendency for smaller cake volume with larger creamed volume was noted by Lowe and Nelson (1939).

An expert of the Society of Bakery Engineers was quoted by Alexander (1931) as favoring the building up of an emulsion to a definite specific gravity rather than creaming for a definite time, thereby reducing mixing and creaming variables. He found a direct relation between specific gravity of batter and quality of the finished cake. A low specific gravity seemed to produce the best scoring cake.

Halliday and Noble (1928) decided the real problem of making an ideal cake was to get the ingredients finely divided and thoroughly combined to form a good stable emulsion without liberating all the carbon dioxide. They concluded that a cake would be more velvety and retain its freshness for a longer period if a stable emulsion were formed during the mixing. Grewe (1937) found that a more stable emulsion was formed by adding eggs slowly to the fat-sugar foam with the temperature of the fat from 21° to 23° C. and the specific gravity of the emulsion greater than 0.75.

Collins and Sunderlin (1940) found substantial correlation between the type of emulsion and the viscosity of the batter; a high viscosity of the batter was associated with a water-in-oil emulsion and a low viscosity with an oil-in-water emulsion. Batters of high viscosity when examined microscopically were found by these workers to have many small gas bubbles grouped in clusters while those of low viscosity had fewer but larger and less uniform gas bubbles scattered throughout the batter. Lowe (1943) observed that many

small gas cells should be present in the batter if a fine-celled, thin-walled cake was to be produced. In agreement with the discussion by Collins and Sunderlin, she found viscous batters produced more desirable cakes but she also noted that curdled batters often gave desirable cakes if the flecks were small.

Bailey and LeClerc (1935) stated that a water-in-fat emulsion resulted when eggs and milk were added gradually during the creaming process. If these were added too rapidly, a curdled mass would be formed as the emulsion changed from a water-in-fat to a fat-in-water dispersion. However, they reported that the addition of flour to the curdled mass brought about a smooth mixture and the quality of the resulting cake was practically as good as that made from a non-curdled batter. Lowe and Nelson (1939) pointed out that the method of combining the ingredients affected the viscosity of the batter and that the more viscous the batter, the higher the score given the cake. They referred to work done by Buel (1934) in which she found that if the batter were viscous enough to stand in waves when poured into the baking pan, a good cake could be expected. Lowe (1937) also stated that an important factor in the production of a velvety cake was the proper distribution of fat adsorbed by sugar crystals during creaming. Less velvety cakes were produced by mixing at higher temperatures when the emulsion formed was oil-in-water.

Pyke and Johnson (1940) made similar observations regarding the relationship between viscosity of the batter and the quality of the finished cake and concluded that a batter with high specific gravity and low viscosity yielded a cake of lower volume, coarser grain, and somewhat harsher, rubbery texture which was not of the velvety type.

Berrigan (1937), too, observed that cakes of good volume and crumb texture were produced from batters having high initial viscosity while those of low viscosity produced cakes of small volume and poor texture.

Work quoted by Lowe and Nelson (1939) showed that cake quality declined on very humid days. Dunn and White (1937) also found that humid conditions in the laboratory impaired the volume of cakes.

Lowe (1943) indicated that the pan used had an effect on the cake. She believed that a pan with straighter sides produced a cake with better texture and that better volume was obtained if the sides were not oiled. She favored cutting wax paper to fit the bottom of the pan and oiling the side next to the batter as a help in removing the cake. She gave 365° F. as the optimum baking temperature and found that cakes started in a pre-heated oven were superior in texture, velvetiness, and eating quality to those started in cold ovens.

For cakes containing fat, Justin, Rust, and Vail (1940) considered it well to allow the cake to cool slightly before removing it from the pan, for it is soft and fragile when first removed from the oven and may have a tendency to fall apart if not cooled.

A good cake containing fat as described by Justin, Rust, and Vail (1940) should be symmetrical and only slightly rounded; it should have a soft crust, an even golden brown color with no appearance of sugariness; it should be a good size in proportion to the ingredients used and feel light when lifted. When cut, it should hold its shape and not crumble excessively. The crumb should be light and moist. The cake should be tender and the grain fine and uniform; it should show no "off color", and should have a characteristic odor and flavor.

Softness or compressibility was considered by Platt and Powers (1940) as an important factor in freshness. It was used as an objective test to

show variation in texture from slice to slice or to indicate existence of lumps. Platt and Kratz (1933) defined texture as an expression of elasticity, softness or pliability and smoothness or silkiness of the crumb.

In scoring food, Platt (1931) said one must consider the whole impression it would make upon the user. Opinions expressed in words were often more accurately and consistently stated by the average person; therefore, a space for comments on the score card was considered worthwhile. Duplicate samples given the judges were also found a useful practice.

Palatability of cakes was found by Lowe and Nelson (1939) to be affected by the method and temperature of combining. They usually found higher scores given those cakes with the larger creamed volume. High scores in velvetiness were observed by them when the texture was scored high.

Thus the importance of the method of mixing cakes containing fat is emphasized by many writers. The tendency to replace the conventional method of mixing, which has been so long followed, and to vary the order of combining ingredients is evident in the literature. The satisfactory use of dried whole eggs in cakes may well involve the use of one of these newer methods.

GENERAL DISCUSSION OF RESULTS

General Comments

The data in Series I were summarized, averaged, and recorded in Table 1, and for Series II in Table 2. The tables show averages found when testing the batters and the baked cakes. The extremes cited in the discussion of the individual methods do not show in the tables.

Time of Creaming. With most methods used, the first mixture was creamed to a definite specific gravity. Alexander (1931) had found that in so doing,

creaming and mixing variables could be reduced. The length of time necessary to reach that specific gravity seemed to be related to room temperature and temperature of the mixture. Warmer room temperatures usually required a shorter creaming time.

Appearance of Batter. Batters varied in appearance from method to method. The method of combining ingredients tended to give characteristic type batters ranging from a batter so thin that it could easily be poured to one so viscous that it needed to be pushed into the corners of the baking pan. A few batters curdled. This is discussed under the individual methods.

Temperature. The work in this study was done during the winter and early spring months when outdoor temperatures ranged from cold to cool. The laboratory temperatures tended to vary with the outside temperatures, as the only way to adjust the amount of heat was by raising and lowering the window. For most of the work in Series I, during both the mixing and the testing, the temperature ranged from 23° to 26° C. (73° to 79° F.). In a few instances the temperature was either above or below this range, one reaching as high as 28 1/2° C. (83° F.) during the mixing and others dropping as low as 21° C. (70° F.) during both periods. In Series II, during the mixing and testing periods the temperatures for most of the study also ranged from 23° to 26° C. (73° to 79° F.), with 28° C. (82° F.) being the highest and 22° C. (72° F.) the lowest extreme.

The temperature of the first creamed mixture varied principally in Series I from 23° to 25° C. (73° to 77° F.), with 20° C. (68° F.) being the extreme low and 28° C. (82° F.) the high. In Series II the principal range was from 24° to 26° C. (75° to 79° F.), with a low extreme of 22° C. (72° F.) and a high of 31° C. (88° F.). This great difference in extremes probably is not so significant as it appears on first reading since the first creamed

mixture contained very different ingredients, depending upon the method followed.

The temperature of the batter in both series ranged, with few exceptions, from 23° to 25° C. (73° to 77° F.). In Series I the extremes were 20° C. (68° F.) and 31° C. (88° F.) while in Series II they were 19° C. (66° F.) and 28° C. (82° F.).

There appeared to be no relationship between temperature and consistency and specific gravity of the batter.

Consistency of Batter. When all methods were considered, there appeared to be no correlation between consistency of batter and the tests on the finished product.

Color of Crumb. The cakes containing frozen eggs were noticeably more yellow than the ones containing dried eggs. In order to camouflage these so that the palatability committee would not be prejudiced, some color was added to part of the cakes containing dried eggs. Therefore, color of crumb, as given in Tables 1 and 2, is not entirely an evaluation of color due to egg. However, the added coloring always mixed in uniformly and any unevenness (Form I) in color was due to incomplete blending of egg or other ingredients. The evaluation of "rich looking" (Form I) may have been influenced by the depth of the yellow color and hence by the added coloring material.

Tenderness or Shortness of Cake. The results of the physical measurements such as shortness and compressibility show a wide variation. Dried egg cakes made by four methods in Series I and by eight methods in Series II required 100 g or less to break. Cakes which required less than 110 g to break were arbitrarily classed as very tender. Five methods in Series I and six methods in Series II produced cakes which needed at least 130 g to break and were considered definitely less desirable as far as tenderness was concerned.

Compressibility of Cakes. Dried egg cakes in Series I whose average compressibility was 3.5 cm or more tended to be given a higher total score by the palatability committee than did those which compressed less. In Series II those which compressed 4.5 cm or more tended to receive the highest total score.

The averages for compressibility of cakes made by the different methods showed that some methods yielded cakes of high compressibility while others gave a low compressibility. There was a tendency for batters of high specific gravity to give cakes of low compressibility. Cakes which were most short were not always most compressible.

Standing Height. The standing height of cakes made by the same method varied as much as 0.5 cm from day to day. On days when the humidity in the laboratory was high the cakes tended to pull away from the sides of the pan and to shrink when cooling, resulting in less volume. This was probably due largely to a formula with such a high liquid content that on days when the humidity was high the amount of liquid was too much to produce a good cake.

Rating of Cakes. Cakes containing dried eggs were ranked above those containing frozen eggs 96.0 percent of the time. At no time did the judges comment on the poor flavor or odor due to the dried eggs. With few exceptions dried egg cakes were more tender than those made with frozen egg. In Series I cakes made by Method 13 were rated first most often by the palatability committee and cakes made by Methods 4, 20, and 8 were rated next. In Series II the cakes rated first most frequently were made by Method 2 and those made by Methods 5, 8, and 10 rated next.

Total Score of Cakes. In Series I the lowest average total score for the dried egg cakes was 549 for Method 15, while the highest was 589 for

Method 17. In Series II the extreme scores were 557 for Method 15 and 603 for Method 8. The same cakes in each series had respectively the highest and lowest compressibility.

Palatability Committee. Form I was used by the judges for scoring and ranking the cakes. A frozen egg cake was included with each baking for use as the control. Great variation was shown in the rating for a given cake from first to sixth as designated by the various members of the palatability committee. This was thought to be due largely to the personal preference, partially to the degree of hunger at the time of testing, and partially to the hurried schedule of each judge.

Choice of Methods. A cake made by the modified cake-mixer method in which the eggs were sifted with the flour and baking powder, 75 g water added with the creamed mixture, and 25 g water added with the milk the investigator believes would produce the most desirable cake with the greatest ease of mixing. Fewer utensils were needed and less time was consumed in the preparation than with some of the others. Cakes made by this method were rated high when made with both mixers and were scored high, both subjectively and objectively. They had more of the qualities of the ideal cake. An adjustment in the time of mixing might improve this method.

Comparison of Mixers. Cakes made with the Hamilton Beach mixer scored above those made with the KitchenAid mixer the majority of times. Objective tests showed those made by the latter were less short and less compressible than those made with the Hamilton Beach mixer. The palatability committee also assigned lower values, the majority of times, for tenderness and crumb to those made with the KitchenAid mixer. The KitchenAid mixer has a greater efficiency than the Hamilton Beach mixer and the fact that it does not show up to best advantage in this particular study may be due to an error in judgment of the correct time of mixing.

DISCUSSION OF INDIVIDUAL METHODS

Results for each of the methods used in the two series are discussed in the following paragraphs.

Cake-Mixer Method

Batters made using the cake-mixer method of mixing were very viscous. Collins and Sunderlin (1940) found substantial correlation between high viscosity in the batter and the water-in-oil type of emulsion; the viscosity of the batter varied with the type of emulsion when the proportions of ingredients were constant. They also found when examining batters of high viscosity microscopically that many small gas bubbles were grouped in clusters. This would indicate that a cake with better grain and texture might be expected.

In this study cakes made by the cake-mixer method rated among the highest in velvetiness and tenderness. They were compressible, soft and moist. These cakes made with the KitchenAid mixer were more compressible than any others excepting those made by the conventional method.

Cakes made using eggs reconstituted in 100 g water at 68° C. were easier to make and, considering all tests, produced nicer products than those made with eggs reconstituted in 100 g water with the use of a hot water bath of 65° to 70° C.

The bakery research department of Procter and Gamble Company (1929) had earlier found that the reconstitution of dried eggs could be speeded up by using warm water.

Method 1. Cake-mixer method: Eggs reconstituted in 100 g water at 68° C. With both the KitchenAid and Hamilton Beach mixers the emulsion broke with the addition of liquid but became fairly thick and smooth with the final portions

of the flour. Bailey and LeClerc (1935) stated that in such cases the quality of the resulting cakes was nearly as good as that of those made from non-curdled batters. The resulting batters were fairly thick and medium low in specific gravity. The volume of the cakes was good; the grain was loose but fairly even. The cakes were soft and moist.

Cakes made with the Hamilton Beach mixer rated some higher by all the tests than did those made using the KitchenAid mixer, as is shown in Tables 1 and 2.

Method 2. Cake-mixer method: Eggs reconstituted in 75 g water at 68° C.; 25 g water added with milk. With both the KitchenAid and Hamilton Beach mixers the resulting batters were fairly thick and of medium low specific gravity. During the mixing the emulsion broke each time liquid was added. The volume of the cakes was good. The grain was loose, with a few large holes. The cakes were soft and moist, almost crumbly in the mouth.

This method ranked as one of the four best methods with the Hamilton Beach mixer. This mixer produced products superior to those made with the KitchenAid mixer.

Method 3. Cake-mixer method: Eggs reconstituted in 100 g water. Hot water bath (65° to 70° C.) used. With both the KitchenAid and Hamilton Beach mixers the resulting batters were of medium thickness and specific gravity. The volume of the cakes was good. The grain was open, holey, and tended to be uneven. The texture was bready but soft. The cakes were crumbly, comparatively short, and compressible.

Cakes made with the Hamilton Beach mixer rated above those made with the KitchenAid mixer.

Method 4. Cake-mixer method: Eggs reconstituted in 75 g water; 25 g water added with the milk. Hot water bath (65° to 70° C.) used. With both

the KitchenAid and Hamilton Beach mixers the resulting batters were of medium thickness and specific gravity. The volume of the cakes was medium. The grain was open, holey, and tended to be uneven. The texture was soft but bready and crumbly. The cakes were comparatively short and compressible.

Cakes made with the KitchenAid mixer rated above those made with the Hamilton Beach mixer.

Modified Cake-Mixer Method

Cake batters produced by this method had considerable range in consistency with extremes from the very thinnest to the thickest, as shown in Tables 1 and 2. Those batters made by Methods 5, 6, 7, 8, and 9 in which the dried eggs were sifted with the flour and baking powder were very viscous. Those made by Methods 11, 12, and 14 in which the dried eggs were sifted with the sugar and salt or sugar, salt and flour were very mobile. Murphy (1943) also found this to be true. Those made by Method 10 in which the eggs were made into a paste with one-half the water were fairly thick but not as thick as when the eggs were sifted with the flour. Those made by Method 13 in which the eggs were reconstituted with 75 g water were also very viscous. This agrees with observations of Lowe and Nelson (1939) who stated that the method of combining the ingredients affected the viscosity of the batter.

The range in objective test scores for cakes produced by the same method was much greater for those made with the KitchenAid mixer than with those made with the Hamilton Beach mixer. A possible explanation for this would be that the amount of mixing with the KitchenAid mixer was not optimum.

Method 5. Modified cake-mixer method: Eggs sifted with flour and baking powder; 100 g water added with milk. With both the KitchenAid and the Hamilton Beach mixers, the resulting batters were thick and the specific gravity

was low. The batter curdled with the first additions of liquid but became quite smooth and thick with the last portions of flour. Bailey and LeClerc (1935) pointed out that this often occurred, with little or no harmful effect on the finished cake. When removed from the oven, the cakes had a good volume but tended to shrink during the cooling period until almost flat on top. The texture of the cakes was moist and soft although slightly compact. The grain was fine with a tendency toward crumbliness.

The cakes made with the Hamilton Beach mixer gave a greater compressibility and required less grams to break, denoting that they were more tender. The quality of the cakes as scored by the palatability committee was higher for cakes made by this method than for those made with the KitchenAid mixer. These characteristics might indicate that the cakes made with the KitchenAid mixer were overmixed. Cakes made with the Hamilton Beach mixer by this method were among the four rated first most often.

Method 6. Modified cake-mixer method: Eggs sifted with flour and baking powder; 25 g water added with the creamed mixture, 75 g added with the milk. With both the KitchenAid and Hamilton Beach mixers, the emulsion broke with the first additions of liquid but became smooth with the addition of the last portions of flour as in Method 5. The finished batters had a low specific gravity and were very viscous. The resulting cakes always shrank upon removal from the oven, producing a flat cake which tended to be compact but quite moist. There appeared to be two layers, the bottom one having a tendency toward sogginess. Pyke and Johnson (1940) have said that with an excess of liquid, greater than 110 percent on the flour basis, the batter would curdle and become so unstable that separation into two distinct layers might occur during baking. The appearance of two layers in cakes made by this method

may then have been due to a formula which was too near the border line to always produce a good cake. If this were true, however, it was apparent with only certain methods of mixing.

Better cakes were produced with the Hamilton Beach mixer than with the KitchenAid mixer.

Method 7. Modified cake-mixer method: Eggs sifted with flour and baking powder; 50 g water added with creamed mixture, 50 g added with milk. With both the KitchenAid and Hamilton Beach mixers, the batters curdled during the early stages of mixing but were smooth and thick at the last. The specific gravity was low. Resulting cakes were very soft. They always shrank upon removal from the oven. The grain in every case was fine. Some were crumbly.

The Hamilton Beach mixer produced very tender, highly compressible cakes with fairly good volume. Again they were scored somewhat higher than those made with the KitchenAid mixer.

Method 8. Modified cake-mixer method: Eggs sifted with flour and baking powder; 75 g water added with creamed mixture, 25 g water added with milk. With both the KitchenAid and Hamilton Beach mixers, the batter showed small curds during the early stages of mixing but did not appear as curdled as when larger amounts of water were added with the milk. As portions of the flour mixture were added, the batter became thick and smooth. The cakes had soft crusts, which were even and golden brown in color with no appearance of sugariness; the grain was fine and uniform, and the crumb was light and moist but inclined to be crumbly. The cakes were scored high by the judges in everything but shape and crust. Cakes made with each mixer by this method were among the four rated first by the palatability committee the greatest number of times.

Cakes made with the Hamilton Beach mixer were superior to those made with the KitchenAid, according to both subjective and objective tests.

Method 9. Modified cake-mixer method: Eggs sifted with flour and baking powder; 100 g water added with creamed mixture. The batters produced by both the KitchenAid and the Hamilton Beach mixers were smooth, thick, and of low specific gravity. The batters curdled during the early stages of mixing. The cakes shrank during cooling, producing a compact but fine grain. Two distinct layers were often noticeable, the bottom one being almost soggy as described by Pyke and Johnson (1940). The cakes were tender and moist.

Cakes made by using the Hamilton Beach mixer scored higher both objectively and subjectively than did those made with the KitchenAid mixer.

Method 10. Modified cake-mixer method: Eggs made into a paste with 50 g water; 50 g water added with milk. Cakes made by this method with the KitchenAid and Hamilton Beach mixers were somewhat similar. The batters produced were relatively thin. The crumb was coarse and bready in appearance, often seeming dry and harsh as tasted. Both gave cakes with good volume. However, the cakes made with the Hamilton Beach mixer were softer and more moist than those mixed with the KitchenAid. The former cakes rated higher in all tests. Considering the rating of the cakes by the palatability committee, this was one of the four best methods when the Hamilton Beach mixer was used.

Method 11. Modified cake-mixer method: Eggs sifted with sugar and salt; 100 g water added with creamed mixture. The batters produced by this method with both the KitchenAid and Hamilton Beach mixers were very thin and glossy-appearing and of medium specific gravity. The cakes were of good volume but less tender, not as compressible nor as fine-grained as those made by many of the other methods.

Those cakes made with the Hamilton Beach mixer scored over those made with the KitchenAid mixer.

Method 12. Modified cake-mixer method: Eggs sifted with sugar and salt; 75 g water added with creamed mixture, 25 g water added with milk. Batters made by this method with both the KitchenAid and Hamilton Beach mixers were thin and glossy-appearing. Cakes made from these batters were never rated as first choice by the palatability committee. The cakes were less tender, with very open grain, and were often holey, bready and harsh. Those made with the Hamilton Beach mixer scored somewhat higher than those made with the KitchenAid mixer.

Method 13. Modified cake-mixer method: Eggs reconstituted in 75 g water and added with milk; 25 g water added with creamed mixture. With both the KitchenAid and Hamilton Beach household mixers the batters were thick, smooth and viscous, and of low specific gravity. The volume of the cake was medium. There was a tendency for two layers to form during the baking process. The cakes were frequently flat or nearly so, the grain was fine and even, and the crusts were smooth.

The cakes made with the KitchenAid mixer were scored higher by the palatability committee than those made with the Hamilton Beach although the latter compressed more and were more tender as measured by the shortometer. Considering the ratings given by the palatability committee, this was one of the four best methods when the Hamilton Beach mixer was used.

Method 14. Modified cake-mixer method: Eggs sifted with sugar, salt and 68 g flour; 100 g water added with creamed mixture. With both the KitchenAid and Hamilton Beach mixers, the resulting batters were thin and of medium specific gravity. The finished cakes were well rounded and of good volume

but were inclined to have a very open grain and to be holey, coarse and bready. They were less tender and less compressible than many of the others. Those made with the Hamilton Beach mixer scored a little higher than the ones produced with the KitchenAid mixer.

Four-Minute Method

Method 15. Four-minute method: Eggs reconstituted in 75 g water; 25 g water added with milk. Cakes made by this method with both the KitchenAid and Hamilton Beach mixers were given the lowest scores by the palatability committee. Both produced poor cakes. The batters were thin and had a high specific gravity. Kramer (1935) also found batters of high specific gravity to be thin. The crusts of the finished products usually were sugary, indicating that the cake was poorly mixed. They compressed the least of all the cakes made by all methods. The volume was small but the cakes were quite tender. They were inclined to be uneven in texture and the eggs were not always mixed well. Berrigan (1937) found that cake batters having a low viscosity produced cakes of small volume and poor texture. When considering all tests, those cakes made with the Hamilton Beach mixer scored a little higher than those made using the KitchenAid mixer.

Modified Conventional-Sponge Method

Method 16. Modified conventional-sponge method: Eggs reconstituted in 100 g water at 68° C. When mixing with each mixer, the egg-sugar foam became thin and the foam and syrup tended to form two distinct layers before it was added to the fat-sugar emulsion. The resulting batter was thin and slightly curdled looking. Cakes tended to be small in volume, rather compact

and uneven but fine-grained. The crusts were sugary and rough. The cakes were scored low on velvetiness. Halliday and Noble (1933) reported that the emulsion was in a stable form in a velvety cake.

Those cakes made using the KitchenAid mixer scored higher with physical measurements but were scored lower by the palatability committee than those made with the Hamilton Beach mixer.

Conventional Method

Method 17. Conventional method: Eggs reconstituted in 100 g water. With both the KitchenAid and Hamilton Beach mixers, the resulting batters were thick, dull in appearance, and low in specific gravity. The volume of the cakes was good. The cakes were soft, moist, and slightly crumbly. The grain was open and inclined to be holey. Lowe (1943) stated that the grain of a cake is finer and cell walls thinner with the right amount of mixing. This would be an indication that the optimum amount was not used here.

Cakes made with the KitchenAid scored higher than those made with the Hamilton Beach mixer in all tests except shape of the cake. This might indicate that the amount of mixing with the KitchenAid mixer was not entirely right for some of the other methods.

Modified Conventional Method

Method 18. Modified conventional method: Eggs sifted with sugar and salt; 100 g water added with creamed mixture. With both the KitchenAid and Hamilton Beach mixers the resulting batters were fairly thin but dull in appearance and low in specific gravity. The cakes were well rounded but very open-grained, holey and bready in appearance. The crumb was rather dry and

crumbly. Lowe (1937) stated that cakes which are not mixed to their optimum extent are not smooth and velvety when tasted; they are crumbly and have a bready texture.

Cakes made using the Hamilton Beach mixer scored somewhat better than those made with the KitchenAid mixer in shortness, compressibility, and crust.

Flour-Batter Method

Method 19. Flour-batter method: Eggs reconstituted in 100 g water at 68° C. With both the KitchenAid and Hamilton Beach mixers the resulting batters were of medium thickness and fairly high specific gravity. The volume was small. The grain was uneven, coarse, and holey. The crumb was rather harsh and dry. These cakes always shrank from the edge of the pan after baking only 41 minutes while 43 minutes were required to bake the others. The cakes made with the Hamilton Beach mixer were rated higher on shape, tenderness, and eating quality but those made with the KitchenAid were more compressible and were given a higher value on crust, crumb, velvetiness, and total score.

This method of mixing with both mixers was time-consuming and required more mixing equipment than other methods. The quality of the finished cake was not sufficient to warrant the extra time involved.

Dough-Batter Method

Method 20. Dough-batter method for dried eggs: Eggs sifted with flour, salt and baking powder; 100 g water added with milk. This method showed less difference in the finished cakes when comparing those made with the two mixers, than did any other. The batter in each case was quite thin and of fairly high

specific gravity. The finished cakes had a good volume and medium compressibility but were among the less tender. The grain was even and uniform but inclined to be open and bready.

Considering the rating of the cakes by the palatability committee, using the KitchenAid mixer, this was one of the four best methods.

Method 21. Dough-batter method for frozen eggs: Frozen eggs added with last 83 g of milk-vanilla mixture. With both the KitchenAid and Hamilton Beach mixers the resulting batters were relatively thick and smooth and of medium specific gravity. The cakes were comparatively tender as measured by the shortometer. The compressibility and volume were medium. The grain was fine and uniform, sometimes almost compact. The texture was soft and moist.

The Hamilton Beach mixer produced only slightly better products than did the KitchenAid.

SUMMARY

The purpose of this study was to determine the effect of different methods of incorporating dried eggs into a cake containing fat, and to find an acceptable method of incorporating dried eggs into the cake to obtain a standard product.

Twenty different methods were used to mix the cakes. The work was divided into two series; in the first a KitchenAid mixer was used and in the second a Hamilton Beach. Each method was checked four times with each mixer. A frozen whole egg cake was made at each baking for a comparison.

The following determinations were made: Time of creaming; temperature of the room when mixing, of the creamed mixture, of the batter, and of the room when testing; specific gravity of the creamed mixture and of the batter;

Table 1. Summary of data from Series I for cakes made by different methods using the KitchenAid mixer.

Method*	Time of creaming (min.)	Temperature: Room when mixing (°C.)	Temperature: Creamed mixture (°C.)	Temperature: Batter (°C.)	Temperature: Room when testing (°C.)	Specific gravity: Creamed mixture	Specific gravity: Batter	Consistency of batter (min.-sec.)	Standing height of cake (cm)	Shortness of cake (g)	Compressibility of cake (mm)	Average scores of palatability committee: Crust	Shape	Color of crumb	Crumb	Tenderness	Velvetiness	Eating quality	Total score
1	11	25	23	24	25	.6280	.8421	10-26	5.2	125	4.3	82	84	89	81	83	79	80	578
2	8	26	25	25	25	.6035	.8085	11-36	5.3	124	4.3	82	86	85	80	83	81	81	578
3	10	26	26	25	25	.6105	.8316	5-07	5.3	129	3.9	81	86	88	77	81	78	77	568
4	8	26	27	26	25	.6105	.8228	4-16	5.1	125	4.0	82	87	84	81	84	81	80	579
5	15	23	26	24	23	.6316	.8000	17-35	5.0	112	3.8	79	78	84	81	83	82	82	569
6	15	24	24	23	23	.6631	.7632	24-16	5.0	118	3.5	81	81	84	82	83	83	82	576
7	14	24	24	23	23	.6544	.7509	29-11	5.0	123	3.5	80	81	81	81	84	83	83	573
8	16	25	25	24	23	.6614	.7526	25-30	5.1	114	3.8	79	81	86	82	85	83	84	580
9	17	25	25	23	23	.6772	.7526	28-27	4.9	120	3.6	81	80	85	78	85	83	82	574
10	8	25	24	25	24	.6807	.8263	2-05	5.3	139	3.9	82	85	84	82	84	83	82	582
11	8	25	25	26	24	.6385	.8474	0-21	5.3	141	3.6	83	86	84	80	85	81	80	579
12	8	26	23	24	24	.6246	.8614	0-20	5.1	147	3.4	83	84	84	79	81	79	82	568
13	13	26	25	24	24	.6175	.7597	21-41	5.2	108	4.2	82	82	86	83	87	87	86	590
14	8	26	23	23	24	.7315	.8667	0-18	5.5	141	3.4	82	86	85	80	80	77	78	568
15	--	25	--	24	24	--	.9667	0-31	4.6	113	3.1	78	80	82	77	77	76	79	549
16	5	24	24	23	24	.4807	.8667	3-22	4.9	109	3.5	78	78	86	79	79	78	80	558
17	13	25	23	23	24	.6035	.7649	12-33	5.3	104	4.9	83	84	89	83	86	82	82	589
18	10	25	22	24	24	.5895	.7825	0-40	5.4	119	3.9	82	86	83	82	84	82	83	582
19	11	26	25	25	25	.7965	.9105	6-01	5.0	127	3.3	87	84	87	81	82	80	79	580
20	12	25	--	23	24	--	.9579	0-25	5.1	134	3.6	84	83	86	82	82	81	82	580
21	13	25	--	23	24	--	.8711	13-17	5.1	133	3.6	80	83	87	81	82	81	82	576

*1 Cake-mixer: Eggs reconstituted in 100 g water at 68° C.
2 Cake-mixer: Eggs reconstituted in 75 g water at 68° C.; 25 g water added with milk.
3 Cake-mixer: Eggs reconstituted in 100 g water; hot water bath (65° - 70° C.) used.
4 Cake-mixer: Eggs reconstituted in 75 g water; hot water bath (65° - 70° C.) used; 25 g water added with milk.
5 Modified cake-mixer: Eggs sifted with flour and baking powder; 100 g water added with milk.
6 Modified cake-mixer: Eggs sifted with flour and baking powder; 75 g water added with milk, 25 g water added with creamed mixture.
7 Modified cake-mixer: Eggs sifted with flour and baking powder; 50 g water added with milk, 50 g water added with creamed mixture.
8 Modified cake-mixer: Eggs sifted with flour and baking powder; 25 g water added with milk, 75 g water added with creamed mixture.
9 Modified cake-mixer: Eggs sifted with flour and baking powder; 100 g water added with creamed mixture.
10 Modified cake-mixer: Eggs made into a paste with 50 g water; 50 g water added with milk.
11 Modified cake-mixer: Eggs sifted with sugar and salt; 100 g water added with creamed mixture.
12 Modified cake-mixer: Eggs sifted with sugar and salt; 25 g water added with milk, 75 g water added with creamed mixture.
13 Modified cake-mixer: Eggs reconstituted with 75 g water and added with milk; 25 g water added with creamed mixture.
14 Modified cake-mixer: Eggs sifted with sugar, salt and 68 g flour; 100 g water added with creamed mixture.
15 Four-minute: Eggs reconstituted in 75 g water; 25 g water added with milk.
16 Modified conventional-sponge: Eggs reconstituted in 100 g water at 68° C.
17 Conventional: Eggs reconstituted in 100 g water.
18 Modified conventional: Eggs sifted with sugar and salt; 100 g water added with creamed mixture.
19 Flour-batter: Eggs reconstituted in 100 g water at 68° C.
20 Dough-batter: Eggs sifted with flour, salt and baking powder; 100 g water added with milk.
21 Dough-batter: Frozen eggs added with last 83 g milk-vanilla mixture.

Table 2. Summary of data from Series II for cakes made by different methods using the Hamilton Beach mixer.

Method*	Time of creaming (min.)	Temperature: Room when mixing (°C.)	Temperature: Creamed mixture (°C.)	Temperature: Batter (°C.)	Temperature: Room when testing (°C.)	Specific gravity: Creamed mixture	Specific gravity: Batter	Consistency of batter (min.-sec.)	Standing height of cake (cm)	Shortness of cake (g)	Compressibility of cake (mm)	Average scores of palatability committee: Crust	Shape	Color of crumb	Crumb	Tenderness	Velvetiness	Eating quality	Total score
1	15	26	25	25	25	.6316	.7930	13-47	5.2	115	4.5	82	85	86	80	84	83	80	580
2	11	26	26	25	25	.6018	.8211	7-51	5.3	115	4.4	81	89	88	81	85	83	82	589
3	16	26	28	27	25	.6789	.8439	1-40	5.3	127	4.3	82	85	83	77	83	80	79	569
4	13	26	28	26	25	.6789	.8578	1-58	5.1	135	3.6	82	86	85	78	82	79	79	571
5	13	25	27	23	24	.6912	.8351	6-41	5.0	102	5.0	83	87	89	86	87	84	85	601
6	11	26	26	24	24	.6474	.7772	21-58	5.1	103	5.7	81	83	86	84	87	85	84	590
7	12	26	25	25	24	.6456	.7684	14-15	5.1	104	5.8	80	82	89	82	87	85	83	588
8	13	26	25	25	24	.6386	.7579	28-44	5.1	97	6.6	83	84	88	86	88	89	85	603
9	13	25	24	25	24	.6456	.7579	26-30	5.0	104	5.0	80	86	88	85	86	86	84	595
10	6	25	24	23	25	.6667	.7965	7-10	5.3	114	4.7	83	84	87	84	85	85	84	592
11	8	25	24	24	25	.6228	.8386	0-32	5.3	135	4.1	82	85	82	80	82	81	80	572
12	7	25	24	24	25	.6140	.8526	0-28	5.3	134	3.8	85	87	82	78	80	80	79	571
13	13	25	25	23	25	.6351	.7667	22-20	5.1	101	4.9	78	80	88	82	84	84	85	581
14	9	25	23	23	25	.7158	.8351	0-40	5.2	131	4.0	83	86	87	79	82	81	80	578
15	--	23	--	23	24	--	1.0298	0-14	4.6	105	3.1	77	80	89	77	78	78	78	557
16	7	24	29	23	24	.8105	.9456	1-33	4.7	115	3.1	80	81	88	79	80	78	79	565
17	14	24½	23½	23½	24	.6158	.7684	13-06	5.2	108	4.2	81	85	86	80	86	82	81	581
18	9	25	24	23	24	.6053	.7947	1-20	5.3	116	4.1	83	86	86	80	84	81	80	580
19	9	23	29	24	25	.7193	.9053	3-54	5.0	131	3.5	86	85	83	80	83	80	81	578
20	12	24	--	22	24	--	.9158	0-25	5.1	132	3.5	84	85	87	83	83	82	81	585
21	13	25	--	24	24	--	.8697	15-19	5.0	123	3.6	81	82	87	82	82	81	81	576

* 1 Cake-mixer: Eggs reconstituted in 100 g water at 68° C.
2 Cake-mixer: Eggs reconstituted in 75 g water at 68° C.; 25 g water added with milk.
3 Cake-mixer: Eggs reconstituted in 100 g water; hot water bath (65° - 70° C.) used.
4 Cake-mixer: Eggs reconstituted in 75 g water; hot water bath (65° - 70° C.) used; 25 g water added with milk.
5 Modified cake-mixer: Eggs sifted with flour and baking powder; 100 g water added with milk.
6 Modified cake-mixer: Eggs sifted with flour and baking powder; 75 g water added with milk, 25 g water added with creamed mixture.
7 Modified cake-mixer: Eggs sifted with flour and baking powder; 50 g water added with milk, 50 g water added with creamed mixture.
8 Modified cake-mixer: Eggs sifted with flour and baking powder; 25 g water added with milk, 75 g water added with creamed mixture.
9 Modified cake-mixer: Eggs sifted with flour and baking powder; 100 g water added with creamed mixture.
10 Modified cake-mixer: Eggs made into a paste with 50 g water; 50 g water added with milk.
11 Modified cake-mixer: Eggs sifted with sugar and salt; 100 g water added with creamed mixture.
12 Modified cake-mixer: Eggs sifted with sugar and salt; 25 g water added with milk, 75 g water added with creamed mixture.
13 Modified cake-mixer: Eggs reconstituted with 75 g water and added with milk; 25 g water added with creamed mixture.
14 Modified cake-mixer: Eggs sifted with sugar, salt and 68 g flour; 100 g water added with creamed mixture.
15 Four-minute: Eggs reconstituted in 75 g water; 25 g water added with milk.
16 Modified conventional-sponge: Eggs reconstituted in 100 g water at 68° C.
17 Conventional: Eggs reconstituted in 100 g water.
18 Modified conventional: Eggs sifted with sugar and salt; 100 g water added with creamed mixture.
19 Flour-batter: Eggs reconstituted in 100 g water at 68° C.
20 Dough-batter: Eggs sifted with flour, salt and baking powder; 100 g water added with milk.
21 Dough-batter: Frozen eggs added with last 83 g milk-vanilla mixture.

consistency of the batter; standing height of the cake; shortness and compressibility of the cake; and quality as judged by a palatability committee.

Cakes made with dried whole eggs were preferred over those made with frozen whole eggs 96 percent of the time.

In the majority of cases, cakes made with the Hamilton Beach mixer were preferred to those made with the KitchenAid.

The results indicate that the method of incorporating dried whole eggs into a cake containing fat has a definite effect upon the finished product. In one-half of the eight methods, which produced the best cakes, the eggs were sifted with the flour and in the other half they were reconstituted before they were added. With one exception, these preferred cakes had the fat, sugar and either the egg or part of the liquid creamed together. In the other high-ranking cakes the fat was creamed with the flour which was sifted with the egg, baking powder, and salt.

A quick method of mixing always gave an inferior product, showing the importance of thoroughly combining the ingredients if a cake of high quality was to be produced.

Methods in which the dried whole eggs were incorporated by sifting with the flour or sugar were easier to use and required less work than those in which it was necessary to reconstitute the eggs before using.

As a rule, the batters of cakes in which the eggs were sifted with the flour were very thick. The cakes were soft and moist, and had fairly good volume, a fine grain and medium to high shortness and compressibility. Batters in which the eggs were sifted with the sugar were thin. These cakes had excellent volume; were open-grained, often coarse or holey; were bready, harsh, less short and less compressible than those made by other methods.

The batters in which the eggs were reconstituted before incorporating were fairly thick. The cakes from these batters were soft and moist, had good volume, and a loose but fairly even grain, and were of medium to high shortness and compressibility.

The preferred cakes, in both series, were made by creaming together the fat, sugar and three-fourths of the water, and then adding the eggs sifted with the flour and baking powder alternately with the milk and remaining water. This was a convenient method, as it was easy to use, required comparatively little equipment and manipulation, and yielded a superior product. The cakes were short and had a high compressibility. They tended to have slightly less volume than those made by other methods but the fine cell walls, velvety texture and high eating quality were characteristic of all made by this method.

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APPENDIX

Form I

SCORE CARD FOR CAKES

Date _____

	Perfect (No Detectable Fault)	Remarks	Sample No.					
General Appearance	1. CRUST - Entire crust should be an even golden brown - Not too thick nor too thin - Not blistered, sugary, or greasy.							
	2. SHAPE - Symmetrical - Top should be smooth and only slightly rounded - No cracks or bumps.							
	3. COLOR OF CRUMB - Even and rich looking - No objectionable color							
Texture	1. CRUMB - Should be springy and elastic - Even grain, i.e., cells small and uniform in size - Not too compact - Cell walls should be thin and fine.							
	2. TENDERNESS - Tender but not too light and feathery - Not tough or gummy.							
	3. VELVETINESS - Smooth and soft like velvet to tactile sense; (finger and palate).							
Eating Quality	This includes all the qualities that make a cake agreeable or disagreeable for eating - Especially flavor, aroma, velvetiness or pleasing texture.							

Which cakes do you prefer?

1st Choice _____
2nd Choice _____
3rd Choice _____
4th Choice _____
5th Choice _____
6th Choice _____

Signature of Judge _____

Form Ia

Directions for Use of Score Card for Cakes

Abbreviations to be used in scoring:

Perfect - X	No detectable fault
Excellent - E	Of unusual excellence but not perfect
Good - G	Average good quality
Fair - F	Below average, slightly objectionable
Poor - P	Objectionable but edible
Bad - B	Highly objectionable (not edible)

(+ or -) may be used where fine distinctions are to be made. Thus, if two samples are good in flavor but one slightly better than the other but not excellent, mark one G+ and the other G-.

Note appearance of each sample and score before tasting.

Note texture and score crumb.

Taste sample and score remaining points.

Any remarks as to why certain samples were graded high or low will be particularly helpful. Remarks should be accompanied by the number of the cake about which they are made.

Form Ib

Rating Scale with Abbreviations for Use in Scoring Cakes

Note: For use of investigator only.

Rating	Abbreviations	Numerical scoring expressed as percentage of perfect
Perfect	X	100
Perfect minus	X-	97
Excellent plus	E+	93
Excellent	E	90
Excellent minus	E-	87
Good plus	G+	83
Good	G	80
Good minus	G-	77
Fair plus	F+	73
Fair	F	70
Fair minus	F-	67
Poor plus	P+	63
Poor	P	60
Poor minus	P-	57
Bad plus	B+	53
Bad	B	50

Form II

Chart for Recording Data for Individual Cakes

Cake	Method	Cake number	Temperature				Weight for specific gravity		Time of creaming (min.)	Consistency of batter (min.-sec.)	Shortness (g)	Compressibility (mm)	Standing height (cm)
			Room when mixing (°C.)	Room when testing (°C.)	Creamed mixture (°C.)	Batter (°C.)	Creamed mix	Batter					